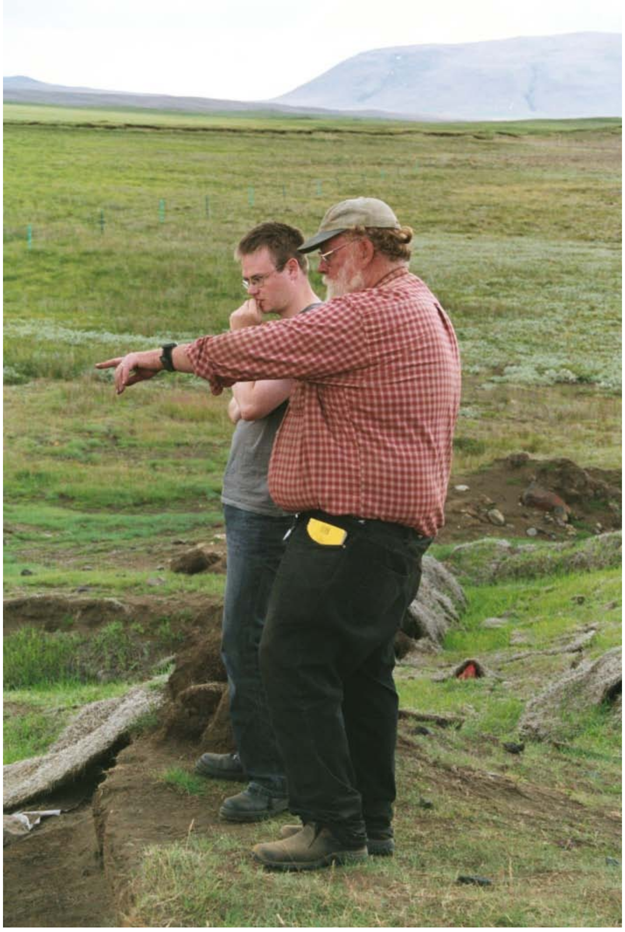
Norse Utilisation of Archaeobotanical Resources within the Myvatnssveit locale, Northern Iceland

BOLD, RACHAEL

Norse utilisation of archaeobotanical resources within the Mývatnssveit locale, Northern Iceland



Rachael Bold

MSc by Research

Department of Archaeology

Durham University

2011

CONTENTS

List of Figures

Page number

List of Tables

Acknowledgements

The funding bodies North Atlantic Biocultural Organisation (NABO), International Polar Year (IPY), Icelandic Archaeological Institute (FSÍ) & National Science Foundation (NSF), which facilitated excavation of the Hrísheimar and Skútustaðir sites as part of the *Landscapes of Settlement* project, are gratefully acknowledged, with thanks afforded to Prof. Thomas H. McGovern (CUNY) and Dr. Michael J. Church (Durham University) for making available the midden materials for analysis. Indeed, special thanks are afforded to Mike Church for his continued support and advice, and in allowing access to: comparison data from Undir Sandmúla, and his personal charcoal reference collection. The assistance of staff from Durham University, Archaeological Services, Environmental Laboratories is also gratefully appreciated. For allowing utilisation of her personal archaeobotanical reference collection and expertise, its Manager Dr. Charlotte O'Brien is particularly acknowledged, while the assistance of Ms. Louisa Gidney is also thankfully appreciated. Finally sincere thanks are offered to Ms. L. Duarte (former BSc student, Durham University) for the raw charcoal data from the Hofstaðir and Sveigakot sites.

Abstract

Mývatnssveit has been the focus of interdisciplinary research regarding the complex dynamics of human-environment interactions. This research considers utilisation of botanical resources from two farm sites; Hrísheimar, an iron production centre and farm, and Skútustaðir, a farmstead occupied from landnám to the 20th century. A total of 56 bulk samples from Hrísheimar and 81 from Skútustaðir were processed and analysed for their macrobotanical remains. The main research questions addressed were:

- Was evidence of arable agriculture visible?
- What wood procurement strategies were utilised, and was there evidence regarding the use and management of woodlands?
- What other botanical resources were exploited from the local landscape?
- Was there any evidence for trade in plant resources?

Conclusions from the new dataset produced indicate that barley was grown at both locations, while oat may have been trialled at Hrísheimar in the landnám period. Wood remained the main fuel across sites, contexts and time. This appears to have been mainly sourced from the local birch woodland, but also included some evidence of driftwood, and in the case of Skútustaðir, imported species such as oak, yew and hazel. Selective harvesting techniques, apparent from landnám, suggest early attempts at conservation of local woodland. Macro-floral suites reflected local habitats which demonstrated a richer diversity at Skútustaðir; however, possible wetland expansion following forest clearance appears to have occurred later at this site. A range of trees, shrubs, weeds and wild plants may have been gathered to satisfy various culinary, craft and medicinal needs. While trade is more evident at Skútustaðir, with the recovery of imported wood, fruit and grain, this activity was not widespread prior to the abandonment of Hrísheimar. It is significant that, while past research proposes severe arboreal depletion soon after landnám, current charcoal data demonstrates the presence of wood as fuel into the final phase for each site.

Norse utilisation of archaeobotanical resources within the Mývatnssveit locale, Northern Iceland

Chapter 1: Introduction

The Norse were both intrepid explorers and opportunists, their voyages spanning as far afield as Byzantium and Russia in the east (Andersen, 1971, 17), and North America in the west (Ebenesersdóttir et al, 2010). Colonisation of the Atlantic Islands began in Atlantic Scotland circa AD 800 (McGovern et al, 1988, 226) from whence they moved steadily north and west, settling in the Faroe Islands early in the 9th century (Edwards et al, 2005, 622; Arge et al, 2005, 597), Iceland AD 871 (Dugmore et al, 2007a, 2), and Greenland circa AD 985 (Barlow et al, 1997, 489; Buckland et al, 1996, 88), finally reaching Vinland in around AD 1000 (McGovern et al, 1988, 227).

The establishment and survival of these Norse settlements was totally reliant on the successful adaptation of their new environments to provide sustainable food resources. As the North Atlantic Islands may have appeared largely similar to the Norwegian homelands, from which settlers largely originated (McGuire, 2006, 13; Smith, 1995, 320; Schach, 1984, 3), the Norse intended to utilise the familiar agricultural package of domesticates and cereal crops. They recognised many taxa and had experience of managing birch in terms of pollarding and harvesting for fodder and firewood (Hjelle et al, 2006, 155). Yet in the North Atlantic, biota were much closer to their biological limits with a greater likelihood that pressure would tip the balance (Dugmore et al, 2006, 341). Unaware of this, the colonists may have entertained unrealistic expectations regarding their new environs.

Interdisciplinary research from North Atlantic island locations has been funded and facilitated by the North Atlantic Biocultural Organisation (NABO) formed in 1992, and further supported by the International Polar Year (IPY) which focuses on the circumpolar northern regions. Such investigations encompass all aspects of human-ecodynamics spanning the whole range of Norse habitation dates. This allows coordination and comparison of data sets from regional scale excavations, increasing understanding of complex human-environmental interactions (NABO, 2007). The current dissertation considers Norse utilisation of the Icelandic botanical environment from landnám to the 20th century, analysing the management of forests, sustainability of farming methods and collection of natural resources. Such archaeobotanical analysis is vital, as an understanding of the processes surrounding past vegetation and environmental change may have implications for future land management policies. This is particularly important in Iceland where loss of vegetative cover contributed to

wide-scale erosion which has rendered much of the island a veritable desert. The Norse were heavily dependent on the natural biota, yet their management of agrarian resources played a large part in subsequent land degradation (Zutter, 1992, 139). The ability of the Icelandic landscape to support the large number of domesticates both in terms of grazing and production of fodder for overwintering was a key factor in agrarian production, and hence sustainable food resources (Dugmore et al, 2005, 31; Simpson et al, 2004, 472). Pressure from human intervention and/or climate may have initiated the processes of deforestation leading to erosion and land degradation, thus reducing land available for farming (McGovern et al, 2007, 29). Timing and variability of such events between regions may help provide evidence which refutes or supports the traditional view of rapid forest clearance post-landnám (Hallsdóttir & Caseldine, 2005). Spatial and temporal variations between two landnám farm sites in Mývatnssveit were accordingly selected for such comparison, and the following research questions formulated to explore these issues.

- Can a generic taphonomic model be utilised to explain the incorporation of carbonised plant macrofossils into the Icelandic archaeological record, and if so, is it possible to apply this to both sites?
- Is evidence of arable agriculture visible in the archaeological record?
- Does the presence of certain taxa indicate the quality of arable land?
- What taxa were purposefully gathered and what was their utility?
- What may be deduced about the local ecology from the identified wild plant species?
- What materials were used for fuel and did these differ between sites and over time? Was this linked to variations in the local ecology?
- Does the composition of wood utilised for fuel differ between sites and over time?
- Were different fuels utilised for industrial purposes?
- Is there any evidence of woodland management strategies, and did these differ between sites and over time?
- Are indications of trade evident in terms of the presence of non-indigenous species?
- How do current results fit in with research from the wider North Atlantic context?

Chapter 2: Past Research in North Atlantic Environmental Archaeology

The North Atlantic Islands have been the focus for research investigating human impact on pristine environments for over two decades (Vésteinsson et al, 2002, 98). While this continues, a more integrated approach has now emerged recognising the inter-relationship of both human and environmental factors (McGuire, 2006, 11). Consequently more recent studies have considered specific challenges encountered by settlers due to inherent qualities of the individual island environments, and focusing on management strategies and possible solutions, such as coppicing, irrigation and soil enrichment (Church et al, 2007a; Adderley & Simpson, 2005, 2006). The move from single to interdisciplinary studies has yielded data from many sources including: historical land use, climatology, sedimentology, geomorphology, zooarchaeology, plus micro- & macrobotanical remains. Over the past ten years, use of computer generated environmental simulation models have provided a new method for testing dominant/limiting factor hypotheses, and these have proved useful in consideration of both pastoral and arable farming methods, particularly in Iceland (Thomson & Simpson, 2007; Simpson et al, 2002).

The Faroes constitute 18 habitable islands, Iceland; situated at the junction of two climatic zones (ie. Temporal zone – south, Arctic zone – north) (Helldén & Ólafstdóttir, 1999), produces regional differences, while Greenland consists of the Eastern & Western settlements. This provides the potential for comparison studies between two or more locations.

North Atlantic Islands of Faroes & Greenland

Although climatic conditions were generally warmer in the Viking Age (Adderley et al, 2008, 504; Axford et al, 2009, 7) these became more marginal and arctic in nature as the polar fronts were crossed from east to west (Church et al, 2005, 180). Compared to the mild, wet and gale-prone Faroe Islands (Hannon et al, 2001, 31), the more marginal conditions of Iceland 450km to the north-west, forced its natural biota closer to their biological limits, while Greenland 350km further west and partially within the arctic circle (Figure 2.1), yielded the most limited variety of botanical resources (Dugmore et al, 2005, 27). Thus while the Norse agricultural package was similar across islands, the natural flora encountered by colonists differed (Dugmore et al, 2005, 21). This required adaption of the traditional Norse farming strategies, producing unique methods and requiring different management practices between islands. This is most marked in the utilisation of arboreal resources.

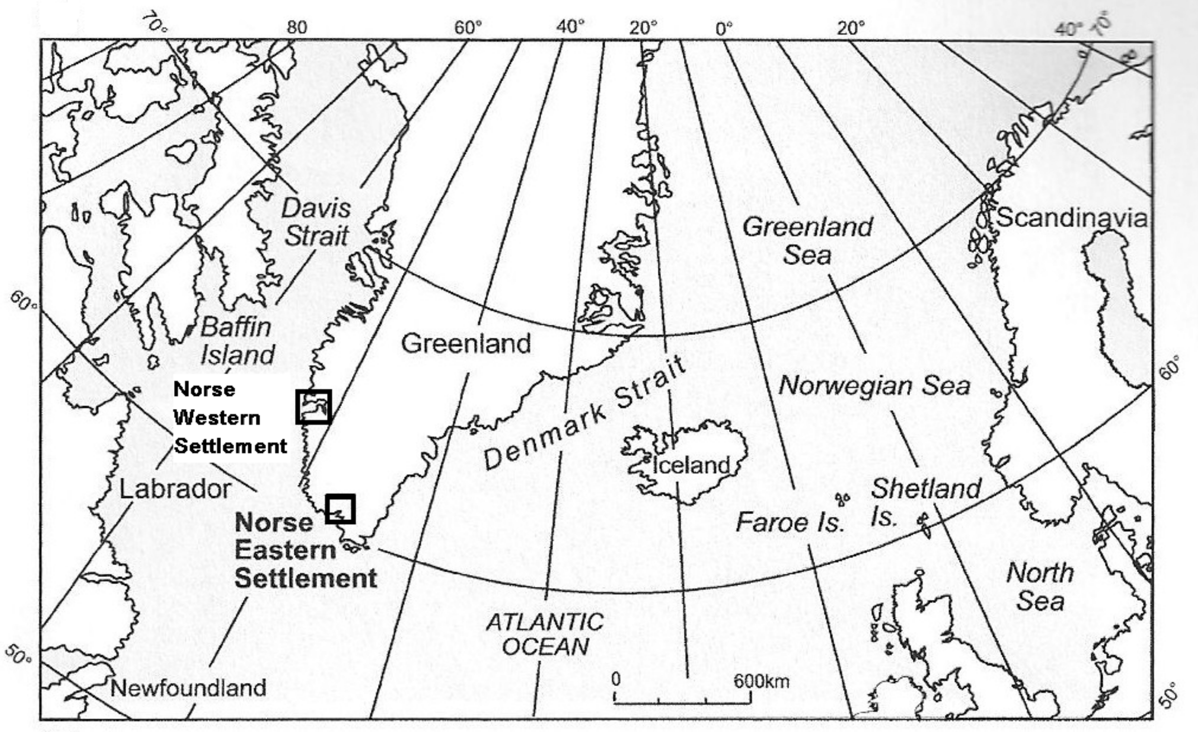


Figure 2.1 – Map demonstrating relative locations of the North Atlantic Islands (Altered from Edwards et al, 2008, 3)

Figure 2.2 – Major islands of the Faroes (Reproduced from Hannon et al, 2001, 131)

It is uncertain how much tree cover existed on the Faroe Islands (Figure 2.2) during the Holocene. Evidence suggests that birch (*Betula* sp.) was certainly growing between 2460 BC and AD 770 (Malmros, 1994). Small areas of downy birch (*Betula pubescens* Ehrh. ssp. tortuosa (Lebed.) Nyman) may have existed in sheltered locations with a thick shrub cover of juniper (*Juniperus* sp.), hazel (*Corylus* sp.), willow (*Salix* sp.), heather (*Calluna* sp.), and crowberry (*Empetrum nigrum* L.) prior to Viking landnám (Dugmore et al, 2005, 26; Malmros, 1994, 552). This absence of substantial woodland is confirmed post-landnám by the extensive utilisation of peat and turf for fuel (Church et al, 2005, 191). While charcoal sources, derived from local roundwood, coniferous driftwood and imported oak have been recovered; these were rare (Church et al, 2005, 194; Lawson et al, 2008, 1148). A lack of primary woodland however, meant soil erosion was extremely limited (Dugmore et al, 2005, 31). Nonetheless the already deteriorating climate negatively impacted on tree cover, with landnám further exacerbating the decline (Hannon & Bradshaw, 2000, 242).

In contrast to the towering cliffs of the Faroe Islands, Greenland attracted settlers with its wide open grassy spaces close to the coast (Edwards et al, 2004, 264). Remaining land deemed suitable for occupation was predominantly covered in dense shrub: birch and willow in the Eastern settlement, and with the addition of alder at the Western Settlement (McGovern et al, 1988, 230). Land clearance both manually and by burning was necessary to increase agricultural utility. The impact of such burning is notable by a thin black deposit underlying the occupational layers of the Western settlement (Dugmore et al, 2005, 30). In the long term, such practice may have led to soil erosion. Yet there was a considerable lag before this was apparent, and effects of settlement did not have the same devastating impact as witnessed on Iceland (Dugmore et al, 2005, 31).

Although trees provided many basic necessities, pastureland was considered to be the main indicator of elite status (McGovern et al, 2007, 29). Surviving closer to the limits of their subsistence system than other North Atlantic colonies, Greenlanders relied on a mixed herding and hunting economy (Barlow et al, 1997, 491). Distribution of pasture plants largely influenced settlement decisions (Dugmore et al, 2007b, 15), hay supply being vital for overwintering in the harsh climate (Buckland et al, 1996, 89; Barlow et al, 1997, 491). Apart from wild fruit such as Crowberry (*Empetrum nigrum* L.) and Bilberry (*Vaccinium uliginosum* L.), no evidence exists that plants made a significant contribution to the human diet, yet full utilisation of natural biota was vital for the survival of domestic animals (Dugmore et al, 2007b, 20), with some evidence of seaweed being fed to stock (Buckland et

al, 1996, 94; Arneborg et al, 1999, 165). Due to the limited amount of pasture particularly in the south west (Buckland et al, 1996, 94), there was virtually no unused grazing within the area by the 12th century, and indeed the impact of domestic stock is claimed to be greatest during this time (Barlow et al, 1997, 492). Based on FARMPACT (McGovern, 1995), Barlow et al (1997, 495) aimed to determine farm viability with different levels of pasture productivity. A reduction of up to 30% was manageable if followed by favourable years, while repeated reductions of 60-80% heavily stressed the Norse economy. Even good quality pasture was difficult to maintain however, due to extremes of temperature. Grass crops in particular were sensitive to such fluctuations. Severe winters produced frozen ground for extensive periods while warmer winters increased the growing season. Both led to drought conditions requiring irrigation of the infields. Additionally, any erosional losses depleted depth and organic content of soil, further exacerbating the situation. While c.11% of years following landnám produced drought conditions this increased to c.16% by the 14th century (Adderley & Simpson, 2006, 1675).

Conversely, the amount of land suitable for growing fodder and/or cereal crops was limited both by topography and drainage in the Faroes, and was largely concentrated in coastal areas (Arge et al, 2005, 597, Adderley & Simpson, 2005, 711) therefore requiring management strategies for production of maximum yields (Adderley & Simpson, 2005, 711). The most common pre-settlement plants were wet meadow varieties and ericaceous heathland communities, while evidence of tall herbs such as Angelica (*Angelica sylvestris* L.) and Meadowsweet (*Filipendula ulmaria* (L.) Maxim.) indicate land free from grazing (Lawson et al, 2005, 661). Following landnám, grasses and docks became more prevalent as selective feeding of sheep tended to suppress herb flora allowing the spread of grasses. Yet while the amount of biomass available may have decreased, major changes in constituent herbage would not have been extensive (Edwards, 2005, 592), as apart from decreases in the tall herbs and small populations of juniper and birch, vegetation cover was not structurally altered to any significant degree (Lawson et al, 2005, 678). While human activity did increase floristic diversity, this was offset by the above losses (Edwards et al, 2005, 646). The shift to drier conditions post settlement reflects drainage of land for establishment of hayfields and cultivation of cereals (Hannon & Bradshaw, 2000, 408-411).

As only a small amount of the Faroese landscape was suitable for intensive exploitation, amendment to ecosystems was similarly muted. Yet stability may also have been maintained by such factors as low population density, few trees and coarse, thin soils less prone to

erosion (Lawson et al, 2008, 1149). Adderley & Simpson (2005, 733) reported widespread soil amendment across the Faroe islands which increased nutrient levels and thus yields. Edwards et al (2005, 647) postulate that as soil wetness was a major constraint on cereal production, however, amendment aimed to improve drainage and thus facilitate more sustainable cropping. While such inherent soil limitations may be partly overcome by manuring, this would not be sufficient for flax (*Linum usitatissimum* L.) or rye (*Secale cereale* L.) producing a near monoculture of barley (*Hordeum* sp.) (Church et al, 2005, 193). Palynological evidence records oat (*Avena* sp.) as being the first cereal-type pollen followed by barley during the landnám period (Jonhansen, 1979, 1985). As oat yield does not respond to soil enrichment (Bond, 2002, 177) it is unlikely to have been cultivated on the Faroes in the long term. In most cases, cereal production is accompanied by an increase in arable weeds, in particular docks (*Rumex* sp.) and plantains (*Plantago* sp.) (Dugmore et al, 2005, 31).

In Greenland arable agriculture was far less viable with regular ripening of cereal crops virtually impossible (Dugmore et al, 2005, 27). Thus subsistence cereal growing could not exist long term (McGovern et al, 1988, 227). Documentary sources support this; *The King's Mirror* relates that by the 13th century most Greenlanders had never seen bread (Larson, 1917, 65). The few rotary querns found on Norse Greenlandic farms were probably used for milling grain imports or locally grown lyme grass (*Leymus arenarius* L.) (McGovern et al, 1988, 227). Few weed species have been recorded, most notably Yarrow (*Achillea millefolium* L.), Autumn hawkbit (*Leontodon autumnalis* L.), Knotgrass (*Polygonum aviculare* L.), and Sheep's sorrel (*Rumex acetosa* L.) (Dugmore et al, 2005, 31).

<u>Iceland</u>

While both the Faroes and Greenland had predominantly open landscapes at landnám, as much as 40% of Iceland's land surface was covered with woodland concentrated on the coastal lowlands at landnám (Hallsdóttir, 1995; Ólafsdóttir et al, 2001; Lawson et al, 2009a). While this was predominately Downy Birch (*Betula pubescens* Ehrh. ssp. tortuosa (Lebed.) Nyman), the only woodland forming tree on the island (Caseldine, 2001, 139), Willow (*Salix* sp.), Juniper (*Juniperus* sp.), and Rowan (*Sorbus* sp.) were also represented in some areas. Extensive woodland ensured a supply of timber procured for fuel, construction and charcoal production as evidenced by the large number of charcoal production pits found throughout Iceland (Church et al, 2007a, 660; McGovern et al, 2007, 38).

Conversely such arboreal advantages also limited the amount of land available for agriculture. As present birch coverage does not exceed 1%, it is estimated that 90-95% of woodland cover was removed between landnám and the 20th century. While some evidence exists for burning of woodland on Iceland at landnám (Buckland et al, 1991, 252; Smith, 1995, 334), this practice of land clearance was more widespread in Greenland (Dugmore et al, 2005, 30).

Yet there was huge variability in terms of settlement patterns and level of human impact. Initial settlements in southern Iceland favoured areas of open meadow and pasture requiring little modification and thus immediately available for grazing and hay making (Mairs et al, 2006, 370). In Mývatnssveit in northern Iceland, early settlers tended to bypass the unattractive lowland wooded areas to occupy the rich highland pastures further inland (Dugmore et al, 2007b, 15).

Deforestation was probably not immediate therefore, and tended to be local rather than universal (McGovern et al, 2007, 45). The open grassland of Dalur in the south of Iceland required little alteration and exploitation of a range of resources over a wide geographical area produced minimal environmental impact (Mairs et al, 2006, 370). Conversely the necessary woodland clearance at the adjacent farm at Mörk initiated soil erosion and land degradation (Mairs et al, 2006, 368) due to the highly friable nature of Icelandic andisols increasing susceptibility to wind and water transport following deforestation (McGovern et al, 2007, 29). This increased the need for land management practices.

Yet such rapid and complete clearance is not typical. In the Markarfljót valley, two phases of woodland clearance have been demonstrated by Church et al (2007a, 670), the first occurring two hundred years after landnám and the other following a century later. At Reykholt in Western Iceland, despite evidence of some immediate forest clearance the first drastic reduction in woodland took place between AD 1150-1300 (Sveinbjarnsdóttir et al, 2008, 5). In Mývatnssveit too, birch populations remained stable from pre-landnám until the 11th century, indicating a more gradual decline over 400 years (Lawson et al, 2007, 8 & 11).

Despite some heavily wooded areas and inherent soil weakness, around 40,000 sq km of land was available for agriculture at landnám (Friðriksson, 1972, 786) and this included woodland, heathland and wetland fen (Smith, 1995, 323). The much greater emphasis on dairy cattle in Iceland required more extensive sources for fodder and grazing. Unable to be grazed throughout winter, the herd required good quality fodder, especially for continued milk production (Vésteinsson et al, 2002, 12). In terms of pasture, grass and sedge were most

beneficial, with part of the land being used for hay making to feed the cattle, while the remainder provided natural grazing for sheep (Friðriksson, 1972, 790). As wet meadows produced superior fodder, they were targeted as initial settlement sites throughout Iceland. Indigenous herbaceous and heathland species colonised the land as forests decreased with grass, sedges and weed species following as pasture and cultivated fields became established (Smith, 1995, 334). A spread of such weeds plus those associated with pasture creation may be traced in pollen assemblages across Iceland (Smith, 1995, 333).

Grazing of domesticates also caused widespread landscape modification which vastly reduced vegetation cover post landnám (65% to 25%), also reducing productivity of remaining biota rendering it more susceptible to soil erosion (Thomson & Simpson, 2007, 151). Modelling fodder production against vegetation degradation in various air temperatures (key climatic control on vegetation growth in Iceland) indicated that grazing activity did not necessarily result in land degradation however, provided management strategies (supplementary winter feed, shepherding, autumn cull) were adopted (Thomson & Simpson, 2007, 163).

A similar methodology has been utilised to explore limiting factors of grain production which have been found to rarely exceed subsistence levels in Iceland. Poor yields were traditionally thought to be due to cool and deteriorating climatic conditions as barley will not germinate in temperatures below 1ºC (Simpson et al, 2002, 430). Soil amendment has now been postulated as the main limiting factor in profitable barley production. Investigating certain key soil nutrients in relation to potential barely yields, inherent soil quality was found to be crucial. Thus initial choice for arable field locations would have been critical (Simpson et al, 2002, 437). Appropriate amendment strategies may have addressed poor soil quality, yet this practice does not appear to have been widely adopted. Lack of animal manure, containing the highest level of vital nutrients (N & P) and labour shortages, may account for the lack of enrichment which kept cereal production on a small scale.

While archaeological, palynological and historical evidence of cereal growing exists, much of this is barley and from south and south-west Iceland (Erlendsson et al, 2009, 177). Zutter (1992, 144) argues this is due to unfavourable climatic conditions for grain production in the north and east. Water availability was not a limiting factor in hay/cereal production (Adderley et al, 2008, 520) and soils were less responsive to enrichment (McGovern et al, 2007, 30). Thus in spite of management strategy adopted, maximum yields provided little more than subsistence living (Adderley et al, 2008, 520).

Figure2.3 – Location of Lake Mývatn within Iceland (Reproduced from Tinsley, 2004)

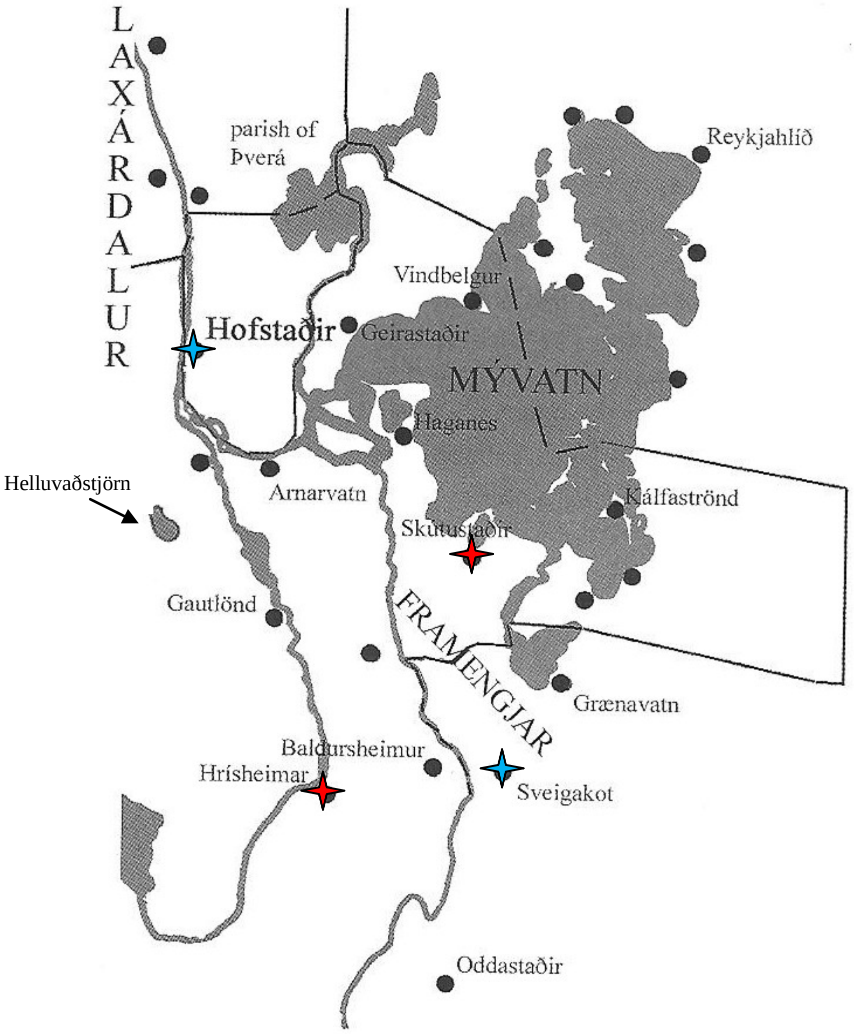


Figure 2.4 – Major archaeological farm sites within Mývatnssveit. Solid black lines indicate parish boundaries and red stars mark study sites and blue indicate comparison sites with the exception of Undir Sanmúla which is located c.30km further south (Altered from Friðriksson et al, 2004, 198).

Study Sites

The Mývatnssveit region (Figures 2.3 & 2.4) has been the focus for extensive interdisciplinary research with support and funding from NABO (North Atlantic Biocultural Organisation) and IPY (International Polar Year). The *Landscapes of Settlement* project, initiated by Vésteinsson and Friðriksson (Hicks et al, 2011, 25), co-ordinates all investigations, and sites already excavated include Brenna, Hofstaðir, Hrísheimar, Oddastaðir, Selhagi, Skútustaðir, Steinbogi, Stong, Sveigakot and Undir Sandmúla (McGovern et al, 2007, 33). Located in northern Iceland with Lake Mývatn, the third largest lake in Iceland (Lawson et al, 2006, 376), at its heart (65º36'N, 17º00'W), it is the only major settlement area so far inland (Thompson & Simpson, 2007, 152), providing comparative data for the process of settlement.

More settled continental climatic conditions prevail within this area than in most other regions of Iceland providing a relatively dry climate (Ólafsdóttir & Júlíusson, 2000, 439; Thompson & Simpson, 2007, 153). Regional soils tend to be erosion sensitive (McGovern et al, 2007, 29), with periods of increased erosional activity indicated by previous studies for both pre- and post-landnám time frames (Thompson & Simpson, 2007, 153).

The two locations selected for this research are both found to the south of Lake Mývatn and are approximately 10km apart (Figure 2.4). The first site is Hrísheimar, an abandoned landnám farm located at the edge of an erosion front. Indeed severe erosion had already degraded the land in the south and south west to glacial gravel or prehistoric tephra (Edvardsson et al, 2003, 4; Edvardsson & McGovern, 2007, 3), thus necessitating rescue archaeology.

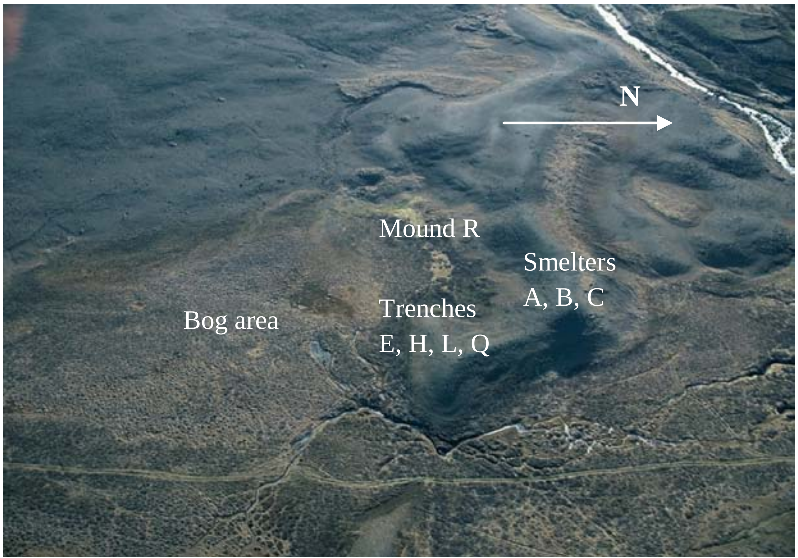


Figure2.5 – Ariel view of the Hrísheimar site showing location of trenches and bog area

Situated within the curve of a ridge, a substantial bog area lies to the south east of the farm (Figure 2.5), while in the opposite direction the River Bjarnastaðalœkur merges with several smaller tributaries before eventually reaching Lake Mývatn (Edvardsson et al, 2003, 3).

The second site of Skútustaðir, less than 1km from Lake Mývatn (Figures 2.4 & 2.6), has been continuously occupied since landnám. As with Hrísheimar, the archaeological importance of the site was realised following erosional processes which exposed midden material (Edwald & McGovern, 2010, 4). Investigations have been ongoing since 2007 and have provided two preliminary site reports incorporating a finds register, initial zooarchaeological results and dating evidence. No archaeobotanical remains have previously been analysed and the present analysis seeks to provide the first data spanning landnám to the 20th century contexts.

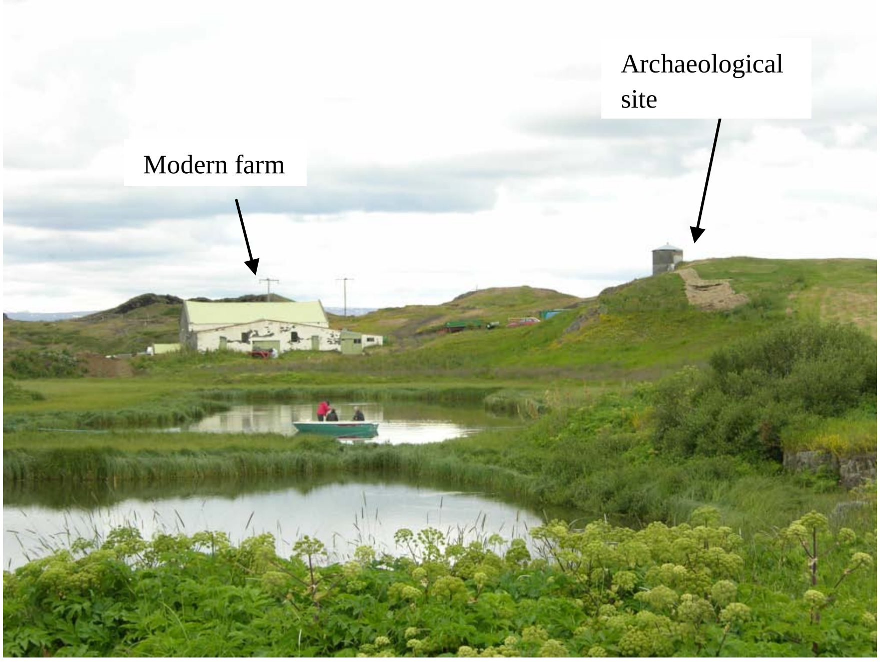


Figure 2.6 – Location of Skútustaðir site in relation to present day farm

Figure 2.7 – Site layout showing industrial and domestic areas (Edvardsson et al, 2003)

<u>Hrísheimar</u>

Initial investigations including geophysical analysis, discovered a number of slag pits in the 2002 season. Due to advancing erosion, the following season concentrated on two main areas, the first later identified as an iron ore processing and production site (areas A, B & C), and the other a domestic context including sheet middens (areas H & L) (Edvardsson et al, 2003, 4). Despite the degradation of the site, a substantial number of buildings and features were discovered in surprisingly good preservation (Figure 2.7). Two structures were identified within areas H and L, one a pit house

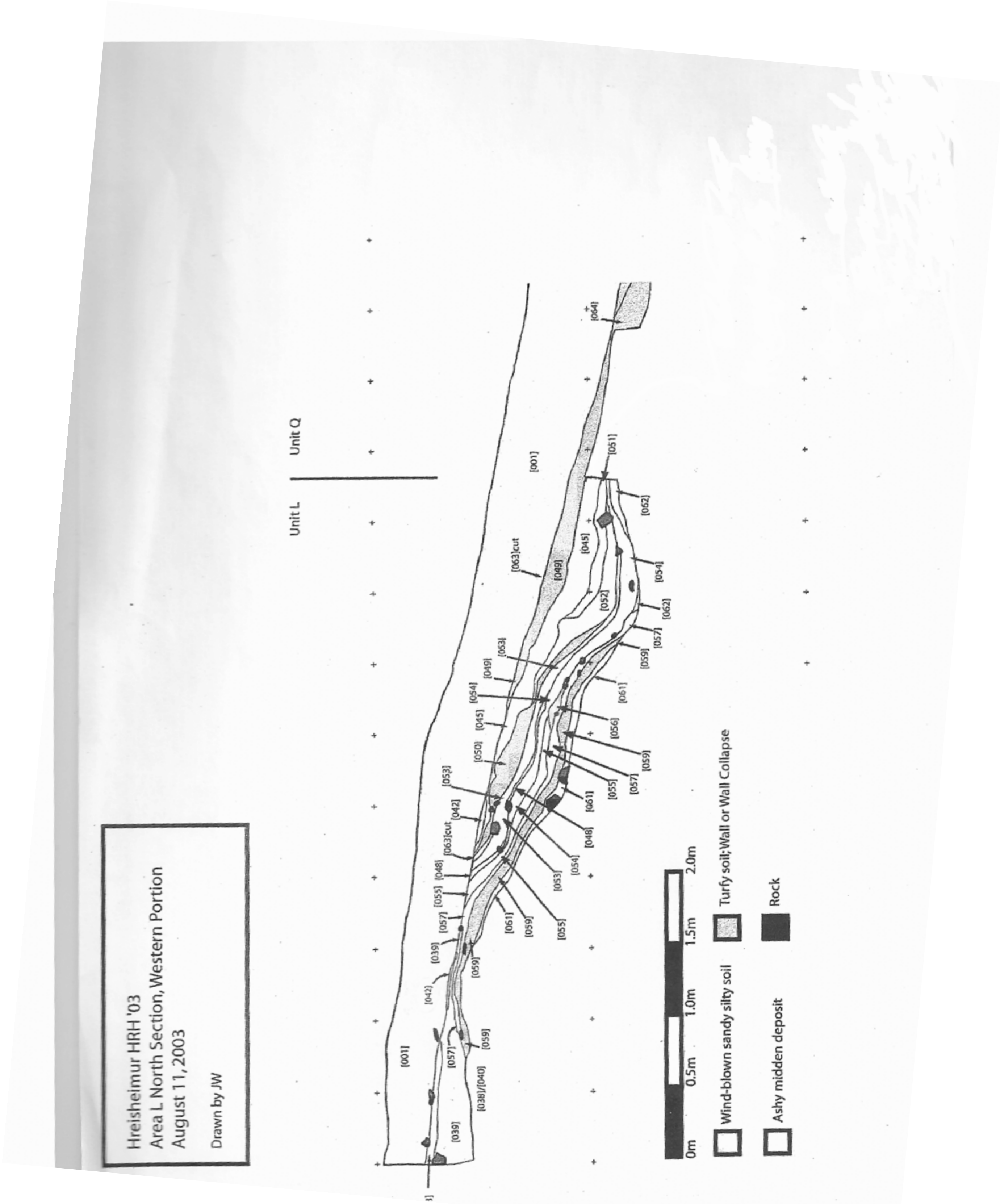


Figure 2.8 – Section drawing from the westerly portion of the north wall of Trench L indicating location of midden samples (Edvardsson et al, 2003, 31)

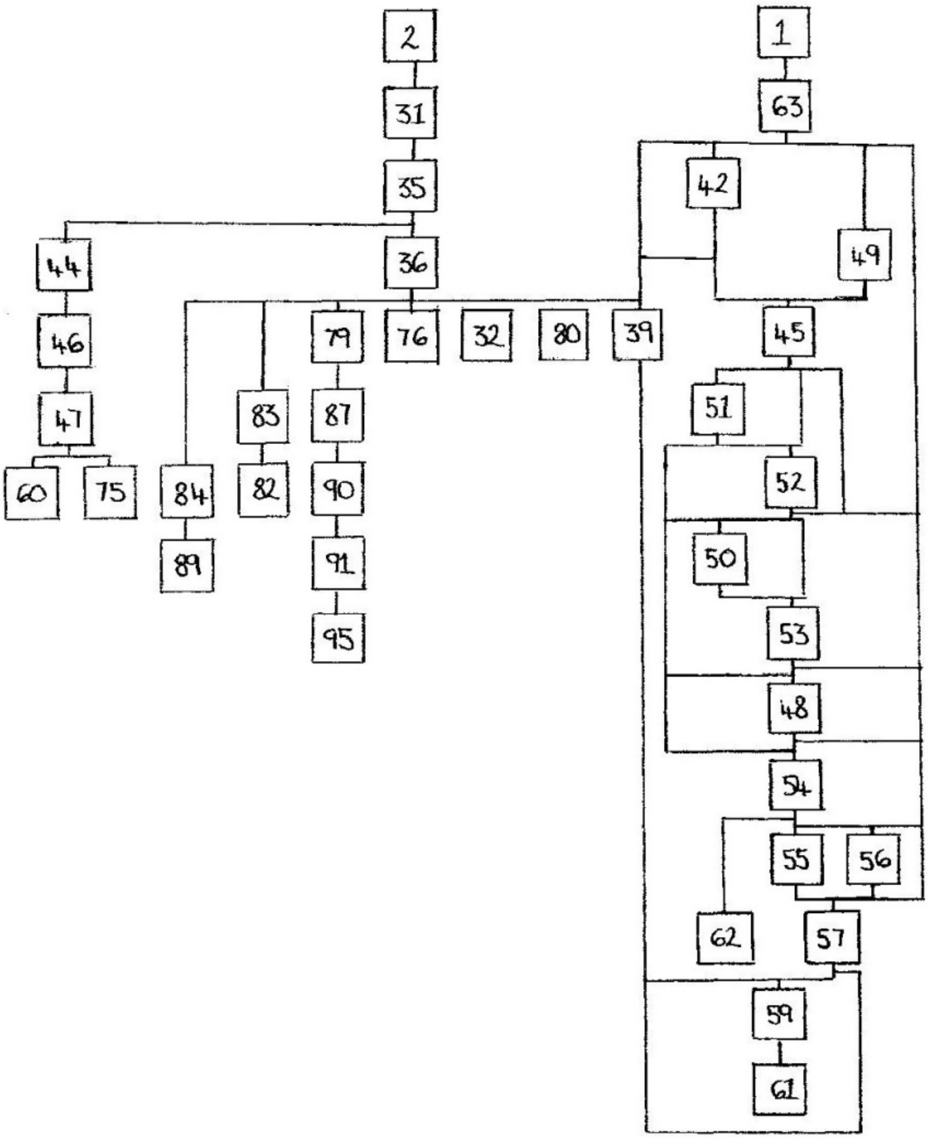


Figure 2.9 – Author constructed Harris Matrix displaying contexts of midden samples from Hrísheimar

with the other remaining unclassified. A closer inspection of these was undertaken in the 2004 season, and possible associations between midden deposits and tephra were also explored with trench L expanded to connect with H & Q (Edvardsson et al, 2005, 8).

Areas A-C yielded a smithy and a number of furnaces (Figure 2.10) (Edvardsson et al, 2003, 4-8). Discovery of extensive industrial debris indicated large scale metal working requiring an abundance of charcoal, suggesting extensive woodland close by. Results of the bog survey 2006 showed that the area was wetter and more productive at landnám, bog iron deposits being a major attraction to settlement. Later changes to drainage patterns may have adversely affected formation of iron ore (Edvardsson & McGovern, 2007, 17). Similarly, wood depletion from iron production may have led to deforestation. Either of these factors may have contributed to site abandonment in the 11th century.

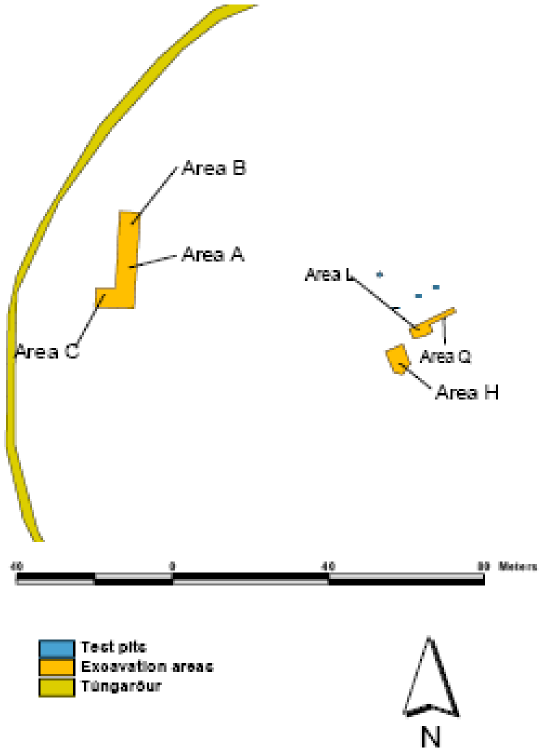


Figure 2.10 – Site plan showing relative position of trenches (Edvardsson et al, 2003).

Animal husbandry practices would have placed additional pressure on the woodland. Zooarchaeological analysis of midden deposits indicates a reversed trend to the rest of Mývatnssveit with pig numbers increasing from landnám to the 10th century (McGovern et al, 2007, 40). As with other sites in this area, bird bones and egg shells reflect a long term sustainable harvesting of eggs while the presence of marine fish bones indicates early coastal trade (Edvardsson & McGovern, 2006, 10).

All samples analysed for the current research originate from midden deposits or ash spreads across areas A, B, C, H & L. The section drawing of the north face of area L indicates the location of seven of the analysed samples (Figure 2.8) Contextual information may be found in Appendix One, while the relationship between samples is demonstrated in an author constructed Harris Matrix based on all available evidence (Figure 2.9).

Skútustaðir

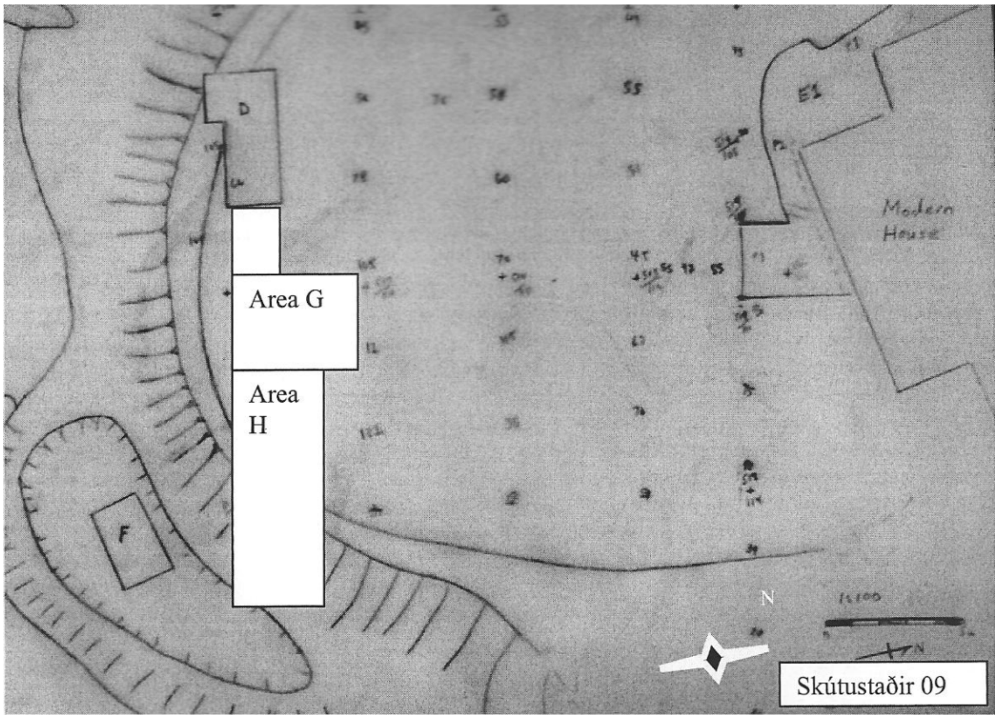


Figure 2.11 – Site plan of Skútustaðir showing layout of trenches (Edwald & McGovern, 2010).

Coring and test trench surveys conducted in 2007 were followed up by excavation of three test trenches in 2008 (D, E1&2, F). These uncovered midden deposits with excellent preservation and multiple tephra (Hicks et al, 2011, 6). Trench F constituted a very rich, early modern midden, while midden material from E1 & 2 was located directly above the landnám tephra. Trench D was subsequently expanded (2009) into two larger interconnected units (G & H) which revealed a productive Viking Age midden deposit (Figure 2.11). Unit G contains the demolition debris of a turf house from the 18th – 19th centuries which overlaid multiple midden layers, becoming increasingly rich below the 1477 tephra back to landnám. Midden material from G and E1 were utilised as infill for landscaping and extension of the infield areas as occurred at other sites in Iceland and Greenland (Edwald & McGovern, 2010, 16).

Although structures were found in E3 (opened in 2010), these were outside the remit of the project but were dated to AD 940-1262. The trench did however provide midden material which spanned landnám through to post 1717. Area H yielded plentiful midden material interspersed with turf lenses which may have been laid to prevent its dispersal by the elements (Hicks et al, 2011, 19). These midden layers have been dated to the period 1477- 20th century. Excavation will continue in 2011 down to bedrock level.

Most of the cultural layers produced a plethora of animal bones, yet like Hrísheimar trends were surprising, with an increase of caprines relative to cattle not becoming evident until the early modern period. This change also occurred at other Mývatnssveit sites yet at a much

earlier date. Skútustaðir is therefore unique in retaining a 5:1 caprine to cattle ratio rather than 20:1 as found elsewhere (Edwald & McGovern, 2010, 6). While fish representations appear to have increased considerably into the early modern period (1550-1850), there is insufficient detail in the preliminary report to determine if this reflects an increase in coastal trading (Hicks et al, 2011, 34). Avian bones and egg shells, also from the midden samples, illustrate settlers once again utilising this sustainable resource. Midden samples for archaeobotanical analysis were obtained from a variety of units (D, E2, E3, F, G & H) and spanned the landnám to 20th century periods (Appendix One). Section drawings from H & E3 are reproduced in Figures 2.12 & 2.13 and related Harris Matrices are also displayed.

Dating & Phasing

As Iceland is a volcanic island, it is subject to frequent eruptions which produce widespread fallouts of tephra (volcanic ash). These layers form time-parallel isochronous marker horizons which can be identified, and thus used for dating archaeological sites through the study of tephrochronology (McGovern et al, 2007, 28; Dugmore et al, 2005, 23). This is particularly beneficial as Iceland, and Mývatnssveit specifically, are subject to marine and freshwater reservoir effects which makes radiocarbon dating difficult (Ascough et al, 2010).

Fortunately, both study sites, but especially Skútustaðir (Hicks et al, 2011, 6), have clear tephrochronologies which were utilised during their phasing for this report. Subsequently a three phase model has been developed for Hrísheimar with the industrial material dated to 870-1000, while domestic contexts have been split between 870-940, and 940-1000. Skútustaðir has similarly been assigned five phases; 870-1000, 1000-1477, 1477-1717, 1717-1900 and C20th into which samples have been allocated.

Information from such sites contributes to the overall regional data set. After establishing a chronology of events, the complex relationship between environment, resource utilisation and management strategies may be examined with reference to abandonment/survival decisions. Both study sites are unique. Hrísheimar offers a rare opportunity for detailed investigation of a metalworking site, allowing comparison with domestic contexts. While Skútustaðir offers the chance to address continuous occupation in the area. Site information may then be compared with the rest of Mývatnssveit, Iceland, and the North Atlantic Islands as a whole.

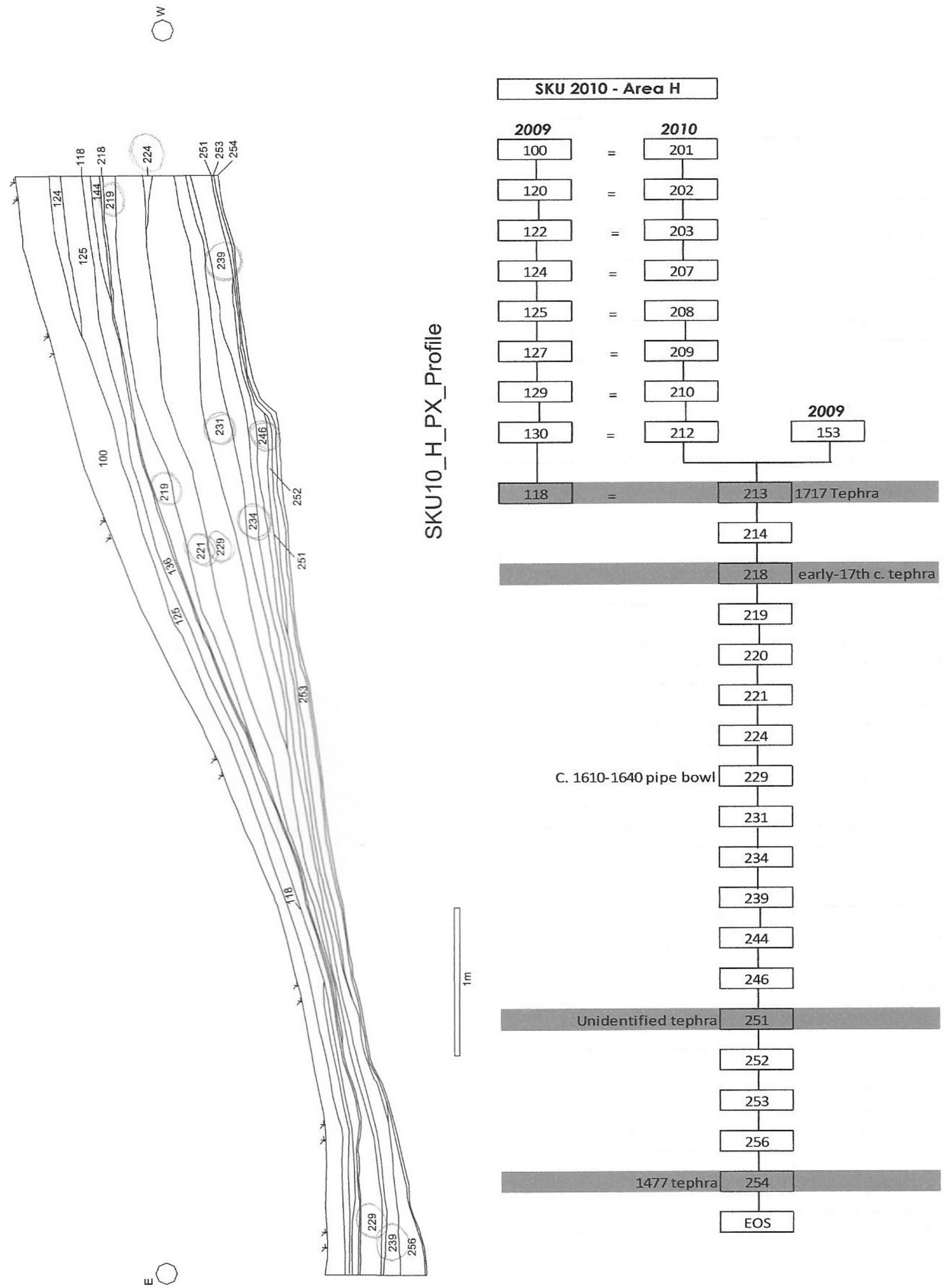


Figure 2.12 – Harris matrix and section drawing for trench H (Skútustaðir) (Hicks et al, 2011).

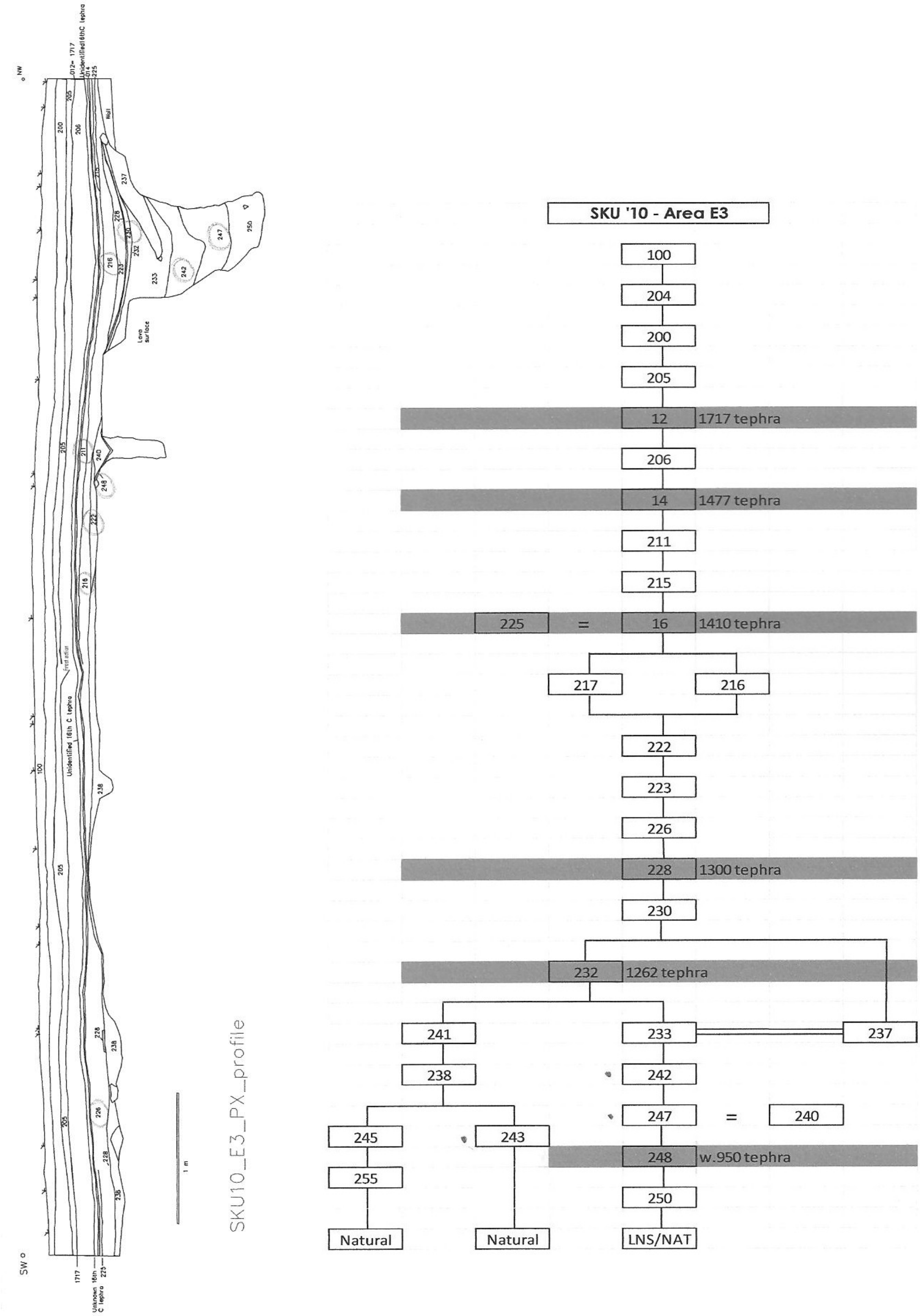


Figure 2.13 – Harris matrix and section drawing for trench E3 (Skútustaðir) (Hicks et al, 2011).

Chapter 3: Methodology

Bulk environmental samples of the standard 10 litre volume were taken of relevant contexts from both sites. These were collected using a judgement sampling strategy in accordance with Jones (1991), whereby contexts are targeted according to the richness of organic matter contained within the sediment. Sampling is therefore at the discretion of the site supervisor. All samples were then initially processed using a Siraf-type flotation tank (Kenward et al, 1980), with 1mm and 0.3mm mesh sieves being utilised for the flot, and a 1mm sieve net catching the residue (Guðmundsson, 2009, 322; Church et al, 2005, 183). Samples originating from the Skútustaðir site had received only minimal on-site preparation and required secondary flotation by hand. Any additional flot material recovered from this re-flotation was then added to the initial amounts. Flots and residues of all samples were air-dried. The 1mm flots from both study sites were analysed (4F, 2F, 1F) with the >4mm residue fraction from Skútustaðir also being examined. The selected material was subsequently sorted under ×3.5 magnification using a low powered stereo/binocular microscope. Macrobotanical identifications were made from certain characteristics of the seeds and caryopses such as size, anatomy, morphology and surface cell patterning of the seedcoats. Such features were then compared to reference material including the reference collection at Durham University and the personal collection of Dr. Charlotte O'Brien. A range of seed atlases were also consulted to obtain digital images and detailed drawings which further aided identification (Cappers et al, 2006), and nomenclature follows Stace (1997). To ascertain the preservation level of assemblages, the condition of each cereal grain was recorded utilising the index devised by Hubbard and al Azm (1990), each grain also being measured. Van der Veen's (1992) criteria were used to classify wild seeds, with grasses (*Poaceae* undiff.) only differentiated to large/medium/small, and sedges (*Carex* sp.) to biconvex/trigonous (Church et al, 2005, 183). The methodology of van der Veen was also followed for the counting of seeds with each seed being given a count of one, irrespective of condition. All other plant parts were given a fragment count due to possible multiple fragmentation (Dickson, 1994).

Due to the difficulties in identification of charcoal <4mm (Pearsall, 2000, 130), only fragments sorted from the 4mm fraction were selected for further analysis. Fifty pieces (of charcoal) were removed from every sample at random using a riffle box (van der Veen & Fieller, 1982). Fragments were generally identified to genus, and subdivided into four categories: bark, timber, roundwood (pith-to-bark), and roundwood (not-pith-to-bark). Number of fragments and weight of each category were carefully recorded (Church et al,

2007a, 662). Measurements of diameter and radius were made for all roundwood pith-to-bark fragments while estimations were obtained for roundwood (not-pith-to-bark) by comparing curvature of the outer ring with a stencil. A ring count was recorded for all relevant fragments (Church et al, 2007a, 662). To increase size/age data, all >10mm fragments of roundwood from every context where size could be determined were examined (pith-to-bark, and not-pith-to-bark with an outer ring). Additional information from the Skútustaðir contexts was minimal and thus the sample containing the highest charcoal content from each phase was selected. Roundwood from the 4F category was then chosen for analysis to obtain a total of 100 fragments per phase.

For all deciduous pieces, identifications were established from transverse cross sections, while for coniferous specimens, transverse, tangential and radial sections were examined under a high power reflected light microscope at ×50-500 magnification. Identifications were made with reference to the anatomical features and images provided by Schweingruber (1990) and Hather (2000).

Following the sorting and identification of all samples, contexts were grouped by phase for each site thus allowing generic comparison (individual sample data is available, however, in the Appendices). For every category of recovered material, ubiquity counts were calculated per phase and as a total for each site to provide relative frequencies. Such information is obtained by ascertaining the number of samples which contain a specific species in a particular time phase. This number is then divided by the total number of samples in the phase and multiplied by one hundred. Such information is in tabular format in the following section.

Chapter 4: Results

Data from Hrísheimar has been divided into two temporal phases (870-940 & 940-1000) for the domestic context, and an industrial context which spans the total AD 870-1000 period. Due to the extended activity at the Skútustaðir site however, results cover five domestic time periods. The initial phase for the site is 870-1000, and to aid direct comparison, the two domestic phases at Hrísheimar have been combined where appropriate. Where this has occurred, clear labelling has been used to avoid confusion with the industrial context.

Recovered archaeobotanical material from each site is summarised in Tables 1 & 2 which lists every category of biota. Similarly cereal data is shown per site in Tables 3 & 4, while Table 5 provides a comparison of weed/wild species between sites.

The remaining data is presented in graphical format, the first seven bar charts relating to cereal cultivation. Graphs 4.1 & 4.2 depict preservation levels per site, and graph 4.3 provides visual comparison between sites for the 870-1000 period. Graphs 4.4 & 4.5 present percentage grain per litre for each site, while graphs 4.6 & 4.7 demonstrate chaff frequencies per farm.

Wild/weed species are portrayed in graphs 4.8-4.10. The former showing the range of species at Hrísheimar, while graph 4.9 is a comparison between sites for the AD 870-1000 period. The much wider total range at Skútustaðir across all five phases is detailed in graph 4.10.

Relative frequencies of fuel sources across phases at the Skútustaðir farm are available in graph 4.11 while the subsequent nine graphs highlight categories of charcoal at each farmsite; graphs 4.12-4.15 from Hrísheimar and graphs 4.16-4.20 at Skútustaðir. Generally these constitute one representation per time phase; however graph 4.15 is a combination of the two domestic phases at Hrísheimar to facilitate comparison with Skútustaðir.

The next twelve graphs which provide roundwood measurement data are from Hrísheimar and have been combined (4 per figure) for the following categories: ringcount, diameter and xy-scattergraphs. Information from the latter was utilised to produce lines of best fit and r values were added demonstrating the correlation coefficient which aims to relate productivity levels. A similar format has been adopted to display this information from the Skútustaðir site; however, here each figure displays five graphs.

	Phase	870-1000 (Industrial)	870-940 (Domestic)	940-1000 (Domestic)	Total Site
	No. of Samples in Phase	13	37	6	56
	Total volume (litres)	130	370	60	560
Charcoal (g.)		535.95 [100]	697.34 [97.30]	98.1 [100]	1331.39 [98.21]
APM (g.)		52.93 [38.46]	0	0	52.93 [8.93]
Grain					
Avena sp.	Oat grain	0	5 [8.11]	0	5 [5.36]
Hordeum sp.	Barley grain	0	3 [8.11]	0	3 [5.36]
Hordeum sp. hulled	Hulled barley grain	0	6 [8.11]	0	6 [5.36]
H. hulled symmetric	Hulled barley straight grain	0	3 [8.11]	0	3 [5.36]
H. hulled asymmetric	Hulled barley twisted grain	0	3 [8.11]	1 [16.67]	4 [7.14]
Cereal indet.	Cereal grain	1 [7.69]	1 [2.70]	2 [16.67]	4 [5.36]
Chaff					
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	0	2 [5.41]	2 [33.33]	4 [7.14]
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	0	0	0	0
Wild plants					
Arctostaphylos uva-ursi (L.) Spreng	Bearberry leaf	0	0	0	0
Betula nana L.	Dwarf Birch leaf	1F [7.69]	0	0	1F [1.79]
Empetrum nigrum L.	Crowberry leaf	342F [69.23]	1F [2.70]	0	343F [17.86]
Juniperus sp.	Juniper leaf	21F [23.08]	0	0	21F [5.36]
Indeterminate leaf	Indeterminate leaf	4F [7.69]	0	0	4F [1.79]
Betula sp.	Birch fruit	1 [7.69]	0	0	1 [1.79]
Salix sp.	Willow fruit	2 [15.39]	1 [2.70]	0	3 [5.36]
Arctostaphylos uva-ursi (L.) Spreng	Bearberry seed	1 [7.69]	0	0	1 [1.79]
Carex sp. (biconvex)	Sedge seed	29 [38.46]	33 [29.73]	2 [33.33]	64 [32.14]
Carex sp. (trigonous)	Sedge seed	10 [15.39]	6 [10.81]	3 [50.00]	19 [16.07]
Chenopodium album L.	Fat Hen seed	0	1 [2.70]	0	1 [1.79]
Empetrum nigrum L.	Crowberry seed	34 [30.77]	10 [21.62]	1 [16.67]	45 [23.21]
Menyanthes trifoliata L.	Bog Bean seed	1 [7.69]	0	0	1 [1.79]
Montia fontana L.	Blinks seed	1 [7.69]	0	0	1 [1.79]
Poaceae undiff. (small)	Grass seed	2 [15.39]	4 [8.11]	0	6 [8.93]
Polygonum aviculare L.	Common knotgrass seed	1 [7.69]	1 [2.70]	0	2 [3.57]
Stellaria media (L.) Villars	Common chickweed seed	345 [30.77]	48 [35.14]	0	393 [30.36]
Stellaria media (L.) Villars	Common chickweed seed pod	37 [7.69]	0	0	37 [1.79]
Vaccinium sp.	Cranberry seed	0	1 [2.70]	0	1 [1.79]
Vicia sp.	Vetch seed	0	2 [5.41]	0	2 [3.57]
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	2 [7.69]	1 [2.70]	0	3 [3.57]
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	0	0	0	0
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	0	0	0	0
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	0	1 [2.70]	0	1 [1.79]

Indeterminate seed	Indeterminate seed	32 [38.46]	21 [24.32]	2 [33.33]	55 [28.57]
Indeterminate seaweed	Indeterminate seaweed	1 [7.69]	0	0	1 [1.79]
Fungi					
Cenococcum undiff.	Fungus	204F [84.62]	1190F [100.00]	178F [83.33]	1572 [94.64]
Uncarbonised Seeds					
Arctostaphylos uva-ursi (L.) Spreng	Bearberry seed	1 [7.69]	0	0	1 [1.79]
Carex sp. (biconvex)	Sedge seed	0	2 [2.70]	0	2 [3.57]
Carex sp. (trigonous)	Sedge seed	1 [7.69]	0	0	1 [1.79]
Empetrum nigrum L.	Crowberry seed	1 [7.69]	0	0	1 [1.79]
	Total Wild	496	127	10	633
	Total QC	497	150	15	662
	Grain/litre	0.008	0.057	0.05	0.05
	QC/litre	3.82	0.41	0.25	1.18
Grain Preservation (Hubbard & Al Azm 1990)	**Class 1 (best preservation %)**	0	5	0	5
	Class 2 (%)	0	20	0	17
	Class 3 (%)	0	20	33	22
	Class 4 (%)	0	15	0	9
	Class 5 (%)	100	30	0	30
	Class 6 (worst preservation %)	0	10	67	17

Table 4.1 – Archaeobotanical remains from Hrísheimar showing domestic and industrial contexts

	Phase	870-1000	1000-1477	1477-1717	1717-1900	C20th	Total Site
	No. of Samples in Phase	14	18	29	17	3	81
	Total volume (litres)	140	180	290	170	30	810
Charcoal (g.)		105.39 [100.00]	39.59 [100.00]	184.4 [100.00]	17.4 [100.00]	4.76 [100.00]	351.54 [100.00]
APM (g.)		0.43 [35.71]	0.15 [22.22]	42.88 [75.86]	8.67 [58.82]	1.19 [100.00]	53.32 [54.32]
Uncarbonised wood fragments		1F [7.14]	0	25F [10.35]	5F [11.77]	0	31F [7.41]
Carbonised ovicaprid coprolite		0	0	93F [24.14]	16F [23.53]	6F [66.67]	115F [16.05]
Coal					4F [5.88]		4F [1.24]
Grain							
Avena sp.	Oat grain	0	0	0	1 [5.88]	0	1 [1.24]
Hordeum sp.	Barley grain	0	0	0	0	0	0
Hordeum sp. hulled	Hulled barley grain	1 [7.14]	0	0	2 [5.88]	1 [33.33]	4 [3.70]
H. hulled symmetric	Hulled barley straight grain	0	0	0	0	0	0
H. hulled asymmetric	Hulled barley twisted grain	0	0	0	0	1 [33.33]	1 [1.24]
Cereal indet.	Cereal grain	0	0	1 [3.45]	1 [5.88]	0	2 [2.47]
Chaff							
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node			2 [6.90]		1 [33.33]	3 [3.70]
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	3 [14.29]	1 [5.56]	19 [20.69]	4 [11.77]	0	27 [13.58]
Wild plants							
Arctostaphylos uva-ursi (L.) Spreng	Bearberry leaf	8F [14.29]	0	227F [44.83]	5F [17.65]	0	240 [22.22]
Betula nana L.	Dwarf Birch leaf	0	0	10F [13.79]	0	0	10 [4.94]
Empetrum nigrum L.	Crowberry leaf	0	1F [5.56]	19F [27.59]	7F [17.65]	0	27 [14.82]
Juniperus sp.	Juniper leaf	0	0	1F [3.45]	0	0	1 [1.24]
Indeterminate leaf	Indeterminate leaf	1F [7.14]	2F [11.11]	5F [6.90]	3F [5.88]	0	11 [7.41]
Salix sp.	Willow fruit	0	1F [5.56]	3F [10.35]	0	0	4 [4.94]
Agrimonia eupatoria L.	Common Agrimony seed	0	1 [5.56]	0	0	0	1 [1.24]
Arctostaphylos uva-ursi (L.) Spreng	Bearberry seed	0	0	2 [6.90]	0	0	2 [2.47]
Brassica rapa L.	Field Mustard seed	1 [7.14]	0	1 [3.45]	0	1 [33.33]	3 [3.70]
Calluna vulgaris (L.) Hull	Common Heather seed head	0	0	3 [10.35]	2 [11.77]	2 [33.33]	7 [7.41]
Carex sp. (biconvex)	Sedge seed	2 [14.29]	17 [22.22]	311 [86.21]	137 [88.24]	20 [100.00]	487 [60.49]
Carex sp. (trigonous)	Sedge seed	5 [28.57]	4 [16.67]	81 [55.17]	43 [64.71]	13 [33.33]	146 [43.21]
Chenopodium album L.	Fat Hen seed	0	0	0	1 [5.88]	0	1 [1.24]
Cyperaceae/Polygonaceae	Sedge/Knotweed seed	0	2 [5.56]	1 [3.45]	0	0	3 [2.47]
Empetrum nigrum L.	Crowberry seed	13 [21.43]	13 [33.33]	28 [31.04]	5 [23.53]	0	59 [27.16]
Ficus carica L.	Common Fig seed	0	0	0	0	2 [33.33]	2 [1.24]
cf. Hippuris vulgaris L.	Marestail seed	1 [7.14]	0	2 [6.90]	5 [5.88]	1 [33.33]	9 [4.94]
Juncus acutiflorus L.	Sharp-flowered Rush seed	0	0	1 [3.45]	0	0	1 [1.24]
Menyanthes trifoliata L.	Bog Bean seed	0	0	1 [3.45]	0	0	1 [1.24]
Montia fontana L.	Blinks seed	0	0	0	2 [11.77]	0	2 [2.47]
Plantago lanceolata L.	Ribwort Plantain seed	1 [7.14]	0	0	0	0	1 [1.24]
Poaceae undiff. (large)	Grass seed	0	0	0	1 [5.88]	0	1 [1.24]
Poaceae undiff. (small)	Grass seed	1 [7.14]	1 [5.56]	2 [6.90]	10 [41.18]	0	14 [13.58]
Polygonum aviculare L.	Common Knotgrass seed	1 [7.14]	11 [5.56]	5 [10.35]	10 [29.41]	3 [33.33]	30 [13.58]
Polygonum lapathifolia L.	Pale Persicaria seed	0	0	2 [6.90]	0	0	2 [2.47]
Prunus domestica L.	Plum seed	0	0	0	0	2 [33.33]	2 [1.24]
Ranunculus acris L.	Meadow Buttercup seed	2 [14.29]	0	4 [13.79]	4 [11.77]	4 [66.67]	14 [12.35]

Ranunculus bulbosus L.	Bulbous Buttercup seed	2 [14.29]	4 [16.67]	8 [20.69]	2 [11.77]	3 [33.33]	19 [17.28]
Ranunculus polyanthemos L.	Multiflowered Buttercup seed	0	0	0	0	1 [33.33]	1 [1.24]
Ranunculus repens L.	Creeping Buttercup seed	1 [7.14]	2 [11.11]	2 [6.90]	1 [5.88]	1 [33.33]	7 [8.64]
Rumex crispus L.	Curled Dock seed	0	0	3 [10.35]	4 [17.65]	1 [33.33]	8 [8.64]
Spergula arvensis L.	Corn Spurrey seed	0	0	2 [3.45]	0	0	2 [1.24]
Stellaria media (L.) Villars	Common chickweed seed	41 [28.57]	243 [50.00]	26 [44.83]	24 [41.18]	0	334 [40.74]
Vaccinium myrtillus L.	Bilberry seed	0	0	1 [3.45]	1 [5.88]	0	2 [2.47]
Vicia sp.	Vetch seed	0	0	0	0	0	0
Viola-type	Violet seed	0	0	1 [3.45]	0	0	1 [1.24]
Indeterminate seed	Indeterminate seed	2 [14.29]	5 [16.67]	31 [55.17]	28 [52.94]	8 [66.67]	74 [39.51]
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	2 [14.29]	0	28 [17.24]	14 [29.41]	1 [33.33]	45 [16.05]
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	2 [7.14]	1 [5.56]	43 [27.59]	5 [23.53]	2 [66.67]	53 [19.75]
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	1 [7.14]	0	5 [10.35]	1 [5.88]	0	7 [6.17]
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	3 [14.29]	1 [5.56]	12 [17.24]	20 [23.53]	9 [66.67]	45 [17.28]
Indeterminate root/tuber	Indeterminate root/tuber	0	0	0	1 [5.88]	1 [33.33]	2 [2.47]
Indeterminate seaweed	Indeterminate seaweed	1F [7.14]	0	0	0	0	1F [1.24]
Fungi							
Cenococcum undiff.	Fungus	33F [50.00]	41F [44.44]	12F [24.14]	1F [5.88]	0	87F [28.40]
Uncarbonised Seeds							
Arctostaphylos uva-ursi (L.) Spreng	Bearberry seed	0	0	3 [3.45]	0	0	3 [1.24]
Carex sp. (biconvex)	Sedge seed	0	1 [5.56]	3 [10.35]	28 [17.65]	8 [33.33]	40 [9.88]
Carex sp. (trigonous)	Sedge seed	0	0	3 [10.35]	8 [17.65]	2 [33.33]	13 [8.64]
Empetrum nigrum	Crowberry seed	0	16 [11.11]	13 [10.35]	9 [17.65]	2 [33.33]	40 [11.11]
Menyanthes trifoliata L.	Bog Bean seed	0	0	0	3 [5.88]	0	3 [1.24]
Polygonum aviculare L.	Common Knotgrass seed	0	0	0	5 [5.88]	0	5 [1.24]
Potentilla intermedia L.	Russian Cinquefoil seed	0	0	0	1 [5.88]	0	1 [1.24]
Ranunculus acris L.	Meadow Buttercup seed	0	0	3 [6.90]	1 [5.88]	0	4 [3.70]
Ranunculus bulbosus L.	Bulbous Buttercup seed	0	0	4 [6.90]	8 [11.77]	7 [33.33]	19 [6.17]
Ranunculus repens L.	Creeping Buttercup seed	0	0	0	1 [5.88]	0	1 [1.24]
Rumex crispus L.	Curled Dock seed	0	0	0	2 [5.88]	0	2 [1.24]
Stellaria media (L.) Villars	Common chickweed seed	0	2 [11.11]	0	0	0	2 [2.47]
Viola-type	Violet seed	0	0	7 [6.90]	670 [23.53]	1 [33.33]	678 [8.64]
Cenococcum undiff.	Fungus	0	4F [11.11]	0	0	0	4F [2.47]
	Total Wild	90	305	606	321	75	1397
	Total QC	94	306	628	329	78	1435
	Grain/litre	0.007	0	0.004	0.024	0.067	0.0099
	QC/litre	0.67	1.7	2.17	1.94	2.6	1.77
Grain Preservation (Hubbard & Al Azm 1990)	**Class 1 (best preservation -%)**	0	0	0	0	0	0
	Class 2 (%)	0	0	0	0	50	12.5
	Class 3 (%)	0	0	0	25	0	12.5
	Class 4 (%)	0	0	0	25	50	25
	Class 5 (%)	100	0	100	25	0	37.5
	Class 6 (worst preservation %)	0	0	0	25	0	12.5

Table 4.2 – Archaeobotanical remains from Skútustaðir across phases

Sample	Context	Identification	Preservation Count	Dimensions (mm)
s.03/5	c.129	Cereal indeterminate	5	3.5×2×1
s.03/22	c.42	*H.* hulled asymmetric	3	4×3×2
s.03/22	c.42	Cereal indeterminate	6	3×2×1.5
s.03/22	c.42	Cereal indeterminate	6	2.5×1.5×1
s.03/25	c.48	*H.* hulled	4	4.5×2×2
s.03/25	c.48	*H.* hulled	5	4×3.5×2
s.03/25	c.48	*H.* hulled	5	3.5×2×1.5
s.03/25	c.48	*Avena* sp.	6	5×1.5×1.5
s.03/27	c.53	*H.* hulled asymmetric	4	3.5×2×1.5
s.03/31	c.61	*Hordeum* sp.	5	3×3×1.5
s.04/5	c.47	Cereal indeterminate	6	4×2×2
s.04/9	c.77	*H.* hulled asymmetric	2	5.5×3×2.5
s.04/9	c.77	*H.* hulled symmetric	3	4.5×2.5×2
s.04/9	c.77	*H.* hulled	4	4.5×3×2.5
s.04/9	c.77	*Hordeum* sp.	5	5×3×2.5
s.04/18	c.85	*Hordeum* sp.	5	3×2×2
s.04/19	c.84	*H.* hulled symmetric	3	4×2.5×2
s.04/19	c.84	*H.* hulled	5	5×2.5×1.5
s.04/22	c.90	*H.* hulled symmetric	2	5×2.5×2
s.04/24	c.52	*H.* hulled asymmetric	2	4.5×2×1.5
s.04/29	c.91	*Avena* sp.	1	6.5×1.5×1.5
s.04/29	c.91	*Avena* sp.	2	5×2×1.5
s.04/29	c.91	*Avena* sp.	3	6.5×2×2

Table 4.3 – Preservation and dimensions of cereal caryopses for Hrísheimar

Sample	Context	Identification	Preservation Count	Dimensions (mm)
s.08/01	c.02	*H.* hulled asymmetric	2	5×2.5×2.5
s.08/01	c.02	*H.* hulled	4	3.5×2×2
s.09/01	c.104	*H.* hulled	3	5×2.5×2
s.09/01	c.104	*H.* hulled	5	
s.09/02	c.105	*Avena* sp.	4	11.5×2.5×1.5
s.09/05	c.110	Cereal indeterminate	6	3.5×2×2.5
s.09/09	c.121	Cereal indeterminate	5	
s.09/48	c.156	*H.* hulled	5	

Table 4.4 – Preservation and dimensions of cereal caryopses for Skútustaðir

	Site	HRH	SKU
	Phase	870-1000 (Domestic)	870-1000
	Volume (litres)	430	140
Brassica rapa L.	Field Mustard seed	0	1 [7.14]
Chenopodium album L.	Fat Hen seed	1 [2.33]	0
Plantago lanceolata L.	Ribwort plantain seed	0	1 [7.14]
Polygonum aviculare L.	Common knotgrass seed	1 [2.33]	1 [7.14]
Ranunculus acris L.	Meadow buttercup seed	0	2 [14.29]
Ranunculus repens L.	Creeping buttercup seed	0	1 [7.14]
Stellaria media (L.) Villars	Common chickweed seed	48 [30.23]	41 [28.57]
Carex sp. (biconvex)	Sedge seed	13 [30.23]	2 [14.29]
Carex sp. (trigonous)	Sedge seed	9 [16.28]	5 [28.57]
cf. *Hippuris vulgaris* L.	Mare's tail seed	0	1 [7.14]
Poaceae undiff. (small)	Grass seed	4 [6.98]	1 [7.14]
Ranunculus bulbosus L.	Bulbous buttercup seed	0	2 [14.29]
Vicia sp.	Vetch seed	2 [4.65]	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry leaf	0	8F [14.29]
Empetrum nigrum L.	Crowberry leaf	1F [2.33]	0
Empetrum nigrum L.	Crowberry seed	11 [20.93]	13 [21.43]
Salix sp.	Willow fruit	1 [2.33]	0

Table 4.5 – Comparative archeobotanical data for wild/weed species 870-1000. (Domestic contexts have been combined to provide the frequencies for Hrísheimar.)

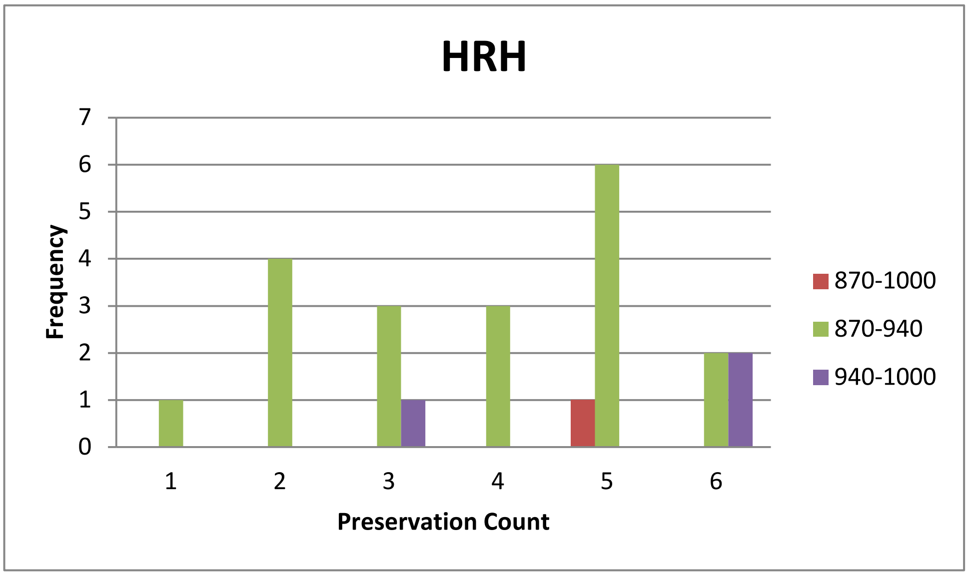


Figure 4.1 – Frequency of preservation counts for Hrísheimar by phase

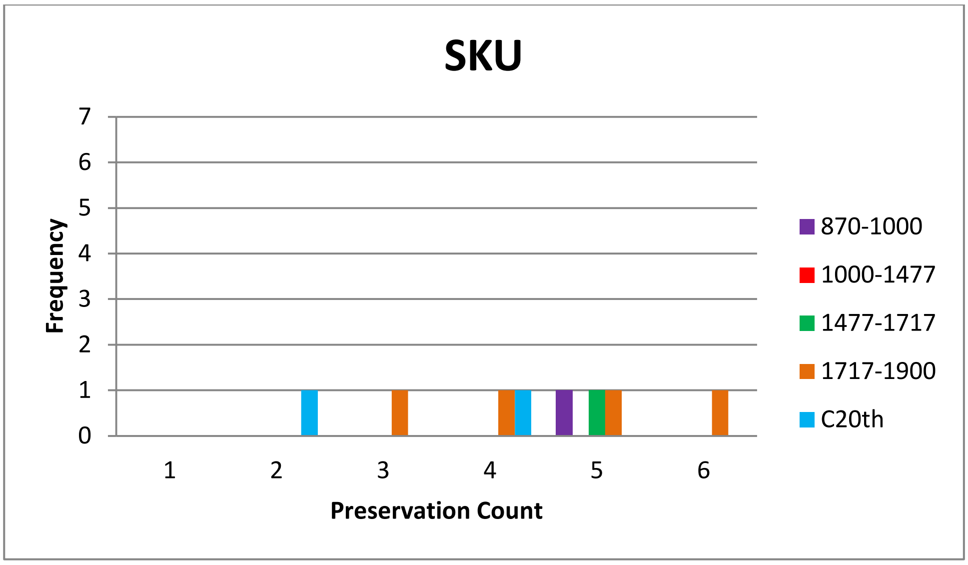


Figure 4.2 – Frequency of preservation counts for Skútustaðir by phase

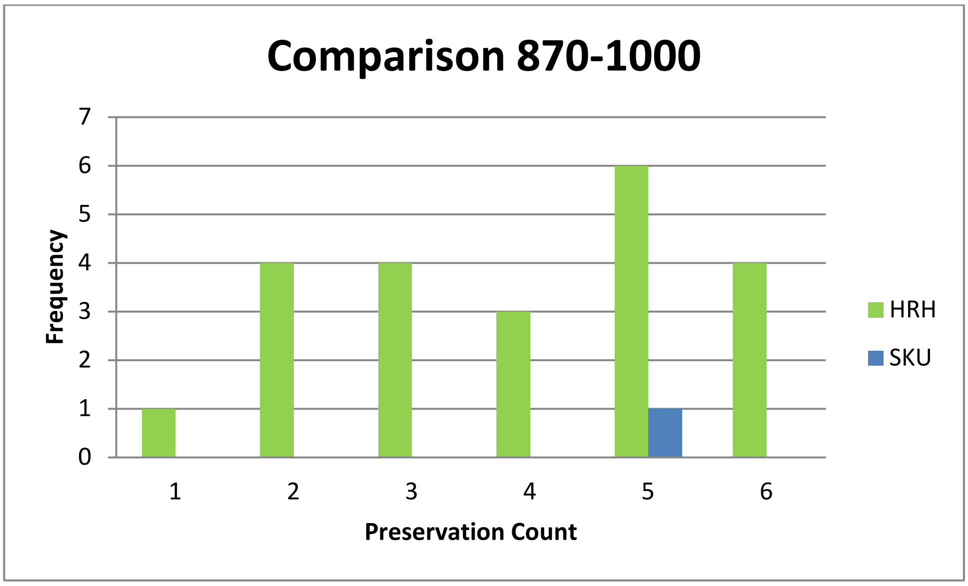


Figure 4.3 – Comparison of preservation counts for each site (870-1000) (Domestic contexts have been combined to provide the frequencies for Hrísheimar.)

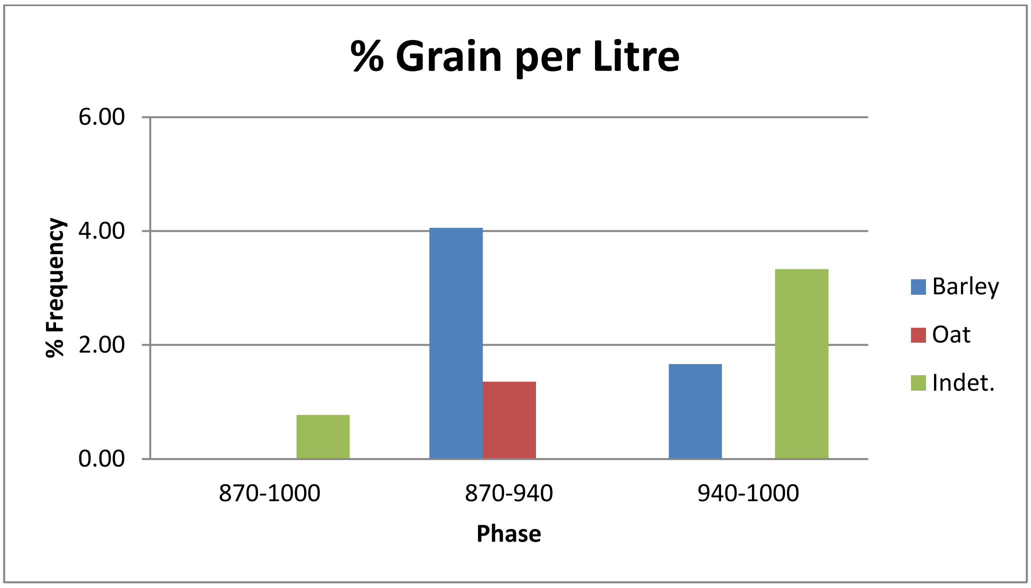


Figure 4.4 – Comparison of cereal categories across phases at Hrísheimar (% grain per litre)

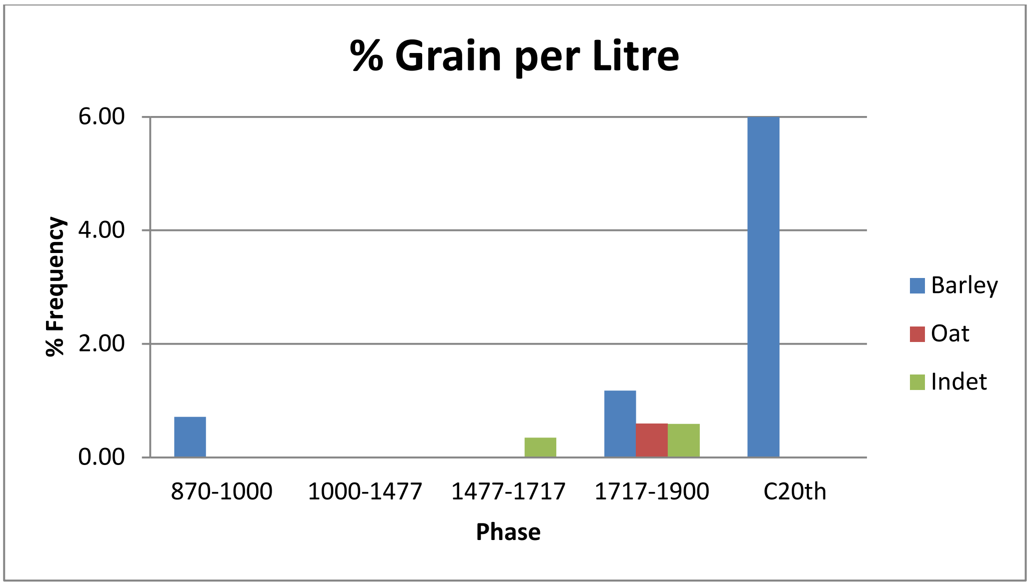


Figure 4.5 – Comparison of cereal categories across phases at Skútustaðir (% grain per litre)

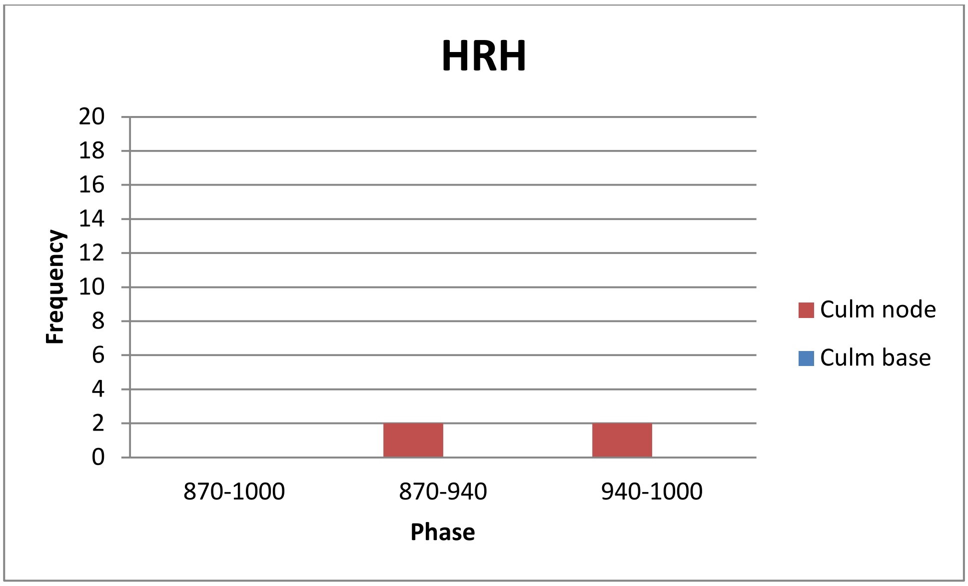


Figure 4.6 – Frequency data for cereal chaff according to phase for Hrísheimar

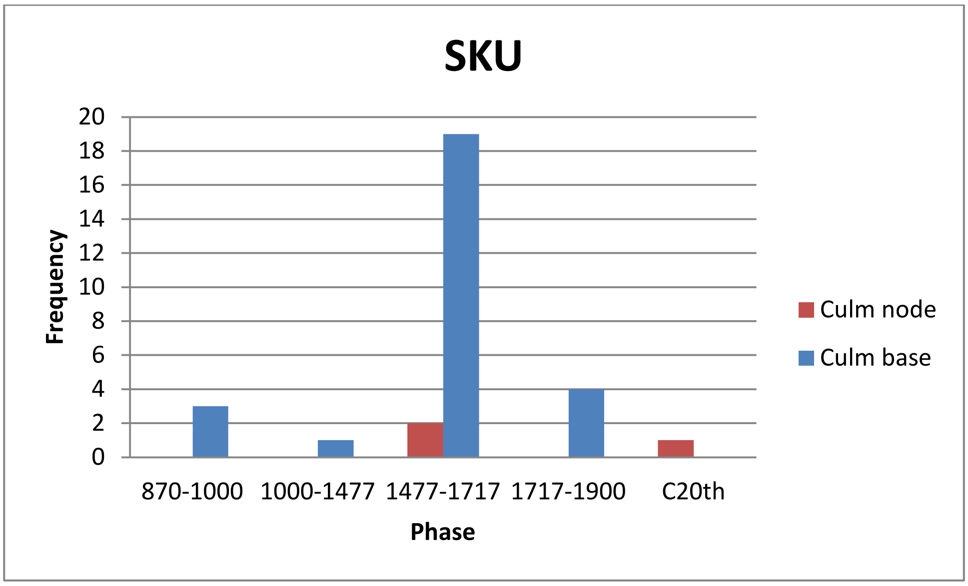


Figure 4.7 – Frequency data for cereal chaff according to phase for Skútustaðir

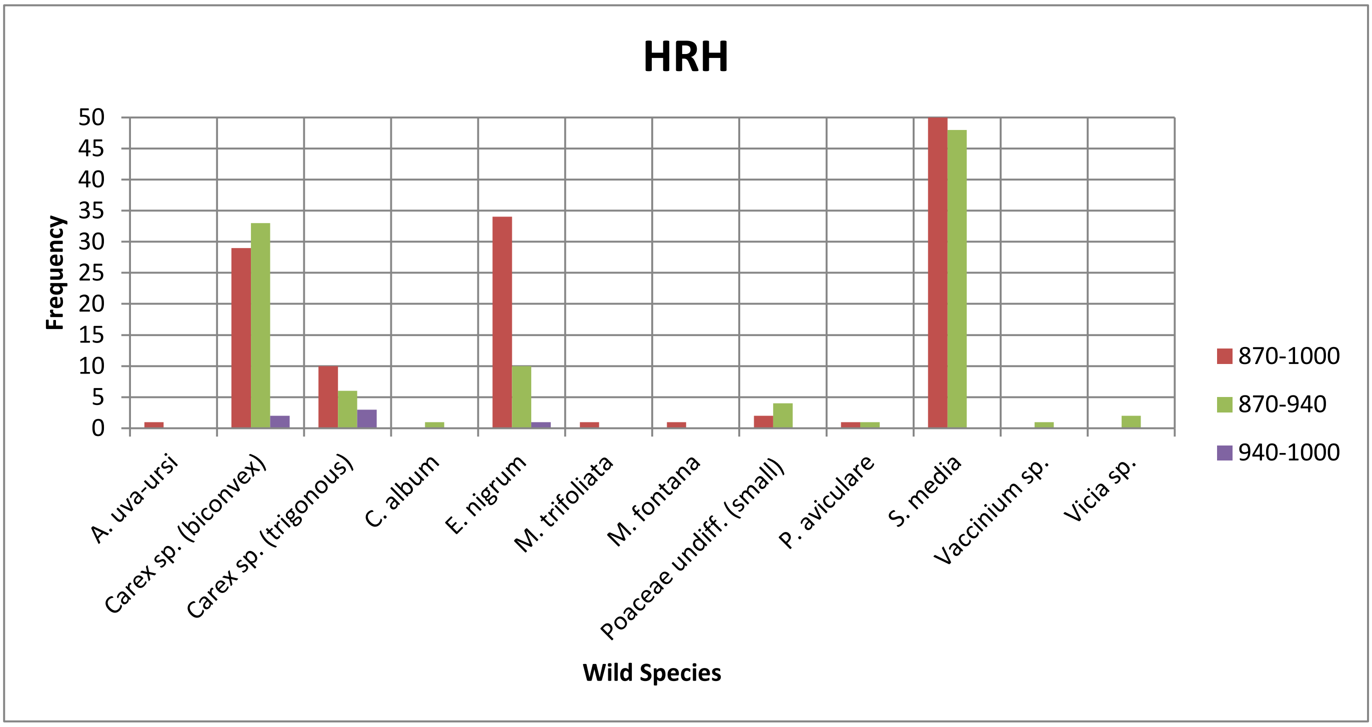


Figure 4.8 – Relative distributions of weed/wild species per phase at Hrísheimar

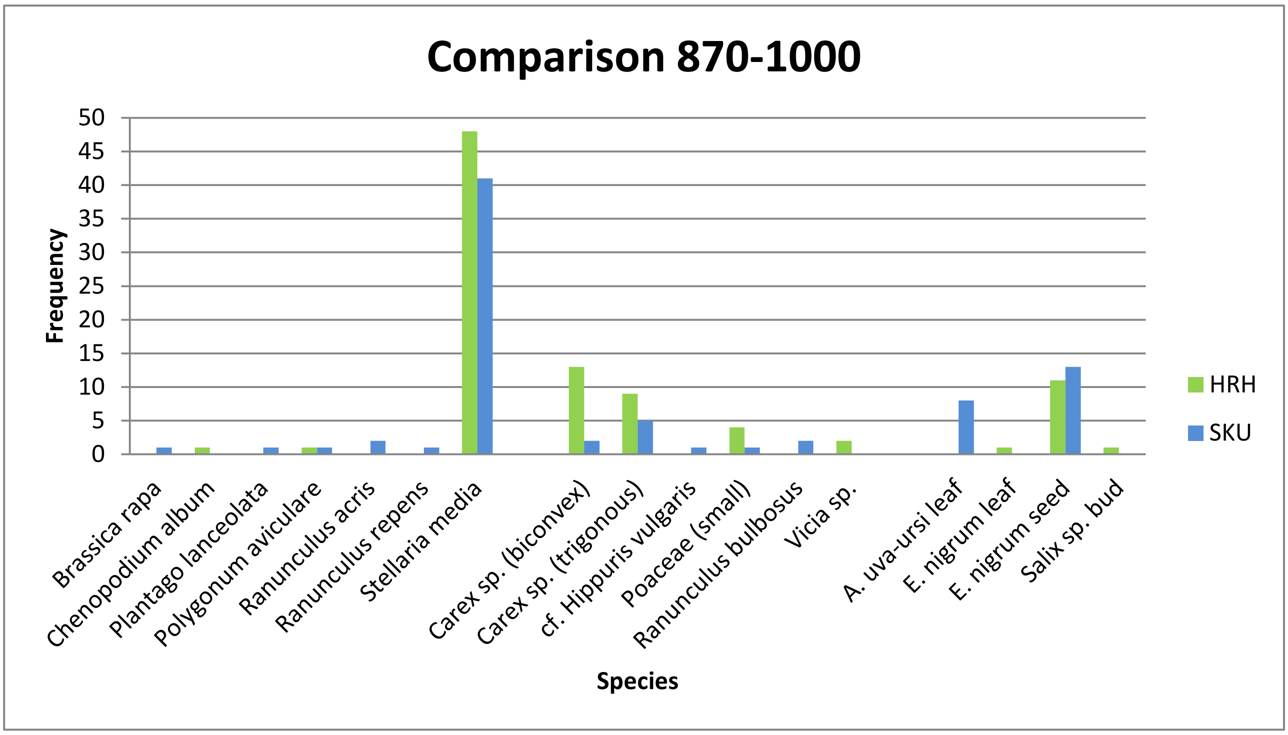


Figure 4.9 – Comparison of relative distributions for wild/weed species between sites (870-1000) (Domestic contexts have been combined to provide the frequencies for Hrísheimar.)

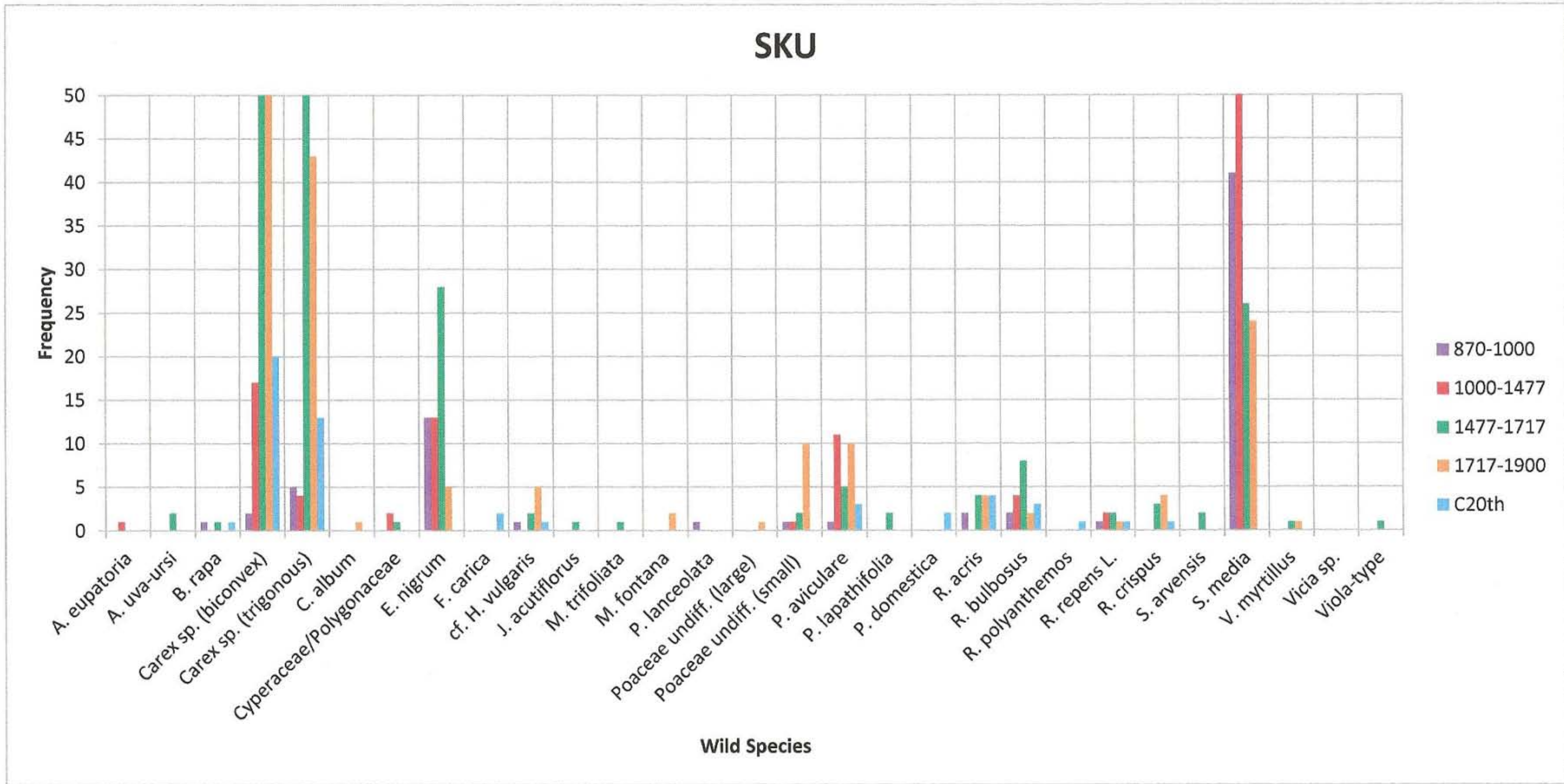


Figure 4.10 – Relative distributions of weed/wild species per phase at Skútustaðir

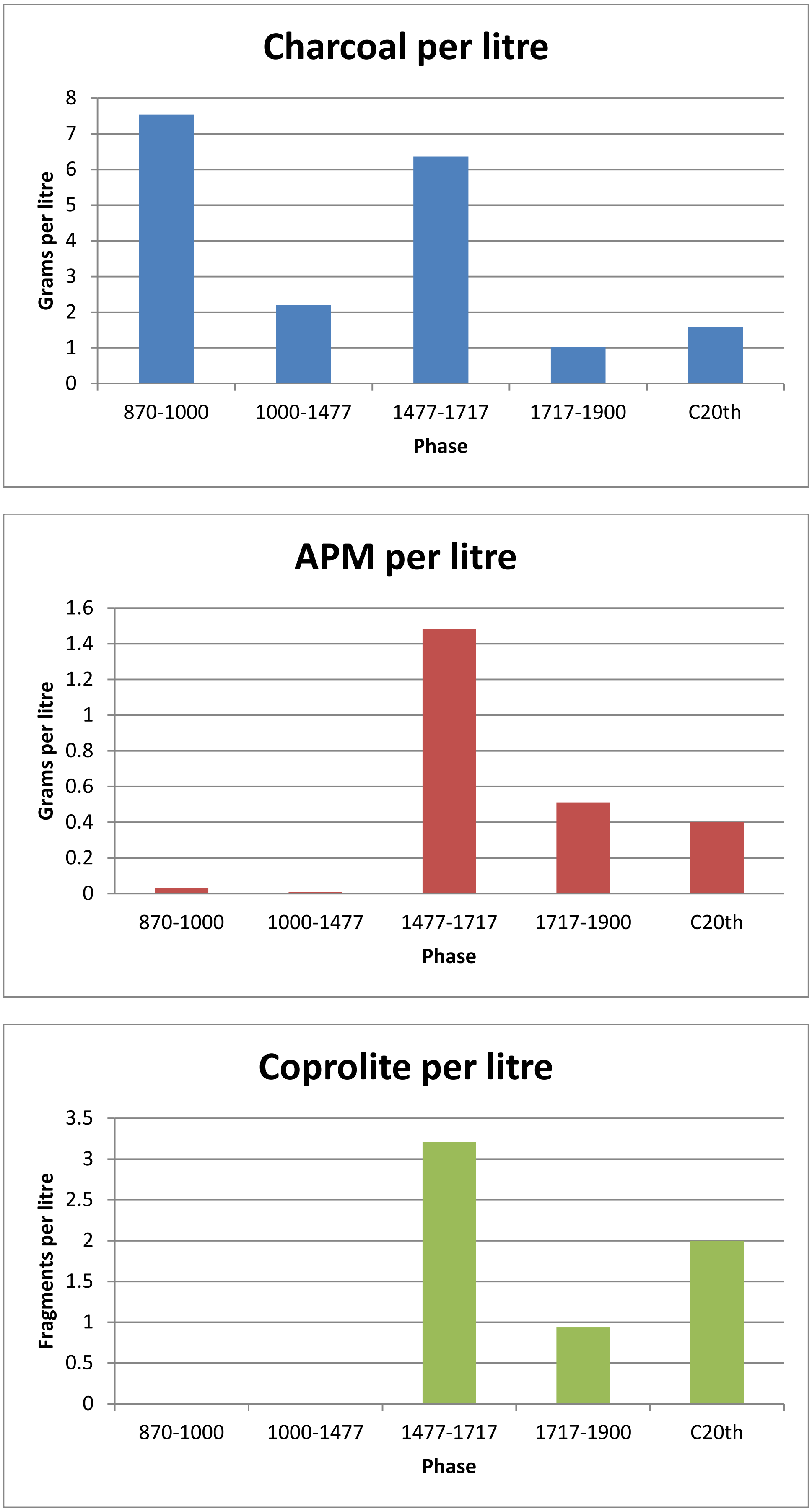


Figure 4.11 – Fuel constituents per litre across phases at Skútustaðir

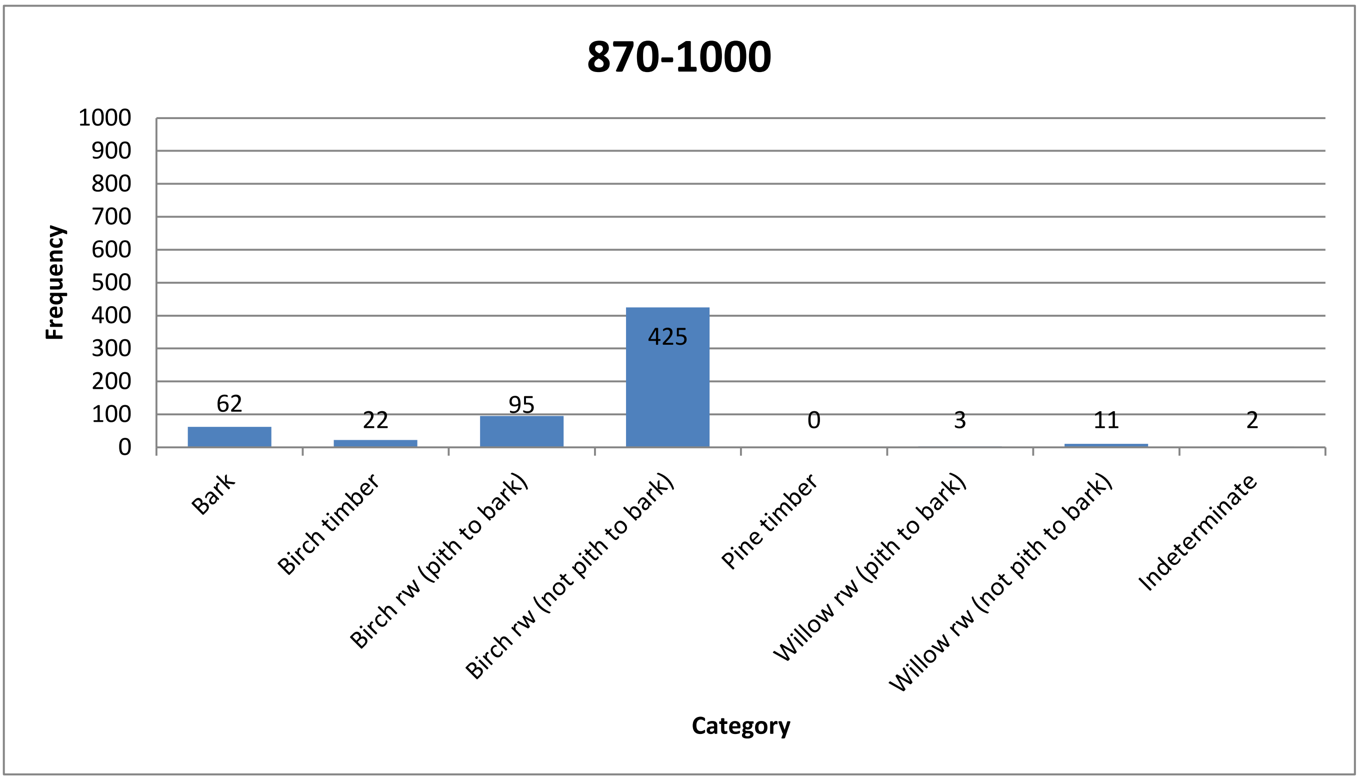


Figure 4.12 – Categories of charcoal for the industrial phase (870-1000) at Hrísheimar

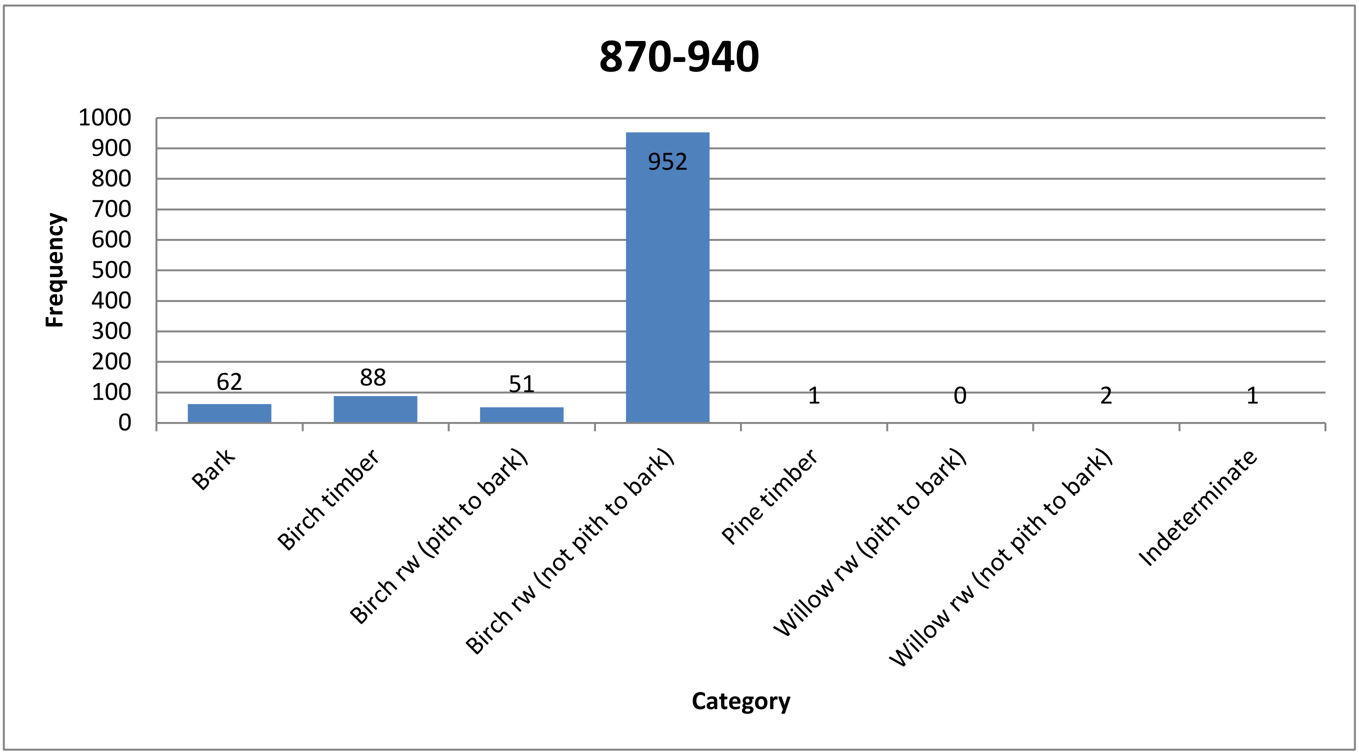


Figure 4.13 – Categories of charcoal for domestic phase 1 (870-940) at Hrísheimar

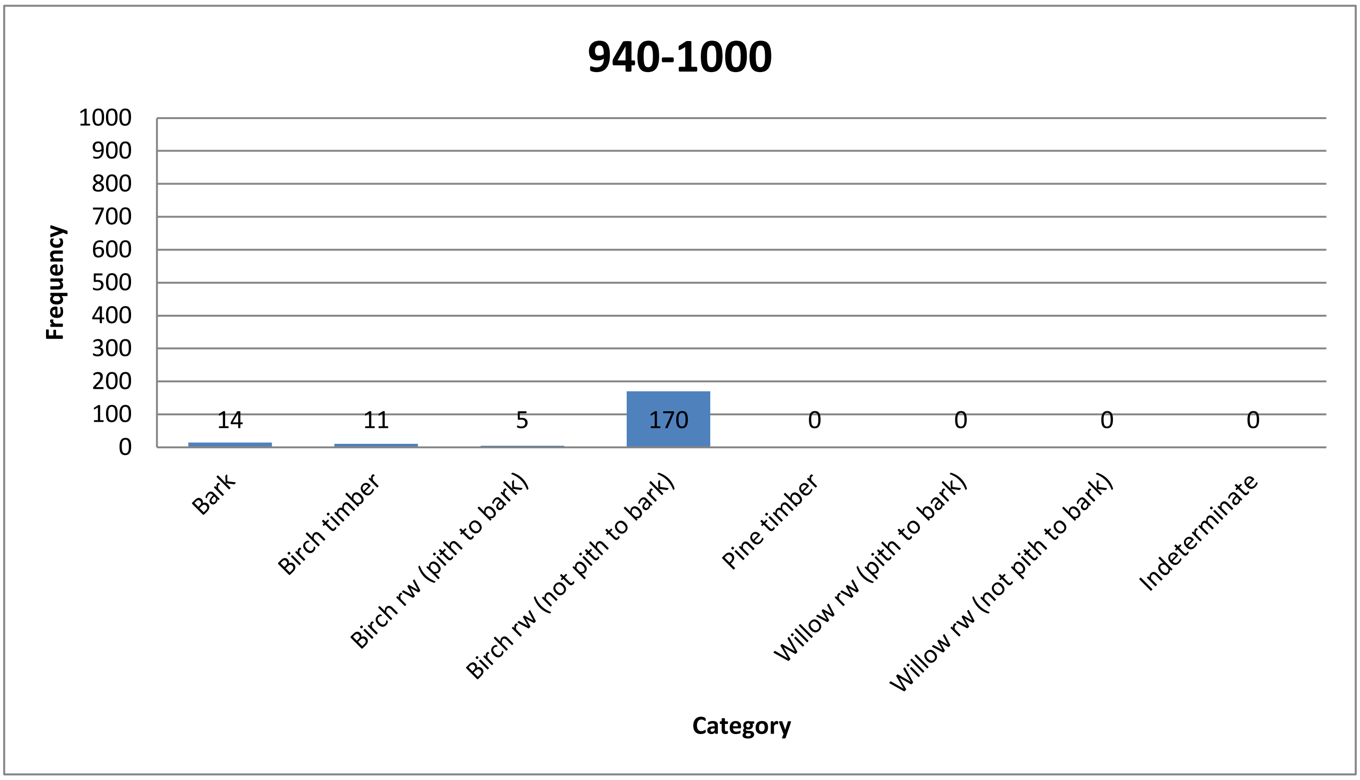


Figure 4.14 – Categories of charcoal for domestic phase 2 (940-1000) at Hrísheimar

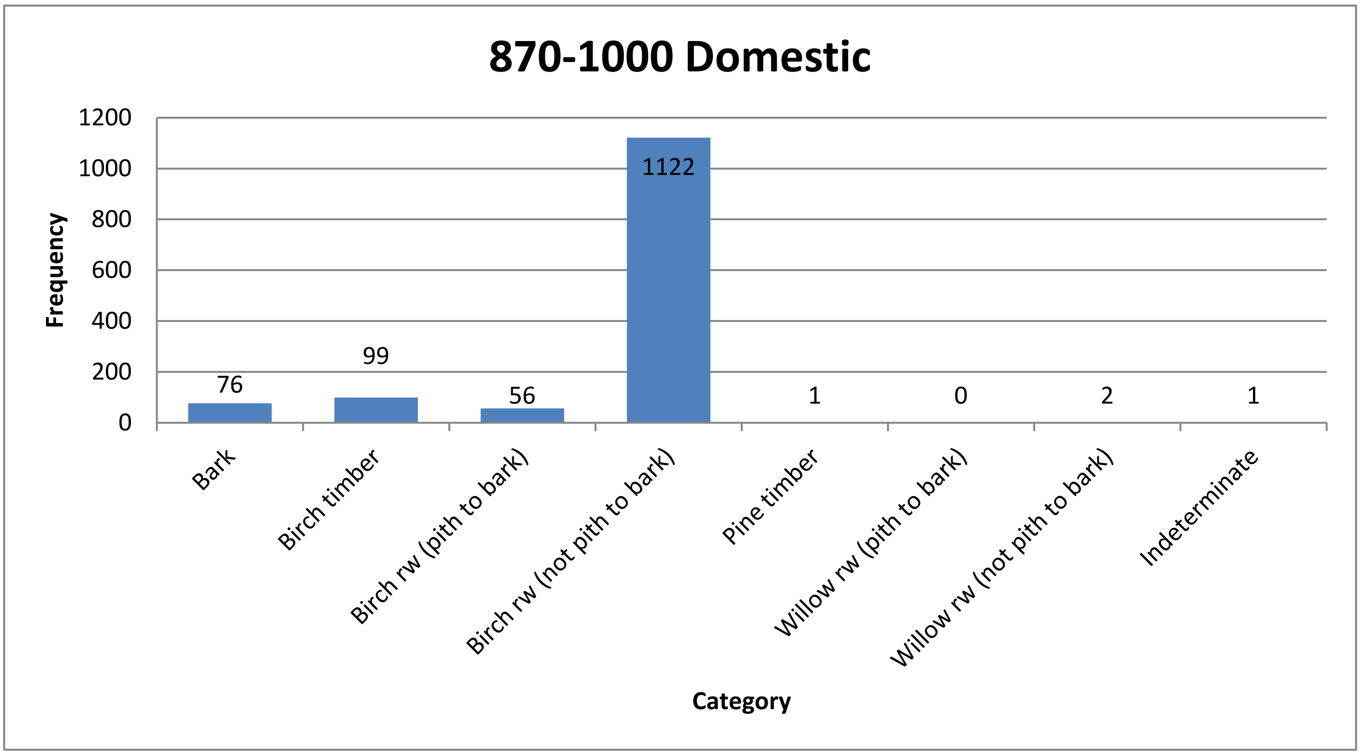


Figure 4.15 – Categories of charcoal for combined domestic phases (870-1000) at Hrísheimar

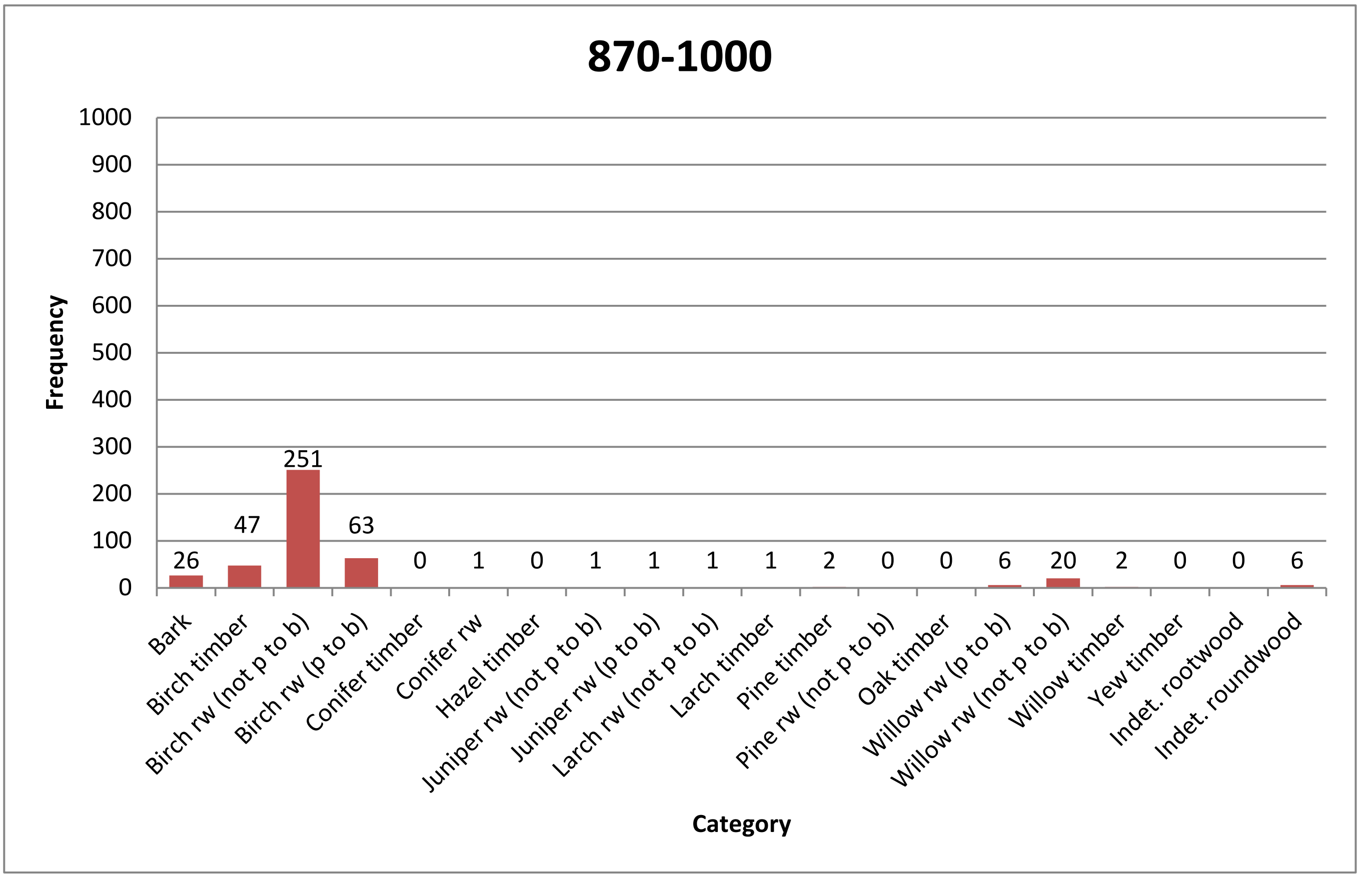


Figure 4.16 – Categories of charcoal for phase 1 (870-1000) at Skútustaðir

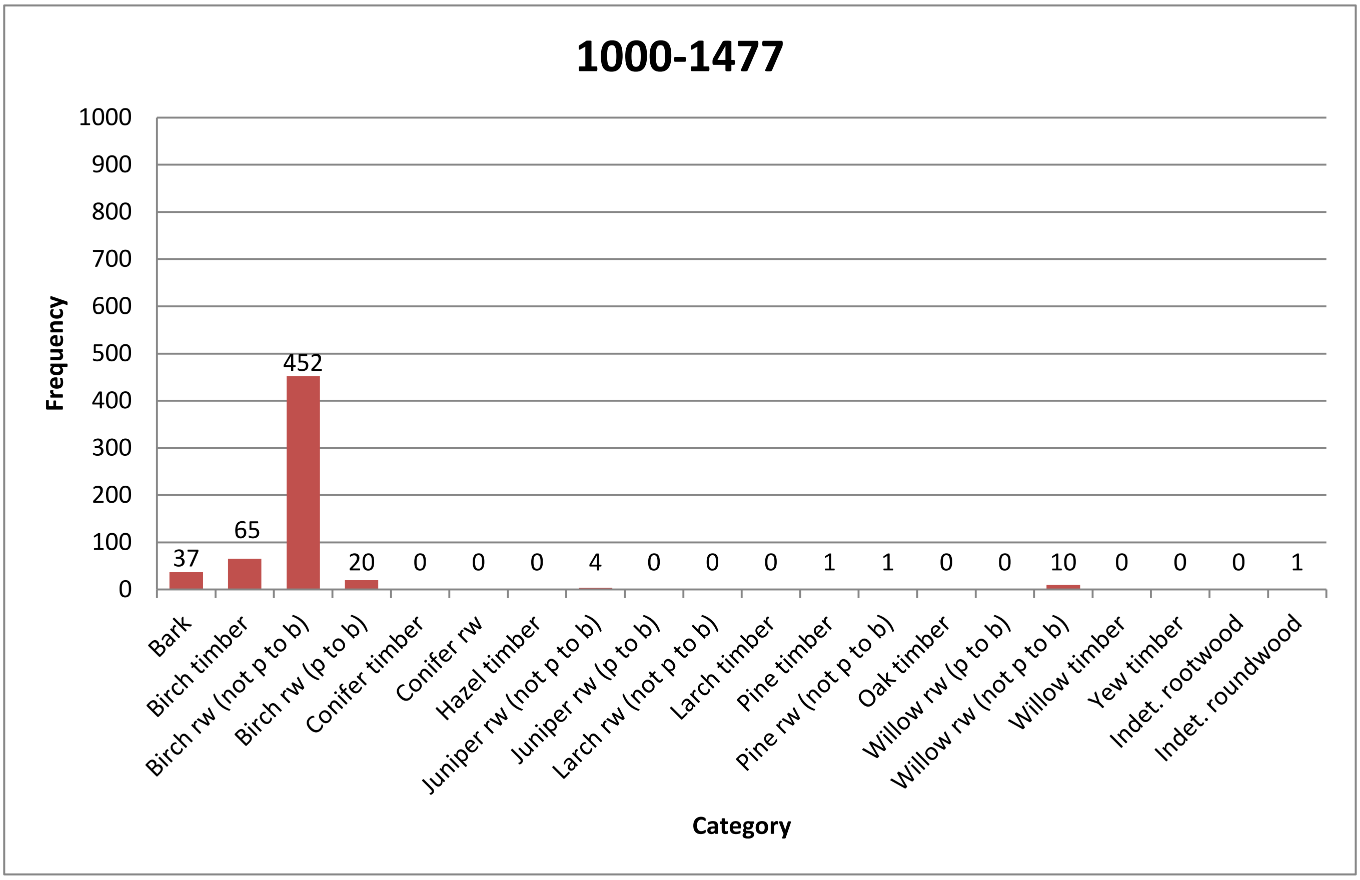


Figure 4.17 – Categories of charcoal for phase 2 (1000-1477) at Skútustaðir

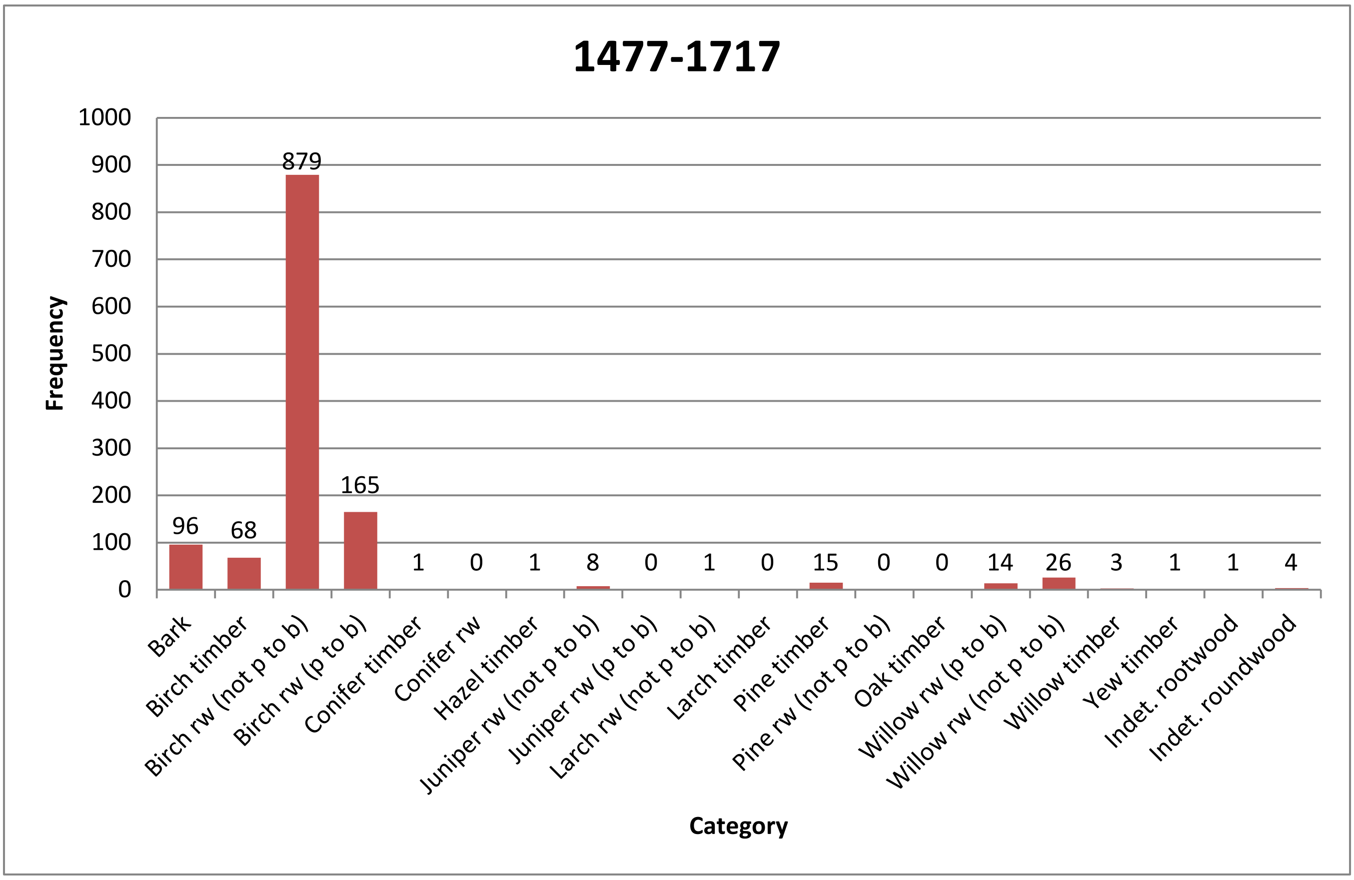


Figure 4.18 – Categories of charcoal for phase 3 (1477-1717) at Skútustaðir

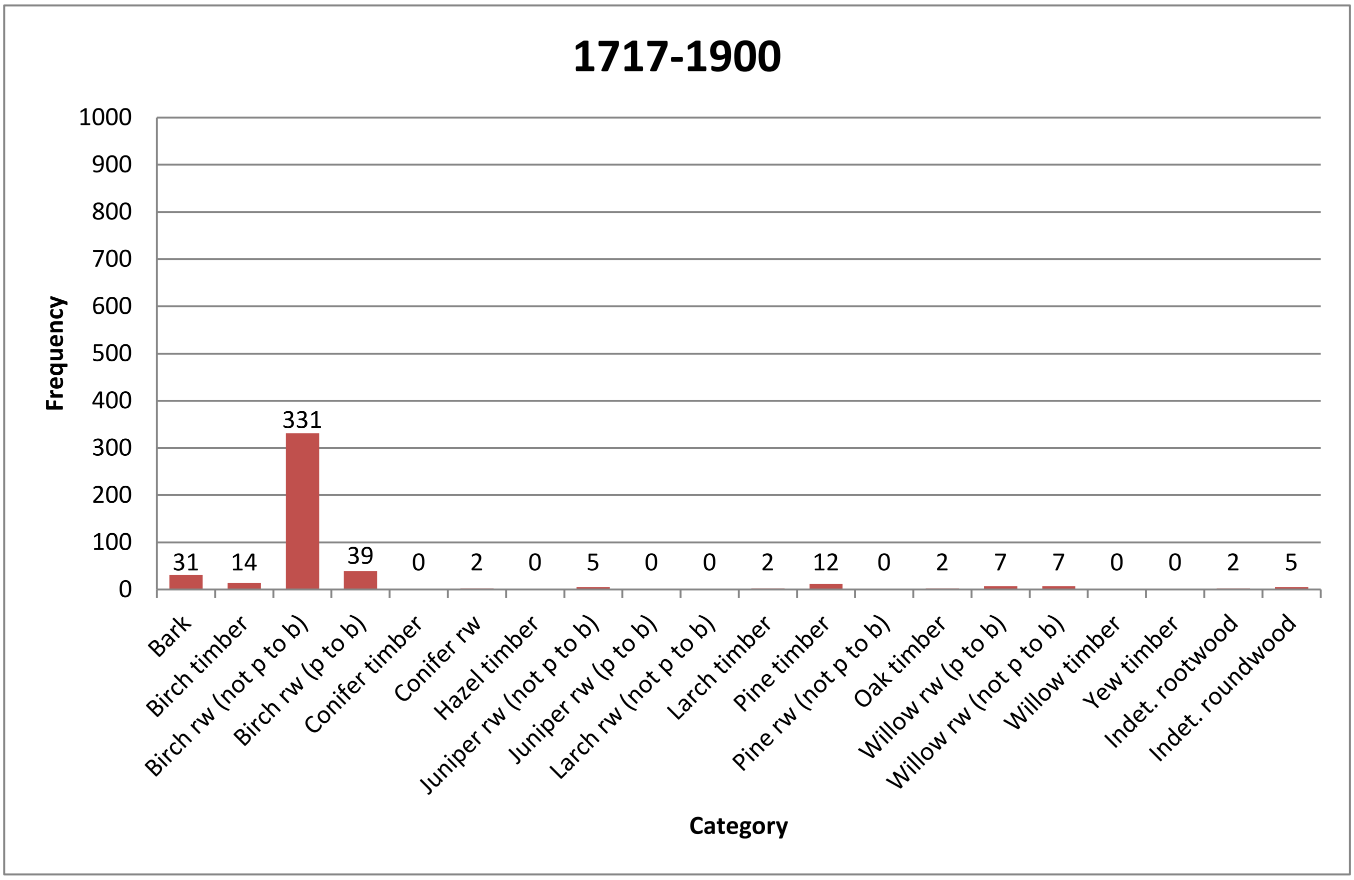


Figure 4.19 – Categories of charcoal for phase 4 (1717-1900) at Skútustaðir

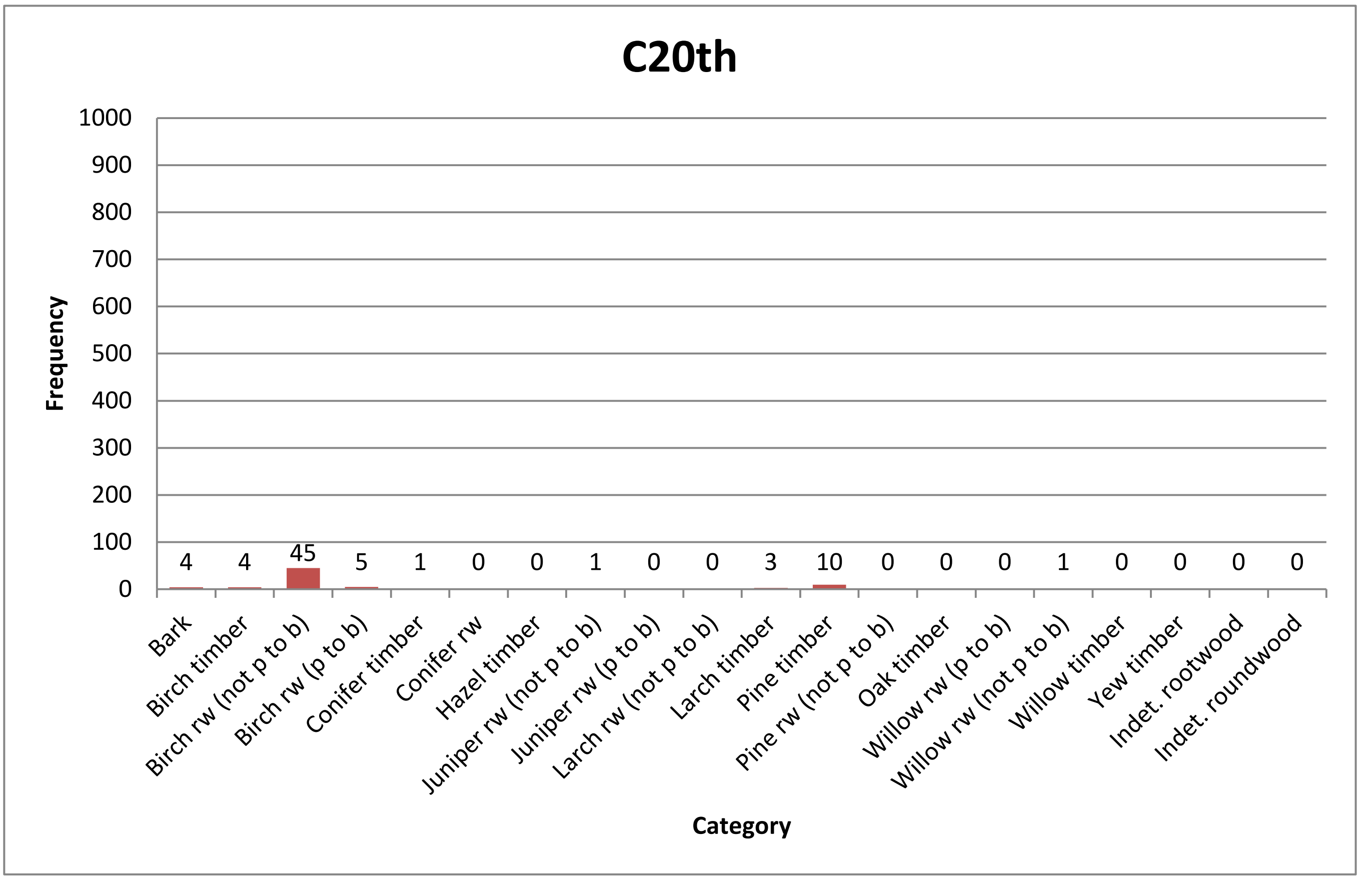


Figure 4.20 – Categories of charcoal for phase 5 (C20th) at Skútustaðir

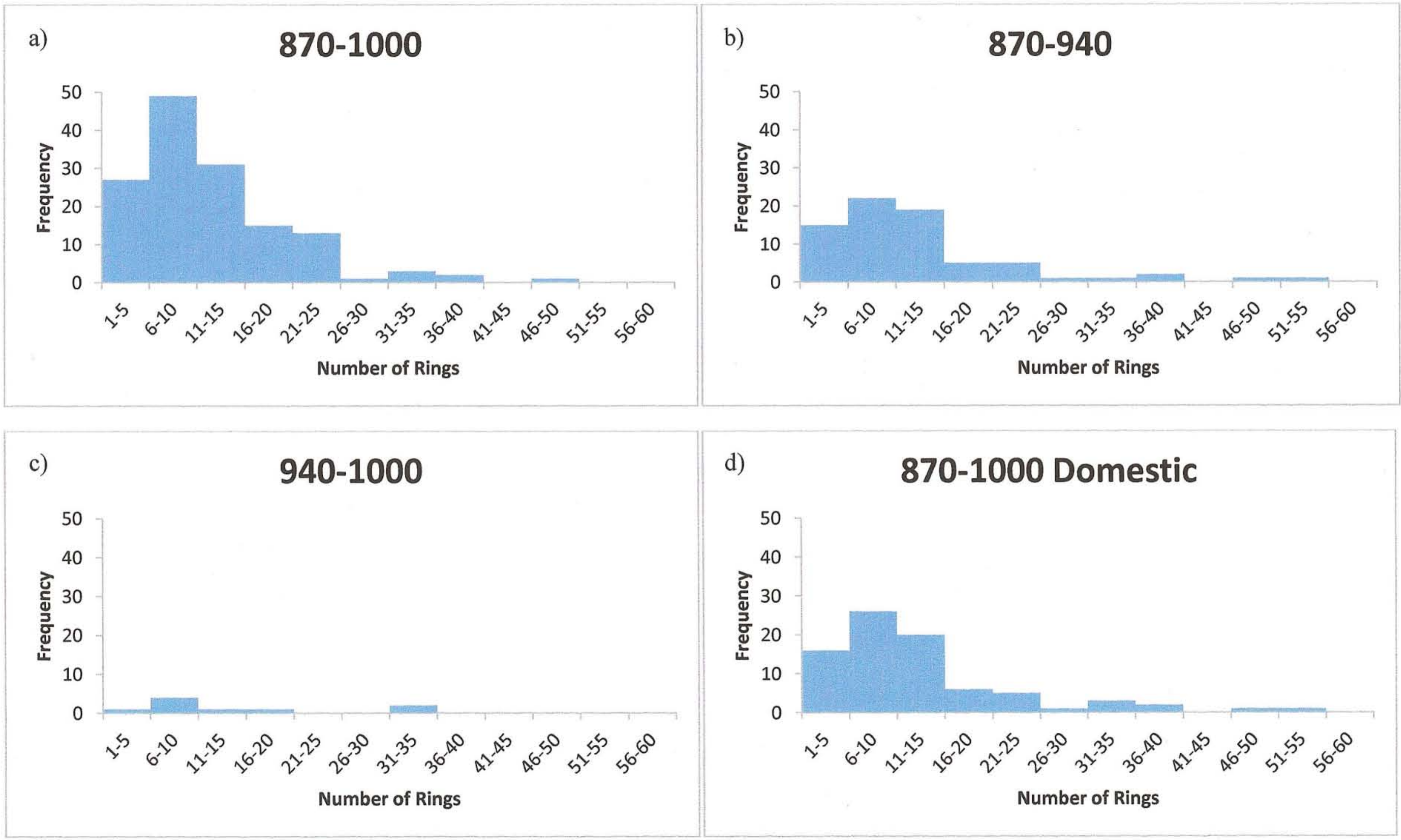


Figure 4.21 – Frequency of ring counts for all phases at Hrísheimar - a) industrial phase (870-1000), b) domestic phase 1 (870-940), c) domestic phase 2 (940-1000), d) combined domestic phases (870-1000)

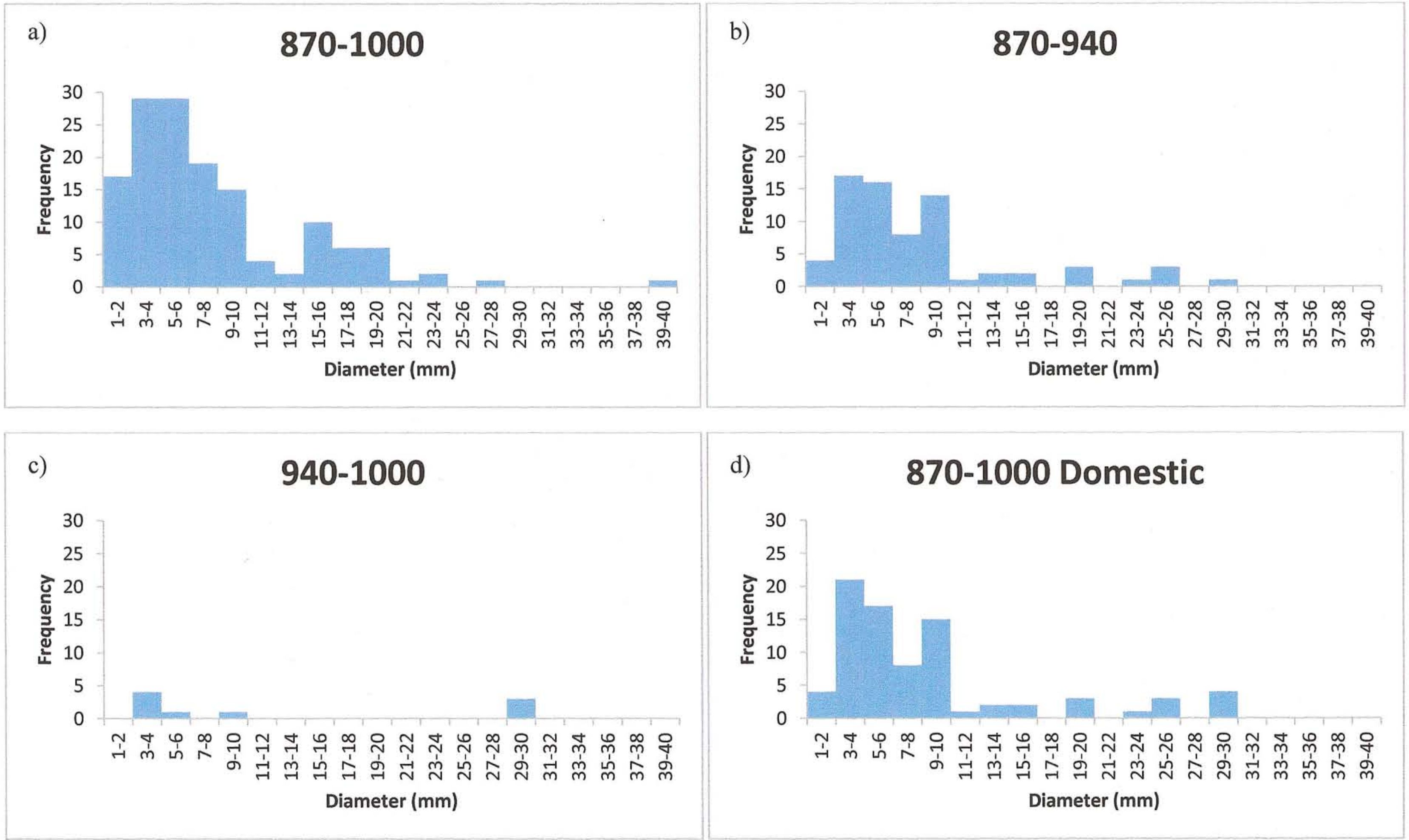


Figure 4.22 – Frequency of diameter measurements for all phases at Hrísheimar - a) industrial phase (870-1000), b) domestic phase 1 (870-940), c) domestic phase 2 (940-1000), d) combined domestic phases (870-1000)

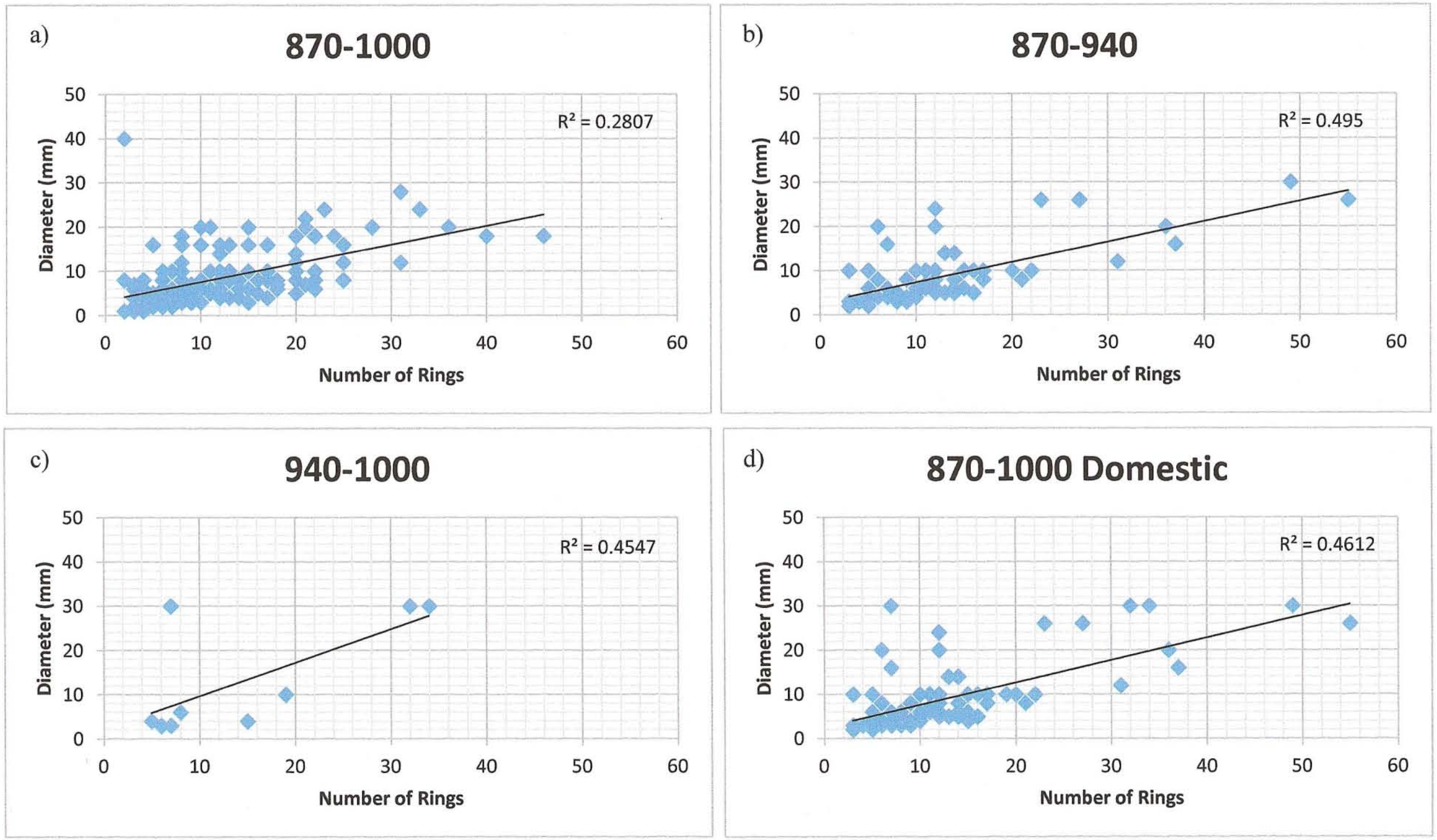


Figure 4.23 – Ring count/diameter data for all phases at Hrísheimar - a) industrial phase (870-1000), b) domestic phase 1 (870-940), c) domestic phase 2 (940-1000), d) combined domestic phases (870-1000)

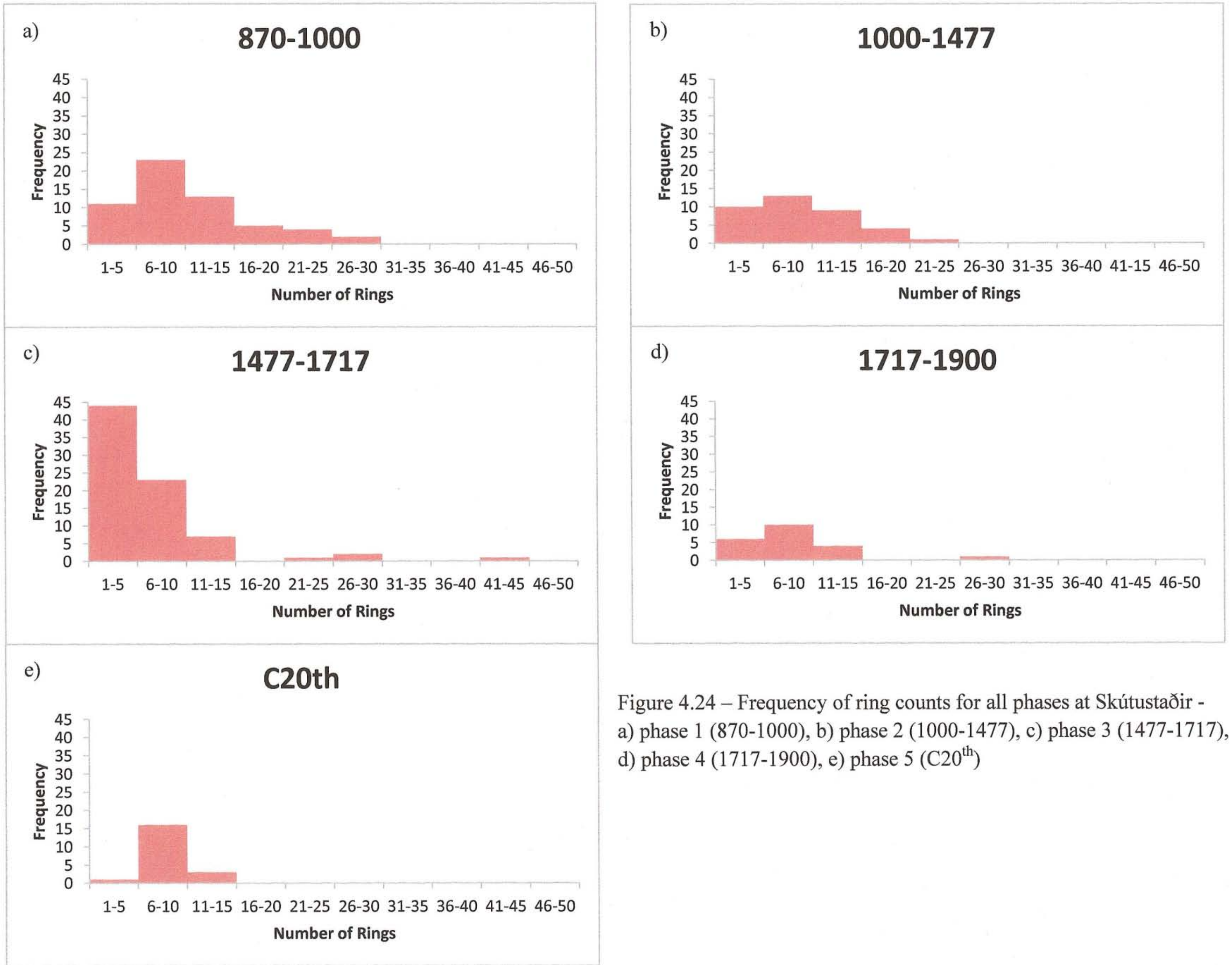


Figure 4.24 – Frequency of ring counts for all phases at Skútustaðir - a) phase 1 (870-1000), b) phase 2 (1000-1477), c) phase 3 (1477-1717), d) phase 4 (1717-1900), e) phase 5 ($C20^{th}$)

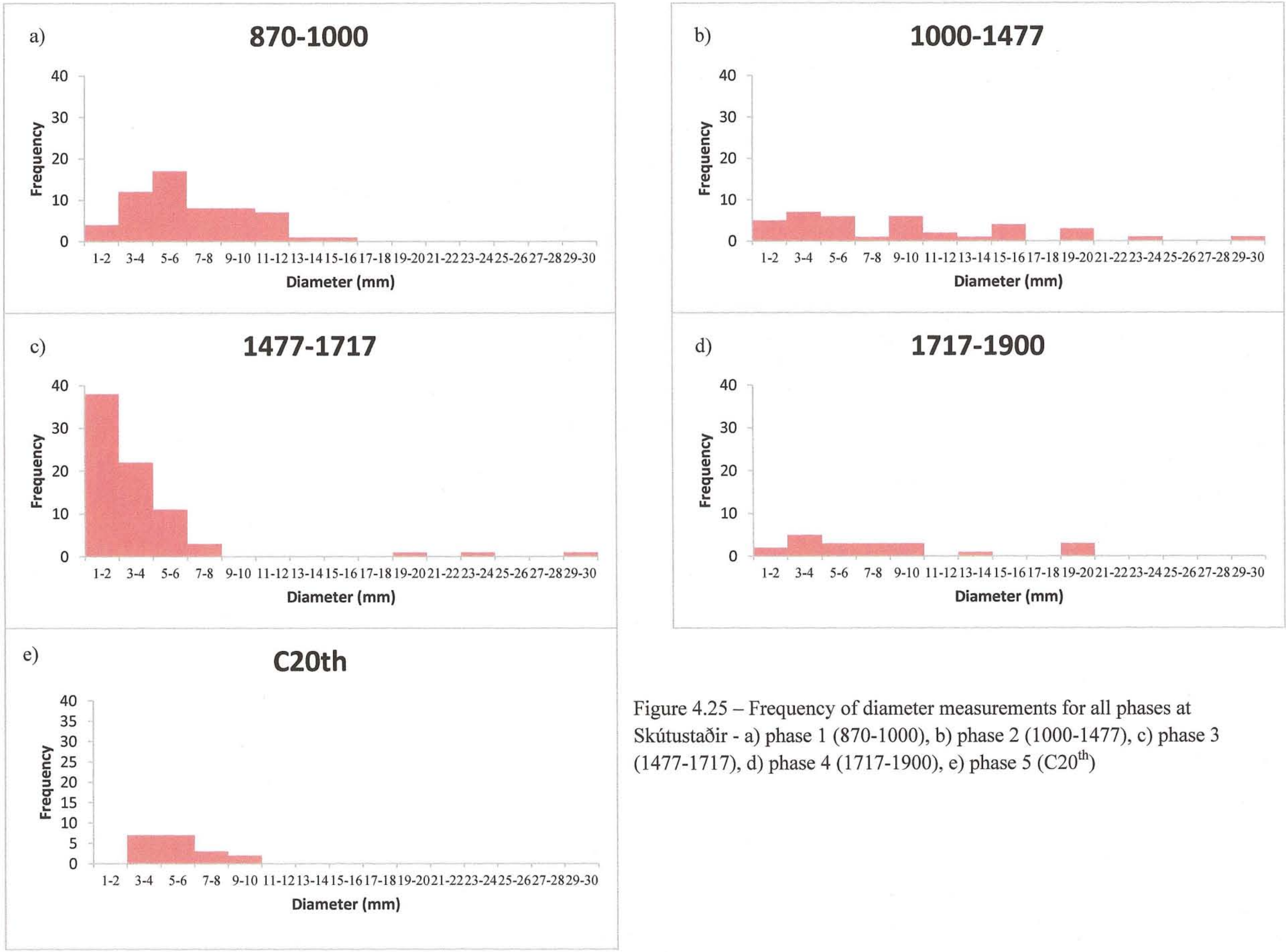


Figure 4.25 – Frequency of diameter measurements for all phases at Skútustaðir - a) phase 1 (870-1000), b) phase 2 (1000-1477), c) phase 3 (1477-1717), d) phase 4 (1717-1900), e) phase 5 ($C20^{th}$)

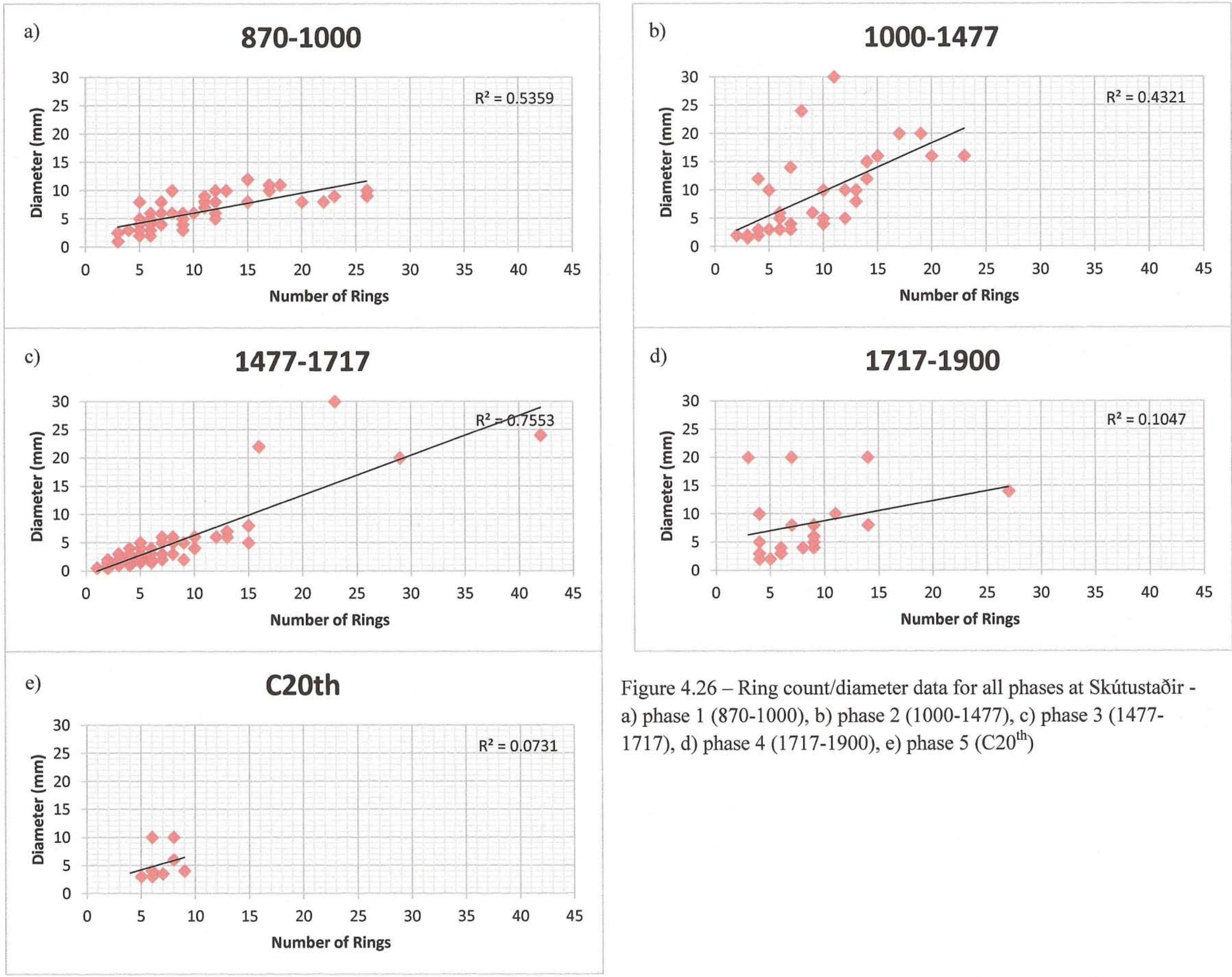


Figure 4.26 – Ring count/diameter data for all phases at Skútustaðir - a) phase 1 (870-1000), b) phase 2 (1000-1477), c) phase 3 (1477-1717), d) phase 4 (1717-1900), e) phase 5 (C20th)

Chapter 5: Discussion

This section will focus on a discussion of all results obtained, following the order of research questions formulated in the introduction. Subheadings have been utilised for ease of identification, and relevant tabular and graphical support has been referenced where appropriate.

Taphonomy

Generic taphonomic models may be utilised to explain the incorporation of plant macrofossils into the archaeological record at both Hrísheimar and Skútustaðir, concentrating on origin and preservation of recovered material. While survival of ecofacts requires specific conditions such as desiccation, freezing, charring, waterlogging and mineralisation (van der Veen, 2006, 1), taphonomic processes, occurring between deposition and recovery, determine continued survival and level of preservation. Presence or accumulation of macrofossil evidence may be indicative of human activity (Bohrer & Adams, 1977, 48; Zutter, 1999, 833). In order to be carbonised rather than burned, taxa need to drop quickly through the flame to be deposited in the ash residue, thus proximity to an ignition source is indicated (Hillman, 1981, 140; van der Veen, 2006, 11). This might reflect a domestic context such as the central hearth, or an industrial context such as a kiln or furnace.

The sites under investigation represent both contexts. At Hrísheimar the midden from areas H and L was in the vicinity of the long house suggestive of a domestic context (Edvardsson et al, 2003, 9; Byock et al, 2005, 209), while samples recovered from areas A, B and C were proximal to the iron working production unit. This indicates the necessity for two separate models to explain macrofossil incorporation. At Skútustaðir however, all midden samples derived from a domestic origin (Hicks et al, 2011, 6), similarly reflecting the central hearth model.

The domestic model incorporates three distinct stages; botanical materials were brought to the central hearth either purposefully to be cooked/dried, accidentally on feet, clothes or hair or as an accidental inclusion with food or fuel (van der Veen, 2006, 11; Church et al, 2007b, 750). Following accidental charring of the taxa, sweeping of the central hearth would facilitate their incorporation into the midden deposits where all domestic refuse was placed (Edvardsson et al, 2003, 23; Church & Peters, 2004, 99; Peters et al, 2004, 89). The industrial model however, relates to remains obtained from the purposeful burning of fuel for industrial

processes, such as smelting and metal-working. This includes both primary and secondary deposition. Primary deposition refers to *in-situ* deposits obtained from excavation of a furnace, while secondary depositions have been transported from the original site of burning. Such remains would include fuels utilised in the industrial process, dross (slag, hammerscale) plus accidental inclusions (from feet, clothes and hair), however, remains would tend not to include foodstuffs or materials accidentally harvested with them. Materials derived from both domestic and industrial sources may thus be explained by accepted taphonomic models (Church, 2000, 123).

At Hrísheimar, site evidence supports the domestic model, as an abundance of fireplace cleaning debris is recorded in the Interim Site report 2003. Seasonality of archaeofaunal remains (neonatal cattle and sheep plus bird egg shells) and a "... few small basket-dump sized deposits ..." (Edvardsson et al, 2003, 24) strongly suggest that household cleaning was on the basis of a few major episodes rather than regular daily chores (Edvardsson et al, 2003, 23-4).

Reflecting purely cultural deposits, midden examination is particularly useful when considering human use of botanical resources (Zutter, 1992, 140). Only taxa specifically targeted by humans are represented, although accidental inclusions may occur (Church et al, 2007b, 763). Species and plant parts are subject to differential collection, however, it is not always possible to determine the reasons behind such selection or whether alternatives were available (Zutter, 1999, 843). For example, an abundance of birch may signify its woodland dominance, or be due to specific qualities valued by humans. Midden deposits do not, therefore, reflect the full range of species in an area and only non-cultural or palynological evidence can provide a more realistic picture of environmental reconstruction (Zutter, 1999, 843).

A variety of domestic refuse including butchery waste and meal consumption debris would have been placed on the midden on a regular basis (Edvardsson et al, 2003, 23). Such deposition may have been utilised for fertilisation of the infields to improve hay and cereal yields. In the case of Hrísheimar, the build up of midden material suggests soil amendment was not practised on a regular basis (Edvardsson et al, 2003, 18). This may imply that cereal cultivation was minimal or had ceased after an initial phase. Conversely at Skútustaðir, infield soils had been repeatedly built up as a result of regular distribution of midden material by past inhabitants to enrich the soil with a view to increasing productivity (Hicks et al, 2011, 10).

Lack of soil amendment at Hrísheimar may have contributed to erosion which influenced the later decision for farm abandonment. In contrast Skútustaðir remains to the present day (although subject to limited erosion), and this allows temporal comparison. Depositional patterns change over time and some midden areas display intense usage followed by a period of abandonment (Hicks et al, 2011, 29). Low density deposits between the 1477 tephra and the Viking Age material, as seen in areas H, E3 and G suggest that High Medieval domestic refuse was deposited elsewhere. This may indicate that the inhabitants shifted their residence or that they regularly changed their midden site (Hicks et al, 2011, 19). The latter would support land enrichment as one midden may be in current usage, while an earlier one may contain material more suitable for spreading on the land. An interesting usage of midden material at Skútustaðir was for in-filling of what Edwald & McGovern (2010, 15) describe as 'pseudocraters' in the landscape. This practice would have evened out the land in effect expanding the infield area and thus increasing production capacity (Edwald & McGovern, 2010, 16). Such alterations accord with changes over time in settlement organisation and spatial allocation of domestic/work related areas. Yet the domestic taphonomic model remains constant until the mid 20th century. Introduction of electric ovens and central heating made the central hearth, and the model based on it, obsolete. This transformed household operations and both constituents of waste, and its disposal, were radically altered.

In contrast, the industrial model provides more limited information being restricted to one site and a much reduced time frame. Additionally waste disposal itself is less precise. Within areas A-C, twenty-one features were discovered and represent the remains of two types of iron smelting furnace used to process iron ore (Edvardsson et al, 2003, 8 & 25). The structure in area B contains a fireplace, and due to producing lower temperatures, may have been utilised for cleaning bog iron or bloom after firing (Edvardsson et al, 2003, 8). Much metal working debris has been recovered from these contexts and while some remains are found *in-situ* (eg. from the fireplace in B and several furnaces in A & C), many other deposits have been removed from the original site of burning (Please refer to Appendix One). Nonetheless there does not appear to be a common site for dumping industrial waste. Due to the number of furnaces and extensive debris however, iron production is thought to represent a major part of the economy at Hrísheimar (Edvardsson et al, 2005, 17).

Unusually a single cereal grain was obtained from the industrial context (Table 4.3 & Figure 4.1) but in a very poor state of preservation (P5) and this may indicate high temperature burning. Yet while quality of preservation is subject to chance to a limited degree,

preservation bias may account for the amount and range of archaeobotanical material, with certain species favoured by specific methods of preservation. Charring differentially preserves cereal grains, glumes of ancient wheat plus dense and woody seeds (Boardman & Jones, 1990; Wilkinson & Stevens, 2003, 151-160; van der Veen, 2006, 13).

At Hrísheimar preservation level of cereal grains from the first phase of the domestic context covered all 6 classes (Table 4.3 & Figure 4.1). While the majority of samples (30%) demonstrated a poor level of preservation (P5), high representations were also obtained in classes 2 and 3, with one oat (*Avena* sp.) grain showing excellent preservation (P1). The 870-940 ubiquity count for indeterminate seeds is lower than for the later phase and industrial context (Table 4.1), implying a higher level of preservation as more seeds could be identified. Similarly, later grain preservation provided the highest representation at class 6. Although this may reverse expectations of increased preservation in later phases, proximity to the surface and site erosion/weathering may have played a significant part in archaeobotanical degradation. Exposure to high temperatures may have been an additional factor for the highest ubiquity count for indeterminate seeds in the industrial phase.

Interestingly Skútustaðir provides conflicting results (Table 4.2, 4.4, Figure 4.2). A lower indeterminate seed ubiquity count was recorded for the 870-1000 phase when compared to the same time period at Hrísheimar, while grain preservation was also lower. Yet as the Skútustaðir phase contained only a single caryopsis, no conclusions can be drawn. This trend continues across phases however, for as grain preservation improves over time at Skútustaðir, indeterminate seed ubiquity counts also increase. This suggests improved preservation for cereal caryopses over time while seed preservation deteriorates. As a food source, their pre-charring conditions may have been more carefully regulated than seeds which may be in a poor physical state prior to being burnt. Cereal caryopses are favoured by the charring process and their increased size may also be advantageous (Wilkinson & Stevens, 2003, 151-160). If placed on the fire with the fuel source, seeds would have been exposed to higher temperatures for a longer duration. Alternatively**,** caryopses may possess greater botanical refuse durability and, for example, may be more resistant to Icelandic freeze-thaw conditions (Zutter, 1999, 833). Deteriorating preservation levels over time as occurred on both sites (Figure 4.3) (with Skútustaðir seeds and all material at Hrísheimar), may be generally explained by taphonomic conditions. Yet such factors cannot be used to explain divergence over time.

It is now widely accepted that use of plant materials as fuel are responsible for the majority of carbonised assemblages (Hillman, 1981; van der Veen, 2006, 11). Many fuels contain accidental inclusions; however even those without such additions may not be a targeted fuel source. Thus while wood is the most common, timber charcoal is more likely to originate from offcuts created by construction activities or via the purposeful disposal of wooden artefacts which have outlived their utility. Peat, turf and dung contain inclusions yet differ in one vital respect. Constituents of peat and turf naturally include seeds and plant parts of species growing in the vicinity, while inclusions in dung such as chaff, arable weeds and seeds of pasture vegetation, must first have been consumed by domesticates (van der Veen, 2006, 14). In the above examples, incorporation into the archaeological record via the industrial or domestic models identified in this research would not have been intentional.

Arable Agriculture

Historical, archaeological and palynological evidence agree that barley (*Hordeum* sp.) was the primary cereal crop in Iceland. Yet while the Saga of Bishop Gudmund relates that barley is the sole arable crop (apart from hay), growing in only a few places in the south (Byock, 2001, vi), archaeobotanical evidence for both barley and oat (*Avena* sp.) has occurred throughout Iceland. Pollen grains have been recorded for both cereals from two sites in southern Iceland. Although identification criteria have been called into question at Stóra-Mörk (Vickers et al, 2011), representations from Ketilsstaðir have been dated to AD 935-1075 for barley and AD 1195 for oat (Erlendsson et al, 2009). At Skalholt barley pollen appears immediately post-landnám (Einarsson, 1962), while at two sites (Vatnsýri & Mosfell) such pollen was recovered from beneath the landnám tephra (Hallsdóttir, 1987, 22 & 26). This may be indicative of a wild species, or signify an earlier settlement. Oat and barley pollen was also found at Reykholt in western Iceland, which dates from the later Middle Ages (Sveinbjarnardóttir et al, 2007). In the north too, Lake Helluvaðstjörn, in the midst of Mývatnssveit, yielded evidence of both oat and barley, although the *Avena*-type grains were below the landnám tephra and assumed to be from a wild species (Lawson et al, 2007, 13).

Macrobotanical evidence is also found predominantly in the south of Iceland with Aðalstraeti and Gröf recording barley caryopses. While the former are dated to approximately landnám (Roberts et al, 2004), Gröf samples remain undated (Friðriksson, 1959). At Skalholt, macrobotanical remains support palynological evidence, however as they are undated and include barley, oat and rye, they may belong to a later period and thus constitute imports

(Archaeological Services, 2010). At Reykholt barley caryopses dated to the 10^{th}-11^{th} centuries confirm palynological evidence; however no oat specimens were recovered. In the north of the island, Reynistaður provided barley caryopses dated to 870-1000 (Trigg et al, 2009), however the barley and oat grains recovered from Hofstaðir, Mývatnssveit were interpreted as imports with oat being a weed contaminant (Guðmundsson, 2009). At all sites, barley was found to be the dominant cereal crop, and this was confirmed at the two research locations. The higher number of grains found at Hrísheimar covered a wider range of classifications, the relative frequencies of which can be seen in Tables 4.1 & 4.3. While only a proportion of barley grains could be further identified, the presence of asymmetrical grains indicates a six-row hulled (*Horduem vulgare* var. *vulgare* L.) variety was being cultivated (Church, 2000, 122). In two-row barley (*Hordeum vulgare* f. *distichon* L.) the central spikelets alone are fertile and produce only straight grains, whereas in six-row, all three florets are fertile, and the grains that develop on the two outer flowers are twisted, although the central grains remain straight (Renfrew, 1973, 71; Guðmunsson, 2009, 329). As symmetrical grains can be produced by both types, straight and non-identifiable grains may indicate the simultaneous presence of a two-row hulled type. The charring process may distort grains however, and some grains which have been identified as twisted, may in fact be straight (Gudmundsson, 2009, 329; McGinnes et al, 1974). While a 2:1 ratio normally exists between asymmetrical and symmetrical grains from six-row hulled barley (Renfrew, 1973, 71), the Hrísheimar results yielded a 4:3 ratio (Tables 4.1 & 4.3). This may reflect simultaneous presence of the two-row variety or result from small sample size. Hulled barley predominated on both sites, however only one grain could be further identified from Skútustaðir (Tables 4.2 & 4.4). Ratio analysis was thus impossible, yet presence of a six-row hulled type may be suggested providing distortion of the grain did not occur. The hulled varieties would have been the preferred barley crops as the glume clings to the grain offering increased protection from climate, fungi and pests, even though they require more post-harvest processing (Hillman, 1981).

The two sites may be compared by focusing on the 870-1000 period. Ubiquity counts for total barley grains over this phase are 20.93 and 7.14 for Hrísheimar and Skútustaðir respectively, demonstrating a much higher recovery of barley from the Hrísheimar site (Tables 4.1 &4.2). Several reasons may account for this. The inhabitants at Hrísheimar may have adhered more closely to the Norse model farm, attempting to mirror grain production in the homeland (Hjelle et al, 2006, 155; Dugmore et al, 2005, 27). A larger family unit necessary for farming

plus metal working and/or increases in consumption of porridge, bread and ale may also have contributed. Alternatively Skútustaðir residents may have been more focused on pastoral farming, especially considering their proximity to the lake and wet meadow areas (McGuire, 2006, 6). While meal preparation accidents are most likely to account for the inclusion of cereal caryopses into the archaeological record, by-products of cereal harvesting are easily burnt off (van der Veen, 2006, 10). Yet both grains and chaff may be proximal to the fire during post-harvesting processes, and these may have differed between sites. In particular, the final crop processing stage of hulled barley involved drying the grain prior to the process of graddening, during which the hull was removed by grinding (Fenton, 1982). Requiring a heat source, the central hearth was often utilised to perform this function. This may have occurred at Hrísheimar while Skútustaðir employed off site processing.

The small amount of chaff recovered from each site (Figures 4.6 & 4.7) and absence of other waste products associated with cereal processing, suggests off site operations. Differences were apparent however, as Hrísheimar produced 4 culm nodes, while at Skútustaðir, 3 culm bases were recovered. This suggests a different harvesting strategy with plant stems cut at Hrísheimar, but pulled up whole at Skútustaðir; and this may have had a significant effect on fodder biomass between sites. Cereals were considerably taller at this time due to the need for longer culms for straw fodder. Cutting rather than pulling would have reduced each stem by at least 2 inches, and taken over a whole infield area, would have yielded significantly less. This suggests that either Skútustaðir had a greater need for such fodder or that they made better use of their valuable resources. Allowing free grazing domesticates to feed on remaining stalks, as seems to have occurred at Hrísheimar would have allowed natural dunging, however, it appears likely from midden accumulation that this was the only period and form of enrichment at this site. Animal husbandry practises may also have required the inclusion of chaff as an on-site fodder source, which was then accidentally introduced to the central hearth (Church, 2000, 122).

At Hrísheimar, the amount of grain recovered per phase remains fairly constant. Due to the increasingly poor preservation of the later samples however, it is not possible to distinguish between barley and oat. Thus while Figure 4.4 demonstrates a fall in barley and oat during the second phase, the large number of indeterminates suggests this is unlikely to be a true representation of events.

Temporal changes are more pronounced at Skútustaðir, with only barley grains obtained from the initial phase (Figure 4.5). The following period (1000-1477) yields no evidence of cereal grains and may be explained by midden relocation, however, adverse conditions may also account for this. Many periods of severe famine have been recorded in Iceland from the 10th century and indeed while the 14th century is reported to have suffered repeated shortages, the 15th century is said to have been characterised by famine and disaster (Friðriksson, 1972, 785). Deteriorating climatic conditions from 14th century due to the onset of the Little Ice Age (LIA) rendered cereal growing virtually impossible (Guðmundsson, 2009, 331), and this was accompanied by social and economic factors. Population decline resulted in insufficient labour to work the land while a shortage of manure decreased enrichment activities (Sveinbjarnardóttir et al, 2007, 203; Simpson, 2001, 440). Thus grain production is unlikely to have been significant. With an increase of sea ice blocking the harbours (Axford et al, 2007, 3355; Simpson et al, 2002, 424; Smith, 1995, 324), imports would also have been extremely difficult to obtain, making every grain precious. Considerable reductions in the cost of imported barley in the Medieval period, however, ensured the decline in local cereal production (Erlendsson et al, 2009, 180).

Many sources agree that barley production had virtually disappeared by 15th century (Simpson et al, 2002, 424), and indeed no distinguishable cereal was recovered for the subsequent phase (1477-1717), although a small number of indeterminates were recorded. A temporary respite in the 16th century was quickly reversed, yet this interim may have facilitated the growth of imports. Level of preservation was poor however, and may have been adversely affected by travel conditions or the freeze/thaw process. The increase in all grain categories for Phase 4 (1717-1900) relates more and better preserved grain (Table 4.4 & Figure 4.2). Even as an import, barley remains the dominant species, yet oat (*Avena* sp.) appears for the first time. While it is claimed that rye (*Secale cereale* L.) had become the most important imported grain in the Icelandic diet by the Middle Ages (Rögnvaldardóttir, 2002), there is no evidence for its existence at the Skútustaðir site. By the final 20th century phase, the only representation is for barley. This reflects the good level of preservation in the uppermost midden layers, which had not been subject to erosional factors.

While the discussion so far is based on the assumption of local cereal growing from landnám to the 14thcentury, evidence of cereal cultivation in Iceland is limited. Due to being on the margins of productive cereal cultivation only oat and barley would have been viable (Sveinbjarnardóttir et al, 2007, 202). Barley was a vital constituent of the Norse agricultural

package being a stable crop in Norway (Hjelle et al, 2006, 155), and thus a sustainable barley crop would have been anticipated by settlers (Erlendsson et al, 2009, 174). While few sites have produced macrobotanical remains, it is widely accepted that barley was grown on Iceland (McGovern et al, 2007, 29; McGuire, 2006, 19; Vésteinsson et al, 2002, 102; Smith, 1995, 329), although this tends to be regional with the south and west considered most favourable (Erlendsson et al, 2009, 174; Zutter, 1992, 144). Cereal species are limited in their pollen production and as such are often underrepresented in pollen diagrams (Edwards, 1989). With the identification of *Hordeum*-type pollen, difficulties still exist in separating it from that of other wild grasses such as lyme grass (*Leymus arenarius* (L.) Hochst.) (Tweddle et al, 2005; Erlendsson et al, 2009, 177). Indeed at some sites, such as Mýrdalur in southern Iceland, this species was utilised as a cereal substitute (Erlendsson et al, 2009, 184). Yet the Mývatnssveit locale, with its more continental climate, has yielded palynological evidence of barley cultivation (Lawson et al, 2007, 12). Originating from Lake Helluvaðstjörn, less than 8km distant from Hrísheimar and approximately 5km from Skútustaðir, such practices were certainly feasible in this area. The limited locations for cereal growing also tended to be the higher status farms (Sveinbjarnardóttir et al, 2007, 203) which would apply to both Hrísheimar and Skútustaðir.

Lack of chaff at the Hrísheimar site (Figure 4.6) would seem to suggest that cereal was imported, and failure of an experimental barley crop at Hofstaðir in 1992 may support this (Guðmundsson, 2009, 331). One method for determining whether a crop is imported or local, however, is to examine the composition of associated weeds. Any which are not indigenous to the local area, or Iceland generally, may indicate transportation from other areas of Iceland, or importation from abroad (Sveinbjarnardóttir et al, 2007, 202). No such taxa were recovered from the Hrísheimar samples (Table 4.1). It is further suggested that small barley grains may indicate harsh conditions as prevail in Iceland, thus allowing a distinction to be made between local and foreign origins (Sveinbjarnardóttir et al, 2007, 202). A variety of factors are ultimately responsible for dimensions of caryopses however, including temperature, rainfall, amendment strategies, position of grain within the ear and carbonisation conditions. The average size of grains at Hrísheimar and Skútustaðir (Figures 4.3 &4.4) were very similar (Hrísheimar, barley: 4.23×2.57×1.93mm, Skútustaðir, barley: 4.4×2.3×2.1mm) however a significant difference existed in oat grain dimensions between sites (Hrísheimar, oat: 5.75×1.75×1.625mm, Skútustaðir, oat: 11.5×2.5×1.5mm). The sole Skútustaðir oat sample was from a later time period and so is likely to have been an import. Reduced dimensions of

the Hrísheimar oat grains may indicate that samples were a weed of the barley crop and therefore not intentionally cultivated. Combined evidence from macro-remains, pollen evidence (Lawson et al, 2007, 12), weed species and plough marks discovered at another site in Mývatnssveit (Ingiríðarstaðir) (Guðmundsson, 2009, 331), would seem to favour home grow barley production. Chaff may have been utilised as animal fodder without having the opportunity to become carbonised. The scenario is broadly similar at Skútustaðir during the initial phases, suggesting local cultivation. In Phase 3 however, chaff increases massively, which is confusing as barley production had ceased by this stage. This could be the result of the burning of turf, peat or dung however, as chaff may be attributable to large grasses.

While cultivation of barley would have been at no more than subsistence level (Simpson et al, 2002, 424), soil management may have been a limiting factor in early grain production. Yet the effectiveness of enrichment strategies may have been reduced by aeolian accumulations from eroding soils, resulting in a regional/localised spread of barley growth (Simpson et al, 2002, 434). Evidence for oat growing tends to be palynological and extremely rare. *Avena* sp. may not have been included in the Scandinavian agricultural package, however many Viking settlers had colonised Iceland via the Scottish Isles (Sveinbjarnardóttir et al, 2008, 1) where oat was an important crop (Bond et al, 2004, 142; Church et al, 2005, 193). Thus immigrants probably brought this cereal with them. The Hrísheimar site produced 5 grains from the first domestic phase; however no evidence was recovered from Skútustaðir from this time period (Figures 4.4 & 4.5). A single grain has also been discovered at Hofstaðir and these occurrences indicate either very limited oat cultivation or the presence of wild oat as a weed of the barley crop (Guðmundsson, 2009, 331). The distinguishing characteristics of *Avena* sp. are located on the floret bases, and as these do not generally survive, it is impossible to determine if specimens are from the wild or a cultivated species (Bond et al, 2004, 141; Lawson et al, 2005, 668). Certainly oat cultivation was not commonly practiced despite its less specific habitat requirements. Oat yields do not substantially improve from land enrichment (Bond, 2002, 183; Bond et al, 2004, 142; Church et al, 2005, 193), however as Icelandic soils are less responsive to fertilisation (McGovern et al, 2007, 30), significant increases in cropping would probably not have been achieved. Nonetheless, as oat may yield a reasonable crop on poorer soils than barley would tolerate, it could have been cultivated on outfield areas without competing for prime infield locations. Extending the area of cereal cultivation in this way would have provided additional animal fodder. In turn nutrition of dairy cattle, and indeed numbers, may have been increased, thus producing additional manure

from overwintered animals (Bond, 2002, 183; Bond et al, 2004, 142). Such factors would have been vital considering the Norse reliance on milk herds and the short growing season in Iceland. Yet the main advantage of barley was in its utility as both human and animal food and in the making of beer.

Edvardsson et al (2003, 17) suggest that in the initial occupation at Hrísheimar, primary focus was on metal working however, this does not mean that agricultural activity was not important. Site results record both barley (*Hordeum* sp.) and oat (*Avena* sp.) in the first domestic phase, when settlers were most committed to reflecting homeland farming strategies and imports were more unlikely. Evidence is more indicative of initial trials to cultivate both familiar cereals. While constituent percentages at Hrísheimar are comparable to Atlantic Scotland however (Church et al, 2005, 192), the concentration in terms of grains per litre, is significantly lower (Figure 5.1). At Skútustaðir early cultivation may have been restricted to barley. The representation of oat occurs in the 1717-1900 period, and this minimal amount suggests rather that it was a weed of the imported barley crop.

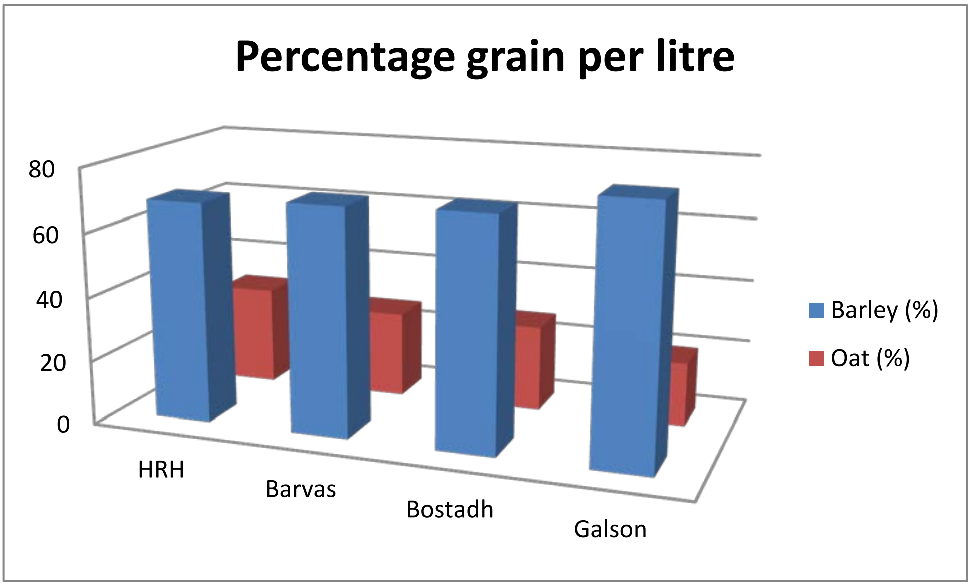


Figure 5.1 – Comparison of relative percentage distribution of cereals between Hrísheimar (HRH) and Atlantic Scotland sites (Data from Church et al, 2205, 193).

Nonetheless arable agriculture is evident from the archaeological record. At Hrísheimar following initial trials for barley and oat, the latter may have been judged to be unproductive and halted. Evidence supports continued cultivation of barley however up to farm abandonment in the 11th century. Conversely at Skútustaðir, while early barley cultivation may have occurred, absence of identified grain over the following two phases suggests this practice was extremely minimal or had been discarded. The reappearance of grain evidence from the 18th century is indicative of imports which includes both crops.

Quality of Cultivated Land

The quality of land utilised for cultivation may be assessed by examination of the accompanying weed species to determine fertility and hydrological soil conditions. Comparison between sites for the landnám period illustrates around twice the diversity of weed species at Skútustaðir (Table 4.5, Figure 4.9), and this may be indicative of a wider range of original habitats. Nonetheless Chickweed (*Stellaria media* (L.) Villars) predominates on both sites and indeed demonstrates similar distributions (Hrísheimar 30.23, Skútustaðir 28.57). This species is one of a group of apophytes that thrive in phosphate rich soil and in disturbed areas (Zutter, 1992, 143), and its presence also indicates nitrogenous conditions (Kristinsson, 2010, 124). As a common weed of the barley crop, it had the capacity to produce up to 80% yield losses if left unchecked (Davis et al, 2005). The high representation of Chickweed at both locations strongly suggests therefore soil amendment practices by field rotation, dung or midden.

Knotgrass (*Polygonum aviculare* L.) is the only other weed taxon represented on both sites, yet only in minimal amounts (1 per site). This is a common weed of arable land, preferring homefields, waste ground, farmyards, trampled areas or ground indicative of manuring (Kristinsson, 2010, 130; Preston et al, 2002).

The only other representation at Hrísheimar (Figure 4.8) is of Fat Hen (*Chenopodium album* L.). Yet again this taxon is widespread in nitrogen rich soils and is one of the more robust and competitive plants. Representative of weeds common on cultivated land at this time (Håkansson, 2003, 37), it colonises newly cut or disturbed ground before other species. Despite presence of only a single specimen, this may indicate initial land clearance for cultivation purposes.

All weed representations at Hrísheimar have utility as starvation food. Chickweed is extremely nutritious and may have been eaten raw or cooked (Linford, 2007, 217), while Knotgrass may have been a constituent of soups and stews, and its seeds were also edible (PlantsforaFuture, 1996). The leaves and young shoots of Fat Hen would have been consumed in moderation (being poisonous in large amounts), providing a vegetable similar to spinach. Its seeds could also be ground to make bread (Grieve, 1995). Such additional resources may have proved useful at initial settlement while waiting for herds to become established, or during times of hardship (Vésteinsson et al, 2002, 108).

After Chickweed, the highest representations at Skútustaðir (Figure 4.10) were of Buttercups (*Ranunculus* sp.). Former species commonly colonise crop cultivation areas, yet Buttercups may be found in cultivated homefields, hayfields and pasture (Kristinsson, 2010, 166-8). Such families contain many species with widely differing ecological requirements (Buckland et al, 2009, 110), for example, Creeping buttercup (*R. repens* L.) is very specific in habitat requiring moister, non-acidic soils and is spread via the transportation of hay (Grieve, 1995). Ribwort plantain (*Plantago lanceolata* L.) is also scarce on acidic soils, but prefers drier conditions (Edwards et al, 2005, 640). It is a common weed of cultivated land being indicative of any type of agricultural activity (Vickers et al, 2011, 14). It is worth noting that this plant is heat loving and is normally only found in the south of the island or on thermal soils in the north and this may support either a warmer climate at landnám (Axford et al, 2009, 20), or imports from the south. Finally Field mustard (*Brassica rapa* L.) has been widely cultivated in Europe over the past 4,000 years as a cool climate crop (Duke, 1983). Related to turnip, which is known to have been grown in Norway, this may have been cultivated as a leaf or root vegetable, as an alternative to mustard, or appeared as a weed. Similarly, the leaves of Creeping buttercup may have been eaten but required prior cooking (PlantsforaFuture, 1996), and it is likely this would only have occurred during extremely unfavourable conditions.

While Hrísheimar taxa appear to show nutrient rich land subject to manuring, the representations at Skútustaðir are more diverse, confirming the idea of a wider variety of habitats. Certainly its closer proximity to Lake Mývatn is indicated by moisture loving plants and presence of acid intolerant species suggests soil pH levels were neutral to alkaline which are more productive for barley cultivation (ALA, 2010).

At Hrísheimar, weed species occur only in the first domestic context (870-940). This may signal the abandonment of initial cereal cultivation or be due to the relatively small sample size in the later phase (Table 4.1 and Figure 4.8). It is intriguing that a large number of weed taxa were recovered from the industrial context; however, these can only be dated to the more general range of AD 870-1000 and therefore cannot be compared over time. Specimens derived from only two species (knotgrass & chickweed). It is possible that these may have been constituents of peat, turf or dung fuel sources (Church et al, 2007b, 750) and this will be discussed further, later in the discussion.

At Skútustaðir comparison is be demonstrated across phases (Table 4.2 & Figure 4.10).

Phase 1 → 2 870-1477	Three species disappear including Field mustard, Meadow buttercup (*Ranunculus acris* L.) and Ribwort plantain, the latter on a permanent basis. Increase in Chickweed numbers are most marked with a rise of both representations (41 to 243) and ubiquity counts (28.57 to 50). This also occurs with Creeping buttercup but on a much smaller scale. Knotgrass increases in number yet ubiquity decreases reflecting its reduced incidence across samples. Small numbers of sedge/knotweed make an initial appearance. This suggests an increase in soil fertility and agricultural activity, and may denote increased moisture content. The *Cyperaceae/Polygonaceae* category represents two distinct families whose seeds are sufficiently homogeneous to make further identification difficult, especially in poor preservation conditions. Only the *Polygonaceae* family contain weed species, and four of these knotgrasses are native to Iceland (Kristinsson, 2010). Their preference for nutrient rich conditions is in accordance with the other taxa. It may be pertinent that increases in Chickweed, Creeping buttercup and Knotgrass occur during this time, as periods of famine and disaster are increasingly prevalent, particularly in the 14th and 15th centuries. The reserves of Icelandic fertility were soon exhausted after the age of settlement and climatic conditions also played a role. If arctic ice became anchored to the North coast, the impact on vegetation growth was devastating (Friðriksson, 1972, 791).
Phase 2 → 3 1000-1717	No taxa disappeared from Phase 2, however, decreases in certain species are evident. The numbers and ubiquity of sedge/knotweed fall minimally, in contrast to a drastic reduction in the numbers of Chickweed, yet it is still well represented across samples. Common Knotgrass numbers are reduced although it becomes more widespread, while Creeping buttercup is found less frequently in samples. Both Field mustard and Meadow buttercup reappear, and this phase notes the appearance of three new species: Curled dock (*Rumex crispus* L.), Corn spurrey (*Spergula arvensis* L.) and Pale persucica (*Polygonum laphalifolia* L.). It is evident that overall species diversity increases and while overall fertility appears to remain fairly constant, a preference for increased ground water is indicated by the arrival of the new species, especially Pale persucica which prefers wet conditions being found in fields, waste ground, margins of lakes, ponds and streams. At up to 1m tall, this was one of the

	tallest weeds but would still be hidden amongst cereal crops which would exceed this (Bond et al, 2007).
Phase 3 → 4 1477-1900	This phase witnesses the disappearance of four species and the reduction of several others; *Cyperaceae/Polygonaceae*, Pale persucica and Corn spurrey are erased during this phase, however, Field mustard vanishes only temporarily. Creeping buttercup and chickweed both diminish minimally, while meadow buttercup is discovered in fewer samples. This indicates a possible change to drier and/or less fertile habitats. The simultaneous appearance of Fat Hen (*Chenopodium album* L.) and Blinks (*Montia fontana* L.) are accompanied by a significant expansion of Knotgrass and a greater frequency of Curled dock across samples. The presence of Fat Hen indicates sustained nitrogen content of the soil and may indicate the clearing of new land, while conversely it may have been an unintentional constituent of barley imports. The increase in Knotgrass and Curled dock points to increased cultivation, however as historical and archaeological sources relate a halt in cereal production by 1500, it is proposed that hay cultivation was expanded, unless they were contaminants of an imported barely crop. The appearance of Blinks (*Montia fontana*) which favours wet, even aquatic conditions, could occur due to the proximity to Lake Mývatn which would support wetland ecological niches. Nonetheless species diversity appears to have contracted in homefield areas.
Phase 4 → 5 1717-C20th	As Phase 5 contained only a small number of samples, ubiquity counts may not be truly representative for this period. Apart from the reappearance of field mustard (one seed), and the stability of buttercup numbers, the 20th century produces an overall decrease for infield weed taxa. Number of docks and common knotgrass decrease significantly while chickweed, fat hen and blinks are eradicated. This is most likely to be due to a change in farming methods following the introduction of farm machinery or use of chemical pesticides.

Initial increases in agricultural activity were accompanied by improved soil fertility, reflecting probable soil amendment. Appearance of starvation food in the archaeological record may relate to the frequent periods of famine during Phase 2. Nonetheless soil fertility remains fairly stable until 1717, with an increase in ground moisture. After this time fertility appears to decrease slightly while hydrological soil content decreases. Due to possible decreases in

hay yield, new areas may have been opened up for farming, while in the 20th century eradication of many weed species indicates substantial changes to farming techniques.

Homefield hay production was a vital component in farm sustainability (Dugmore et al, 2005, 31; Smith, 1995, 331). While climate and inherent soil differences may have influenced yields across sites in Mývatnssveit, these tended to remain at subsistence level (Adderley et al, 2008, 524). Agroecosystem modelling indicated that even additional soil amendment practices could not increase yields beyond subsistence level, restricting management options. Yet changes in land management strategies were able to positively affect long term sustainability. Thus while evidence of enrichment exists at both sites, as indicated by the presence of certain habitat-specific taxa, this practice would have required long term commitment which relied on availability of manure and labour. Such factors were periodically scarce (Simpson et al, 2002, 440).

Gathering of Wild Species

In addition to weed assemblages from cultivated homefield locations, many other wild species were represented in Icelandic biota and these may have been indigenous or introduced by Norse settlers. To aid discussion regarding changes over time, these have been further divided into woody and plant species. While both Hrísheimar and Skútustaðir yielded 7 such species during the landnám period (870-1000), Hrísheimar had a higher representation of woody species and Skútustaðir also produced a single specimen of seaweed (Table 4.5, Figures 4.8-4.10).

Tree/shrub Species

Only one shrub species was located at both sites. The count and spread of Crowberry (*Empetrum nigrum* L.) is very similar between farms and is indeed a constituent of macrofloral remains on a majority of Icelandic sites (Zutter, 1992, 1999; Sveinbjarnardóttir et al, 2007; Vickers et al, 2011). Twigs and leaves would have been collected for animal fodder and bedding, while berries were utilised for human consumption, as a dye, or as a source for wine-making (Zutter, 1992, 143). Found only at Hrísheimar, the *Vaccinium* genus includes bilberry, blueberry, cranberry etc. and thus produces berries primarily as a food source, while Bilberry may also have had a secondary purpose as a dye. Both *Vaccinium* sp. and Willow (*Salix* sp.) yielded low representations. At Skútustaðir a large number of Bearberry (*Arctostaphylos uvi-ursi* (L.) Spreng.) leaf fragments were recovered. This woody shrub

produces edible red berries and was used as a dye in Scandinavian countries (Grieve, 1995). The leaves contain abundant tannin which was utilised in tanning leather in Sweden and Russia. Leaf samples may have been an accidental inclusion, remaining on twigs selected for kindling, or brought in with turfs for fuel.

Wild Plants

Three species including the two *Carex*-types and *Poaceae* (small) were common to both sites. Even with particularly high numerical values at Hrísheimar, the higher ubiquity count at Skútustaðir indicates a greater distribution of *Carex* spp. This taxon is often collected from wetland meadows for fodder, and may have been a possible floor covering (Buckland et al, 1983) instead of rushes due to the pleasant odour of some species (Grieve, 1995). The stems were also utilised as a wick in lighting. The small representation and ubiquity count for *Poaceae* undiff. (small) at both sites may indicate increased abundance of sedges or preferential utilisation, being considered as superior to grass for fodder (Vésteinsson et al, 2002, 109). Grass crops took two forms, purposeful cultivation for hay and natural grassland used for pasture (Friðriksson, 1972, 789). As the pastoral economy of Iceland was heavily reliant on grass, it appears to be under represented, however, it may be that grasses are less likely to be utilised for building or burning during their flowering stage.

At Hrísheimar, only one plant species was specific to the site, during the comparison phases (Figure 4.9). The seeds of the legumous plant Vetch (*Viccia* sp.) provided a useful fodder source, while the straw also has high nutritional value for livestock, and may even be utilised for human consumption as a starvation food (Hanaka, 1976, 924; Hedrick, 1972, 686).

Two additional categories were represented at Skútustaðir. Bulbous buttercup (*Ranunculus bulbosus* L.), has the familial trait of being poisonous, and while not consumed by cattle, its rhizomes are sought out by pigs. The single seed of Mare's tail (*Hippuris vulgaris* L.) was a surprising find due to its natural aquatic habitat. This again is likely to be an accidental inclusion due to the proximity of the site to Lake Mývatn. A recovered seaweed frond could not be identified to species but will probably have been transported from the coast, either as packaging with goods such as fish, as a fodder source (McGovern et al, 1988, 242), as fuel (Sveinbjarnardóttir et al, 2007, 192), as a fertiliser (Krisljansson, 1980, 127), or during industrial processes such as salt extraction (McGovern et al, 2006, 199).

While the majority of species are present in the first domestic phase at Hrísheimar, only sedges and crowberry remain by AD 940 (Figure 4.8). These are the most represented and widespread of the Phase 1 taxa and an important source of human and animal food.

Surprisingly the industrial phase (870-1000) comprises a wider diversity of wild species (9 plus seaweed), 4 of which overlap with the domestic phases. Industrial samples primarily consist of trees and woody shrub species (Crowberry, Bearberry, Birch, Willow and Juniper) with a predominance of leaf fragments. These may have been purposefully utilised as fuel or have been an accidental addition to turfs as probably occurred with grass and sedge. The metal working process involved extracting iron pan from the nearby bog (Edvardsson & McGovern, 2007, 4) and the presence of bog bean seems to confirm use of the bog to obtain raw materials. As only one specimen was recovered, it is postulated that Norse settlers realised its value in the flavouring of beer (BTCV, 2004).

Trees were also an excellent resource, although Icelandic specimens tended to be fairly short with narrow girths. Nonetheless as a food source, Dwarf birch (*Betula nana* L.) leaves and catkins could be eaten raw while Willow catkins were eaten as a mash during hard times (Hageneder, 2001, 172). Birch twigs and buds were utilised for flavouring stews, while Juniper berries were used for flavouring meat dishes and in sauces or stuffings. Juniper has a long association in flavouring alcoholic beverages and it was used to make traditional Finnish ale (Sysila, 1998), it is possible therefore that it was a constituent of Norse beer making. Willow was valued as a dye and dwarf birch created a better yellow dye than common birch. Willow bark may have been used in the tanning process, while its wood was also used to make furniture, mats, baskets and in boat construction (National History Museum, 2011). Both Willow and Juniper were used in rope making and indeed juniper was used extensively as a raw material, especially for producing utensils and containers in which to store dairy produce (Hageneder, 2001; Larsen, 1990). Used by almost every culture for purifying and ritual cleansing, this species was thought to ward off evil spirits and plague when burnt (Herbal Encyclopedia, 2011).

Several interesting changes occur across phases at the Skútustaðir site (Figure 4.10).

Phase 1 → 2 870-1477	Only minor changes are evident. Agimony (*Agrimonia eupatyoria* L.) appears in Phase 2 (1000-1477), however, while this taxon has been used for warding off witchcraft since the time of Pliny the Elder (Hawes, 2010, 88), Iceland had politically chosen Christianity by this date (Clark, 2003, 18). Alternative uses

as a tea, wine or dye may also explain its incorporation into the archaeological record (Grieve, 1995).

Phase 2 → 3 1000-1717	A significantly wider range of culturally selected species is demonstrated, suggesting an expanded selection of resources were utilised. The appearance of Heather (*Calluna vulgaris* (L.) Hull) may have been a non-purposeful inclusion however, via the burning of peat/turf, or human transportation. This plant is widespread in upland areas and was an important food source for sheep in snowy/icy conditions (Sæbo et al, 2001, 823). It could also be used, to produce heather beer (especially in Scotland prior to the introduction of hops), as a dye, or as part of the tanning process (Vickery, 1995). The increase in utility is likely to have been for fodder however, as wetland meadow taxa (Sedges (*Carex* sp.), Sharp-flowered rush, (*Juncus acutiflorus* L.), Mare's tail, Bog bean (*Menyanthes trifoliate* L.) are particularly evident. Yet the sharp flowered rush is also much favoured for flooring and inclusion may have originated from the house rather than the outfields (Grieve, 1995). A single specimen of *Viola* sp. appeared in this phase but could not be identified to species, making possible usage difficult.
Phase 3 → 4 1477-1900	During this phase (1717-1900), large tree species seem to have disappeared, while large grasses make an initial appearance and small grasses increase considerably.
Phase 4 → 5 1717-C20th	Shrubs have also been eliminated by the final phase (C20th) and evidence of imports appears in terms of fruits for human consumption such as fig (*Ficus caraca* L.) and plum (*Prunus domestica* L.). The multiflowered buttercup (*Ranunculus polyanthemos* L.) also appears at this juncture. As it travels with people, it is likely to have arrived with the imports (NatureGate, 2011).

Apart from being consumed by livestock therefore, wild species had a variety of utilities, as human starvation foods, as dyes and in the production of domestic and household implements. Yet the vast majority had a much greater purpose in the everyday lives of the Icelanders.

The Norse travelled widely and through settling and trading had contact with many cultures, providing ample opportunities for the exchange of knowledge and information. While the early Vikings were not scribes (Vésteinsson et al, 2002, 99), they absorbed information which was pertinent to their lives. At a time when premature death and battle wounds were common and diseases rife, plants would have provided primary health care. With no alternative

treatment available, Scandinavians would have had considerable knowledge regarding the healing power of plants. While the earliest herbal text produced in Scandinavia was the *Urtebogen* or *Liber Herbarum* ‘The Book of Herbs’ by Master Henrik Harpestreng in the 13th century. This contained translations from 11th century Latin texts (Macer’s *De Viribus Herbarum* c.1090 and Constantius Africanus’ *De Gradibus Liber* c.1050), indicating prior awareness of herbal remedies and applications. While over 70% of males originated from Scandinavia however, a significant proportion of females derived from Britain and/or Ireland (Ebenesersdóttir et al, 2010, 1; McGuire, 2006, 22; Helgason et al, 2000, 697) where herb lore was established and sometimes even documented. This is important, for it was women who took responsibility for health matters until the advent of Christianity, which initiated a role reversal (Foote & Wilson, 1970, 93). The majority of identified plants have medicinal utility and thus a table has been constructed to reflect the healing properties of biota from Tables 4.1 & 4.2.

At both sites wild plants, weeds, trees and shrubs appear to have been purposefully collected for a variety of functions. These included culinary, industrial, craft and medicinal usages, and demonstrate a desire on the part of the Vikings to fully benefit from the natural environment.

Plant Name	Medical Importance
Arctostaphylos uva-ursi	Historically used for medicinal purposes with an early recorded use in 13th century Wales. Only leaves have medicinal properties treating urinary tract complaints. Grows across the Northern hemisphere including Scandinavia and Scotland.
Agrimonia eupatoria	One of the most famous vulnerary herbs and particularly popular with Anglo-Saxons. In addition to treating wounds it is traditionally used to treat insomnia. Found in England and Scotland.
Betula nana	Known uses as an anti-rheumatic and sedative. Leaves are taken for problems related to digestion. Mainly found in arctic regions of Northern Europe.
Carex sp.	Rhizomes of some species have considerable medical value for treating digestive disorders. Found in all European countries, used in herbal medicine in England, Germany, Turkey, India, Malaysia, Ceylon and the Orient.
Chenopodium album	Makes a very wholesome medicine. The seeds are high in nutrients and used in African medicine. Grows in most countries.
Hippuris vulgaris	Has a number of medicinal uses including healing wounds, stopping bleeding and soothing inflammation. Confined to temperate, boreal and subarctic regions.
Juniperus sp.	Used by ancients as a sedative and listed by Dioscorides who states the berries are a female contraceptive. Falsely administered to cure typhoid, cholera, dysentery and tapeworms.
Menyanthes trifoliate	Historical medicinal uses of this plant include treatment of heart problems and TB. It was held to be of great value against scurvy and prescribed in cases of dropsy and gout. Later used as herb tobacco. Occurs throughout Europe, Asia and North America.
Plantago lanceolata	Leaves applied as a natural remedy for bites and stings as the juice has cooling, anti-inflammatory, antibacterial and pain relieving properties. Found as a common weed in Norway and the British Isles.
Polygonum aviculare	Formerly employed as a vulnerary and styptic and recommended by Culpepper to cure the spitting of blood. A decoction with wine was administered to kill worms. Recognised as treating dysentery, jaundice, gall and kidney stones.
Ranunculus acris	Leaves used to remove warts and to cure headaches and gout. Appears almost worldwide.
Ranunculus bulbosus	As with *R. acris*, this species is used to treat headaches as well as shingles and sciatica. Common to Western Europe.
Rumex crispus	Roots are used to aid skin diseases, blood cleansing and treat hepatic disorders. Used historically as a gentle laxative.
Salix sp.	In past times, leaves were most commonly used medicinally, making a tea taken for pain relief and fever. Discorides recommended a willow leaf drink to relieve lower back pain.
Stellaria media	Very popular in folk medicine, chickweed water is a traditional remedy for weight loss. Treats skin disorders; including cuts, burns and bruises, rheumatic pain and scurvy. Especially popular as an ointment. Naturalised wherever man has settled.
Vaccinium myrtillus	Fruits used since ancient times in the treatment of diarrhoea and dysentery. Popular as a tea, it is found in Europe, northern Asia, Greenland, Canada and America.

Table 5.1 – Medicinal utility of wild species recovered from Hrísheimar and Skútustaðir (Bremness, 2009; Culpepper, 2009; Grieve, 1995; Hawes, 2010; Linford, 2007)

Local Ecological Landscape

Post landnám, human impact had a major effect on local ecology as natural taxa were gradually converted to anthropogenic flora (Vickers et al, 2011, 6). Original species were dominated by woody and tall herb communities (Erlendsson et al, 2009, 180). As this research examines man-made midden deposits, pre-landnám floral composition could only be obtained from pollen analysis. Such data is available from the Lakes at Helluvaðstjörn (Figure 5.2) and Vestmannsvatn, while more particularly pertinent to Hrísheimar is the bog within the

farm locale (Figure 5.3). Diagrams from Vestmannsvatn and the bog area are however skeletal, providing limited dating and evidence.

Pollen assemblages indicate that both sites comprised a mixture of birch woodland and wetland pre-landnám, although Hrísheimar probably had more extensive woodland than Skútustaðir, consisting primarily of birch with an island of sedge (Lawson et al, 2009b, 34-5). Being in closer proximity to Lake Mývatn, Skútustaðir contained more wetland areas which do not support tree growth (Thomson & Simpson, 2007, 155). This is reflected in the comparison between sites for the period 870-1000 in which more woody species are represented at Hrísheimar and more wetland taxa at Skútustaðir (Table 4.5, Figure 4.9). Both sites appear to have available dry grassland for pasture, as indicated by the presence of species such as *Poaceae* sp., *Vicia*-type and *R. bulbosus*, and a cultivated homefield area as demonstrated previously. During this period, these farms are seen to have an equal diversity of resources, however there is some evidence that Skútustaðir was making better use of its assets, and this may explain its continued presence compared to Hrísheimar which was abandoned early in the 11th century.

Effective management of resources may be indicated by considering changes to the range and composition of taxa over time. At Hrísheimar the assemblage from Phase 1 of the domestic context (Figure 4.8) relates a range of woody shrubs from heathland environments, wetland taxa and small grasses. By Phase 2, only three out of the eight categories are still represented, illustrating a decrease in diversity and with the only increase being for sedges. Results therefore suggest a decrease in heathland taxa and simultaneous increase in wetland sedges. An absence of macrobotanical birch may indicate a more restricted utilisation as a fuel source. The industrial context does, however, produce minimal evidence of birch, juniper and willow, and it is also evident from both pollen data and charcoal results, discussed later in this report, that tree species declined only gradually post landnám (Lawson et al, 2007, 11), thus producing contradictory evidence. Early forest clearance would have been necessary to increase the land available for cultivation and grazing (Vésteinsson et al, 2002, 100); however it may have had consequences for soil hydrology. With decreased interception of rainfall and increased moisture levels, soils may have become increasingly waterlogged (Lawson et al, 2009b, 38), favouring expansion of sedges and creating unfavourable conditions for trees and woody species (Thomson & Simpson, 2007, 155). Such wetland habitats may have been

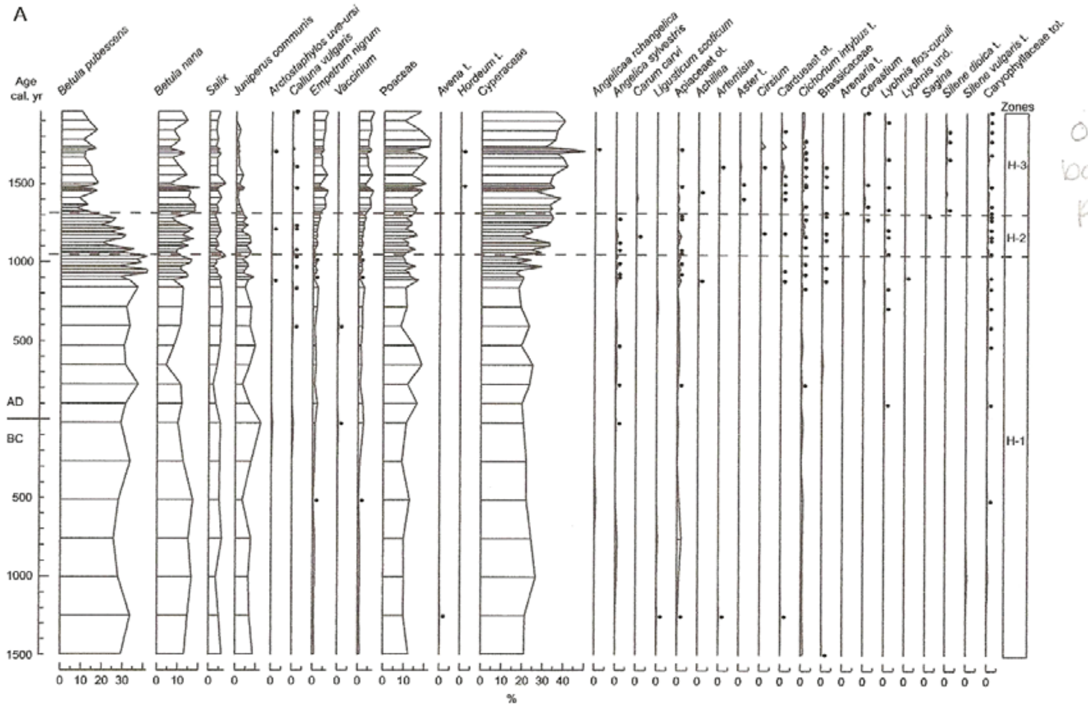


Figure 5.2 – Pollen data from Helluvaðstjörn in percentage terms. Presence of taxa of less than 0.5% is represented by the black dots. Percentages have been based on the sum of total land pollen (Reproduced from Lawson et al, 2007, 7).

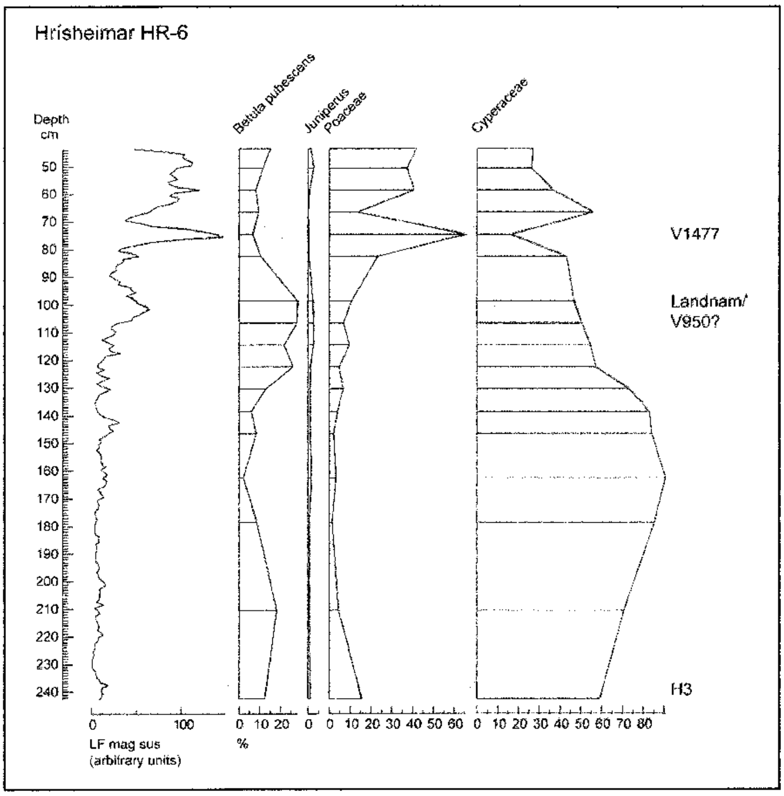


Figure 5.3 – Pollen data of selected taxa from Hrísheimar bog in percentage terms. Core HR6, location 150m SE of farm site (Reproduced from Lawson et al, 2009b, 35).

welcomed by settlers since they provided ideal fodder sources for the domestic stock, especially cattle, on which they were heavily reliant (McGovern et al, 2007, 29; Friðriksson, 1972, 790). Sample size for Phase 2 is limited however, and it must be remembered that data obtained from culturally selected species are not representative of the complete range of biota present in the landscape (Zutter, 1999, 843).

Pollen evidence from Lake Helluvaðstjörn and Vestmannsvatn would suggest that Skútustaðir also contained an area densely covered with Birch at landnám. Due to its proximity to Lake Mývatn however, this site would have had extensive wet meadow areas to the North of the farmsite (McGuire, 2006, 13). Thus a wider selection of wet meadow plants was represented pre-landnám (Figure 4.10).

Phase 1 → 2 870-1477	Apart from a minimal increase in Crowberry, the compositional balance of woody and wet species remains stable.
Phase 2 → 3 1000-1717	In Phase 3 there is a significant increase in diversity with a large increase in the number of woody species, while both *Carex* types expand considerably. As these appear in the archaeological record, the felling of trees and woody shrubs is indicated, the cleared land then being available for colonisation. Introduction of more fen species (Sharp-flowered rush, Bog bean) plus the increase of sedges indicates an expansion of wetland taxa.
Phase 3 → 4 1477-1900	By the beginning of the 20th century, all tree species have disappeared, although some woody species remain (Crowberry, Bearberry, Bilberry (*Vaccinium myrtillus* L.)). The increase in Bilberry and Heather, plus accompanied decreases in mare’s tail and the disappearance of sharp flowered rush and bog bean, indicate a drying out of soil conditions. Human drainage may account for this, and may have encouraged the large increases in *Poaceae* sp.
Phase 4 → 5 1717-C20th	During the 20th century woody species have also disappeared, yet heathland taxa such as heather expanded.

It is pertinent that the period between 870 - 1477 remains fairly stable, as during this time many surrounding farms had been abandoned. Hrísheimar demonstrates a decrease in overall numbers and variety of taxa between its two domestic phases, while Skútustaðir appears to have retained its resource base. With the appearance of woody shrubs in Phase 3 (1477-1717), it may be that significant land clearance, causing a reduction in trees and woody species, did

not occur until after 1477 at Skútustaðir. Cleared land was colonised by wet species, indicating the continuation of wetland habitats and only from the 20th century is there an indication of drier soil conditions, which may have been natural or induced. In contrast, clearance seems to have occurred much earlier at Hrísheimar, the additional arboreal coverage increasing the necessity of this activity to create a productive infield area (Edvardsson et al, 2003, 25). Taking the weed and wild species together, there was a dramatic decrease in diversity between the two phases (10 species to 3) and only *Carex* sp. increased in frequency. Grazing pressure may be suggested, with only the bog locale retaining its productivity. This may have been due to a complex interaction of many factors including ineffective management of resources.

As the Icelandic landscape and many species of plant would have seemed familiar, settlers may have expected to utilise management techniques which had proved successful in the homelands. Yet as biota were closer to their ecological limits, they would have been more vulnerable to environmental pressure and change (Dugmore et al, 2006, 340). Such 'false analogy' may have blinded the Norse therefore to critical threshold differences (McGovern et al, 1988, 245).

Viking farms operated on the infield-outfield system already widespread in Norway at landnám (Vickers et al, 2011, 13), of which they should have had experience. Summer grazing took place in outlying highland areas, while the infield, close to the farm, was utilised for haymaking and cereal cultivation (Vickers et al, 2011, 13), which required superior soils. Yet the soils within the Mývatnssveit area are erosion sensitive, particularly via aeolian deflation (Lawson et al, 2009b, 38). While deforestation is the major trigger for land degradation, overgrazing also removes the vegetation which helps bind together upper soil horizons thus also initiating erosion (Lawson et al, 2009b, 38). Yet recent studies have indicated that land degradation was not an inevitable conclusion (Thompson & Simpson, 2007, 166). Even with proximal sites such as at Hrísheimar and Skútustaðir with similar climatic conditions, access to resources and management strategies may have varied significantly, producing different responses to negative environmental conditions. Such a difference was evident at Hofstaðir and Sveigakot also within the Mývatnssveit area. Hofstaðir, being a more elite site, had access to a wider range of resources and was therefore, more easily able to adapt its management strategies which enabled longer term sustainability (McGuire, 2006, 19).

In an attempt to mirror the cattle and pig rich farms of southern Norway, settlers were intent on establishing dairy farms, even if the land was unsuitable for sustaining such a practice. At the Mývatnssveit farms of Hofstaðir, Sveigakot and Undir Sandmúla (Figure 2.4), faunal results have shown a high (approx 25%) ratio of cattle bones, even though such locales are in upland locations and more suitable for keeping sheep (Vésteinsson et al, 2002, 109; McGovern, 2005, 11). Additionally dairy cattle and pigs afforded a coveted elite status. Substantial amounts of good quality fodder would be required for overwintering, placing great pressure on infield areas which were quite small (Friðriksson, 1972, 789). While failure to remove livestock from upland grazing has traditionally been thought to trigger land degradation processes, this view has now been challenged (Thomson & Simpson, 2007). Búmodel simulations suggest sufficient biomass was initially produced to support proposed livestock numbers, yet land degradation still occurred. Management strategies at Hofstaðir did not always prevent overgrazing, particularly in severe climatic conditions, although large scale land degradation was generally averted. At Sveigakot, however, management options were more limited due to a variety of factors including location and status. Erosion of over-grazed shrub heath increased grazing pressure on remaining areas, yet even this did not produce immediate estate wide overgrazing (Thomson & Simpson, 2007, 166).

Certainly erosion was more effectively managed at Hofstaðir which had an inherently more stable landscape, while at Sveigakot, occupation and exploitation of land which was inherently susceptible to erosion, probably triggered and increased land degradation (Simpson et al, 2004, 498-9). While cattle numbers could have been reduced as a management response, once initiated, the process was irreversible. At Hrísheimar, an increase in cattle numbers did occur after AD 950 (10 to 16% of domestic mammals) (Edvardsson & McGovern, 2006, 11) however, this may have been due to the establishment of the herd. At Skútustaðir, while no temporal trends are available, cattle numbers were consistently high, and a 5:1 caprine to cattle ratio was maintained into the early modern period, compared with the 20:1 usual on Mývatnssveit farms (Hicks et al, 2011, 6). Although there is no indication that numbers were being managed, at Skútustaðir, the commitment to enrichment and fodder maximisation plus increased wetland habitats, suggests they were able to absorb grazing pressure more easily.

Alterations in both composition and numbers of wild species are able to provide therefore, valuable information regarding landscape changes, soil hydrology, human activity and pressure on the environment. While Hrísheimar was predominantly wooded at landnám, and Skútustaðir comprised more wetland habitats; both demonstrate a change to anthropogenic

species. Diminishing woodland resources and expansion of wetland may be evident at both sites, however an increase in fenland species may be due to changes to the taphonomic processes by which seeds were recovered. Whatever the reason, this alteration occurred at a later date at Skútustaðir. Although both processes are in operation at Hrísheimar by AD 940, wetland expansion does not occur at Skútustaðir until 1477, and trees decrease only after 1717. By 20th century even the shrubs have disappeared from this site and drier conditions prevail, possibly due to drainage. Grazing pressure from domesticates is consistent across sites during the landnám phase, however, due to strategies adopted at Skútustaðir, this appears to have been more effectively managed. While modification of the land for farming negatively impacted on the environment in many ways, the most pronounced effect was on the woodlands which were exploited for timber, fuel and charcoal (Dugmore et al, 2005, 30).

Fuel Sources in Mývatnssveit

A range of fuel sources were recovered from domestic contexts across the two sites with wood being the predominant taxa in both cases (Tables 4.1 & 4.2). Samples yielded evidence of peat/turf, dung, coal and possibly seaweed. This order reflects importance according to the Land Register compiled between 1702 and 1714 (Simpson et al, 2003, 1403). It must be remembered that such fuels would have been utilised only on the central hearth, those used for industrial purposes will be discussed later in the section. Some fuel sources however, would not appear in the archaeological record at all. Oil, for example, derived from seal and shark, was utilised for lighting (Byock, 2001, 52). Yet at landnám, it was the hearth fire that provided light, warmth plus sufficient heat for cooking, thus giving it a vital function in early Viking communities (Simpson et al, 2003, 1402). While charcoal evidence indicates a wood fuel source, specific archaeological evidence is required to identify other fuels. Prior research has demonstrated that differential arrays of plant parts and species are indicative of specific types of fuel (Dickson, 1998; Church, 2000, 121). Turf burning produces small (<2mm) carbonised macrofossils comprising leaf fragments of moss and ling heather (*Calluna vulgaris* (L.) Hull), small rhizomes, small culm nodes and bases, and seeds of species found in heath and grassland environments (Dickson 1998; Church et al, 2007a, 663). Such macrofossils would have been incorporated within the turfs, and carbonised during the burning process. This occurs with peaty turf also, however culm nodes are absent and remains yield an abundance of small culm bases and rhizomes, fibrous burnt peat and seeds from heather, sedge and grass communities (Church, 2000, 121). While well-humified peat may also be utilised as fuel, remains comprise mainly large quantities of more amorphous burnt

peat. Fewer macrofossils are present and the majority of these are small rhizomes. Animal dung was occasionally used as fuel, especially in times of hardship and has distinguishing characteristics, for example, cow dung may be identified by black isotropic material in thin section analysis (Simpson et al, 2003, 1410). Plant seeds and chaff eaten by domesticates would become incorporated in the dung which entered the hearth as fuel and hence the archaeological record (van der Veen, 2006, 16). Indeed as wood supplies diminished, dung became a more important fuel source (van der Veen, 2006, 14), and was the preferred fuel for smoking both meat and fish throughout Iceland. This process preserves food and thus pre-cooking may have reduced winter fuel requirements (Byock, 2001, 51). Seaweed was also a common fuel source being transported from the coast. It remained in use as late as the early 20th century in Iceland (Sveinbjarnardóttir et al, 2007, 192).

At Hrísheimar however, there is little evidence of any fuel source other than wood (Table 4.1). This is not surprising as the farm was located in an area of dense forest (Evardsson et al, 2003, 25). Reliance on a single source implies that either the source was extensive or that strategies were in place to conserve supplies. Very limited evidence does exist for the burning of turfs, in the form of one culm node, and one rhizome as well as wild plant evidence which could indicate incorporation with the fuel. Results do not support the burning of peat and dung in the domestic phase, while the site had been abandoned before the use of coal for fuel. In contrast the Skútustaðir site may have been utilising all possible fuel resources, although, like Hrísheimar, wood was most represented (Table 4.2). The presence of amorphous plant material (APM) is usually indicative of burnt peat, turf or dung, and at Skútustaðir, the range of macrofossil evidence implies the combustion of peaty turf. As the macrofossils indicative of the burning of peat and turf are similar, it is likely that turf was also utilised as fuel. This is supported by identified remains of heather. Coprolite and coal samples had retained their distinguishing characteristics aiding identification, while seaweed could not be further identified. It appears that Hrísheimar relied on a single fuel source while Skútustaðir seems to have utilised whatever was readily available. To investigate this further, comparison of sites during the landnám period is necessary.

From AD 870-1000, wood was the primary fuel source at both sites, while definitive evidence for peaty turf utilisation occurs at Skútustaðir. Thus Skútustaðir farmers appear to have been increasing their options from first settlement. Turfs may have been restricted to construction usage, while limited dung availability prior to herd establishment, may have been used for enrichment of infield areas. Fertile land was necessary to cultivate cereal and hay, which

would have been particularly important at this time. Such factors may also have been considered at Hrísheimar.

Yet wood remains the main, and maybe only, fuel source at Hrísheimar over the two domestic periods. If minimal turf burning had been practiced at this site, it had ceased by AD 940. There is no indication that wood utilisation was being scaled down and indeed charcoal was recovered from every sample across Phase 2. This would suggest that either management strategies were in place to conserve supplies, or that landowners were not aware of any future supply issues.

Dominance of wood as a fuel was repeated at Skútustaðir, as it was recovered from every sample across all phases (Table 4.2).

Phase 1 → 2 870-1477	In spite of an increase in the number of samples in Phase 2, there is significantly less charcoal by weight (Figure 4.11). This is accompanied by a decrease in APM suggestive of less burning activity overall. This reflects a general decrease in all archaeobotanical remains between AD 1000-1477. This might be due to temporary abandonment of the site, fewer inhabitants for a variety of reasons, or change in method of disposal for domestic waste (Hicks et al, 2011, 29).
Phase 2 → 3 1000-1717	While the weight of the charcoal rises it does not return to proportionate landnám levels. Alternative fuel sources become apparent as ubiquity of APM increases and two new fuels are introduced. Turf burning is indicated by the presence of heather, and dung is represented in large amounts. The accompanying suite of macrofloral remains to both turf and peat burning have also increased accordingly. Utilisation of four fuel sources indicates a serious attempt to conserve wood supplies (Simpson et al, 2003, 1415).
Phase 3 → 4 1477-1900	The weight of charcoal decreases disproportionately to the number of samples (in Phase 4). Ubiquity of APM also drops with a slight reduction of dung utilisation, although turf burning increases to a similar extent. Specimens of coal are now indicated although wood remains the dominant fuel. As Iceland is a young volcanic island, coal seams are unlikely to exist (Church, pers. comm.) and therefore this is more likely to have been an imported commodity. Such importation would suggest insufficient fuel supplies to meet present and future demand, implying a reduction in woodland. This is in accordance with other

macrobotanical evidence previously discussed which relates the disappearance of trees in this phase.

Phase 4 → 5 1717-C20th	Wood for fuel is still indicated as charcoal appears in all samples, yet this is now matched by APM. Dung is also more prevalent, being found in two thirds of samples. While heather frequency also rises indicating increased use of turfs, coal disappears completely. This may indicate a rise in the cost of imports, or interruption of supply due to climate, wars, strikes etc.

During the landnám period more wood was burned than in subsequent phases although even at this time, additional fuel sources were utilised. Combustion of fuel appears to have decreased significantly from AD 1000, and this concurs with archaeobotanical evidence suggesting a general fall in sample numbers and ubiquity counts at this time. This decline in archaeological material reflects the excavation findings which noted reduced bones and artefacts below the 1477 tephra until the Viking Age was reached (Hicks et al, 2011, 19). Several reasons have been postulated for this deficit, however it is most likely that residents moved their dwelling early in the High Medieval period, or relocated their midden site (Hicks et al, 2011, 19). Subsequent increases in the range of fuels may indicate the need to conserve wood resources, and this continued into the next phase with the introduction of coal, even though its utility was short lived. All other fuels survive into the 20th century and proportions of alternate fuels to wood increase, implying a continuing desire to conserve more limited resources (Figure 4.11).

Certainly constituents of fuel at each site reflect resources available from the local environment at settlement. While turf may have had marginal usage at Hrísheimar, this is by no means certain. Thus the total reliance on wood for the central hearth indicates the vast expanse of forest surrounding the farmsite. Similarly the abundance of wet meadow environments to the south of Lake Mývatn enabled collection of peat to supplement wood supplies (Edwald & McGovern, 2010, 6). Although the Hrísheimar site possessed some wet meadow in the vicinity of the bog, the bog itself was required for alternative usage (Edvardsson et al, 2003, 25). With less wet meadow area available, pasture may have been much more valuable as a fodder source at Hrísheimar than as a fuel source. Changes to ubiquity counts in Phase 4 at Skútustaðir, mirror the ecological changes observed earlier, as turf is increasingly utilised as a fuel when drier conditions ensue.

While it is claimed that trees declined gradually in the 400 years post-landnám (Lawson et al, 2007, 11) this is not reflected in the archaeobotanical and charcoal remains. The general lack of evidence for Phase 2 at Skútustaðir (1000-1477) renders any reduction effectively invisible, however Phase 3 does indicate a fall in weight of charcoal and evidence of alternative fuel sources. Yet despite archaeobotanical evidence that trees have practically disappeared by 1717, wood utilisation as fuel is apparent into the final phase. Indeed some trees still exist on the lava fields of Mývatnssveit today. To fully address this issue the sourcing of wood from local, imported or driftwood supplies needs to be determined.

<u>Wood Species</u>

Wood utilised for fuel derives from three different sources: native, driftwood and imported. Only four tree species are native to the island, Birch, Willow, Juniper and Rowan (*Sorbus* sp.) (Dugmore et al, 2005, 26; McGovern et al, 1988, 230; Kristinsson, 2010). None of the latter was recovered in this study. The downy birch predominates across Iceland and while it may have been fairly tall at settlement, impact from felling, livestock browsing and acidification of the soil reduced stature to 1.5-3m (Smith, 1995, 336; McGovern et al, 1988, 229). This is because any regeneration occurs from basal buds, which transform the tree into a low shrub, further increasing vulnerability to grazing pressure (Smith, 1995, 336). Such timber with extremely narrow girth would have been unsuitable for house or ship construction, thus driftwood, common in Iceland at landnám, was a particularly valuable resource. Icelandic driftwood has been encased in sea ice which acts as a preservative and eventually reaches shore after a prolonged period of time (Eggertsson, 1993, 19). The reason such large timbers are recovered is that buoyancy decreases as volume decreases, resulting in the relatively fast sinking of smaller pieces. Most driftwood tended to originate from coniferous species such as Pine (*Pinus* sp.), Larch (*Larix* sp.), or Spruce (*Picea* sp.) which would probably have originated from Russia and Siberia (Eggertsson, 1993, 29). Most Larch driftwood has roots attached, indicating riverbank erosional processes, while Pine and Spruce are typically logs that became loose during timber floating. Extended transit provides inaccurate dating due to the old wood effect (Sveinbjörnsdóttir et al, 2004), yet this process does not appear to have affected the quality of the timber to any great extent. As driftwood was in high demand, access to coastal resources was much coveted. By the 12th century, birch coppices and driftwood beaches were economically important (Smith, 1995, 336). Yet there were insufficient large timbers to meet construction needs, and imports became more common. These tended to be of Oak (*Quercus* sp.) mainly from Norway. Size restrictions meant such

resources were utilised for house building, and ship construction subsequently diminished (Byock, 2001, 33).

While all three sources are represented at Skútustaðir, imports are absent from Hrísheimar (Figures 4.13-4.20). This is not surprising however as the site was abandoned before imports became common. As has been shown with wild/weed resources, Skútustaðir employed a much wider variety of wood species to satisfy fuel requirements, 20 categories compared to the 8 utilised at Hrísheimar. This demonstrates the concentration of pressure on a reduced number of resources at Hrísheimar that occurred from initial settlement.

As anticipated Hrísheimar utilised more birch than at Skútustaðir, yet this predominated at both sites. While birch timber percentages were identical, proportion of birch roundwood (pith-to-bark) and birch roundwood (not-pith-to-bark) are significantly different (Figures 4.15 & 4.16). The larger distribution of pith-to-bark at Skútustaðir suggests that from the outset, more branches were harvested (rather than trunks) implying that farmers realised the importance of managing available woodland. While Hrísheimar utilised little other than birch, Skútustaðir utilised a larger selection of native trees and driftwood. This indicates that Skútustaðir had Juniper and Willow in the locale, while at Hrísheimar, Willow was extremely rare in the landscape and Juniper was absent. Driftwood represents a very small proportion of samples, yet while Hrísheimar yielded only one specimen of Pine, sources and numbers were much greater at Skútustaðir. Five specimens were obtained over four categories, which included twice the representation of pine. This may suggest that Skútustaðir farmers had better access to coastal resources and/or were a higher status site, that Hrísheimar did not burn its driftwood; fully utilising it for construction purposes, or that additional wood sources were not deemed necessary.

When comparing the two domestic phases at Hrísheimar (Figure 4.13 & 4.14), even driftwood and any samples other than birch have disappeared by the second Phase (940-1000). Access to driftwood may have been controlled by an elite who managed the resource, however as only one specimen derives from the first Phase, it could be that it was not a requisite component for the site. Willow may have been utilised for non-fuel purposes and so not brought to the hearth, or may have been severely depleted within the locale. The constituents of Birch utilised for fuel change over time with a small drop in Birch timber which may suggest that fewer larger trees existed, or that they were not being targeted for felling. Birch roundwood (pith-to-bark) also decreases slightly, while Birch roundwood (not-pith-to-bark) increases by a

marginally higher amount. This may imply either collection of fewer branches, or harvesting of larger branches which fragment more in the fire accounting for the minor increases in bark representations.

While only small scale changes appear at Hrísheimar over time, temporal deviations are more marked at Skútustaðir (Figures 4.16-4.20).

Phase 1 → 2
870-1477

The number of non-birch species are reduced mirroring the overall reduction in categories from 14 to 9. Pine becomes the only form of driftwood, yet the total number for this category remains stable. A fall for all Willow categories is accompanied by a significant decrease in representations and may be due to different usage, stock depletion or may reflect the reduced archaeological remains recovered from Phase 2. Composition of Birch within the sample also changes. Substantial increases in roundwood (not-pith-to-bark), plus minimal rises in timber and bark percentages result in decreases in roundwood (pith-to-bark). This implies the utilisation of a greater number of large trees including trunks, and reduced harvesting of smaller branches. As this stage may have reflected a shortage of hay, smaller branches and twigs may have been utilised as supplementary fodder, as livestock survival would have been a primary objective.

Phase 2 → 3
1000-1717

Total number of categories increases to a peak (15), and this is reflected in the rise of non-birch categories. Driftwood now includes, pine timber, larch roundwood (not-pith-to-bark) and coniferous timber. This may reflect an increased need to conserve birch supplies. Alternatively, a fairly stable distribution would be indicated in relation to Phase 1 if Phase 2 results were due to residence or midden relocation and therefore under represented. Imports become evident with Hazel (*Corylus* sp.) and Yew (*Taxus baccata* L.) timbers, maybe demonstrating that at this juncture, imported wood had increased in popularity. Specimens could have been off-cuts from construction processes or an attempt to conserve natural woodland. Yet the latter may be disputed by the presence of rootwood which may imply the uprooting of whole trees, although this may be attributed to driftwood species. Reappearance of Juniper and increases in Willow are addressed by reductions in birch. This demonstrates a continued availability of non-birch in the surrounding forest. Willow and Birch roundwood (pith-to-bark) increase substantially, suggesting harvesting of twig

and branch parts, indicative of conservation. Decreases in Birch timber support this.

Phase 3 → 4 1477-1900 Non-birch species contract and the total number of categories reduces slightly (15 to 13). Larch and Pine timber increase quite significantly and conifer timber is replaced by conifer roundwood, which is better represented. Hazel and Yew imports vanish and are replaced by Oak (*Quercus* sp.) with overall numbers slightly reduced. In terms of native species, all categories of willow decrease, while juniper remains fairly stable. Rootwood increases may imply additional uprooting, or may mirror increased driftwood levels. All categories of Birch reduce with the exception of roundwood (not-pith-to-bark), which suggests a return to the harvesting of whole trees or larger branches.

Phase 4 → 5 1717-C20th While overall categories contract from 13 to 9, proportions of non-birch species expand considerably. Much of this is accounted for by species of driftwood with Larch and Pine timber increasing massively. This may be due to the relative lack of Birch forest and disappearance of wood imports, although alternatively, the need for imports may have been negated by large increases in driftwood. A decrease in Willow, results in equal representation with Juniper which remains stable and this signifies that they are still a component of the Icelandic flora, even though this may be in decreased numbers. Birch timber expands significantly (from 2 to 9%) suggesting continued harvesting of the larger trees. Bark and Birch roundwood (pith-to-bark) are reduced indicating less twig and branch collection. Birch roundwood (not-pith-to-bark) also decreases to its lowest level, although it still comprises 50% of the total sample which surprisingly indicates an ongoing supply of substantial Birch branches for fuel.

Birch utilisation is dominant throughout all phases at Skútustaðir, although Phases 1 & 3 demonstrate more small branch harvesting. The reduction in all archaeobotanical material despite additional samples for Phase 2 concurs with prior weed/wild species evidence. This probably signifies removal of the house or midden, although social and climatic factors may have reduced production, requiring the feeding of twigs and branches to valued livestock. Imports occur only from 1477 to 1900, and may reflect an additional need for larger timbers, as driftwood also increases significantly from 1717. Such a change in strategy may have been an attempt to take pressure off the native woodland. While Juniper remains fairly stable,

Willow gradually decreases across phases. Representations of rootwood between 1477-1717 are not supported by increases in either Birch timber or Birch roundwood (not-pith-to-bark), and while a substantial increase in roundwood (not-pith-to-bark) from this date to the 20th century suggests whole trees were being harvested, this is not confirmed by increases of timber. Although driftwood percentages increase with rootwood in Phase 4, the lack of correlation in any other phases suggests these categories are not linked. Harvesting strategy switched to whole trees and larger branches from 1717. As use of driftwood increased simultaneously, this may indicate a change in usage to that of a fuel source due to the declining native species.

Overall results provide conflicting evidence from both sites. Specimens of rootwood may be anticipated in the early stages at Hrísheimar and Skútustaðir due to the necessity to clear land for housing and agriculture, however there are no representations and burning horizons are also absent. This is puzzling as construction of infields and living accommodation cannot occur on land containing the remnants of trees. Results indicate that larger pieces of birch roundwood (not-pith-to-bark) were being utilised at Hrísheimar in the second domestic phase, which contradicts the earlier archaeobotanical evidence of tree reduction (Figure 4.8). This phase has only a sixty year duration due to the site being deserted in the early 11th century. Thus landowners may have vacated the site prior to total forest destruction, or enforced abandonment may have occurred to preserve remaining woodland, as happened at Þórsmörk (Dugmore et al, 2007a, 8). As data remains relatively stable over the two phases, it may be therefore, that resources were carefully controlled. This does not explain however, the complete lack of rootwood from both phases. Similarly at Skútustaðir, supplies of Birch are evident long after weed/wild evidence (Figure 4.10) and palynological sources suggest supplies had been depleted. This may suggest that gathering of wood occurred further from the farm as forests were reduced, or that wood supplies were being stored for longer which allowed time for bark, leaves and other attachments to drop off. This may be supported by the increase in Birch roundwood (not-pith-to-bark) from 1717. It is surprising therefore, that evidence for substantial Birch timbers is recorded in 20th century contexts.

Industrial Fuels

Industrial processes require higher temperature burning and thus fuels would have been selected to attain this. While domestic hearth fires did not exceed 400ºC, which resulted in incomplete combustion, industrial processes operated at twice this temperature (800ºC)

providing complete combustion (Simpson et al, 2003, 1403). In iron smelting, the furnace needed to be brought to a temperature of between 1,000 and 1,300ºC to remove impurities from the iron (Edvardsson et al, 2003, 25). Charcoal and peat are deemed capable of producing such temperatures and indeed, peat utilisation is most associated with higher temperature burning (McGovern et al, 2007, 39). There was therefore, high demand for peat and charcoal to fuel various industrial processes, yet metalworking was the primary consumer. Charcoal was utilised to extract iron from its ore and for working the metal (Church et al, 2007a, 660). The density and spread of charcoal production pits across Iceland is testimony to the intensive production taking place post landnám (McGovern et al, 2007, 38). Such extensive activity required vast supplies of wood (Coles, 1973) and a local bog, as iron ore could only be obtained from this source during the Viking Age (Edvardsson et al, 2003, 25). Pits tended to be located in or adjacent to local woodland, as charcoal has less mass than the raw material and was therefore easier to transport (Lawson et al, 2009a).

Hundreds of charcoal production pits have been sighted in the Mývatnssveit area from aerial survey (Church et al, 2007a, 669), yet metalworking activity would have been restricted to a limited number of higher status farms with access to extensive areas of woodland and bog sources. Indeed experiments in processing bog iron in shaft furnaces, the type used by Vikings, has illustrated that around 4kg of charcoal was necessary to create 1kg of raw bloom (Edvardsson et al, 2003, 25). The impact of charcoal making, smelting and iron working on forests therefore, would have been immense (McGovern et al, 2007, 38). While the Hrísheimar site included a bog and extensive woodland resources, the Skútustaðir farm did not, and thus the review of industrial fuels is limited to one site.

Site evidence from the group of smelters and smithy structures located on the ridge above the farm, illustrates that iron smelting and metal working were conducted on a large scale at Hrísheimar. Results show that this was fuelled by a mixture of charcoal and peat, the former being represented in 100% of samples, while the ubiquity count reduces to around 38% for APM (Table 4.1). Due to the lack of accompanying macrofossil evidence, the APM is more likely to represent the burning of well-humified peat (Church, 2000, 121). The only other sample constituent was a single frond of indeterminate seaweed species, which might have been accidentally burnt in an industrial process such as salt extraction, or reflect an attempt to utilise seaweed as a fuel (Hicks et al, 2011, 34; McGovern et al, 2006, 199; Simpson et al, 2003, 1403)

Specific fuel sources appear to have been utilised for industrial processes, and these differ from those identified in the domestic context. While wood and turf were recovered from the central hearth, charcoal and peat were the chosen fuels for industrial activity. Data from the domestic phases indicates limited fuel sourcing; however this does not present the overall view. Indeed, it is apparent that landowners were retaining their most precious fuel assets for industrial usage. At Skútustaðir it was not necessary to set aside specific resources, resulting in a wider range within the domestic context. With no evidence of industrial activity at this site, no charcoal production was required.

Comparison of wood species and categories between industrial and domestic phases at Hrísheimar, may highlight preferences for particular usage, however composition of charcoal remains fairly stable as Birch predominates in both contexts (Figures 4.12-4.15). An increase in Willow is evident for the industrial phase while driftwood species are not represented. Willow produces a particularly pure charcoal so may have improved overall quality giving it more value in this capacity. Conversely, driftwood would have been highly coveted for construction. Similarly as birch timber had wider utility; it is less likely to be well represented in the industrial situation. This is confirmed by increased frequency of roundwood (pith-to-bark), demonstrating the selection of smaller branches and twigs for charcoal production. This practice may be responsible for the higher representation of bark, which also helps produce better quality charcoal. Birch bark detaches easily, and its greater prevalence suggests the wood had been stored for a short duration prior to its utilisation (Church et al, 2007a, 663). Wood may be stored more indefinitely for domestic contexts, providing ample opportunity for the bark to peel off prior to its journey to the hearth. An increase in indeterminate charcoal specimens may be due to the higher temperature burning.

While it is not possible to conclude that sufficient local birch was available to support industrial processes in Phase 2, due to the inability to subdivide industrial samples, the 100% ubiquity count demonstrates higher levels of utilisation in the later phase for domestic purposes. As the industrial process was so important, wood sources for charcoal would have taken priority. Thus indications of birch wood shortages would have appeared as alternative domestic fuels. This did not occur, strongly suggesting continued availability of local woodland.

As both domestic and industrial data has been discussed, it is now possible to compare patterns of fuel resource utilisation with other sites in the Mývatnssveit area, specifically

Hofstaðir and Sveigakot. Hofstaðir was a high status ritual site with access to a wide range of resources, while Sveigakot was a more marginal site, enclosed on all sides by bordering farms/features making access to resources much more limited (Simpson et al, 2004, 477). Following settlement however, both farms utilised turf as the staple fuel resource for low temperature domestic combustion. In contrast both Hrísheimar and Skútustaðir used a predominance of wood with supplementary additions. Hrísheimar may have burnt a marginal amount of turf, while peaty turf comprised over a third of samples at Skútustaðir. The single specimen of seaweed may also have indicated a fuel source (Sveinbjarnardóttir et al, 2007, 192). At Sveigakot from AD 950 frequency of turf increased substantially demonstrating an increased reliance on this source as a low temperature fuel. At Hofstaðir however, there was a gradual shift towards peat and wood fuels which became the major constituents in later periods, and while Sveigakot also increased wood utilisation in later periods, this was not to the same extent, and peat was not used at all (Simpson et al, 2003, 1415). Instead animal manure became part of the fuel base, and this may suggest additional resources needed to be exploited to meet fuel requirements (Simpson et al, 2003, 1413). The Hofstaðir and Hrísheimar sites provide no evidence of such residues and it is postulated that sufficient fuel resources were deemed to exist. Skútustaðir did not utilise dung until after 1477 and this may coincide with a reduction in tree numbers.

While no evidence of industrial activity was apparent at Skútustaðir, micromorphological analysis would be required to detect higher temperature combustion. At Hofstaðir and Hrísheimar, charcoal and peat were employed for industrial purposes. As stated earlier, these two fuels are most suitable for this task. Yet the composition appears to have differed with Hrísheimar using more wood and Hofstaðir more peat. This was unusual as there were no peat reserves located on the site and so supplies had to be transported to the farm (Simpson et al, 2009, 359). Hrísheimar had substantial woodland close by and the bog from which peat could be extracted (Edvardsson et al, 2003, 25). Although peat resources were only 3km from Sveigakot, it does not appear to have had access to them, and it was forced to rely on turf for its high temperature burning, although this was an inferior fuel for high combustion tasks. It may have been that a social elite was regulating availability of the peat, and thus the lower status of Sveigakot seems to be confirmed (Simpson et al, 2003, 1415).

Considering all evidence it is apparent that fuels were selected for purpose, with those capable of producing the highest temperatures utilised for industrial activity. Yet this was not always possible and may suggest that control of certain resources was an important factor in fuel

choice. Even though a wide range of fuels might be available, if access to superior fuels was restricted, less suitable alternatives would need to be utilised (Lawson et al, 2007, 11). This was probably the case at Sveigakot, which had to rely on turf, even for its high temperature combustion. Thus fuel utilisation may provide important information regarding status and power.

Woodland Management Strategies

In Norway, an agrarian society and animal husbandry practices had been established by the Late Neolithic (Hjelle et al, 2006, 147). This had involved some forest clearance, and evidence suggests pollarding and leaf collection for fodder was already being practiced in order to best utilise and conserve assets (Hjelle et al, 2006, 155). Thus the Viking settlers had experience of managing land and farm resources in a visually similar landscape. It would be expected therefore, that such techniques would be applied to their new environment.

Management of woodland may be assessed by examination of specific categories. Only roundwood (pith-to-bark) and roundwood (not-pith-to-bark) with an outer ring provide diameter and ring count information, vital for determining whether particular ages or girths were being targeted for collection. A correlation between these factors may indicate productivity, an increase of which would suggest employment of management strategies. Larger pith-to-bark pieces tend to be underrepresented however, as wood fragmentation during burning does not favour their survival. Continued attachment of bark and buds may also be a sound indicator regarding time of harvesting, and how quickly the wood was utilised (Church et al, 2007a, 663). A lack of attachments may indicate a clearance event in the past, which resulted in long term storage, during which buds and bark would have dropped off before carbonisation.

When comparing domestic phases for 870-1000 between sites, it is evident that only the Skútustaðir graph representation for ring counts is unimodal, although the overall pattern is quite similar (Figures 4.21 & 4.24). Both graphs show a peak at 6-10 years suggesting this is the preferred age for harvesting. While frequency decreases significantly to the next age group (11-15), this is not as apparent at Hrísheimar where harvesting remains relatively high. A minor representation of old trees (46-55 years) is evident at this site while the oldest specimens at Skútustaðir are in the 26-30 age bracket. Comparative data from diameter measurements demonstrates a noticeable divergence in pattern however, with Skútustaðir showing unimodality, but Hrísheimar displaying greater fluctuation (Figures 4.22 & 4.25).

Skútustaðir peaks at 5-6mm, while 3-4mm frequencies are highest at Hrísheimar, followed by 5-6mm, but with 9-10mm close behind. While categories between 11 and 30mm demonstrate minimal frequencies or absence of data, no representations occur above 30mm. At Skútustaðir however, largest girths are in the 15-16mm category, yet representations over 12mm are minimal. Hrísheimar displays a larger variety of width categories. Limited evidence of older trees and wider girths suggests that such specimens may have been harvested for a specific purpose, or had ceased being productive, as Birch rarely attains more than 100 years (Atkinson, 1992, 848). Apart from this, only younger and smaller branchwood seems to have been collected, while mature trees appear to have been conserved. The harvesting of younger and slimmer appendages also occurs at Skútustaðir, denoting harvesting of branches rather than whole trees. Correlation xy-graphs indicate that rate of growth across populations at both Hrísheimar and Skútustaðir appears to follow a normal pattern of productivity implying similar growth conditions (Figures 4.23 & 4.26). Focusing on temporal changes at Hrísheimar, it can be seen that neither phase produces unimodal graphs (Figure 4.21), however, while the 6-10 yr group is most represented in both periods; it appears that tree younger than 15 years are being specifically targeted in Phase 1. This could indicate coppicing, as younger trees produce smaller branches which are being targeted. No older trees have been harvested in the later phase; this may be evidence of conservation, absence from the landscape, or selection for another purpose. Size graphs are not unimodal (Figure 4.22), and yet Phase 1 (870-940) specimens are mainly clustered from 1-10mm with either a small number of samples or no representations after 10mm up to 30mm which constitutes the largest girth. By AD 940 only 9 samples are represented and this may have produced the unusual results for Phase 2. While most of these occur in the lower values, a third of samples were in the 29-30mm category which may imply the targeting of larger branches, although these may have originated from the same host. Nonetheless, line of best fit for Phase 2 is steeper (Figure 4.23), indicative of increased productivity which is often an indicator of coppicing. The targeting of young, slender specimens, also suggests management strategies are in place. Comparison between domestic and industrial phases demonstrates remarkable similarity in distribution, with the 6-10 year categories being most represented, followed by 11-15 years. Industrial activity seems to also favour younger trees with minimal representations of older (46-50 years) specimens. More data was obtained for diameter from the industrial phase, and this is surprising since wood tends to fragment more easily at higher temperatures. As with age, diameter does not follow a unimodal distribution. Highest representations are shared in the industrial phase covering 3-6mm widths, while a second

peak is apparent at 15-16mm. A single specimen with a girth of 39-40mm is not matched in the domestic phase, in which no wood exceeding 30mm was recovered. Conversely the industrial data also comprised a much greater number of very small 1-2mm specimens. While the 3-6mm categories are most frequent in domestic data, branches of 9-10mm are also well represented. Yet for both types of activity small twigs/branches of 1-10mm are most favoured. Correlation graphs are broadly similar, although industrial data is more clustered. As wood shrinkage during charcoal production may be around 45% (McGinnes et al, 1974), it may be anticipated that initial wood portions would need to be fairly substantial. Experimental charcoal production pits created at Mývatnssveit, aimed to determine the existence of preferential wood sizes for charcoal production. Smaller diameter pieces were found to pyrolise more easily than larger samples, and may explain the selection of smaller fragments for industrial activity (Lawson et al, 2009a).

Overall it appears that trees were targeted on an age basis of less than 15 years. Composition is extremely similar between industrial and domestic phases, suggesting that the two types of combustion process required similar sizes of wood. This is suggestive of a management strategy, which aims to conserve older specimens, and improve productivity. Temporal changes at Skútustaðir will now be analysed to determine if similar techniques were in operation (Figures 4.24-4.26).

Phase 1→2 870-1477	Both ring count representations are unimodal and demonstrate a peak at 6-10 years, however this is much reduced by Phase 2. Trees over 20 years also decrease in frequency. Diameter data broadly reflects age in the initial phase showing a preference for younger, more slender branches, however by Phase 2 the distribution is much flatter. This suggests that trees were being targeted by age rather than size. Correlation shows a much wider distribution in Phase 2, and may be due to the accelerated growth of several specimens, falsely implying an overall increase in production.
Phase 2→3 1000-1717	Although Phase 3 ring count and diameter are not unimodal, they follow very similar patterns. Focus has switched from 6-10 year trees to even younger and thinner branches. Some older trees are still represented however, including one specimen at 41-45 years. Particularly large girths are demonstrated in two specimens (79-80mm and 93-94mm), which are not represented due to graphical distortion. Correlation suggests some increase in productivity and as

harvesting appears to focus on fewer categories; evidence of management intervention is suggested.

Phase 3→4 1477-1900 By Phase 4, although the first three ring count categories remain central to harvesting strategy, focus has reverted to the 6-10 year specimens, and peak diameter has increased correspondingly. Yet frequency values are flatter across categories with the second largest being for 19-20mm. Nonetheless specimens continue to be targeted by age rather than size. Productivity seems to have increased, and two samples demonstrate unusually rapid growth, while one outlier at 49-50mm has been excluded.

Phase 4→5 1717-C20th In these unimodal representations, age targets reflect phase 4, while older specimens disappear. Diameter peak extends over two categories 3-6mm and productivity remains constant.

Phases 1, 3 and 5 provide unimodal distributions, in which diameter broadly reflects age. Yet in all phases, selection appears to be by age, the main target being 6-10 years with the exception of Phase 3 which is for 1-5 year old saplings. The collection of younger branches which are usually smaller, may indicate a deficit in tree numbers or growth, and hence a management strategy to encourage woodland regeneration. Such results strongly indicate a managed resource which may include age specific areas of woodland, indicative of coppicing or pollarding.

Indeed, age related selection is evident at both sites, for both industrial and domestic phases and over time. While Hrísheimar were targeting trees of <15 years, Skútustaðir specimens tended to be younger at <10 years which may suggest fewer woodland resources. Coppicing and/or pollarding may have been practiced to conserve valuable woodland reserves. Original base felling of the straight trunk at landnám would have encouraged basal growth in much the same way as coppicing, and this strategy utilised for land clearance, may have immediately increased the vulnerability of the trees (Smith, 1995, 336). This process renders new shoots vulnerable to grazing activity, whereas in pollarding trees are cut back about a metre from the base. This might have proved difficult with Icelandic birch however, as they rarely exceeded 3 metres (Smith, 1995, 336). Coppicing would therefore have been the most likely strategy.

Branch harvesting creates open wounds from which sap is able to leak. As birch sap rises in spring, harvesting at this time would have been most detrimental to the plants (Church et al, 2007a, 669). Already close to their ecological limits, a tree weakened in this way would be more susceptible to adverse conditions such as climate deterioration and grazing, or human

intervention. Substantial amounts of birch roundwood from both sites were still endowed with pieces of bark, indicating harvesting from live trees. The excellent state of preservation implied that wood had been utilised shortly after harvesting. At Hrísheimar, the presence of well preserved buds in several samples, suggests that at least some of the harvesting activity occurred during spring (Church et al, 2007a, 667). This management strategy may have negatively impacted on the birch woodland therefore in the Hrísheimar locale.

The Norse complex of cattle, caprines and pigs also had a major impact on the woodland. Occasional cattle grazing and browsing of saplings and seeds by caprines contributed to the decline of Birch as shoot production was depressed, preventing woodland regeneration (Miles & Kinnard, 1979; Pigott, 1983; Atkinson, 1992, 844). Pigs proved to be the major culprits however, as their grubbing around tree roots was particularly destructive (McGovern et al, 2007, 40). While this species was relatively scarce at Skútustaðir (Hicks et al, 2011, 33), the numbers exceeded those of cattle at Hrísheimar in the 10th century. When most farmsites were decreasing their pig populations, Hrísheimar increased stocks. This also appears to have been a questionable management strategy especially considering the farm's reliance on the woodland. As pigs and cows were high status domesticates (Dugmore et al, 2005, 27), social standing may have taken priority over environmental issues. Indeed, management strategies may have been affected by status, in terms of access to, and control over, a wider range of resources, and this will be considered with reference to the neighbouring sites of Hofstaðir, Sveigakot and Undir Sandmúla.

While Hofstaðir shows the widest range of arboreal resources, Skútustaðir has the most tree species, including the highest representation of driftwood. This item signifies control over coastal access and resources, and is therefore an indicator of both status and wealth. Lack of driftwood at Undir Sandmúla would force reliance on local wood supplies. Regardless of status however, all sites relied primarily on birch assemblages, although constituents varied according to site. In the initial phase no local rootwood was recovered from Hrísheimar, Skútustaðir or Undir Sandmúla, implying a different management strategy to Hofstaðir and Sveigakot from the outset. Yet uprooting occurred more widely at Hofstaðir, which may have had implications for deforestation. Attachment of bark on many of the samples from this site demonstrated live harvesting with utilisation soon after, as was found at Hrísheimar and Skútustaðir. This process signals a form of branch harvesting indicative of woodland control. Rowan was recovered from only the Hofstaðir and Sveigakot sites, the former comprising three categories (timber, roundwood (pith-to-bark) and roundwood (not-pith-to-bark)), while

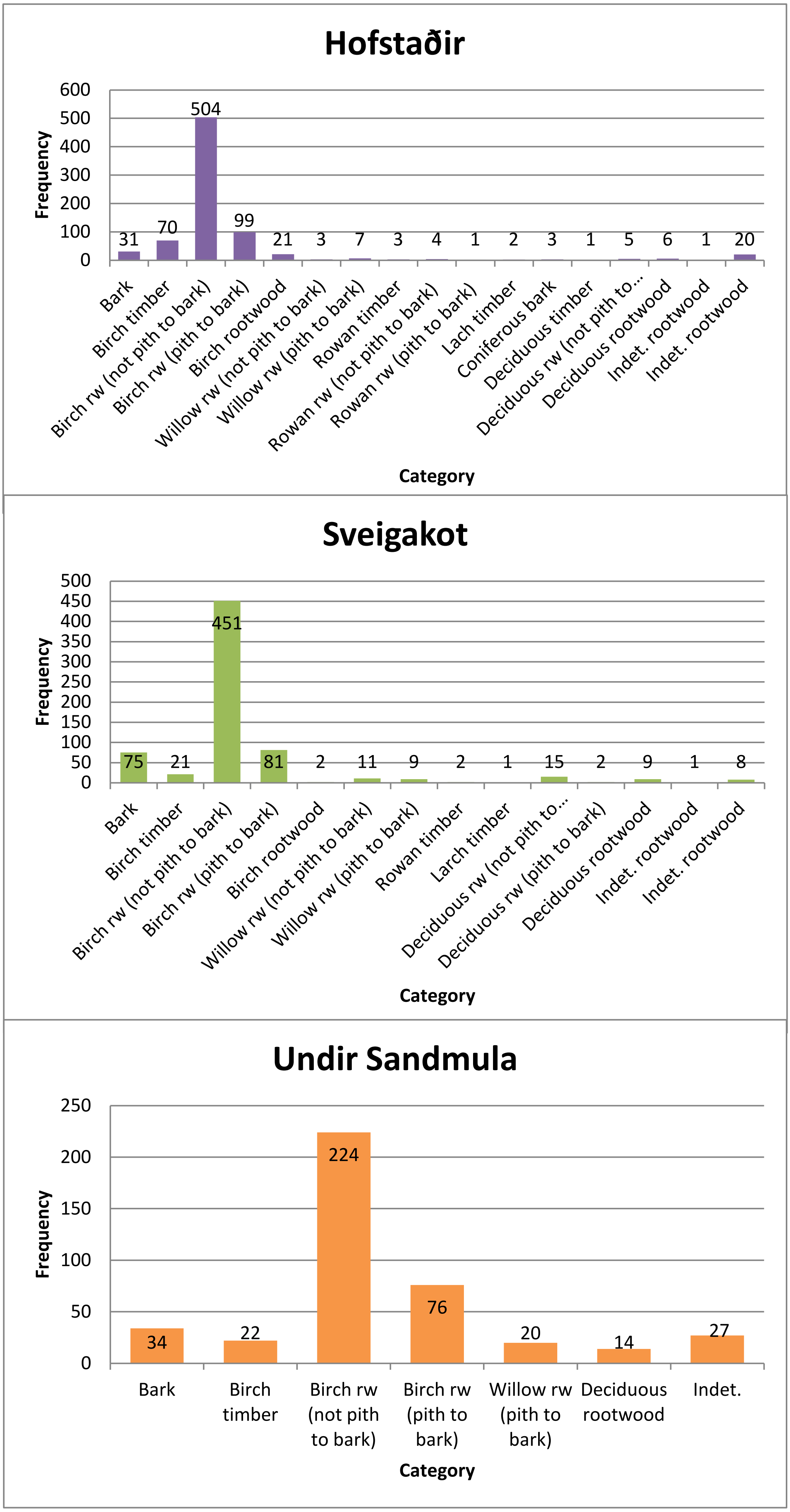


Figure 5.4 – Relative charcoal constituents from other Mývatnssveit sites (Data from Duarte, 2006 and Church, unpublished).

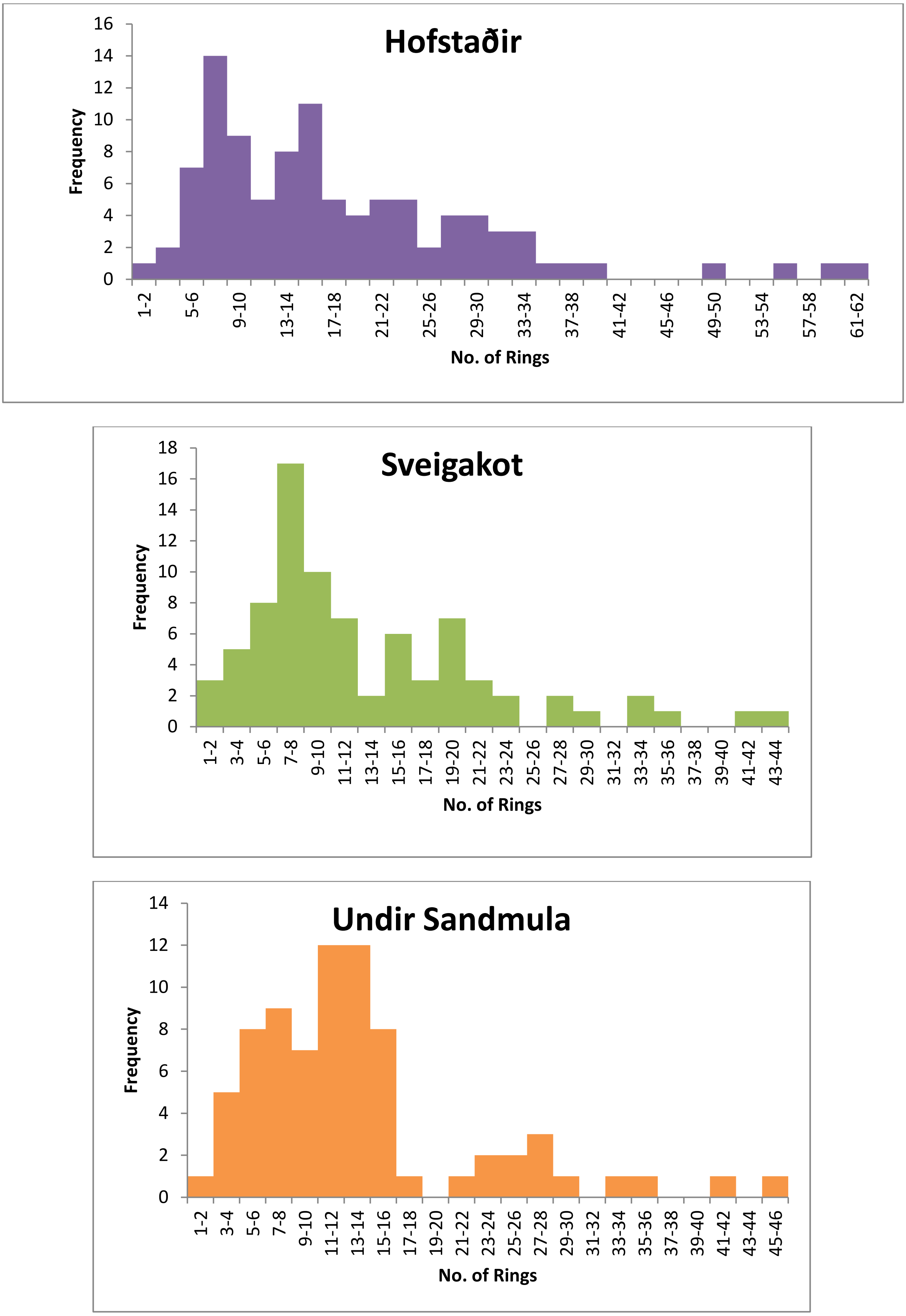


Figure 5.5 – Relative ring counts of Birch roundwood (pith-to-bark) from other Mývatnssveit sites

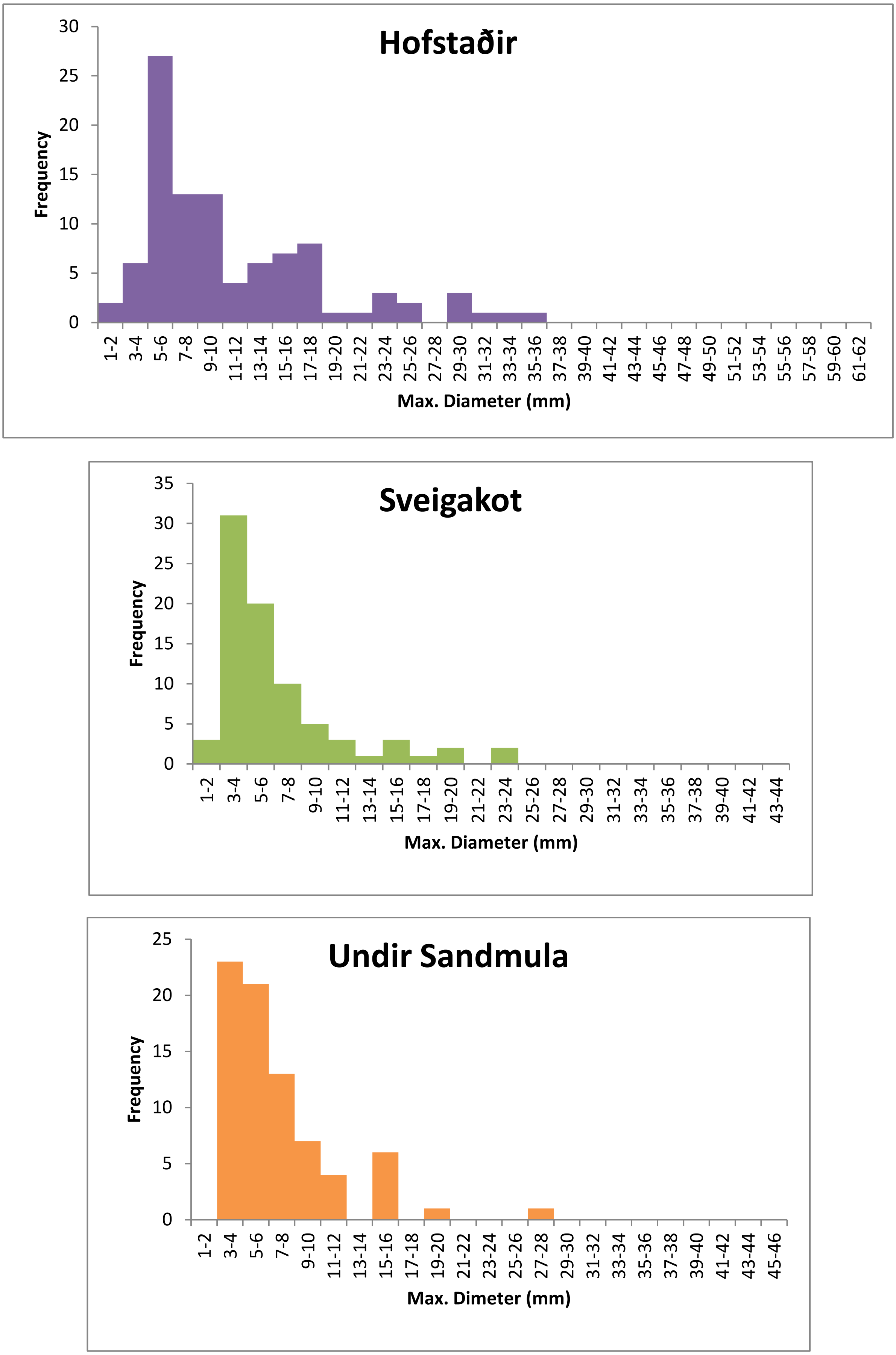
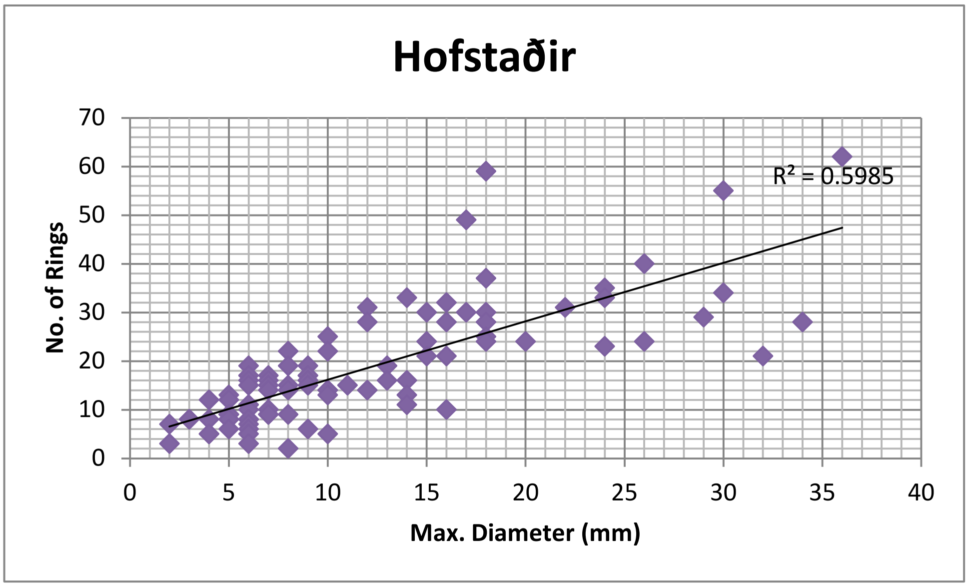
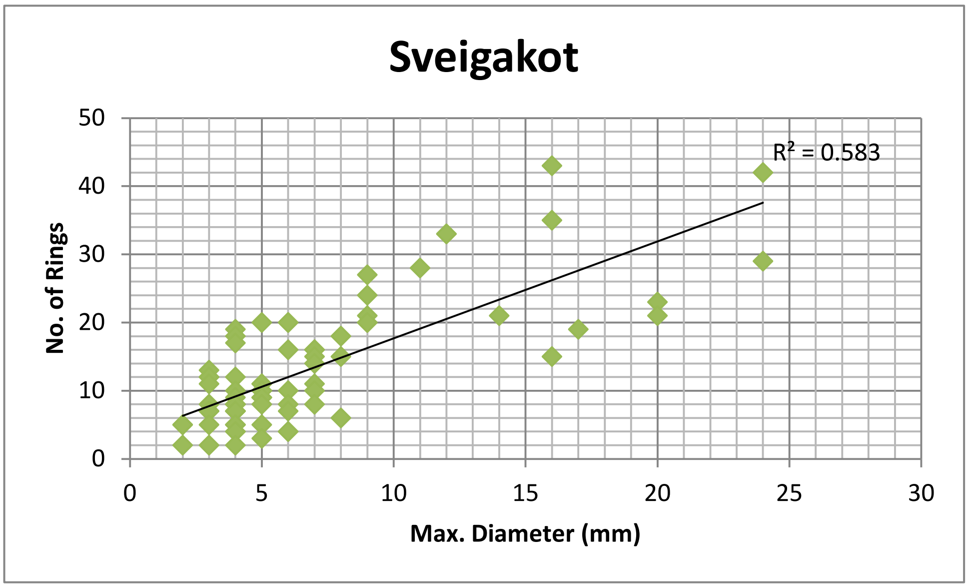


Figure 5.6 – Relative diameters of Birch roundwood (pith-to-bark) from other Mývatnssveit sites





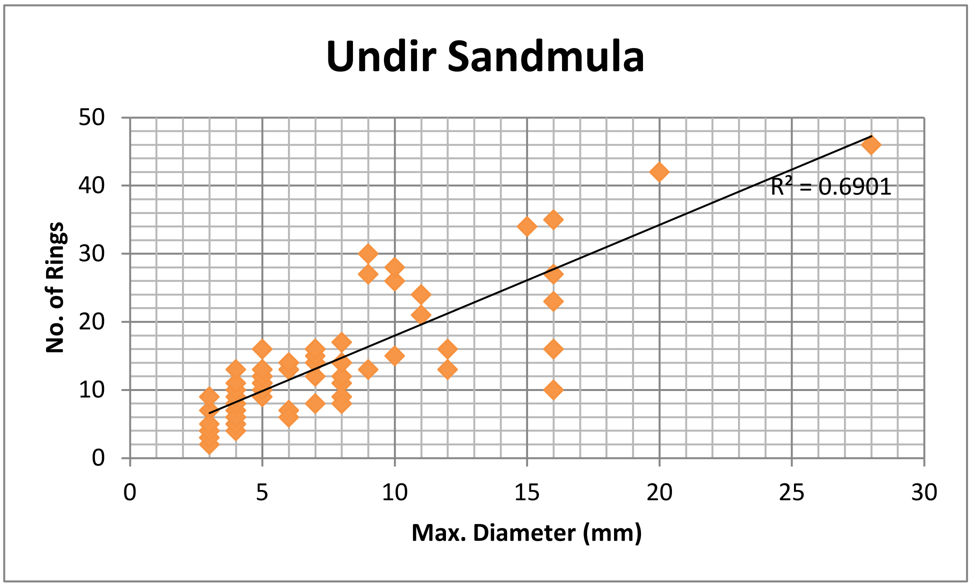


Figure 5.7 – Relative correlation of ring count/diameter of Birch roundwood (pith-to-bark) from other Mývatnssveit sites

the latter contained only timber. This suggests that Rowan was found within the Hofstaðir area, while it was obtained by trading at Sveigakot. This may suggest that Hofstaðir had control of this resource in the locale. While Hrísheimar and Undir Sandmúla display the narrowest range of arboreal resources, the status acquired through metal working and the sheer expanse of natural woodland surrounding Hrísheimar would afford sufficient status and wood resources to meet initial requirements.

It may be seen from examination of Figures 4.21-4.26 & 5.4-5.7 that while Hrísheimar and Skútustaðir appear to have targeted by age, the three comparison sites all seem to have selected by size. Harvesting across all sites concentrates on the smaller, younger appendages, and while Hrísheimar, Undir Sandmúla and Sveigakot peak at 3-4mm, Hofstaðir and Skútustaðir demonstrate a preference for slightly larger branches (5-6mm). Hofstaðir has the oldest trees with the widest girths; however Skútustaðir has the youngest and most slender specimens. This shows that the forest at Hofstaðir was better established, and also that older trees were being felled, maybe with a specific purpose in mind. The oldest representation at Hofstaðir is 61-62 years while specimens do not exceed 55mm at the other sites. Representations are spread across a wider range of ages at the three comparison sites, however, while these have their own unique pattern of frequencies, younger trees tend to be favoured. Simpson et al (2003, 1415) suggest that a woodland management strategy such as coppicing results in different areas of woodland having different age structures and densities which would raise productivity for a time. It appears that such strategies were employed at all sites across the region, as appendages were targeted by age or width, favouring the lower categories. As suggested by Simpson et al, (2003) coppicing is most likely to have been adopted. While this may have proved effective at some sites, counter measures such as pig husbandry may have reversed any favourable outcomes. Some sites such as at Sveigakot drastically reduced pig stocks, while Hofstaðir numbers remained fairly stable (McGovern et al, 2007, 40). Only at Hrísheimar did numbers increase in the 10th century which must have significantly impacted on the woodland. Thus while evidence of management practices exist, not all of these could be claimed to be appropriate.

Trading Links

Non-indigenous species were recovered in several categories including grain, fruit and wood, yet trading activity cannot always be concluded from this evidence. Although barley and oat are non-indigenous to Iceland, they formed part of the Norse agricultural package and were

introduced to the island rather than being imported. Cereal growing is only claimed to be viable in specific areas of Iceland (Erlendsson et al, 2009, 174; Zutter, 1992, 144). Yet even if initial trialling of crops occurred, it is likely that barley, the more successful of the two, provided only subsistence yields (Simpson et al, 2002, 424). Thus Iceland was never self-sufficient in grain production (Rögnvaldardóttir, 2002, 4). Cereal imports were necessary for making porridge, a substantial constituent of the daily diet, and for beer production. These probably derived from the homelands. Much of the limited early cereal production had ended during the 1400s, although lower lying regions may have continued into the next century (Simpson et al, 2002, 439; Rögnvaldardóttir, 2002, 4). While the cessation of grain production cannot be wholly attributed to the climatic downturn apparent at this time (Simpson et al, 2002, 439), imports were certainly affected. In some years imports of grain were scarce, as severe weather and other factors, prevented ships completing the hazardous journey. In 1326, for example, no Norwegian ships were able to carry imports to Iceland, resulting in a real shortage of many basic commodities including grain (Rögnvaldardóttir, 2002, 5). The fairly substantial recovery of rye at Skalholt in south Iceland is wholly attributable to imports (Archaeological Services, 2010). No dating is yet available from this site, yet specimens will originate from the site habitation dates of 1056-1785. Certainly imports of rye steadily increased until it became the grain most utilised in human consumption (Rögnvaldardóttir, 2002, 4). Evidence of flax cultivation is extremely limited (Smith, 1995, 329), a recent find at Skalholt providing the first archaeological evidence (Archaeological Services, 2010, 4). Yet flax requires good quality land and therefore would have been competing for the limited amount of infield required for barley production (Bond et al, 2004, 143). Thus such evidence is more likely to have signalled importation rather than cultivation.

The Norse had enjoyed several varieties of fruit in their homelands. Plums, cherries, pears and small apples, plus hazelnuts, beech nuts and walnuts were grown in Scandinavia (Rögnvaldardóttir, 2002, 2). As no fruit bearing trees grew in Iceland, such fruits would have needed to be imported, and fruit available from shrubs such as the crowberry and bilberry would have had increased importance. While Skútustaðir provides evidence of two fruit categories, fig and plum (Figure 4.2), the medieval site of Skalholt in the south of the island, yielded, fig, plum, cherry, apricot, peach, grape, olive and hazelnut. This had been a particularly high status site (Lucas et al, 2002, 1) however, which would have had well established routes from the coast. Inclusion of fig and olive suggests imports from as far

afield as the Mediterranean and possibly the Middle East. In contrast, fruit remains at Skútustaðir appear only from the 20th century, reflecting a general increase in imports.

Importation normally refers to goods (and services) intentionally brought into the country for sale or exchange, however the arrival of some commodities may be non-purposeful. Wood falls into both categories and it is often difficult to establish which route non-indigenous species have followed. While only Pine (*Pinus* sp.) was recovered from Hrísheimar, Skútustaðir yielded four additional species; Oak (*Quercus* sp.), Hazel (*Corylus* sp.), Larch (*Larix* sp.), and Yew (*Taxus baccata* L.). Of these, oak, yew and hazel are most likely to have been imported. Icelandic species provided insufficient girth for construction, and imported timbers may have been utilised primarily in house construction and ship building (Byock, 2001, 33). Prior to the deforestation of Iceland the Laxdæla saga (Kunz, 2001, 286-288) relates that Hoskuld has to return to Norway to obtain timber for his farm buildings (Owen, 2009, 232). As the Pine sample from Hrísheimar was recovered from the first domestic phase (870-940), it may have been utilised for the initial dwelling. It has been suggested that oak fragments may be the staves of barrels, which derived from English coopers for the purposes of tanning (Zutter, 2000, 81); however such fragments may have been constituents of other artefacts not imported for their wood. At Skútustaðir these imports, probably from Northern Europe (Rackham, 1980), occurred only after 1477; at a time when English merchants began to journey into Icelandic waters. The Norse were able to trade dried fish and homespun cloth in exchange for wood, grain, candlewax and luxuries such as honey (Rögnvaldardóttir, 2002, 5). The switch from hazel and yew to oak may reflect a fashion trend for the production of more substantial construction work or furniture. Such imports would confirm the prestige of the site. Yet driftwood also conferred status, in some cases due to the implied control over coastal access (Simpson et al, 2003, 1403; Smith, 1995, 336). This was extremely important as it provided essential items for exchange and even survival (Zutter, 2000, 81). While presence of driftwood at both study sites reflects a high social position it may not infer control over access, but rather internal trade within Iceland. This is also demonstrated by the presence of marine fish at these sites which could not be obtained any other way (Hicks et al, 2011, 24**;** Edvardsson et al, 2005, 16). Nonetheless such timbers, probably originating from Siberia or Russia (Eggertsson, 1993, 15), would have dramatically increased in importance as wood supplies began to dwindle.

Exotic species of wood, fruit and grain appear to have been widespread in Iceland from 1477, and indeed coal specimens are also indicative of trading activity. This commodity is likely to

have derived from Britain as trading links were already well established for a variety of items including luxury goods (Rögnvaldardóttir, 2002, 5). Level of imports, provide an indication of wealth as surplus would be required for trading to occur, and this was particularly pertinent in the case of luxury items. This indicates that Skútustaðir was profitable up to the 20th century.

North Atlantic Context

The success of landnámsmenn, who colonised the North Atlantic islands, was dependent upon many factors including climate, soil and sediments, availability of resources, and management strategies. Many of the tasks required to ensure the Greenlanders survival such as seal and walrus hunting, demanded co-operation, and this was true of the Faroes to some extent, where communal whale hunts are still in operation (Dugmore et al, 2007, 19). Yet, Faroese farms were also self sufficient therefore avoiding over interdependence. Due to inhabiting small islands, farmers would tend to live in close proximity and have access to coastal resources. Iceland was unique in that farms were often fairly isolated and landowners who vied for prestige, honour and access to resources, tended to be more competitive than co-operative (McGovern et al, 2007, 30). Power and status afforded additional opportunities on Iceland, especially when trying to replicate the Norse model farm. This may be seen in the limited number of farms that attempted cereal cultivation. Such activity required seeds, manure and labour which required wealth and authority. Even with such attributes however, past research and present results support the theory that this never attained more than subsistence level. While Greenland's climate could not facilitate the ripening of cereals, it would probably have been cultivated as animal fodder, and lyme grass was often used as a cereal substitute, as occurred in parts of Iceland (Buckland et al, 2009, 111; Erlendsson et al, 2009, 184). With a milder climate, the Faroes were able to achieve more profitable levels of farming, despite field size limitations due to local topography (Adderley & Simpson, 2005, 711). While Hrísheimar and Skútustaðir produced limited representations of barley with a minimal amount of oat (the only crops which were viable on Iceland), these two crops also predominated in the Faroe Islands (Sveinbjarnardóttir et al, 2007, 202; Church et al, 2005, 192). Six row hulled barley was preferred at both North Atlantic locations, being resilient to adverse weather conditions and due to its importance in the brewing of beer. Palynological evidence of oat cultivation exists for both Iceland and the Faroes, although macrobotanical remains are rare. While oat may have been a minority crop, it may also have been a weed of barley cultivation. It is suggested however, that post harvesting processing of barley may have differed between these two locations. Results from Hrísheimar and Skútustaðir accord with other Icelandic

research suggesting that crops tended to be processed off site. In the Faroes however, on site processing is more likely, as more chaff tends to be recovered from farmsites, providing increased opportunities for carbonisation (Church et al, 2005, 186).

Many taxa across several categories are common to all North Atlantic locations. These are often indicative of human activity and include: weeds of cultivated land such as Chickweed (*Stellaria media* (L.)Villars) and *Polygonaecae*, apophytes such as Docks (*Rumex* sp.), Blinks (*Montia fontana* L.) and Buttercups (*Ranunculus* sp.), which commonly appear across islands after settlement, and wild berries like Crowberry (*Empetrum nigrum* L.) and *Vaccinium* sp. (Church et al, 2005, 186; Lawson et al, 2005, 668, 2007, 8; Sveinbjarnardóttir et al, 2007, 198; Edwards et al, 2008, 4; Buckland et al, 2009, 110). While all were represented at Skútustaðir, buttercups and docks were absent from Hrísheimar samples. Nonetheless, site results appear to accord with previous research, both throughout Iceland and the wider North Atlantic. Such biota is most often evident in the archaeological record due to its incorporation in peat/turf or dung brought into the central hearth as fuel (Church et al, 2007b, 763).

Fuel utilisation tends to reflect the relative abundances of floral composition and, to some extent, status and power. Peat and turf have been identified as the main fuel sources in the Faroe Islands due to the high concentrations of their carbonised remains across islands (Church et al, 2005, 191). Peat was readily available from extensive areas of blanket bog, and its procurement was a vital part of the local economy. This activity required planning and equipment, which was reliant on communal organisation (Church et al, 2005, 192). Turf was also in plentiful supply in Iceland and Greenland, however in Greenland its utilisation was primarily for the construction of houses and byres (McGovern et al, 1988, 231). Although woodland/shrubland was not as extensive as in Iceland, wood was utilised for domestic purposes and the recovery of willow and alder charcoals suggest it was also used in metal working activity. While the Norse did extract and smelt bog iron in Greenland (McGovern et al, 1988, 230), this would have been on a smaller scale than in Iceland. Forests were absent in the Faroe Islands, however, limited supplies of wood were supplementary fuel sources. Dung from domesticates was utilised across islands for enrichment and also as a supplementary fuel source, although this was more prevalent on Greenland due to shortages of alternatives (Dugmore et al, 2005, 32). In other localities utilisation may have reflected a lower status and/or restricted access to resources, as at Sveigakot in Iceland.

Individual farms utilised specific suites of combustible materials, and indeed the two farmsites discussed in this report used a different range and composition of fuel resources. The predominance of wood as fuel at Hrísheimar reflects the local woodland environment and supplementary peat used in industrial processes may have been sourced from the proximal bog area. Turf as fuel may have been used minimally, yet despite being listed as an Icelandic fuel, there is no record of seaweed utilisation for this purpose on either Greenland or the Faroes, despite their access to coastal resources. At Skútustaðir a wide range of fuel sources were employed, yet the greater reliance on peat, mirrors local wet meadow areas, while dung usage in a later period may indicate hardship or conservation of valuable wood resources. This may be for a specific purpose. Hrísheimar utilised wood for both its domestic and industrial burning. The smaller scale metal working activity on Greenland would also have required a fuel which was suitable for high combustion burning, and this could not be attained by dung. It is possible therefore that limited wood resources were retained for industrial activity while dung may have predominated in the domestic setting. In the case of Sveigakot in Mývatnssveit, however, lack of access to more suitable fuels limited farmers to using turf for high temperature combustion, even though this would have been less effective (Simpson et al, 2003, 1413). The two study sites therefore reflect the factors involved in making fuel choices, across the North Atlantic islands.

While wood was an important fuel source across the North Atlantic, the composition of native tree species differed. Iceland with its arboreal advantages also shared the widest diversity of species; birch, willow and juniper were native to all three locations (Hannon et al, 2005, 641), however rowan was indigenous to Iceland alone, while alder scrub was found only in Greenland (Dugmore et al, 2005, 29). This additional tree cover however, combined with the highly friable andisols and increased population compared to its neighbours, contributed to the more pronounced ecosystem responses in Iceland following deforestation. Yet this was vital for pasture creation, domestic hearth and industry (Lawson et al, 2008, 1148-9). Utilisation of local resources as fuel may be obtained from analysis of recovered charcoal. Although carbonised wood deposits are rare on the Faroes, they consist of local roundwood, coniferous driftwood and minor representations of imported species, such as the oak specimens found on Sandoy (Malmros, 1994; Church et al, 2005, 194). Similarly fragments of willow and alder are commonly found in hearth deposits in Greenland (McGovern et al, 1988, 230), although driftwood was probably a supplementary source.

Composition of wood fuel at both Mývatnssveit sites also relies heavily on native species, predominantly birch although neither site shows the full range of species. This is supplemented by driftwood and minimal fragments of imported wood. Driftwood species of Larch, Spruce and Pine are common to all North Atlantic locations and originate from the same areas, namely Russia and Siberia (Eggertsson, 1993, 29) although some American driftwood is also found in Greenland (Eggertsson, 1993, 19). It is recorded that Greenlanders often made journeys to Labrador in order to procure timber, however this is not reflected in the charcoal record (McGhee, 2009; Trigger & Washburn, 1996, 333). Of the study sites, only Skútustaðir provided evidence of imported wood species which derived from the later phases (1477-1900), one of these being oak which, as mentioned above, has also been recorded on the Faroes (Church et al, 2005, 194).

Data obtained from Hrísheimar and Skútustaðir accords with prior research from Icelandic locations, which allows consistent comparison with the other North Atlantic islands. In particular, the importance of status in respect of access to resources, appears to be particularly pertinent to Iceland. Such comparison helps to emphasise the importance of local conditions and individual management strategies in determining the sustainability of landnám settlements.

Conclusion

As the two farm sites examined for this dissertation have different lifespans, it has not been possible to compare sites over the full time period. Similarly, the industrial phase at Hrísheimar could not be subdivided, and reduced evidence from Skútustaðir for the 1000-1477 period, ascribed to midden relocation, renders temporal trends impossible and difficult respectively. Nonetheless, site results provide valuable insights into Norse utilisation of their botanical environment.

The presence of both domestic (central hearth) and industrial contexts illustrates the necessity for two distinct taphonomic models to explain the incorporation of taxa into the archaeobotanical record. Evidence of cereal cultivation may have entered the hearth due to cooking accidents or from purposeful drying of grain, and includes caryopses, chaff and accompanying weeds. Both Skútustaðir and Hrísheimar demonstrate cultivation of six-row hulled barley in the initial phase, while Hrísheimar also has minor representations of oat. This suggests initial trials to ascertain viability. The presence of oat at Skútustaðir (1717-1900) however, indicates this was a weed of the imported barley crop, since cereal cultivation had ceased in Iceland by the 15th century as imports became more economically sound.

After this time only hay cultivation continued, yet this was vital for the over wintering of domesticates. The remains of cereal crops provided a good source of fodder and harvesting strategy determined overall yield. Uprooting (Skútustaðir) rather than cutting the culm (Hrísheimar) increased total yield, which constituted a significant amount across the whole infield. Yet allowing domesticates to feed on the remaining stalks at Hrísheimar, produced natural enrichment of the soil. While enrichment was evident at both sites, the build up of midden material at Hrísheimar suggests additions were irregular and minimal. As there is evidence of landscaping at Skútustaðir, to improve topography and maximise the infield area however, it is likely that these landowners were committed to regular and consistent enrichment activities. Such requirements would have been necessary to act as a buffer against adverse weather conditions. While evidence of enrichment was supported by the presence of certain weed species at both sites, this had ceased at Hrísheimar by AD 940. Conversely evidence for this practice continued until the 20th century at Skútustaðir.

Outfield areas were also productive, and a range of trees, shrubs, weeds and wild plants satisfied many culinary, craft and medicinal needs. Such flora has preferential requirements regarding habitat, and thus assemblages relate the local ecology, although this may not be

completely representative due to being culturally selected. Macrobotanical assemblages for both sites, reflect their immediate environment with a predominance of wetland species at Skútustaðir and more woody species at Hrísheimar. Expansion of wetland appears to occur in both locations but during different time periods. At Skútustaðir, tree species are not represented after 1717, while shrubs also disappear by the 20th century, after which drier conditions are indicated. Absence of woody species from later periods may signify conservation for fuel purposes. Although wood, peat, turf, dung, coal and possibly seaweed were recovered; most pressure was placed on the woodlands. Both sites utilised proximal sources. At Hrísheimar this was predominantly wood with minimal turf additions, while a larger inclusion of peat at Skútustaðir reflected its wet meadow resources. Fuel variety increased at Skútustaðir post 1477. Inclusion of turf and dung may indicate wood depletion or general hardship, while coal imports from 1717 may demonstrate an improving economy.

Reflecting the distribution of other resources, Skútustaðir demonstrated a wider range of wood species, while Hrísheimar relied primarily on its birch woodland, minimal stands of willow and limited pine driftwood. Imports from 1477 further increased the range at Skútustaðir, and increasing use of driftwood in the 20th century probably indicates a significant reduction in local wood supplies. While there is no indication of industrial activity at Skútustaðir, Hrísheimar's extensive metal working activities relied on charcoal and peat, (the former being predominantly birch), as these were superior for high temperature combustion.

As Hrísheimar had fewer fuel sources, pressure was more focused on its woodland environment which was being heavily utilised for the dual purposes of agriculture and industry, whether they were simultaneous or not. The need to conserve such valuable assets must have been recognised, and indeed evidence of management strategies existed at both sites in the targeting of branches from younger trees. Yet this appeared to be more focused at Skútustaðir and continued until the 20th century. Unfortunately, at Hrísheimar this was offset both by the harvesting of some birch branches at spring sap rise; reducing resilience to other pressures, and by increasing numbers of pigs in the second phase and thus reversing the trend elsewhere in Mývatnssveit. This prevented regeneration of an already vulnerable woodland, contributing significantly to deforestation and subsequent erosion. Nonetheless while archaeobotanical results conflict with charcoal ubiquity counts for Phase 2, strong evidence exists to indicate that sufficient woodland remained to support continued domestic usage. Industrial activity may have continued up to the 11th century or have terminated at some

earlier point. The final management decision may have been to abandon the farm before it was completely denuded.

While macrobotanical evidence suggests trees survived until at least the 18th century at Skútustaðir, charcoal supports continuation into the 20th century. This site appears to have suffered less erosion and this may be partly attributable to factors beyond the landowners control such as inherent soil quality. Early choice of land which reduced the necessity for clearance, however, and more appropriate, consistent and effective management strategies in all time periods, may have played more of a role. This is evidenced by trading links from 1477, (although this may have occurred earlier). Trade requires wealth, attesting to the status and success of the Skútustaðir farm. While location, resources and activities also confirm the elite status of the Hrísheimar site, several questionable management strategies contributed significantly to its demise, prior to the expansion of trade.

While current evidence accords largely with previous studies in the Mývatnssveit area, arboreal resources appear to have survived longer than anticipated, and their utility as a fuel into the 20th century suggests that sufficient trees still survived in the Skútustaðir locality. This research confirms the importance of local conditions, status and management of resources in the success or failure of landnám era farms.

(24,742 words)

Bibliography

Adderley, P.A. & Simpson, I. A., 2005, Early-Norse Home-Field Productivity in the Faroe Islands, *Human Ecology*, 33 (5), 711-736

Adderley, P.A. & Simpson, I. A., 2006, Soils and palaeo-climate based evidence for irrigation requirements in Norse Greenland, *Journal of Archaeological Science*, 33, 1666-1679

Adderley, P.A., Simpson, I.A. & Vésteinsson, O., 2008, Local-Scale Adaptations: A Modeled Assessment of Soil, Landscape, Microclimatic, and Managemnet Factors in Norse Home-Field Productivities, *Geoarchaeology*, 23 (4), 500-527

Andersen, P. S., 1971, *Vikings of the West: The Expansion of Norway in the Early Middle Ages*, Sandnes, Tanum

Archaeological Services, 2010, *Skalholt, Iceland: Palaeoenvironmental assessment*, unpubished report 2382

Arge, S.V., Sveinbjarnardóttir, G., Edwards, K.J. & Buckland, P.C., 2005, Viking and Medieval Settlement in the Faroes: People, Place and Environment, *Human Ecology*, 33 (5), 597-618

Arneborg, J., Heinemeier, J., Lynnerup, N., Nielsen, H.L., Rud, N. & Sveinbjörnsdóttir, A.E., 1999, Change of diet of the Greenland Vikings Determined from Stable Carbon Isotope Analysis and ^{14}C Dating of their Bones, *Radiocarbon*, 41(2), 157-168

Ascough, P.L., Cook, G.T., Church, M.J., Dunbar, E., Einarsson, A., McGovern, T.H., Dugmore, A.J., Perdikaris, S., Hastie, H., Friðriksson, A. & Gestsdóttir, H., 2010, Temporal and Spatial Variations in Freshwater ^{14}C Reservoir Effects: Lake Myvatn, Northern Iceland, *Radiocarbon*, 52(2), 1098-1112

Atkinson, M.D., 1992, *Betula pendula* Roth (*B. verrucosa* Ehrh.) and *B. pubescens* Ehrh. *Journal of Ecology*, 80, 837-870

Axford, Y., Miller, G.H., Geirsdóttir, A. & Langdon, P.G., 2007, Holocene temperature history of northern Iceland inferred from subfossil midges, *Quaternary Science Reviews*, 26, 3344-3358

Axford, Y., Geirsdóttir, A., Miller, G.H. & Langdon, P.G., 2009, Climate of the Little Ice Age and the past 2000 years in northeast Iceland inferred from chironomids and other lake sediment proxies, *Journal of Palaeolimnology*, 41, 7-24

Barlow, L.K., Sadler, J.P., Ogilvie, A.E.J., Buckland, P.C., Amorosi, T., Ingimundarson, J.H., Skidmore, P., Dugmore, A.J. & McGovern, T.H., 1997, Interdisciplinary investigations of the end of the Norse Western Greenland Settlement in Greenland, *The Holocene*, 7(4), 489-499

Boardman, S., & Jones, G., 1990, Experiments on the effects of charring on cereal plant components, *Journal of Archaeological Science*, 17, 1-11

Bohrer, V.L. & Adams, K.R., 1977, *Ethnobotanical Techniques and Approaches at Salmon Ruin, New Mexico,* Mexico, Eastern New Mexico University

Bond, J.M., 2002, Pictish pigs and Celtic cowboys: food and farming in the Atlantic Iron Age. In Smith, B.B. & Banks, I. (Eds.) *In the Shadow of the Brochs; the Iron Age in Scotland*: 177-190, Stroud, Tempus

Bond, J.M., Guttman, E. & Simpson, I.A., 2004, Bringing in the sheaves; farming intensification in the post-broch Iron Age. In Housely, R. & Coles, G. (Ed.), 2004, *Atlantic Connections and Adaptations; economies, environments and subsistence in lands bordering the North Atlantic*: AEA/NABO Monograph, Oxford, Oxbow Books, 138-145

Bremness, L., 2009, *The Essential Herbs Handbook,* London, Duncan Baird Publishers

Buckland, P.C., Sveinbjarnardóttir, G., Savory, D., McGovern, T.H., Skidmore, P. & Andreasen, C., 1983, Norsemen at Nipáitsoq, Greenland: A Palaeoecological Investigation, *Norwegian Archaeological Review*, 16(2), 86-98

Buckland, P.C., Dugmore, A., Perry, D., Savory, D. & Sveinbjarnardóttir, G., 1991, Holt in Eyjafjallasveit, Iceland: a palaeoecological study of the impact of landnám, *Acta Archaeologica*, 61, 252-261

Buckland, P.C., Amorosi, T., Barlow, L.K., Dugmore, A.J., Mayewski, P.A., McGovern, T.H., Ogilvie, A.E.J., Sadler, J.P. & Skidmore, P., 1996, Bioarchaeological and climatological evidence for the fate of Norse farmers in medieval Greenland, *Antiquity*, 70, 88-96

Buckland, P.C., Edwards, K.J., Panagiotakopulu, E. & Schofield, J.E., 2009, Palaeoecological and historical evidence for manuring and irrigation at Garðar (Igaliku), Norse Eastern Settlement, Greenland, *The Holocene*, 19(1), 105-116

Byock, J., 2001, *Viking Age Iceland*, London, Penguin Books

Byock, J., Walker, P., Erlandson, J., Holck, P., Zori, D., Guđmundsson, M. & Tveskov, M., 2005, *A Viking-age Valley in Iceland: The Mosfell Archaeological Project, Medieval Archaeology*, 49, 195-218

Cappers, R.T.J., Bekker, R.M. & Jans, J.E.A., 2006, *Digital Seed Atlas of the Netherlands*, Groningen, Barkhius Publishing

Caseldine, C., 2001, Changes in Betula in the Holocene record from Iceland – a palaeoclimatic record or evidence for early Holocene hybridisation?, *Review of Palaeobotany and Palynology*, 117, 139-152

Church, M.J., 2000, Carbonised plant macrofossils and charcoal. In Harding, D.W. & Dixon, T.N. (Eds.), *Dun Bharabhat, Cnip an Iron Age settlement in west Lewis*, Edinburgh, University of Edinburgh, 120-130

Church, M.J. & Peters, C., 2004, Application of mineral magnetism in Atlantic Scotland archaeology 2: magnetic susceptibility and archaeobotanical taphonomy in West Lewis, Scotland. In (Ed.), 2004, *Atlantic connections and adaptations: economies, environments and subsistence in lands bordering the North Atlantic*, Oxford, Oxbow Books, 99-115

Church, M.J., Arge, S.V., Brewington, S., McGovern, T.H., Woollett, J.M., Perdikaris, S., Lawson, I.T., Cook, G.T., Amundsen, C., Harrison, R., Krivogorskaya, Y. & Dunbar, E., 2005, Puffins, Pigs, Cod and Barley: Palaeoeconomy at Undir Junkarinsfløtti, Sandoy, Faroe Islands, *Environmental Archaeology*, 10, 179-197

Church, M.J., Dugmore, A.J., Mairs, K.A., Millard, A.R., Cook, G.T., Sveinbjarnardóttir, G., Ascough, P.A. & Roucoux, K.H., 2007a, Charcoal production during the Norse and Early Medieval Periods in Eyjafjallahreppur, Southern Iceland, *Radiocarbon*, 49(2), 659-672

Church, M.J., Peters, C. & Batt, C.M., 2007b, Sourcing Fire Ash on Archaeological Sites in the Western and Northern Isles of Scotland, Using Mineral Magnetism, *Geoarchaeology*, 22(7), 747-774

Clark, V., 2003, *The Far-Farers: A Journey from Viking Iceland to Crusader Jerusalem*, London, Pan Macmillan Ltd.

Coles, J., 1973, *Archaeology by Experiment*, New York, Charles Scribner's sons

Culpepper, N., 2009, *Culpepper's Complete Herbal*, London, Arcturus Publishing Limited

Davis, A.S., Renner, K.A., Sprague, C.L., Dyer, L. & Mutch, D.R., 2005, *Integrated weed management. One years seeding*, Michigan State University Extension Bulletin E-2931.

Dickson, C.A., 1994, Plant Remains. In Ballin Smith, B. (Ed.), 1994, *Howe: Four Millennia of Orkney Prehistory*, Society of Antiquaries of Scotland Monograph Series 9, Edinburgh, Society of Antiquaries of Scotland, 125-139

Dickon, C.A., 1998, Past uses of turf in the Northern Isles. In Coles, G. & Miller, C.M. (Eds.), *Life on the Edge: Human Settlement and Marginality*, Oxford, Oxbow Books, 105-9

Duarte, L., 2006, *Unpublished BSc Dissertation*, Dept. of Archaeology, Durham University

Dugmore, A.J., Church, M.J., Buckland, P.C., Edwards, K.J., Lawson, I.T., McGovern, T.H., Panagiotakopulu, E., Simpson, I.A., Skidmore, P. & Sveinbjarnardóttir, G., 2005, The Norse landnám on the North Atlantic islands: an environmental impact assessment, *Polar Record*, 41(216), 21-37

Dugmore, A.J., Church, M.J., Mairs, K., McGovern, T.H., Newton, A.J., Sveinbjarnardóttir, G., 2006, An Over-optimistic Pioneer Fringe? Environmental Perspectives on Medieval Settlement Abandonment in Þórsmörk, South Iceland. In Arneborg, J. & Grønnow, B. (Eds.), 2006, *Dynamics of Northern Societies,* Copenhagen, Publications from the National Museum, 335-345

Dugmore, A.J., Church, M.J., Mairs, K., McGovern, T.H., Perdikaris, S. & Vésteinsson, O., 2007a, Abandoned Farms, Volcanic Impacts, and Woodland Management: Revisiting Þjórsárdalur, the "Pompeii Of Iceland", *Arctic Anthropology*, 44 (1), 1-11

Dugmore, A.J., Keller, C. & McGovern, T.H., 2007b, Norse Greenland Settlement: Reflections on Climate Change, Trade, and The Contrasting Fates of Human Settlements in the North Atlantic Islands, *Arctic Anthropology*, 44(1), 12-36

Ebenesersdottir, S.S., Sigurðsson, A., Sánchez-Quinto, F., Lalueza-Fox, C., Stefánsson, K. & Helgason, A., 2010, A New Subclade of mtDNA Haplogroup C1 Found in Icelanders: Evidence of Pre-Columbian Contact?, *American Journal of Physical Anthropology*, 144(1), 1-8

Edwards, K.J., 1989, The cereal pollen record and early agriculture. In Milles, A., Williams, D. & Gardner, N. (Eds.), *The Beginnings of Agriculture*, International Series 496, Oxford, British Archaeological Reports, 113-135.

Edwards, K.J., 2005, "On the Windy Edge of Nothing": A Historical Human Ecology of the Faroe Islands, *Human Ecology*, 33(5), 585-596

Edwards, K.J., Buckland, P.C., Dugmore, A.J., McGovern, T.H., Simpson, I.A. & Sveinbjarnardóttir, G., 2004, Landscapes circum-Landnám: Viking settlement in the North Atlantic and its human and ecological consequences - a major new research programme. In Housley, R. & Coles, G. (Eds), *Atlantic connections and adaptations: economies, environments and subsistence in lands bordering the North Atlantic*, Oxford, Oxbow Books, 260-271

Edwards, K.J., Borthwick, D., Cook, G., Dugmore, A.J., Mairs, K., Church, M.J., Simpson, I.A. & Adderley, W.P., 2005, A Hypothesis-Based Approach to Landscape Change in Suðuroy, Faroe Islands, *Human Ecology*, 33(5), 621-650

Edwards, K.J., Schofield, J.E. & Mauquoy, D., 2008, High resolution paleoenvironmental and chronological investigations of Norse landnám at Tasiusaq, Eastern Settlement, Greenland, *Quaternary Research*, 69, 1-15

Eggertsson, O., 1993, Origin of the Driftwood on the Coasts of Iceland; A Dendrochronological Study, *Jökull*, 43, 15-32

Einarsson, Þ., 1962, Evidence of pollen analysis, vegetation, climate and settlement of Iceland, History, 442 - 469

Erlendsson, E., Edwards, K.J. & Buckland, P.C., 2009, Vegetational response to human colonisation of the coastal and volcanic environments of Ketilsstaðir, southern Iceland, *Quaternary Research*, 72, 174-187

Fenton, A., 1982, Net-drying, pot-drying and graddening: small-scale grain drying and processing techniques, *Saga och sed* (Yearbook of the Royal Gustav Adolfs Academy 1982), 86-106

Foote, P.G. & Wilson, D.G., 1970, *The Viking Achievement*, London, Sidgwick & Jackson Ltd

Friðriksson, S., 1959, Korn frá Gröf í Öræfum (Barley grain from the farm Gröf in southern Iceland), Árbók hins íslenzka fornleifafélags, 1959, 88–91

Friðriksson, S., 1972, *Grass and Grass Utilisation in Iceland*, Agricultural Research Institute, Reykjavík, 786-795

Friðriksson, A., Vésteinsson, O. & McGovern, T.H., 2004, Recent Investigations at Hofstaðir, northern Iceland. In Housely, R. & Coles, G. (Ed.), 2004, *Atlantic Connections and Adaptations; economies, environments and subsistence in lands bordering the North Atlantic*: AEA/NABO Monograph, Oxford, Oxbow Books, 191-202

Guðmundsson, G., 2009, The Plant Remains. In Lucas, G. (Ed.), 2009, *Hofstaðir: Excavations of a Viking Age Feasting Hall in North Eastern Iceland*, Reykjavik, Institute of Archaeology, 322-334

Hageneder, F., 2001, *The Heritage of Trees*, Edinburgh, Floris

Håkansson, S., 2003, *Weeds and Weed Management on Arable Land: An Ecological Approach*, Oxfordshire, CABI Publishing

Hallsdottir, M., 1987, *Pollen analytical studies of human influence on vegetation in relation to the landnám tephra layer in southwest Iceland*, Lund, Lund University, Department of Quaternary Geology (Thesis 18)

Hallsdóttir, M, 1995, On the pre-settlement history of *Icelandic* vegetation, *Icelandic Agricultural Science*, 9, 17-29

Hallsdóttir, M. & Caseldine, C., 2005, The Holocene vegetation history of Iceland, state-of-the-art and future research. In Caseldine, C.J. et al (Eds.), 2005, *Iceland: Modern processes, Past Environments,* 319-334

Hanaka, T., 1976, *Tanaka's Encyclopedia of Edible Plants of the World*, Tokyo, Keigaku Publication Co.

Hannon, G.H. & Bradshaw, R.H.W., 2000, Impacts and Timing of the First Human Settlement on Vegetation of the Faroe Islands, *Quaternary Research*, 54, 404-413

Hannon, G.H., Wastegard, S., Bradshaw, E. & Bradshaw, R.H.W., 2001, Human Impact and Landscape degradation on the Faroe Islands, *Biology and Environmental: Proceedings of the Royal Irish Academy*, 101B (1-2), 129-139

Hannon, G.H., Bradshaw, R.H.W., Bradshaw, E.G., Snowball, I. & Wastegard, S., 2005, Climate change and human settlement as drivers of late-Holocene vegetational change in the Faroe Islands, *The Holocene*, 15(5), 639-647

Hather, J.G., 2000, *The Identification of the Northern European Woods: A guide for archaeologists and conservations*, London, Archetype Publications Ltd.

Hawes, Z., 2010, *Wild Drugs: A Forager's Guide to Healing Plants*, London, Octopus Publishing Group Ltd.

Hedrick, U.P. (Ed.), 1972, *Sturtevant's Edible Plants of the World*, New York, Dover Publications

Helgason, A., Sigurethardóttir, S., Nicholson, J., Sykes, B., Hill, E.W., Bradley, D.G., Bosnes, V., Gulcher, J.R., Ward, R., & Stefánsson, K., 2000, Estimating Scandinavian and Gaelic ancestry in the male settlers of Iceland, *American Journal of Human Genetics*, 67(3), 697-717

Hillman, G. C., 1981, Reconstructing crop husbandry practices from charred remains of crops. In R. Mercer (Ed.), *Farming practice in British prehistory*, Edinburgh, Edinburgh University Press, 123-162

Hjelle, K.L., Hufthammer, A.K. & Bergsvik, K.A., 2006, Hesitant hunters: a review of the introduction of agriculture in western Norway, *Environmental Archaeology*, 11(2), 147-170

Hubbard, R. N. L. B. & al Azm, A., 1990, Quantifying preservation and distortion in carbonised seeds, and investigating the history of friké production, *Journal of Archaeological Science*, 16, 103–6

Jones, M. K., 1991, Sampling in palaeoethnobotany. In van Zeist, W. et al (Eds.), *Progress in Old World Palaeoethnobotany*, Rotterdam, A. A. Balkema, 53–62

Jóhansen, J., 1979, Cereal cultivation in Mykines, Faroe Islands AD 600. *Danmarks Geologiske undersogelse*, Arbog, 1978, 93–103

Jóhansen, J., 1985, *Studies in the Vegetational History of the Faroe and Shetland Islands*, Annales Societatis Scientiarum Faeroensis Supplementum XI, Tórshavn

Kenward, H.K., Hall, A.R. & Jones, A.K.G., 1980, A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits, *Science and Archaeology*, 22, 3-15

Krisljansson, J., 1980, *Icelandic Sagas and Manuscripts*, Reykjarvik, Iceland Review

Kristinsson, H., 2010, *Flowering Plants and Ferns of Iceland*, Reykjarvík, Mál og Menning

Kunz, K., 2001, The Laxdæla Saga. In Smiley, J. (Ed.), 2001, *The Sagas of the Icelanders*, London, Penguin

Larsen, A.C., 1990, Norsemen's use of juniper in Viking Age Faroe Islands, *Acta Archaeologica*, 61, 54-59

Larson, L. M., 1917, *The King's Mirror*, (Speculum Regale – Konungs Skuggsja), New York, Twayne

Lawson, I.T., Church, M.J., McGovern, T.H., Arge, S.V., Woollett, J., Edwards, K.J., Gathorne-Hardy, F.J., Dugmore, A.J., Cook, G., Mairs, K., Thomson, A.M. & Sveinbjarnardóttir, G., 2005, Historical Ecology on Sandoy, Faroe Islands: Palaeoenvironmental and Archaeological Perspectives, *Human Ecology*, 33(5), 651-682

Lawson, I.T., Gathorne-Hardy, F.J., Church, M.J., Einarsson, A., Edwards, K.J., Perdikaris, S., McGovern, T.H., Amundsen, C. & Sveinbjarnardóttir, G., 2006, Human Impact on Freshwater Environments in Norse and Early Medieval Myvatnssveit, Iceland. In Arneborg, J. & Grønnow, B. (Eds.), 2006, *Dynamics of Northern Societies*, Copenhagen, Publications from the National Museum, 375-382

Lawson, I.T., Gathorn-Hardy, F.J., Church, M.J., Newton, A.J., Edwards, K.J., Dugmore, A.J. & Einarsson, A., 2007, Environmental impacts of the Norse settlement: palaeoenvironmental data from Mývatnssveit, northern Iceland, *Boreas*, 36, 1-19

Lawson, I.T. Edwards, K.J., Church, M.J., Newton, A.J., Cook, G.T., Gathorne-Hardy, F.J. & Dugmore, A.J., 2008, Human impact on an island ecosystem: pollen data from Sandoy, Faroe Islands, *Journal of Biogeography*, 35, 1130-1152

Lawson, I.T., Roucoux, K., Milner, A., Church, M.J., Bishop, R.R. & Einarssin, A., 2009a, *Vegetation History in Mývatnssveit, Iceland*, Reykjavík, NABO

Lawson, I.T., Milek, K.B., Adderley, W.P., Casely, A.F., Church, M.J., Duarte, L., Dugmore, A.J., Edwards, K.J., Gathorne-Hardy, F.J., Gudmundsson, G., Morrison, S., Newton, A.J. & Simpson, I.A., 2009b, The palaeoenvironment of Myvatnssveit: Vegetation. In Lucas, G (Ed.), 2009, *Hofstaðir: Excavations of a Viking Age feasting hall in north-eastern Iceland*, Reykjavik, Institute of Archaeology Monograph No. 1, 26-54

Linford, J, 2007, *A Concise guide to Herbs*, Bath, PaRragon

Mairs, K.A., Church, M.J., Dugmore, A.J. & Sveinbjarnardóttir, G., 2006, Degrees of Success: Evaluating the Environement Impacts of Long Term Settlement in South Iceland. In

Arneborg, J. & Grønnow, B. (Eds.), 2006, *Dynamics of Northern Societies*, Copenhagen, Publications from the National Museum, 365-373

Malmros, C., 1994, Exploitation of local, drifted and imported wood by the Vikings on the Faroe Islands, *Botanical Journal of Scotland*, 46, 552–558

McGinnes, R.A., Szopa, P.S. & Phelps, J.E., 1974, Use of scanning electron microscopy in studies of wood charcoal formation, *Proceedings: Workshop on Scanning Electron Microscope and The Plant Sciences*, 469-476

McGovern, T.H., 1995, A View from the North Atlantic, *Witness the Arctic,* 2, 1-2

McGovern, T.H., Bigelow, G., Arnold, T. & Russell, D., 1988, Northern Islands, Human Error, and Environmnetal Degradation: A View of Social and Ecological Change in the Medieval North Atlantic, *Human Ecology*, 16(3), 225-270

McGovern, T.H., Perdikaris, S., Einarsson, A. & Sidell, J., 2006, Costal Connections, Local Fishing, and Suitable Egg Harvesting: Patterns of Viking Age Inland Wild Resource Use in Mývatn District, Northern Iceland, *Environmental Archaeology*, 11(1), 187-206

McGovern, T.H., Vésteinsson, O., Friðriksson, A., Church, M.J., Lawson, I.T., Simpson, I.A., Einarsson, A., Dugmore, A., Cook, G., Perdikaris, S., Edwards, K.J., Thomson, A.M., Adderley, W.P., Newton, A., Lucas, G., Edvardsson, R., Aldred, O. & Dunbar, E., 2007, Landscapes of Settlement in Northern Iceland: Historical Ecology of Human Impact and Climate Fluctuation on the Millennial Scale, *American Anthropologist*, 109 (1), 27-51

McGuire, E.H., 2006, Archaeology in Iceland: Recent Developments, *Scandinavian-Canadian Studies*, 16, 10-26

Miles, J. & Kinnaird, J.W., 1979, Grazing: with particular reference to birch, juniper and Scots pine in the Scottish highlands, *Scottish Forestry*, 33, 280-289

Ólafsdóttir, R. & Júlíusson, A.D., 2000, Farmers perception of Land-cover changes in NE Iceland, *Land Degradation and Development*, 11, 439-458

Ólafsdóttir, R., Schlyter, P. & Haraldsson, H.V., 2001, Simulating Icelandic vegetation cover during the Holocene Implications for long-term land degradation, *Geografiska Annuler* 83A, 203-215

Owen, S., 2009, Taming the Wild: Paradise Gained, Maintained, and Lost in medieval Icelandic literature, *Innervate*, 1, 230-235

Pearsall, D.M., 2000, *Palaeoethnobotany: A Handbook of Procedures*, San Diego, Academic Press

Peters, C., Church, M.J. & Batt, C., 2004, Application of mineral magnetism in Atlantic Scotland archaeology 1: techniques, magnetic enhancement and the identification of fuel sources. In (Ed.) *Atlantic connections and adaptations: economies, environments and subsistence in lands bordering the North Atlantic*, Oxford, Oxbow books, 86-95

Pigott, C.D., 1983, Regeneration of oak-birch woodland following exclusion of sheep, *Journal of Ecology*, 71, 629-646

Preston, C.D., Pearman, D.A. & Dines, T.D., 2002, *New Atlas of the British and Irish Flora*, Oxford, Oxford University Press

Rackham, O., 1980, *Ancient Woodland: Its History, Vegetation and Uses in England*, London, Castlepoint Press

Renfrew, J., 1973, *Palaeoethnobotany*, London, Methuen

Rögnvaldardóttir, N., 2002, *What Did They Eat? Icelandic food from the Settlement through the Middle Ages*, Reykjavík, Gestgjafinn

Sæbo, A., Haland, A., Skre, O. & Mortensen, L.M., 2001, Influence of Nirtogen & Winter Climate Stresses on Calluna vulgaris (L.) Hull, *Annals of Botany*, 88, 823-828

Schach, P., 1984, *Icelandic Sagas*, Massachusetts, Twayne Publishers

Schweingruber, F.H., 1990, *Microscopic Wood Anatomy; Structural Variability of Stems and Twigs in Recent and Subfossil Woods from Central Europe*, Geneva, Swiss Federal Institute for Forest, Snow and Landscape Research

Simpson, I.A., 2001, Archaeology and soil micromorphology. In Brothwell, D.R. & Pollard, A.M. (Eds.), 2001, *Handbook of Archaeological Science*, Oxford, Wiley-Blackwell

Simpson, I.A., Adderley, W.P., Guðmundsson, G., Hallsdóttir, M., Sigurgeirsson, M.A. & Snæsdóttir, M., 2002, Soil Limitations to Agrarian Land Production in Premodern Iceland, *Human Ecology*, 30(5), 423-443

Simpson, I.A., Vésteinsson, O., Adderley, W.P. & McGovern, T.H., 2003, Fuel resource utilisation in landscapes of settlement, *Journal of Archaeological Science*, 30, 1401-1420

Simpson, I.A., Guðmundsson, G., Thomson, A.M. & Cluett, J., 2004, Assessing the Role of Winter Grazing in Historic Land Degradation, Mývatnssveit, Northeast Iceland, *Geoarchaeology*, 19, 471-502

Simspon, I.A., Adderley, W.P., Thomson, A.M., Gudmundsson, G., Vésteinsson, O., Friðriksson, A. & McGovern, T.H., 2009, Land: Its Organisation and Managemnet at Norse Hofstaðir. In In Lucas, G (Ed.), 2009*, Hofstaðir: Excavations of a Viking Age feasting hall in north-eastern Iceland*, Reykjavik, Institute of Archaeology Monograph No. 1, 335-370

Smith, K.P., 1995, Landnám: the Settlement of Iceland in Archaeological and Historical Perspective, *World Archaeology*, 26, 319-47

Stace, C.A., 1997, *New Flora of the British Isles*, Cambridge, Cambridge University Press

Sveinbjörnsdóttir, A.E., Heinemeier, J. & Gudmundsson, G., 2004, ^{14}C Dating of the Settlement of Iceland, *Radiocarbon*, 46(1), 387-394

Sveinbjarnardóttir, G., Erlendsson, E., Vickers, K., McGovern, T.H., Milek, K.B., Edwards, K.J., Simpson, I.A. & Cook, G., 2007, The Palaeoecology of a high status Icelandic farm, *Environmental Archaeology*, 12, 187-206

Sveinbjarnardóttir, G. Simpson, I.A. & Thomson, A.M., 2008, Land in Landscapes Circum Landnám: An Integrated Study of Settlements in Reykholtsdalur, Iceland, *Journal of the North Atlantic*, 1, 1-15

Sysila, I., 1998, Sahti - A Remnant of Finland's Rustic Past, *Brewing Techniques*, 6(4)

Thomson, A.M. & Simpson, I.A., 2007, Modelling Historic Rangeland Management and Grazing Pressures in Landscapes of Settlement, *Human Ecology*, 35, 151-168

Tinsley, C.M., 2004, The Viking Settlement of Northern Iceland: A Preliminary Zooarchaeological Analysis. In Housely, R. & Coles, G. (Ed.), 2004, *Atlantic Connections and Adaptations; economies, environments and subsistence in lands bordering the North Atlantic*: AEA/NABO Monograph, Oxford, Oxbow Books, 211-217

Trigg, H.B., Bolender, D.J., Johnson, K.M., Patalano, M.D. & Steinberg, J.M., 2009, Note on barley found in dung in the lowest levels of the farm mound midden at Reynistaður, Skagafjörður Iceland, *Archaeologica Islandica*, 7, 64-72

Trigger, B.G. & Washburn, W.E., 1996, *The Cambridge History of the Native Peoples of the Americas*, Cambridge, Cambridge University Press

Tweddle, J.C., Edwards, K.J. & Fieller, N.R.J., 2005, Multivariate statistical and other approaches for the separation of cereal from wild Poaceae pollen using a large Holocene dataset, *Vegetation History and Archaeobotany*, 14(1), 15-30

van der Veen, M., 1992, *Crop Husbandry Regimes: an Archaeobotanical Study of Farming in Northern England, 1000 BC–AD 500*, Sheffield, Collis Publications

van der Veen, M., 2006, Formation processes of desiccated and carbonised plant remains – the identification of routine practice, *Journal of Archaeological Science*, 34(6), 968-990

van der Veen, M. & Fieller, N., 1982, Sampling Seeds, *Journal of Archaeological Science*, 9(3), 287-298

Vésteinsson, O., McGovern, T.H. & Keller, C., 2002, Enduring Impacts: Social and Environmental Aspects of Viking Age Settlemenet in Iceland and Greenland, *Archaeologia Islandica*, 2, 98-136

Vickers, K., Erlendsson, E., Church, M.J., Edwards, K.J. & Bending, J., 2011, 1000 years of environmental change and human impact at Stóra-Mörk, southern Iceland: A multiproxy study of a dynamic and vulnerable landscape, *The Holocene*, 21(5), 1-17

Vickery, R., 1995, *A dictionary of plant lore*, Oxford, Oxford University Press

Wilkinson, K. & Stevens, C., 2003, *Environmental Archaeology: Approaches, Techniques & Applications*, Gloucestershire, Tempus Publishing Limited

Zutter, C.M., 1992, Icelandic Plant and Land-use Patterns: Archaeobotanical Analysis of the Svalbarð Midden (6706-60), Northeastern Iceland. In Morris, C.D. & Rackham, D.J. (Eds.), 1992, *Norse and later Settlement and Subsistence in the North Atlantic*, Glasgow, University of Glasgow, 139-148

Zutter, C.M., 1999, Congruence or Concordance in Archaeobotany: Assessing Micro- and Macro-botanical Data Sets from Icelandic Middens, *Journal of Archaeological Science*, 26, 833-844

Zutter, C.M., 2000, Wood and Plant-use in 17th-19th Century Iceland: Archaeobotanical Anaysis of Reykholt, Western Iceland, *Environmental Archaeology*, 5, 73-82

Site Reports

Edvardsson, R., McGovern, T.H., Batey, C. & Woollett, J., 2003, *Hrísheimar 2003: Interim Report*, Reykjavík, NABO

Edvardsson, R., McGovern, T.H. & Batey, C., 2005, *Hrísheimar 2004: Interim Report*, Reykjavík, NABO

Edvardsson, R. & McGovern, T.H., 2006, *Hrísheimar 2005: Interim Report*, Reykjavík, NABO

Edvardsson, R. & McGovern, T.H., 2007, *Hrísheimar 2006: Interim Report*, Reykjavík, NABO

Edwald, A. & McGovern, T., 2010, *Skútustaðir Midden Investigations Mývatn Northern Iceland 2009*, Reykjavík, NABO & IPY

Hicks, M.T., Pálsdóttir, L.B., Pétursdóttir, Þ., McGovern, T.H., Kendall, A., Brewington, S., Schreiner, A., Hambrecht, G., Perdikaris, S., Gunyadin, D., Friedman, E., Gamliel, M, Javier, F., Kearns, K., Lisudottir-Feeney, I., Oti, A., Persaud, R., Tchurchenthaler, J. & Vobornik, J., 2011, *Excavations at Skútustaðir, Mývatn Northern Iceland: Preliminary Field Report After the Excavation Season June-July 2010*, Reykjavík, NABO & IPY

Lucas, G., Aldred, O., Sigurgeirsson, M.A. & Simpson, I. A., 2002, *Skálholt 2002, Interim Report No. 1*, Reykjavík, NABO

McGovern, T.H., 2005, *Report of Midden Investigations at Undir Sandmúla, Bardardalur, N. Iceland*, New York, CUNY Northern Science & Education Centre

Roberts, H.M., Snæsdóttir, M., Mehler, N., Aldred, O., Guðmundsson, G., Sveinbjörnsdóttir, A.E., Heinemeier, J., Milek, K. & Lusty, A.C., 2004, *Excavations at Aðalstræti, 2003*, Reykjavík, NABO

Websites

ALA, 2010, *Optimum pH for Crop Growth*, http://www.aglime.org.uk/technical09.htm, accessed: 13/08/11

Bond, W., Davies, G. & Turner, R., 2007, *The biology and non-chemical control of Pale Persicaria*, http://www.gardenorganic.org.uk/organicweeds/downloads/persicaria%20lapathifolia.pdf, accessed: 18/07/11

BTCV, 2004, *Bogbean - Menyanthes trifoliate*, http://www.cvni.org/wildflowernursery/wildflowers/bogbean, accessed 18/07/11

Duke J.A., 1983, *Handbook of Energy Crops*, http://www.hort.purdue.edu/newcrop/duke_energy/brassica_rapa.html, accessed 18/07/11

Grieve, M., 1995, *A Modern Herbal*, http://botanical.com/botanical/mgmh/mgmh.html, accessed: 20/07/11

Helldén, U. & Ólafsdottir, R., 1999, *Land Degradation in NE Iceland An assessment of extent, causes and consequences*, Sweden, Lund University, http://www.nateko.lu.se/Elibrary/LeRPG/3/LeRPG3Article.htm, accessed 16/07/11

Herbal Encyclopaedia, 2011, *Juniper*, http://www.cloverleaffarmherbs.com/juniper/, accessed: 19/07/11

McGhee, R., 2009, *Norse in North America*, http://www.jrank.org/history/pages/6367/Norse-In-North-America.html accessed: 15/08/11

NABO, 2007, *Human Ecodynamics in the Norse North Atlantic*, http://www.polarfocus.dk/pdfer/NABO%20IPY%20Edinburgh%20Workshop%2007%20Report.pdf, accessed: 11.01.10

National History Museum, 2011, *Seeds of Trade: Willow*, http://www.nhm.ac.uk/nature-online/life/plants-fungi/seeds-of-trade/page.dsml?section=crops&page=early_uses&ref=willow, accessed: 16/08/11

NatureGate, 2011, *Multiflowered Buttercup*, http://www.luontoportti.com/suomi/en/kukkakasvit/multiflowered-buttercup, accessed 18/07/11

Plants for a Future, 1996, *Polygonum aviculare - L.*, http://www.pfaf.org/user/plant.aspx?LatinName=Polygonum+aviculare, accessed: 18/07/11

A P P E N D I C E S

Appendix One

Hrísheimar Contextual Information

Sample No.	Context No.	Area	Contextual Info	Notes	Phase
s.03/1	c.103	A	Charcoal deposit/eroded		870-1000
s.03/2	c.105	A	Dark brown/light turfish material on mound		870-1000
s.03/3	c.111	A	Woody deposit		870-1000
s.03/4	c.115	A	Charcoal ash		870-1000
s.03/5	c.129	B	Charcoal deposit in fireplace		870-1000
s.03/6	c.136	A	Dark brown deposit, inside a pit?		870-1000
s.03/7	c.137	C	Mixed deposit inside kiln		870-1000
s.03/8	c.159	A	Fill in a furnace		870-1000
s.03/12	c.168	A	Woodish deposit. Fill		870-1000
s.03/13	c.161	A	Iron working furnace		870-1000
s.03/14	c.181	C	Deposit beneath undefined deposit in furnace		870-1000
s.03/15	c.186	B	Charcoal/turf mix underneath possible floor layer		870-1000
s.03/16	c.187	B	Charcoal deposit		870-1000
s.03/19	c.3	H	Upper midden fill		940-1000
s.03/20	c.4	H	Upper midden fill		940-1000
s.03/21	c.6	H	Lower midden deposit		870-940
s.03/22	c.42	L	On my Harris Matrix and section		940-1000
s.03/23	c.43	L	In situ turf wall		870-940
s.03/24	c.46		On DSR Harris Matrix	same c. as s.04/2	870-940
s.03/25	c.48	L	On my Harris Matrix and section		870-940
s.03/26	c.51	L	On my Harris Matrix and section		870-940
s.03/27	c.53	L	On my Harris Matrix and section		870-940
s.03/28	c.60	L	Midden deposit inside structure in midden	On DSR harris matrix	870-940
s.03/29	c.50	L	On my Harris Matrix and section		870-940
s.03/30	c.54	L	On my Harris Matrix and section		870-940
s.03/31	c.61	L	On my Harris Matrix and section		870-940
s.04/1	c.36	L	Midden deposit in western part. Med dark brown turfy dep/ w.grey green tephra		940-1000
s.04/2	c.46	L	Dark brown w/charcoal midden	On DSR harris matrix	870-940
s.04/3	c.44	L	Charcoal layer/orange brown		940-1000
s.04/4	c.35	L	Lens of beige peat ash/charcoal		940-1000
s.04/5	c.47	L	Light grey midden deposit		870-940
s.04/8	c.76	L	Midden material outside. N of structure		870-940
s.04/9	c.77	L	Midden material		870-940
s.04/10	c.39	L	Dark brown turfy deposit OR Turf collapse		870-940
s.04/11	c.203	H	Fill in a drain/east wall		870-940
s.04/13	c.212	H	Bottom part of fill in barrel pit		870-940
s.04/16	c.205	H	Fill in pit in north end 'barrel pit'		870-940
s.04/17	c.82	L	Big bone midden		870-940
s.04/18	c.85	L	Chunked, mixed turf walling		870-940
s.04/19	c.84	L	Midden dump with charcoal and ash		870-940

s.04/20	c.88	L	Ashy midden deposit		870-940
s.04/21	c.89	L	Posthole		870-940
s.04/22	c.90	L	Midden deposit		870-940
s.04/24	c.52	L	Midden layer		870-940
s.04/25	c.93	L	Midden layer		870-940
s.04/26	c.94	L	Midden layer		870-940
s.04/29	c.91	L	Midden deposit		870-940
s.04/30	c.249	H	Fill of the heath on the east side		870-940
s.04/33	c.220	H	Posthole/Stakehole		870-940
s.04/34	c.221	H	Postholefill. Structural post		870-940
s.04/35	c.223	H	Posthole fill in south end		870-940
s.04/36	c.224	H	Posthole fill in south end		870-940
s.04/37	c.236	H	Posthole fill. Divisional post of south side		870-940
s.04/39	c.234	H	Posthole fill. Structural on east side		870-940
s.04/40	c.216	H	Posthole fill		870-940
s.04/85	c.229	H	Stakehold fill		870-940

Appendix One

Skútustaðir Contextual Information

Sample No.	Context No.	Area	Contextual Info	Notes	Phase
s.08/1	c.002	D	Grey ashy dump	Appears on harris matrix	C20th
s.08/3	c.006	E2	Midden deposit		1000-1477
s.08/4	c.005	D	Windblown silty deposits	Appears on harris matrix	1717-1900
s.08/5	c.029	D	Brown midden deposit	Appears on harris matrix	1717-1900
s.08/6	c.032	D	Brown-grey midden dump	Appears on harris matrix	1477-1717
s.08/7	c.035	F	Midden		1717-1900
s.08/8	c.045	F	Black and grey mottled midden deposit		1717-1900
s.08/9	c.047	F	Peat and midden layer some structural turf		1717-1900
s.08/12	c.046	D		Appears on harris matrix	1477-1717
s.08/13	c.052	D	Mottled orange turf dump	Appears on harris matrix	1477-1717
s.08/15	c.055	D	Mixed ash and turf dump with a bit of peat	Appears on harris matrix	1477-1717
s.08/16	c.058	E2	Midden layer		1000-1477
s.08/17	c.057	D	Mixed orange turf and green tephra	Appears on harris matrix	1477-1717
s.08/18	c.059	E2	Midden layer		1000-1477
s.08/20	c.062	D		Appears on harris matrix	1477-1717
s.08/21	c.063	E2		No contextual info	870-1000
s.08/22	c.060	E2	Midden layer		1000-1477
s.08/23	c.067			Appears on harris matrix	1000-1477
s.08/24	c.071	D	Turf dump	Appears on harris matrix	1000-1477
s.08/25	c.063	E2		No contextual info	870-1000
s.08/26	c.069	F			1717-1900
s.08/27	c.073	F	Black and grey gravelly deposit		1717-1900
s.08/28	c.074	F	Turf deposit		1717-1900
s.08/29	c.075	F	Mixed turf and charcoal deposit		1717-1900
s.09/01	c.104	G		Appears on section & harris matrix	1717-1900
s.09/02	c.105	G		Appears on section & harris matrix	1717-1900
s.09/05	c.110	G		Appears on section & harris matrix	1717-1900
s.09/06	c.115	G		Appears on section & harris matrix	1717-1900
s.09/07	c.119	G		Appears on harris matrix	1477-1717
s.09/08	c.120	H		No contextual info	C20th
s.09/09	c.121	G		Appears on section & harris matrix	1477-1717
s.09/10	c.123	G		Appears on section & harris matrix	1477-1717
s.09/11	c.122	H		No contextual info	C20th
s.09/12	c.126	G		Appears on section & harris matrix	1477-1717
s.09/14	c.127	H		No contextual info	1717-1900
s.09/15	c.128	G		Appears on section & harris matrix	1477-1717
s.09/16	c.129	H		No contextual info	1717-1900
s.09/17	c.131	G		Appears on section & harris matrix	1477-1717
s.09/18	c.130	H		No contextual info	1717-1900
s.09/19	c.132			Appears on section & harris matrix	1477-1717

s.09/20	c.133	G		Appears on section & harris matrix	1477-1717
s.09/21	c.135	G		Appears on section & harris matrix	1477-1717
s.09/22	c.138	G		Appears on section & harris matrix	1000-1477
s.09/23	c.139	G		Appears on section & harris matrix	1000-1477
s.09/24	c.136	H		Appears on harris matrix	1477-1717
s.09/25	c.140	G		Appears on harris matrix	1000-1477
s.09/26	c.141	H		Appears on harris matrix	1477-1717
s.09/27	c.142	G		Appears on harris matrix	1000-1477
s.09/28	c.145	G		Appears on section & harris matrix	1000-1477
s.09/29	c.146	H		Appears on harris matrix	1477-1717
s.09/30	c.144	H		Appears on harris matrix	1477-1717
s.09/31	c.147	G		Appears on section & harris matrix	870-1000
s.09/41	c.149	G		Appears on harris matrix	870-1000
s.09/42	c.148	G		Appears on section & harris matrix	870-1000
s.09/45	c.152	G		Appears on section & harris matrix	870-1000
s.09/46	c.154	G		Appears on harris matrix	870-1000
s.09/47	c.155	H		Appears on harris matrix	1717-1900
s.09/48	c.156	G		Appears on section & harris matrix	870-1000
s.09/49	c.158	G		Appears on harris matrix	870-1000
s.09/50	c.161	G		Appears on harris matrix	870-1000
s.10/02	c.211	E3	Brown uniform deposit (soil amendment?)		1000-1477
s.10/03	c.214	H	Lensed midden deposit		1477-1717
s.10/04	c.216	E3	Brown deposit with small amount of midden material		1000-1477
s.10/05	c.217	E3	Medium brown midden deposit		1000-1477
s.10/06	c.219	H	Medium brown bone rich midden deposit		1477-1717
s.10/07	c.221	H	Brown grey mottled midden deposit		1477-1717
s.10/08	c.222	E3	Med brown midden deposit with ash lumps		1000-1477
s.10/09	c.224	H	Dark grey brown fine mottled midden		1477-1717
s.10/10	c.226	E3	Medium brown midden		1000-1477
s.10/11	c.229	H	Grey brown midden deposit with turf lenses		1477-1717
s.10/13	c.231	H	Mid-grey finely mottled midden deposit		1477-1717
s.10/14	c.230	E3	Mottled tan deposit with pebbles		1000-1477
s.10/17	c.234	H	Mottled brown midden		1477-1717
s.10/18	c.236	E3	Turf debris		1000-1477
s.10/20	c.239	H	Uniform brown deposit		1477-1717
s.10/22	c.242	E3	Orange brown midden		870-1000
s.10/23	c.243	E3	Turf debris with charcoal lenses and gravel		870-1000
s.10/24	c.246	H	Wood ash midden		1477-1717
s.10/25	c.247	E3	Mixed midden in crevice		870-1000
s.10/26	c.248	E3	Turf deposit in crevice		870-1000
s.10/27	c.246	H	Charcoal wood ash midden		1477-1717

Appendix Two

Hrísheimar Raw Data

Sample			s.03/1	s.03/2	s.03/3	s.03/4	s.03/5	s.03/6	s.03/7	s.03/8	s.03/12	s.03/13	s.03/14	s.03/15	s.03/16	s.03/19
Context			c.103	c.105	c.111	c.115	c.129	c.136	c.137	c.159	c.168	c.161	c.181	c.186	c.187	c.3
Area			A	A	A	A	B	A	C	A	A	A	C	B	B	H
Phase			870-1000	870-1000	870-1000	870-1000	870-1000	870-1000	870-1000	870-1000	870-1000	870-1000	870-1000	870-1000	870-1000	940-1000
Volume (litres)			10	10	10	10	10	10	10	10	10	10	10	10	10	10
Total charcoal mass (g.)			146.1	53.86	1.88	47.61	37.86	4.19	1.9	46.62	34.53	14.24	42.83	27.66	76.67	9.15
Amorphous plant material (g.)			44.53		0.47	0.89				2.37					4.67	
Cereal Grains	**Common Name**	**Plant Part**														
Avena sp.	Oat grain	caryopsis														
Hordeum sp.	Barley grain	caryopsis														
Hordeum sp. hulled	Hulled barley grain	caryopsis														
H. hulled symmetric	Hulled barley straight grain	caryopsis														
H. hulled asymmetric	Hulled barley twisted grain	caryopsis														
Cereal indet.	Cereal grain	caryopsis					1									
Chaff		**Total Grain**	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node														
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base														
Wild plants		**Total Chaff**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf														
Betula nana L.	Dwarf Birch	leaf													1F	
Empetrum nigrum L.	Crowberry	leaf	91F	6F		2F	5F	1F			12F		5F	42F	178F	
Juniperus sp.	Juniper	leaf							5F				2F	14F		
Indeterminate leaf	Indeterminate leaf	leaf													4F	
Betula sp.	Birch	bud	1F													
Salix sp.	Willow	bud					1F							1F		
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed	1													
Carex sp. (biconvex)	Sedge	seed	14	1				1			2		11			1
Carex sp. (trigonous)	Sedge	seed	4										6			
Chenopodium album L.	Lambsquarters	seed														
Empetrum nigrum L.	Crowberry	seed	19								3		2		10	
Menyanthes trifoliata L.	Bog Bean	seed	1													
Montia fontana L.	Blinks	seed	1													
Poaceae undiff. (small)	Grass	seed	1												1	
Polygonum aviculare L.	Common Knotgrass	seed											1			
Stellaria media (L.) Villars	Common chickweed	seed	5								3		337			
Stellaria media (L.) Villars	Common chickweed	seed head											37			
Vaccinium sp.	Cranberry	seed														
Vicia sp.	Vetch	seed														
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node	2													
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base														
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome														
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome														
Indeterminate seed	Indeterminate seed	seed	15				2						12	2	1	
Indeterminate seaweed	Indeterminate seaweed	frond						1								
Fungi																
Cenococcum undiff.	Fungus	seed	11F	15F	41F	16F		20F	6F	1F	12F	9F	53F		5F	15F
Uncarbonised Seeds																
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed	1													
Carex sp. (biconvex)	Sedge	seed														
Carex sp. (trigonous)	Sedge	seed	1													
Empetrum nigrum	Crowberry	seed	1													
		Total Wild	63	1	0	0	2	2	0	0	8	0	406	2	12	1
		Total QC	**63**	**1**	**0**	**0**	**3**	**2**	**0**	**0**	**8**	**0**	**406**	**2**	**12**	**1**
		Grain (%)	**0**	**0**	**0**	**0**	**33**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Chaff (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Wild Species (%)	**100**	**100**	**0**	**0**	**67**	**100**	**0**	**0**	**100**	**0**	**100**	**100**	**100**	**100**
Other sorted material																
Bone			P			P	P		P		P		P	P	P	P
Insect Remains			P	P	P			P			P					P
Mollusc																
Metal Object						1F										
Slag (g.)				10.57		3.71					2.78	7F	2.28			
Pottery																
Glass																
Stone object																

Sample			s.03/20	s.03/21	s.03/22	s.03/23	s.03/24	s.03/25	s.03/26	s.03/27	s.03/28	s.03/29	s.03/30	s.03/31	s.04/1	s.04/2	s.04/3
Context			c.4	c.6	c.42	c.43	c.46	c.48	c.51	c.53	c.60	c.50	c.54	c.61	c.36	c.46	c.44
Area			H	H	L	L		L	L	L	L	L	L	L	L	L	L
Phase			940-1000	870-940	940-1000	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	940-1000	870-940	940-1000
Volume (litres)			10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Total charcoal mass (g.)			15.73	12.3	17.88	9.37	14.37	27.09	37.97	63.46	11.75	83.81	47.96	49.26	21.51	14.63	19.08
Amorphous plant material (g.)																	
Cereal Grains	**Common Name**	**Plant Part**															
Avena sp.	Oat grain	caryopsis						1									
Hordeum sp.	Barley grain	caryopsis												1			
Hordeum sp. hulled	Hulled barley grain	caryopsis						3									
H. hulled symmetric	Hulled barley straight grain	caryopsis															
H. hulled asymmetric	Hulled barley twisted grain	caryopsis			1					1							
Cereal indet.	Cereal grain	caryopsis			2												
Chaff		**Total Grain**	0	0	3	0	0	4	0	1	0	0	0	1	0	0	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node			1										1		
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base															
Wild plants		**Total Chaff**	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf															
Betula nana L.	Dwarf Birch	leaf															
Empetrum nigrum L.	Crowberry	leaf															
Juniperus sp.	Juniper	leaf															
Indeterminate leaf	Indeterminate leaf	leaf															
Betula sp.	Birch	bud															
Salix sp.	Willow	bud															
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed															
Carex sp. (biconvex)	Sedge	seed		1				20	1				1	2	1	1	
Carex sp. (trigonous)	Sedge	seed						2	2				1		1		1
Chenopodium album L.	Lambsquarters	seed															
Empetrum nigrum L.	Crowberry	seed		1		1			1	2			1		1	1	
Menyanthes trifoliata L.	Bog Bean	seed															
Montia fontana L.	Blinks	seed															
Poaceae undiff. (small)	Grass	seed						1						2			
Polygonum aviculare L.	Common Knotgrass	seed															
Stellaria media (L.) Villars	Common chickweed	seed		3				19						5			
Stellaria media (L.) Villars	Common chickweed	seed head															
Vaccinium sp.	Cranberry	seed															
Vicia sp.	Vetch	seed											1		1		
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node													1		
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base															
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome															
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome															
Indeterminate seed	Indeterminate seed	seed						11	1	1		1	1		1		1
Indeterminate seaweed	Indeterminate seaweed	frond															
Fungi																	
Cenococcum undiff.	Fungus	seed	6F	101F	67F	12F	4F	23F	31F	22F	3F	61F	2F	23F		19F	18F
Uncarbonised Seeds																	
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed															
Carex sp. (biconvex)	Sedge	seed															
Carex sp. (trigonous)	Sedge	seed															
Empetrum nigrum	Crowberry	seed															
		Total Wild	0	5	0	1	0	53	5	3	0	1	5	9	6	2	2
		Total QC	**0**	**5**	**4**	**1**	**0**	**57**	**5**	**4**	**0**	**1**	**5**	**10**	**7**	**2**	**2**
		Grain (%)	**0**	**0**	**75**	**0**	**0**	**7**	**0**	**25**	**0**	**0**	**0**	**10**	**0**	**0**	**0**
		Chaff (%)	**0**	**0**	**25**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**14**	**0**	**0**
		Wild Species (%)	**0**	**100**	**0**	**100**	**0**	**93**	**100**	**75**	**0**	**100**	**100**	**90**	**86**	**100**	**100**
Other sorted material																	
Bone			P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Insect Remains				P					P	P	P	P		P	P		
Mollusc						P	P	P	P			P	P	P		P	
Metal Object									P								
Slag (g.)			1.53	3.14	P	0.87		3.28					P		P	3.49	
Pottery																	
Glass																	
Stone object																	

Sample			s.04/4	s.04/5	s.04/8	s.04/9	s.04/10	s.04/11	s.04/13	s.04/16	s.04/17	s.04/18	s.04/19	s.04/20	s.04/21	s.04/22	s.04/24	s.04/25
Context			c.35	c.47	c.76	c.77	c.39	c.203	c.212	c.205	c.82	c.85	c.84	c.88	c.89	c.90	c.52	c.93
Area			L	L	L	L	L	H	H	H	L	L	L	L	L	L	L	L
Phase			940-1000	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940
Volume (litres)			10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Total charcoal mass (g.)			14.75	42.24	14.93	40.03	7.04	23.8	0.94	7.52	24.1	1.01	44.55	5.65	1.95	11.09	11.3	2.52
Amorphous plant material (g.)																		
Cereal Grains	**Common Name**	**Plant Part**																
Avena sp.	Oat grain	caryopsis				1												
Hordeum sp.	Barley grain	caryopsis				1						1						
Hordeum sp. hulled	Hulled barley grain	caryopsis				2							1					
H. hulled symmetric	Hulled barley straight grain	caryopsis				1							1			1		
H. hulled asymmetric	Hulled barley twisted grain	caryopsis				1											1	
Cereal indet.	Cereal grain	caryopsis		1														
Chaff		**Total Grain**	0	1	0	6	0	0	0	0	0	1	2	0	0	1	1	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node																1
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base																
Wild plants		**Total Chaff**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf																
Betula nana L.	Dwarf Birch	leaf																
Empetrum nigrum L.	Crowberry	leaf				1F												
Juniperus sp.	Juniper	leaf																
Indeterminate leaf	Indeterminate leaf	leaf																
Betula sp.	Birch	bud																
Salix sp.	Willow	bud																
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed																
Carex sp. (biconvex)	Sedge	seed				1	1						2	1				
Carex sp. (trigonous)	Sedge	seed	1									1						
Chenopodium album L.	Lambsquarters	seed		1														
Empetrum nigrum L.	Crowberry	seed									2						1	
Menyanthes trifoliata L.	Bog Bean	seed																
Montia fontana L.	Blinks	seed																
Poaceae undiff. (small)	Grass	seed														1		
Polygonum aviculare L.	Common Knotgrass	seed																1
Stellaria media (L.) Villars	Common chickweed	seed		4		1						1	2	1		1	1	1
Stellaria media (L.) Villars	Common chickweed	seed head																
Vaccinium sp.	Cranberry	seed											1					
Vicia sp.	Vetch	seed																
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node																
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base																
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome																
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome																
Indeterminate seed	Indeterminate seed	seed			2				2							1		
Indeterminate seaweed	Indeterminate seaweed	frond																
Fungi																		
Cenococcum undiff.	Fungus	seed	72F	16F	80F	33F	110F	44F	4F	9F	66F	92F	24F	16F	2F	194F	15F	27F
Uncarbonised Seeds																		
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed																
Carex sp. (biconvex)	Sedge	seed																2
Carex sp. (trigonous)	Sedge	seed																
Empetrum nigrum	Crowberry	seed																
		Total Wild	1	5	2	2	1	0	2	0	2	2	5	2	0	3	2	2
		Total QC	**1**	**6**	**2**	**8**	**1**	**0**	**2**	**0**	**2**	**3**	**7**	**2**	**0**	**4**	**3**	**3**
		Grain (%)	**0**	**17**	**0**	**75**	**0**	**0**	**0**	**0**	**0**	**33**	**29**	**0**	**0**	**25**	**33**	**0**
		Chaff (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**33**
		Wild Species (%)	**100**	**83**	**100**	**25**	**100**	**0**	**100**	**0**	**100**	**67**	**71**	**100**	**0**	**75**	**67**	**67**
Other sorted material																		
Bone			P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Insect Remains					P	P		P			P					P		P
Mollusc				P	P	P							P		P		P	
Metal Object																		
Slag (g.)			3.49	P		1.5	0.7	1.71			P	6.81		6.81			1.59	5.92
Pottery																		
Glass																		
Stone object																		

Sample			s.04/26	s.04/29	s.04/30	s.04/33	s.04/34	s.04/35	s.04/36	s.04/37	s.04/39	s.04/40	s.04/85		
Context			c.94	c.91	c.249	c.220	c.221	c.223	c.224	c.236	c.234	c.216	c.229		
Area			L or Q?	L	H	H	H	H	H	H	H	H	H		
Phase			870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940	870-940		
Volume (litres)			10	10	10	10	10	10	10	10	10	10	10		
														Totals	
Total charcoal mass (g.)			10.04	29.87	14.06	0.56	0.45	0.66	0	0.56	0.44	1.86	28.2	1331.39	
Amorphous plant material (g.)														52.93	
Cereal Grains	**Common Name**	**Plant Part**													
Avena sp.	Oat grain	caryopsis		3										5	
Hordeum sp.	Barley grain	caryopsis												3	
Hordeum sp. hulled	Hulled barley grain	caryopsis												6	
H. hulled symmetric	Hulled barley straight grain	caryopsis												3	
H. hulled asymmetric	Hulled barley twisted grain	caryopsis												4	
Cereal indet.	Cereal grain	caryopsis												4	
Chaff		**Total Grain**	0	3	0	0	0	0	0	0	0	0	0	25	
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node		1										4	
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base												0	
Wild plants		**Total Chaff**	0	1	0	0	0	0	0	0	0	0	0	4	
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf												0	
Betula nana L.	Dwarf Birch	leaf												1	
Empetrum nigrum L.	Crowberry	leaf												343	
Juniperus sp.	Juniper	leaf												21	
Indeterminate leaf	Indeterminate leaf	leaf												4	
Betula sp.	Birch	bud												1	
Salix sp.	Willow	bud	1F											3	
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed												1	
Carex sp. (biconvex)	Sedge	seed		2										64	
Carex sp. (trigonous)	Sedge	seed												19	
Chenopodium album L.	Lambsquarters	seed												1	
Empetrum nigrum L.	Crowberry	seed												45	
Menyanthes trifoliata L.	Bog Bean	seed												1	
Montia fontana L.	Blinks	seed												1	
Poaceae undiff. (small)	Grass	seed												6	
Polygonum aviculare L.	Common Knotgrass	seed												2	
Stellaria media (L.) Villars	Common chickweed	seed	1	6				2						393	
Stellaria media (L.) Villars	Common chickweed	seed head												37	
Vaccinium sp.	Cranberry	seed												1	
Vicia sp.	Vetch	seed												2	
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node												3	
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base												0	
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome												0	
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome		1										1	
Indeterminate seed	Indeterminate seed	seed	1											55	
Indeterminate seaweed	Indeterminate seaweed	frond												1	
Fungi															
Cenococcum undiff.	Fungus	seed	26F	23F	1F	20F	24F	35F	5F	24F	2F	8F	4F	1572	
Uncarbonised Seeds															
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed												1	
Carex sp. (biconvex)	Sedge	seed												2	
Carex sp. (trigonous)	Sedge	seed												1	
Empetrum nigrum	Crowberry	seed												1	
		Total Wild	2	9	0	0	0	2	0	0	0	0	0	633	Total ID
		Total QC	**2**	**13**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	662	2557
		Grain (%)	**0**	**23**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
		Chaff (%)	**0**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
		Wild Species (%)	**100**	**69**	**0**	**0**	**0**	**100**	**0**	**0**	**0**	**0**	**0**		
Other sorted material															
Bone			P	P	P	P									
Insect Remains			P		P			P			P		P		
Mollusc				P											
Metal Object															
Slag (g.)			1.09	P									4.3		
Pottery															
Glass															
Stone object															

Appendix Two

Skútustaðir Raw Data

Sample			**s.10/02**	**s.10/03**	**s.10/04**	**s.10/05**	**s.10/06**	**s.10/07**	**s.10/08**	**s.10/09**	**s.10/10**	**s.10/11**	**s.10/13**
Context			**c.211**	**c.214**	**c.216**	**c.217**	**c.219**	**c.221**	**c.222**	**c.224**	**c.226**	**c.229**	**c.231**
Area			**E3**	**H**	**E3**	**E3**	**H**	**H**	**E3**	**H**	**E3**	**H**	**H**
Phase			**1000-1477**	**1477-1717**	**1000-1477**	**1000-1477**	**1477-1717**	**1477-1717**	**1000-1477**	**1477-1717**	**1000-1477**	**1477-1717**	**1477-1717**
Volume (litres)			**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Total charcoal mass (g.)			2.57	5.99	0.67	3.24	2.87	10.4	1.32	3.37	3.29	7.86	14.43
Amorphous plant material (g.)				1.82			0.59	0.58		0.57		1.04	2.12
Uncarbonised wood fragments													
Carbonised ovicaprid coprolite													
Coal													
Cereal remains													
Avena sp.	Oat grain	caryopsis											
Hordeum sp.	Barley grain	caryopsis											
Hordeum sp. hulled	Hulled barley grain	caryopsis											
H. Hulled symmetric	Hulled barley straight grain	caryopsis											
H. hulled asymmetric	Hulled barley twisted grain	caryopsis											
Cereal indet.	Cereal grain	caryopsis											
Chaff		**Total Grain**	0	0	0	0	0	0	0	0	0	0	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node										1	
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base											
Wild plants		**Total Chaff**	0	0	0	0	0	0	0	0	0	1	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf					122	9		5		14	5
Betula nana L.	Dwarf Birch	leaf					1	1					
Empetrum nigrum L.	Crowberry	leaf		3				1				1	3
Juniperus sp.	Juniper	leaf											1
Indeterminate leaf	Indeterminate leaf	leaf				1							
Salix sp.	Willow	bud				1							
Agrimonia eupatoria L.	Common Agrimony	seed	1										
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed											
Brassica rapa L.	Field Mustard	seed											
Calluna vulgaris (L.) Hull	Common Heather	seed head											
Carex sp. (biconvex)	Sedge	seed		4	1		11	13		26	9	45	61
Carex sp. (trigonous)	Sedge	seed	2					3		2	1	27	11
Chenopodium album L.	Lambsquarters	seed											
Cyperaceae/Polygonaceae	Sedge/Knotweed	seed		1							2		
Empetrum nigrum L.	Crowberry	seed	3			2		1	1	1	2	1	
Ficus carica L.	Common Fig	seed											
cf. Hippuris vulgaris L.	Marestail	seed											
Juncus acutiflorus L.	Sharp-flowered Rush	seed											
Menyanthes trifoliata L.	Bog Bean	seed											
Montia fontana L.	Blinks	seed											
Plantago lanceolata L.	Ribwort Plantain	seed											
Poaceae undiff. (large)	Grass	seed											
Poaceae undiff. (small)	Grass	seed											
Polygonum aviculare L.	Common Knotgrass	seed									11	3	1
Polygonum lapathifolia L.	Pale Persicaria	seed										1	
Prunus domestica L.	Plum	seed											
Ranunculus acris L.	Meadow Buttercup	seed						1					1
Ranunculus bulbosus L.	Bulbous Buttercup	seed									2	2	
Ranunculus polyanthemos L.	Multiflowered Buttercup	seed											
Ranunculus repens L.	Creeping Buttercup	seed									1		
Rumex crispus L.	Curled Dock	seed								1			
Spergula arvensis L.	Corn Spurrey	seed											
Stellaria media (L.) Villars	Common chickweed	seed	5		1	8	2	1	1	3	221	2	
Vaccinium myrtillus L.	Bilberry	seed											
Vicia sp.	Vetch	seed											
Viola-type	Violet	seed						1					
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node											
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base											
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome											
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome											
Indeterminate root/tuber	Indeterminate root/tuber	root/tuber											
Indeterminate seed	Indeterminate seed	seed				1					1	2	5
Indeterminate seaweed	Indeterminate seaweed	frond											
Fungi													
Cenococcum undiff.	Fungus	seed	7		1	3	3	2	6	1	2		2
Uncarbonised Seeds													
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed											

Carex sp. (biconvex)	Sedge	seed					1						
Carex sp. (trigonous)	Sedge	seed										1	
Empetrum nigrum	Crowberry	seed		11		15					1		
Menyanthes trifoliata L.	Bog Bean	seed											
Polygonum aviculare L.	Common Knotgrass	seed											
Potentilla intermedia L.	Russian Cinquefoil	seed											
Ranunculus acris L.	Meadow Buttercup	seed										1	
Ranunculus bulbosus L.	Bulbous Buttercup	seed										1	
Ranunculus repens L.	Creeping Buttercup	seed											
Rumex crispus L.	Curled Dock	seed											
Stellaria media (L.) Villars	Common chickweed	seed			1								
Viola-type	Violet	seed		6									
Cenococcum undiff.	Fungus	seed							1				
		Total Wild	11	8	2	13	136	31	2	38	250	98	88
		Total QC	**11**	**8**	**2**	**13**	**136**	**31**	**2**	**38**	**250**	**99**	**88**
		Grain (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Chaff (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
		Wild Species (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**99**	**100**
Other sorted material													
Bone			P	P	P	P	P	P	P	P	P	P	P
Marine mollusc (<4mm)							P	P					
Eggshell (<4mm)													
Metal object			3F	8F				1F	11F		2F		
Pottery													
Glass								3F					
Stone object													
Carbonised textile												1F	
Bead													

Sample			**s.10/14**	**s.10/17**	**s.10/18**	**s.10/20**	**s.10/22**	**s.10/23**	**s.10/24**	**s.10/25**	**s.10/26**	**s.10/27**
Context			**c.230**	**c.234**	**c.236**	**c.239**	**c.242**	**c.243**	**c.246**	**c.247**	**c.248**	**c.246**
Area			**E3**	**H**	**E3**	**H**	**E3**	**E3**	**H**	**E3**	**E3**	**H**
Phase			**1000-1477**	**1477-1717**	**1000-1477**	**1477-1717**	**870-1000**	**870-1000**	**1477-1717**	**870-1000**	**870-1000**	**1477-1717**
Volume (litres)			**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Total charcoal mass (g.)			0.79	2.42	0.75	2.72	1.52	0.52	8.07	0.43	0.56	56.57
Amorphous plant material (g.)									1.99			25.81
Uncarbonised wood fragments												
Carbonised ovicaprid coprolite												51F(8.42)
Coal												
Cereal remains												
Avena sp.	Oat grain	caryopsis										
Hordeum sp.	Barley grain	caryopsis										
Hordeum sp. hulled	Hulled barley grain	caryopsis										
H. Hulled symmetric	Hulled barley straight grain	caryopsis										
H. hulled asymmetric	Hulled barley twisted grain	caryopsis										
Cereal indet.	Cereal grain	caryopsis										
Chaff		**Total Grain**	0	0	0	0	0	0	0	0	0	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node										
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base										
Wild plants		**Total Chaff**	0	0	0	0	0	0	0	0	0	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf		1					13			39
Betula nana L.	Dwarf Birch	leaf							2			6
Empetrum nigrum L.	Crowberry	leaf							5			4
Juniperus sp.	Juniper	leaf										
Indeterminate leaf	Indeterminate leaf	leaf	1								1	3
Salix sp.	Willow	bud										
Agrimonia eupatoria L.	Common Agrimony	seed										
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed										
Brassica rapa L.	Field Mustard	seed										
Calluna vulgaris (L.) Hull	Common Heather	seed head										
Carex sp. (biconvex)	Sedge	seed		19		4			15			44
Carex sp. (trigonous)	Sedge	seed		1					5			16
Chenopodium album L.	Lambsquarters	seed										
Cyperaceae/Polygonaceae	Sedge/Knotweed	seed										
Empetrum nigrum L.	Crowberry	seed		3					2			16
Ficus carica L.	Common Fig	seed										
cf. Hippuris vulgaris L.	Marestail	seed										
Juncus acutiflorus L.	Sharp-flowered Rush	seed										
Menyanthes trifoliata L.	Bog Bean	seed										
Montia fontana L.	Blinks	seed										
Plantago lanceolata L.	Ribwort Plantain	seed										

Poaceae undiff. (large)	Grass	seed										
Poaceae undiff. (small)	Grass	seed					1					
Polygonum aviculare L.	Common Knotgrass	seed							1			
Polygonum lapathifolia L.	Pale Persicaria	seed										1
Prunus domestica L.	Plum	seed										
Ranunculus acris L.	Meadow Buttercup	seed										
Ranunculus bulbosus L.	Bulbous Buttercup	seed										1
Ranunculus polyanthemos L.	Multiflowered Buttercup	seed										
Ranunculus repens L.	Creeping Buttercup	seed										1
Rumex crispus L.	Curled Dock	seed										1
Spergula arvensis L.	Corn Spurrey	seed										
Stellaria media (L.) Villars	Common chickweed	seed		1					3			2
Vaccinium myrtillus L.	Bilberry	seed										
Vicia sp.	Vetch	seed										
Viola -type	Violet	seed										
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node										
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base										
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome										
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome										
Indeterminate root/tuber	Indeterminate root/tuber	root/tuber										
Indeterminate seed	Indeterminate seed	seed							1			
Indeterminate seaweed	Indeterminate seaweed	frond										
Fungi												
Cenococcum undiff.	Fungus	seed	3		7	1	7			7	1	
Uncarbonised Seeds												
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed										
Carex sp. (biconvex)	Sedge	seed			1				1			
Carex sp. (trigonous)	Sedge	seed							1			
Empetrum nigrum	Crowberry	seed										
Menyanthes trifoliata L.	Bog Bean	seed										
Polygonum aviculare L.	Common Knotgrass	seed										
Potentilla intermedia L.	Russian Cinquefoil	seed										
Ranunculus acris L.	Meadow Buttercup	seed										
Ranunculus bulbosus L.	Bulbous Buttercup	seed										
Ranunculus repens L.	Creeping Buttercup	seed										
Rumex crispus L.	Curled Dock	seed										
Stellaria media (L.) Villars	Common chickweed	seed			1							
Viola -type	Violet	seed										
Cenococcum undiff.	Fungus	seed			3							
		Total Wild	1	25	0	4	1	0	47	0	1	134
		Total QC	**1**	**25**	**0**	**4**	**1**	**0**	**47**	**0**	**1**	**134**
		Grain (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**#DIV/0!**	**0**	**0**
		Chaff (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**#DIV/0!**	**0**	**0**
		Wild Species (%)	**100**	**100**	**0**	**100**	**100**	**0**	**100**	**#DIV/0!**	**100**	**100**
Other sorted material												
Bone			P	P	P	P	P	P	P			P
Marine mollusc (<4mm)												
Eggshell (<4mm)												
Metal object												
Pottery												
Glass												
Stone object												
Carbonised textile												23F
Bead												

Sample			s.09/01	s.09/02	s.09/05	s.09/06	s.09/07	s.09/08	s.09/09	s.09/10	s.09/11	s.09/12	s.09/14	s.09/15
Context			c.104	c.105	c.110	c.115	c.119	c.120	c.121	c.123	c.122	c.126	c.127	c.128
Area			G	G	G	G	G	H	G	G	H	G	H	G
Phase			1717-1900	1717-1900	1717-1900	1717-1900	1477-1717	C20th	1477-1717	1477-1717	C20th	1477-1717	1717-1900	1477-1717
Volume (litres)			10	10	10	10	10	10	10	10	10	10	10	10
Total charcoal mass (g.)			0.26	0.08	2.25	0.12	0.08	3.6	0.59	2.52	0.8	3.6	0.32	0.93
Amorphous plant material (g.)			0.55	0.26	1.32		0.03	0.69	0.17	0.63	0.29	0.07	0.58	
Uncarbonised wood fragments					2F								3F	
Carbonised ovicaprid coprolite					6F(0.14)			5F(0.12)		1F(0.07)	1F(0.1)		7F(1.7)	
Coal														
Cereal remains														
Avena sp.	Oat grain	caryopsis		1										
Hordeum sp.	Barley grain	caryopsis												
Hordeum sp. hulled	Hulled barley grain	caryopsis	2											
H. Hulled symmetric	Hulled barley straight grain	caryopsis												
H. hulled asymmetric	Hulled barley twisted grain	caryopsis												
Cereal indet.	Cereal grain	caryopsis			1				1					
Chaff		**Total Grain**	2	1	1	0	0	0	1	0	0	0	0	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node								1				
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base								3		4		
Wild plants		**Total Chaff**	0	0	0	0	0	0	0	4	0	4	0	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf			1	1	3			5			3	
Betula nana L.	Dwarf Birch	leaf												
Empetrum nigrum L.	Crowberry	leaf			3							1		
Juniperus sp.	Juniper	leaf												
Indeterminate leaf	Indeterminate leaf	leaf												
Salix sp.	Willow	bud												
Agrimonia eupatoria L.	Common Agrimony	seed												
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed												
Brassica rapa L.	Field Mustard	seed						1						
Calluna vulgaris (L.) Hull	Common Heather	seed head	1								2		1	
Carex sp. (biconvex)	Sedge	seed	11	4	6	2	4	16	2	6	3	10	23	1
Carex sp. (trigonous)	Sedge	seed	3		5		1	13		2		1	5	2
Chenopodium album L.	Lambsquarters	seed												
Cyperaceae/Polygonaceae	Sedge/Knotweed	seed												
Empetrum nigrum L.	Crowberry	seed								1			2	
Ficus carica L.	Common Fig	seed									2			
cf. Hippuris vulgaris L.	Marestail	seed						1	1			1		
Juncus acutiflorus L.	Sharp-flowered Rush	seed												
Menyanthes trifoliata L.	Bog Bean	seed												
Montia fontana L.	Blinks	seed												
Plantago lanceolata L.	Ribwort Plantain	seed												
Poaceae undiff. (large)	Grass	seed	1											
Poaceae undiff. (small)	Grass	seed	3		1							1	1	
Polygonum aviculare L.	Common Knotgrass	seed									3		4	
Polygonum lapathifolia L.	Pale Persicaria	seed												
Prunus domestica L.	Plum	seed									2			
Ranunculus acris L.	Meadow Buttercup	seed						1			3		1	
Ranunculus bulbosus L.	Bulbous Buttercup	seed			1			3		1				
Ranunculus polyanthemos L.	Multiflowered Buttercup	seed									1			
Ranunculus repens L.	Creeping Buttercup	seed						1						
Rumex crispus L.	Curled Dock	seed						1						
Spergula arvensis L.	Corn Spurrey	seed												
Stellaria media (L.) Villars	Common chickweed	seed							1	2		4		
Vaccinium myrtillus L.	Bilberry	seed												
Vicia sp.	Vetch	seed												
Viola-type	Violet	seed												
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node	3		7			1				1	2	
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base						1	3	4		6		
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome								3				
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome	1			4		1	3	2	8	2	14	1
Indeterminate root/tuber	Indeterminate root/tuber	root/tuber						1						
Indeterminate seed	Indeterminate seed	seed	5		6	2	1	7		4		4		1
Indeterminate seaweed	Indeterminate seaweed	frond												
Fungi														
Cenococcum undiff.	Fungus	seed												
Uncarbonised Seeds														
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed												
Carex sp. (biconvex)	Sedge	seed									8		9	
Carex sp. (trigonous)	Sedge	seed									2		2	
Empetrum nigrum	Crowberry	seed									2		3	
Menyanthes trifoliata L.	Bog Bean	seed												
Polygonum aviculare L.	Common Knotgrass	seed												
Potentilla intermedia L.	Russian Cinquefoil	seed												
Ranunculus acris L.	Meadow Buttercup	seed												
Ranunculus bulbosus L.	Bulbous Buttercup	seed									7			
Ranunculus repens L.	Creeping Buttercup	seed												
Rumex crispus L.	Curled Dock	seed												
Stellaria media (L.) Villars	Common chickweed	seed												
Viola-type	Violet	seed									1		2	
Cenococcum undiff.	Fungus	seed												

		Total Wild	28	4	30	9	9	48	10	30	24	31	56	5
		Total QC	**30**	**5**	**31**	**9**	**9**	**48**	**11**	**34**	**24**	**35**	**56**	**5**
		Grain (%)	**7**	**20**	**3**	**0**	**0**	**0**	**9**	**0**	**0**	**0**	**0**	**0**
		Chaff (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**12**	**0**	**11**	**0**	**0**
		Wild Species (%)	**93**	**80**	**97**	**100**	**100**	**100**	**91**	**88**	**100**	**89**	**100**	**100**
Other sorted material														
Bone			P	P	P	P	P	P	P	P	P	P	P	P
Marine mollusc (<4mm)														
Eggshell (<4mm)					P			P			P			
Metal object			1F(2.8)						2F		5F		7F	1F
Pottery					1F		1F			1F	2F		2F	
Glass					1F						2F		5F	
Stone object														
Carbonised textile				5F									2F	
Bead														

Sample			**s.09/16**	**s.09/17**	**s.09/18**	**s.09/19**	**s.09/20**	**s.09/21**	**s.09/22**	**s.09/23**	**s.09/24**	**s.09/25**	**s.09/26**
Context			**c.129**	**c.131**	**c.130**	**c.132**	**c.133**	**c.135**	**c.138**	**c.139**	**c.136**	**c.140**	**c.141**
Area			**H**	**G**	**H**		**G**	**G**	**G**	**G**	**H**	**G**	**H**
Phase			**1717-1900**	**1477-1717**	**1717-1900**	**1477-1717**	**1477-1717**	**1477-1717**	**1000-1477**	**1000-1477**	**1477-1717**	**1000-1477**	**1477-1717**
Volume (litres)			**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Total charcoal mass (g.)			0.13	0.99	0.34	0.67	22.83	0.22	9.43	0.48	6.79	0.32	1.81
Amorphous plant material (g.)					0.14				0.06		1.89		0.21
Uncarbonised wood fragments				2F									21F
Carbonised ovicaprid coprolite													4F(0.48)
Coal													
Cereal remains													
Avena sp.	Oat grain	caryopsis											
Hordeum sp.	Barley grain	caryopsis											
Hordeum sp. hulled	Hulled barley grain	caryopsis											
H. Hulled symmetric	Hulled barley straight grain	caryopsis											
H. hulled asymmetric	Hulled barley twisted grain	caryopsis											
Cereal indet.	Cereal grain	caryopsis											
Chaff		**Total Grain**	0	0	0	0	0	0	0	0	0	0	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node											
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base											
Wild plants		**Total Chaff**	0	0	0	0	0	0	0	0	0	0	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf									3		
Betula nana L.	Dwarf Birch	leaf											
Empetrum nigrum L.	Crowberry	leaf											
Juniperus sp.	Juniper	leaf											
Indeterminate leaf	Indeterminate leaf	leaf											
Salix sp.	Willow	bud											
Agrimonia eupatoria L.	Common Agrimony	seed											
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed											
Brassica rapa L.	Field Mustard	seed		1									
Calluna vulgaris (L.) Hull	Common Heather	seed head											
Carex sp. (biconvex)	Sedge	seed	3	1	6				6		5		4
Carex sp. (trigonous)	Sedge	seed	2	2							3		
Chenopodium album L.	Lambsquarters	seed			1								
Cyperaceae/Polygonaceae	Sedge/Knotweed	seed											
Empetrum nigrum L.	Crowberry	seed							4		1		2
Ficus carica L.	Common Fig	seed											
cf. Hippuris vulgaris L.	Marestail	seed											
Juncus acutiflorus L.	Sharp-flowered Rush	seed		1									
Menyanthes trifoliata L.	Bog Bean	seed											
Montia fontana L.	Blinks	seed											
Plantago lanceolata L.	Ribwort Plantain	seed											
Poaceae undiff. (large)	Grass	seed											
Poaceae undiff. (small)	Grass	seed	1						1				
Polygonum aviculare L.	Common Knotgrass	seed			2								
Polygonum lapathifolia L.	Pale Persicaria	seed											
Prunus domestica L.	Plum	seed											
Ranunculus acris L.	Meadow Buttercup	seed	1								1		
Ranunculus bulbosus L.	Bulbous Buttercup	seed	1						1	1	1		
Ranunculus polyanthemos L.	Multiflowered Buttercup	seed											
Ranunculus repens L.	Creeping Buttercup	seed											
Rumex crispus L.	Curled Dock	seed	1										
Spergula arvensis L.	Corn Spurrey	seed											2
Stellaria media (L.) Villars	Common chickweed	seed		1					3		1	2	3
Vaccinium myrtillus L.	Bilberry	seed											

Vicia sp.	Vetch	seed											
Viola-type	Violet	seed											
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node			1								
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base						1	1				
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome		1									
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome			1				1				
Indeterminate root/tuber	Indeterminate root/tuber	root/tuber											
Indeterminate seed	Indeterminate seed	seed		2		1	1				1		2
Indeterminate seaweed	Indeterminate seaweed	frond											
Fungi													
Cenococcum undiff.	Fungus	seed			1	1					2	1	
Uncarbonised Seeds													
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed									3		
Carex sp. (biconvex)	Sedge	seed			3								
Carex sp. (trigonous)	Sedge	seed	1										
Empetrum nigrum	Crowberry	seed			2						1		1
Menyanthes trifoliata L.	Bog Bean	seed											
Polygonum aviculare L.	Common Knotgrass	seed											
Potentilla intermedia L.	Russian Cinquefoil	seed											
Ranunculus acris L.	Meadow Buttercup	seed	1										
Ranunculus bulbosus L.	Bulbous Buttercup	seed	7										
Ranunculus repens L.	Creeping Buttercup	seed	1										
Rumex crispus L.	Curled Dock	seed											
Stellaria media (L.) Villars	Common chickweed	seed											
Viola-type	Violet	seed	650		2								
Cenococcum undiff.	Fungus	seed											
		Total Wild	9	9	11	1	1	1	17	1	16	2	13
		Total QC	**9**	**9**	**11**	**1**	**1**	**1**	**17**	**1**	**16**	**2**	**13**
		Grain (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Chaff (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Wild Species (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Other sorted material													
Bone			P	P	P	P	P	P	P	P	P	P	P
Marine mollusc (<4mm)			P						P				
Eggshell (<4mm)									P		P	P	P
Metal object			2F			1F					1F		1F
Pottery					1F								
Glass			1F										
Stone object													
Carbonised textile													
Bead													

Sample			**s.09/27**	**s.09/28**	**s.09/29**	**s.09/30**	**s.09/31**	**s.09/41**	**s.09/42**	**s.09/45**	**s.09/46**	**s.09/47**	**s.09/48**	**s.09/49**
Context			**c.142**	**c.145**	**c.146**	**c.144**	**c.147**	**c.149**	**c.148**	**c.152**	**c.154**	**c.155**	**c.156**	**c.158**
Area			**G**	**G**	**H**	**H**	**G**	**G**	**G**	**G**	**G**	**H**	**G**	**G**
Phase			**1000-1477**	**1000-1477**	**1477-1717**	**1477-1717**	**870-1000**	**870-1000**	**870-1000**	**870-1000**	**870-1000**	**1717-1900**	**870-1000**	**870-1000**
Volume (litres)			**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Total charcoal mass (g.)			0.95	1.41	0.74	1.65	0.81	2.03	2.36	6.37	31.46	0.25	10.28	16.36
Amorphous plant material (g.)					0.19	0.31			0.04			0.27	0.02	0.03
Uncarbonised wood fragments						2F					1F			
Carbonised ovicaprid coprolite					1F(0.03)	1F(0.02)						2F(0.05)		
Coal												4F(0.34)		
Cereal remains														
Avena sp.	Oat grain	caryopsis												
Hordeum sp.	Barley grain	caryopsis												
Hordeum sp. hulled	Hulled barley grain	caryopsis											1	
H. Hulled symmetric	Hulled barley straight grain	caryopsis												
H. hulled asymmetric	Hulled barley twisted grain	caryopsis												
Cereal indet.	Cereal grain	caryopsis												
Chaff		**Total Grain**	0	0	0	0	0	0	0	0	0	0	1	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node												
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base				1				2			1	
Wild plants		**Total Chaff**	0	0	0	1	0	0	0	2	0	0	1	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf								1				
Betula nana L.	Dwarf Birch	leaf												
Empetrum nigrum L.	Crowberry	leaf				1								
Juniperus sp.	Juniper	leaf												
Indeterminate leaf	Indeterminate leaf	leaf												
Salix sp.	Willow	bud												
Agrimonia eupatoria L.	Common Agrimony	seed												
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed												

Brassica rapa L.	Field Mustard	seed												
Calluna vulgaris (L.) Hull	Common Heather	seed head												
Carex sp. (biconvex)	Sedge	seed			1	9			1	1		27		
Carex sp. (trigonous)	Sedge	seed		1		3					1	15	2	1
Chenopodium album L.	Lambsquarters	seed												
Cyperaceae/Polygonaceae	Sedge/Knotweed	seed												
Empetrum nigrum L.	Crowberry	seed		1							9		3	
Ficus carica L.	Common Fig	seed												
cf. Hippuris vulgaris L.	Marestail	seed					1							
Juncus acutiflorus L.	Sharp-flowered Rush	seed												
Menyanthes trifoliata L.	Bog Bean	seed			1									
Montia fontana L.	Blinks	seed												
Plantago lanceolata L.	Ribwort Plantain	seed												
Poaceae undiff. (large)	Grass	seed												
Poaceae undiff. (small)	Grass	seed										2		
Polygonum aviculare L.	Common Knotgrass	seed									1			
Polygonum lapathifolia L.	Pale Persicaria	seed												
Prunus domestica L.	Plum	seed												
Ranunculus acris L.	Meadow Buttercup	seed				1					1			
Ranunculus bulbosus L.	Bulbous Buttercup	seed				2		1		1				
Ranunculus polyanthemos L.	Multiflowered Buttercup	seed												
Ranunculus repens L.	Creeping Buttercup	seed				1				1		1		
Rumex crispus L.	Curled Dock	seed			1									
Spergula arvensis L.	Corn Spurrey	seed												
Stellaria media (L.) Villars	Common chickweed	seed	1					3			1	1	25	12
Vaccinium myrtillus L.	Bilberry	seed												
Vicia sp.	Vetch	seed												
Viola-type	Violet	seed												
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node												
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base												
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome												1
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome								1			2	
Indeterminate root/tuber	Indeterminate root/tuber	root/tuber												
Indeterminate seed	Indeterminate seed	seed				1							1	
Indeterminate seaweed	Indeterminate seaweed	frond							1					
Fungi														
Cenococcum undiff.	Fungus	seed	2					8						8
Uncarbonised Seeds														
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed												
Carex sp. (biconvex)	Sedge	seed				1						16		
Carex sp. (trigonous)	Sedge	seed				1						5		
Empetrum nigrum	Crowberry	seed										4		
Menyanthes trifoliata L.	Bog Bean	seed										3		
Polygonum aviculare L.	Common Knotgrass	seed										5		
Potentilla intermedia L.	Russian Cinquefoil	seed										1		
Ranunculus acris L.	Meadow Buttercup	seed			2									
Ranunculus bulbosus L.	Bulbous Buttercup	seed			3									
Ranunculus repens L.	Creeping Buttercup	seed												
Rumex crispus L.	Curled Dock	seed										2		
Stellaria media (L.) Villars	Common chickweed	seed												
Viola-type	Violet	seed			1							16		
Cenococcum undiff.	Fungus	seed												
		Total Wild	1	2	3	18	1	4	2	5	13	46	33	14
		Total QC	**1**	**2**	**3**	**19**	**1**	**4**	**2**	**7**	**13**	**46**	**35**	**14**
		Grain (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**
		Chaff (%)	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**29**	**0**	**0**	**3**	**0**
		Wild Species (%)	**100**	**100**	**100**	**95**	**100**	**100**	**100**	**71**	**100**	**100**	**94**	**100**
Other sorted material														
Bone			P	P	P	P	P	P	P	P	P	P	P	P
Marine mollusc (<4mm)					P	P								P
Eggshell (<4mm)					P	P							P	
Metal object												2F		
Pottery			2F	2F		1F						1F		
Glass												2F		
Stone object														
Carbonised textile														1F
Bead								1F						

Sample			s.09/50	s.08/1	s.08/3	s.08/4	s.08/5	s.08/6	s.08/7	s.08/8	s.08/9	s.08/12
Context			**c.161**	**c.002**	**c.006**	**c.005**	**c.029**	**c.032**	**c.035**	**c.045**	**c.047**	**c.046**
Area			**G**	**D**	**E**	**D**	**D**	**D**	**F**	**F**	**F**	**D**
Phase			**870-1000**	**C20th**	**1000-1477**	**1717-1900**	**1717-1900**	**1477-1717**	**1717-1900**	**1717-1900**	**1717-1900**	**1477-1717**
Volume (litres)			**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Total charcoal mass (g.)			13.2	0.36	5.19	0.04	0.11	0.83	2.69	1.57	2.08	3.9
Amorphous plant material (g.)				0.21		0.02		0.19	0.06	4.89	0.58	0.28
Uncarbonised wood fragments												
Carbonised ovicaprid coprolite										1F(0.02)		
Coal												
Cereal remains												
Avena sp.	Oat grain	caryopsis										
Hordeum sp.	Barley grain	caryopsis										
Hordeum sp. hulled	Hulled barley grain	caryopsis		1								
H. Hulled symmetric	Hulled barley straight grain	caryopsis										
H. hulled asymmetric	Hulled barley twisted grain	caryopsis		1								
Cereal indet.	Cereal grain	caryopsis										
Chaff		**Total Grain**	0	2	0	0	0	0	0	0	0	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node		1								
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base						1		3	1	6
Wild plants		**Total Chaff**	0	1	0	0	0	1	0	3	1	6
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf										1
Betula nana L.	Dwarf Birch	leaf										
Empetrum nigrum L.	Crowberry	leaf			1				2		2	
Juniperus sp.	Juniper	leaf										
Indeterminate leaf	Indeterminate leaf	leaf							3			
Salix sp.	Willow	bud										1
Agrimonia eupatoria L.	Common Agrimony	seed										
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed						1				1
Brassica rapa L.	Field Mustard	seed										
Calluna vulgaris (L.) Hull	Common Heather	seed head										
Carex sp. (biconvex)	Sedge	seed		1	1			1	2	6	20	2
Carex sp. (trigonous)	Sedge	seed						1		5	1	
Chenopodium album L.	Lambsquarters	seed										
Cyperaceae/Polygonaceae	Sedge/Knotweed	seed										
Empetrum nigrum L.	Crowberry	seed				1				1		
Ficus carica L.	Common Fig	seed										
cf. Hippuris vulgaris L.	Marestail	seed									5	
Juncus acutiflorus L.	Sharp-flowered Rush	seed										
Menyanthes trifoliata L.	Bog Bean	seed										
Montia fontana L.	Blinks	seed							1		1	
Plantago lanceolata L.	Ribwort Plantain	seed										
Poaceae undiff. (large)	Grass	seed										
Poaceae undiff. (small)	Grass	seed										
Polygonum aviculare L.	Common Knotgrass	seed								1		
Polygonum lapathifolia L.	Pale Persicaria	seed										
Prunus domestica L.	Plum	seed										
Ranunculus acris L.	Meadow Buttercup	seed							2			
Ranunculus bulbosus L.	Bulbous Buttercup	seed										
Ranunculus polyanthemos L.	Multiflowered Buttercup	seed										
Ranunculus repens L.	Creeping Buttercup	seed			1							
Rumex crispus L.	Curled Dock	seed									2	
Spergula arvensis L.	Corn Spurrey	seed										
Stellaria media (L.) Villars	Common chickweed	seed							1	9	6	
Vaccinium myrtillus L.	Bilberry	seed								1		1
Vicia sp.	Vetch	seed										
Viola-type	Violet	seed										
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node	1					2			1	2
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base		1				3	1	1	1	6
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome								1		
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome										
Indeterminate root/tuber	Indeterminate root/tuber	root/tuber										
Indeterminate seed	Indeterminate seed	seed		1	3	1			1	3	5	2
Indeterminate seaweed	Indeterminate seaweed	frond										
Fungi												
Cenococcum undiff.	Fungus	seed	1									
Uncarbonised Seeds												
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed										
Carex sp. (biconvex)	Sedge	seed										
Carex sp. (trigonous)	Sedge	seed										
Empetrum nigrum	Crowberry	seed										
Menyanthes trifoliata L.	Bog Bean	seed										
Polygonum aviculare L.	Common Knotgrass	seed										
Potentilla intermedia L.	Russian Cinquefoil	seed										
Ranunculus acris L.	Meadow Buttercup	seed										
Ranunculus bulbosus L.	Bulbous Buttercup	seed									1	
Ranunculus repens L.	Creeping Buttercup	seed										
Rumex crispus L.	Curled Dock	seed										
Stellaria media (L.) Villars	Common chickweed	seed										
Viola-type	Violet	seed										
Cenococcum undiff.	Fungus	seed										

		Total Wild	1		3	6	2	0	8	13	28	44	16
		Total QC	**1**		**6**	**6**	**2**	**0**	**9**	**13**	**31**	**45**	**22**
		Grain (%)	**0**		**33**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Chaff (%)	**0**		**17**	**0**	**0**	**0**	**11**	**0**	**10**	**2**	**27**
		Wild Species (%)	**100**		**50**	**100**	**100**	**0**	**89**	**100**	**90**	**98**	**73**
Other sorted material													
Bone			P		P	P	P	P	P	P	P	P	P
Marine mollusc (<4mm)					P	P			P				
Eggshell (<4mm)			P										
Metal object						1F			1F		1F		
Pottery											1F		
Glass											1F		
Stone object													
Carbonised textile													
Bead													

Sample			**s.08/13**	**s.08/15**	**s.08/16**	**s.08/17**	**s.08/18**	**s.08/20**	**s.08/21**	**s.08/22**	**s.08/23**	**s.08/24**	**s.08/25**
Context			**c.052**	**c.055**	**c.058**	**c.057**	**c.059**	**c.062**	**c.063**	**c.060**	**c.067**	**c.071**	**c.063**
Area			**D**	**D**	**E2**	**D**	**E2**	**D**	**E2**	**E2**	**D**	**D**	**E2**
Phase			**1477-1717**	**1477-1717**	**1000-1477**	**1477-1717**	**1000-1477**	**1477-1717**	**870-1000**	**1000-1477**	**1000-1477**	**1000-1477**	**870-1000**
Volume (litres)			**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Total charcoal mass (g.)			4.61	8.97	1.34	4.84	2.81	3.13	5.78	4.29	0.35	0.39	13.71
Amorphous plant material (g.)			1.48	1.2	0.02	0.29	0.04	1.42	0.06			0.03	0.28
Uncarbonised wood fragments													
Carbonised ovicaprid coprolite				34F(1.32)		1F(0.05)							
Coal													
Cereal remains													
Avena sp.	Oat grain	caryopsis											
Hordeum sp.	Barley grain	caryopsis											
Hordeum sp. hulled	Hulled barley grain	caryopsis											
H. Hulled symmetric	Hulled barley straight grain	caryopsis											
H. hulled asymmetric	Hulled barley twisted grain	caryopsis											
Cereal indet.	Cereal grain	caryopsis											
Chaff		**Total Grain**	0	0	0	0	0	0	0	0	0	0	0
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node											
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base		4						1			
Wild plants		**Total Chaff**	0	4	0	0	0	0	0	1	0	0	0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf		7					7				
Betula nana L.	Dwarf Birch	leaf											
Empetrum nigrum L.	Crowberry	leaf											
Juniperus sp.	Juniper	leaf											
Indeterminate leaf	Indeterminate leaf	leaf		2									
Salix sp.	Willow	bud				1		1					
Agrimonia eupatoria L.	Common Agrimony	seed											
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed											
Brassica rapa L.	Field Mustard	seed							1				
Calluna vulgaris (L.) Hull	Common Heather	seed head		1		1		1					
Carex sp. (biconvex)	Sedge	seed		9		13		1					
Carex sp. (trigonous)	Sedge	seed		1					1				
Chenopodium album L.	Lambsquarters	seed											
Cyperaceae/Polygonaceae	Sedge/Knotweed	seed											
Empetrum nigrum L.	Crowberry	seed							1				
Ficus carica L.	Common Fig	seed											
cf. Hippuris vulgaris L.	Marestail	seed											
Juncus acutiflorus L.	Sharp-flowered Rush	seed											
Menyanthes trifoliata L.	Bog Bean	seed											
Montia fontana L.	Blinks	seed											
Plantago lanceolata L.	Ribwort Plantain	seed							1				
Poaceae undiff. (large)	Grass	seed											
Poaceae undiff. (small)	Grass	seed						1					
Polygonum aviculare L.	Common Knotgrass	seed											
Polygonum lapathifolia L.	Pale Persicaria	seed											
Prunus domestica L.	Plum	seed											
Ranunculus acris L.	Meadow Buttercup	seed											1
Ranunculus bulbosus L.	Bulbous Buttercup	seed		1									
Ranunculus polyanthemos L.	Multiflowered Buttercup	seed											
Ranunculus repens L.	Creeping Buttercup	seed											
Rumex crispus L.	Curled Dock	seed											
Spergula arvensis L.	Corn Spurrey	seed											
Stellaria media (L.) Villars	Common chickweed	seed			1								
Vaccinium myrtillus L.	Bilberry	seed											

Vicia sp.	Vetch	seed											
Viola-type	Violet	seed											
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node		9		14			1				
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base		10		10							2
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome		1									
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome				4							
Indeterminate root/tuber	Indeterminate root/tuber	root/tuber											
Indeterminate seed	Indeterminate seed	seed		2		1							1
Indeterminate seaweed	Indeterminate seaweed	frond											
Fungi													
Cenococcum undiff.	Fungus	seed							1				
Uncarbonised Seeds													
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed											
Carex sp. (biconvex)	Sedge	seed											
Carex sp. (trigonous)	Sedge	seed											
Empetrum nigrum	Crowberry	seed											
Menyanthes trifoliata L.	Bog Bean	seed											
Polygonum aviculare L.	Common Knotgrass	seed											
Potentilla intermedia L.	Russian Cinquefoil	seed											
Ranunculus acris L.	Meadow Buttercup	seed											
Ranunculus bulbosus L.	Bulbous Buttercup	seed											
Ranunculus repens L.	Creeping Buttercup	seed											
Rumex crispus L.	Curled Dock	seed											
Stellaria media (L.) Villars	Common chickweed	seed											
Viola-type	Violet	seed											
Cenococcum undiff.	Fungus	seed											
		Total Wild	0	43	1	44	0	4	12	0	0	0	4
		Total QC	**0**	**47**	**1**	**44**	**0**	**4**	**12**	**1**	**0**	**0**	**4**
		Grain (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Chaff (%)	**0**	**9**	**0**	**0**	**0**	**0**	**0**	**100**	**0**	**0**	**0**
		Wild Species (%)	**0**	**91**	**100**	**100**	**0**	**100**	**100**	**0**	**0**	**0**	**100**
Other sorted material													
Bone			P	P	P	P	P	P	P	P	P	P	P
Marine mollusc (<4mm)						P							
Eggshell (<4mm)													
Metal object									1F				1F
Pottery													
Glass													
Stone object									1F				
Carbonised textile													
Bead													

Sample			**s.08/26**	**s.08/27**	**s.08/28**	**s.08/29**	
Context			**c.069**	**c.073**	**c.074**	**c.075**	
Area			**F**	**F**	**F**	**F**	
Phase			**1717-1900**	**1717-1900**	**1717-1900**	**1717-1900**	
Volume (litres)			**10**	**10**	**10**	**10**	
							Totals
Total charcoal mass (g.)			3.04	1.67	0.55	1.9	351.54
Amorphous plant material (g.)							53.32
Uncarbonised wood fragments							
Carbonised ovicaprid coprolite							
Coal							
Cereal remains							
Avena sp.	Oat grain	caryopsis					1
Hordeum sp.	Barley grain	caryopsis					0
Hordeum sp. hulled	Hulled barley grain	caryopsis					4
H. Hulled symmetric	Hulled barley straight grain	caryopsis					0
H. hulled asymmetric	Hulled barley twisted grain	caryopsis					1
Cereal indet.	Cereal grain	caryopsis					2
Chaff		**Total Grain**	0	0	0	0	8
Cereal/monocotyledon (>2 mm.) culm node	Cereal/monocotyledon culm node	culm node					3
Cereal/monocotyledon (>2 mm.) culm base	Cereal/monocotyledon culm base	culm base					27
Wild plants		**Total Chaff**	0	0	0	0	30
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	leaf					240
Betula nana L.	Dwarf Birch	leaf					10
Empetrum nigrum L.	Crowberry	leaf					27
Juniperus sp.	Juniper	leaf					1
Indeterminate leaf	Indeterminate leaf	leaf					11
Salix sp.	Willow	bud					4
Agrimonia eupatoria L.	Common Agrimony	seed					1
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed					2

Brassica rapa L.	Field Mustard	seed					3
Calluna vulgaris (L.) Hull	Common Heather	seed head					7
Carex sp. (biconvex)	Sedge	seed	5	5	17		487
Carex sp. (trigonous)	Sedge	seed	1	1	4	1	146
Chenopodium album L.	Lambsquarters	seed					1
Cyperaceae/Polygonaceae	Sedge/Knotweed	seed					3
Empetrum nigrum L.	Crowberry	seed				1	59
Ficus carica L.	Common Fig	seed					2
cf. Hippuris vulgaris L.	Marestail	seed					9
Juncus acutiflorus L.	Sharp-flowered Rush	seed					1
Menyanthes trifoliata L.	Bog Bean	seed					1
Montia fontana L.	Blinks	seed					2
Plantago lanceolata L.	Ribwort Plantain	seed					1
Poaceae undiff. (large)	Grass	seed					1
Poaceae undiff. (small)	Grass	seed			1	1	14
Polygonum aviculare L.	Common Knotgrass	seed		1		2	30
Polygonum lapathifolia L.	Pale Persicaria	seed					2
Prunus domestica L.	Plum	seed					
Ranunculus acris L.	Meadow Buttercup	seed					14
Ranunculus bulbosus L.	Bulbous Buttercup	seed					19
Ranunculus polyanthemos L.	Multiflowered Buttercup	seed					1
Ranunculus repens L.	Creeping Buttercup	seed					7
Rumex crispus L.	Curled Dock	seed		1			8
Spergula arvensis L.	Corn Spurrey	seed					2
Stellaria media (L.) Villars	Common chickweed	seed		2	4	1	334
Vaccinium myrtillus L.	Bilberry	seed					2
Vicia sp.	Vetch	seed					0
Viola-type	Violet	seed					1
Monocotyledon (<2 mm.) culm node	Monocotyledon culm node	culm node					45
Monocotyledon (<2 mm.) culm base	Monocotyledon culm base	culm base		2			53
Indeterminate (>2 mm.) rhizome	Indeterminate rhizome	rhizome					7
Indeterminate (<2 mm.) rhizome	Indeterminate rhizome	rhizome					45
Indeterminate root/tuber	Indeterminate root/tuber	root/tuber				1	2
Indeterminate seed	Indeterminate seed	seed		3	2		74
Indeterminate seaweed	Indeterminate seaweed	frond					1
Fungi							
Cenococcum undiff.	Fungus	seed					78
Uncarbonised Seeds							0
Arctostaphylos uva-ursi (L.) Spreng	Bearberry	seed					3
Carex sp. (biconvex)	Sedge	seed					40
Carex sp. (trigonous)	Sedge	seed					13
Empetrum nigrum	Crowberry	seed					40
Menyanthes trifoliata L.	Bog Bean	seed					3
Polygonum aviculare L.	Common Knotgrass	seed					5
Potentilla intermedia L.	Russian Cinquefoil	seed					1
Ranunculus acris L.	Meadow Buttercup	seed					4
Ranunculus bulbosus L.	Bulbous Buttercup	seed					19
Ranunculus repens L.	Creeping Buttercup	seed					1
Rumex crispus L.	Curled Dock	seed					2
Stellaria media (L.) Villars	Common chickweed	seed					2
Viola-type	Violet	seed					678
Cenococcum undiff.	Fungus	seed					4
		Total Wild	6	15	28	7	1682
		Total QC	**6**	**15**	**28**	**7**	1720
		Grain (%)	**0**	**0**	**0**	**0**	
		Chaff (%)	**0**	**0**	**0**	**0**	
		Wild Species (%)	**100**	**100**	**100**	**100**	
Other sorted material							
Bone			P	P	P	P	
Marine mollusc (<4mm)							
Eggshell (<4mm)							
Metal object			2F			1F	
Pottery							
Glass							
Stone object							
Carbonised textile							
Bead							