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Wood Utilisation Strategies in Norse Greenland (985-1500 AD)

Lísabet Guðmundsdóttir

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Sverrir Jakobsson
Dean of faculty

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Doctoral Committee:
Orri Vésteinsson, supervisor
Jette Arneborg
Ólafur Eggertsson

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ISBN 978-9935-9700-7-7
ORCID 0000-0002-7171-5535

Abstract

This study investigates wood procurement and utilisation in Greenland during the Norse settlement ca. 985-1500 AD. Greenland was settled by Norse farmers in the late 10th century. They established two settlements: Eystribyggð in southwest Greenland and Vestribyggð 500 km further north on the west coast. Farming was based on animal husbandry subsidised by hunting, which became increasingly significant over time. The settlements were concentrated on the best farmland in the inner fjords, requiring long journeys to obtain a variety of vital resources, one of which was wood. Due to Greenland's northerly latitude and short, cool summers, the native trees are generally low-growing with limited girth. It is therefore unlikely that the local woodland could have met all the wood needs of the Norse settlers, such as house construction, boatbuilding, and building projects that needed more robust timber. They therefore had to obtain much of their wood by other means. The main objective of this study is to establish where the Norse Greenlanders obtained wood from, how it was utilised, and how the different sources were managed over space and time.

The study is based on the analysis of wood assemblages from five Norse sites: one in Vestribyggð, and four in Eystribyggð. While the sites were in use throughout the Norse period, they are not all contemporary; however, the majority of them overlap at some point. Wood anatomical analysis was applied to assign taxonomic identifications. This allows for taxonomic provenancing, in order to determine whether the wood retrieved from archaeological contexts is native, driftwood, or imported.

The results show that driftwood and native woodland were the main wood resources, while import was sporadic and mainly available at high-status sites like the episcopal manor. Wood was procured from the North American mainland throughout the Norse period for elite consumption while lower status households do not seem to have had access to this resource.
The study supports the view that the Norse settlers in Greenland were self-sufficient and did not rely on the import of basic necessities. At the same time, however, it highlights the costs involved in maintaining that self-sufficiency. There are indications that the society was highly centralised and that these resources were controlled by a small number of high-status sites, like the episcopal manor.

Ágrip

Markmið þessarar rannsóknar er að rannsaka hvernig norrænir menn á Grænlandi öfluðu trjáviðar og nýttu hann á tímabilinu 985-1500 e. Kr. Grænland var numið af norrænu fólki á seinni hluta 10. aldar. Byggðarlögin voru tvö: Eystribyggð á suðurvestur Grænlandi og Vestribyggð um 500 km norðar. Hinir norrænu Grænlendingar voru bændur sem reiddi sig einnig á veiðar sem urðu æ mikilvægari fyrir afkomuna eftir því sem á leið. Byggðin var dreifð og þurfti fólk að ferðast langar vegalengdir á milli bæja sem og til þess að nálgast náttúrulegar auðlindir hvort sem það var vegna verslunar og viðskipta eða til eigin nota.

Vegna hnattstöðu Grænlands, er veðurfar almennt kalt og sumur stutt. Þar af leiðandi eru tré almennt lítil og kræklótt þó undantekningar séu þar á. Því er ólíklegt að innlendur efniviður hafi dugað til allra þarfa, til að mynda við bátasmíðar og stærri byggingarframkvæmdir. Því hafa Grænlendingar þurft að leita annarra leiða til þess að afla viða. Meginmarkmið verkefnisins er að kanna hvaðan Grænlendingar öfluðu viða, hvernig var hann nýttur og hvort það urðu breytingar þar á í tíma og rúmi.

Verkefnið byggir á greiningu viðarsafna frá fimm norrænum býlum, einu í Vestribyggð og fjórum í Eystribyggð. Tímabilið sem um ræðir er frá landnámi til endaloka norrænu byggðanna. Hver staður fyrir sig var þó ekki í notkun á öllu tímabilinu en flestir voru þeir samtíða á einhverjum hluta þess.

Til þess að varpa ljósi á uppruna viðarins voru söfnin greind til ættkvísla og, þegar hægt var, til tegunda. Þannig er hægt að túlka hvort viðurinn sé innlendur, reki eða innfluttur.

Niðurstöður rannsóknarinnar benda til þess að Grænlendingar hafi aðallega notað rekavið og innlendan efnivið. Innflutningur var slitróttur og nánast eingöngu í boði fyrir þá sem voru hátt settir í samfélaginu eins og á biskupsstólnum á Görðum. Innflutningur á timbri frá Norður Ameríku var merkjanlegur á norræna tímabilinu en eingöngu á biskupstólnum. Venjuleg heimili reiddu sig nánast eingöngu á innlent timbur og viðarreka. Norrænir menn voru sjálfbærir hvað varðar timburöflun en hins vegar var timburöflunin kostnaðarsöm hvað varðar tíma og mannskap.

Engar vísbendingar eru um að á Grænlandi hafi verið viðarskortur og aðgengi að timbri virðist hafa verið stöðugt allan tímann sem byggðin varði. Vísbendingar eru um að mikil miðstýring hafi verið í hinu grænlenska samfélagi og að örfá höfuðból eins og biskupsstóllinn hafi setið ein að þeim timburinnflutningisem þó viðgekkst.

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I am particularly grateful to my *Stick and Stone* partners, Guðrún Alda Gísladóttir and Sólveig Guðmundsdóttir Beck, who were invaluable support throughout this project and wells of knowledge.

The wood analysis part of the project took place in Greenland, Iceland, Norway and Denmark. I´m incredibly grateful to everyone at the visiting institution, where I was warmly welcomed. In Iceland the work took place at the Institute of Archaeology, Iceland, and I would like to thank all my friends at the Institute for giving me the time and space for the study. At the National Museum in Greenland, I especially want to thank Christian Koch Madsen, Michael Nielsen and Kirstine Møller for good conversation and assistance. In Denmark, the analyses took place at the National Museum of Denmark, the Department of Environmental Archaeology and Material Science. I´m particularly thankful to Claudia Baittinger and Peter Rasmussen, who were very helpful and provided me with facilities for the wood analyses. The wood assemblage from Borgund was identified at the Bryggen Museum in Bergen. I particularly want to thank Gitte Hansen for giving me access to the wood assemblage and all the assistance throughout the process., I also want to thank my colleagues in the Borgund Kaupang project.

Furthermore, I want to thank the people who led the excavation project, from where the more recent woodassemblages come from. Thank you for allowing me access to the material and helpful discussion about the sites and stratigraphy. First of all, Konrad Smiarowski, who led the excavations in Tatsip Ataa and Tasilikulooq, Orri Vésteinsson, who led the excavation in Igaliku, Jette Arneborg and Guðmundur Ólafsson who were part of the team leading the excavation in Gården under sandet (GUS)

I also want to think everyone who assisted me through the writing process, especially Dawn Mooney, Jack Threfall, Grace Cecario and Kathrin Catlyn, whose helpful comments improved the articles, Gwendolyne Knight for proofreading the thesis and finally, Bergsveinn Birgisson for getting me through the last part of this process (nightmare).

Furthermore, I want to thank my fellow North Atlantic wood crew, Dawn Mooney and Elie Pinta, with whom I have had endless conversations about wood resources in the North Atlantic. Lastly, I want to thank my family, Sigvaldi Jónsson, and my kids, Hilmar Búi Sigvaldason and Auður Sigvaldadóttir, who have been incredibly positive, supportive, and patient throughout the whole process.

Life in the North Atlantic can be unpredictable due to various natural factors. During this research project alone, there has been one global pandemic, four volcanic eruptions, countless earthquakes and multiple storms. All of which made this project challenging to finish within the correct time frame. In modern times, we are informed about natural disasters and have the infrastructure to deal with the consequences. It makes me think about the people living here in the past who had to deal with the same elements and natural disasters we do today but under very different circumstances. Still, they prevailed and adapted to these unpredictable circumstances. They could probably teach us a few lessons in resilience and more sustainable utilisation of local resources. The Norse in the North Atlantic had their own material culture, everyday, practical items along with more personal things. These objects and other fragments ended up being left behind or thrown out over time. By doing so, leaving a little window into the past for us to peek through. Allowing us the opportunity to shed light on daily life of the Norse in the North Atlantic. For that, I am thankful.

Content

List of Figures

List of Tables

1 Introduction

Wood is a basic raw material that almost all past societies have needed in order to function. Greenland was settled by Norse farmers in the late 10th century, and they had the same needs for structural timber for house- and boat-building, as well as for tools and utensils, as other Norse societies. The Greenlandic flora is limited by its northerly latitude and harsh climate (Born & Böcher, 2001). This is particularly evident in the limited range of woody taxa, many of which are low-growing shrubs. In general, it is thought that the native tree flora could not have met all the timber needs of the Norse. This resource, therefore, had to be subsidised by other means, such as driftwood or the import of wood. Although it is generally accepted that driftwood was utilised, it is commonly argued that the Norse in Greenland could not have survived without imported wood (Gad, 1970, p. 56; Nansen, 1911, p. 232-233; Nedkvitne, 2019, p. 169; Nørlund, 1929, p. 1; Roesdahl, 1995, p. 33; Seaver, 1996, p. 28, 49). This view finds support in the 13th century Norwegian courtier's manual, *Konungs skuggsjá* (*King's mirror*), which claims that the Greenlanders had to rely on imported wood for their timber needs:

> "*Everything that is needed to improve the land must be purchased abroad, both iron and all the timber used in building houses*" (Larson, 1917, p. 142)

Scholarly assessments differ regarding the availability of wood resources in Norse Greenland; to those that feel it was characterised by scarcity, this has been cited as a factor in the disappearance of the Norse (Diamond, 2005, p. 248-249). There has not, however, been any firm data to base such assessments on.

Excavations of Norse ruins in Greenland have produced several large wood collections, and in recent years this material group has received growing interest. However, these studies are focused on particular artefact groups or sites, such as boat parts, vessels, and charcoal horizons (Andersen & Malmros, 1993; Bishop, et al. 2012; Mooney, Pinta, & Guðmundsdóttir, 2022; Pinta, 2018; Pinta, et al. 2021). Even though these studies give indications about where the Norse acquired their timber from, so far there have been no comprehensive analyses of complete wood assemblages in order to establish a firm baseline for the availability and acquisition of this key raw material in Norse Greenland.

1.1 Research aims and questions

The project *Sticks and stones. Raw material use in Norse Greenland* aims to establish an evidence-based understanding of resource availability, wood procurement strategies, and wood utilisation practices in Norse Greenland. Through taxonomic provenancing, it is possible to estimate whether the wood retrieved from archaeological contexts is native, driftwood or imported. This method is not without its complications. It is, however, relatively easily applied in Arctic environments where native tree species are few.

For this study, five Norse Greenlandic wood assemblages from archaeological investigations were used: four from Eystribyggð, and one from Vestribyggð. In Eystribyggð the sites are*: Garðar/Igaliku (Ø47)*; the bishopric, *Tatsip Ataa Killeq (Ø172)*; *Tasilikulooq (Ø171)*; and *Narsaq (Ø17)*. The Vestribyggð site is *Gården under Sandet (GUS)*. These five sites are from different periods and of different statuses (*Fig 1*).

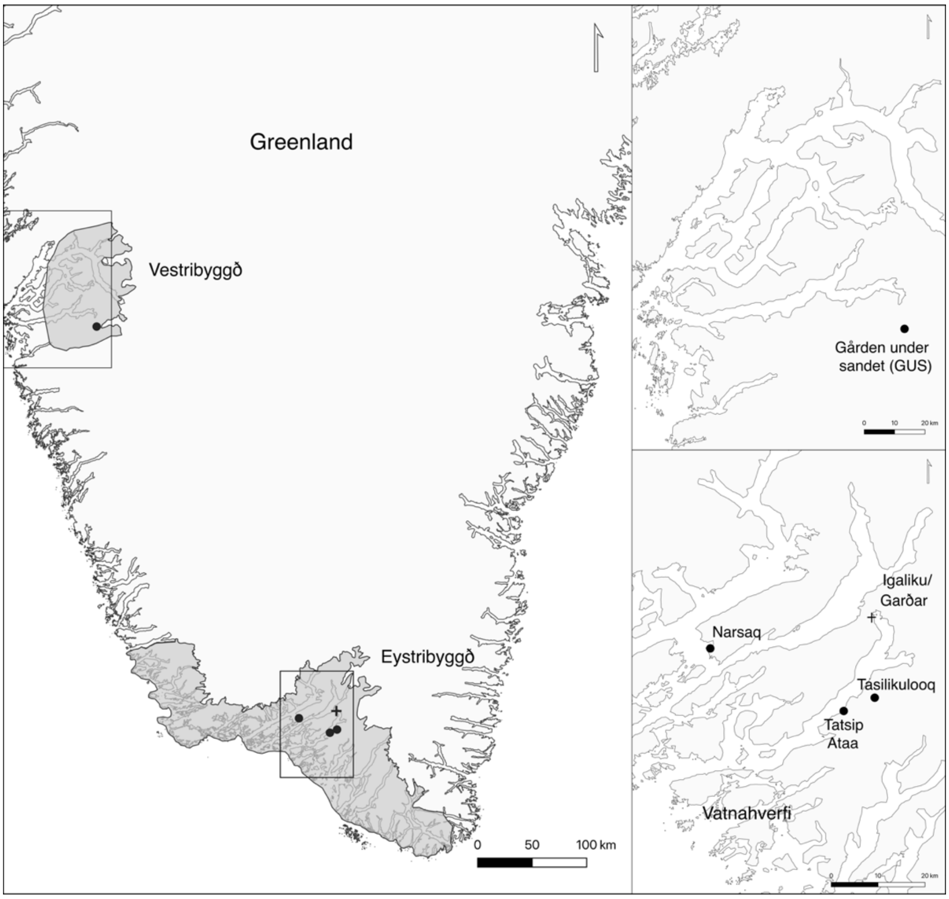


Figure 1 Location of the Norse Greenlandic sites used in this study.

Furthermore, to put the Greenlandic material in a wider perspective, the results are compared to contemporaneous assemblages from Reykjavík, Iceland, and Borgund, western Norway. The assemblages consist of wooden artefacts and samples, including branches, offcuts, shavings, and various sticks and planks. The dataset consists of 2071 artefacts and 6481 non-artefactual pieces, for a total of 8552 pieces. Not included in these numbers are 200 artefacts identified from Borgund, as well as 721 pieces from Reykjavík.

The four articles presented in this thesis address the following overarching questions: Where did the Norse procure timber from? Was it found locally (typically 0-10 km from a farm), regionally (typically 11-500 km from a farm), or did it have to be imported from outside the settlement areas, either from other parts of Greenland, from Europe or perhaps even from across the Davis Strait? These categories relate to distance, and therefore transport time and effort, but their significance is also derived from the social dimensions involved. Locally available raw material would have been directly accessible, often within properties or defined by traditional use-rights. It would have been accessible when the household needed it and at a relatively low cost, in terms of both physical effort and social interaction. Acquisition of regionally available raw materials would have required collaboration, co-ordination, and communal relations, including regulation of the use of commons, and such endeavours may have been combined with long-range hunting expeditions involving a variety of social relationships. Acquisition of imported raw materials required negotiations with foreign merchants and possibly non-Norse peoples. These social dimensions need to be weighed in when assessing the costs of acquiring raw materials. These main questions and sub-questions presented in the four articles (see section 1.4) are:

1. Where did the wood used by the Norse Greenlanders originate? Is there a socio-economic difference with regard to wood procurement strategies between the Norse sites? Does the wood procurement of the Norse differ from other cultural groups in Greenland and the Smith Sound?

2. Was scarcity of local woodland a limitation for the Norse Greenlandic economy? Did the local woodland become depleted as time went by, thus contributing to deteriorating conditions? How was the native woodland utilised?

3. Was there sufficient driftwood to meet the timber demands of the Norse? If not, did they have to supplement it by other means? Or was the supplementary wood only necessary for specific purposes, like for boatbuilding? Did all the farmsteads have equal access to this resource? Where did the Norse acquire their driftwood from, and at what cost?

4. How significant was imported wood for the Norse Greenlandic society, and where was the wood imported from? How was imported wood distributed between the farms and settlements?

The four articles focus on three categories of wood resources available in Greenland: native woodland, driftwood, and imported wood. Furthermore, they show how each category was an important source of raw material. The native woodland was utilised for a variety of purposes that are often overlooked, like insulation, bedding, fodder, food, and medicinal purposes. Driftwood was utilised for more robust constructions like houses, boats, and various household necessities, while the utilisation of imported wood is more ambiguous. By analysing large wood assemblages from multiple sites, a more nuanced picture of wood utilisation and procurement strategies comes to light. The acquisition of resources like driftwood, which in most cases had to be obtained from areas far from the farmsteads, also throws light on social relationships. Its procurement required collaboration and co-ordination. Most likely it was part of the same system that was used for hunting, whether for basic subsistence, like seal hunting, or for commercial products like walrus hunting in remote resource regions such as the Norðurseta.

1.1 Thesis Outline

The results of this research have been published in four peer-reviewed journal articles, which are reproduced here in Chapter 8.

Chapter 1. Introduction.

Chapter 1 presents an introduction to the research project, followed by the aims and main research questions. This chapter also presents the thesis outline and, lastly, the list of articles and their main aims.

Chapter 2. Historical background.

This chapter gives a brief history of the Norse settlement in Greenland.

Chapter 3. State of research.

This chapter presents the state of research of wood utilisation in Greenland, the Arctic, and the North Atlantic. It also reviews research on the Greenlandic environment and its natural flora, as well as debates regarding the environmental impact of the Norse settlement.

Chapter 4. Wood utilisation strategies in the historical sources

This chapter discusses evidence of wood utilisation and acquisition in medieval and post-medieval historical sources.

Chapter 5. Materials and methods

This chapter presents the methodology used for identifying wood taxa. The anatomical features of softwoods and hardwoods are presented, as well as how this method is used to provenance to wood assemblages.

Chapter 6. Results

This chapter presents the results of the study. Implications of the wood anatomical analyses are discussed for each of the five sites. The results are also discussed in a wider perspective and compared to contemporaneous assemblages from Iceland and Norway.

Chapter 7. Conclusion.

This chapter presents the results of the thesis and summarises the main findings.

Chapter 8. Articles

This chapter contains the published articles of the thesis.

Chapter 9. Bibliography

Appendix I

Results of the wood taxa and typological analysis.

1.2 List of articles

Article 1 – Wood utilisation in Norse Greenland (11th-15th century AD)

This paper was published in 2021 in *Journal of Archaeological Science*. It presents a baseline for assessing the availability of wood resources in Norse Greenland. It establishes the background upon which the other three articles build. It addresses the problem of distinguishing between wood taxa that can be either drifted or imported by comparing the results from the Norse sites to other cultural groups in Greenland and the Smith Sound.

Lísabet Guðmundsdóttir (2021). Wood utilisation in Norse Greenland (11th – 15th century AD). *Journal of Archaeological Science*. Vol 134. https://doi.org/10.1016/j.jas.2021.105469

Article 2 - The utilization of native woodland in Norse Greenland

This paper was published in 2022 in *Environmental Archaeology* and focuses on the utilisation of the native woodland. The research data consist of artefact assemblages from the five sites and collections of small twigs and branches from Tatsip Ataa and Igaliku. Due to excellent preservation and extensive sampling strategies at these sites, it was possible to examine wood utilisation practices from a new perspective. This paper also discusses whether lack of woodland was a factor in the disappearance of the Norse settlements.

Lísabet Guðmundsdóttir (2022). The Utilization of Native Woodland in Norse Greenland. *Environmental Archaeology*. DOI: 10.1080/14614103.2022.2031839

Article 3 - Driftwood utilization and procurement in Norse Greenland

This paper is in press in the journal *Acta Borealia*. The analysis of the non-native conifer taxa identified in this research shows that driftwood was one of the main sources of timber in Greenland. The article deals with driftwood procurement strategies and the distribution of this resource between farms. The Norse settlements are dispersed and mainly placed in the inner fjords, where hardly any driftwood arrives. The Norse Greenlanders had to travel further afield to acquire this resource which required time and human resources as well as transport. The paper assesses where the driftwood-rich areas were most likely to have been, and how that compares with the written sources, which predominantly identify Norðurseta as the main driftwood source area.

Lísabet Guðmundsdóttir (2022). Driftwood utilization and procurement in Norse Greenland. *Acta Borealia*, 39:2, 138-167. DOI: 10.1080/08003831.2022.2131089

Article 4 - Timber imports to Norse Greenland: lifeline or luxury?

The fourth paper is in press in the journal *Antiquity*. Its aim is to shed light on the import of timber to Greenland and its significance for Norse Greenlandic society. Indications for both European and North American origins of imports are presented. The sites are compared in order to establish if there was equal access to imports or if it was mainly associated with high social status.

Lísabet Guðmundsdóttir (2023). Timber imports to Norse Greenland: lifeline or luxury? *Antiquity,* 97:392, 454–471. DOI: https://doi.org/10.15184/aqy.2023.13

2 Historical background

The settlement of Greenland represents the final stage of a major colonisation event during the Viking Age. The Norse settlements in Orkney and Shetland can be dated to the 9th century (Graham-Campbell & Batey, 1998). The Norse settlement of the Faroes took place in the early 9th century (Arge, 2014; Dugmore et al. 2005), or as early as the 6th century, although this was not part of the same colonisation episode (Church et al. 2013; Curtin et al. 2021), followed by that of Iceland in ca. 870 AD (Schmid, et al. 2017; Vésteinsson, 2013; Vésteinsson & McGovern, 2012). According to *Íslendingabók* (*The Book of Icelanders*), Greenland was settled 14 or 15 years before Christianity was accepted in Iceland, or in 984/985 AD, and the settlement was organised from Iceland (ÍF I, 1968, p. 14; Arneborg, 2004). This date is consistent with archaeological dates, which place the start of the colonisation in the late 10th century (Arneborg, Lynnerup, & Heinemeier, 2012; Arneborg & Price, 2014; Edwards, et al. 2013; Madsen, 2014). Two main colonies were established: Eystribyggð in southwest Greenland, in the present-day municipality of Kujalleq, and Vestribyggð in the inner fjords east of Nuuk. For still-unknown reasons, these settlements were eventually abandoned:

Vestribyggð around 1350 AD and Eystribyggð around 1450 AD (Arneborg et al. 2012; Barlow et al. 1997). The combined population of the two settlements at their height is thought to have been around 2500-3000 (Lynnerup, 1998; Madsen, 2014). The farms were few and dispersed, located in the mid- and inner fjord regions along the coast, and along rivers and lakes in areas suitable for animal husbandry (Arneborg & Price, 2014).

The Norse society was sedentary with an economy largely based on animal husbandry, supported by hunting. The Norse farmers imported assemblage of domestic anmials cattle, sheep, goats, pigs, horses, dogs, and cats. In general, more cattle can be found on larger farms furthermore, they seem to retain large numbers of cattle throughout majority of the settlement period. While smaller farms relied more on caprines as well as marine resources (Smiarowski et al. 2017; 2022). Marine fishing was immediately replaced by seal hunting, both non-migratory harbor seal and migratory harp and hooded seals (Smiarwoski, 2022). Which became an increasingly important component of the Norse Greenlanders' diet (Arneborg, et al. 1999; Arneborg et al. 2012; Dugmore, Keller, & McGovern, 2007; Ogilvie et al. 2009; Perdikaris & McGovern, 2008; Smiarowski et al. 2017). Marine resources also supplied the settlements' main exports. Both archaeological as well as textual sources show that walrus ivory was one of the main export products (Barrett et al. 2020; Frei et al. 2015; Halldórsson, 1978; Keller, 2010; Larson, 1917; Nedkvitne, 2019; Roesdahl, 1995; Seaver, 1996; Smiarowski et al. 2017; Star, et al. 2018). While it is difficult to find archaeological evidence of goods such as walrus rope, furs, falcons and even polar bears, these are mentioned as important export commodities in historical sources such as *Grœnlendinga þáttur* (Halldórsson, 1978, p. 115), *The King's Mirror* (Larson, 1917, p. 142) and *Króka-Refs saga* (ÍF XIV, 1959, p. 157). Walrus bones are found in both settlements, although in greater concentration in Vestribyggð, especially at the chieftain's farm, Sandnes (V51) (McGovern et al. 1996; Perdikaris & McGovern, 2008). Zooarchaeological data show that only the heads of the walrus were transported back from the hunting grounds, as walrus bone finds are made up almost entirely of fragments of the maxilla (Perdikaris & McGovern, 2008). Furthermore, there are indications, such as paleogenetic and stable isotope research, that walrus was over-exploited. However, there is no indication that hunting was reduced or ceased after ca. 1300 as might have been expected due to climate change (Frei, et al. 2015; Barrett et al. 2019; Smiarowski, 2022). The walrus could have been hunted in the vicinity of Vestribyggð (McGovern et al. 1996), in the Nuuk fjord (Enghoff, 2003). Based on historical records walrus is thought to have been mainly hunted in the northern hunting ground, Norðurseta (Located in the Disko Bay area), and around present day Sisimiut, where there is archaeological evidence of Norse presence (Arneborg, 1998;

Ljungqvist, 2005; Madsen, 2019). Hunters may even have ventured as far north as the Smith Sound, where Norse artefacts have been found in Thule Inuit contexts (Arneborg, 2003; Gulløw, 2008). It has been proposed by Barrett et al. (2019) that due to overexploitation of the walrus colony in Norðurseta the Norse Greenlanders were forced to to travel increasingly longer distances to meet the European demand for ivory (Barrett et al. 2019).

Historical sources also mention the eastern hunting grounds, including the site of Finnsbúðir, the location of which is unknown, but is understood to be somewhere on the east coast of Greenland (Halldórsson, 1978, p. 134). Norðurseta is the one location that is mentioned in the historical sources in regard to driftwood procurement. It has been argued that hunting was a communal effort (Dugmore, Keller, et al. 2007; McGovern, 1991), most likely organised by high-status farmers, as stated in *Grœnlands Annál*, a 17th century source most likely compiled by Björn in Skarðsá (Halldórsson, 1978). This 17th century compilation, drawing on earlier sources, claims that wealthy farmers in Greenland had large ships and vessels built to send crews to the northern hunting grounds to pursue all kinds of hunting and procure hewn timbers (Halldórsson, 1978, p. 55). This is further indicated in Ívar Bárðarson's 14th century description of Greenland, the oldest surviving manuscript of which is from the 17th century (Halldórsson, 1978, p. 407). Here it is stated several times that wild resources and vast tracts of land were owned by the cathedral or churches and permission was needed if these resources were to be used (Halldórsson, 1978, p. 407). At that time the whole of Einarsfjörður belonged to the church, along with a number of islands lying at the entrance of both Einarsfjörður and Eiríksfjörður, as well as hunting grounds on the east coast (*Fig 2*) (Halldórsson, 1978, p. 134-137).

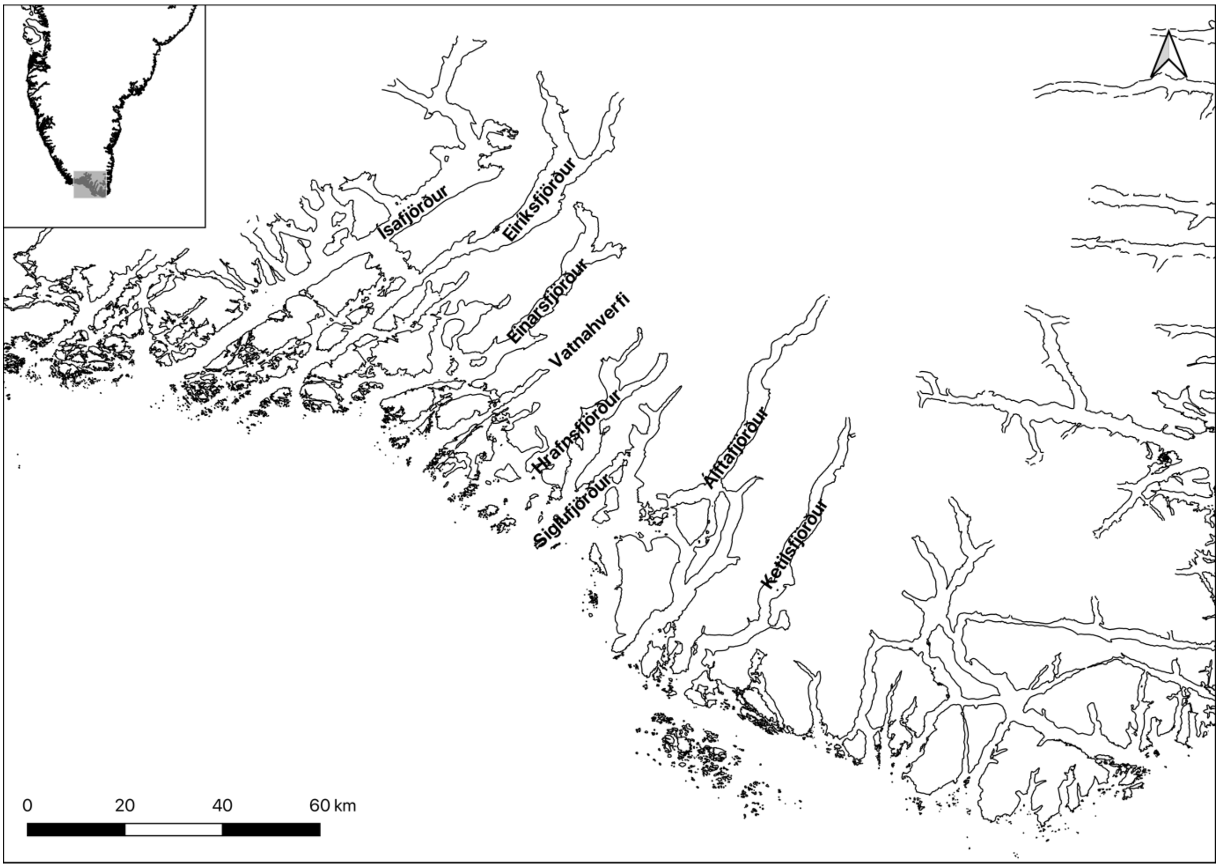


Figure 2. The Norse fjord names in Eystribyggð. Modified from (Vésteinsson 2010).

This indicates a centralised society where large landowners and religious institutions controlled the resource base as well as internal and external trade networks (Arneborg, 2015). It has been argued that with deteriorating climatic conditions and more sporadic contact with Europe the Norse Greenlandic society became increasingly centralised with fewer (but larger) manor farms (Madsen, 2014; Vésteinsson, 2010). These larger farms and the smaller ones were co-dependent with regard to resource procurement and distribution: while the high-status landowners owned the ships and equipment, they were dependent on the manpower of smaller farmers (Arneborg, 2015). While the research focus has so far been on subsistence strategies like communal hunting (Dugmore et al. 2007; Dugmore et al. 2012; McGovern, 1980; McGovern, Perdikaris, & Tinsley, 2001; Smiarowski et al. 2017), collecting driftwood would have needed the same or comparable infrastructure.

It has been argued that the demand for walrus ivory declined in European markets after the 14th century due to increased availability of elephant ivory (Barrett et al. 2019). Furthermore, written sources indicate that value of walrus ivory declined by the late 13th century (Barrett et al. 2019; Roesdahl, 1995, p. 30), and this caused a stagnation in the Greenlandic economy. This may have contributed to the Norse Greenlanders agreeing to submit to the Norwegian crown in 1261 AD, as the Icelanders did the following year (Arneborg, 2004; Gad, 1964; Krogh, 1967). It is commonly assumed that the agreement involved the king guaranteeing regular shipping from Norway, most likely with necessary commodities (Arneborg, 2004; Madsen, 2014; Seaver, 1996). However, it has been argued that the clause in the Icelandic agreement about the ship arrivals is much younger (Boulhosa, 2005). In a letter from the Danish king Frederik II, from 1568 AD, it is stated that two ships should sail yearly to Greenland. At this time all contact with Greenland had ceased, but perhaps this statement relates to a clause in the old agreement known to Frederik. However, it is unknown what this clause may have entailed (Gad, 1964, p. 262; *Grönlands Historiske Mindesmærker*, 1845, p. 202).

Whatever the actual agreement was, ships from Norway seem to have been infrequent, and sometimes there were years between trips (Gad, 1964; Magerøy, 1993). During the mid-14th century, the bubonic plague (Black Death) reached Norway (Benedictow, 2021, p. 406; Karlsson & Kjartansson, 1994). This must have led to even fewer ships sailing between Norway and Greenland (Keller, 2010; Þorsteinsson & Grímsdóttir, 1989). Communications that were already sporadic became even more infrequent. The last written source from Greenland is a letter written at Garðar on 19 April, 1409, in which the marriage between Þorsteinn Ólafsson and Sigríður Björnsdóttir is confirmed (Halldórsson, 1978, p. 143). The abandonment of the Norse settlements has been attributed to several factors, such as the scarcity of basic raw materials, subsistence failure and isolation (Diamond, 2005; Seaver, 1996), economic vulnerability and failure to adapt to a cooling climate (Barlow et al. 1997; Dugmore et al. 2005; Dugmore et al. 2007; Dugmore, Keller, McGovern, 2007; Dugmore et al. 2012; McGovern, 1980; McGovern, 1991; Roesdahl, 1995), and competition with Inuit communities (Nedkvitne, 2019). Other studies attribute the settlements' demise to multiple factors (Arneborg, 2003; Hartman et al. 2017; Jackson et al. 2018) and population dynamics (Lynnerup, 2014). The fate of the Norse Greenlanders is still an ongoing research theme, but, ultimately, the population disappears in the 15th century, for still unknown reasons.

3 State of research

3.1 Wood anatomical studies

Systematic anatomical studies on archaeological wood assemblages in the North Atlantic can be traced back to Claus Malmros' work in the Faroes. Malmros used wood taxa analysis to distinguish between native wood, driftwood and imported wood (Malmros, 1994). This approach has been widely adopted and further developed in Iceland (Gestsdóttir et al. 2017; Guðmundsdóttir, 2010, 2011, 2013a, 2020; Kristjánsdóttir, Lazzeri, & Macchioni, 2001; Mehler & Eggertsson, 2006; Mooney, 2014, 2016a, 2016b, 2016c), the Faroes (Christiensen, 2013; Malmros, 1990) and Greenland (Andersen & Malmros, 1993; Bishop et al. 2012; Grønnow, 1996; Guðmundsdóttir, 2021, 2022a; Pinta, 2018; Pinta et al. 2021), and in the High Arctic, but mainly to identify between native and drifted taxa since import of wood was almost none existent before European colonisation (Alix, 2005, 2009a, 2009b, 2012; Alix & Brewster, 2004; Laeyendecker, 1993; Lepofsky, Lyons, & Moss, 2003; Shaw, 2012; Steelandt et al. 2013). These studies show that in all these countries and regions, non-native coniferous wood, or driftwood, was the main source of wood in addition to native woodland. While imported wood is noted in Iceland, the Faroes and Greenland, it plays a far smaller role than drift and native wood.

This research builds on the robust knowledge base that has already been established in the North Atlantic and the Arctic. This is, however, the first time that a complete wooden artefact assemblage, including non-artefactual material from Greenlandic sites, has been comprehensively analysed. Previous studies on Norse Greenlandic wood finds focused on artefact categories like boat parts (Andersen & Malmros, 1993), vessels (Pinta, 2018), or fuel (Bishop et al. 2012; Edvardsson et al. 2007). In total, eight boat parts were identified by Andersen and Malmros. They were retrieved from Narsaq (Eystribyggð) and Sandnes (Vestribyggð); of that total, six of them could be identified as larch, and two as either larch or spruce. They conclude that it is more likely that the items were made from driftwood than from wood from the east coast of North America (Andersen & Malmros, 1993). Elie Pinta conducted a wood anatomical as well as typological study on various types of vessels from Norse Greenland, encompassing 710 artefacts in total. Larch (*Larix* sp.) and spruce (*Picea* sp.) represented 77.3% of the assemblage, and pine (*Pinus* sp.) mostly Scots pine, (*Pinus sylvestris* L.) 11.5%, while 7.8% were identified as juniper and 3.4% deciduous taxa. Thus, the majority of the artefacts were made from raw material which was most likely available in Greenland (Pinta, 2018). The aim of Rosie Bishop and colleagues' study was to assess if a charcoal horizon found at the farm Ø69 was related to vegetation burning. The study demonstrated that the charcoal horizon was most likely the result of a soil improvement strategy. The majority of the taxa identified were deciduous taxa, which are native to Greenland, but Bishop further identified the coniferous taxa pine, larch, and fir (Bishop et al. 2012).

Other studies, such as Laeyendecker's analysis of wood material from Sandnes, offer insights into the utilisation of twigs and branches in Vestribyggð, but were limited to a handful of pieces (Laeyendecker, 1985; Buckland et al. 1994). The wood utilisation strategies of other cultural groups in Greenland have also been studied, most comprehensively from the Saqqaq culture site Qeqertasussuk in Disko Bay dating from 2400-1000 BC. The results show that these people were highly dependent on non-native coniferous taxa that arrived to Greenland as drift (Grønnow, 1996). Although, in the Smith Sound rather than Greenland, a Thule Inuit site on Skraeling Island displays similar wood utilisation strategies as the Saqqaq culture. The Skraeling Island site is contemporary with the Norse presence in southern Greenland and Norse artefacts were found at the site, most likely from a shipwreck (Schledermann, 1980; Alix, 2009a). What these studies show whether conducted in the North Atlantic or the Canadian Arctic and despite great temporal differences as well as cultural ones, is that all these cultural groups relied mostly on locally available material like native woodland and driftwood.

3.2 Wood resources in the North Atlantic

Wood resources in the North Atlantic have three possible origins: native woodland, driftwood or import. The local flora is distinct from the taxa that arrive as drift, so distinguishing between those two categories is fairly simple, although native taxa can be found in modern driftwood assemblages in small proportions (Eggertsson, 1993, 1994; Eggertsson & Layendecker, 1995; Malmros, 1994). Distinguishing between drift and imported wood can be more challenging, as will be discussed in section 3.2.4.

3.2.1 Native woodland flora

Greenland is commonly divided into three vegetation zones: Low Arctic, Middle Arctic, and High Arctic. The separation between High Arctic and the Middle Arctic is based on the distribution patterns of several plant species (*Fig 3*). The boundary between the Low Arctic and the Middle Arctic is defined by the 5°C isotherm for July (Born & Böcher, 2001).

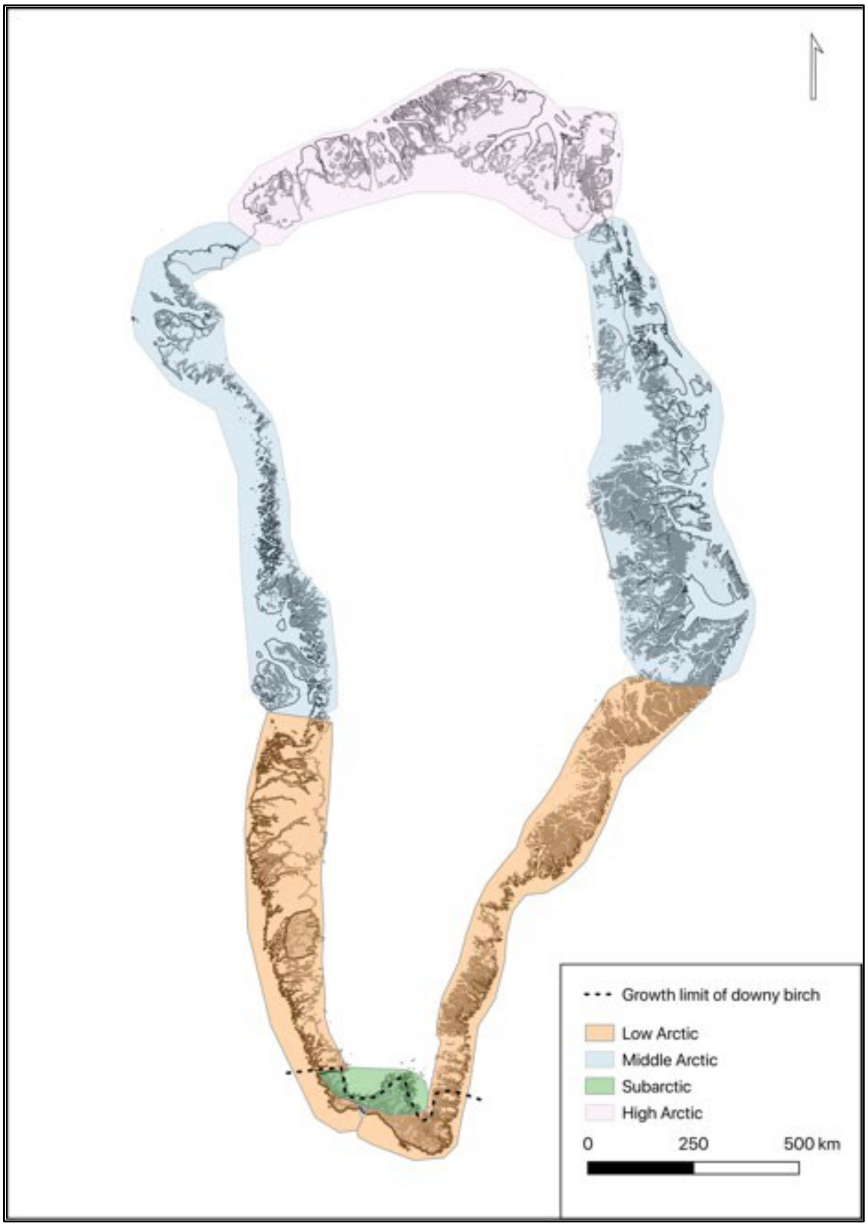


Figure 3. The High Arctic, Middle Arctic and the Low Arctic are defined on this map. (Modified from Born & Böcher, 2000)

Within the Low Arctic zone is a Sub-arctic zone, in which Eystribyggð is located. The Sub-arctic zone is divided into the Hyper-oceanic low arctic zone, Sub-continental sub-arctic zone, and Sub-oceanic sub-arctic zone (Feilberg, 1984) (*Fig 4*).

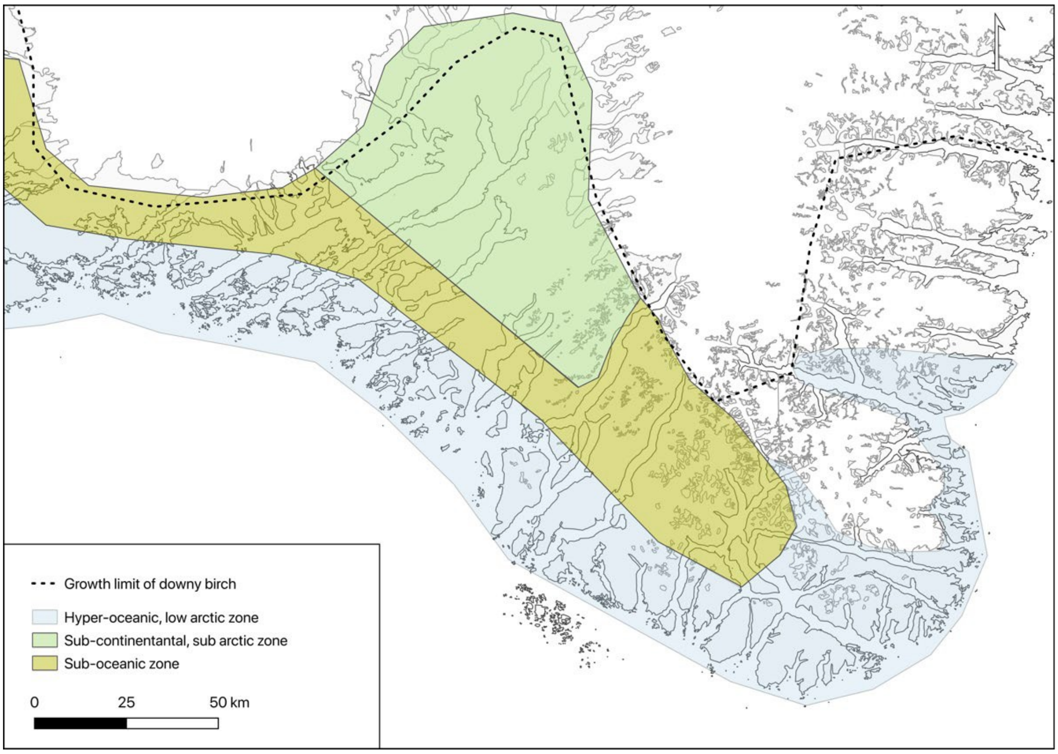


Figure 4. The vegetation belts in the Sub-arctic zone in South Greenland. (Modified from Madsen 2014)

The Hyper-oceanic low arctic zone, encompassing the coastal areas, is generally poor in vegetation, characterised by a rocky coastline with salt marshes and sandy beaches confined to the heads of inlets and fjords (Feilberg, 1984). The vegetation is dominated by dwarf shrub heath like crowberry (*Empetrum nigrum*) and arctic blueberry (*Vaccinium uliginosum*). The middle fjords are in the Sub-oceanic sub-arctic zone, where plants such as angelica (*Angelica archangelica*) and fireweed (*Chamerion angustifolium*) are common, as well as dwarf shrubs and heath plant communities. The inner fjords of central and southwestern Greenland are in the Sub-continental sub-arctic zone. This zone is dominated by dwarf shrubs like glandular birch (*Betula glandulosa*) and grayleaf willow (*Salix glauca*) heath. Downy birch (*Betula pubescens*) is the only forest forming tree in Greenland and is found in sheltered locations within the Sub-continental sub-arctic vegetation zone (Böcher, Holmen, & Jakobsen, 1968). The majority of the Norse farms are situated in the Sub-arctic zone, where there is potential to support low-growing woodland (Born & Böcher, 2001; Dugmore et al. 2005). In Greenland, four native tree species have the potential to reach heights from 2.5 m up to 5 m. These species are green alder (*Alnus viridis* ssp. *crispa*), downy birch (*Betula pubescens*), mountain ash (*Sorbus groenlandica*) and grayleaf willow (*Salix glauca*) (Rune, 2011) (*Fig 5*). Green alder has a modern distribution in Greenland between 61-66°N (Feilberg, 1984), where it forms scrub communities, mostly in association with grayleaf willow. It is rarely found in Eystribyggð, which is further south, and only isolated stands are found in Vatnahverfi (Ledger, Edwards, & Schofield, 2016). The vegetation in Vestribyggð is dominated by dwarf shrub heath, mostly dwarf birch (*Betula nana*), northern willow (*Salix arctophila*), crowberry, and occasionally juniper (*Juniperus communis*). Dense stands of greyleaf willow can reach up to 2 m in height; these stands often also contain green alder (*Alnus viridis* ssp. *crispa*) in damp sheltered areas beside rivers and on the lower valley slopes (Böcher et al. 1968) (*Table 1*).

Figure 5. Native woodland in southwest Greenland. (Photo: Morten Ramstad).

Table 1. Wood and dwarf shrub taxa native to Greenland. (Böcher et al.1968, Jensen 2003, Rune 2011)

Species name	English common name	Distribution in Greenland	Description and habitat	Potential height
Alnus viridis ssp. *crispa*	Green alder	West and south Greenland up until 66°N	Small tree or scrub which grows in wet conditions often close to birch and willow woodland	Up to 2 m
Betula glandulosa	Resin birch	SW and SE Greenland up until 70°N	Small low-lying scrub, similar to dwarf birch. Grows in heaths and mountain areas	Up to 0.5 m
Betula nana	Dwarf birch	Grows from 59°N up to 72°N	Small low-lying scrub, grows in heathland	Up to 0.5 m
Betula pubescens	Downy birch	The inner fjords in SW Greenland up until 65°N	The only forest forming tree in Greenland	Up to 10 m in sheltered valleys in South Greenland
Juniperus communis	Juniper	SW and SE Greenland up until 70°N	Grows in heathland and rocky environment	Up to 0.5 m
Sorbus groenlandica	Mountain ash	The inner fjords in SW Greenland, up to 63°N	Grows in birch woodland but does not form woods.	Up to 3 m
Salix arctica	Arctic willow	Northern W and E coast. From 68°N to 83°N	Small low-lying scrub, grows in heathland and mountain areas	Up to 0.5 m
Salix arctophila	Northern willow	SW Greenland up until 70°N	Small low-lying scrub, grow in moss and shrubland	Up to 0.5 m
Salix glauca	Greyleaf willow	All around the W and E coast from 59°N to 72°N	Small low-lying scrub, grows in heathland and mountain areas	Up to 2 m
Salix herbacea	Dwarf willow	All around the W and E coast from 59 °N up to 78°N	Small low-lying scrub, grows in heathland and mountain areas	Up to 0.5 m
Empetrum nigrum	Crowberry	All around the Greenlandic coast from 59°N to 83°N	Small low-lying scrub, grows in heathland, wetlands and on the coast	Up to 0.25 m
Vaccinium uliginosum	Bog bilberry	All around the Greenlandic coast from 59°N to 83°N	Small low-lying scrub, grows in heathland and wetlands	Up to 0.8 m

3.2.2 The environmental impact of the Norse Greenlandic settlements

The majority of palynological studies have found that there was scattered woodland or scrubland in the Sub-oceanic sub-arctic zone, with denser woodland in the inner fjords and birch forests in sheltered areas (Gauthier et al. 2010; Ledger, 2013; Schofield, Edwards, & Christensen, 2008). It has been suggested that the *landnám* ('land-taking') had a significant effect on the environment, with woodland making way for grassland. The impacts have been viewed as catastrophic for the environment (Fredskild, 1973, 1983, 1992) , and as having caused severe soil erosion (Jacobsen, 1987; Jakobsen, 1991). Recent years have seen a surge in palaeoenvironmental studies in southern Greenland. These studies are focused on the environmental impact of the Norse settlement and have created several high resolution in-depth models of the vegetation history of south Greenland, especially Eystribyggð (Buckland et al. 2008; Dugmore et al. 2007; Dugmore et al. 2005; Edwards et al. 2011; Golding et al. 2011; Ledger, Edwars, & Schofield, 2013, 2014; Ledger et al. 2016; Ledger, 2014, 2015, 2017; Schofield et al. 2008; Schofield & Edward, 2011; Schofield et al. 2013). These studies indicate that there were significant impacts in the vicinity of each farm, whereas there was less impact on the outfields (Bichet et al. 2013; Ledger et al. 2014). There was an increase in soil erosion, which varied between areas, but the available pollen and environmental studies do not indicate that soil erosion was on the scale that could explain the end of the Norse settlements (Bichet et al. 2013; Massa et al. 2012).

Fewer studies have focused on Vestribyggð (Schofield et al. 2019), but they suggest the impact of the Norse settlers in Vestribyggð appears to have been more subtle than in Eystribyggð. This may indicate that farming was less intense, and hunting was of relatively greater significance (Schofield et al. 2019) and may also relate to the more dispersed nature of human settlement.

The majority of the studies suggest that there certainly were environmental changes, with woodland giving way to grassland. Although it varied between areas, woodland clearance appears to have been rapid around the Norse Farm Ø2 (Edwards et al. 2008) and in the region around Lake Igaliku (Gauthier et al. 2010) while in Vatnahverfi the woodland seems to have remained relatively stable (Ledger, 2014). In general the environmental response to *landnám* appears to have been far more subtle in Greenland than, for example, in Iceland, where woodland clearance and soil erosion seems to have been a more rapid and drastic process (Buckland et al. 2008; Buckland et al. 2009; Dugmore et al. 2005; Erlendsson & Edwards, 2010; Gauthier et al. 2010; Golding et al. 2011; Ledger et al. 2013, 2014; Massa et al. 2012; Schofield & Edward, 2011; Schofield et al. 2013; Schofield et al. 2019; Trbojević, 2016). Given the patchiness of the available data this conclusion may change in light of future research.

3.2.3 Driftwood

The driftwood in the North Atlantic originates from the boreal forest zones of Canada, Alaska, Russia and Siberia. The trees enter the river systems, the Mackenzie and the Yukon river systems in North America, and the Pechora, Dvina, Ob, Yenisei, Lena and the Kolyma rivers in Eurasia (Dyke et al. 1997; Eggertsson, 1993, 1994; Eggertsson & Layendecker, 1995; Funder et al. 2011; Hellmann et al. 2013b; Tremblay et al. 1997) in the spring or summer months when the rivers are ice free (*Fig 6*). The summer melt and ice break-up can cause severe floods, leading to river-bank erosion (Häggblom, 1982). Trees in the erosion zone fall into the rivers

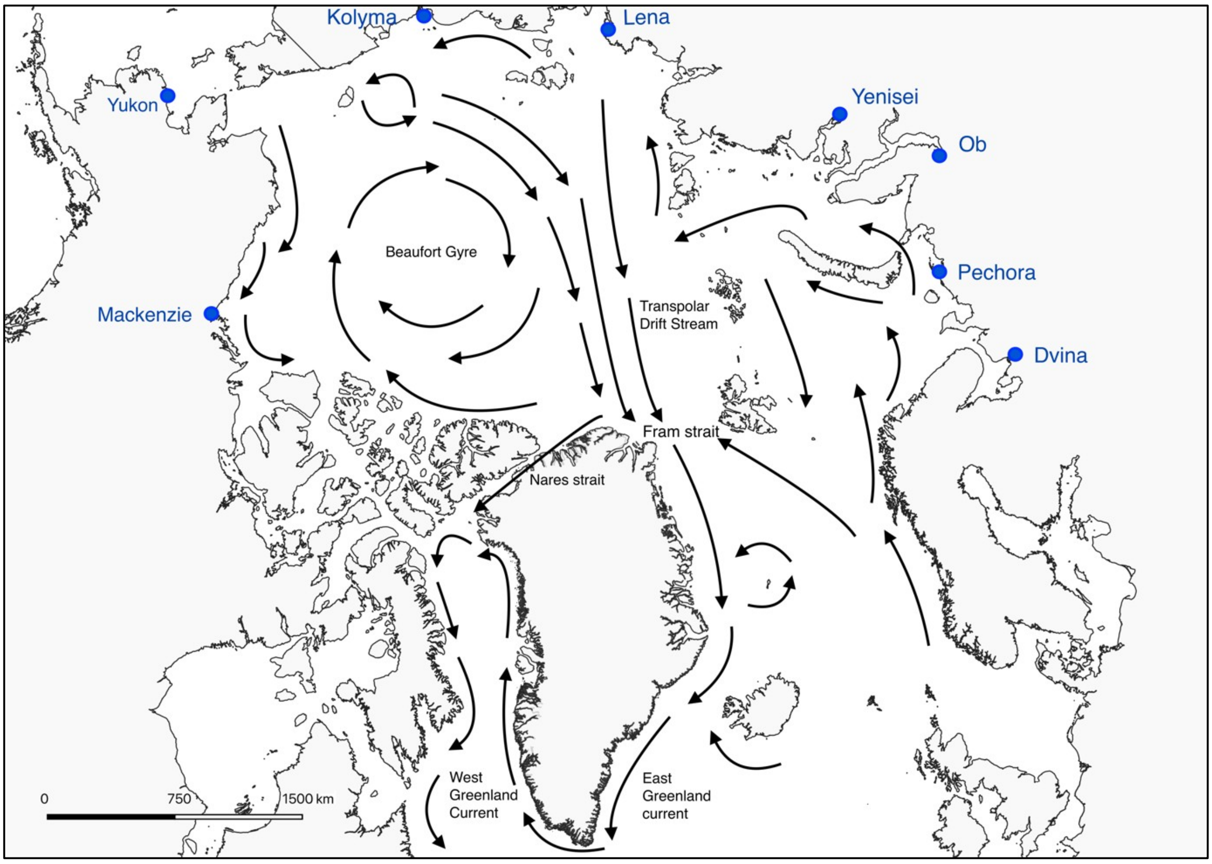


Figure 6 The location of the main river systems as well as driftwood carrying ocean currents (Modified from Hellman 2013).

and are carried by one of the large river systems to the Arctic Ocean (Alix, 2005). When they reach the Arctic Ocean, some of the logs are frozen into the sea ice, while others sink due to their lack of buoyancy. Wood has limited buoyancy (i.e., the ability to float on water), and there are several factors that can influence the buoyancy of wood. One is the size of the log: the larger the log, the longer it can stay afloat. The density of the wood can impact the buoyancy, the denser the wood, the faster it sinks. Removal of the bark impairs buoyancy, while the formation of cracks and the condition of the outer layers of the wood can also be decisive for the length of time the log can float. Furthermore, how long a log can float in the sea depends on the tree taxa (*Table 2*) (Häggblom, 1982). After the logs are embedded in ice, they are transported along the currents from the Arctic Ocean through the Fram Strait to where it reaches the East Greenland current. The East Greenland current carries the ice southwards along the east coast of Greenland. Some of the ice melts around the coast of Iceland, where logs are released and float to the coast, while others are still embedded in ice that is carried by the ocean currents to the southernmost tip of Greenland. From there it is caught by the West Greenland current, which carries the driftwood north along the west coast of Greenland (Eggertsson, 1993; Eggertsson & Layendecker, 1995), where it is released from the ice and deposited on the outer coast. The driftwood is reliant on sea ice to carry it a long way towards its final deposition; the less sea ice, the less driftwood there is. Hence climate change has a huge impact on driftwood delivery to countries in the North Atlantic, with the most recent study suggesting that sea-ice loss will terminate Iceland´s driftwood supply by 2060 CE (Kolář et al. 2022). It would have the same effect on driftwood delivery to Greenland.

Table 2. The maximum buoyancy of some wood taxa (Häggblom 1982).

Type of wood	Maximum buoyancy
Picea abies (Norway spruce)	17 months
Pinus sylvestris L. (Scots pine)	10 months
Larix sibirica (Siberian larch)	9-10 months
Betula sp. (Birch)	6 months
Populus tremula (Aspen)	10 months
Salix sp. (Willow)	6-10 months

With the onset of the Little Ice Age around 1300 AD, proxy data indicate increased sea ice in East Greenland (Dugmore et al. 2007; Kuijpers et al. 1999; Kuijpers et al. 2014; Ogilvie et al. 2009). Increased sea ice has the potential to bring more driftwood to Greenland, a pattern which is also known from Iceland (Matthíasson, 1967). However, the wood needs to break from the ice somehow, either by melt or storms (Guðmundsdóttir, 2022a).

The main taxa that are found in modern driftwood assemblages in Iceland and Greenland are pine (*Pinus sp.)* larch (*Larix sp*.), spruce (*Picea sp*.), and fir (*Abies sp*.) (Eggertsson, 1993; Eggertsson & Layendecker, 1995; Hellmann et al. 2013a, 2013b). In North America, spruce dominates the boreal forest zone west of Hudson Bay. In Eurasia, larch and to lesser extent pine dominate the eastern Siberian forest, while spruce is common in the western parts of Siberia (Eggertsson, 1993; Hellmann et al. 2013b). Dendrochronological research on modern driftwood has shown that the majority of the driftwood in Iceland comes from the Eurasian boreal forests, though there is a small contribution of driftwood from North America in Greenland, mostly spruce (Eggertsson, 1993; Eggertsson & Layendecker, 1995; Funder et al. 2011). Within the archaeological material, the proportions of spruce are higher in Greenland than in Iceland, perhaps due to the influx of driftwood from North America (Guðmundsdóttir, 2021; Pinta, 2018).

Modern driftwood research allows us to deduce which taxa arrived in Greenland as driftwood in the past, although there is potential overlap, which will be discussed in section 3.2.4. Furthermore, the modern driftwood assemblage is biased by logging, which results in far greater volumes of Scots pine entering the driftwood system. Logging and log rafting started around 1840 AD in Russia, with peak intensity between 1880-1940. After World War II, there was extensive logging from the 1950s until the early 1970s, but from then on log floating gradually decreased, until it stopped entirely in 1995 (Hellmann, Kirdyanov & Büntgen, 2016). Hence a large part of the Scots pine in modern driftwood assemblages is the result of modern logging, not of natural processes, as was the case for driftwood in the past. Therefore, it is not possible to use unmodified modern driftwood statistics as a comparison for archaeological assemblages. However, by excluding the logged material, we can gain insights into the proportions of driftwood taxa in the past. Considering only non-logged material from East Greenland and Svalbard, larch makes up 31% of the material, spruce 22.8% and Scots pine 13% (Hellmann et al. 2013b). Furthermore, studies show that Arctic Ocean circulation has been relatively stable in the Holocene (Funder et al. 2011), which supports the idea that these proportions might give an indication of the taxonomic makeup of natural driftwood in the North Atlantic. There are, however, other environmental factors that can influence the quantity and composition of driftwood; therefore, this must be done with caution (Alix, 2005).

3.2.4 Imports

The taxa identified in this study that are imported are oak (*Quercus sp.*), beech (*Fagus sp.*), hemlock (*Tsuga sp.*), and Jack pine (*Pinus banksiana*). As previously mentioned, there is an overlap between drifted and potentially imported taxa. Furthermore, expeditions from Greenland to North America further complicate the matter. Greenlanders potentially had more options regarding wood acquisition than, for example, Icelanders. Classified as potential imports are Pine (*Pinus* sp.), spruce (*Picea* sp.), larch (*Larix* sp.) and fir (*Abies* sp.) (*Table 3*). Within the pine taxa are Scots pine (*Pinus sylvestris* L.), a potential import or drift from

Europe which is not distinguishable from and red pine (*Pinus resinosa*), a potential import from America, white pine (*Pinus strobus*), a potential import from America which cannot be distinguished from Siberian pine (*Pinus sibirica*) which is driftwood. Within the spruce taxa are white spruce (*Picea glauca*) and black spruce (*Picea mariana*) from North America and Norway spruce (*Picea abies*), a potential import and drift from Europe. The North American larch taxa, for example, tamarack (Larix laricina), which could be imported, cannot be distinguished from the European larch (e.g., Larix decidua), which is driftwood. The fir taxa that can potentially be imported from America is balsam fir (*Abies balsmea* L.) and is indistinguishable from the drifted fir (*Table 3*) (Richter et al. 2004; Schweingruber, 1990b).

Table 3. List of wood taxa that are classified as imports or potential imports. The North American taxa in this table grow naturally in Newfoundland and/or Labrador.

Imports	Potential imports from North America	Potential import from Europe
Quercus sp. - Oak sp.	*Picea glauca* - White spruce	*Picea abies* - Norway spruce
Fagus sp. - Beech sp.	*Picea mariana* - Black spruce	*Pinus sylvestris* L. - Scots pine
Tsuga canadensis - Hemlock	*Larix laricina* - Tamarack	
Pinus banksiana - Jack pine	*Abies balsmea* L. - Balsam fir	
	Pinus strobus - White pine	
	Pinus pendirosa - Red pine	

Wood anatomy alone cannot distinguish between import or driftwood. In this study, a comparison is made between Norse sites and sites from other cultural groups to estimate if the taxon is imported or drifted. While a biogeochemical analysis using hydrogen, oxygen, and strontium isotopes could conceivably give more accurate results, they have not been successful so far (Pinta et al. 2021) due to the difficulties of removing the original seawater of seawater-immersed wood (Van Ham Meert et al. 2020). In a Norse Greenlandic context, the timber that could have been imported from Europe are: Scots pine which most likely would have been imported from Norway, oak and beech which could potentially be from both continents. It is estimated, though, that the majority, if not all, of the oak arrived in Greenland as ready-made artefacts, such as a barrel stave in Tatsip Ataa, and that it, therefore, came from Europe (Guðmundsdóttir 2023). That is based on the rarity of the taxon within the assemblage and the artefact collection. Hemlock and Jack pine unambiguously originate from North America (*Fig 7*).

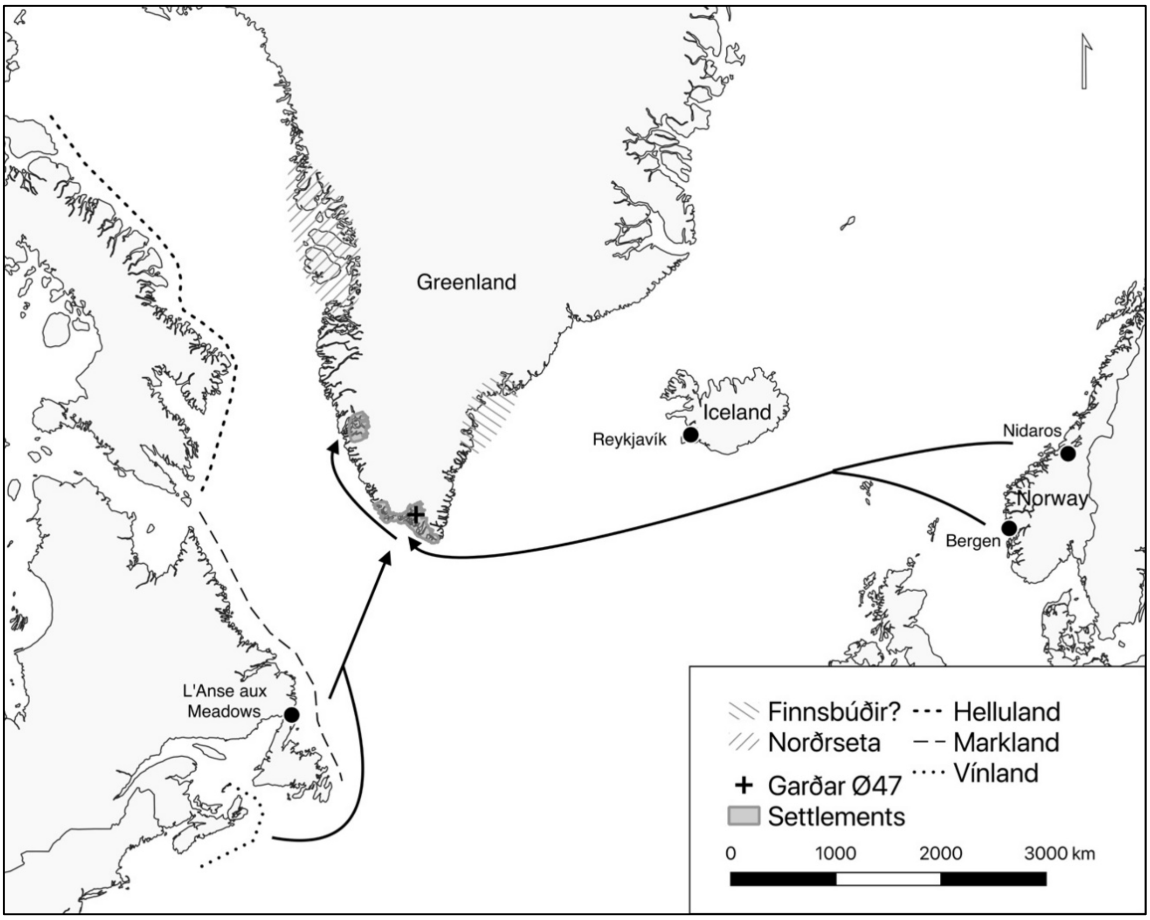


Figure 7. The origin of imports can mostly be associated with Norway with sporadic imports from North America.

Both written and archaeological sources show that Greenlanders journeyed to the east coast of North America. As yet, one Norse site has been discovered in North America: L'Anse aux Meadows in Newfoundland (Ingstad, 1985). It has been argued that the site was an outpost for acquiring resources in Markland and Vínland, amongst them wood (Wallace, 2003, 2005, 2009). A recent study shows that the site was in use until the 12^{th} – 13^{th} century, although material dated from this time might be associated with indigenous activities (Ledger et al. 2019). A wiggle-match study using C^{14} spikes shows that the site was in use at least in 1021 AD. Three wood pieces were used in the study, two identified as fir (*Abies* sp.) and one as either juniper or thuja (*Juniperus* sp./*Thuja* sp.). The authors claim the wood analysed could not be driftwood because the outer layer was preserved (Kuitems et al. 2021). However, the outer layer of wood and bark can be preserved in Arctic driftwood; although it is rare, it is frequent in local driftwood that has travelled short distances (*Fig 8a, b*). At least in the case of the fir, driftwood cannot be excluded, which would extend the time the site was in use, since it can take driftwood several years to reach Newfoundland.

Figure 8 - 8a and 8b driftwood log in Strandir NW, Iceland with bark still attached next to the root system.

Botanical analyses conducted in the 1970s identified wood and nuts from White Walnut (*Juglans cenerea*) at L'Anse aux Meadows (LAM), which does not grow naturally in Newfoundland, suggesting voyages further south (Wallace, 2005). This result is further supported by this study, since Jack pine does not grow in Newfoundland either. It is only found further south, including in present-day New Brunswick (Brouillet et al. 2010) which might have been the location of Vínland.

4 Wood utilisation strategies in the historical sources

Another way of looking at wood utilisation strategies is through historical sources. These sources can be categorised as sagas, with most written 200-300 years after the actual events they depict (Grove, 2009; Halldórsson, 1978), and more contemporary sources like *Grænlendinga þáttur*, *Konungs skuggsjá* and *The description of Greenland* by Ívar Bárðason. The majority of the sources do not, however, originate in Greenland. Most of them were written in Iceland or Norway. Furthermore, they do not represent the views of the Greenlanders themselves but the Icelanders or Norwegians who wrote them (Arneborg, 2001; Grove, 2009). Even so, they add another dimension to the study that is worth considering.

The medieval laws of Iceland and Norway can be examined on the grounds that similar laws must have existed in Greenland, as will other types of documents like charters. Although the material has limitations, it can give some idea about the likely parameters of resource control in Greenland. In an Icelandic context, Mooney (2014) has synthesised the written sources with regard to wood utilisations and concluded that the laws and the beach right inventories are the most useful tools for understanding resource control across Iceland (Mooney, 2014). Such documents have not survived from Greenland, though it is made clear in *Grœnlendinga þáttur* that Greenlandic laws did exist (Halldórsson, 1978, p. 107). Icelandic laws were in many ways similar to the Norwegian ones, although the Icelandic laws are much more detailed regarding woodland and driftwood utilisation; hence, the Greenlandic ones might have been so as well, especially in regard to wood utilisation and procurement.

4.1 Driftwood

There is one contemporary source regarding drift goods in Norse Greenland, which is *The Description of Greenland* by Ívar Bárðason. The phrasing of this text (keeping in mind its problematic transmission) is reminiscent of Icelandic charters (*máldagar*), which list property like drift rights in geographical order (Vésteinsson, 2003). Although this is not a charter, Ívar Bárðason, as a steward of the episcopal see at Garðar, would have been familiar with such documents, and is most likely summarising their contents in his description. The church at Árós owned all land between Herjólfsnes and Pétursvík, including islands, islets and drift (*Fig 9*) (Halldórsson, 1978, p. 134).

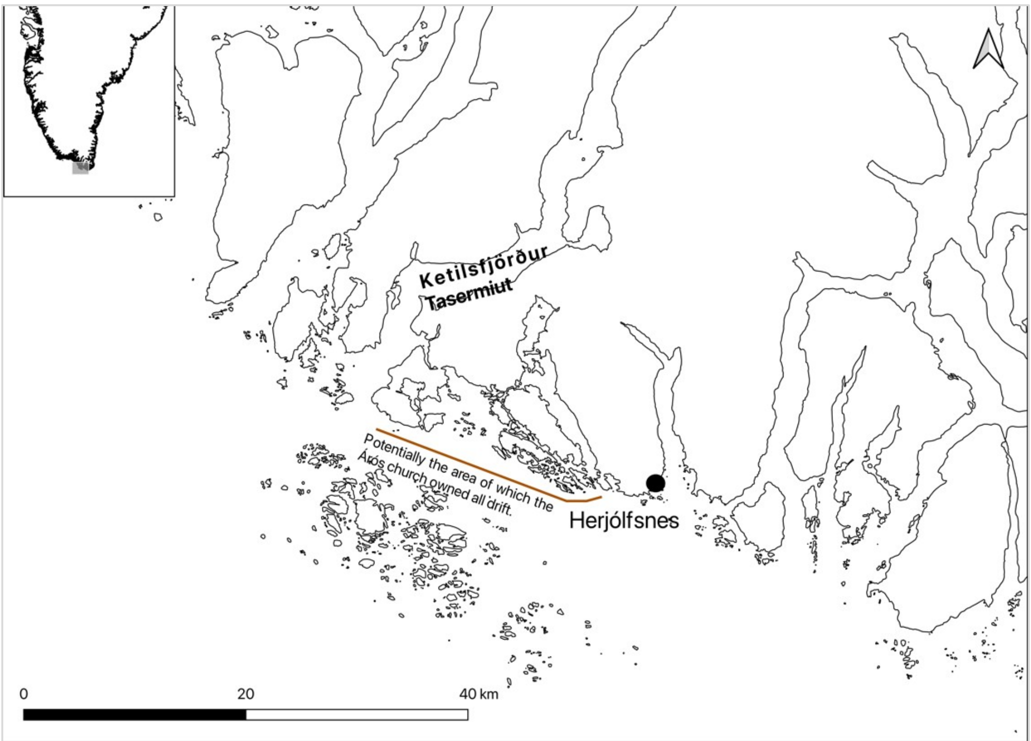


Figure 9. The potential area of which Árós church owned all drift. Árós church was located in Ketilsfjörður, current day Tasermiut.

The drift rights are clearly under the ownership of the church, which is also the landowner. This is elaborated in the Icelandic law codes, Grágás and Jónsbók, which state that each man owns the right to the driftwood that reaches his land, unless the right has been sold, given away, or is owned by others. In Iceland, as in Greenland, ownership by religious institutions was very common (Pálsson, 2018). If the wood is found at sea, who the owner is depends how far from the coastline the wood is encountered (*Grágás*, 1883, p. 385). It further states that the wood should be marked with the owner's mark (*Grágás*, 1883, p. 380). It is reasonable to assume that there were similar regulations in Greenland. The details are liable to have varied between regions and periods but Ívar Bárðarson's description suggests that the basic principle, that outfield resources like driftwood were considered private property, was the same in both countries.

The majority of the Norse farms in Greenland were located in the inner fjords, while the majority of the driftwood was found on the outer coast or even further afield, in Norðurseta (Halldórsson, 1978) or in natural driftwood traps, such as bays and skerries, on the east and west coasts (Grønnow, 1996; Guðmundsdóttir, 2021, 2022a; Rink, 1877). The outer coast consists mostly of rocky areas with little lowland, so there are few areas where wood can reach land. Thus, the acquisition of driftwood was most likely primarily done at sea. The laws must therefore have been adapted to those conditions. There are several sites on the outer coast which have been interpreted as marine shielings, short seasonal dwellings focused on the acquisition of marine resources, which could include driftwood (Madsen, 2019). However, these sites cannot directly or geographically be associated with driftwood beaches. The acquisition of driftwood is most likely linked to the extensive outfield system in Greenland, which the sea was part of (Bertelsen, 2005). This clause in Ívar Bárðason *Description* does indicate that driftwood was not exclusively found in Norðurseta, but it may be significant that it is only in this southernmost extremity of the Eastern settlement that drift is mentioned. The sources that mention Greenland and driftwood acquisition indicate that acquiring driftwood was not a simple task. According *Grænlands annál*, driftwood was collected in Norðurseta, where Greenlanders went annually to hunt:

> "*all high-status farmers had large ships and sailing boats built to send to Norðrseta to procure all kinds of hunting and hewed wood, sometimes they went themselves on these journeys…. The men who travelled to Norðrseta had their own booths or longhouses, both in Greipar and some in Króksfjarðarheiði. There is driftwood in the area, but trees do not grow there naturally. This bay in the North collects trees and other drift material from Marklandsbotnar.*" (Halldórsson, 1978, p. 55).

The driftwood found in Norðurseta (associated with Disko Bay) is according to the annal, thought to have originated in Markland, due to its thick forests (Halldórsson, 1978, p. 24). If the main driftwood resources were in Norðurseta, the people who lived in Eystribyggð had to travel around 1000 km for this basic raw material. Although wood was most likely acquired on these trips, it was not the only potential source area: modern observations demonstrate that driftwood could be found, for example, in the vicinity of present-day Nuuk (Grønnow, 1996) and in south Greenland (Fabricius, 1810; Guðmundsdóttir, 2022a; Rink, 1877).

The question is, who controlled these resources? Again, a hint can be found in *The Description of Greenland*, which clearly indicates that extensive areas were under the control of the episcopal manor and church farms. Even if the areas were *almenningur* (i.e., commons) that everyone was allowed to utilise for grazing or hunting, in order to do so permission was needed from the bishop, and, furthermore, he could potentially claim ownership of everything that was hunted (Halldórsson, 1978, p. 134, 135). *Almenningur* where driftwood could be collected are also known from Iceland, for instance in Hornstrandir in the northwest (Kristjánsson, 1965), and here utilisation was free for all. In Norway, however, according to the Gulaþing law, all drift on common land was owned by the king, but the finder could keep the driftwood he found at sea (Larson, 1935). Norwegian society seems to have been more centralised in this regard (Bratrein, 2009). Wood that had been worked, or *vogrek*, which could be shipwrecks that drifted ashore, could be claimed by the landowner unless someone could prove the ownership of it (*Jónsbók*, 2004), while in Norway the king owned all worked wood that drifted ashore (Larson, 1935). The laws were changed in 1274 so that ownership of drift was shared between the king and the finders: 1/3 went to the finder and 2/3 to the king (*Den nyere Lands-Lov utgiven af Kong Magnus Haakonsön,* 1848). This was most likely done to encourage people to fetch driftwood and report it. There is however, no noticeble change within the Greenlandic wood assemblage. In 1595 the laws were also changed in Iceland: all *vogrek* belonged to the king and crown if not claimed within a year by the owner of the drift rights (Kristjánsson, 1980). As has previously been discussed, there are indications that, like in Norway, the Norse Greenlandic society was extremely centralised. The settlement was small and dispersed, organized around a few centralised farmsteads or manor farms (Arneborg, 2002, 2004; Madsen, 2014; Seaver, 1996; Vésteinsson, 2006). Thus, while the driftwood could be found widely, and potentially in areas which were categorised as *almenningur*, it was still under the control of the bishop. The laws might have resembled the Norwegian ones in that sense.

4.2 Native woodland

The medieval lawcodes regarding forest ownership and utilisation in Iceland during the medieval period are extensive, and utilisation was highly regulated. This was not the case in Norway according to the Frostaþing law and the Gulaþing law. This may indicate how valuable this resource was in Iceland, where woodland was scarcer (Mooney, 2014). Since native woodland in Greenland was also not extensive, it is highly likely that the ownership and use of this resource was regulated there as well. Both Grágás and Jónsbók state that woodland is owned by the landowner and wood should not be utilised without the owner's permission (*Grágás*, 1879; *Jónsbók,* 2004). Woodland was also not necessarily owned by the landowner: as with driftwood, the rights could be sold, paid, or gifted to, for example, religious institutions, churches, and monasteries. Ownership could also be divided between multiple owners. The use of woodland was regulated, and quite severe punishments could be applied if it was misused (*Jónsbók*, 2004). As with driftwood, it is unknown how this system worked in Greenland, but due to the nature of the Greenlandic woodland, which was, at least in some places, not far from the farmsteads, it is not unlikely that the legal framework was similar to the Icelandic system. Woodland could also be found in the outfield or *almenningur,* where the ownership or utilisation rights were in the hands of the bishop or church institutions.

The written sources that mention native woodlands in Greenland are few, and their reliability is questionable. Perhaps the most accurate is the *Description of Greenland*, in which Ívar Barðarson states that on the right side, when sailing towards the cathedral at the head of Einarsfjörður, there is a large forest that belongs to the cathedral, wherein the bishop's livestock grazed (Halldórsson, 1978, p. 135). Although it is not clear where exactly this forest was located, it was most likely in Vatnahverfi, which was, according to palaeoenvironmental studies, green and lush and by Ívar's time, and was even seeing an increase in woodland (Ledger et al. 2014).

There are a few landscape descriptions relating to Greenland in the sagas, but how accurate they are is debatable. The first description can be found in *Íslendingabók* (*Book of Icelanders*). It states that Eiríkur rauði was the first Norse settler there, and named the land Greenland with the aim of attracting more settlers, rather than as an accurate landscape description (ÍF I, 1968, p. 14):

> *„The country called Greenland was discovered and settled from Iceland. A man from Breiðafjǫrðr called Eiríkr the Red went out there from here, and took possession of land in a place that has since been called Eiríksfjǫrðr. He gave a name to the country and called it Greenland, and said that it would encourage people to go there that the country had a good name" (Íslendingabók. The book of the Icelanders,* 2006, p. 7*).*

Grænlendinga þáttur describes the landscape in Einarsfjörður as *hrísótt*, or shrubby (Halldórsson, 1978, p. 114), a generalised description which nevertheless squares well with modern knowledge of vegetation in the inner fjords. Another source is the 14th century saga *Króka Refs saga*, which is perhaps not the most reliable, due to several historical inconsistencies and having been written when the contact was diminishing between Iceland and Greenland (Grove, 2009). It states that the *óbyggðir* or wilderness of Greenland has narrow deep fjords that are forested and have bountiful driftwood (ÍF XIV, 1959, p. 132). There were even speculations in the early 17th century that perhaps Greenland was called *Grenland* ("Spruceland") due to abundant spruce forests in the country (Einarsson, 1971). This is unlikely though: as mentioned above, spruce is not native to Greenland. However, it might have arrived to Greenland as imported timber.

4.3 Import

Almost all the sources discussing the imports of timber to Greenland are found in *Grænlendinga saga*, which focuses on the importation of timber from Markland and Vínland. As previously stated (Section 3.2.4), the only Norse site so far discovered in North America is L'Anse aux Meadows in Newfoundland. This site is thought to have been located in the region the Norse called Markland, while Vínland is thought have been further south, closer to current day New Brunswick. The estimated locations of these regions are based on landscape descriptions, as well as where plants like *vínviðr* or grape vines, which are mentioned in the sagas, grow (Wallace, 2008). According to *Grænlendinga saga*, Leifur Eiríksson, the son of Eiríkur rauði, explored the east coast of North American and felled trees to bring to Greenland. So did Freydís, Leifur's sister, who sailed to Markland, as well as Þorfinnur karlsefni (ÍF IV, 1935, p. 265). However, as previously mentioned in section 4, these sources were written more than 200 years after the events they describe, and care needs to be taken when interpreting them. There are younger sources that state that Greenlanders were still sailing to Markland in the 14th century. In an Icelandic annal from 1347, it is noted that a Greenlandic ship called a *Marklandsfar*, which had sailed to Markland, accidentally drifted to Iceland. It had 18 men on board and was smaller than the *Íslandsför* ships which sailed in the waters around Iceland *(Storm, 1888*, p. 213, 403). Although it is not known how large these ships were, Lúðvík Kristjánsson has argued that majority of the Norse Greenlandic settlement fleet consisted of boats similar to the ten oared fishing ships of Breiðafjörður, west Iceland, which could be manoeuvred in both sheltered waters and open seas. They were smaller than a knörr but easier to manoeuvre and were built in Iceland from local materials (Kristjánsson, 1965). Similar boats could have been built from driftwood in Greenland and used to cross the Davis Strait. The label *Marklandsfar* further indicates that trips to Markland occurred on a regular basis, and one of the main reasons for this could have been to obtain timber. One idea is that journeys to Markland may have become increasingly important for the Norse Greenlanders as communications with Norway dwindled in the latter part of the 14th century (Guðmundsson, 2009). It is therefore possible that the Norse Greenlanders had outposts in North America until the late 14th century. The importance of this resource for Norse Greenlandic society is unknown, but this study indicates that while such trips were indeed being made, the impact on the overall wood procurement strategies was minimal (Guðmundsdóttir, 2021).

There is one indication in the written sources for timber imports most likely coming from Norway. When Leifur Eiríksson was sailing from Vínland with a cargo of vines and wood, he came across a shipwreck. The captain of the wrecked ship was a man called Þórir, who told Leifur that he was a Norseman (*norrænn maður*). In total 15 men were on board, and Leifur brought all of them and part of their cargo safely to Greenland (ÍF IV, 1935, p. 253). Þorvaldur, Leifur's brother, now became very eager to sail to Vínland and explore further. Leifur told his brother that he could use his ship but first he had to fetch the timber that had been on board Þórir's ship, which he did (Hreinsson, 1997; ÍF IV, 1935, p. 254). The cargo was in all likelyhood coming from Norway, although the ethnicity *norrænn* or Norse does not necessarily indicate a Norwegian (Karlsson, 2009). Regardless, the aim of Þorvaldur's voyage is the same: to salvage the timber, which indicates its importance.

One of the most frequently cited sources when it comes to the necessity of timber import in Greenland is *Konungs skuggsjá* (*The King's Mirror*) (Gad, 1970; Guðmundsson, 2009; Halldórsson, 1978; Kopár, 2009; Nedkvitne, 2019; Nørlund, 1972; Roussell, 1941), which is a Norwegian text written in the late 13th century (Halldórsson, 1978, p. 406). It states:

> "*Everything that is needed to improve the land must be purchased abroad, both iron and all timber used in building houses*[1]" (Larson, 1917, p. 142)

[1] Previously mentioned in the Introduction of this thesis.

Konungs skuggsjá is a courtier's manual, where a father advises his son about what is needed to become a successful courtier. This includes knowledge of the world and the art of the merchant, but it is uncertain to what extent the advice can be considered practical, or whether it was primarily intended as preparation for polite conversation at court. With regard to the import of timber, there seems to have been a general perception that Greenland had limited woodland and was a barren land compared to Scandinavia. But just as scholars today do not fully understand wood procurement strategies in the North Atlantic, it may be that the author of *Konungs skuggsjá* did not have a detailed understanding of the conditions in Greenland. He may have been extrapolating from what he knew about timber imports when stating that there was an absolute scarcity of this commodity.

5 Materials and Methods

5.1 Wood anatomy

Modern trees can be identified by various morphological characteristics like the size and shape of the tree, the type of bark, branching, leaves and flowers; wood may also even be identified through other characteristics such as odour and colour. These characteristics rarely survive in archaeological samples, and it is therefore necessary to examine the wood microscopically. Taxonomic identification is achieved by observing a range of anatomical characteristics which vary between species, genera, and families. These characteristics can be viewed in three planes of the wood. The transverse section or cross section cuts across the trunk or branch of the tree, while both radial and tangential longitudinal section run down the axis of the trunk or branch (*Fig 10*).

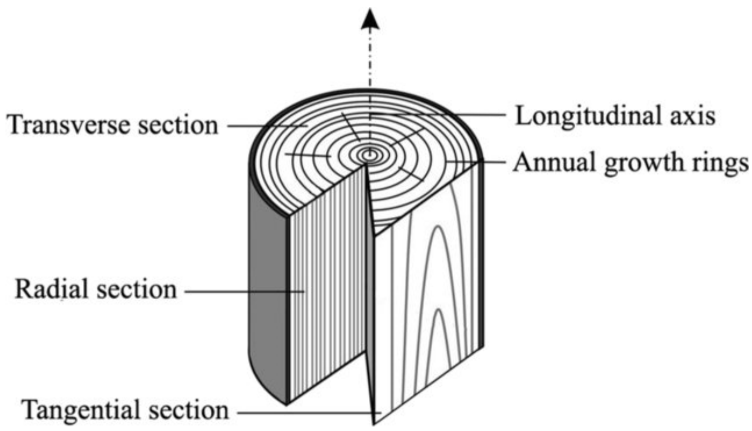


Figure 10 The sections used for wood taxa analysis.

These sections provide different perspectives on features which are morphologically different between families, genera and in some instances species (Hather, 2000). Wood comprises two cell systems: the axial system, which includes cells transporting water up and down the tree, and the radial system, composed of rays that provide support and transport water along the radius of the trunk (Hather, 2000). The following section introduces the main microscopic characteristics of the taxa identified in this study.

5.2 Anatomical Features of coniferous wood (Gymnosperms)

Conifers generally have a relatively simple anatomy compared to deciduous trees. The axial system is made up of cells called tracheids, which are thin tapering cells that have bordered pits that allow water to pass between them. These pits can be in a single row (uniseriate) or two or more seriate and is an identifying feature. Ray composition is another identifying feature. In conifers, two types of rays are distinguished, rays only composed of parenchyma cells and rays composed of parenchyma cells and ray tracheids (Richter et al. 2004, p. 40).
The transversal ray tracheids can have dentate, smooth or reticulate-shaped walls (Hather, 2000; Richter et al. 2004; Schoch et al. 2004). Cross-field pitting in rays in radial sections is another diagnostic feature of coniferous taxa. They are defined by their shape, size, number, and arrangement; for example, large fenestriform (window-like) pits that occupy almost the entire cross-field are a diagnostic feature for the pine genus. Taxodioid pits are smaller than the fenestriform pits, and the pit aperture is larger than the pit border. In cupressoid pits the pit aperture is almost the same size as the pit border, while in piceoid pits the pit aperture is smaller than the pit border. Piceoid pits are an identifying feature of, for example, larch and spruce while cupressoid pits are an identifying feature for juniper (Richter et al. 2004; Schoch et al. 2004). Resin canals are present in some taxa, and they are one of the main diagnostic features for larch, pine, and spruce, in general they are not found in other conifer taxa however, traumatic resin canals can form in other conifer taxa such as fir and hemlock (Richter et al. 2004). The epithelia cells of the resin canals can either be thin- or thick-walled (Hather, 2000). Another identifying features is the transition between early and latewood. The transition can be gradual or abrupt, this character is noted but can be of limited value due to atypical growth conditions (Richter et al. 2004). As with the deciduous trees, multiple anatomical characteristics are used to identify the conifers to genus or species levels. Below is the list of the main anatomical characteristics of the conifers identified in this study.

***Pinus sylvestris* L.**: The transition between early and late wood in this taxon is rather abrupt, it has large resin canals with thin-walled epithelia cells. The axial tracheid pits are usually uniseriate. The ray-tracheid wall is dentated within the taxon and the cross-field pits are large and fenestriform (*Fig 11, 12*). The presence of dentate walls in the ray tracheids and the fenestriform ray pits is the main identifying feature which differ from other *Pinus* species. However, the taxon cannot be distinguished from the native American taxon *Pinus resinosa* (Richter et al. 2004; Schoch et al. 2004; Schweingruber, 1990b).

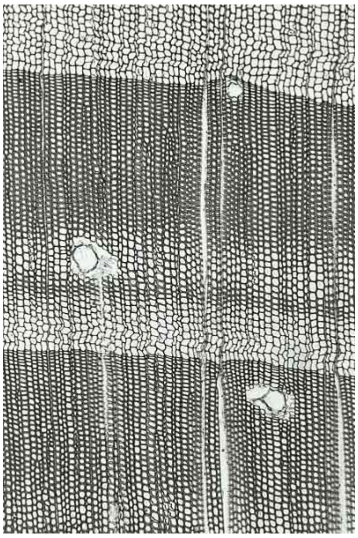


Figure 11. Pinus sylvestris L. Transversal section (Scochs et al. 2004).

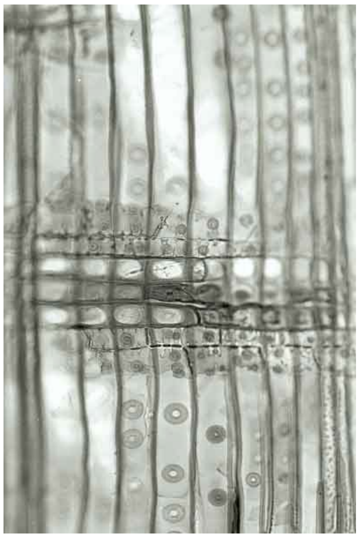


Figure 12 . Pinus sylvestris L Radial section (Scochs et al. 2004).

***Pinus sibirica/Pinus cembra/ Pinus strobus*:** The transition between early and late wood is usually gradual within these taxa, they have resin canals with thin-walled epithelia cells. The axial tracheid pits are usually uniseriate. The ray-tracheid wall structure is smooth and thin, and the cross-field pits are large and fenestriform, usually just one or two within the cross-field (*Fig 13, 14*)) (Robichaud et al. 2012; Schoch et al. 2004). It is not possible to distinguish Siberian pine (*Pinus sibirica*) from white pine (*Pinus strobus*), a taxon native to North America, and Swiss stone pine (*Pinus cembra*), which is native to Central Europe (Schweingruber, 1990a).

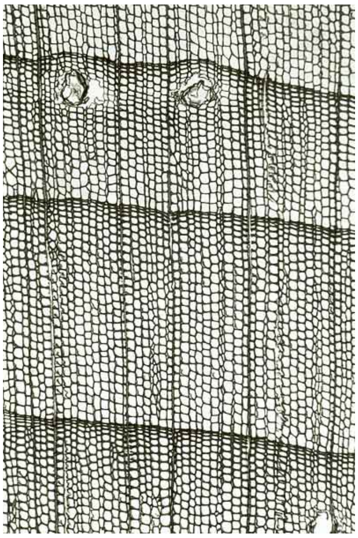


Figure 13. Pinus sect. strobus. Transversal section (Scochs et al. 2004).

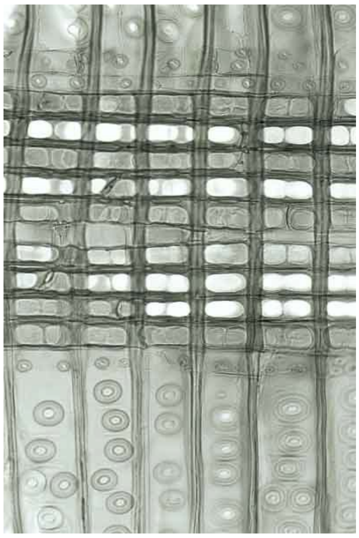


Figure 14. Pinus sect. strobus. Radial section (Scochs et al. 2004).

Pinus banksiana: The transition between early and latewood is usually abrupt; the taxon has large resin canals with thin epithelial cells and the axial tracheid pits are usually uniseriate. The ray-tracheid wall structure is reticulated, and the cross-field pits are pinoid, usually four our more pits per cross-field (Ricther et al. 2004). What differentiates this taxon from *Pinus* sect. *strobus* is that the ray parenchyma have two to five pinoid pits in the cross-field, where as *Pinus* sect. *strobus* usually has one, along with reticulated ray-tracheid wall (*Fig 15, 16*) (Richter et al. 2004; Robichaud et al. 2012).

Figure 15. Pinus banksiana – Transversal section (Microlab, 2007).

Figure 16. Pinus banksiana - Radial section (Microlab, 2007).

Picea sp.: Transition between early and late wood is gradual; the taxon has resin canals with thick-walled epithelial cells. Axial tracheid pits are usually uniseriate. The ray-tracheid wall structure is smooth; and the cross-field pits are generally picoid, usually two to six pits per cross-field (*Fig 17, 18*) (Robichaud et al. 2012; Schweingruber, 1990b).

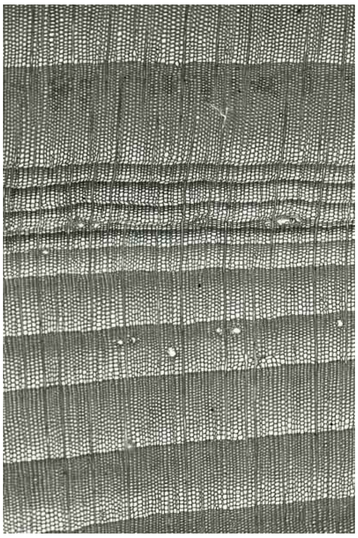


Figure 17. Picea sp. Transversal section (Scochs et al. 2004).

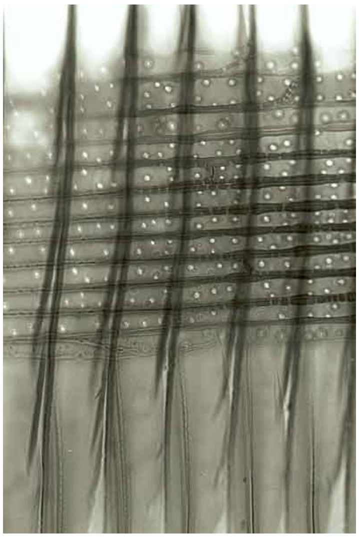


Figure 18. Picea sp. Radial section (Scochs et al. 2004).

Larix sp.: Transition between early and late wood is usually abrupt, resin canals are present with thick-walled epithelia cells. Axial tracheid pits are usually biseriate. The ray-tracheid wall structure is smooth; and the cross-field pits are generally picoid, usually two to six pits per cross-field (*Fig 19, 20*) (Schweingruber, 1990b).

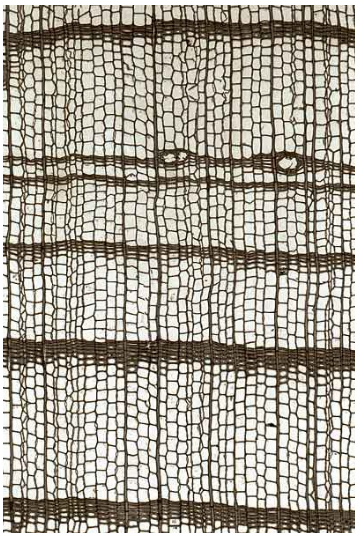


Figure 19. Larix sp. Transversal section (Scochs et al. 2004).

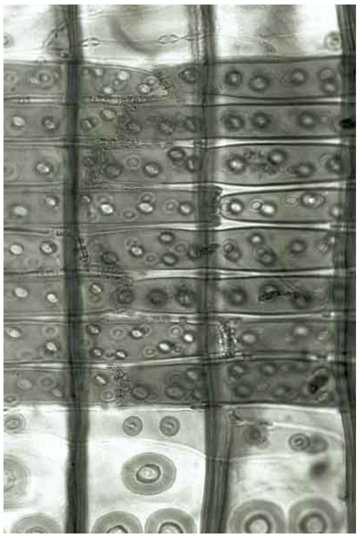


Figure 20. Larix sp. Radial section (Scochs et al. 2004).

***Larix sp*. and *Picea sp*.:** Distinguishing between larch and spruce can be difficult when dealing with archaeological samples. The method used in this study was to look at pit borders in ray tracheids in radial section. Pit borders are angular or angular with dentate thickening in spruce but rounded in larch (*Fig 21*) (Bartholin, 1979; Anagnost et al. 1994), along with other characteristics such as axial bordered pits, which is in general biseriate in larch but uniseriate in spruce.

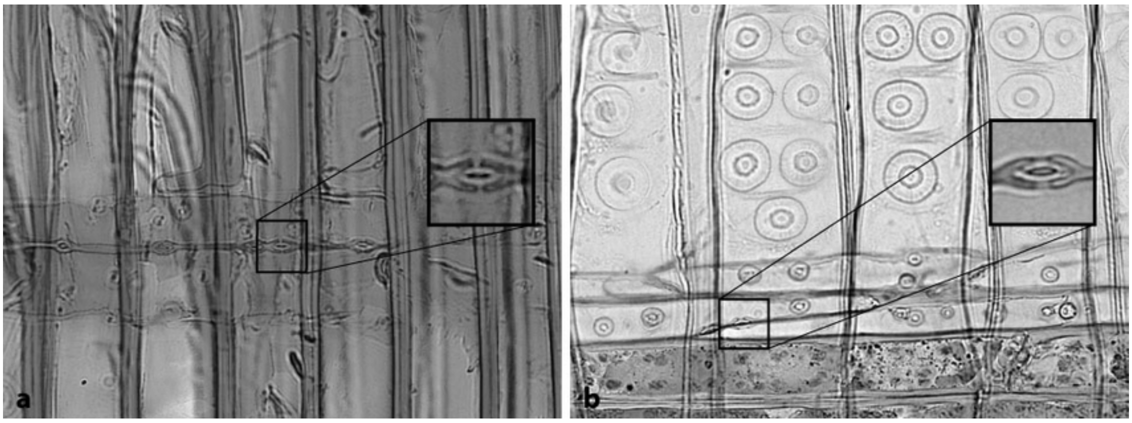


Figure 21. The left photo depicts pit borders in spruce while the right photo depicts pit borders in larch (Hellmann et al. 2013).

***Abies sp.*:** The transition between early and late wood is generally abrupt, the fir taxon has no resin canals, but sometimes traumatic resin canals arranged in rows can be present. Axial tracheid pits are usually uniseriate. The ray-tracheid wall structure is smooth to dentate; and the cross-field pitting is taxodioid usually two to five pits per cross-field. The fir taxa are without ray tracheids. (*Fig 22, 23*) (Schoch et al. 2004; Schweingruber, 1990b).

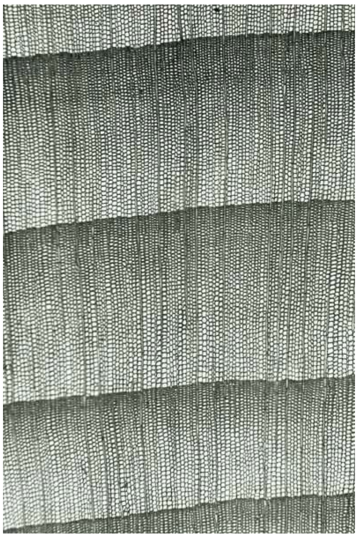


Figure 22. Abies sp. Transversal section (Scochs et al. 2004).

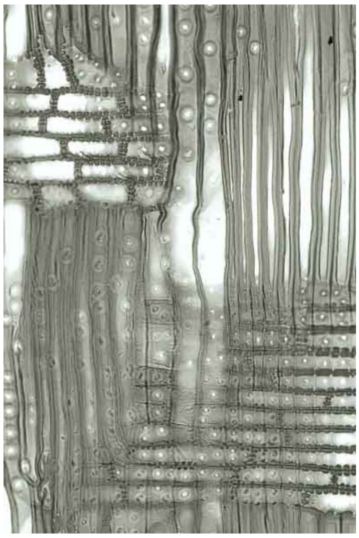


Figure 23. Abies sp. - Radial section (Scochs et al. 2004).

Juniperus sp.: Transition between early and late wood is generally gradual, the taxon has no resin canals. The axial tracheid pits are usually uniseriate. The parenchyma cells have a brown substance in the heartwood. The ray cell wall structure is generally smooth but slightly undulated; nodular tangential walls; and indentures at junction of horizontal and tangential walls. The cross-field pitting is generally cupressoid in earlywood. There are no transversal tracheids in the rays of this taxon. The taxon can be confused with *Thuja* but the ray pits are taxodioid in the latter taxon (*Fig 24, 25*) (Schoch et al. 2004; Schweingruber, 1990a, b).

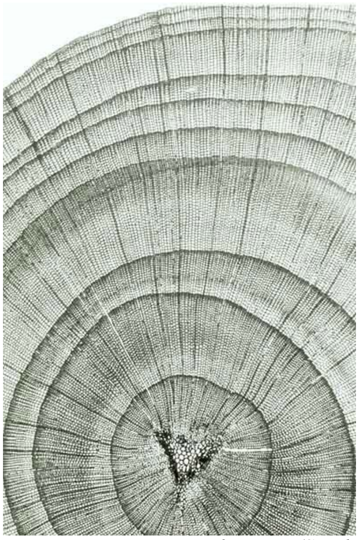


Figure 24. Juniperus sp. Transversal section (Scochs et al. 2004).

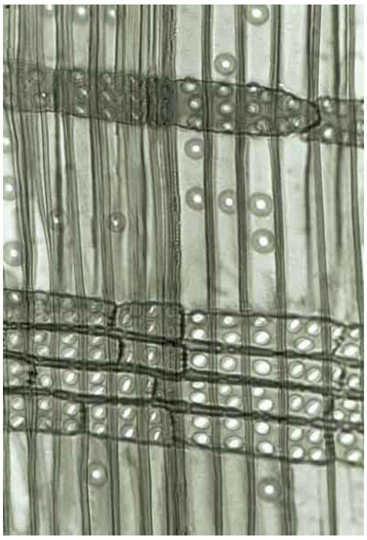


Figure 25. Juniperus sp. Radial section (Scochs et al. 2004).

Tsuga sp.: Transition between early and late wood is gradual to abrupt; the taxon has no resin canals, but traumatic resin canals may occur. The axial tracheid pits are often biseriate with transverse tracheids present (Robichaud et al. 2012). Although Ricther et al. (2004), state that that tracheid pits are uniseriate. Ray tracheid wall is smooth; the cross-field pitting is generally taxodioid but can be piceoid and cupressoid as well – average number of pits per-crossfield is two to six. *(Fig 26, 27)* (Richter et al. 2004; Robichaud et al. 2012).

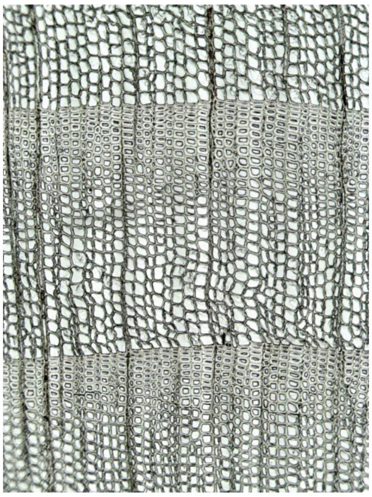


Figure 26. Tsuga sp. Transversal section (InsideWood, 2004).

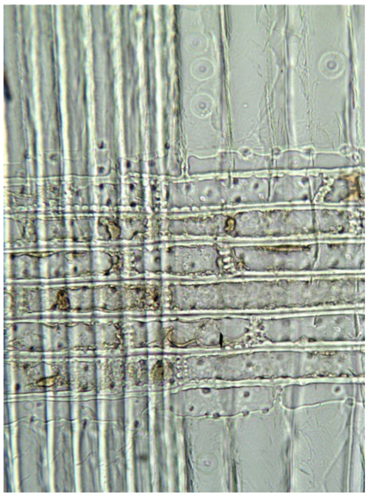


Figure 27. Tsuga sp. Radial section (InsideWood, 2004).

5.3 Anatomical Features of deciduous trees (Dicotyledons)

The anatomical features of deciduous trees are more complex than those of coniferous trees. The axial system is made up of more cell types that have variety of functions, such as libriform fibres, fibre tracheids and vascular tracheids, however most of the vascular function of the axial system is conducted by vessels, also known as pores which are made up of various vessel elements (Hather, 2000). There are several biological characteristics needed to identify between deciduous taxa of which handful of will be discussed here. The boundary between growth rings, which can be distinct, indistinct, or absent. The main anatomical feature of deciduous taxa is the distribution of these vessels. The arrangement is categorised as being ring-porous, semi-ring-porous, or diffuse-porous. In ring-porous taxa, the diameter of the pores in the earlywood is greater than the diameter of the pores in latewood, and they are clustered together in the earlywood. They form a well-defined ring, which usually transitions abruptly to the latewood of the same ring. I n semi-ring porous taxa, vessels in the earlywood are larger than those in the latewood of the previous growth ring but gradually change to narrower vessels within the same growth ring. In diffuse-porous taxa, the size and distribution of the vessels is more regular throughout the growth ring than in ring- and semi-ring porous taxa. (Hather, 2000; Schoch et al. 2004; Schweingruber, 1990b; Wheeler et al. 1989). Within the diffuse-porous and ring-porous taxa the vessels can be arranged in different ways: for example, vessels can be in tangential bands, vessels in diagonal and/or radial pattern, or in a dendritic pattern. Another identifying feature is vessel groupings, they can be exclusively solitary, in radial multiples of 4 or more common or vessels in clusters (Wheeler et al. 1989). At the end of each vessel element there is an opening called a perforation plate, which can be either simple, a single circular or elliptical opening, or scalariform; that is, parallel horizontal bars across the opening. The number of pars within the perforation plate can be used as a diagnostic feature (Hather, 2000; Wheeler et al. 1989). Ray width, hight and structure are another identifying feature. Rays can be exclusively uniseriate, from one to three cells while large rays can be from four to ten seriate or larger. The composition of the ray cells can be procumbent, also termed homogenous; they can be upright and/or square. If the body ray cells are procumbent with one or more rows of upright and/or square marginal cells they would be categorised heterogeneous. In most instances, several features are used to identify each sample (Hather, 2000; Wheeler et al. 1989). What follows is a list of the main identifying features of the more common deciduous taxa discussed in this study.

Betula sp.: The vessel arrangement is diffuse-porous, with short radial files of 2 to 3, rarely 4, vessels as well as solitary vessels. Ring boundary is distinct. The perforation plate is scalariform with 10-15 bars. The rays are mostly homogeneous, biseriate to 4-seriate and up to 15 cells high. The pits in ray-vessel intersections are numerous and very small (*Fig 28, 29*) (Hather, 2000; Schoch et al. 2004).

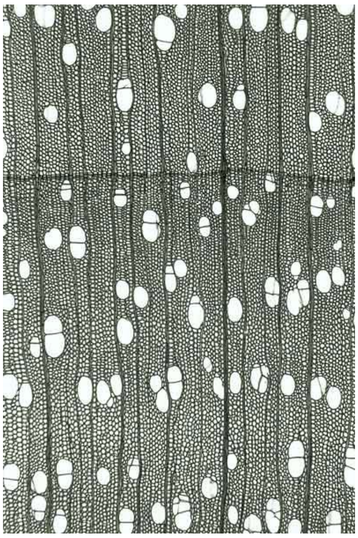


Figure 28. Betula sp. Transversal section (Scochs et al. 2004).

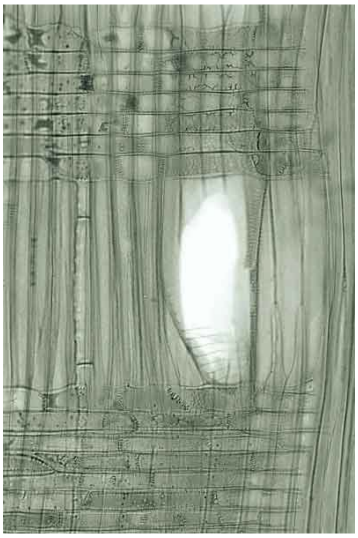


Figure 29. Betula sp. Radial sectio. (Scochs et al. 2004).

Salix sp.: The vessel arrangement is diffuse- to semi-ring-porous; the pores are solitary or in short radial files of 2-3 pores. The growth ring boundary is variable. The perforation plate in the radial section is simple. Rays are predominantly heterogeneous, with a single row of square cells. Rays are uniseriate and up to 15 cells high. Pits in ray-vessels are large. The *Salix* genus has very similar anatomy as *Populus* and in most cases these two genera cannot be separated (*Fig 30, 31)* (Hather, 2000; Schoch et al. 2004).

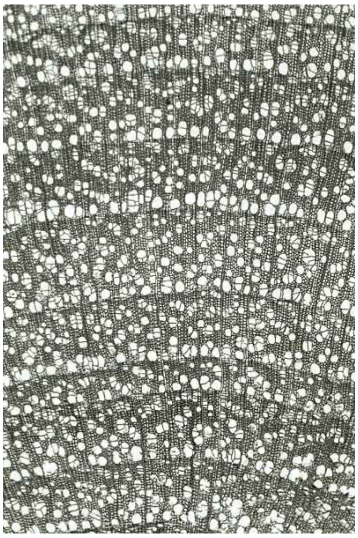


Figure 30. Salix sp. Transversal section (Scochs et al. 2004).

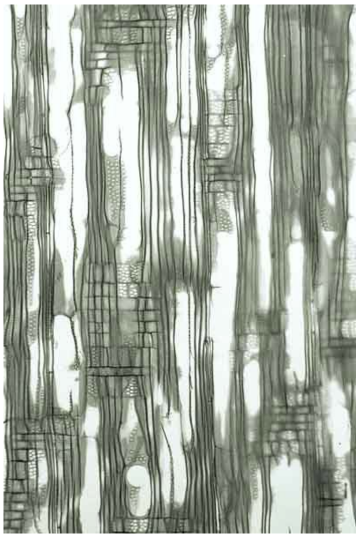


Figure 31. Salix sp. Radial section (Scochs et al. 2004).

Alnus sp.: The vessel arrangement is diffuse- and semi-ring-porous; pores are in long radial files, solitary, clusters. Growth ring boundary varies. The perforation plates are scalariform with 10 to often more than 20 bars. Rays are homogeneous and uniseriate up to 25 cells high, uniseriate rays to triseriate rays occur within the aggregate rays. Ray-vessel pits are generally small (*Fig 32, 33*) (Hather 2000).

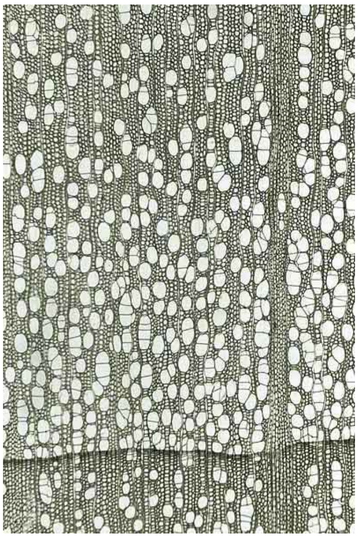


Figure 32 Alnus sp. Transversal section (Scochs et al. 2004).

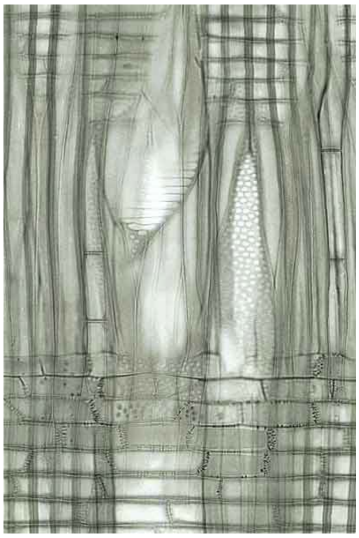


Figure 33 Alnus sp. Radial section (Scochs et al. 2004).

Empetrum sp.: The vessel arrangement is semi-ring-porous with numerous very small pores, which are mostly solitary. Growth rings boundaries are distinct. The perforation plate is scalariform with 3-10 bars. Rays are homogeneous, uniseriate with upright cells. Ray vessel pits have large apertures. The taxon can closely resemble *Vaccinium vitisidaea* but can be differentiated by its semi-ring porous tendency (*Fig 34, 35*) (Schweingruber, 1990b, p 355).

Figure 34. Empetrum nigrum L. Transversal section (Schweingruber,1990b).

Figure 35. Empetrum nigrum L. Radial section (Schweingruber, 1990b).

Vaccinium sp.: The *Vaccinum* genus is diffuse-porous, with numerous generally solitary pores. The boundary between growth rings is indistinct. The perforation plates are scalariform with 5-10 bars. Rays are homogeneous. Rays are either uniseriate or multiseriate, generally with upright and square cells, one to 6 cells high. (*Fig 36, 37*) (Schweingruber, 1990b, p. 383).

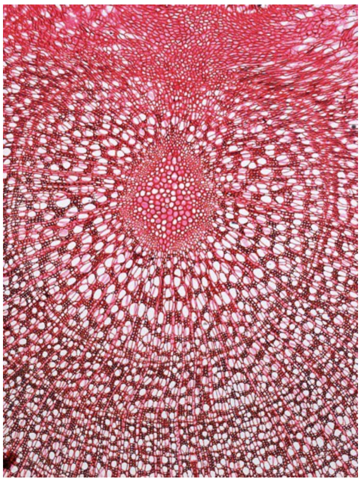
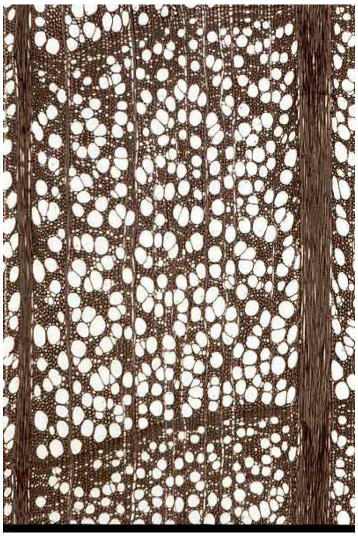


Figure 36. Vaccinium sp. Transversal section (InsideWood, 2004).

Figure 37. Vaccinium sp. Radial section (InsideWood, 2004).

Fagus sp.: The *Fagus* genus is diffuse- to semi-ring-porous with very numerous solitary and clustered pores in the earlywood. Growth ring boundary is distinct. The perforation plates are simple but occasionally scalariform with up to 20 bars. Rays are homogeneous to slightly heterogeneous. Rays are uniseriate to multiseriate, up to 0.5 mm wide and up to 20 cells high, furthermore rays can be of two distinct sizes (*Fig 38, 39*) (Schoch et al. 2004; Wheeler et al. 1989).



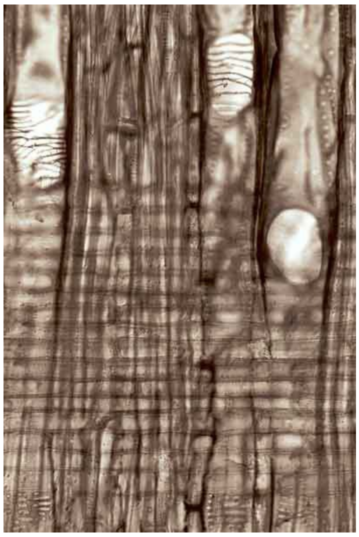
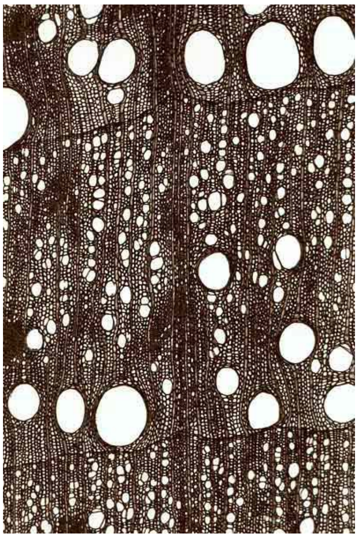


Figure 38. Fagus sp. Transversal section (Scochs et al. 2004).

Figure 39. Fagus sp. Radial section (Scochs et al. 2004).

Quercus sp.: The *Quercus* genus is ring-porous; the earlywood has one to many rows of large pores, but the latewood pores are solitary or in radially orientated to dendritic groups. Growth ring boundary is usually distinct. The perforation plates are simple, and the rays are homogeneous. The rays are wide uni- and multiseriate and visible to the naked eye, as are the large pores. Tyloses are common in the early wood vessels (*Fig 40, 41*) (Hather, 2000; Schoch et al. 2004).



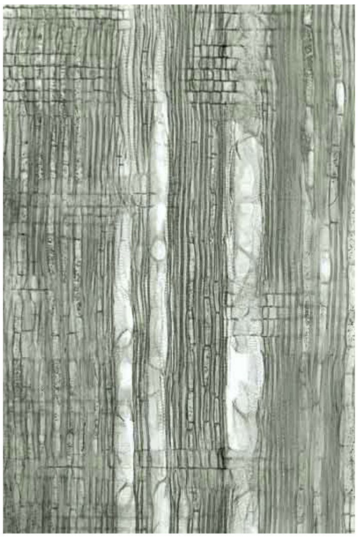


Figure 40. Quercus sp. Transversal section (Scochs et al. 2004).

Figure 41. Quercus sp. Radial section (Scochs et al. 2004).

***Maloideae* family:** Taxa within the maloiedaea family cannot be distinguished from one another. They are diffuse- to semi-ring-porous, with mostly solitary numerous pores. Growth ring boundaries are distinct. They have simple perforation plates, and fine spiral thickening occurs occasionally. Rays are 2-3 cells wide and up to 15 cells high, mostly homogeneous. Uniseriate rays are absent or rare. (*Fig 42, 43*) (Hather, 2000; Schweingruber, 1990a).

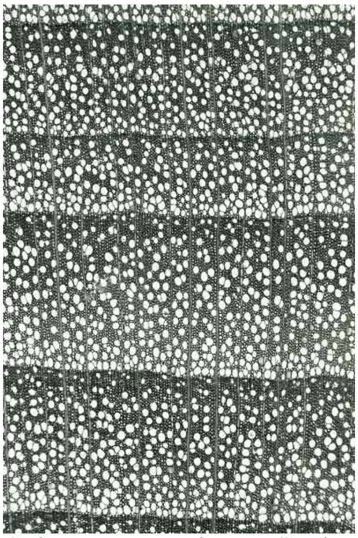


Figure 42. Sorbus sp. Transversal section (Scochs et al. 2004).

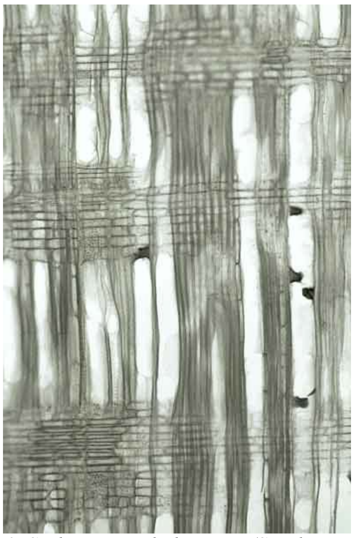


Figure 43. Sorbus sp. Radial section (Scochs et al. 2004).

5.4 Wood analysis and typology

The preservation of the wood assemblages was generally good, especially from the more recently excavated sites. The majority of the artefacts had been dried slowly, which worked well for the conifer taxa; however, other methods should be considered for objects made from birch. Part of the birch artefacts had shrunk considerably and twisted. It did not prevent the wood identification process but made identifying to type more challenging. The assemblages from the older excavation had, in some cases, gone through chemical treatment such as PEG and other unknown chemicals, which made wood analysis almost impossible. Even so, the majority of the assemblages were in good condition. Along with wood taxa analysis, all objects were measured, described, and typologically analysed when possible. Growth rings were counted on twigs and branches, and diameter was measured.

The author conducted the wood analysis except for vessel objects from GUS and Tasilikulooq, which Elie Pinta conducted see: Pinta, 2018. Each wood artefact or fragment was observed under at least two planes: transverse, tangential, and, when necessary, longitudinal. The sampling area of each object or fragment was chosen where it would cause minimal damage. If the object was partly damaged or splintered, sampling was done within that part. The object's cross-section was first observed under a stereo microscope, then thin sections were cut by hand with a surgical knife. The sections were placed on a microscope slide with a drop of water and a thin glass cover over and examined at 50x – 600x magnifications using a trans-illuminating microscope. Taxonomic identification was conducted by comparing the anatomical characteristics of the samples with reference material as well as published literature and online datasets.[2]

The typological study of the artefacts was done in collaboration with Guðrún Alda Gísladóttir. However, typological work already done by Vebæk on the Narsaq material and Smiarowski on the Tasilikulooq material was also considered. The typological analyses were conducted with the aid of published literature as well as comparison with museum collections, mainly in Iceland.[3]

The artefact assemblage was divided into 12 sub-groups according to use. The groups were adapted from other published studies, for example, Brisbane & Hather, 2007. However, sub-groups overlap, and some objects could belong to more than one group.

The non-artefactual material was divided into four sub-groups, which consisted of branches and twigs as well as woodworking debris such as wood shavings, offcuts and various unidentifiable worked pieces (sticks) which could not be categorised as artefacts but were very clearly worked (*Table 4*).

Table 4. The groups and sub-groups discussed in this study including description.

Group	Sub-group	Description
Artefacts	Construction timber/furniture components	Planks, boards, posts, door components, boat parts
	Decorative and ritual objects	Carved or decorated objects
	Farming/hunting/accounting	Suckling stick, tally stick
	Food preparation	Cutting boards, ladle, spoon, knife, meat fork
	Nails	Tree nails
	Personal items	Combs, clothing pins
	Stakes/pegs/wedge/pins	Stakes/pegs/wedge/sausage pins, unidentifiable pins
	Textile production	Spindle, thread winder, line splitter, loom component
	Toys, games	Chess piece, toys or miniatures, boards
	Unidentifiable	Unidentifiable objects
	Utensils and tools	Awl, handle
	Vessels	Stave, stopper, lid, base, hoop
Non-artefactual	Twigs	Branches under 0.5 mm and heathland taxa
	Bra nches	Branches over 0.5 mm with or without tool marks
	Woodworking debris	Offcuts, shaving, splinters, unidentifiable worked sticks
	Other	Knots, burl, roots, trunk, charcoal

[2] See: Schweingruber 1990a; b; Hather, 2000; Schoch et al. 2004; Richter et al. 2004; Robichaud et al. 2012.
[3] See for example: Brisbane & Hather 2007; Færden et al. 1990; Morris 2000; Øye, 1988.

5.5 Site choices and methodological considerations

In this study, wood assemblages from five Norse sites were studied: Gården under sandet (GUS) in Vestribyggð, and Narsaq, Igaliku, Tasilikulooq, and Tatsip Ataa in Eystribyggð (*Fig 44*). Originally, the study involved three recently excavated sites in Eystribyggð: Igaliku, Tasilikulooq, and Tatsip Ataa. The assemblages come from secondary deposits and middens. They were all excavated with the same sampling strategy aimed at the complete retrieval of artefacts and non-artefactual material. In all three cases, the same retrieval methods were used, wet sieving through a 4 mm mesh, ensuring comparability between the assemblages, which is why these sites were chosen. Most of the wood assemblages from these sites were stored at the National Museum in Denmark. There was a nationwide lockdown at the beginning of March 2020 due to the COVID-19 pandemic. When the pandemic hit, I had finished all of the artefacts from the three sites as well as the non-artefactual material from Igaliku along with a large part of the non-artefactual material from Tatsip Ataa.[4] The non-artefactual assemblage from Tasilikulooq was not analyzed. The National Museum in Copenhagen was closed to external researchers for most of the pandemic years. By mid-2020, it had become clear that adjustments would need to be made to the original plan if the project was to be successfully finished. In late October 2020, there was a window to fly to Greenland and look at available wood assemblages at the National Museum in Greenland. Apart from the three assemblages which form the core of this study, all Norse Greenlandic assemblages consist of artefacts only, and most come from excavations of buildings rather than middens.[5] It, therefore, felt essential to include representative cases that would facilitate comparisons and allow the evaluation of Norse Greelandic wood remains. The choice of GUS and Narsaq was furthermore affected by the following interests:

- Is there a difference between the two settlements regarding wood availability?
- What were the main taxa used as building material and do they differ from the rest of the assemblages?
- What options were available during the settlement period, and does that differ from the later phases?

[4] The analysed material provided a good representative sample of the non-artefactual assemblage even though it was not analysed from all available contexts.

[5] There were no wood assemblages from recent excavations stored at the Museum which were comparable to the other sites regarding excavation methods and sampling.

Even though the excavations and retrieval methods were different and, to some extent, problematic, these older assemblages provide valuable information about wood utilisation strategies and should not be wholly disregarded. It is necessary to be aware that they cannot be taken to reflect the entire wood material culture comprehensively. Nor, indeed, do the midden deposits, which result from different processes of discard than prevail, inside buildings. They also represent other challenges for phasing: material was being thrown away on a daily basis, but intermittently, floors were also cleaned out, and complete floor layers, with accumulations potentially spanning decades, were shovelled out and thrown on top of the midden. Older floor layers are, therefore, liable to end up on top of younger midden layers. This was taken into consideration when re-evaluating the phasing of the sites. The assemblages from Igaliku, Tatsip Ataa were divided into two time periods which span almost the entirety of the Norse period in Greenland.[6] The assemblage from Tasilikulooq was divided arbitrarily into two phases in section 6.2, but since excavation and post-ex are not finished the material was not divided into phases when compared to other sites. The assemblage from Narsaq belongs to a single phase, while GUS was not divided into phases since the post-ex is still in process, along with re-evaluation of the entire excavation, including phasing of the site.

[6] For a more detailed discussion on phasing, see sections 6.1, 6.2 and 6.3.

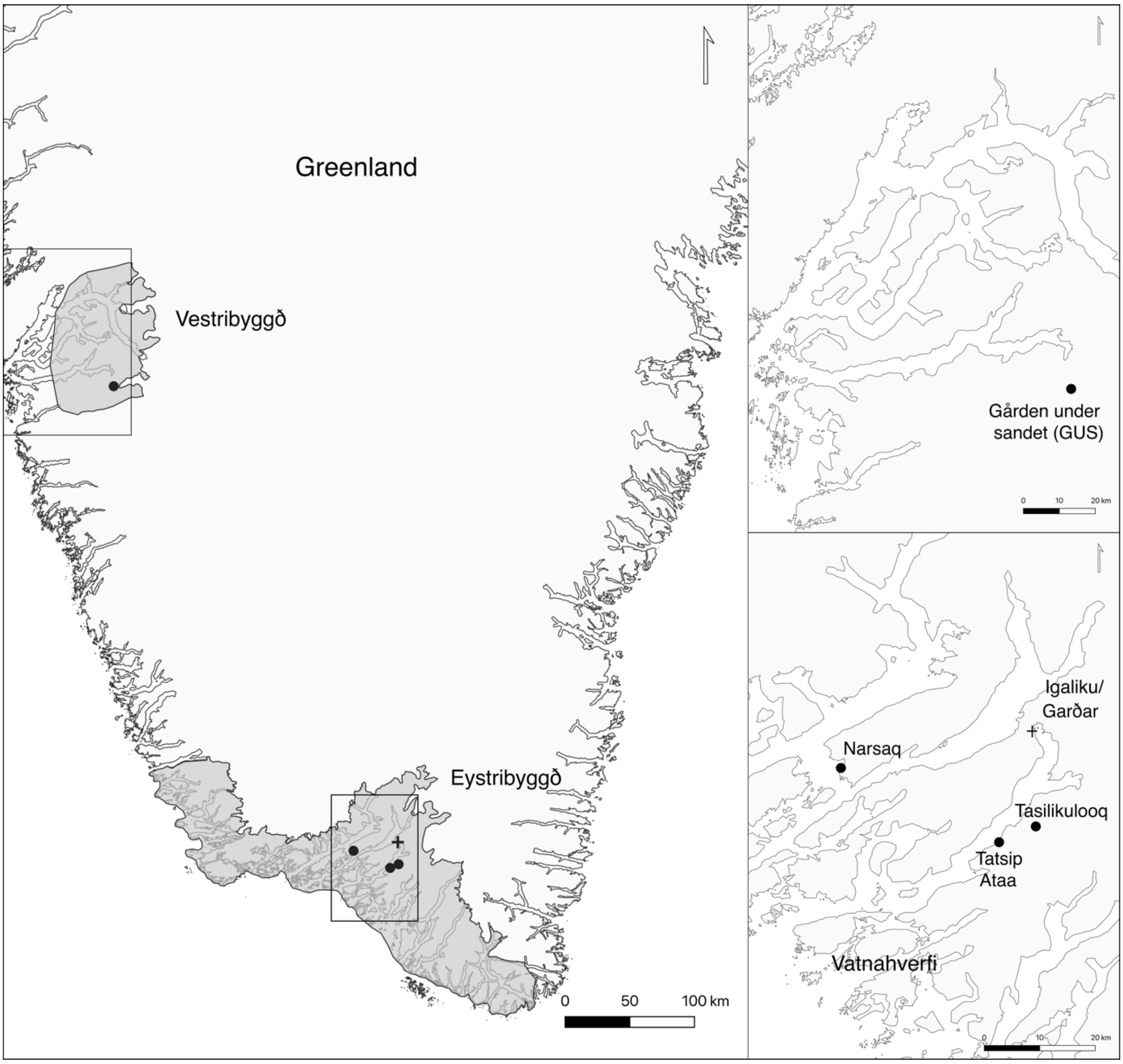


Figure 44. Location of sites discussed in this study.

6 Results

6.1 Ø172 – Tatsip Ataa

The Norse farm Ø172 in Tatsip Ataa is located in Vatnahverfi, a peninsula on the southern side of Igalikufjord or Einarsfjörður. The farm lies on a gentle slope in a small bay in Igaliku fjord and has a substantial homefield (*Fig 45*). It has a good landing site and a harbour (Smiarowski, 2010; Vebæk, 1992). The site was originally surveyed by Vebæk in 1948, where he recorded 14 ruins (Vebæk, 1992). The site was surveyed again in 1971 by Albrethsen, in 1985 by Krogh, and in 2005 by Møller and Madsen, who recorded 21 ruins (Møller & Madsen, 2006). The

2006 survey and the following excavations are part of a collaborative project called *Norse Settlement in Vatnahverfi Region, South Greenland ca. AD 985-1450*.[7]

Pilot investigations showed good organic preservation, and the site was therefore chosen for further excavation with a focus on the midden. Organic preservation in the area is becoming extremely rare and Smiarowski points out that out of about 50 sites cored between 2007-2011, only two had good organic preservation (Smiarowski, 2010). The midden was excavated in 2009-2010 following test trenching in 2007. Three separate areas were excavated; area A, B and C, with areas B and C being extensions of area A, is northwest of the main dwelling, while area D is northwest and E southeast of the dwelling.

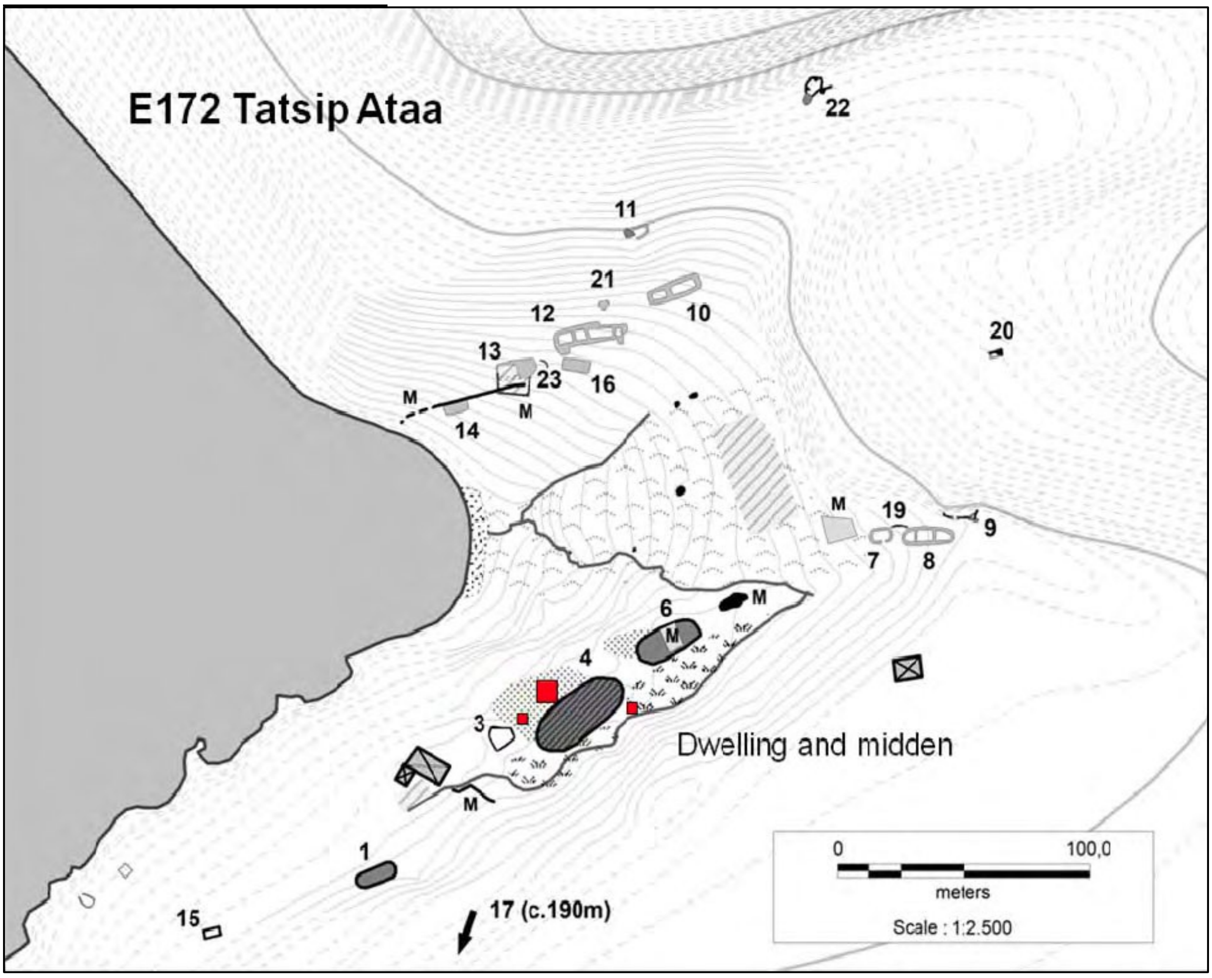


Figure 45. Map of Tatsip Ataa. The excavation areas are marked in red (Map by: (Madsen 2014; Smiarowski 2017).

[7] For more information about the project see: https://natmus.dk/organisation/forskning-samling-og-bevaring/nyere-tid-og-verdens-kulturer/etnografisk-samling/arktisk-forskning/previous-projects/vatnahverfi/ and https://www.nabohome.org/cgi-bin/explore.pl?seq=17

The entire assemblage is from areas A-C, except for four artefacts which were found in area E. The site was in use from the early 11th century up until the 14th century, according to 12 radiocarbon dates on terrestrial mammal bones (Smiarowski, 2010). However, radiocarbon dating of textile extended the period up to the 15th century (Hayeur Smith, 2014; 2020). Furthermore, there are indication of disturbance of the topsoil layers due to wide range of dates within the top layers (Hayeur Smith, 2020, p. 108).

For this study, the assemblage was divided in two phases: phase 1 represents the period from 1100-1300 AD and phase 2 from 1300-1400 AD.[8] The excavation at Tatsip Ataa made use of the single context excavation method. All deposits were sieved on site through a 4 mm mesh sieve. Soil samples were taken from every single context (Smiarowski, 2010). Several of the contexts had large quantities of non-artefactual wood material. For this study only one 5 litre bag from each context was used for analysis. The branches and small twigs were divided into three categories: small branches under 5 mm, branches over 5 mm, and wood working debris. The majority of this assemblage consisted of twigs; therefore, 100 branches were chosen randomly from each 5-litre sample for wood analyses. The wood debris and all branches over 5 mm were identified. All artefacts were analysed with regards to taxa by the author; the artefacts had previously been typologically analysed by Smiarowski (Smiarowski, 2010), and were re-evaluated by the author and Guðrún Alda Gísladóttir. While all the artefacts were analysed, it was not possible to finish the analysis of the non-artefactual material due to the COVID-19 pandemic and lockdown of the National Museum in Denmark. The wood artefacts and non-artefactual material used in this study were found in 63 contexts (*Table 5*).

[8] The phasing was re-evaluated in 2020 by Guðrún Alda Gísladóttir, who is currently working on the artefact assemblage from Igaliku, Sólveig Guðmundsdóttir Beck, who is doing a study on the stones within the same project as the author.

Table 5. Number of wood pieces within each context.

Area	Unit no	Type of deposit	Comments	Phase no. 2021	Dating	Number of wood artefacts	Number of non-artefactual material
E	155			Not phased		2	0
E	165			Not phased		1	0
E	174			Not phased		1	0
A	16	Floor deposit	Redeposition in midden	Phase 1	1000-1300 Low	1	45
B	68	Floor deposit	Redeposition in midden	Phase 1	1000-1300 Low	5	0
B	69	Midden deposit	Twigs	Phase 1	1000-1300 Low	16	3
C	218	?		Phase 1	1000-1300 Low	12	2
B	64	Floor deposit.	Redeposition in midden	Phase 1	1000-1300 Mid	3	152
B	65	Midden deposit		Phase 1	1000-1300 Mid	4	0
B	66	Midden deposit		Phase 1	1000-1300 Mid	2	122
C	120	Midden deposit	Charcoal rich	Phase 1	1000-1300 Mid	1	0
C	139	Floor deposit		Phase 1	1000-1300 Mid	1	0
C	152	Floor deposit	Redeposition in midden, rich in wood	Phase 1	1000-1300 Mid	1	0
A	12	Floor deposit	Cryoturbation. Redeposition in midden. Twigs	Phase 1	1000-1300 High	53	500
A	13	Floor deposit?	Cryoturbation. Redeposition in midden	Phase 1	1000-1300 High	4	8
A	14	Midden deposit		Phase 1	1000-1300 High	3	107
B	43	Midden deposit	Disturebed?	Phase 1	1000-1300 High	3	0
B	57	Midden deposit	Mixed w turf. Fill in cut 56	Phase 1	1000-1300 High	3	0
C	90	Midden and turf		Phase 1	1000-1300 High	5	0
C	96	Floor deposit	Redeposition in midden	Phase 1	1000-1300 High	4	3
C	97	Floor deposit	Redeposition in midden	Phase 1	1000-1300 High	1	0
C	105	Midden deposit		Phase 1	1000-1300 High	1	0
C	114	Cryoturbation	Iron panning	Phase 1	1000-1300 High	2	1
C	117	Floor deposit?	Redeposition in midden	Phase 1	1000-1300 High	1	0
C	119	Midden and turf		Phase 1	1000-1300 High	1	0
B	55	Midden deposit	Thick	Phase 2	1300-1400 Mid	18	193
B	46	Midden deposit	Disturebed?	Phase 2	1300-1400 High	1	12
B	47	Midden deposit	Disturebed?	Phase 2	1300-1400 High	7	4
B	48	Floor deposit	Redeposition in midden	Phase 2	1300-1400 High	17	0
V	49	Mixed turf		Phase 2	1300-1400 High	0	80

Area	Unit no	Type of deposit	Comments	Phase no. 2021	Dating	Number of wood artefacts	Number of non-artefactual material
B	50	Floor deposit	Redeposition in midden	Phase 2	1300-1400 High	12	6
B	51	Floor deposit	Redeposition in midden	Phase 2	1300-1400 High	7	0
B	52	Midden deposit		Phase 2	1300-1400 High	1	0
B	53	Midden deposit		Phase 2	1300-1400 High	1	3
A	10	Floor deposit	Cryoturbation. Redeposition in midden. Twigs	Phase 2	1300-1400 Low	1	46
A	11	Midden deposit	Cryoturbation - Disturbed?	Phase 2	1300-1400 Low	0	68
B	31	Silty material	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Low	2	76
B	32	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Low	2	0
B	33	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Low	14	375
B	34	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Low	3	142
B	36	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Low	2	0
B	37	Midden deposit	Disturebed?	Phase 2	1300-1400 Low	10	298
B	38	Midden deposit	Disturbed?	Phase 2	1300-1400 Low	2	223
B	39	Midden deposit	Disturebed?	Phase 2	1300-1400 Low	6	3
B	40	Midden deposit	Disturebed?	Phase 2	1300-1400 Low	22	1
B	42	Midden deposit	Disturbed?	Phase 2	1300-1400 Low	0	64
B	44	Midden deposit	Disturebed?	Phase 2	1300-1400 Low	18	297
C	78	Midden deposit	Arbitrary, Stratigraphy	Phase 2	1300-1400 Low	1	1
A	8	Midden deposit		Phase 2	1300-1400 Mid	0	14
A	9	Floor deposit	Cryoturbation. Redeposition in midden. Twigs	Phase 2	1300-1400 Mid	1	79
	22	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Mid	0	58
B	25	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Mid	6	186
B	26	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Mid	3	0
B	27	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Mid	1	0
B	28	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Mid	5	1
B	29	Midden deposit	Disturbed? Arbitary dvision between high low mid - by matrix colours	Phase 2	1300-1400 Mid	4	0
C	80	Midden deposit	Arbitrary, Stratigraphy	Phase 2	1300-1400 Mid	2	0
C	85	Midden and turf	Structureal turf	Phase 2	1300-1400 Mid	1	0

Area	Unit no	Type of deposit	Comments	Phase no. 2021	Dating	Number of wood artefacts	Number of non-artefactual material
C	86	Midden and turf	Structureal turf	Phase 2	1300-1400 Mid	1	0
C	118	Midden and turf		Phase 2	1300-1400 Mid	1	0
A	6	Midden and turf	Disturbed. Structural stones and turf present.	Phase 2	1300-1400 Top	0	6
A	7	Midden deposit	Cryoturbation. Silty	Phase 2	1300-1400 Top	1	15
B	21	Midden deposit	Disturbed	Phase 2	1300-1400 Top	0	30
B	29	Midden deposit	Disturbed? Arbitrary division between high low mid - by matrix colours	Phase 2	1300-1400 Mid	4	0
C	80	Midden deposit	Arbitrary, Stratigraphy	Phase 2	1300-1400 Mid	2	0
C	85	Midden and turf	Structural turf	Phase 2	1300-1400 Mid	1	0
C	86	Midden and turf	Structural turf	Phase 2	1300-1400 Mid	1	0
C	118	Midden and turf		Phase 2	1300-1400 Mid	1	0
A	6	Midden and turf	Disturbed. Structural stones and turf present.	Phase 2	1300-1400 Top	0	6
A	7	Midden deposit	Cryoturbation. Silty	Phase 2	1300-1400 Top	1	15
B	21	Midden deposit	Disturbed	Phase 2	1300-1400 Top	0	30
					Total:	**304**	**3224**

Wood taxa analysis

As can be seen in *Figure 46*, there are substantial differences between the results of the wood taxa analysis of the artefactual and non-artefactual material. Native wood dominates the non-artefactual assemblage: birch (*Betula sp.*), willow sp. (*Salix sp.*), juniper sp. (*Juniperus sp.*), the Maloideae family, most likely Greenland mountain ash (*Sorbus groenlandica*.), crowberry sp. (*Empetrum nigrum*), and bog bilberry/blueberry (*Vaccinium sp.*) make up over 68% of the assemblage. Non-native conifer taxa comprise 30% of the non-artefactual assemblage while 2% were unidentifiable.

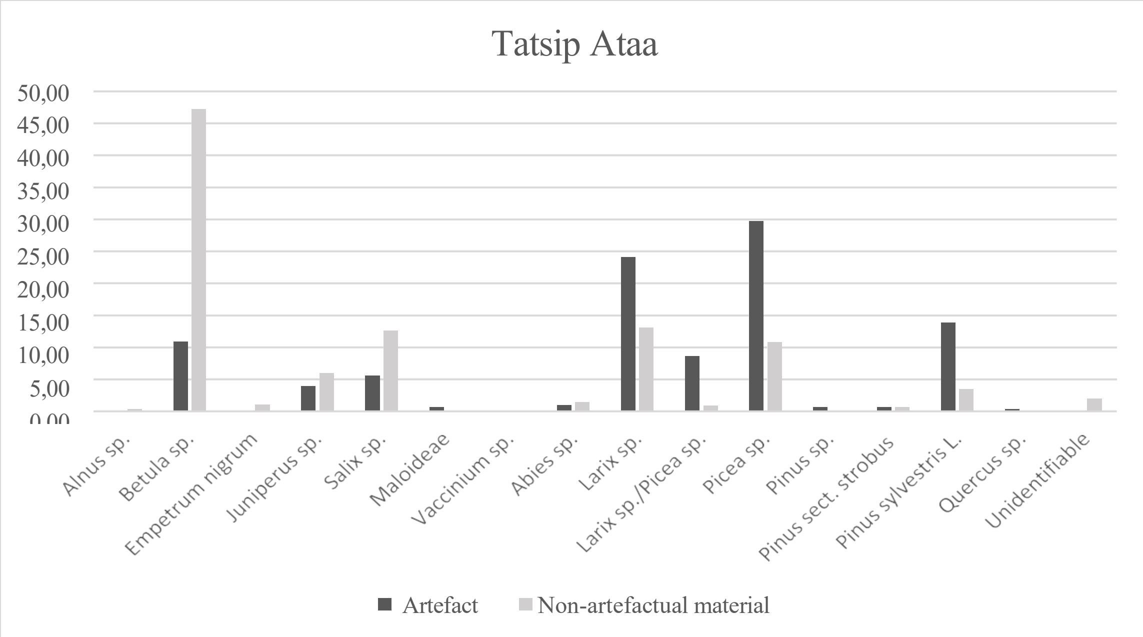


Figure 46. The results of the wood taxa analysis in Tatsip Ataa.

Within the artefact assemblage, native wood makes up 21% of the assemblage, non-native coniferous taxa make up 78.5% of the assemblage and 0.3% could be identified as import. In *Figure 47,* the assemblage has been combined and divided into two phases. There is no drastic change between the phases: there is a reduction in birch, an increase in willow, and a slight increase in larch and spruce, while the proportions of Scots pine stay the same throughout the Norse period.

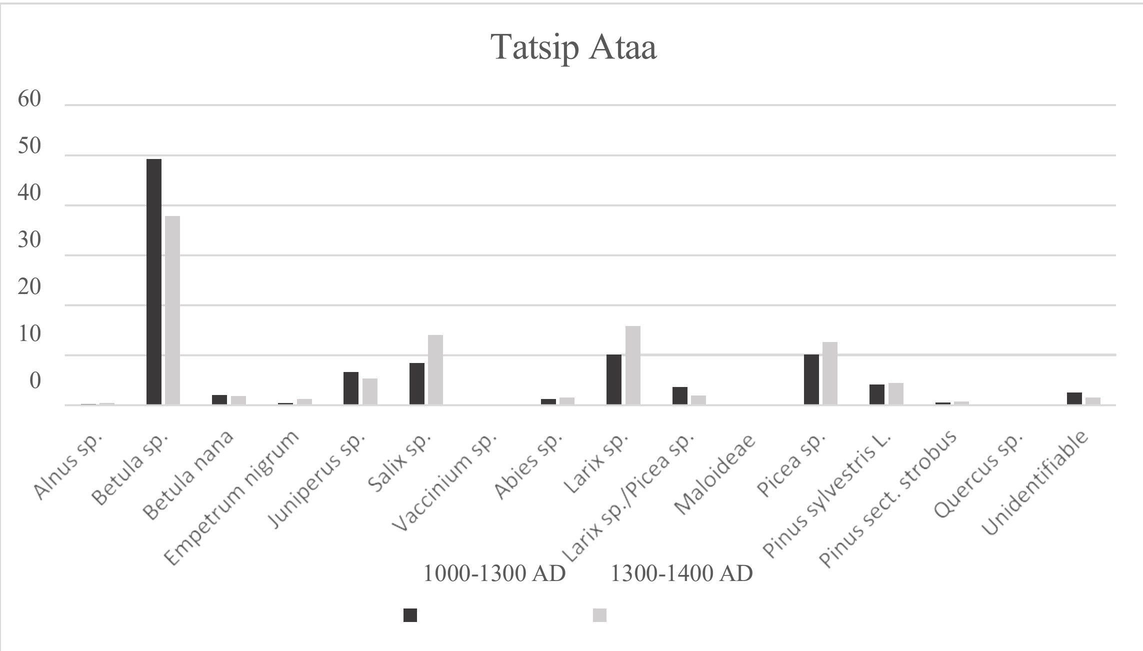


Figure 47 Combined assemblage, comparison between phases.

Discussion

The material studied from Tatsip Ataa was divided into two groups: artefacts and non-artefactual material. The composition and utilisation of these two material groups vary, which is discussed in Guðmundsdóttir (2022b); the non-artefactual group mainly consisted of twigs and branches, used as floor and roof insulation and woodworking debris. Leaves are also known to have been used as animal fodder, while taxa such as juniper, crowberry, and bilberry were used for human consumption (Guðmundsdóttir, 2022b). Non-native conifer wood was more commonly used for various tools and utensils, vessels, and other artefacts, while native wood was used for smaller artefacts, mostly pins, nails and pegs (*Fig 48*).

Figure 48. Various artefacts identified from Tatsip Ataa as well as non-artefactual material, a) A tool handle (X-80) – larch sp.; b) A tally stick with circular decorations (X-348) - Maloideae; c) A small container or a cup (X-676) – fir sp.; d) Bottom or a lid from a stave built vessel (X-352) – spruce sp.; e) A stave (X-591) – larch sp.; f) A stave (X-254) – spruce sp.;g) A barrel stave (X-89) – oak sp.; h) Branches, twigs and wood shaving (W-14); i) Branches, twigs and wood shaving (W- 25); j) Tools (X-75) – spruce sp.; k) Spade (X-469) – spruce sp.

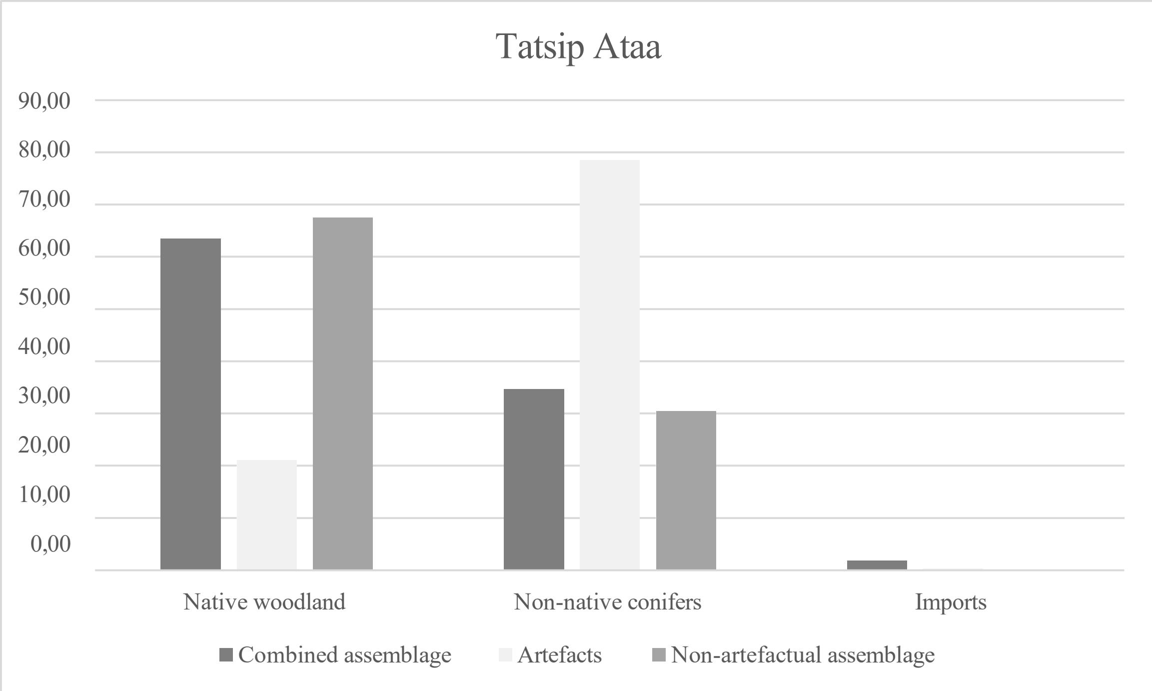


Figure 49. This graph represents proportions of native taxa, the potential driftwood taxa and imports in Tatsip Ataa.

Only one artefact could be identified securely as import, and that was an oak barrel stave that most likely arrived in Greenland as a ready-made barrel rather than being made in Greenland from imported wood. The household in Tatsip Ataa was sustainable concerning wood acquisition and did not have to rely on imports to sustain its wood needs (*Fig 49*).

6.2 Ø171 – Tasilikulooq

The Norse site in Tasilikulooq is a medium-sized inland farm in Vatnahverfi, located near the centre of a small valley between the lakes Saqaata Tasi in the north and Tasersuaq in the south. The site was initially surveyed in 1939 and 1948 by Vebæk, who described 11 ruins in total (Vebæk, 1992). In 2005, the site was surveyed again by the Danish National Museum. A total of 16 features were recorded and the farm is categorised as middle-sized (Madsen, 2014; Møller & Madsen, 2006). In 2011 the site was cored, and a test trench was dug in the midden to evaluate the organic preservation, which proved to be good. Tasilikulooq is the second site in Vatnahverfi with good organic preservation. The excavation of the midden in Tasilikulooq took place in 2016. The excavation was part of the same research project as in Tatsip Ataa, the collaborative project called *Norse Settlement in Vatnahverfi Region, South Greenland ca. 985-1450 AD* (*Fig 50*).

Figure 50. Map of Tasilikulooq, the wood assemblages were retrieved from the midden which is number 9 on the map (Map by (Madsen 2013)).

The excavation at Tasilikulooq utilised the same methods as in Tatsip Ataa. It was not possible to access the non-artefactual material during the lockdown of the National Museum in Denmark due to COVID-19. However, all the artefacts were analysed with regard to both wood taxa and typology, except for vessels that had been analysed previously by Elie Pinta (Pinta 2018). The wood artefacts analysed in this study were found in 10 contexts with no wood finds preserved in the youngest layers. Most of the finds came from context [12] which can be dated to the 13th century (*Table 6*). Madsen (2014) indicates that the farm was founded around 1050 AD, suggesting that most of the wood comes from a narrow timeframe.

An arbitrary phasing was attempted, and the material divided into two phases: phase 1 from 1050-1200 AD (contexts 10-15), and phase 2 from 1200-1300 AD (contexts 16-22). There are two radiocarbon dates from the midden, both from unsecure contexts, but they date the site to the middle of the 11th and 13th centuries (Madsen, 2014, p. 229). There is one securely dateable textile from context [10] in the upper part of the midden. It is from the 13th century, along with artefacts, like a double-sided comb and a button from the middle of the midden, further indicating the 13th century (Hayeur Smith, 2020, p. 108; Hayeur Smith, pers. comm). Post-excavation analysis of the midden investigation is ongoing, so this site's chronology may be better understood. However, for this project the following was taken into consideration:

- Double sided comb with rivets along the middle generally dated to 1200-1350 AD in context [12].

- C14 dating from a textile (E171-04 x93) retrieved from context [10] in the midden (1190-1270 AD)[9]
- Two C14 dating from unsecure contexts which, with 2-sigma ranges give the dates 1025-1209 AD and 1040-1259 AD (Madsen 2014, p. 229)[10].

However, due to the arbitrary phasing, this site was not compared temporally with Igaliku and Tatsip Ataa. At least, it is possible to detect stratigraphical differences within the assemblage.

Table 6. Distribution of identified wood between contexts; in total, 348 artefacts were identified.

Unit	Nr. of wood artefacts	Arbitrary dating	Phase
10	14	1200-1300 AD	Phase 2
11	16	1200-1300 AD	Phase 2
12	126	1200-1300 AD	Phase 2
13	19	1200-1300 AD	Phase 2
15	2	1200-1300 AD	Phase 2
16	9	1050-1200 AD	Phase 1
17	51	1050-1200 AD	Phase 1
20	35	1050-1200 AD	Phase 1
21	47	1050-1200 AD	Phase 1
22	29	1050-1200 AD	Phase 1
Total:	**348**		

Wood taxa analysis

The most common taxon identified is larch (*Larix sp.*), which comprises around 33 % of the assemblage and can be categorised as driftwood. The second most common taxon is birch (*Betula sp.*), which comprises 25% of the assemblage and can be classified as a native taxon. Then spruce (*Picea sp.*) at 20%, Scots pine (*Pinus sylvestris* L.) at 12% and fir *(Abies sp.)* at 1%, all of which can most likely be categorised as driftwood. The native taxa willow *(Salix sp.)* makes up around 7%, and juniper (Juniperus sp.) is 1%. The non-native conifer taxa comprise around 66% of the assemblage, and native taxa around 34%. When the assemblage is divided into two arbitrary phases, the most common taxon in the earlier phase is birch, which makes up around 39% of the assemblage and can be categorised as native taxa. The second most common taxon is larch which consists of 25% of the assemblage, then spruce at 17 % and

[9] Laboratory number: Beta-344492. 2-sigma calibration (95% probability): Cal AD 1190-1200 and Cal AD 1210-1270.
[10] The source does not say what was used to radiocarbon date.

Scots pine at 10.5%. These three taxa along with fir, at 0.6%, can be categorised as driftwood and possibly imports, while willow, in total 8.1% of the assemblage, can be categorised as native (*Fig 51, 52*).

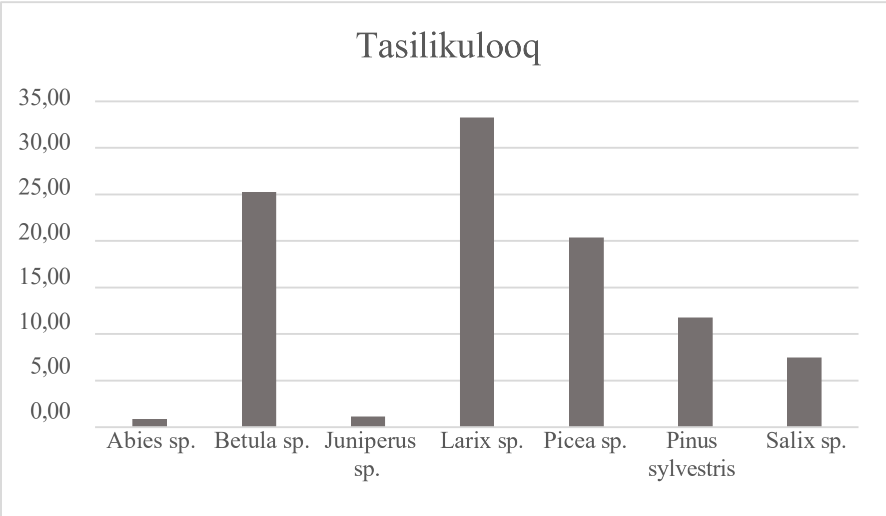


Figure 51. The result of the wood taxa analysis.

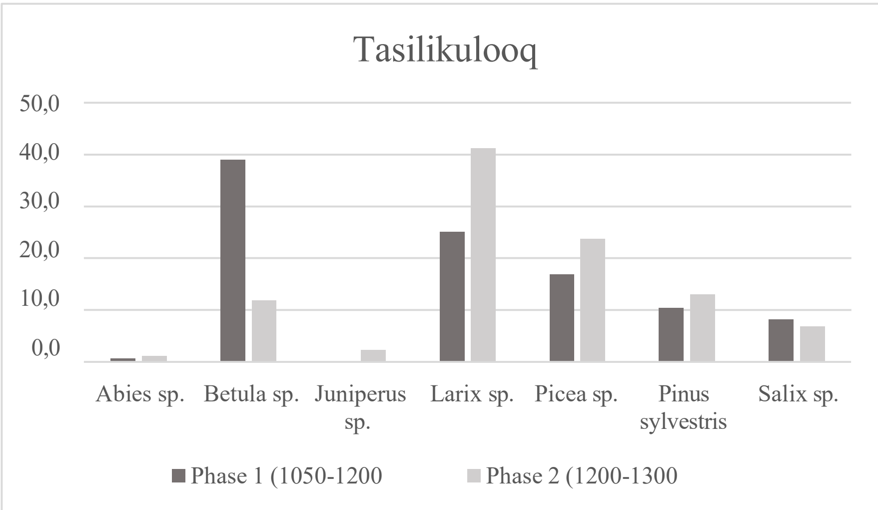


Figure 52. Results of the wood taxa analysis in Tasilikulooq when the assemblage has been divided in two phases.

In total 53% of the assemblage is non-native conifer taxa, most likely driftwood, while 47% can be categorised as native wood. In the latter phase there is a sharp decrease in birch and a slight decrease in willow, giving a combined proportion of 18.7%, or 21% if proportion of juniper is added to the native wood. In the later phase, there is an increase in non-native coniferous taxa, which consists of 79% of the assemblage.

Discussion

Even though the phasing is arbitrary, there are indications of a reduction of native woodland in Tasilikulooq in the 12th-13th century. At the same time, the utilisation of driftwood taxa increased, mainly larch, spruce and Scots pine, to some degree. Hence, the household had the opportunity to substitute the native wood with driftwood, perhaps due to a reduction in native woodland. As stated above, the Scots pine can either be a European import or driftwood. The proportion of Scots pine increased from 8.1% to 13%, which might indicate that a small proportion of the Tasilikulooq assemblage is imported rather than driftwood. However, more accurate provenancing studies are needed to confirm that (*Fig 53*).

Figure 53. Various artefacts from Tasilikulooq. a)Nails, pins and pegs (X-152) – larch sp. x9, Scots pine x2, birch x1 and willow x1; b) Various vessel fragments (X-227) – spruce sp. x5, larch sp. x3, Scots pine x1 and willow x1; c) Unidentifiable object (X-390) – spruce sp.; d) Tally stick (X-399) – Scots pine; e) Clamp (X-426) – birch sp.; f) Part of a through (X-249) - spruce sp.

6.3 Ø47 – Igaliku (The episcopal manor Garðar)

Igaliku is at the head of the Igaliku Kangerlua fjord in Southern Greenland. The site was recognised as the site of the episcopal manor Garðar in the late 19th century (Bruun, 1918, p. 188; Nørlund, 1929, p. 27) because of the extensive ruins in the area. The site has a long research history, which can be traced to the late 18th century. It was not until 1926 that the first large-scale archaeological excavation took place, which was conducted by Poul Nørlund and Aage Roussell (*Fig 54*). Nørlund mapped the area and made accurate descriptions of the entire site; he also excavated the cathedral and the structures of the central residential complex, including the two large byres. An extensive collection of artefacts and animal and human bones were retrieved from the cemetery (Nørlund, 1929).

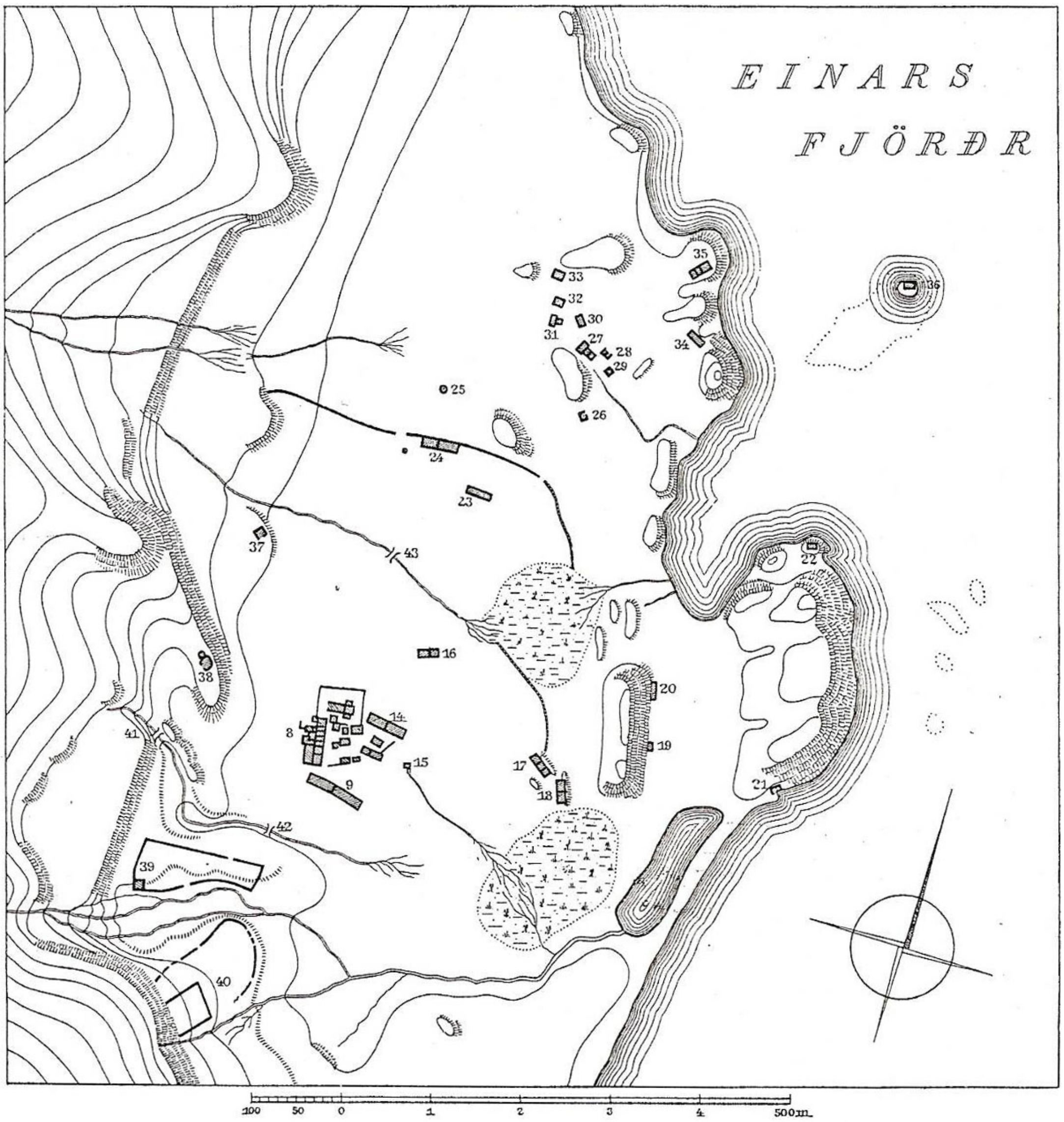


Figure 54. Plan of Igaliku/Garðar from 1926 (Nørlund, 1929).

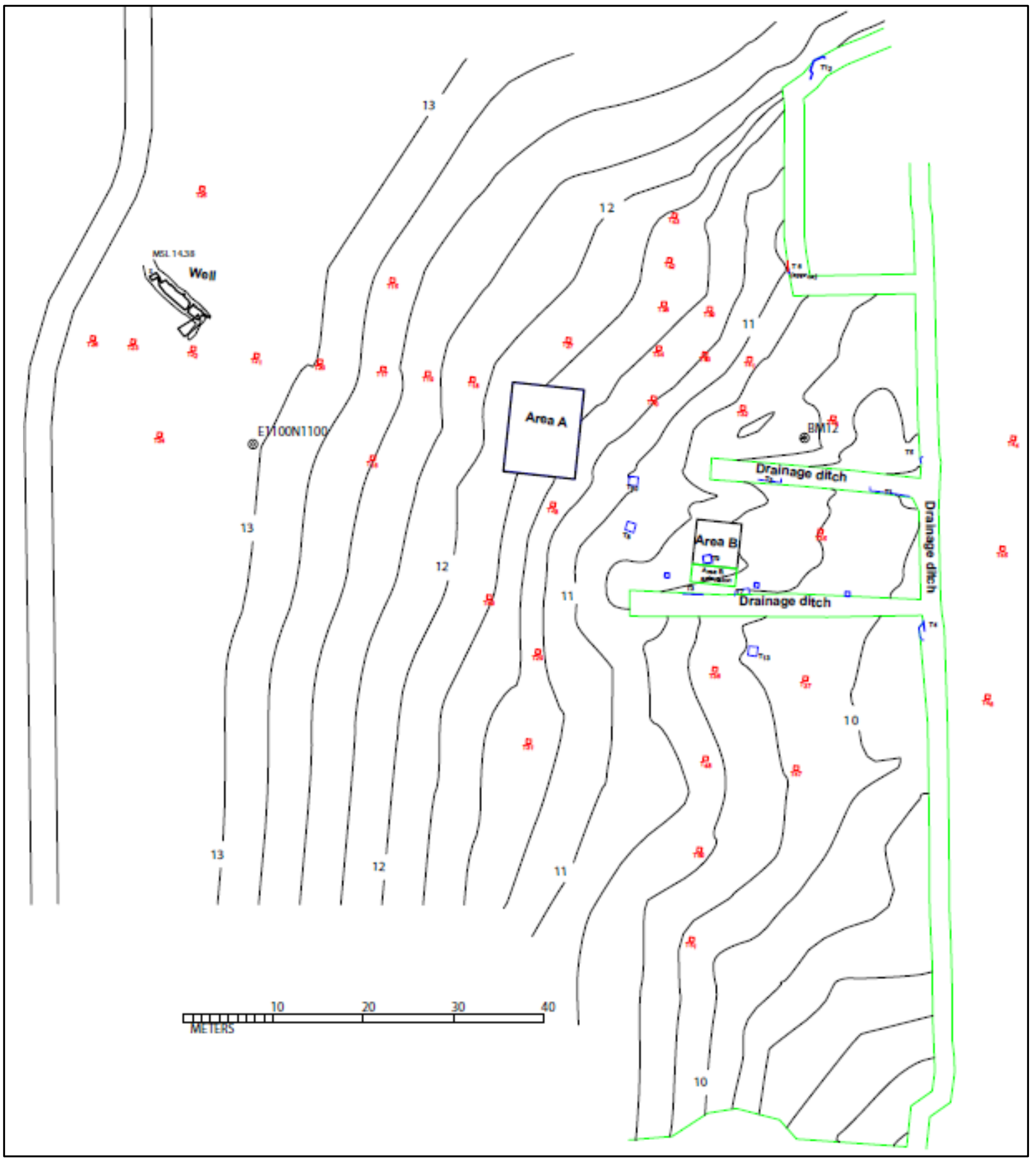


Figure 55. Location of excavation areas and trenches discussed in this thesis (Vésteinsson, 2014).

Since then, a few small-scale projects have taken place in Igaliku, mainly regarding maintaining the ruins, but it was not until 2012-13 that another extensive open area excavation took place. The research was a rescue excavation due to the draining of the meadow and will be discussed in more detail below. In 2019, an excavation was conducted between Nørlund's excavation east of the choir and the foundations for a stone house, where five burials were discovered (Arneborg & Pedersen, 2020). For a more detailed research history of the site, see Arneborg & Pedersen, 2020, p. 5-9 and Vésteinsson, 2014, p. 4-5. The assemblage from this study was retrieved during the excavation in 2012-2013. The manor's central building complex sits on a rise, but around it were extensive homefields that extended to lower ground to the north, east and south, where, in some places, they merged with marshland. Much of this land has been drained and turned into hayfields in the 20th century. In 2005, several well-preserved wooden artefacts and animal bones were found in the spoil heaps from the digging of drainage ditches some 110 m east of the central complex. The site was examined by Hans Kapel at that time, who observed cultural layers that were about 0.5 m thick (Kapel, 2005). The site was further examined by Paul Buckland, Kevin Edwards, Eva Pangiotakopulu, and J. Edward Schofield, who made palaeoenvironmental observations and defined an area of cultural material encompassing about 90x80 m. (Buckland et al. 2008, 2009; Panagiotakopulu & Buckland 2012). The site was further examined by the palaeobotanist Peter Steen Henriksen in 2010, who concluded that the frequent twigs found in the area were related to the deposition of cultural material during the time when the area had been wet and fertilised during the Norse occupation (Henriksen, 2012). The excavation started in 2012 and was managed by Georg Nyegaard of Greenland's National Museum (Vésteinsson, 2014).

The wood assemblages originate from the two open area excavations, Areas A and B, as well as test trenches (*Fig 55*). The excavation method utilised in Area A was single context recording, but in Area B, only one pre-modern cultural layer was identified, which was excavated in 10 cm spits. All cultural layers were wet-sieved. The twigs, charcoal, and woodworking debris were recorded as samples or non-artefactual assemblage, while worked wood was recorded as artefacts (Vésteinsson, 2014). For further information about the assemblage, see Appendix I.[11] The phasing of the site is built on 14 AMS radiocarbon dates, as well as the typology of the artefact assemblage (*Table 7*). The excavated contexts were classified into six groups:

[1000]: Topsoil

[1001]: Modern disturbance

[1002]: Peaty silt above cultural layers [1003]: Charcoal and stone horizon

[1004]: Widespread wood-chip layer [1005]: Natural substrate

[11] Most of the artefacts' dimensions were recorded, although they might not necessarily represent the original dimensions. Studies of wood artefacts in Stóraborg in Iceland have shown a considerable change in size since the material was excavated. The weight was not recorded since some artefacts had dried up and shrunk while others had been preserved with various substances. The weight would, therefore, not have represented the original weight.

Table 7. Results of the radiocarbon dating from Igaliku (Vésteinsson 2014, p. 100).

Area	Deposit type	Sample nr.	Context	Group	Sample material	Conventional C14 age (BP)	δ13C	Prior 2- σ cal range (95.4%)	Modelled 2-σ cal range (95.4%)
A	Charcoal horizon	SUERC-46208	16	1003	Birch	575±27	- 25.20%	1305-1419	1307-1411
A	Charcoal horizon	SUERC-46214	27	1003	Caprine	653±29	-19.20%	1279-1394	1305-1395
A	Charcoal horizon	SUERC-46209	38	1003	Caprine	595±27	-20.20%	1299-1410	1302-1392
A	Charcoal horizon	SUERC -46213	31	1004	Cattle	837±29	-18.20%	1270-1389	1269-1308
A	Charcoal horizon	SUERC-46215	36	1004	Cattle	837±29	-21.10%	1158-1262	1166-1260
B	Wood-chip layer	SUERC-8576	505-1	29- 28 cm	Seed	625±35	-28.20%	1289-1400	1276-1324
B	Wood-chip layer	SUERC-46216	505-1	1004	Cattle	764±27	-20.90%	1221-1281	1221-1282
B	Wood-chip layer	SUERC-46217	505-2	1004	Cattle	881±30	-20.40%	1042-1221	1151-1246
B	Wood-chip layer	SUERC-46218	505-3	1004	Cattle	835±30	-21.00%	1157-1264	1167-1260
B	Wood-chip layer	SUERC-46219	505-4	1004	Cattle	827±29	-21.00%	1164-1262	1171-1263
B	Wood-chip layer	AAR-17478	505-4	1004	Hazelnut	983±25	-26.37%	995-1153	996-1153
B	Wood-chip layer	SUERC-8575	505-4/5	47- 46 cm	Seed	875±35	-27.90%	1041-1246	1155-1252
B	Wood-chip layer	SUERC-46223	505-5	1004	Cattle	875±27	-21.00%	1045-1225	1153-1242
B	Wood-chip layer	AAR-17479	505-5	1004	Cherry seed	219±25	-27.82%	1644-1953	1644-1953

For this study, the assemblages were divided into two phases: phase 1 represents the period 1100-1300 AD and phase 2 1300-1400 AD.[12]

All artefacts from Igaliku were analysed. Guðrún Alda Gísladóttir had previously identified the artefacts according to type and function (Vésteinsson, 2014), which was to a small extent re-evaluated by the author. The non-artefactual material consisted mostly of wood working debris, various unidentifiable sticks, offcuts and shavings. In total, 50% of the non-artefactual assemblage was analysed (*Table 8*).

[12] The phasing was re-evaluated in 2020 by Guðrún Alda Gísladóttir who is currently working on the artefact assemblage from Igaliku, Sólveig Guðmundsdóttir Beck who is doing a study on the stones within the same project and the author.

Table 8 Distribution of the wood assemblages between areas and contexts.

Area	Unit no.	Type of deposit	Comments/ Group no.	Phase no 2021	Phase- 2021	No. of wood Artefacts (838)	No. of non-artefactual Material (3234)
8	Unstratified	Test trench	1002/1004	2	1300-1400?	1	16
9	4	Test trench	1004	1	1100-1300	14	128
9	5	Test trench	1004	1	1100-1300	11	39
9	6	Test trench	1004	1	1100-1300	5	63
9	7	Test trench	1004	1	1100-1300	0	6
9	8	Test trench	1004	1	1100-1300	0	1
10	2	Test trench	1003	2	1300-1400	0	6
10	3	Test trench	1003	2	1300-1400	7	104
10	4	Test trench	1004	2	1300-1400	5	50
11	2	Test trench	1002	2	1300-1400	3	5
13	Unstratified	Test trench	1004	1	1100-1300	7	5
A	36	Wood chip layer	1004	1	1100-1300	42	279
A	2	Disturbed context	1001	2	Post 1300 - Disturbed	5	34
A	3	Disturbed context	1001	2	Post 1300 - Disturbed	1	14
A	5	Disturbed context	1001	2	Post 1300 - Disturbed	20	5
A	9	Charcoal horizon	1003	2	1300-1400	5	20
A	12	Charcoal horizon/wood chip layer	1003/1004	2	1300-1400	51	415
A	13	Charcoal horizon	1003	2	1300-1400	1	3
A	14	Charcoal horizon	1003	2	1300-1400	1	17
A	16	Charcoal horizon	1003	2	1300-1400	1	9
A	18	Disturbed mcontext	1001-1	2	Post 1300 - Disturbed	1	12
A	19	Charcoal horizon	1003	2	1300-1400	4	9
A	21	Charcoal horizon	1003	2	1300-1400	2	6
A	24	Charcoal horizon	1003	2	1300-1400	1	14
A	27	Charcoal horizon	1003	2	1300-1400	3	15
A	30	Charcoal horizon	1003	2	1300-1400	3	3
A	31	Wood chip layer	1003/1004	1	1300-1400	101	509
A	33	Charcoal horizon	1003	2	1300-1400	2	7
A	38	Charcoal horizon	1003	2	1300-1400	8	185
B	506	Wood chip layer	1004	1	1100-1300	3	16
B	505-0	Wood chip layer - south of the modern ditch	1004	1	1100-1300	57	175
B	505-1	Wood chip layer	1004	1	1100-1300	19	0
B	505-2	Wood chip layer	1004	1	1100-1300	66	191

Area	Unit no.	Type of deposit	Comments/ Group no.	Phase no 2021	Phase- 2021	No. of wood Artefacts (838)	No. of non-artefactual Material (3234)
B	505-3	Wood chip layer	1004	1	1100-1300	159	43
B	505-4	Wood chip layer	1004	1	1100-1300	148	475
B	505-5	Wood chip layer	1004	1	1100-1300	25	92
B	505-6	Wood chip layer	1004	1	1100-1300	2	0
B	507-3	wood chip layer - north of modern ditch	1004	1	1100-1300	11	28
B	507-4	wood chip layer - north of modern ditch	1004	1	1100-1300	2	7
B	507-5	wood chip layer - north of modern ditch	1004	1	1100-1300	6	17
B	Unstratified	Wood chip layer	1004	1	1100-1300	2	0
B	502	Natural peaty silt	1002	2	1300-1400	33	135
Test trenches	Various	Various test trenches		2	1300-1400	0	53
Total:						**838**	**3234**

Group [1004]

Group [1004], or the wood chip layer, is described as a natural peat formation with external anthropogenic material mixed in. No clear stratigraphic divisions could be made within the wood chip layer in Area B, except for [506]; therefore, this layer was recorded altogether as [505] and excavated in 10 cm spits. In Area A, the wood chip layer could be divided in two: reddish peat layer [031], which was similar to [502] in area B, and [036], which is grey and more mixed. In both areas the layer was over 40 cm in thickness and spread over a large area. This layer seems to be the result of a natural formation, but how the anthropogenic material got there is less well understood. Even so, the accumulation is in stratigraphical order and this group is part of phase 1, 1100-1300 AD (Vésteinsson, 2014). The wood pieces were retrieved from both areas as well as various test trenches, especially trench 9. However, the majority was found in Area B within context [505] and within context [31] in area A. In total 579 artefacts were found within this group, and 1565 pieces of non-artefactual material.

Group [1003]

Charcoal horizon [1003] was documented over a 65 m long transect. The distribution of the layer is uneven and discontinuous, but it is more substantial and find rich around Area A, where it is made up of a series of heterogenous deposits formed on top of a stone scatter. The series consists of alternating bands of charcoal rich silt layers as well as turf with midden lenses [014] and a possible hearth [011]. What most of these layers have in common is that they are all secondary deposits, but how and why they accumulated in this place is not fully understood. The series might have formed due to change in the management of the run-off from the well, located further up the slope, i.e. that midden material was dumped up-slope and was carried with the run-off to be deposited in the meadow (Vésteinsson, 2014). Another possibility is that the material represents midden material that has been scattered in the wet meadow as a fertiliser.

The majority of the material was found in test trench 10, context [3], and in context [38], a stone scatter, in Area A. The scatter was on top of a soft peaty wood chip layer, perhaps to make it easier to walk on the damp surface (Vésteinsson, 2014). Relatively few artefacts were found within both these layers, mostly wood chips, which may have been used to dry up wet surfaces, as has been noted in Reykjavík (Nordahl, 1988). In total, 82 artefacts and 703 non-artefactual pieces were found within this group and belonging to phase 2.

Group [1002]

Group [1002] was described as natural peaty silt on top of the charcoal horizon [1003]. This layer was found in area B, context [502], but is missing altogether in area A, perhaps due to machine levelling of the field. It has been suggested that this layer began to form at the time of the abandonment of the site (Buckland et al. 2009; Vésteinsson, 2014). In total, 175 pieces were identified from this group: 35 artefacts and 140 pieces of non-artefactual material. Most of the material was retrieved from context [502] in Area B, while seven pieces were retrieved from Trench 11. There is cultural material within the group despite the layer being categorised as natural. However, due to soggy conditions in Area B, artefacts retrieved from [502] could be from the top of the layer below [505=507] (Vésteinsson, 2014). The wood pieces are therefore categorised in phase 2.

Group [1001]

[1001] is a group number for contexts that have been extensively modified by modern farming, mainly in connection with drainage ditches. In total, 92 wood pieces were identified from this group, all of which came from the top layers in Area A and can be related to either digging or the infilling of a ditch alongside layer [007] and [004] or the heavily mixed top layer [002], while disturbed deposits [005] and [003] were less mixed (Vésteinsson, 2014). Most of the wood pieces were found in [005], which was less mixed, and the artefacts are medieval in type but there is a potential that these deposits are mixed, although they do not appear to be from digging elsewhere on site. They were, however, all in the later phase since the contexts below are not disturbed and belong to the earlier phase. In Area B, this phase is represented by context [501], where there were no wooden finds.

Wood taxa analysis

In total, 4042 wood pieces were analysed from Igaliku: 2153 pieces from phase 1 (1100-1300 AD) and 1919 pieces from phase 2 (1300-1400 AD) (*Fig 56*).

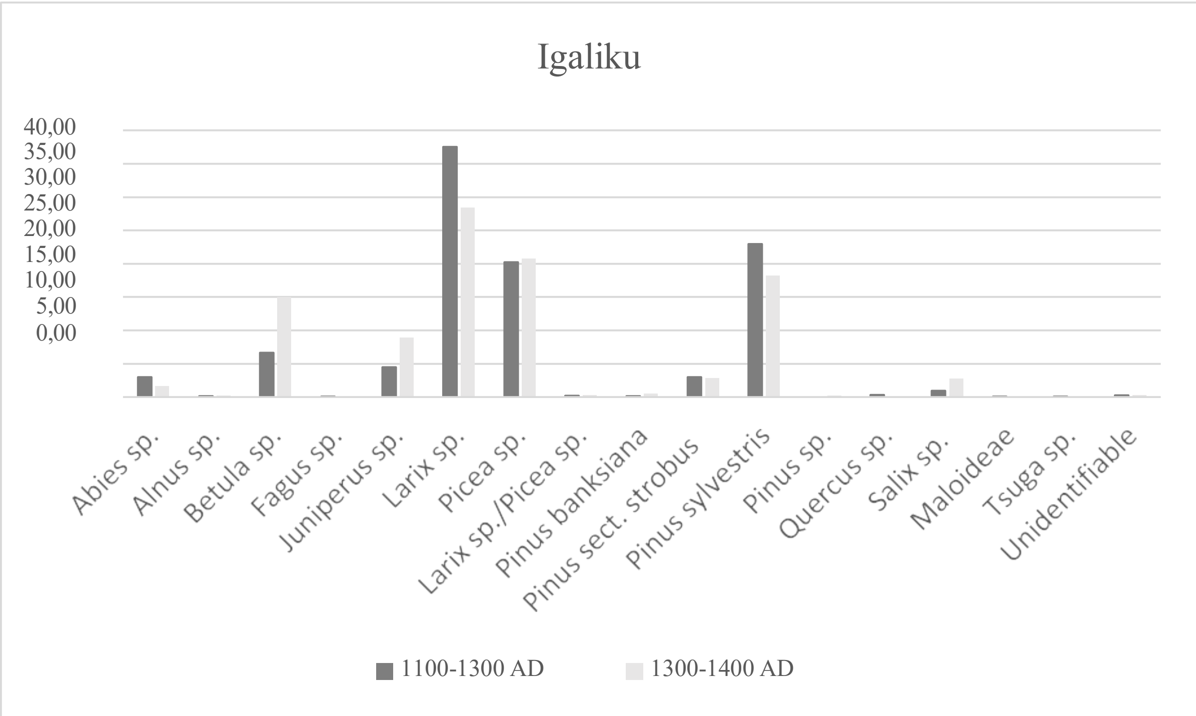


Figure 56. Results of the wood taxa analysis in Igaliku.

Table 9. The result of the wood taxa analysis.

	Taxa	Non-artefactual assemblage (1100-1300 AD)	Artefacts (1100-1300 AD)	Combined	Combined (%)	Non-artefactual assemblage (1300-1400 AD)	Artefacts (1300-1400 AD)	Combined	Combined (%)
Native woodland	*Alnus sp.*	2	0	2	0.09	3	0	3	0.16
	Betula sp.	105	12	117	5.43	250	14	264	13.76
	Juniperus sp.	70	21	91	4.23	149	3	152	7.92
	Salix sp.	15	2	17	0.79	45	2	47	2.45
	Maloideae	1	1	2	0.09	0	0	0	0
Driftwood	*Abies sp.*	47	16	63	2.93	27	2	29	1.51
	Larix sp.	591	223	814	37.81	472	87	559	29.13
	Picea sp.	318	124	442	20.53	344	62	406	21.16
	Larix sp./Picea sp.	3	0	3	0.14	4	1	5	0.26
	Pinus sect. *strobus*	47	15	62	2.88	48	7	55	2.87
	Pinus sp.	0	0	0	0	3	0	3	0.16
Driftwood/ Import	*Pinus sylvestris* L.	361	166	527	24.48	303	79	382	19.91
Import	*Pinus banksiana*	2	0	2	0.09	7	0	8	0.36
	Quercus sp.	5	0	5	0.23	1	0	1	0.05
	Fagus sp.	1	0	1	0.05	0	0	0	0
	Tsuga sp.	1	0	1	0.05	0	0	0	0
	Unidentifiable	4	0	4	0.19	4	1	5	0.26
	Total:	1573	580	2153		1660	258	1919	

The most common taxon identified in Igaliku in both phases was larch: 38% in phase 1 and 29% in phase 2 (*Table 9*). The second most common taxon was Scots pine, which comprised 24% of the assemblage in the earlier phase but reduced to 20% in phase 2. The proportions of spruce remain similar throughout the Norse period, i.e., around 20%. In total, non-native coniferous taxa make up 88.9% of the assemblage in the earlier phase and 75% in the latter one, when there is a reduction in the utilisation of non-native conifer taxa, mostly larch and pine, while utilisation of native wood increases. The most common native wood taxon is birch, which makes up 5.4% of the assemblage in phase 1 but increases to 13.8% in phase 2. The second most common taxon is juniper, which, like the birch, increased from 4.2% to 7.9% (*Fig 57*). Other native taxa identified were alder (*Alnus sp.*), willow (*Salix sp.*), and a taxon from the Maloideae family, most likely Greenlandic mountain ash (*Sorbus groenlandica*)**,** but the taxa within this family cannot be distinguished from one another (Schweingruber, 1990b). It has been argued that alder had no or very limited distribution in southwest Greenland, see discussion in Ledger et al. (2016). The presence of it in Igaliku shows that it was most likely growing in the vicinity of the episcopal manor, although it most likely had a limited distribution, as Ledger et al. propose.

Within the assemblage from Igaliku, there are taxa that cannot be categorised as driftwood or native and will, therefore, have arrived in Greenland as import. They are beech (*Fagus sp.*), oak (*Quercus sp.*), Jack pine (*Pinus banksiana*), and hemlock (*Tsuga sp.*). The combined proportion of these taxa is only 0.42% in phase 1 and 0.47% in phase 2. There is a greater variety of taxa in the earlier phase, with beech, oak, jack pine, and hemlock, while only Jack pine and oak were found in the latter. These taxa make up only a small fragment of the entire assemblage, suggesting that import did not significantly impact wood procurement strategies. There are, however, other taxa that can potentially be either import or drift. For example, Scots pine can be imported from northern Europe, and spruce, larch and fir could potentially have been imported from North America since they cannot be distinguished from the European taxa. However, by comparing the proportions of these taxa between the Norse sites in this study, as well as with other cultural groups in Greenland and the Smith Sound, it can be argued that both spruce and larch are driftwood but that some Scots pine were imported and predominantly to Igaliku (Guðmundsdóttir, 2021). The origin of the imported taxa is most likely predominantly European, although there are taxa within the assemblage that can only be found on the North American coast, like Jack pine and hemlock (Brouillet et al. 2010; Roberts et al. 2006), which prove without a doubt that Norse Greenlanders sailed to North America throughout the Norse period (Guðmundsdóttir, 2021).

There is a difference between the non-artefactual material and the artefacts regarding the proportions of wood taxa and changes between phases. Within the artefact assemblage, there is no significant change between phases, and the proportions of taxa remain similar throughout the Norse period (*Fig 57*) (*Table 10*). On the other hand, there is more noticeable change between phases within the non-artefactual material (*Fig 58*).

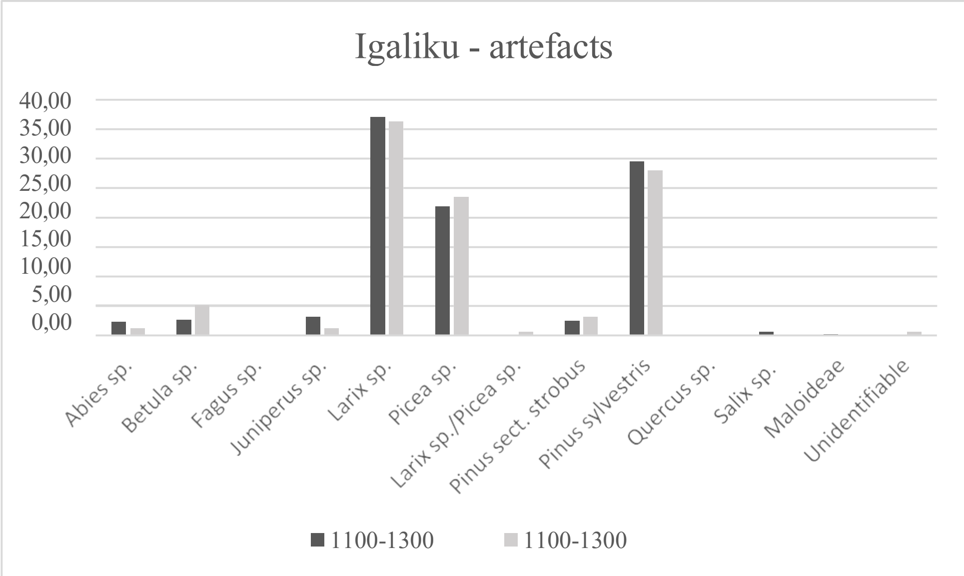


Figure 57. The results of the wood taxa analysis on the artefacts from Igaliku.

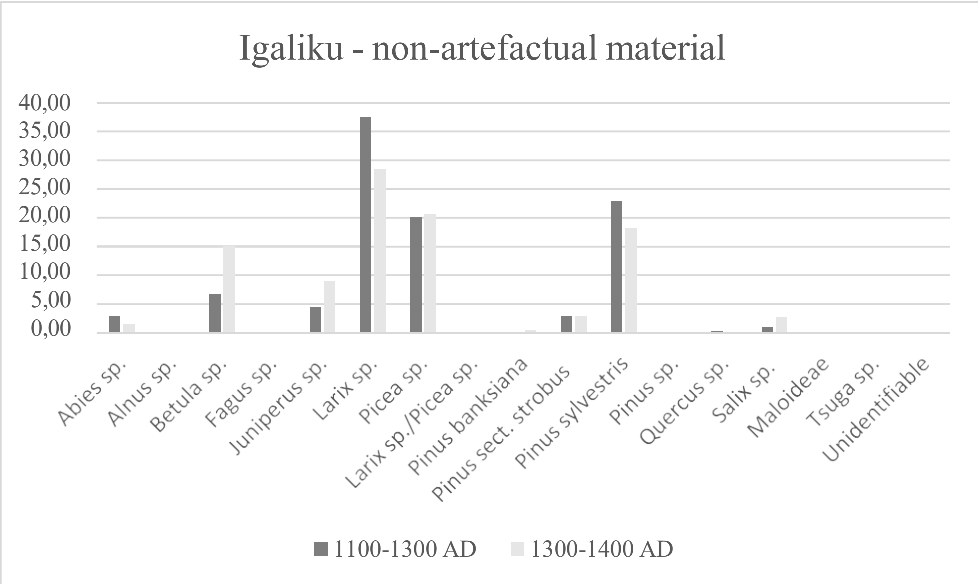


Figure 58. The results of the wood taxa analysis on the non-artefactual material.

There is an increase in the use of native wood in the latter phase, mostly birch and juniper, and a decrease in the use of larch. Another difference is that there is less variety within the artefact assemblage, which is surprising, but the oak, beech, Jack pine, and hemlock in the first phase were all categorised as woodworking debris, not artefacts. The proportion of Scots pine is, however, higher within the artefact assemblage, at ca. 30%. In fact, it is considerably higher than at any of the other sites within this study.

The proportion of native wood is lower within the artefact assemblage than within the non-artefactual assemblage, at least in the latter phase: around 5% compared to 24% in the latter phase of the non-artefactual material, where native wood is predominantly small twigs and branches. There is an increase in the use of that category of material.

Table 10. The results of the wood taxa analysis on the artefact assemblage.

Taxa	(1100-1300 AD) Count (580)	(1100-1300 AD) (%)	(1300-1400 AD) Count (258)	(1300-1400 AD) (%)	Combined Count (838)	Combined (%)
Abies sp.	16	2.76	2	0.78	18	2.15
Betula sp.	12	2.07	14	5.43	26	3.10
Fagus sp.	0	0	0	0	0	0
Juniperus sp.	21	3.62	3	1.16	24	2.86
Larix sp.	223	38.45	87	33.72	310	36.99
Picea sp.	124	21.38	62	24.03	186	22.20
Larix sp./*Picea* sp.	0	0	1	0.39	1	0.12
Pinus sect. *strobus*	15	2.59	7	2.71	22	2.63
Pinus sylvestris L.	166	28.62	79	30.62	245	29.24
Quercus sp.	0	0	0	0	0	0
Salix sp.	2	0.34	2	0.78	4	0.48
Maloideae	1	0.17	0	0	1	0.12
Unidentifiable	0	0	1	0.39	1	0.12
Total:	**580**		**258**		**838**	

Discussion

The proportions of wood taxa within the assemblage from Igaliku are relatively stable throughout the Norse settlement. Although there is an increase in the utilisation of native taxa in the latter phase, this is mostly noticeable in the non-artefactual material. Compared to the other sites, the proportions of native taxa are far lower in Igaliku, even though the episcopal manor certainly had access to this resource (Guðmundsdóttir, 2022b). The proportion of Scots pine is considerably higher than at any of the other sites in this study and makes up 30% of the artefact assemblage in both phases. It is therefore thought that part of the Scots pine represents import from Europe (Guðmundsdóttir, 2021), though increased access to drifted Scots pine cannot be excluded. Furthermore, there are indications of trips being made from Greenland to the east coast of North America, most likely up until the end of the 14th century (*Fig 59*).

Figure 59. On the left side are examples of artefacts from Igaliku and on the right side are wood debris and branches from Igaliku and Tatsip Ataa. A) Decorated plank – larch sp. (X-115); b) A carved object – spruce sp. (X-116); c) A stave with the imprints from the hoops preserved – Scots pine (X-848); d) A stave with an owners mark – larch (X-325) ;e) A toy horse – larch sp. (X-421); f) Redeposited floors from Tatsip Ataa (W-48); g) Wood-working debris from Igaliku (X-120); h) Twigs and branches from Igaliku (X-858); i) Woodworking debris from Igaliku (X-636).

6.4 Narsaq

Narsaq is located at the westernmost end of the peninsula between Tunulliarfik (Norse: Eiríksfjörður) and Sermilik (Norse: Ísafjörður). The farm is on a small plain near the shoreline called Saqqaq, just south of Narsaq. The site was initially surveyed by Daniel Bruun, who systematically registered all known Norse settlements between 1894-1903 (Bruun, 1896; Vebæk, 1993), followed by Roussell in 1933 (Vebæk, 1993). Bruun surveyed ruins in the centre of present-day Narsaq, called Ø17; however, when Roussell surveyed the area, the ruins were gone, but locals directed him to ruins north of the settlement, known as Ø17a (Vebæk, 1993). In 1953, the site Ø17a was disturbed when soil was removed from the area for gardening. Well-preserved artefacts were discovered, and the National Museum in Copenhagen was made aware of these findings. Excavations were carried out at the main dwelling in 1954, 1958 and 1962, run by Christian Leif Vebæk. The ruin in question was a longhouse dated by the excavator to 1000-1200 AD, based on radiocarbon dating, artefact typology and house type. Two charred branches were dated: sample K-5904, a charred willow branch from the lower cultural layer in Room 1 (980-1035 AD), and sample K-5905, a charred birch branch from the long-fire from the earliest phase in Room 1 (905-990 AD) (Vebæk, 1993, p. 73). The main dwelling, a turf-built, the construction orientated NS, was about 36-37 m in length and 6-9 m wide. The building consisted of four rooms in a row. Room 1 appears to be the oldest part, with a hearth in the middle, while rooms 2-4 are later additions (*Fig 60*) (Vebæk, 1993). The building seems to have had several phases, which Vebæk notes, although he had problems distinguishing between them. However, it shows no signs of the architectural changes associated with the 12th century or later (Madsen, 2014). None of the artefacts are registered in any secure context or phase. Therefore, they are all within one phase from ca. 1000-1200 AD; although there is no firm date for the abandonment, it is doubtful it was in use through the 12th century. The radiocarbon dating, despite the potential impact of the old wood effect, artefact typology and decorations, as well as the building type (longhouse), supports the dating to this period.[13] Furthermore, Vebæk was selective in the choice of wood pieces he kept; non- artefactual material was not preserved from the excavation (Arneborg, 2022 pers. comm.). All artefacts were analysed except for those that were on exhibit at the National Museum in Greenland, while Malmros had previously identified some of the boat parts (Andersen & Malmros, 1993). Vebæk's identifications of the artefacts according to type and

[13] Few of the wooden objects had ornaments in the Ringerike style, which can be dated to the 11th century (Fuglesang, 1980).

function (Vebæk, 1993) were re-evaluated by Guðrún Alda Gísladóttir. Vebæk notes that there is evidence of pre-Inuit finds before the Norse arrived in Narsaq (three artefacts) as well as from after the Norse occupation (steatite finds, hammer-stone and bone implements), but not within the Norse material (Vebæk, 1993, p. 47). One wooden artefact was identified that could potentially be of Inuit or pre-Inuit origin (see section 6.2.3).

Figure 60. The longhouse in Narsaq. Modified after (Vebæk 1993).

Wood taxa analysis

In all 169 artefacts were analysed. Of those, 70% were identified as non-native coniferous taxa, either larch, spruce, pine, or fir, with larch being the most common taxon identified (*Fig 61*). Most of these taxa most likely represent driftwood and there is no strong indication of wood import to Narsaq. Around 27% could be identified as native wood, with birch being the most common taxon, at 13%. About 3% of the assemblage was unidentifiable (*Table 11*).

Table 11. The results of the wood taxa analysis in Narsaq.

Taxa	Nr. of artefacts (169)	%
Abies sp.	6	3.55
Betula sp.	22	13.02
Juniperus sp.	16	9.47
Larix sp.	61	36.09
Picea sp.	29	17.16
Larix sp.	3	1.78
Pinus sp.	4	2.37
Pinus sylvestris L.	15	8.88
Salix sp.	8	4.73
Unidentifiable	5	2.96
Total:	**169**	

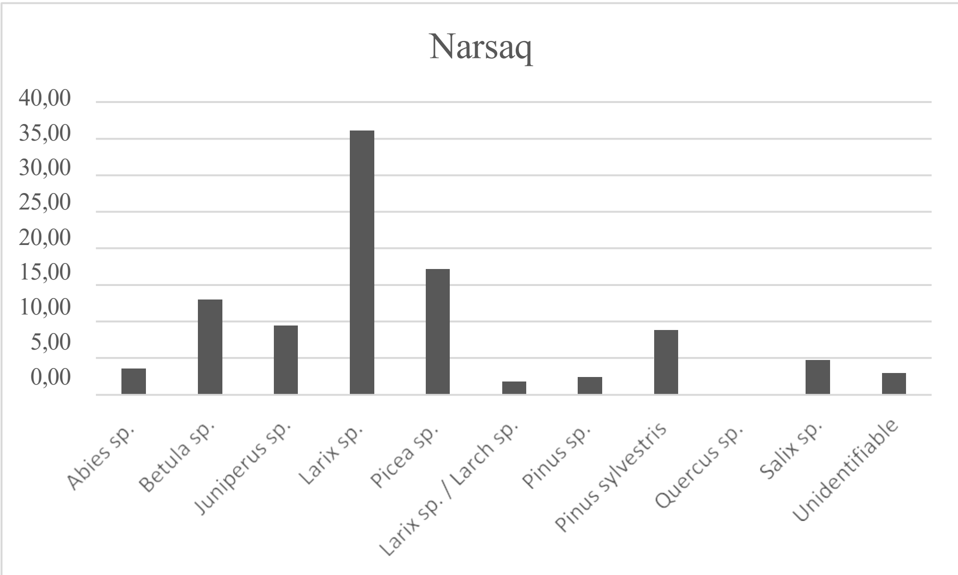


Figure 61. The results of the wood taxa analysis on artefacts from Narsaq.

Discussion

Like the other medium-sized households, the inhabitants in Narsaq were self-sufficient regarding wood acquisition. They relied heavily on driftwood, although native wood was an integral part of the wood utilisation strategy, and Narsaq has one of the highest proportions of artefacts made from native wood (*Fig 62*). Due to the nature of the excavation and how selective Vebæk was, there might be a bias in the assemblage; however, whether it is towards driftwood or native wood is uncertain.

Figure 62. Decorated artefacts from Narsaq made from native wood; a) Decorated plank – willow sp. (Fnr.108); b) Decorated object – birch sp. (Fnr. 201); c) Decorated object – juniper sp. (Fnr. 100); d) The other side of object c.; e) A small plank with decorations –birch sp. (Fnr. 502).

6.5 Gården under sandet

Gården under sandet, or GUS, was discovered by two reindeer hunters in 1990 on a riverbank in an area called Naujaat Kuuat. The site is a middle-sized inland farm in Vestribyggð. It lies on the east side of a small valley running south from the bottom of the Ameralla fjord (Norse: Lýsufjörður), only a few kilometres from the glacier. The glacial river was eroding the site, and given the excellent preservation, an excavation started the following year and continued until 1996. A sand layer that was more than 1 m thick covered the site. Hence the name, and under the sand was permafrost. Due to the sand and the permafrost, organic preservation was excellent. The site was in use from ca. 1050 – 1380 AD, with eight building phases defined and about 63 rooms recorded (Enghoff, 2003; Ólafsson & Albrethsen, 2016). All artefacts were retrieved, and all were found within the various buildings. GUS was the only site where building timber was also retrieved, although only parts were brought from the site (*Fig 64*). The phasing of the site is in its final stages, and the next step is to correlate the phasing and the artefact assemblage; however, due to a lack of information associated with the artefacts, for example, context numbers and structure numbers, the author was not able to attempt any phasing of the objects. This assemblage, therefore, awaits incorporation into the final phasing of the site. However, according to Guðmundur Ólafsson, most of the artefacts are from the later phases, and the few artefacts that were successfully associated with a structure are from the

14th century. There is, however, great future potential for the wood assemblage when the post-excavation has been completed. The author analysed all available building timber and most of the artefacts, a total of 511 pieces, while Élie Pinta analysed the vessels from the site, a total of 217 pieces (Pinta, 2018).

Wood taxa analysis

The most common taxon identified at GUS was spruce (*Picea sp.*), which comprised 37.3% of the assemblage, and larch (*Larix sp.*), ca. 27% of the combined assemblage. Larch and spruce comprised 74% of the whole assemblage, while only 1.5% was identified as Scots pine (*Pinus sylvestris* L.) and around 2% as other pine taxa (*Table 12*). These are far lower proportions than at any of the other sites in this study.

Table 12. Results of the wood taxa analysis in GUS, including artefacts analysed by Pinta.

Taxa	Artefacts	%	Building timber	%	Combined	%
Abies sp.	5	0.88	2	1.25	7	0.96
Alnus sp.	5	0.88	0	0	5	0.69
Betula sp.	59	10.39	1	0.63	60	8.24
Conifer sp.	0	0.00	3	1.88	3	0.41
Juniperus sp.	10	1.76	0	0.00	10	1.37
Larix sp.	132	23.24	64	40.00	196	26.92
Picea sp.	201	35.39	71	44.38	272	37.36
Larix sp. / Piceasp.	72	12.68	1	0.63	73	10.03
Pinus sp.	2	0.35	3	1.88	5	0.69
Pinus sect. *strobus*	11	1.94	0	0	11	1.51
Pinus sylvestris L.	9	1.58	2	1.25	11	1.51
Quercus sp.	5	0.88	3	1.88	8	1.10
Salix sp.	53	9.33	7	4.38	60	8.24
Unidentifiable	4	0.70	3	1.88	7	0.96
Total:	**568**		**160**		**728**	

In total, non-native coniferous taxa comprised 80% of the combined assemblage, while 19% was native wood. The native wood consisted mainly of birch (*Betula sp.)* and willow (*Salix sp.*), each at 8.2%. Juniper (*Juniperus sp.*) and alder (*Alnus sp.*) were also noted but in small proportions. The only unambiguous import was oak (*Quercus sp.*), representing 1% of the assemblage. There is a slight difference between the artefact assemblage and the construction timber. 91% of the construction timbers were non-native coniferous taxa, which can be categorised as driftwood, while the rest were native. Higher proportions of native wood were utilised for the artefacts, while more robust timber was necessary for building projects (*Fig 63*).

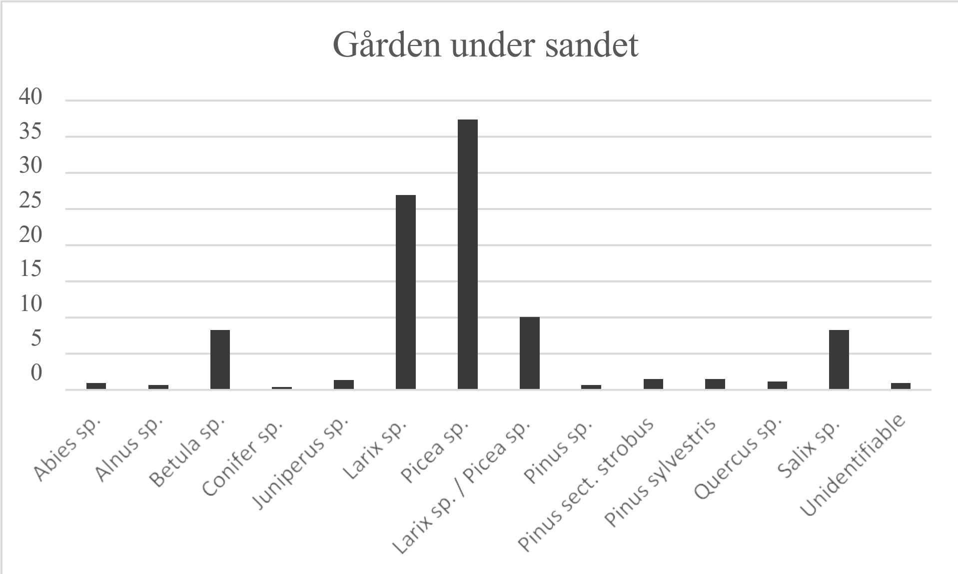


Figure 63. The result of the wood taxa analysis.

Discussion

GUS is the only site in this study in Vestribyggð, and the two settlements seem to have distinct differences. The main difference between the settlements is that the proportion of spruce is higher in GUS; the proportion of spruce in GUS is more in line with wood utilisation patterns of the Thule Inuit group in the Smith Sound and the Saqqaq group in current-day Disko Bay area (Guðmundsdóttir, 2021). There might be differences in the composition of driftwood that reaches the area where the inhabitants of Vestribyggð acquired their wood and the areas used by the Eystribyggð sites, but this is poorly understood. Another noticeable difference is the proportions of Scots pine. GUS comprised only about 1.5% of the wood assemblage, while Eystribyggð comprised 8-13% at the medium-sized farms and around 30% in Igaliku. The GUS figure might represent the actual proportions of Scots pine drifting to Greenland, or the taxon was used for other purposes, such as boats, and is, therefore, less well represented in the building and artefact material. However, the analysed boat timbers were identified as larch and spruce. The Scots pine proportions might also represent, like the spruce, the different composition of driftwood taxa in the area. However, further research is needed, and more assemblages from Vestribyggð might shed light on this issue. The assemblage is distinct from the other sites since it includes building timber and artefacts (*Fig 64, 65*). Wood waste material such as twigs, branches and woodworking debris were not retrieved from GUS. However, according to Guðmundur Ólafsson, who was part of the excavation team, some buildings and rooms were covered in twigs band branches (Ólafsson, 2021, pers comm.). This was also noted in Sandnes by Roussell (1941) and further studied by Buckland (Buckland et al. 1994). Most of the twigs were identified as willow and, to a lesser extent, birch and alder. In contrast, the wood chips consisted of spruce, larch, and pine (Buckland et al. 1994). The artefact assemblage from GUS has about equal proportions of birch and willow. At the same time, it is not unlikely that identification of non-artefactual material would give a more accurate picture of the combination of taxa in the vicinity of GUS.

Figure 64. Examples of construction timber from GUS and Tatsip Ataa. a) A construction timber from GUS (X38) – spruce sp. b) A construction timber from Tatsip Ataa (X1489) – spruce sp. c) A post from GUS (X273) – spruce sp. d) and e) A post with ringholes from shipworms (Teredinida) from GUS (X255) – larix sp.

Figure 65. Various artefacts from GUS, a) Unidentifiable object (X-1885) – birch sp.; b) A small figurine (X-1794) – birch sp.; c) A partially burnt cutting board (X-2173) – larch sp.; d) A cutting board (X-411) – spruce sp.; e) Decorated flat object (X-1466) – birch sp. ;) f) A suckling stick (X-904) – birch sp.

6.6 Typological analysis

As discussed in section 5.4, the wood assemblage was divided into 12 sub-groups according to type and use (*Table 4*). Furthermore, the data from Igaliku and Tatsip Ataa made it possible to address if there are any temporal differences. The combined assemblage shows that the highest proportion of artefacts were categorised as various stakes, pegs, wedges, pins, and nails, about 45% of the assemblage (*Table 13*). These were used for various things within the farm, and it is hard to associate any singular function to them, although they are quite clearly an essential factor in the Norse Greenlandic household. They were relatively easy to produce from offcuts and other wood debris, and thus, they bear witness to utilisation of the wood more sustainably. Most were whittled, while larger objects were most likely carved out or made with an axe. Smaller pins and pegs were frequently made from native woodland but also quite commonly from non-native conifers. The second most common group was vessels, which comprised 23% of the assemblage. The group entailed stave-built vessels, troughs, small baskets, and bowls. They were an integral component in the Norse Greenlander's daily life, used for food storage and preparation along with their carrying capacity for water and farming activities such as milking cows and caprines. The majority of the vessels were made from non-native conifers (for further discussion, see Pinta, 2018).

Construction timber and furniture components comprised 10% of the assemblage, although they were almost exclusively found in GUS. The majority of the construction timber was either larch or spruce. Other groups made up less than 5% of the assemblage. If the non-artefactual material is included from Igaliku and Tatsip Ataa, there is a marked difference in the proportions. Wood debris comprised 45% of the assemblage, and twigs and branches 26%. Most of the wood debris (in the assemblage as mentioned earlier) consists of larch, spruce pine and, to a lesser extent, native taxa. Woodworking with traditional tools during the medieval period produced an extensive number of debris (Fig. *66*). Wood shavings and offcuts from one trunk can produce hundreds of fragments. That was kept in mind when identifying these fragments; they most likely are presented disproportionally when compared with the artefact assemblage. That is why the data is presented both with and without the non-artefactual assemblage. However, it does indicate that woodworking took place at these farms and that most of the taxa were used for house construction along with other projects.

Figure 66. Woodworking in Sunnmøre Museum, Norway. Traditional Norwegian log houses were being renovated for which the carpenters' used axes, commonly used between 1100-1400; note the amount of debris (Photo: Lísabet Guðmundsdóttir).

When looking at individual sites, the pattern observed within the combined assemblage is worth noting, namely that the highest proportion of artefacts were categorised as pegs, pins, wedges and nails. The highest proportions of this category were observed in Igaliku, with over 60% of the assemblage, while in GUS, only 23% consisted of these artefacts. That could be because of find circumstances and one of the main differences between objects found in middens and those found in structures. Worth mentioning is that this difference is not noticeable in Narsaq. The vessel category is another category that is substantially different in GUS than at the other sites. It comprises about 36% of the GUS assemblage, while the proportion varied from 12–21% at the other sites. This, for example, is not the case in Narsaq either. The highest proportion of utensils for textile production was observed in Tatsip Ataa during the earlier period and made up around 16% of the assemblage, while there was a detectable reduction of these objects in the latter period (6%). At the other sites, the proportions vary from 1-3%. Larch and spruce were the most common taxa in each category, excluding twigs and branches. Observing temporal change within the assemblages from Igaliku and Tatsip Ataa, there are very few changes in Igaliku concerning the proportions; they are relatively similar throughout both periods, except for increased production of nails in the latter period. It is more noticeable in Tatsip Ataa that there is an increase of objects categorised as stakes, pegs, wedges and pins from 21% to 36% and a decrease in the vessel and textile production categories along with a slight decrease in the tool and utensil category. The reduction of these categories might indicate specific changes in farming strategies after 1300, with less emphasis on wool production. It was impossible to detect that any particular taxa were chosen for certain types of artefacts, indicating that people made do with the option they had.

Table 13. Results of the typological study (proportions %). Wood debris twigs and branches are not included in this table. E. Pinta identified the vessel components from GUS and Tasilikulooq.

Site	Construction timber/ furniture components	Decorative and ritual objects	Farming/ hunting/ accounting	Food preparation	Nails	Personal items	Stakes/ Pegs/ Wedge/ pins	Textile production	Toys/games	Utensils and tools	Vessels	Unidentifiable/ Other	Ship timber
Igaliku I	3,17	1,50	2,17	0,83	5,84	0,17	55,59	2,84	0,33	4,34	16,19	7,01	0,00
Igaliku II	1,52	1,14	2,28	0,38	12,55	0,00	54,75	1,52	0,00	3,42	15,97	6,46	0,00
Tatsip Ataa I	10,94	0,78	3,91	0,78	21,09	0,00	21,09	15,63	0,78	3,13	16,41	5,47	0,00
Tatsip Ataa II	9,04	1,13	3,39	0,00	20,90	0,00	36,16	5,65	0,00	0,56	11,86	11,30	0,00
Tasilikulooq	2,62	0,95	1,67	0,24	15,24	0,00	30,48	0,71	0,24	5,24	21,43	21,19	0,00
Narsaq	2,47	7,41	0,00	2,47	19,14	1,23	25,93	3,09	1,23	6,79	19,14	7,41	3,70
GUS	24,93	0,71	0,57	1,71	3,28	0,00	19,66	1,00	0,43	3,13	35,75	8,55	0,28

6.7 Wood utilisation and procurement strategies in Norse Greenland

This study used wood taxonomic analysis to establish a baseline for the origin, availability, and acquisition of wood resources in Norse Greenland. The aim was to study a wide range of materials, go beyond the study of single-type artefacts, and utilise understudied materials such as wood debris, twigs, and branches. Furthermore, it became evident that the most fruitful results came from the sites where both material groups were considered. The studies further showed no apparent change in wood procurement throughout the Norse settlement (ca. 985-1500 AD). When only the artefact assemblage is considered, there is a difference between the settlements, even though more sites in Vestribyggð need to be studied to confirm such an assumption. There is a slight difference in the composition of wood taxa between the artefact assemblage found in middens and those found in structures. However, that difference more likely represents different procurement strategies in Vestribyggð and more reliance on native woodland during the initial settlement period. Statistically, the difference is minimal. The combined results of the wood taxa analysis show that the non-native coniferous taxa comprise about 60% of the total assemblage, potential native taxa comprise around 40%, and unambiguous imports represent less than 1%. There is an overlap between imports and driftwood taxa. Still, there is a fair reason to think that the majority of the conifer taxa arrived as drift to Greenland rather than being imported, as was the case with other Norse societies in the North Atlantic (Anderson & Malmros, 1993; Bishop et al. 2012; Christiensen, 2013; Guðmundsdóttir 2022a; Malmros, 1994; Malmros, 1990; Mooney et al. 2022; Mooney, 2014, 2016a, b, c; Pinta, 2018). Further advances on this issue await more accurate provenancing methods, which can be realistically performed on large wood assemblages. Even so, it can be assumed that due to the high proportion of Scots pine in Igaliku, the episcopal manor had access to import from Europe along with a small influx from North America. The fragments identified as American taxa were small, mostly shaving or unidentifiable small objects, thus hindering further study of the material.

The Norse sites in Greenland are conventionally categorised as small, medium, or high-status sites (Madsen, 2014). The sites in this study are all medium-sized except for Igaliku, which is classified as high status, being the episcopal manor. The study does indicate that there was a significant socio-economic difference between the sites in question. The proportions of wood taxa are similar on medium-sized farms. The slight differences, especially between GUS in Vestribyggð and the sites in Eystribyggð, are more easily explained by the ecological setting rather than socio-economic factors. In contrast, Igaliku shows a different pattern indicating access to imported timber, which the other farms did not have.

Written sources, as well as archaeological studies by Smiarowski (2022), Madsen (2014) and Vésteinsson (2010) indicate that Norse Greenland was a hierarchical society, sharply divided between a lower and an upper class (Arneborg, 2004). The latter class consisted of secular and ecclesiastical magnates occupying a small number of manors, which are differentiated from the rest of the sites by much greater ruin numbers, larger byres, and expensive architecture (Vésteinsson et al. 2019). The magnate farms seem to have controlled most of the land and outfield resources and the revenues from farming and hunting (Frei et al. 2015; Madsen, 2019; Vésteinsson, 2010). The occupants of the small and middle-sized farms are generally believed to have been tenants who were dependent on their landowners for access to resources outside of the farmland rented. Outfield resources include both driftwood and native woodland. Driftwood procurement could have happened as a part of the communal seal hunts or on long-range hunting trips. However, transporting driftwood over long distances is complicated and requires equipment (boats), time and workforce that individual smallholders would not have been in command of (Guðmundsdóttir, 2022a). The wood assemblages indicate that the bishop in Garðar had significantly greater access to driftwood than the middle-ranking farmers on the other sites studied, no doubt reflecting greater capacities for organising long-range resource utilisation.

Setting aside the possibility of short-time shortages, which would be impossible to detect, there are no indications of a wood shortage in any of the sites. It is possible that the smallholders were able to supply themselves with sufficient wood as a by-product of their communal seal hunts on the outer coast. Still, it could also indicate the degree of re-distribution that the bishop and other landowners ensured their tenants had access to the resources they required to sustain themselves. This would have parallels in Iceland, where the Bishop of Skálholt owned extensive woodlands, which his tenants were allowed to use to produce charcoal (Vésteinsson & Simpson, 2004).

The Norse Greenlanders had to travel long distances to the hunting grounds, Norðurseta and Finnsbúðir, where walrus hunting took place throughout most of the period of Norse settlement in Greenland (Smiarowski, 2022). These expeditions demanded a travel of up to 1000 km, which required suitable vessels, a skilled workforce, collaboration, and coordination. That entailed choosing a coherent crew who could get along for long periods of time in close proximity to each other. Assumably, experience had taught people some awareness on this topic, at least according to written sources. Thus, it is written in *Laxdœla saga* that wise men chose people and crew who could live and work together peacefully and undramatically in the hunting stations. It further states that it would be disastrous if there were disagreements within the group, and that would lead to unsuccessful hunting trips (ÍF V, 1934, p. 29). To implement these expeditions successfully, this element had to be considered, not the least to make up for the labour lost to the farms when large numbers of workers had to be away on expeditions for a significant part of the short summer. The elite would have had to provide some compensation, and it can be imagined that this included wood or access to areas where it could be collected or cut.

However, based on currently available evidence, it is impossible to flesh out how this could have worked in detail. Still, the evident stability of the wood supply and the lack of any indications of shortages of this vital resource suggests a significant element of re-distribution in this system. In this case, the geographical scale of the resource exploitation and the high degree of interdependence between the magnates and the tenants are unusual. It is not apparent that the longest-range expeditions, namely those to mainland North America, had any such redistributive element. The evidence from Igaliku demonstrates that such expeditions were not limited to the 11th century but recurred throughout the Norse period. Still, there are no signs that the wood so procured ended up in ordinary households. The crew members must have been compensated for their work somehow, but it was (clearly) outside the resources obtained on these distant shores of North America. This raises the question of whether the same was true of the walrus hunt, that the object of the expeditions and the revenue created may not have benefited the households which contributed to the workforce directly, and that instead, they had to be content with being granted the means for bare subsistence. In other words, the redistributive system guaranteed that ordinary households could survive but did not, as far as can be seen, render them a significant share in the surplus created by this system.

Compared to Iceland, the much lower proportion of farms with their own chapels has been interpreted as evidence of an absence of a substantial class of yeomen farmers or affluent tenants (Vésteinsson, 2010). One avenue for further research is to assess if there are significant differences in the wood assemblages of the few sites, which, based on chapel association, might be regarded as upper middle class.

Judging by the one elite residence included in this study, the pinnacle site of Igaliku, the episcopal manor Garðar, the elite had access to timber imports, mainly from Europe but also from mainland America (Guðmundsdóttir, 2023). There are indications that Igaliku, along with churches, had better access to driftwood than the other sites. This is consistent with indications of the written sources (particularly Ívar Bárðarson's *Description*, which is consistent with the less explicit testimony of *Grænlendingaþáttr*), namely, that the magnate farms both had outright ownership of distant driftwood beaches and the equipment and organisation to exploit them. It is not apparent if the elite had preferential access to certain kinds of driftwood, as expected under such a system of ownership and procurement. This, at least, cannot be ascertained from the species distribution. Still, differences in the size of drifted wood (which was an issue in Icelandic driftwood utilisation) cannot be assessed based on the available assemblages, except in the case of GUS. They had access to proper building timber, such as logs, used for posts and planks (Guðmundsdóttir, 2022a).

Likely, the small but nevertheless significant proportion of imported wood in Igaliku reflects the conspicuous consumption of a material which was scarce in Norse Greenlandic society. The assemblage does not allow characterisation of how the imported timber was used in Igaliku. Still, it can be imagined that it played a role both in the consumption of exotic foodstuffs (e.g. barrels for the storage of wine or grain) and in the architecture of the episcopal manor, with its numerous large and imposing buildings (Nørlund, 1929).

In that context, two things can be pointed out: One is the emphasis on stone architecture at Igaliku and other Norse Greenlandic magnate farms (Arneborg, 2004). Compared to Iceland, where practically all monumental architecture was in wood (Ágústsson, 1990; Jónsson, 1919), the Norse Greenlandic sites contrast significantly in both evidence for stone-built, mortared churches (in Hvalsey and Garðar for sure, and possibly other sites too) (Nyegård, 2009; Nørlund, 1929), and for stone-built vernacular buildings like the so-called tithe-barn in Igaliku and the feasting halls at Hvalsey and Herjólfsnes (Arneborg, 2004, 2015; Nørlund, 1929; Roussell, 1941). These buildings have no known parallels in Iceland and suggest a preference for megalithic stone construction to communicate power signals.

The second point relates to the feasting halls and the suggestion that the halls in Hvalsey and Herjólfsnes are just the foundations and basements for timber buildings of a very grand scale (Berglund, 1982). The feasting hall at Garðar is clearly a very different kind of building, with a much larger floor space, which, irrespective of the materials used in its outer walls, would have required very large beams as a part of a substantial timber construction. Based on parallels with other North Atlantic communities, it is likely that the woodwork in these prestigious buildings was richly ornamented with carving (Ágústsson, 1989; Anker & Havran, 2005). Rather than seeing these as conflicting signals, it suggests that the Norse Greenlandic elite was able to play to the strengths of its situation: imported wood was expensive, and the elite was able to acquire it in sufficient quantities to maintain its status, but it had strong incentives also to find other solutions, in particular for its monumental architecture. In the North Atlantic context, as in northern Europe, stone masonry architecture was more expensive and prestigious than wood architecture. The Norse Greenlandic elite would have to import lime mortar (Nedkvitne, 2019) and perhaps experts to build these structures at a comparable or greater expense than if they had been building the churches entirely in wood. As in other matters concerning Norse Greenland, this invites two interpretations: on the one hand, it can be seen as evidence of scarcity, isolation, and high procurement costs and on the other, as a sign of a highly top-heavy society, with a small elite able to embark on building projects and indulge in consumption more conspicuous than the elite of (less unequal) the more egalitarian Iceland could ever dream of, to take an example.

Both characterisations, it seems, have some truth in them, and the wood assemblage can be said to support both assertions: imported wood was not a significant part of all wood consumption and was, at the same time, in part, extremely significant as a status marker. It is, however, more unclear to what extent the elite used its ability to acquire exotic wood species through trade and expeditions to mainland America to support its infrastructure capacity. It is possible, for instance, that imports mattered for the local boat-building industry, but if this was the case, there is no evidence for it.

Wood taxa analysis points to the utilisation of driftwood rather than import for boatbuilding (Anderson & Malmros, 1994; Guðmundsdóttir, 2022a), which is a well-known tradition from Iceland (Kristjánsson, 1965; 1980; Mooney, 2016b). According to Valgeir Benediktsson, a driftwood carpenter in NW Iceland, drifted pine is preferred for boatbuilding since it is easier to bend and manage after it has been headed. Spruce is avoided since it is not as dense and flexible and has frequent knots which tend to pop out of the planks when they dry (Benediktsson, 2019 pers. comm.). Drifted pine was also preferred by boat builders in the 18th and 19th centuries, with larch being the second choice due to its density. The larch boats tended to get very heavy, but they lasted longer and did not get impregnated with seawater (Kristjánsson, 1982). Studies on pre-Christian boat burials show the same pattern, although oak has also been identified (Gestsdóttir et al.; Mooney, 2016b). Generally, pine was preferred for boat building in Iceland, and pine and oak were preferred in Norway (Bill, 2010; Paasche, 2021). Therefore, the main argument goes if these boat parts were imports, then pine would have been chosen rather than larch and spruce. Even so, it cannot be excluded that the larch was imported from North America; a study of growth rings was unfortunately not possible due to the impregnation of PEG. Boats were also necessary for ordinary Norse Greenlandic households, both for travel and general substance. These would have been smaller vessels, perhaps 2-4 oared, and they would have been more numerous than ships used for more extended expeditions. The boat parts analysed could just as well have originated from these smaller vessels, while the ships could have been built from import. Boatbuilding was a specialised task, and not everyone would have the knowledge and expertise required. In an Icelandic context, boat builders usually lived close to the main driftwood areas, and from there, the boats were transported to their owners (Kristjánsson, 1982). This was hardly the case in Greenland, but it could have been done at seasonal outposts on the outer coast. It is unknown if boatbuilders were located at the farms included in this study. If not, they would have to acquire their boats from somewhere else or hire boatbuilders for the job.

Our picture of the social system of Norse Greenland is much clearer for the final two centuries of the settlements than for the earlier period. This is the period for which at least some written records shed light on landownership and ecclesiastical organisation, and archaeology, our foundation for assessing settlement patterns and site-status distribution, also pertains mainly to the final phase.

The high levels of inequality compared to Iceland (Vésteinsson et al. 2019) hold primarily for the 14th century, as does Ívar Bárðarson's description of a society dominated by ecclesiastical landholdings and less prominent secular dominion divided between royal interests and (presumably) a local-born elite. In its final phase, non-local interests, primarily the Church, heavily dominated Norse Greenland and the King, who was not only a landowner but also had a monopoly on the Greenland trade (Seaver, 1996; Nedkvitne, 2019). To what extent the situation had radically changed since before the 1260s, when the Greenlanders accepted the Norwegian king as their overlord, is unclear. Usually, it is assumed that their social organisation was similar to that of Iceland, with a system of assemblies and chieftains who depended on the support of free farmers (Gulløw, 2008b; Krogh, 1967; Sanmark, 2010). Keeping with the analogy of Iceland, it is then expected that the following changes occurred in government in the 1260s: the local elite changed from chieftains to officials, and the Church became even more dominant as a landowner and backbone of local government through the parish system (Arneborg, 2006; 2015; Nedkvitne, 2019).

The wood assemblages do not shed direct light on these matters, but two things can be mentioned: One is the clear indication of stability in wood procurement and use through the period in question. This suggests that the quite complex systems needed to supply Norse Greenlandic households with wood, especially driftwood, developed early and stayed the same, at least not in their capacity to deliver wood to farms, even though there were changes in the organisation of the top management. From the point of view of state formation (Bagge, 2005; Vésteinsson, 2019), the wood evidence is consistent with the idea that the Norwegian incorporation of Greenland in the 1260s was a case of overreach, that the revenues created by Norse Greenland for the royal treasury were not, in the long run at least, sufficient to justify the expenses of keeping up the connections.

The Norse Greenlandic economy was locked into a system which ensured bare subsistence for its people but produced only exotic goods (first and foremost walrus ivory), which had provided its elite with status and buying power since the 11th century but was no longer sufficient to achieve the same ends in the much more market-oriented economy of the 14th century (Arneborg, 2015; Frei et al. 2015; Roesdahl, 1995). Furthermore, as the population dwindled, it became increasingly important for the elite to have access to a sufficient workforce for the hunting expeditions to the northern hunting grounds. This might have resulted in competition over the workforce working in the favour of the people inhabiting medium-sized farms (i.e., households with workforce to spare). They would have been well fed, although smaller farms were more dependent on seals, while larger farms maintained domestic stock along with a higher proportion of caribou (Smiarowski, 2022). In addition, these farms had access to fair amounts of timber, both from native woodland and drift. It is not unlikely that the smaller farms were granted access to leftover timbers, which the larger households did not need, but that could not be shown in this study.

Native woodland was essential for the smaller households, but it is far less used in Igaliku. Accessing native wood, twigs, and branches, was most likely done relatively short distances from the farms. Pollen analysis has shown that Vatnahverfi was rich in woodland (Ledger, 2014), while it seems less so in the vicinity of Igaliku. It is stated in the *Description of Greenland* that the episcopal manor owned vast woodlands (Halldórsson, 1978). Again, this indicates that the right to use the woodland could still have been in the hands of the elite. The proportion of native woodland was lowest in Igaliku compared to the other sites in this study. Indicating that the elite chose other resources and thus had that option. The elite seems not to have hindered any access (of lower classes) to it, and seemingly, any shortage of native wood cannot be detected. Furthermore, it could be acquired at a relatively low cost in terms of effort and social interaction.

6.8 The North Atlantic

It has been established that wood-poor countries in the North Atlantic like Greenland, Iceland and the Faroes relied extensively on driftwood (Mooney et al. 2022). Even so, quite subtle differences can be detected between the mentioned countries. In the next sections, the aim is to place the Greenlandic assemblages in a wider perspective by comparing them with assemblages from Iceland and Norway. No need to argue, there is a fundamental difference between the wood procurement strategies in western Norway on the one hand, and Iceland and Greenland the other. In Norway, wood could be acquired relatively short distances from the sites, and the majority was most likely of local origin while Icelanders and Greenlanders had to rely on other sources such as driftwood and import. There are, however, few studies on wood utilisation and acquisition strategies in Norway. The sites discussed in the following chapters are Alþingisreiturinn, in central Reykjavík, Borgund and Bergen in western Norway (*Fig 67*). These sites were chosen since they are contemporaneous with the Norse Greenlandic material, and since the organic preservation was extremely good. Furthermore, the material culture excavated in Borgund is being re-studied in the still on-going Borgund Kaupang project (Hansen, 2020).

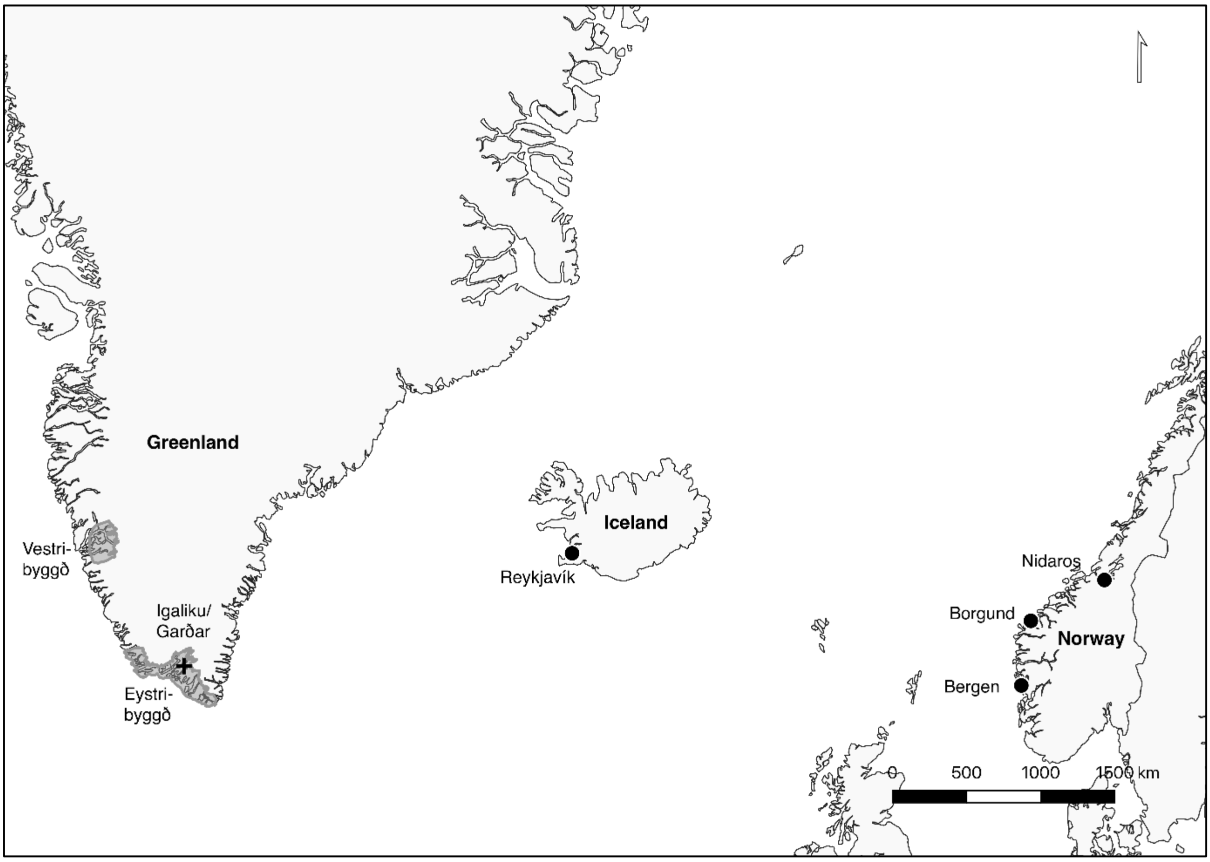


Figure 67.. The location of the sites discussed in this section as well as Nidaros which was the arcdiocese was located.

6.8.1 Alþingisreiturinn

Alþingisreiturinn is located on the southwestern coast of Iceland, on the Reykjanes peninsula. It is a coastal site that sits on a gravel bank between the sea and a small lake in the current city centre of Reykjavík. The excavation took place in 2008-2012, and the site dates from the settlement of Iceland, around 870 AD, to modern times. The material used in this study is from two time periods, 870-1226 AD and 1226-1500 AD, which were dated by tephra chronology (Garðarsdóttir, 2010). The site consists mostly of various outhouses, smithies, and a large midden in the earlier phase, while in the latter phase the emphasis seems to have been more on fish processing (Garðarsdóttir, 2010). The organic preservation was excellent due to waterlogged conditions, with both artefacts and non-artefactual material preserved. Like in the Greenlandic assemblages, the non-artefactual material consisted mostly of wood working debris, twigs, and branches (Guðmundsdóttir, 2010, 2013b).

In total, 863 pieces were analysed from Alþingisreiturinn: 495 from phase IV and 369 from phase III (*Fig 68*), (*Table 14*). The most common taxon identified in the earlier phase is birch (*Betula sp.*), which makes up 54% of the assemblage. The second most common taxon is Scots pine (*Pinus sylvestris* L.), at 17%, while larch and spruce make up about 18% of the assemblage. Other taxa identified are the imported taxa oak (*Quercus sp.*), ash (*Fraxinus sp.*), and yew (*Taxus sp.*), with a combined proportion of about 3%. In short, native taxa make up of 57% of the assemblage, driftwood 40%, and imported wood about 3%. There are substantial differences between the phases in Reykjavík. The proportions of native taxa decrease to 30%, while the non-native conifer taxa increase to 53%, in the later phase. The reason is a substantial increase in the utilisation of pine, which might be explained by increasing imports. There is also a substantial increase in oak, which makes up 16% of the assemblage in phase 2. After 1226 AD, people in Reykjavík relied more heavily on imports than before, mostly of oak and pine.

Table 14. The results of the wood taxa analysis from Alþingisreiturinn, the data represents both artefact and non-artefactual material.

Taxa	Phase IV (871-1226) Count	Phase IV (871-1226 AD) (%)	Phase III (1226-1500) Count	Phase III (1226-1500 AD) (%)	Combined	Combined (%)
Betula sp.	268	54.14	106	28.73	374	43.29
Juniperus sp.	0	0.00	2	0.54	2	0.23
Larix sp.	72	14.55	40	10.84	112	12.96
Larix sp.|Picea sp.	3	0.61	0	0.00	3	0.35
Fraxinus sp.	1	0.20	1	0.27	2	0.23
Taxus sp.	1	0.20	0	0.00	1	0.12
Picea sp.	36	7.27	18	4.88	54	6.25
Pinus sp.	85	17.17	138	37.40	223	25.81
Quercus sp.	14	2.83	60	16.26	74	8.56
Salix sp.	11	2.22	3	0.81	14	1.62
Sorbus sp.	4	0.81	1	0.27	5	0.58

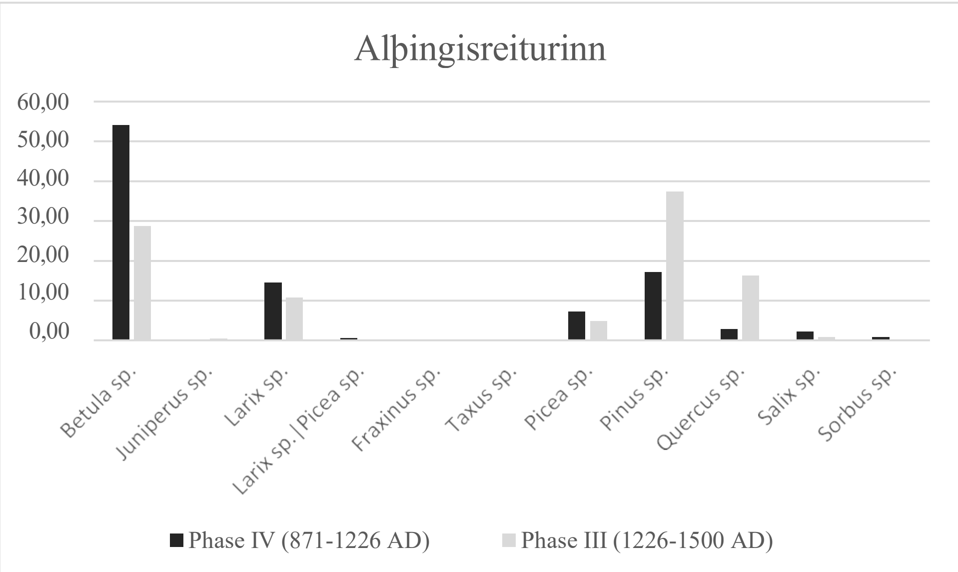


Figure 68. The results of the wood taxa analysis.

6.8.2 Borgund

Borgund is a rocky peninsula in Sunnmøre, western Norway, where Ålesund is located today (*Fig 69*). The site has been identified as a small Kaupang, or a trading town that was in use from around 950 to around 1500 AD (Herteig, 1972). Extensive archaeological excavations took place in Borgund at various times from 1912 until 2013 (Hansen 2020). Nevertheless, little work had been done on the datasets collected in Borgund until the Borgund Kaupang Project was started in 2019 (Hansen 2020). Several datasets are being explored, and one of them is wood that was extremely well preserved due to good organic preservation at site. The assemblage consists of wood objects as well as building timbers, while non-artefactual material like wood debris as well as twigs and branches were not collected (Herteig, 1972). The data presented here are preliminary since the project is still ongoing. However, it gives an indication about the most common taxa being used in Borgund for artefact production during the Viking Age and the mediaeval period. The main aim is to show the difference in wood utilisation strategies between these two countries where environmental conditions are profoundly different although the material culture was still relatively similar. Furthermore, due to political ties with Norway majority of trade went through western Norway, Nidaros initially and then Bergen (Dugmore et al. 2011). Therefore, comparison with these sites might add insight into which taxa would potentially be exported from Norway to Greenland during this period.

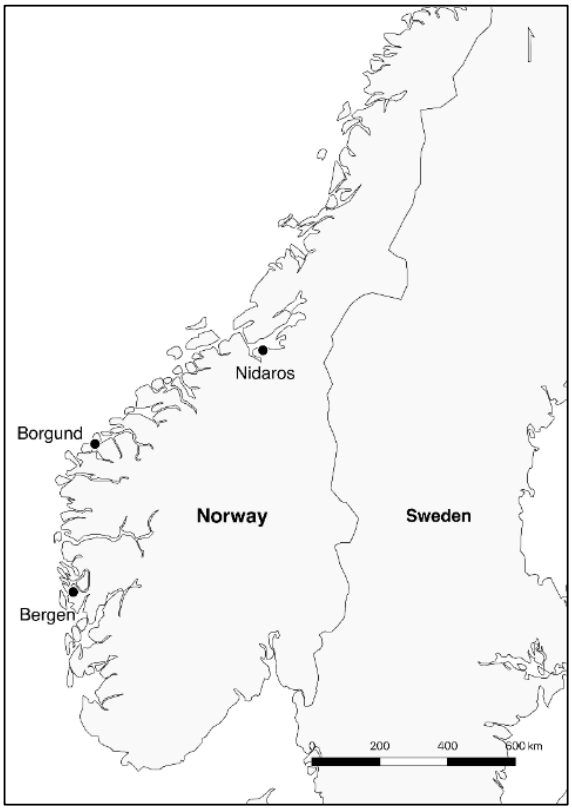


Figure 69. Location of Bergen, Borgund and Niðarós.

Two hundred out of 1049 wood objects from Borgund have been analysed (*Fig 70*). The assemblage consists of artefacts of varying types, from household objects to fishing gear (*Table 15*).

Table 15. The results of the wood taxa analysis on artefacts from Borgund.

Taxa	Borgund (nr.)	Borgund (%)
Alnus sp.	3	1.49
Betula sp.	23	11.39
Corylus sp.	1	0.50
Deciduous species	2	0.99
Quercus sp.	5	2.48
Salix sp./Populus sp.	10	4.95
Juniperus sp.	11	5.45
Picea sp.	4	1.98
Pinus sylvestris L.	136	67.33
Unidentifiable	7	3.47

In total 8 taxa were identified in Borgund, while few of the pieces were unidentifiable or could only be identified as deciduous taxa. The most common taxon identified was by far Scots pine (*Pinus sylvestris* L.), which represents 67% of the assemblage. The second most common taxon was birch, at 11%, while juniper made up 5% of the assemblage. Other taxa identified were alder, hazel, oak, willow, and spruce, all below 5%. Thus, Scots pine was by far the most important wood taxon utilised in Borgund during this time period. In total 78% of the assemblage consisted of coniferous taxa.

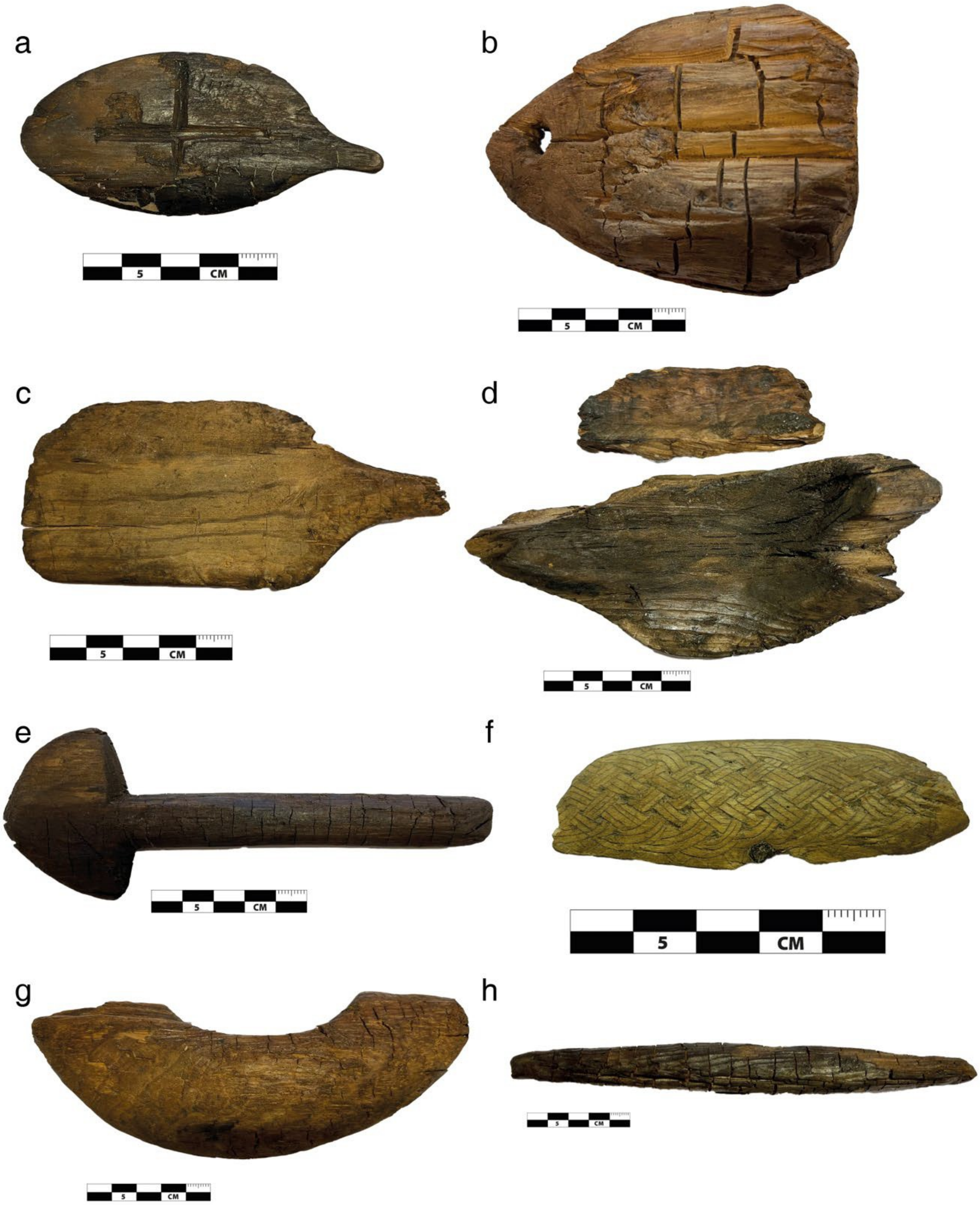


Figure 70. Various artefacts identified from Borgund, a) Decorated object (F-279) – Scots pine; b) Net floater (F-282) – Scots pine; c) Spade (F-270) – Scots pine; d) Scoop (F-407) – willow sp./aspen sp. e) A possible toy sword (F-188) – Scots pine ;f) Decorated spoon handle *(F-1239) – birch sp.; g) Handle (F-248) – juniper sp.; h) Spindle (F-277) – Scots pine.*

There has not been any large-scale wood taxonomic study of a complete wood assemblage from a single site in Norway, only on selected artefacts or groups. For example, there are studies of selected artefacts from the town excavations in Oslo (Færden et al. 1990) and on textile equipment from Bryggen in Bergen (Øye, 1988). When the Borgund material is compared to the results of the wood taxa analysis of textile equipment from Bryggen, a substantial difference is apparent, with far more variety in Bryggen. In total 11 taxa were identified, of which Scots pine was the most common with ca. 29%, which is far lower than in Borgund. Yew (*Taxus baccata L.*) was the second most common taxon at ca. 24%; juniper made up 14% of the assemblage and oak 8%, while the rest of the taxa were at 5% or less. Even though the composition of the two assemblages is substantially different, the combined coniferous assemblage represented around 76% of the material in Bryggen, and 78% in Borgund. Either conifers were chosen for these artefacts, or this represents more or less the available tree taxa in the region.

In general, the wood used in Borgund was of good quality. The Scots pine had few knots and narrow growth rings, which makes the wood stronger and longer lasting (Edlin, 1973). Another factor that differed from the Greenlandic assemblage is that in some cases the natural shape of the tree or branch was used when producing the object. The fibre direction of the wood followed the desired form of the objects and by doing so utilised the natural strength and flexibility of the raw material. This, for example, is a well-known practice by boat and ship builders in Scandinavia (Ravn, 2016). This further suggests a certain level of organisation before collecting raw material. Greenlanders had fewer options in that regard, they had to adapt to the raw material available to them at each time, and that dictated what you could build or produce. This could be observed in the artefact assemblage, it was rare to see curved objects where the natural shape or the fibres of the tree dictated it´s shape.

6.8.3 Palaeo-Inuit and Inuit wood utilisation strategies in Smith Sound and Greenland

Paleo-Inuit groups had lived in the Eastern Arctic for over 4500 years, long before the arrival of the Norse. These cultural groups have a long tradition of woodworking in the Arctic and acquiring wood resources within their geographical zone without contact with Europeans (Grønnow, 1996). Despite indications that both the Dorset and the Thule cultural groups had sporadic contact with the Norse during the medieval period (Gulløw, 2008a, 2016), it is rather unlikely that this had any significant impact on their wood procurement strategies. By analysing the wood procurement strategies of these cultural groups, it is possible to obtain a more comprehensive view of wood resources available in Greenland and to assess if the non-native conifer taxa within the Norse assemblages are likely to be imported or drift (Guðmundsdóttir, 2021). Archaeological research on Inuit sites in south Greenland is limited, and none are geographically close to the Norse settlements. The Norse material was, therefore, compared to two previously analysed paleo-Inuit and Inuit wood assemblages. One from the Saqqaq culture site in Qeqertasussuk, in the Disko Bay, dates from ca. 2500-1000 BC (Grønnow, 1996), and the other from a Thule Inuit site on Skraeling Island in the Smith Sound, which dates from the 13th to 15th century AD (*Fig 71*) (Alix, 2009a).

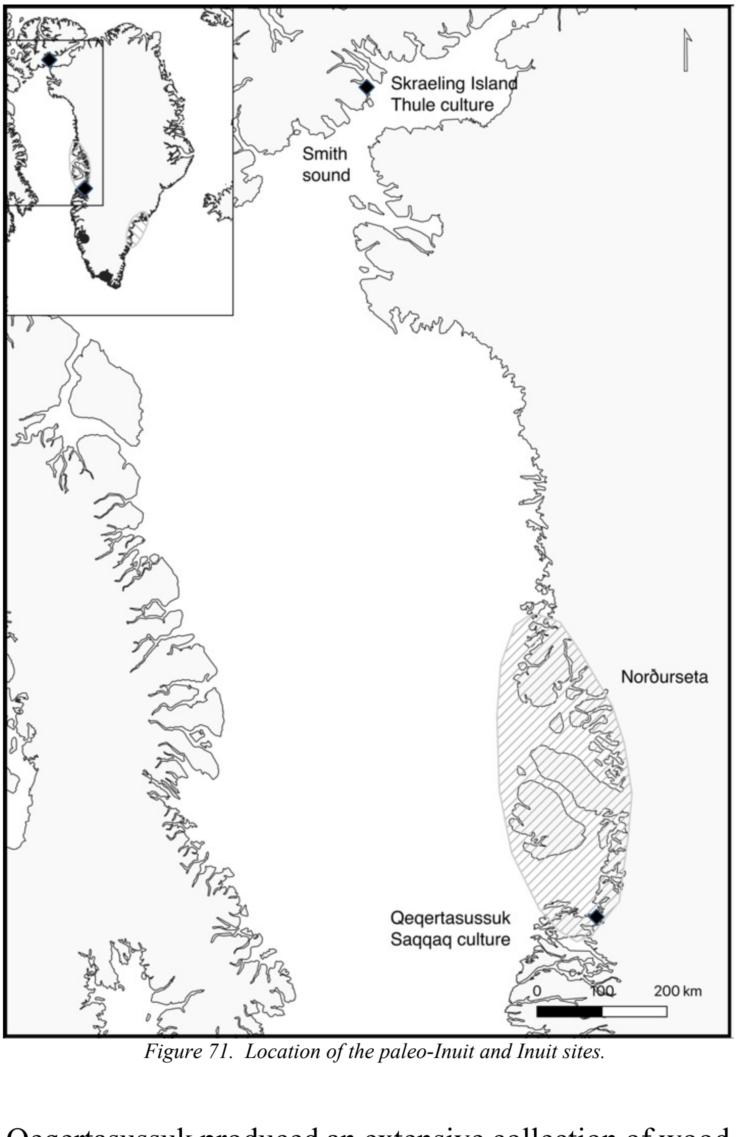


Figure 71. Location of the paleo-Inuit and Inuit sites.

The excavation at Qeqertasussuk produced an extensive collection of wood debris and wooden artefacts. In total, 370 wood fragments were analysed. The researchers focused on wood artefacts that could be categorised as tools, both household and hunting tools. Wood debris and firewood were not analysed. The study revealed that around 50% of the assemblage was spruce

(*Picea* sp.), about 34% was larch (*Larix* sp.), around 5% of the assemblage was identified as pine (*Pinus* sp.) and 5% was juniper (*Juniperus* sp.). The rest of the assemblage was made up of willow (*Salix* sp.), aspen (*Populus* sp.) and fir (*Abies* sp.). The main conclusion is that the Saqqaq culture in Disko Bay relied primarily on driftwood and, to a small extent, on native woodland (Grønnow, 1996). However, it is likely that if wood debris and firewood were analysed, the driftwood-native wood bias would also be reduced.

A similar pattern emerges from studying wood utilisation in a Thule culture site on Skraeling Island in the Smith Sound - contemporary to the Norse settlements. A total of 137 wooden artefacts were analysed, of which 94% were made from conifer species. Spruce comprised 47% of the assemblage, larch 28%, fir 7%, and pine 4%, while the rest was categorised as “other”. The overwhelming abundance of spruce most probably reflects locally available driftwood, either found in the Smith Sound area during journeys east or brought from Alaska as ready-made objects (Alix, 2009a). The majority of the assemblage was categorised as hunting equipment, 56%; 9% as household objects; 4% as ornaments and ritual-related; objects related to transport were 2% while 24% were unidentifiable (Alix, 2009a). Wood utilisation strategies among these two cultural groups are remarkably similar despite being from vastly different periods (*Fig 72*). Both groups relied predominantly on larch and spruce and, to a small extent, native woodland and pine. Comparing the Norse sites to these patterns, GUS shows the most remarkable resemblance and is closest geographically, while the sites in Eystribyggð have higher proportions of pine, especially Igaliku, and lower proportions of spruce. Larch is similar throughout, while the proportion of spruce is higher in Skraeling Island, Qeqertasussuk and GUS, which might indicate a different composition of driftwood available in the north or better preservation (Guðmundsdóttir, 2021). The results suggest that most of the spruce and larch at the Norse sites can be categorised as driftwood, while the pine is partly imported, which is primarily noticeable in Igaliku. Another difference is that the Norse utilised native woodland to a greater extent, which is natural as both Qeqertasussuk and Skraeling Island are beyond the growing limit of downy birch. Furthermore, the native woodland in the area is characterised by small, low-growing taxa (Jensen, 2003).

There is a profound difference between the Norse and Inuit artefact typology. While over 50% of the wood artefact assemblage in Skraeling Island can be categorised as hunting gear, this is almost non-existent within the Norse material, where the majority can be categorised as household items as well as pins, pegs and nails. Furthermore, the people belonging to the Thule culture did not work iron other than meteoric iron (Colligan, 2017), while the Norse only had access to imported iron (Buckwald, 2001).

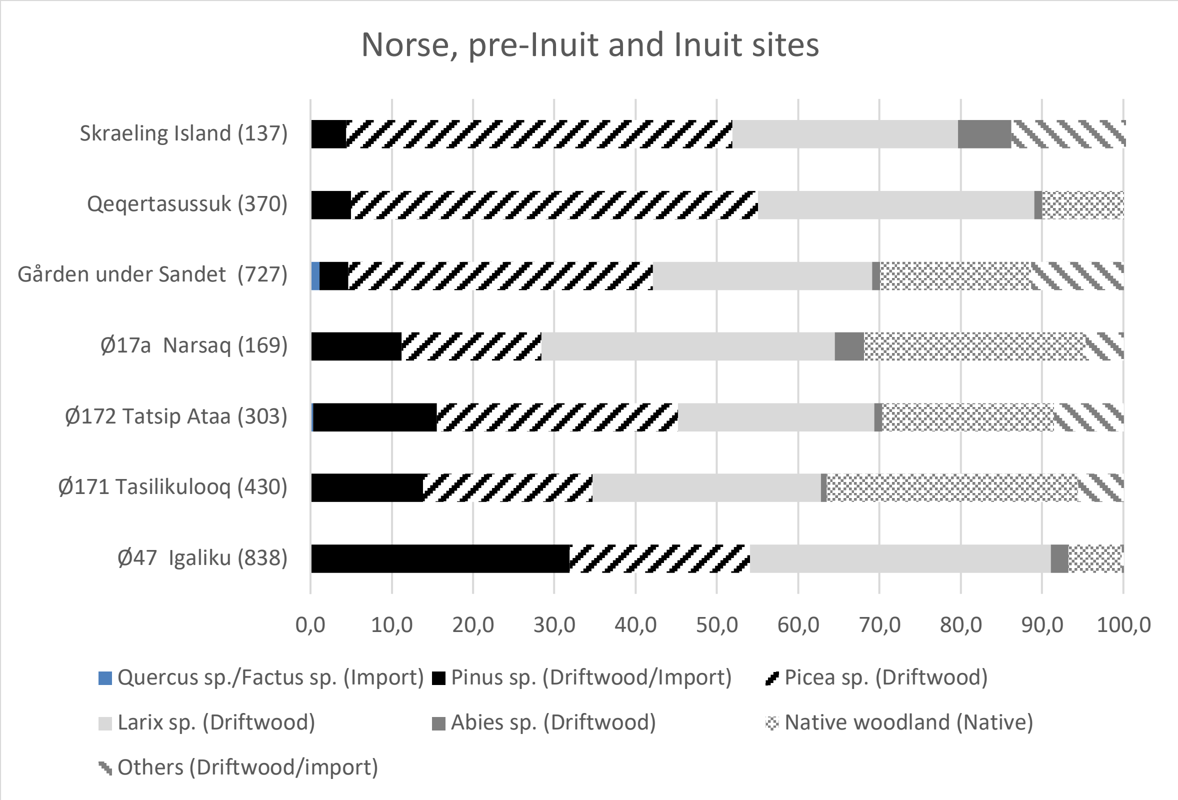


Figure 72. Comparison between the Norse and the pre-Inuit and Inuit sites.

Norse artefacts, such as a plane made from birch and iron boat nails, were found on Skraeling Island. The presence of these artefacts could either be linked to a direct trade between the Norse and the Inuit in the Smith Sound or the salvage of a shipwreck where the boat nails were extracted from the ship (Alix, 2009; Gulløv et al. 2004). The presence of ship rivets makes it more likely that this material represents a shipwreck rather than direct trading. However, it is a further indicator that the Norse ventured this far north, which is also supported by the genetic study of the walrus zooarchaeological material (Barrett, 2019) and written sources (Halldórsson, 1978, p. 53). Archaeological evidence suggests some interaction between the Inuit and the Norse, mainly related to trade; Norse objects have been found in the Inuit context and vice versa (Golding et al., 2011; Gulløw, 2008; Gulløw et al. 2004). The assemblages from this study are predominantly of Norse origin. Still, there are artefacts within them that could have been adapted from pre-Inuit or Inuit culture or be of Inuit origin, indicating trade. These are objects that the author has previously not identified in Iceland and Norway but has seen within Inuit assemblages. One of the object groups would be categorised as hunting gear and were used to hunt birds, see *figures 72 & 73*. However, further studies are needed to confirm its origin, and this does not have sufficient knowledge of Inuit artefacts.

Figure 73. A possible artefact of Inuit origin or indication of trade from Tatsip Ataa, Tasilikulooq and Narsaq, a) Narsaq – (X-183)- spruce sp.; b) Tatsip Ataa X470 – birch sp.; c) Tatsip Ataa (X-468) – birch sp.; d) Tasilikulooq, (X-242) – birch sp.

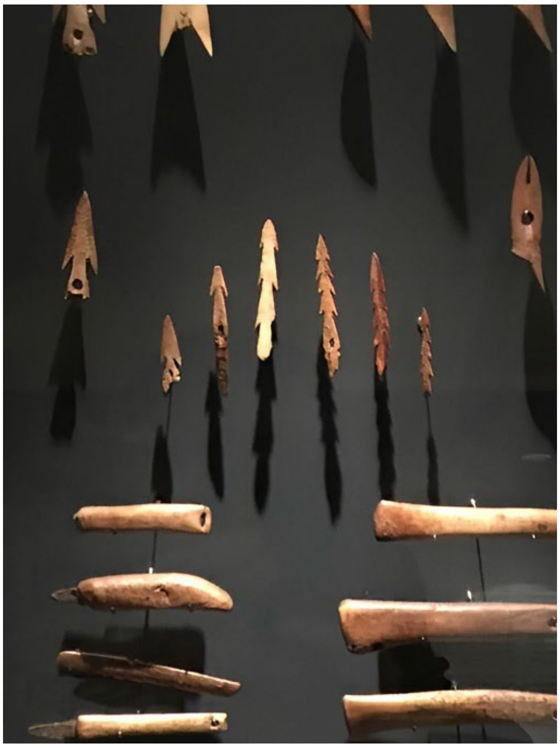


Figure 74. Example of the Inuit artefacts found at the National Museum in Greenland (They are all made from bone).

6.8.4 Discussion

The people who settled in the North Atlantic islands shared a similar material culture. However, in the Faroes, Iceland and Greenland, and other cultural groups in the Arctic, they had to rely on sources of timber other than, for example, the Norwegians. Comparing the results from the wood taxa analyses has the potential to shed light on different wood procurement strategies. The main difference between the Norwegian and North Atlantic sites is the utilisation of larch, which is non-existent in Norway but represents about 25% of the combined Greenlandic assemblage and 14% of the Icelandic assemblage. Larch originates in Siberia and can be categorised as driftwood (Eggertsson, 1993; Eggertsson & Layendecker, 1995). Another taxon that stands out is spruce. Spruce does grow naturally in Norway; however, in modern times, the two sites are outside the natural distribution of spruce (Caudullo et al. 2017). It only comprised 2% of the assemblage in Borgund and was non-existent in Bryggen. This indicates that spruce was transported to Borgund from inland, although in small quantities. In Greenland, it represents 19% of the combined assemblage, and in Iceland, 5%.

If the modern distribution of spruce in Norway indicates past distribution, it supports the view that it was not being imported to Iceland and Greenland from western Norway and is more likely to have arrived in these countries as drift. Scots pine can be found widely in Norway, while in Iceland and Greenland, it can be driftwood or imported. Scots pine represents almost 67% of the Borgund assemblage and 29% in Bergen, while in Iceland, it represents 30% and in Greenland 13% of the combined assemblage (*Fig 74*). While Scots pine is the most common taxon in modern driftwood assemblages, most of that driftwood derives from logging in Russia (Hellmann et al. 2016). However, if the logged material is excluded, the proportion of Scots pine in modern driftwood assemblages in Iceland is about 30%. Thus, the Scots pine in Iceland could potentially all be driftwood. It is worth mentioning that if the material is examined by period, i.e., phase IV from 870-1226 AD and phase III from 1226-1500 AD, a substantial increase in Scots pine is evident in Iceland. Therefore, the increase might represent import in the latter period. The proportions of Scots pine in Greenland are far lower than in Iceland, indicating that less Scots pine drifts to Greenland and less import. Even though the proportion of drifted Scots pine in Greenland is uncertain, proportions of Scots pine are far higher in Igaliku than in any of the other sites in Greenland, indicating that only a high-status site like the episcopal manor had regular access to imports, while the other sites most likely utilised drifted Scots pine more or less exclusively. The natural distribution of Scots pine in Europe during this period (Hather, 2000), as well as the political connection, strongly suggests that the majority of the imported Scots pine in Iceland and Greenland came from Norway.

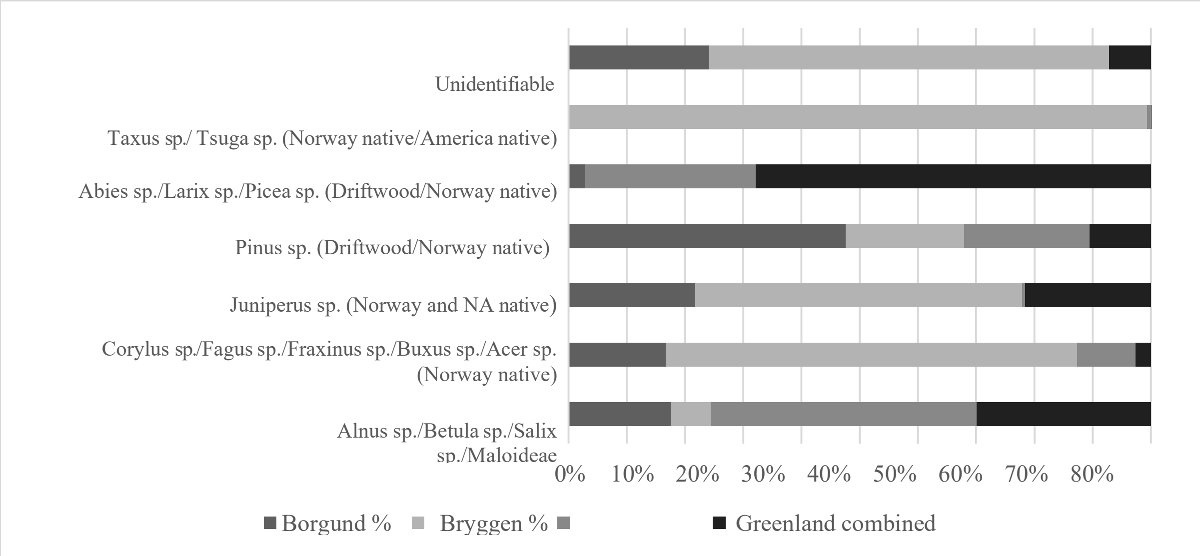


Figure 75. Simplified results of the wood taxa analysis from all of the sites. NA: North Atlantic, Iceland and Greenland. (Alnus is not native to Iceland).

Figure 76. Simplified results of the wood taxa analysis from all of the sites. NA: North Atlantic, Iceland and Greenland. (Alnus is not native to Iceland).

The utilisation of the Icelandic/Greenlandic native taxa birch and willow is distinctly different from that of Norway, even though both taxa grow there. The proportions are far higher in Iceland and Greenland. However, there is a bias since the material in Norway only consists of artefacts, while the material from Reykjavík, and part of the Greenlandic material (Tatsip Ataa and Igaliku), contain non-artefactual material, that is, twigs and branches. If the non-artefactual assemblage is excluded, the proportions are similar to Borgund but considerably lower in Bryggen.

One taxon worth pointing out is oak, which can only have arrived in Greenland and Iceland as an import since it does not appear in driftwood assemblages (Hellmann et al. 2013b). In Borgund, oak represents 2.5% of the assemblage, 8% in Bergen, and 2.2% in Iceland, while it comprises only 0.17% of the assemblage in Greenland. The question becomes: can the proportions of oak in Norway shed light on the origin of oak in Iceland and Greenland? The proportions of oak are similar in Borgund and Iceland, which might indicate that the oak is coming from western Norway. However, this cannot be concluded from the proportions alone, and further research is needed. Isotopic provenancing or other methods may have the potential to provenance the oak found in Iceland and Greenland. The proportion of oak is very low in Greenland and most likely represents imported artefacts rather than timber imports. It is consistent with a picture of minimal imports to Greenland. Another aspect could and might be associated with the infrequency of ships coming from Norway (Gad, 1964; Magerøy, 1993), which could account for the infrequency of imported taxa. However, in Igaliku, the proportion of Scots pine thought partly to be imported, remains similar throughout the Norse period.

There was a marked increase in wood import to Iceland in the 13th century, which is not mirrored in the Norse Greenlandic assemblages (Guðmundsdóttir, 2023). The Icelandic evidence is in line with other indications of a general increase in commercial activity in northern Europe in this period (Barrett, 2018). The contrast with Greenland seems to indicate that Greenland was not included and did not benefit from these developments. However, it shares the same fate as Iceland of being colonised by Norway in the period. The wood evidence suggests that the Norse Greenlanders had developed a system that worked but could not change or allow them to take advantage of changes in the world around them (Dugmore et al. 2012; Hartman et al. 2017). This is reflected in the wood assemblage, where the import of deciduous taxa seems to be an exception rather than a rule.

Another taxon that stands out in the Norwegian assemblage is yew (*Taxus Baccata* L.), which makes up 24% of the assemblage in Bryggen. At the same time, only one piece has been found in Reykjavík, which is non-existent in Greenland and Borgund (*Table 15*). The artefacts identified in Bryggen are all related to textile production, so there is a possibility that this taxon was preferred for such implements. None of the textile production artefacts from Borgund were made from yew, so it might be connected to what taxa were available in the vicinity of the sites. Yew grows near Bergen but not in the Borgund area (Euforgen, 2023). Furthermore, it is possible to confuse yew with juniper, but yew has distinct spiral thickening, which juniper does not (Hather, 2000; Schweingruber 1990b). Needless to say, further studies are needed, and a greater variety of artefact types would have to be studied from Bergen to address this issue.

Table 16. Results of the wood taxa analysis from Norway, Iceland and Greenland. The beech and ash were grouped together in the material from Byggen (Øye, 1988); however, Fagus sp. was only identified in Igaliku and Reykjavík.

	Taxa	Borgun %	Bryggen %	Reykjavík %	Greenland combined %	Igaliku %	Tatsip Ataa %	Tasilikulooq %	GUS %	Narsaq %
Deciduous taxa - Hardwood	*Alnus sp.*	1.49	0.00	0	0.28	0.12	0.35	0.70	0.69	0.00
	Betula sp.	11.39	5.46	43.55	23.4	9.27	44.05	21.16	8.25	13.02
	Corylus sp.	0.50	0.36	0	0	0	0	0	0	0
	Deciduous species	0.99	4.55	0	0.45	0.00	1.10	0	0	0
	Quercus sp.	2.48	8.38	2.22	0.17	0.15	0.03	0	1.10	0
	Salix sp./Populus sp.	4.95	1.28	2.08	6.52	1.57	12.00	7.21	8.25	4.73
	Fagus Silvatica /Fraxinus sp.	0.00	0.73	0.14	0.01	0.02	0	*0*	0	0
	Buxus sp.	0.00	0.36	0	0	0	0	0	0	0
	Maloideae/Sorbus sp.	0.00	0.18	0.55	0.08	0.05	0.14	0	0	0
	Acer sp./Prunus avium	0.00	2.37	0	0	0	0	0	0	0
Coniferous taxa - Softwood	*Abies sp.*	0.00	0.00	0	1.82	2.26	1.45	1.40	0.96	3.55
	Juniperus sp.	5.45	14.03	0.14	5.4	5.97	5.85	1.63	1.38	9.47
	Picea sp.	1.98	0.00	4.99	18.86	20.85	12.46	20.70	37.41	17.16
	Taxus baccata L.	0.00	23.68	0.14	0	0	0	0	0	0
	Pinus sylvestris L.	67.33	28.78	30.51	12.9	22.25	4.38	13.72	1.51	8.88
	Pinus sect. strobus	0	0	0	1.67	2.83	0.64	0	1.51	0.
	Pinus banksiana	0	0	0	0.1	0.22	0.00	0.00	0	0
	Pinus sp.	0	0	0	0.18	0.15	0.06	0.00	0.55	2.37
	Larix sp.	0	0	14.29	25.29	33.75	14.11	27.91	26.96	36.09
	Larix sp./Picea sp.	0	0	1.39	1.83	0.20	1.56	5.58	10.04	1.78
	Tsuga sp.	0	0	0	0.01	0.02	0	0	0	0
	Unidentifiable	3.47	9.84	0	1.03	0.32	1.83	0	1.38	2.96

The wood procurement strategies are profoundly different in these three regions. The Norwegians could acquire their wood in local forests, and there were no great distances they needed to travel for those resources; only the largest construction projects might have required some travel. The Norwegians had more options: they could choose from more varied taxa and capitalise on the natural qualities of the trees. Wood procurement was far more complicated in the North Atlantic region and the Arctic; there was less choice and far more unpredictability when it came to wood procurement and choices. They had to rely on driftwood, a resource that was never secure year-to-year. While there could be good driftwood years with abundant wood, there could also be bad ones with hardly any wood arriving. They also relied extensively on native woodland, which was in general low in height and crooked but suitable for small building projects, utensils, and various smaller artefacts, along with insulation, fodder, medicine, clothing colour and a cleaning agent (Guðmundsdóttir 2022b). Lastly, high-status farms could acquire imported wood. Even though no indication of a chronic shortage of wood in the Norse period can be discerned in Greenland, there could have been stressful years. It is impossible to detect periodic scarcity within the wood assemblages since they derive from prolonged periods, but the existence of such periods is widely recognised in Iceland (Einarsson, 1971; Magnússon & Vídalín, 1940).

As mentioned, the abandonment of the Norse settlements in Greenland has been attributed to multiple environmental and socio-economic factors (Dugmore et al. 2011; Jackson et al. 2018). If periodic scarcity of driftwood could be shown to coincide with the factors that Dugmore et al. (2011) and Jackson et al. (2018) point out, it might suggest an additional component that led to the abandonment of the Norse settlements. The presently available data does not support the idea that wood shortage contributed to the abandonment. The issue would, in any case, need to be considered in relation to the decline in population, which Lynnerup (2014) argues was one of the main reasons for the eventual disappearance of the Norse. Acquiring driftwood was not a simple task; it required that Norse Greenlanders travel substantial distances in expeditions that can be compared to seal and walrus hunting and, most certainly, likewise, had a communal effort as a prerequisite. This was one of the many seasonal projects that needed to be executed, along with pastoral farming and hunting. The Norse population was always small, but by the 15th century, there might not have been a sufficient workforce to implement all the tasks at hand. Even if there was no lack of wood resources, there might not have been enough people to obtain them. Any evidence for scarcity that might emerge could, therefore, reflect labour shortages as much as a declining resource. In this study, a baseline has been established for the availability of wood in Norse Greenland. It is by no means considered a closing study of this material group but rather a starting point upon which further studies could expand.

7 Conclusion

The overarching aim of this study was to shed light on where the Norse settlers in Greenland procured timber. Wood taxa analysis was used to provenance wood assemblages from five Norse Greenlandic sites. While slight variations exist between the sites, all the sites relied predominantly on driftwood and native wood. There does not seem to have been large-scale timber import to Greenland, and import is mostly noticeable in Igaliku, which has been identified as the episcopal manor. This suggests a socioeconomic difference: the high-status farms had access to imports while the middle-sized had very little or no access to them. The imported timber originated predominantly in northern Europe, with a small component from the east coast of North America. The episcopal manor was most likely the only site that had the means and resources to acquire recourses from abroad, as well as organise expeditions to North America. The proportion of the use of native woodland varied between sites, especially when non-artefactual material could be considered, like in Tatsip Ataa and Igaliku. It further highlights differences in wood procurement strategies between high- and medium-sized farms. Furthermore, it sheds light on wood assemblages that are rarely considered, in particular the small twigs and branches that were of great importance for the household, as building material but also as bedding, medicine, food, and fodder for animals. The availability of native woodland seems to have been relatively stable throughout the Norse settlement, with no signs of woodland deterioration that could indicate environmental stress or subsistence crisis. Driftwood was the main source of wood in Norse Greenland; however, acquisition of driftwood was complicated and required the Greenlanders to administer demanding expeditions to access it. These trips were most likely communal efforts in the same way that hunting was, and control and distribution was most likely in the hands of a few. As with the native woodland, there are no indications that there was a shortage of this resource, although individual bad years would not show up in this kind of dataset. There is a substantial difference when the Norse Greenlandic assemblage is compared with a contemporary assemblage from Reykjavík, Iceland. In Iceland there is a noticeable increase in wood-import after 1226 AD. This seems not to be the case in Greenland although sharing the same fate of colonisation from Norway. The Greenlanders relied on the same resources throughout the Norse settlement period without indicating increased import. There are no signs of an absolute lack of wood at any time during the Norse presence in Greenland. Therefore, lack of this resource was not a factor that led to the abandonment of the Norse settlements.

8 Bibliography

Alix, C. (2005). Deciphering the impact of change on the driftwood cycle: contribution to the study of human use of wood in the Arctic. *Global and Planetary Change* (47), 83-98.

Alix, C. (2009a). Driftwood, timber and shrubs! Wood used by Ruin Islander Thule at Skraeling Island, Eastern Ellesmere Island, Canada. In B. Grønnow (Ed.), *On the Track on Thule Culture from Bering Strait to East Greenland: Proceedings of the SILA Conference "The Thule Culture - New Perspectives in Inuit Prehistory" Copenhagen, Oct. 26th-28th, 2006, Papers in Honour of Hans Christian Gulløv* (Vol. 15). Copenhagen: The National Mseum of Denmark, 149-165.

Alix, C. (2009b). Persistence and Change in Thule Wood Use. In O. K. M. H. Maschner, McGhee (Ed.), *The Northern World A.D. 900-1400,* Salt Lake City: The university of Utah Press, 179-205.

Alix, C. (2012). Using wood on King Island, Alaska. *Études/Inuit/Studies, 36* (1), 89-112. doi:10.7202/1015955ar

Alix, C., & Brewster, K. (2004). Not All Driftwood is Created Equal:" Wood Use and Value along the Yukon and Kuskokwim Rivers. *Alaska Journal of Anthropology, 2* (1-2), 48-65.

Anagnost, S. E., Meyer, R. W., & de Zeeuw, C. (1994). Confirmation and Significance of Bartholin's Method for the Identification of the Wood of Picea and Larix. *IAWA Journal*, *15*(2), 171-184. https://doi.org/10.1163/22941932-90001359

Andersen, E., & Malmros, C. (1993). Ship´s parts found in the Viking settlements in Greenland: preliminary assessments and wood-diagnoses. In B. L. Clausen (Ed.), *Viking Voyages to North America*. Roskilde: Viking Ship Museum, 118-122.

Anker, L., Havran, J. (2005). *De norske stavkirkene*. Oslo: Arfo.

Arge, S. V. (2014). Viking Faroes: Settlment, Paleoeconomy, and Chronology. *Journal of the North Atlantic, 7*, 1-17.

Arneborg, J. (1998). The High Arctic "utmark" of the Norse Greenlanders: The Norse Greenlander´s use of High Arctic resources. In H. Anderson, L. Ersgård, & E. Svennson (Eds.), *Outland Use in Preindustrial Europe* (Vol. 20). Lund: Lund Studies in Medieval Archaeology, 156-167.

Arneborg, J. (2001). The Norse Settlement in Greenland: The Initial Period in Written Sources and in Archaeology. In A. Wawn & Þ. Sigurðardóttir (Eds.), *Approaches to Vínland.* Reykjavík: Sigurður Nordal Institute, 122-133.

Arneborg, J. (2002). Kirke, kristendom og storbønder i det norrøne Grønland - et nyt forskningsprojekt. In L. Bisgaard & R. S. Christensen (Eds.), *Kristningen af norden - et 1000 års jubilæum*. Odense: Center for Middelalderstudier, Syddansk Universitet, 8-25.

Arneborg, J. (2003). Norse Greenland: Reflections on Settlement and Depopulation. In J. H. Barrett (Ed.), *Contact, Coninuity, and Collapse: The Norse Colonization of the North Atlantic*. Turnhout: Brepols Publishers, 163-181.

Arneborg, J. (2004). Det Europæiske Landnam - Nordboerne i Grønland, 985 - 1450 e.v.t. In H. C. Gulløv (Ed.), *Grønlands Forhistorie*. København: Gyldendal, 219-280.

Arneborg, J. (2006). *Saga Trails. Brattahlið, Garðar, Hvalsey Fjord's Church, and Herjolfsnes: Four chieftains' farmsteads in the Norse settlements of Greenland*. København: The National Museum of Denmark.

Arneborg, J. (2015). Norse Greenland: Research into abandonment. In M. S. Kristiansen, E. Roesdahl, & J. Graham-Campbell (Eds.), *Medieval Archaeology in Scandinavia and Beyond: History, trends and tomorrow*. Aarhus: Aarhus Universitetsforlag, 257-271.

Arneborg, J., Heinemeier, J., Nielsen, N. L., Rud, N., & Sveinbjörnsdóttir, Á. E. (1999). Change of Diet of the Greenland Vikings Determined from the Stable Carbon Isotope Analysis and 14C Dating of Their Bones. *Radiocarbon, 41* (2), 157-168.

Arneborg, J., Lynnerup, N., & Heinemeier, J. (2012). Human Diet and Subsistence Patterns in Norse Greenland A.D. c. 980 - A.D. c. 1450. Archaeological Interpretations. *Journal of the North Atlantic, 3*, 119-133.

Arneborg, J., & Pedersen, D. D. (2020). *Excavations at the churchyard in Igaliku, the Norse bishop see at Garðar, July 2019*. Copenhagen: National Museum of Denmark.

Arneborg, J., & Price, D. (2014). The Peopling of the North Atlantic: Isotopic Results from Greenland. *Journal of the North Atlantic, 7*, 164-185. doi:10.3721/037.002.0sp713

Ágústsson, H. (1989). *Dómsdagur og helgir men á Hólum: endurskoun fyrri hugmynda um fjalirnar frá Bjarnarstaðahlíð og Flatatungu*. Reykjavík: Hið íslenska bókmenntafélag.

Ágústsson, H. (1990). *Skálholt – Kirkjur*. Reykjavík: Hið íslenska bókmenntafélag.

Bagge, S. (2005). Christianization and State Formation in Early Medieval Norway. *Scandinavian Journal of History* Vol. 30, No. 2. June 2005, 107–134.

Barrett, J. H. (2018). Medieval Fishing and Fish Trade. In C. Gerrard, A. Gutiérrez (eds), *The Oxford Handbook of Later Medieval Archaeology in Britain*, Oxford Handbooks Oxford: Oxford University Press, 128- 140.

Barrett, J. H., Boessenkool, S., Kneale, C. J., & O´Connell, T. C. (2020). Ecological globalisation, serial depletion and the medieval trade of walrus rostra. *Quaternary Science Reviews, 229*. doi:https://doi.org/10.1016/j.quascirev.2019.1061

Barlow L., Amorosi, T., Buckland, P. C., Dugmore, A. J., Ingimundarson, J. H., McGovern, T. H., . . . Skidmore, P. (1997). Interdisciplinary investigations of the end of the Norse Western Settlement in Greenland. *The Holocene 7* (4), 489-499. doi:10.1177/095968369700700411

Bartholin, T. (1979). The Picea-Larix problem. *The IAWA Bulletin* (1), 7-10.

Benedictow, O. J. (2021). *The Complete History of the Black Death*. Woodbridge: Boydell & Brewer Inc.

Berglund, J. (1982). Kirkja, hal og Status. *Tidsskriften Grønland*. 8-9, 275-285.

Bertelsen, R. (2005). The sea as 'innmark' or 'utmark'. In I. Holm, S. Innselset, & I. Øye (Eds.), *'Utmark' The Outfield as Industry and Ideology in the Iron Age and the Middle Ages*. Bergen: University of Bergen Archaeological Series, International 1, 21-29.

Bichet, V., Gauthier, E., Massa, C., Perren, B., & Richard, H. (2013). The history and impacts of farming activities in South Greenland: an insight from lake deposits. *Polar Record*, 1-13. doi:10.1017/S0032247412000587

Bill, J. (2010). Viking Age ships and seafaring in the West. In I. S. Klæsøe (Ed.), *Viking Trade and Settlement in Continental Western Europe* (pp. 19-42). Copenhagen: Museum Tusculanum Press/University of Copenhagen.

Bishop, R. R., Church, M. J., Dugmore, A. J., & Møller, C. K. M. A. (2012). A charcoal-rich horizon at Ø69, Greenland: evidence for vegetation burning during the Norse *landnám*? *Journal of Archaeological Science, 40*, 3890-3902. doi:http://dx.doi.org/10.1016/j.jas.2013.04.012

Böcher, T. W., Holmen, K., & Jakobsen, K. (1968). *The Flora of Greenland*. Copenhagen: Haase and Son.

Born, E. W., & Böcher, J. (2001). *The Ecology of Greenland*. Nuuk: Ministry of Environment and Natural Resources.

Boulhosa, P. P. (2005). *Icelanders and the Kings of Norway. Mediaeval Sagas and Legal Texts* (Vol. 17). Leiden, Boston: Brill.

Brisbane, M., and J. Hather. (2007). *Wood Use in Medieval Novgorod*. Oxford: Oxbow Books.

Bratrein, H. H. (2009). Rekved, drivtømmer, vrakgods og andre nordnorske herligheter. *Ottar, 3*, 25-32.

Brouillet, L. P. D., Coursol, F., Meades, S., Favreau, M., Anions, M., D., S. (2010). Database of Vascular Plants of Canada (VASCAN). Retrieved from http://data.canadensys.net/vascan

Bruun, D. (1896). Arkæologiske undersøgelser i Julianhaabs Distrikt. *Meddelelser om Grønland* (Vol. 16). København, 175-495.

Bruun, D. (1918). The Icelandic colonizatin of Greenland and the finding of Vineland. *Meddelelser om Grønland, LVII*, 1-228.

Buchwald, V. F. (2001). Ancient Iron and Slags in Greenland. *Meddelelser om Grønland. Man and Society* 26. Copenhagen: Danish Polar Center.

Buckland, P., Edwards, K., Panagiotakopulu, E., & Schofield, E. (2008). Land management at the bishop's seat, Garðar, medieval Greenland. *Antiquity Project Gallery, 82* (315). Retrieved from http://www.antiquity.ac.uk/Projgall/buckland315/

Buckland, P., Edwards, K., Panagiotakopulu, E., & Schofield, E. (2009). Palaeoecological evidence for manuring and irrigation at Garðar (Igaliku), Norse Eastern Settlement, Greenland. *Holocene, 19*, 105-116. doi:10.1177/0959683608096602

Buckland, P. C., McGovern T. H., Sadler, J. P., Skidmore, P. (1994). Twig layers, floors and middens. Recent palaeoecological research in the Western Settlement, Greenland. In H. C. Björn Ambrosiani (Ed.), *The Twelfth Viking Corngress. Developments around the Baltic and the North Sea in the Viking age* (Vol. 3). Stockholm, 132-143.

Caudullo, G., Welk, E., San-Miguel-Ayanz, J. (2017). Chorological maps for the main European woody species. Data in Brief 12, 662-666. doi: https://doi.org/10.1016/j.dib.2017.05.007

Christiensen, K. (2013). Wood remains from Toftanes., *Acta Archaeologica*, 83 (1), 143-150. doi: https://doi.org/10.1111/j.1600-0390.2013.00858.x

Church, M. J., Arge, S. V., Edwards, K. J., Bond, J., Cook, G., Dockrill, S. J., Ducmore, A. J., McGovern, T. H., Nesbitt, C., Simpson, I. A. (2013). The Vikings were not the first colonizers of the Faroe Islands. *Quaternary Science Reviews, 77*, 228-232. doi:10.1016/j.quascirev.2013.06.011

Curtin, L., D’Andrea, W. J., Balascio, N. L., Shirazi, S., Shapiro, B., Wet, G. A. D., Bradley, R. S.,Bakke, J. (2021). Sedimentary DNA and molecular evidence for early human occupation of the Faroe Islands. *Communications Earth & Environment, 2*, 253. doi:https://doi.org/10.1038/s43247-021-00318-0

Den nyere Lands-Lov utgiven af Kong Magnus Haakonsön. (1848). Utg. Rudolf Keyser og Peter Andreas Munch, *Norges Gamle Love*, Vol. 2, 1–178. Christiania: Gröndahl.

Diamond, J. (2005). *Collapse. How societies choose to fail or succeed*. New York: Viking, Penguin.

Dugmore, A. J., Borthwick, D. M., Church, M. J., Dawson, A., Edwards, K. J., Keller, C., Mayewski, P., McGovern, T. H., Mairs, K-A., Sveinbjarnardóttir, G. (2007). The role of Climate in Settlment and Landscape Change in the North Atlantic Islands: An assessment of Cumulative Deviations in High-Resolution Proxy Climate Records. *Human Ecology, 35*, 169-178. doi: 10.1007/s10745-006-9051-z

Dugmore, A. J., Church, M. J., Buckland, P. C., Edwards, K. J., Lawson, I., McGovern, T. H., Panagiotkopulu, 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. doi: 10.1017/S0032247404003985

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

Dugmore, A. J., McGovern, T. H., Vésteinsson, O., Arneborg, J., Streeter, R., & Keller, C. (2012). Cultural adaptation, compounding vulnerabilities and conjuctures in Norse Greenland. *PNAS, 109* (10), 3658-3663. https://doi.org/10.1073/pnas.1115292109

Dyke, A. S., England, J., Reimnitz E., Jetté H. (1997). Changes in Driftwood Delivery to the Canadian Arctic Archipelago: The Hypothesis of Postglacial Oscillations of the Transpolar Drift. Arctic, 50 (1), 1-16.

Edlin, H. L. (1973). *Woodland Crafts in Britain. An accound of the Traditional Uses of Trees in the British Countryside*. Newton Abbot: David & Charles.

Edvardsson, R., Paulsen, C., Church, M., Simpson, I., Adderly, P., Pálsdóttir, A., & McGovern, T. H. (2007). *Archeological Excavations at Qassiarsuk 2005-2006. Field Report*. Bolungarvík: Náttúrustofa Vestfjarða.

Edwards, K. J., Cook, G. T., Nyegaard, G., & Schofield, J. E. (2013). Towards a First Chronology for the Middle Settlement of Norse Greenland: 14C and Related Studies of Animal Bone and Environmental Material. *Radiocarbon, 55* (1), 13-29. doi:10.1017/s0033822200047779

Edwards, K. J., Schofield, J. E., Kirby, J. R., & Cook, G. T. (2011). Problematic but promising ponds? Palaeoenvironmentalevidence from the Norse Eastern Settlement of Greenland. *Journal of Quaternary Science, 26* (8), 854-865. doi: 10.1002/jqs.1518

Eggertsson, Ó. (1993). Origin of the driftwood on the coasts of Iceland, a dendrochronological study. *Jökull, 43*, 15-30.

Eggertsson, Ó. (1994). Mackenzie River Driftwood - A Dendrochronological Study. *Arctic, 47* (2), 128-136.

Eggertsson, Ó., & Layendecker, D. (1995). A Dendrochronological Study of the Origin of Driftwood in Frobisher Bay, Baffin Island, N.W.T., Canada. *Arctic and Alpine Research, 27* (2), 180-186.

Einarsson, O. (1971). *Íslandslýsing - Qualiscunque descriptio Islandiae* (S. Pálsson, Trans.). Reykjavík: Bókaútgáfa menningarsjóðs.

Enghoff, I. B. (2003). Hunting, Fishing and animal husbandry at the Farm Beneath the Sand, Western Greenland. *Meddelelser om Grønland, Man & Society, 28*, 3-104.

Erlendsson, E., & Edwards, K. J. (2010). Gróðurfarsbreytingar á Íslandi við landnám. *Árbók Hins íslenzka fornleifafélags, 101*, 29-55.

Euforgen (2023). https://www.euforgen.org/species/picea-abies/ [Accessed 01.02.2023]

Fabricius, O. (1810). Nøjagtig Beskrivelse over alle Grønlaendernes Fange-redskaber ved Saelhunde-fangsten. *Det Kongelige Videnskabernes Selskabs Skrifter, 5* (2), 124-178.

Færden, G., Færden, A., Schia, E., & Weber, B. (1990). *De arkeoligiske utgravninger i Gamlebyen, Oslo* (Vol. 7). Øvre Ervik: Akademisk Forlag.

Feilberg, J. (1984). A Phytogeographical Study of South Greenland Vascular Plants. *Meddelelser om Grønland, Bioscience 15*, 15-69.

Fredskild, B. (1973). Studies in the vegetational history of Greenland. *Meddelelser om Grønland,* 198, 1-245.

Fredskild, B. (1983). The Holocene Vegetational Development of the Godthåbsfjord Area, West Greenland. *Meddelelser om Grønland, Geoscience,* 10, 1-28.

Fredskild, B. (1992). Erosion and Vegetational Changes in South Greenland, Caused by Agriculture. *Geografisk Tidsskrift, 92*, 14-21. doi:https://doi.org/10.1080/00167223.1992.10649310

Frei, K. M., Coutu, A. N., Smiarowski, K., Harrison, R., Madsen, C. K., Arneborg, J., McGovern, T. H. (2015). Was it for walrus? Viking Age settlement and medieval walrus ivory trade in Iceland and Greenland. *World Archaeology, 47* (3), 439-466. doi:10.1080/00438243.2015.1025912

Fuglesang, S. H. (1980). Some Aspects of the Ringrike Style. *A phase of 11th century Scandinavian art. Medieval Scandinavitan Supplements* vol. 1. Odense: Odense University Press, 1-274.

Funder, S., Goosse, H., Jepsen, H., Kaas, E., Kjær, K. H., Korsgaard, N. J., Larsen, Lyså, A., Möller, P., Olsen, J.,Willerslev, E. (2011). A 10,000-Year Record of Arctic Ocean Sea-Ice Variability-View from the Beach. *Science, 333*, 747-750.

Gad, F. (1964). Grønland's tilslutning til Norgesvældet 1261. *Tidsskrifted Grønland, 3*, 81-91.

Gad, F. (1970). *The History of Greenland I: Earliest times to 1700*. London: C. Hurst.

Garðarsdóttir, V. (2010). *Fornleifauppgröftur á Alþingisreitnum 2008-2010*. Reykjavík.

Gauthier, E., Bichet, V., Massa, C., Petit, C., Vanniere, B., & Richard, H. (2010). Pollen and non-pollen palynomorph evidence of medieval farming activities in southwestern Greenland. *Vegetation History and Archaeobotany, 19*, 427-438. doi: 10.1007/s00334-010-0251-5

Gestsdóttir, H., Gísladóttir, G. A., Guðmundsdóttir, L., Roberts, H. M., Snæsdóttir, M., & Vésteinsson, O. (2017). New discoveries: Dysnes. *Archaeologia Islandica, 12*, 93-106.

Golding, K. A., Simpson, I. A., Schofield, J. E., & Edwards, K. J. (2011). Norse-Inuit interaction and landscape change in southern Greenland? A geochronological, pedological, and palynological investigation. *Geoarchaeology, 26* (3), 315-345.

Graham-Campbell, J., & Batey, C. E. (1998). *Vikings in Scotland, an archaeological survey*. Edinburgh: Edinburgh University Press.

Grágás eftir det Arnamagnæanske Haandskrift. (1879). København: Gyldendalske Boghandel

Grágás. Stykker, som findes i det Arnamagnæanske Haandskrift. (1883). København: Gyldendalske Boghandel

Grönlands Historiske Mindesmærker. (1845). (Vol. III). København: Det Kongelige Nordiske Oldskrift - Selskab.

Grønnow, B. (1996). Driftwood and Saqqaq Culture Woodworking in West Greenland. In C. A. Birgitte Jacobsen (Ed.), *Cultural and Social Research in Greenland 95 96 Essays in Honour of Robert Petersen*. Nuuk: Ilisimatusarfik/Atuakkiorfik, 73-89.

Grove, J. (2009). The Place of Greenland in the Medieval Icelandic Saga Narrative. *Journal of the North Atlantic, Special Volume 2*, 34-55.

Guðmundsdóttir, L. (2010). *Alþingisreitur. Viðargreiningar á viðarsýnum úr Alþingisreit*. Reykjavík.

Guðmundsdóttir, L. (2011). *Fornir viðir Keldudals. Viðargreining á kirkju- og líkkistuleifum frá frumkristni ásamt byggingarleifum fjóss frá 9. Til 11. Öld*. Reykjavík.

Guðmundsdóttir, L. (2013a). *Viðargreiningar á fornum kirkjuviðum frá 11. og 12. öld.* (Unpublished MA thesis). University of Iceland, Reykjavík.

Guðmundsdóttir, L. (2013b). *Viðargreiningar á viðarsýnum og gripum frá Alþingisreitnum 2012*. Reykjavík.

Guðmundsdóttir, L. (2020). *The church and cemetery at Keflavík, in Skagafjörður, North Iceland.Wood identification*. Sauðarkrókur: Byggðasafn Skagfirðinga

Guðmundsdóttir, L. (2021). Wood procurement in Norse Greenland (11th to 15th c. AD). *Journal of Archaeological Science, 134*. doi:https://doi.org/10.1016/j.jas.2021.105469.

Guðmundsdóttir, L. (2022a). Driftwood utilisation and procurement in Norse Greenland. *Acta Borealia*. 39 (2), 138-167.

Guðmundsdóttir, L. (2022b). Utilization of native woodland in Norse Greenland. *Environmental archaeology*. doi:https://doi.org/10.1080/14614103.2022.2031839

Guðmundsdóttir, L. (2023). Timber imports to Norse Greenland: lifeline or luxury? *Antiquity.* 97:392, 454–471. https://doi.org/10.15184/aqy.2023.13

Guðmundsson, G. J. (2009). Greenland and the Wider World. *Journal of the North Atlantic, Special Volume 2*, 66-73.

Gulløv, H. C. (2008a). The Nature of Contact between Native Greenlanders and Norse. *Journal of the North Atlantic, 1* (1), 15-24.

Gulløv, H.C. (2008b). Booths from early Norse Greenland or *tjaldat búðir from landnáma Greenland.*, *In* C. Paulsen and H.D. Michelsen (Eds.). *Símunar- bók, Heiðursrit til Símun V. Arge á 60 ára degnum, 5. september 2008*. Fróðskapur, Faroe University Press: Tórshavn, 90–107.

Gulløv, H.C. Inuit-European Interactions in Greenland', in Max Friesen, and Owen Mason (eds), *The Oxford Handbook of the Prehistoric Arctic*, Oxford: Oxford Handbooks. 897-914.

Gulløv, H. C., Andreasen, C., Grønnow, B., Jensen, J. F., Arneborg, J., Berglund, J., (2004). *Grønlands forhistorie*. H. C. Gulløv (Ed.). København: Gyldendal.

Häggblom, A. (1982). Driftwood in Svalbard as an Indicator of Sea Ice Conditions. *Geografiska Annaler. Series A, Physical Geography, 64* (1/2), 81-94. doi:https://doi.org/10.2307/520496

Halldórsson, Ó. (1978). *Grænland í miðaldaritum*. Reykjavík: Sögufélag.

Hansen, G., 2020. Fakta: Borgund Kaupang Prosjektet. *Årbok for Universitetsmuseet*, 2020, 73.

Hartman, S., Ogilvie, A. E. J., Ingimundarson, J. H., Dugmore, A. J., Hambrecht, G., & McGovern, T. H. (2017). Medieval Iceland, Greenland, and the New Human Condition: A case study in integrated environmental humanities. *Global and Planetary Change, 156*, 123-139. doi:http://dx.doi.org/10.1016/j.gloplacha.2017.04.007

Hather, J. G. (2000). *The Identification of Northern European Woods: A Guide for Archaeologists and Conservators*. London: Archetype Publications Ltd.

Hayeur Smith, M. (2014). Dress, Cloth, and the Farmer's Wife: Textiles from Ø 172 Tatsipataa, Greenland, with Comparative Data from Iceland. *Journal of the North Atlantic, 6*, 64-81. doi:http://www.bioone.org/doi/full/10.3721/037.002.sp607

Hayeur Smith, M. (2020). *The Valkyries' Loom: The Archaeology of Cloth Production and Female Power in the North Atlantic*. Florida: University Press Florida.

Hellmann, L., Kirdyanov, A. V., & Büntgen, U. (2016). Effects of Boreal Timber Rafting on the Composition of Arctic Driftwood. *Forests, 7* (257), 1-9. doi:10.3390/f7110257

Hellmann, L., Tegel, W., Eggertsson, Ó., Schweingruber, F. H., Blanchette, R., Kirdyanov, A., Gärtner, H., Büntgen, U. (2013a). On the wood anatomical importance in Arctic driftwood research. *TRACE - Tree Rings in Archaeology, Climatology and Ecology, 11*, 160-165.

Hellmann, L., Tegel, W., Eggertsson, Ó., Schweingruber, F. H., Blanchette, R., Kirdyanov, A., Gärtner H., Büntgen, U. (2013b). Tracing the origin of Arctic driftwood. *Journal of Geophysical Research-Biogeosciences, 118*, 68-76. doi:doi:10.1002/jgrg.20022

Henriksen, P. S. (2012). *The midden at Garðar. Results from the macrofossil analyses.* København: National Museum of Denmark.

Herteig, Å. (1972). Borgund in Sunnmøre. Topography, history of construction, state of research. In Å. Herteig, H.-E. Lidén, & C. Blindheim (Eds.), *Archaeological contributions to the early history of urban communities in Norway.* Oslo/Bergen/Tromsø: Universitetsforlaget, 23-48

Hreinsson, V. (1997). *The Complete Sagas of Icelanders. Including 49 Tales* (Vol. 1). Reykjavík: Leifur Eiriksson Publishing Ltd.

Ingstad, A. S. (1985). *The Norse Discovery of America* (Vol. 1). Oslo: Norwegian University Press.

InsideWood. (2004-onwards.). Published on the Internet. http://insidewood.lib.ncsu.edu/search [07.02.2023].

ÍF I: Benediktsson, J. (1968). *Íslenzk fornrit I*. Reykjavík: Hið íslenzka fornritafélag.

ÍF IV: Sveinsson, E. Ó., & Þórðarson, M. (1935). *Íslenzk fornrit IV*. Reykjavík: Hið íslenzka fornritafélag.

ÍF V: Sveinsson, E. (1934). *Íslenzk fornrit V*. Reykjavík: Hið íslenzka fornritafélag.

ÍF XIV: Halldórsson, J. (1959). *Íslenzk fornrit XIV*. Reykjavík: Hið íslenzka fornritafélag.

Íslendingabók. The book of the Icelanders. (2006). (S. Grønlie, Trans. Vol. 18). London: Viking Society for Northern Research. University College London.

Jackson, R., Arneborg, J., Dugmore, A., Madsen, C., McGovern, T., Smiarowski, K., & Streeter, R. (2018). Disequilibrium, Adaptation, and the Norse Settlement of Greenland. *Human Ecology*, 1-20. doi:https://doi.org/10.1007/s10745-018-0020-0

Jacobsen, N. K. (1987). Studies on Soils and Potential for Soil Erosion in the Sheep Farming Area of South Greenland. *Arctic and Alpine Research, 19* (4), 498-507. doi: https://doi.org/10.1080/00040851.1987.12002632

Jakobsen, B. H. (1991). Soil resources and soil erosion in the Norse settlement area of Østerbygden in southern Greenland. *Acta Borealia, 8* (1), 56-68. doi: 10.1080/08003839108580399

Jensen, D. B. (2003). *The Biodiversity of Greenland – a country study*. Nuuk: Pinngortitaleriffik, Grønlands Naturinstitut.

Jónsbók. Lögbók Íslendinga hver samþykkt var á alþingi árið 1281 og endurnýjuð um miðja 14. öld en fyrst prentuð árið 1578. (2004). (Vol. 8). Reykjavík: Háskólaútgáfan.

Jónsson, G. (1919). Dómkirkjan á Hólum í Hjaltadal. Lýsing íslenzkra miðaldakirkna. *Safn til sögu Íslands*, 5, Reykjavík: Hið íslenzka bókmenntafélag, 353-790.

Kapel, H. (2005). *Besigtigelsesrapport. Gravning og oprensning af afvandingsgrøfter i Igaliku sommeren 2005*. Nuuk: National Museum and Archives.

Karlsson, G. (2009). The Ethnicity of the Vinelanders. *Journal of the North Atlantic, Special Volume 2*, 130-134.

Karlsson, G., & Kjartansson, H. S. (1994). Plágurnar miklu á Íslandi. *Saga, 32*, 11-74.

Keller, C. (2010). Furs, Fish and Ivory – Medieval Norsemen at the Arctic Fringe. *Journal of the North Atlantic, 3*, 1-23. doi: 10.3721/037.003.0105

Kolář, T., Rybníček, M., Eggertsson, Ó., Kirdyanov, A., Čejka, T., Čermák, P., Žid, T., Vavrčík, H., Büntgen, U., Predicted sea-ice loss will terminate Iceland's driftwood supply by 2060 CE, *Global and Planetary Change*, 213, https://doi.org/10.1016/j.gloplacha.2022.103834.

Kopár, L. (2009). The Use of Artistic Media in Norse Greenland. *Journal of the North Atlantic, Special Volume 2*, 106-117.

Kristjánsdóttir, S., Lazzeri, S., & Macchioni, N. (2001). An Icelandic medieval stave church made of drift timber: The implications of the wood identification. *Journal of Cultural Heritage, 2*(2), 97-107. doi:10.1016/S1296-2074(01)01112-8

Kristjánsson, L. (1965). Grænlenzki landnemaflotinn og Breiðfirzki báturinn. *Árbók hins íslenzka fornleifafélags*, 20-68.

Kristjánsson, L. (1980). *Íslenzkir Sjávarhættir* (Vol. I). Reykjavík: Bókaútgáfa menningarsjóðs.

Krogh, K. J. (1967). *Viking Greenland*. Copenhagen: The National Museum.

Kuijpers, A., Abrahamsen, N., Hoffmann, G., Hühnerback, V., Konradi, P., Kunzendorf, H., Mikkelsen, N., Thiede, J., Weinrebe, W. (1999). Climate change and the Viking-age fjord environment of the Eastern Settlement, South Greenland. *Geology of Greenland Survey Bulletin, 183*, 61-67.

Kuijpers, A., Mikkelsen, N., Ribeiro, S., & Seidenkrantz, M.-S. (2014). Impact of Medieval Fjord Hydrography and Climate on the Western and Eastern Settlements in Norse Greenland. *Journal of the North Atlantic, Special volume 6*, 1-13.

Kuitems, M., Wallace, B., Lindsay, C., Scifo, A., Doeve, P., Jenkins, K., Lindauer, S., Erdil., P., Ledger, P. M., Forbes, V., Vermeeren, C., Friedrich, R., Dee, M. W. (2021). Evidence for European presence in the Americas in ad 1021. *Nature*, 1-4. doi: https://doi.org/10.1038/s41586-021-03972-8

Laeyendecker, D. (1985). *Analyses of wood samples from the Sandnes Archaeolgical rescue project*. Unpublished report.

Laeyendecker, D. (1993). Wood and Charcoal Remains from Kodlunam Island. . In W. W. Fitzhugh & J. S. Olin (Eds.), *Archaeology of the Frobisher Voyages*, Washington: Smithsonian Institution Press, 155-172.

Larson, L. M. (1917). *Speculum regale: The Kings Mirror (Speculum regale – Konungs skuggsjá* (L. M. Larson, Trans.). New York: Twayne Publishers.

Larson L. M. (1935). *The Earliest Norwegian Laws. Being the Gulathing Law and the Frostathing Law*. New York: Columbia University Press.

Ledger, P. M. (2013). *Norse landnám and its impact on the vegetation of Vatnahverfi, Eastern Settlement, Greenland.* (Unpublished PhD thesis). University of Aberdeen, Aberdeen.

Ledger, P. M., Edwars, K. J., & Schofield, E. (2013). Shieling activity in the Norse Eastern Settlement: Palaeoenvironment of the 'Mountain Farm', Vatnahverfi, Greenland. *The Holocene, 23* (6), 810-822. doi:https://doi.org/10.1177/0959683612472002

Ledger, P. M., Edwars, K. J., & Schofield, E. (2014a). Vatnahverfi: a green and pleasant land? Palaeoecological reconstructions of environmental and land-use change. *Journal of the North Atlantic*, 29-46. doi:https://doi.org/10.3721/037.002.sp605

Ledger, P. M., Edwards, K. J., Schofield, E. (2014b). A multiple profile approach to the palynological reconstruction of Norse landscapes in Greenland's Eastern Settlement. *Quaternary Research, 82* (1), 22-37. doi:https://doi.org/10.1016/j.yqres.2014.04.003

Ledger, P. M., Edwards, K. J., Schofield, E. (2015). Taphonomy or signal sensitivity in palaeoecological investigations of Norse landnám in Vatnahverfi, southern Greenland? *Boreas, 44*, 197-215.

Ledger, P. M., Edwars, K. J., & Schofield, E. (2016). The biogeographical status of Alnus crispa (Ait.) Pursch in sub-Arctic southern Greenland: Do pollen records indicate local populations during the past 1500 years? *Polar Biology, 39*, 433-441. doi:10.1007/s00300-015-1790-0

Ledger, P. M., Edwards, K. J., Schofield, E. (2017). Competing hypotheses, ordination and pollen preservation: Landscape impacts of Norse landnám in southern Greenland. *Review of Palaeobotany and Palynology, 236*, 1-11. doi:https://doi.org/10.1016/j.revpalbo.2016.10.007

Ledger, P. M., Girdland-Flink, L., & Forbes, V. (2019). New horizons at L'Anse aux Meadows. *PNAS*, 1-3. doi: DOI: 10.1073/pnas.1907986116

Lepofsky, D., Lyons, N., & Moss, M. L. (2003). The use of driftwood on the North Pacific coast: An example from Southeast Alaska. *Journal of Ethnobiology, 23* (1), 125-141.

Ljungqvist, F. C. (2005). The Significance of Remote Resource Regions for Norse Greenland. *Scripta Islandica,* 56, 13-56.

Lynnerup, N. (1998). The Greenland Norse. A Biological-Anthropological Study. *Meddelelser om Grønland - Man & Society,* 24 (3), 3-149.

Lynnerup, N. (2014). Endperiod deomograpics of the Greenland Norse. *Journal of the North Atlantic*, 7, 18-24. doi:https://doi.org/10.3721/037.002.sp702

Madsen, C. K. (2014). *Pastoral Settlement. Farming and Hierachy in Norse Vatnahverfi, South Greenland.* (Unpublished PhD thesis). University of Copenhagen, Copenhagen.

Madsen, C. K. (2019). Marince Shielings in the Medieval Norse Greenland. *Arctic Antropology, 56* (1), 119-159.

Magerøy, H. (1993). *Saga om austmenn. Nordmenn som siglde til Island og Grønland i mellomalderen.* (Vol. 9). Oslo: Det Norske Samlaget.

Magnússon, Á., & Vídalín, P. (1940). *Jarðabók Árna Magnússonar og Páls Vídalíns* (Vol. 6). Kaupmannahöfn: Hið íslenska fræðafjelag í Kaupmannahöfn.

Malmros, C. (1990). Viking Age Wood Resources at Argisbrekka, Faroe Islands. *Norwegian Archaeological Review,* 23 (1-2), 86-92.

Malmros, C. (1994). Exploitation of Local, Drifted and Imported Wood by the Vikings on the Faroe Islands. *Botanical Journal of Scotland, 46* (4), 552-558.

Massa, C., Bichet, V., Gauthier, É., Perren, B. B., Mathieu, O., Petit, C., . . . Richard, H. (2012). A 2500 year record of natural and anthropogenic soil erosion in South Greenland. *Quaternary Science Reviews, 32*, 119-130. doi:https://doi.org/10.1016/j.quascirev.2011.11.014

Matthíasson, Þ. (1967). Við ströndina. *Strandapósturinn, 1*, 97-100.

McGovern, T. H. (1980). Cows, Harps Seals, and Churchbells: Adaptation and Extinction in Norse Greenland. *Human Ecology,* 8 (3), 245-275.

McGovern, T. H., Amorosi, T., Perdikaris, S., & Woollett, J. (1996). Vertebrate Zooarchaeology of Sandnes V51: Economic Change at a Chieftain's Farm in West Greenland. *Arctic Anthropology, 33* (2), 94-121.

McGovern, T. H., Perdikaris, S., & Tinsley, C. (2001). The Economy of Landnám. The Evidence of Zooarchaeology. In A. Wawn & Þ. Sigurðardóttir (Eds.), *Approaches to Vínland*. Reykjavík: Sigurður Nordal Institute, 154-165.

McGovern, T. M. (1991). Climate, Correlation, and Causation in Norse Greenland. *Arctic Anthropology, 28* (2), 77-100.

Mehler, N., & Eggertsson, Ó. (2006). *Gerðfræði tréíláta frá Stóruborg - Lokaskýrsla*. Reykjavík.

Microlab gallery. (2007). http://wwww.microlabgallery.com/PinusFile.aspx [Accessed 07.02.2023]

Møller, N. A., & Madsen, C. K. (2006). *Nordboerne i Vatnahverfi - Rapport om rekognosering og opmåling af Nordboruiner i Vatnahverfi Sommeren 2005.* København: SILA. Nationalmuseets Center for Grønlandsforskning.

Mooney, D. E. (2014). *The Use and Control of Wood Resources in Viking Age and Medieval Iceland.* (Unpublished PhD thesis). University of Aberdeen, Aberdeen.

Mooney, D. E. (2016a). An archeobotanical perspective on wooden artefacts from Medieval Reykjavík. In B. Jervis, L. G. Broderick, & I. G. Sologesoa (Eds.), *Objects, Environment and Everyday Life in Medieval Europe* (Vol. 3), Turnhout Brepols, 41-66.

Mooney, D. E. (2016b). Examining Possible Driftwood Use in Viking Age Icelandic Boats. *Norwegian Archaeological Review*, 1-21. doi:10.1080/00293652.2016.1211734

Mooney, D. E. (2016c). A ´North Atlantic island signature´ of timber exploitation: Evidence from wooden artefact assemblages from Viking Age and Medieval Iceland. *Journal of Archaeological Science: Reports, 7*, 280-289.

Mooney, D., Pinta, É., & Guðmundsdóttir, L. (2022). Wood resource exploitation in the Norse North Atlantic: a review of recent research and future directions. In D. Mooney, L. Guðmundsdóttir, B. I. Dahl, M. Ramstad, & H. Roberts (Eds.), *UBAS - Expanding Horizons: settlement patterns and outfield land use in the Norse North Atlantic*. Bergen. 13-24.

Morris, C. A. (2000). *Craft, Industry and Everyday Life: Wood and Woodworking in Anglo-Scandinavian and Medieval York* (Vol. 17). York: Council for British Archaeology.

Nansen, F. (1911). *Nord i tåkeheimen : utforskningen av jordens nordlige strøk i tidlige tider*. Kristiania: Dybwad.

Nedkvitne, A. (2019). *Norse Greenland: Viking peasants in the arctic*. Oxon: Routledge.

Nordahl, E. (1988). *Reykjavík from the Archaeological Point of View* (Vol. 12). Uppsala: Societas Archaeoligioa Usaliensis.

Nyegård, G. (2009). Restoration of the Hvalsey Fjord Church*. Journal of the North Atlantic, 2, 7–18.*

Nørlund, P. (1929). Norse ruins at Gardar, The episcopal seat of mediaeval Greenland. *Meddelelser om Grønland, 76*, 1-176.

Nørlund, P. (1972). *Fornar byggðir á hjara heims, Lýsingar frá miðaldarbyggðum á Grænlandi* (K. Eldjárn, Trans.). Reykjavík: Ísafoldarprentsmiðjan.

Ogilvie, A. E. J., Woollett, J. M., Smiarowski, K., Arneborg, J., Troelstra, S., Kuijpers, A., Pálsdóttir, A., McGovern, T. H. (2009). Seals and Sea Ice in Medieval Greenland. *Journal of the North Atlantic, 2*, 60-80.

Ólafsson, G., & Albretsen, S. E. (2016). Building Phases at GUS and the myth about the Greenlandic Centralised Farm. In V. E. Turner, O. A. Owen, & D. J. Waugh (Eds.), *Paper presented at the Shetland and the Viking World. Papers from the Proceedings of the Seventeenth Viking Congress in Lerwick, 2013*. Lerwick: Shetland Heritage Publications.

Paasche, (2021). Edøskipet, skipsgraver som kilde til Norges historie. In M, Stige &O. Risbøl (Eds.), *Kulisteinen – grensemerke i tid og rom*. Oslo: Institutt for sammenliknende kulturforskning, 64-85.

Pálsson, G. (2018). Storied Lines: Network Perspectives on Land Use in Early Modern Iceland. *Norwegian Archaeological Review, 51* (1), 112-141. doi: 10.1080/00293652.2018.1468355

Perdikaris, S., & McGovern, T. H. (2008). Codfish and Kings, Seals and Subsistence. In J. Erlandson & T. Rick (Eds.), *Human Impacts on Marine Environments*. California: UCLA Press, 187-214.

Pinta, É. (2018). Norse Management of Wooden Resources across the North Atlantic: Highlights from the Norse Greenlandic Settlements. *Environmental Archaeology* 26 (2), 209-221. doi:10.1080/14614103.2018.1547510

Pinta, É., Pacheco-Forés, S. I., Wallace, E. P., & Knudson, K. J. (2021). Provenancing wood used in the Norse Greenlandic settlements: A biogeochemical study using hydrogen, oxygen, and strontium isotopes. *Journal of Archaeological Science, 131*, 1-16. doi:https://doi.org/10.1016/j.jas.2021.105407

Ravn, M. (2016). Viking-Age War Fleets. Shipbuilding, resource management and maritime warfare in 11th-century Denmark. Maritime Culture of the North 4. Roskilde: Vikingskibs Museet.

Richter, H. G., Grosser, D., Heinz, I., & Gasson, P. E. (2004). IAWA list of microscopic features for softwood identifications. *IAWA Journal, 25* (1), 1-70.

Rink, H. (1877). *Danish Greenland: Its People and Products* (D. R. Brown Ed.). London: Henry S. King & Co

Roberts, B. A., Simin, N. P. P., & Deering, K. W. (2006). The forests and woodlands of Labrador, Canada: ecology, distribution and future management. *Ecological Research,* 21, 868-880. doi:DOI 10.1007/s11284-006-0051-7

Robichaud, A., Ehrman, J. M., Mood, B., & Laroque, C. P. (2012). *Description and wood identification of native coniferous tree species in the Maritimes from dendroarchaeological material*. Sackville

Roesdahl, E. (1995). *Hvalrostand elfenben og nordboerne i Grønland* Odense: Odense Univeritetsforlag.

Roussell, A. (1941). Farms and churches in the Mediaeval Norse settlements of Greenland. *Meddelelser om Grønland,* 89 (1), 1-235.

Rune, F. (2011). *Wild flowers of Greenland – Grønlands vilde planter*. Hiller ød: Gyldenlund Publishing.

Sanmark, A. (2019). The Case of the Greenlandic Assembly Sites. *Journal of the North Atlantic*, 2, 178-192.

Schledermann, P. (1980). Notes on Norse finds from the east coast of Ellesmere Island. *Actic*, 33(3), 454-463.

Schmid, M. M. E., Dugmore, A. J., Vésteinsson, O., & Newton, A. J. (2017). Tephra isochrons and chronologies of colonisation. *Quaternary Geochronology, 4*, 56-66.

Schoch, W., Heller, I., Schweingruber, F. H., & Kienast, F. (2004). Wood anatomy of central European Species. Retrieved from www.woodanatomy.ch

Schofield, J. E., & Edward, K. J. (2011). Grazing impacts on woodland management in Eriksfjord: Betula, coprophilous fungi and the Norse settlement of Greenland. *Vegetation History Archaeobot 20*, 181-197. doi:10.1007/s00334-011-0281-7

Schofield, J. E., Edwards, K. J., & Christensen, C. (2008). Environmental impacts around the time of Norse landnám in the Qorlortoq valley, Eastern Settlement, Greenland. *Journal of Archaeological Science, 35* (6), 1643-1657.

Schofield, J. E., Edward, K. J., Erlendsson, E., & Ledger, P. M. (2013). Palynology supports ´Old Norse´ introductions to the flora of Greenland. *Journal of Biogeography, 40*, 1119-1130.

Schofield, J. E., Pearce, D. M., Mair, D. W. F., Rea, B. R., Lea, J. M., Kamenos, N. A., Schoenrock, K. M., Barr, L. D., Edwards, K. J. (2019). Pushing the Limits: Palynological Investigations at the Margin of the Greenland Ice Sheet in the Norse

Western Settlement. *Environmental Archaeology*. 27 (2), 228-242. doi:https://doi.org/10.1080/14614103.2019.1677075

Schweingruber, F. (1990a). *Anatomy of European woods. An atlas for the identifications of European trees, shrubs and dwarf shrubs*. Birmensdorf: Paul Haupt Berne and Stuttgart Publishers.

Schweingruber, F. H. (1990b). *Microscopic Wood Anatomy; Structural variability of stems and twigs in recent and subfossil woods from Central Europe.* (3 ed.). Birmensdorf: Eidgenössische Forschungsanstalt WSL.

Seaver, K. A. (1996). *The Frozen Echo. Greenland and the Exploration of the North America, ca. A.D. 1000-1500*. Stanford: Stanford University Press.

Shaw, J. D. (2012). Economies of driftwood: Fuel harvesting strategies in the Kodiak Archipelago. *Études/Inuit/Studies, 36* (1), 63-88. doi:https://doi.org/10.7202/1015954aradresse

Smiarowski, K. (2010). *E172 Tatsip Ataa Midden Excavation 2009 & 2010 Preliminary Excavation Report*. New York: CUNY.

Smiarowski, K. (2022). *Historical Ecology of Norse Greenland: Zooarchaeology and Climate Change Responses*. Unpublished PhD thesis. The City Univeristy of New York. New York.

Smiarowski, K., Harrison, R., Brewington, S., Hicks, M., Feeley, F. J., Dupont-Hébert, C., Prehal., B., Hambrecht, G., Woollett., McGovern, T. H. (2017). Zooarchaeology of the Scandinavian settlements in Iceland and Greenland: diverging pathways. In U. Albarella, M. Rizzetto, H. Russ, K. Vickers, & S. Viner-Daniels (Eds.), *The Oxford Handbook of Zooarchaeology*. Oxford: Oxford University Press, 148-163.

Star, B., Barrett, J. H., Gondek, A. T., & Boessenkool, S. (2018). Ancient DNA reveals the chronology of walrus ivory trade from Norse Greenland. *Proc. R. Soc. B, 285*. doi:https://doi.org/10.1098/rspb.2018.0978

Steelandt, S., Bhiry, N., Marguerie, D., Desbiens, C., Napartuk, M., & Desrosiers, P. M. (2013). Inuit knowledge and use of wood resources on the west coast of Nunavik, Canada. *Études/Inuit//Studies, 37*(1), 147-173. doi:https://doi.org/10.7202/1025259ar

Storm, G. (1888). *Islandske Annaler indtil 1578* (Vol. 21). Christiania. Norway: Det norske historiske Kildeskriftfonds Skrifter.

Trbojević, N. (2016). *The Impact of Settlement on Woodland Resources in Viking Age Iceland.* (Unpublished PhD thesis). University of Iceland, Reykjavík.

Tremblay, L.B., Mysak, L.A., Dyke, A.S., (1997). Evidence from driftwood records for century-to-millennial scale variations of the high latitude atmospheric circulation during the Holocene. *Geophysical Research Letters,* 24, 2027–2030.

Van Ham-Meert A, Rodler AS, Waight TA & Daly A. (2020). Determining the Sr isotopic composition of waterlogged wood – Cleaning more is not always better. *Journal of Archaeological Science.* 124: 105261. DOI: 10.1016/j.jas.2020.105261.

Vebæk, C. L. (1992). Vatnahverfi - An inland district of the Eastern Settlement in Greenland. *Meddelelser om Grønland, Man & Society, 17*, 1-132.

Vebæk, C. L. (1993). Narsaq - a Norse landnáma farm. *Meddelelser om Grønland, Man and Society, 18*, 3-46.

Vésteinsson, O. (2003). *The Christianization of Iceland: Priests, Power, and Social Change*. Oxford: Oxford University Press.

Vésteinsson, O. (2006). Communities of dispersed settlements. Social organization at the ground level in tenth to thirteenth-century Iceland. In W. Davies, G. Halsall, & A. Reynolds (Eds.), *People and Space in the Middle Ages, 300-1300*. Turnhout: Brepols, 87-113.

Vésteinsson, O. (2010). Parishes and Communities in Norse Greenland. *Journal of the North Atlantic, 2*, 138-150.

Vésteinsson, O. (2013). North Atlantic Migrations in the Viking Age. In I. Ness (Ed.), *The Encyclopedia of Global Human Migration*. Hoboken: Wiley-Blackwell, 1-7.

Vésteinsson, O. (2014). *Archaeological investigetaions in Igaliku. Excavations in the meadow 2012-2013*. Reykjavík: Fornleifastofnun Íslands.

Vésteinsson, O. (2019). State formation and world view – Commonwealth Iceland as a part of the Norwegian realm. In J. Escalona, O. Vésteinsson & S. Brookes (Eds.), *Polity and Neighbourhood in Early Medieval Europe*, Turnhout: Brepols, 203-223.

Vésteinsson, O., Simpson, I., A. (2004). 'Fuel utilisation in pre-industrial Iceland. A micro-morphological and historical analysis.' *Current Issues in Nordic Archaeology. Proceedings of the 21st Conference of Nordic Archaeologists, September 6th-9th 2001, Akureyri*, Reykjavík, 181-87.

Vésteinsson, O., & McGovern, T. H. (2012). The peopling of Iceland. *Norwegian Archaeological review, 45*(2), 206-218. doi:10.1080/00293652.2012.721792

Vésteinsson, O., Hegmon, M., Arneborg, J., Rice, G., Russell, W. G. (2019). Dimensions of inequality. Comparing the North Atlantic and the US Southwest. *Journal of Anthropological Archaeology*, 54, 172-191.

Wallace, B. (2003). L'Anse aux Meadows and Vinland: An Abandoned Experiment. In J. Barrett (Ed.), *Contact, Continuity, and Collapse: The Norse Colonization of the North Atlantic*. Turnhout: Brepols, 207-238.

Wallace, B. (2005). The Norse in Newfoundland: L'Anse aux Meadows and Vinland. *Newfoundland and Labrador Studies, 19* (1), 5-43.

Wallace, B. (2008). The Discovery of Vinland. In S. Brink & N. Price (Eds.), *The Viking World*. London: Routledge, 604-612.

Wallace, B. (2009). L´Anse aux Meadows, Leif Eriksson´s Home in Vinland. *Journal of the North Atlantic. Special Volume, 2*, 118-129.

Wheeler, E., Baas, P., & Gasson, P. (1989). IAWA list of Microscopic Features for Hardwood Identification with an Appendix on non-anatomical information. *IAWA Bulletin, 10* (3), 219-332.

Þorsteinsson, B., & Grímsdóttir, G. Á. (1989). Norska öldin. In S. Líndal (Ed.), *Saga Íslands* (Vol. IV). Reykjavík: Hið íslenzka bókmenntafélag, 61-248.

Øye, I. (1988). Textile equipment and its working environment, Bryggen in Bergen, c 1150-1500. *The Bryggen Papers, 2*, 13-152.

Appendix 1
Results of wood and typological analyses

Appendix I

Table 17. Appendix I - Results of the wood taxa and typological analysis. This table includes identifications done by Pinta on vessels and vessel components (Pinta, 2018).

Site	Wood ID - Artefact group	Construction timber/ furniture components	Decorative and ritual objects	Farming and accounting utensils	Food preporation	Nails	Personal items	Stakes/ Pegs/ Wedge/ pins	Textile production	Toys/ games	Utensils and tools	Vessels	Unidentifiable /Other	Ship timber	Wood debris	Twigs and branches	Total:
Igaliku 1100-1300	Abies sp.	0	1	1				8			1	5			46		62
	Conifer	0													2		2
	Larix sp.	8	1	4	4	8		134	6	2	10	39	7		591		814
	Larix sp./Picea sp.	0													3		3
	Picea sp.	2	3	2	1	12		64	4		2	27	7		318		442
	Pinus sp.	0													3		3
	Pinus sect. strobus	1	1	1				11			1				46		61
	Pinus sylvestris	6	1	1		14		92	6		10	23	13		361		527
	Pinus banksiana												2				2
	Tsuga sp.												1				1
	Quercus sp.												3		2		5
	Fagus sp.												1				1
	Alnus sp.														1	3	4
	Betula sp.	2	1	4			1	20	1		2	3	5		29	73	141
	Empetrum nigrum																0
	Juniperus sp.		1			1		1					3		22	22	50
	Maloideae							1							1		2
	Salix sp.							2							5	10	17
	Vaccinium																0
	Unidentifiable															1	1

Site	Wood ID - Artefact group	Construction timber/ furniture components	Decorative and ritual objects	Farming and accounting utensils	Food preporation	Nails	Personal items	Stakes/ Pegs/ Wedge/ pins	Textile production	Toys/ games	Utensils and tools	Vessels	Unidentifiable /Other	Ship timber	Wood debris	Twigs and branches	Total:
Igaliku 1300-1400	Abies sp.	0	0	1	0	0	0	1	0	0	0	0	0		27		29
	Conifer	0													2		2
	Larix sp.	0	1	2	1	8		54	1		4	11	5		472		559
	Larix sp./Picea sp.	0						1							4		5
	Picea sp.	0	2	1		8		29	1			18	3		344		406
	Pinus sp.	0										1			3		4
	Pinus sect. strobus	0						4				1	1		49		55
	Pinus sylvestris	1		2		13		42	2		4	9	6		301		380
	Pinus banksiana												2		5		7
	Tsuga sp.																0
	Quercus sp.														1		1
	Fagus sp.																0
	Alnus sp.															1	1
	Betula sp.	3				2		9			1	2			27	219	263
	Empetrum nigrum															0	0
	Juniperus sp.					1		2							27	121	151
	Maloideae															0	0
	Salix sp.							2							16	16	34
	Vaccinium															0	0
	Unidentifiable					1										3	4

Site	Wood ID - Artefact group	Construction timber/ furniture components	Decorative and ritual objects	Farming and accounting utensils	Food preporation	Nails	Personal items	Stakes/ Pegs/ Wedge/ pins	Textile production	Toys/ games	Utensils and tools	Vessels	Unidentifiable /Other	Ship timber	Wood debris	Twigs and branches	Total:
Tatsip Ataa 1300-1400	Abies sp.										1				33		34
	Conifer														0		0
	Larix sp.	5				7		20	2			7	8		302		351
	Larix sp./Picea sp.	1				2		2				1	1		17		24
	Picea sp.	8	1			13		10				10	6		238		286
	Pinus sp.			1											0		1
	Pinus sect. strobus														20		20
	Pinus sylvestris	2				3		12	1			3	3		73		97
	Pinus banksiana																0
	Tsuga sp.																0
	Quercus sp.																0
	Fagus sp.																0
	Alnus sp.															9	9
	Betula sp.		1	3		7		8	4						128	703	854
	Empetrum nigrum															27	27
	Juniperus sp.					2		6					2		39	68	117
	Maloideae			1				1							1	1	4
	Salix sp.			1		3		5	3						31	262	305
	Vaccinium															4	4
	Unidentifiable															32	32

Site	Wood ID - Artefact group	Construction timber/ furniture components	Decorative and ritual objects	Farming and accounting utensils	Food preporation	Nails	Personal items	Stakes/ Pegs/ Wedge/ pins	Textile production	Toys/ games	Utensils and tools	Vessels	Unidentifiable /Other	Ship timber	Wood debris	Twigs and branches	Total:
Tasilikilooq 1000-1300	Abies sp.					3											3
	Conifer																0
	Larix sp.	3				15		41	3		4	11	43				120
	Larix sp./Picea sp.											24					24
	Picea sp.	1	1	2	1	12		21		1	3	23	24				89
	Pinus sp.																0
	Pinus sect. strobus																0
	Pinus sylvestris	3	2	1		6		14			1	21	11				59
	Pinus banksiana																0
	Tsuga sp.																0
	Quercus sp.																0
	Fagus sp.																0
	Alnus sp.	0										3					3
	Betula sp.	2	1	4		23		38			10	5	8				91
	Empetrum nigrum																0
	Juniperus sp.					1		1			1	3	1				7
	Maloideae																0
	Salix sp.	2				4		13			3		2				24
	Vaccinium																0
	Unidentifiable																0

Site	Wood ID - Artefact group	Construction timber/ furniture components	Decorative and ritual objects	Farming and accounting utensils	Food preporation	Nails	Personal items	Stakes/ Pegs/ Wedge/ pins	Textile production	Toys/ games	Utensils and tools	Vessels	Unidentifiable /Other	Ship timber	Wood debris	Twigs and branches	Total:
Narsaq 1000-1200	Abies sp.		1			1						3	0	1			6
	Conifer																0
	Larix sp.	1	1		1	6		28	1		2	11	6	4			61
	Larix sp./Picea sp.					1			1			1					3
	Picea sp.	2	2		1	9		7				7		1			29
	Pinus sp.																0
	Pinus strobus sec.									1		3					4
	Pinus sylvestris		5		1	4		1				2	2				15
	Pinus banksiana																0
	Tsuga sp.																0
	Quercus sp.																0
	Fagus sp.																0
	Alnus sp.																0
	Betula sp.	1	2			5	1	1	1	1	4	2	2				20
	Empetrum nigrum																0
	Juniperus sp.				1	3	1	3	1		5	1	1				16
	Maloideae																0
	Salix sp.		1			2		2	1			1	1				8
	Vaccinium																0
	Unidentifiable																0

Site	Wood ID - Artefact group	Construction timber/ furniture components	Decorative and ritual objects	Farming and accounting utensils	Food preporation	Nails	Personal items	Stakes/ Pegs/ Wedge/ pins	Textile production	Toys/ games	Utensils and tools	Vessels	Unidentifiable /Other	Ship timber	Wood debris	Twigs and branches	Total:
GUS 1050-1350	Abies sp.	2			1			1			1	6	1	0			12
	Conifer	6						2									8
	Larix sp.	64	1		5	5		56	3	2	4	39	15	2			196
	Larix sp./Picea sp.	3			1	2		2	1			64					73
	Picea sp.	82	1		4	4		36	3		6	110	26	0			272
	Pinus sp.	0										1					1
	Pinus sect. strobus	3						1				11					15
	Pinus sylvestris	3			1							6	1				11
	Pinus banksiana																0
	Tsuga sp.																0
	Quercus sp.	3						1				2	2				8
	Fagus sp.																0
	Alnus sp.											5					5
	Betula sp.					8		15		1	5	2	4				35
	Empetrum nigrum																0
	Juniperus sp.		1			1		1				4	3				10
	Maloideae																0
	Salix sp.	9	2	4		3		23			6	1	8				56
	Vaccinium																0
	Unidentifiable																0
	Total	243	36	41	24	250	3	876	66	9	95	553	247	8	4002	2311	8764
	Total %	2,8	0,4	0,5	0,3	2,9	0,0	10,0	0,8	0,1	1,1	6,3	2,8	0,1	45,7	26,4	
	Excluding non-artefactual %	9,9	1,5	1,7	1,0	10,2	0,1	35,7	2,7	0,4	3,9	22,6	10,1	0,3			