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Expanding Horizons

Settlement Patterns and Outfield Land Use in the Norse North Atlantic

Dawn Elise Mooney, Lísabet Guðmundsdóttir, Barbro Dahl, Howell Roberts and Morten Ramstad (eds.)

UNIVERSITY OF BERGEN

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The wood artefacts on the left side are from Borgund, Norway while the artefacts on the right side are from Norse Greenlandic sites.

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Preface

This volume stems from the Expanding Horizons project, which began in 2018. The project was funded by a Workshop Grant from the Joint Committee for Nordic Research Councils in the Humanities and Social Sciences (NOS-HS), held by Orri Vésteinsson, Ramona Harrison, and Christian Koch Madsen. Funding was awarded for two workshops, as well as a subsequent publication of the material presented. Workshop organisation and grant administration were carried out by Morten Ramstad, Lísabet Guðmundsdóttir, Howell Roberts, Barbro Dahl, Birna Lárusdóttir, and Dawn Elise Mooney. The workshops gave researchers and practitioners from across the North Atlantic region an opportunity to forge new connections with each other, not only through academic presentations but also through shared experiences of archaeological sites, standing Medieval structures and their surrounding landscapes.

The first Expanding Horizons meeting took place in Norway, on June 1st–4th 2018. The program began in Bergen with a tour of the city's Medieval sites, led by Prof. Gitte Hansen, before travelling to Mo in Modalen for two days of presentations and discussions. The workshop was attended by 36 participants, 27 of whom gave presentations on topics including archaeological survey in mountain regions, driftwood, seaweed, stone, birds and feathers, and fishing and marine mammals. The two-day seminar was followed by an excursion visiting sites including the stave churches at Borgund, Hopperstad and Kaupanger, the Viking trading sites at Kaupanger and Lærdal, and Norway's oldest secular wooden building, Finnesloftet in Voss, built around AD 1300. In between archaeological sites, the excursion also took in the dramatic fjord landscape of western Norway. Here and in Iceland, both the upstanding structures and their surrounding landscape should be seen as key actors in the development of the settlement and subsistence practices discussed in this volume.

Just under a year later, on April 25th–28th 2019, the Expanding Horizons group met again in Iceland. Forty-one participants gathered in Brjánsstaðir for two more days of talks and discussions. While the first workshop had a main focus on remote wild resources, the second focused on settlement and land-use patterns, agricultural practices, and trade and exchange. Again, the workshop concluded with an excursion to local archaeological sites. Attendees visited the episcopal manor farm and church at Skálholt, the reconstructed Viking Age house at Stöng in Þjórsárdalur, the caves at Ægissíðuhellir, the archaeological site at the manor farm Oddi and the preserved medieval turf-built farm and museum at Keldur. Photographs of the participants of both workshops are presented on the following pages.

Partly due to the ongoing coronavirus pandemic, more time than anticipated has passed between these meetings and the publication of this volume. We thank the authors for their patience, and for their outstanding contributions to the archaeology of western Norway and the Norse North Atlantic diaspora. We are also very grateful to our colleagues who assisted the editors in the peer review of this volume. Lastly, we thank you, the reader, and we hope that you find inspiration in the papers presented here.

Stavanger/Reykjavík/Bergen, Spring 2022

Dawn Elise Mooney, Lísabet Guðmundsdóttir, Barbro Dahl, Howell Roberts and Morten Ramstad

Attendees of the first Expanding Horizons workshop at Mo in Modalen, June 2018.

Back row, left to right: Jennica Einebrant Svensson, Garðar Guðmundsson, Even Bjørdal, Orri Vésteinsson, Morten Ramstad, Jørgen Rosvold, James Barrett, Gísli Pálsson, Michael Nielsen, Christian Koch Madsen, Konrad Smiarowski, Howell Magnus Roberts, Ragnar Orten Lie; Middle row, left to right: Solveig Roti Dahl, Brita Hope, Ragnheiður Gló Gylfadóttir, Kristoffer Dahle, Douglas Bolender, Håkan Petersson; Front row, left to right: Mjöll Snæsdóttir, Birna Lárusdóttir, Lilja Laufey Davíðsdóttir, Irene Baug, Kristin Ilves, Jørn Henriksen, Kathryn Catlin, Lilja Björk Pálsdóttir, Gitte Hansen, Kristborg Þórsdóttir, Élie Pinta, Dawn Elise Mooney, Lísabet Guðmundsdóttir, Sólveig Guðmundsdóttir Beck, Ramona Harrison. *Photo: Kathryn Catlin.*

Attendees of the second Expanding Horizons workshop at Brjánsstaðir, April 2019.

Back row, left to right: Howell Magnus Roberts, Morten Ramstad, Kjetil Loftsgarden, Kristoffer Dahle, Douglas Bolender, Ragnheiður Gló Gylfadóttir, Hildur Gestsdóttir, Michael Nielsen, Orri Vésteinsson, Jennica Einebrant Svensson, Trond Meling, Knut Paasche, Anja Roth Niemi, Knut Andreas Bergsvik, Símun Arge; Middle row, left to right: Guðrún Alda Gísladóttir, Brita Hope, Håkan Petersson, Kathryn Catlin, Even Bjørdal, Ragnheiður Traustadóttir, Élie Pinta, Solveig Roti Dahl, Per Christian Underhaug; Front row, left to right: Kristborg Þórsdóttir, Sólveig Guðmundsdóttir Beck, Guðmundur Ólafsson, Gitte Hansen, Mjöll Snæsdóttir, Lisbeth Prøsch-Danielsen, Kari Loe Hjelle, Irene Baug, Christian Koch Madsen, Ramona Harrison, Barbro Dahl, Dawn Elise Mooney, Thomas Birch, Lísabet Guðmundsdóttir, Jørn Henriksen. *Photo: Lísabet Guðmundsdóttir.*

Dawn Elise Mooney, Élie Pinta and Lísabet Guðmundsdóttir

Wood resource exploitation in the Norse North Atlantic: a review of recent research and future directions

The North Atlantic islands have always been relatively wood-poor. Nonetheless, from the Viking Age they were home to Norse settlers who in their homelands relied significantly on wood resources for the production of a huge variety of objects from cooking utensils to ships. The story of how these settlers adapted their craft processes and exploitation strategies to the limited wood resources available on these islands has only in the last decade begun to be explored in detail through the examination of archaeological remains. Assemblages of wooden artefacts, woodworking debris, charcoal and mineralised wood have been examined from across the region, with a view to understanding patterns of both wood exploitation and woodland management. In the absence of significant forest areas with large trees suitable for construction and boatbuilding, driftwood became an extremely important source of timber. However, several of the wood species which arrive as driftwood also could have been imported to the islands, and as yet there is no reliable method for conclusively identifying archaeological wood remains as driftwood. This paper presents a review of recent research in wood resource exploitation in Iceland and Greenland, along with possibilities and potential pitfalls in future research.

Introduction

Wood was by far the most common craft and construction material in the Norse world: that is, late Iron Age and early Medieval Scandinavia. However, the North Atlantic islands (Iceland, Greenland and the Faroe Islands), which were colonised by the Norse in the 9th and 10th centuries AD, have always had a limited tree flora. In the course of these colonisation events, known as *landnám* after the Old Norse for 'land-take', the Norse settlers adapted their craft processes and exploitation strategies to these limited wood resources. During the last decade in particular, archaeologists have begun to explore these adaptations in detail, analysing uncharred, charred, and mineralised remains of wooden artefacts, timbers, fuel, and boat elements. This paper synthesises published and unpublished results from these investigations to explore the 'state of the art' of wood exploitation studies in the Norse North Atlantic (from the colonisation of Iceland to the abandonment of the Norse colonies in Greenland, c. AD 870-1500). The paper concludes by presenting current challenges and potential future directions in this field.

Historical background

During this period there was significant social and political change in Scandinavia and the North Atlantic region, which influenced trade and availability of imported goods, including timber. The 9th-10th centuries AD saw the Viking colonisation of the Faroe Islands (where there had been earlier settlements [Church *et al.* 2013]), Iceland (Schmid *et al.* 2018, Vésteinsson 2000a), and Greenland (ÍF IV 1985, Arneborg 2004, 2008). All were independent states, but came under the rule of the Norwegian crown by the mid-13th century AD (Arneborg 2008, Roesdahl 1987). In Iceland, these changing political allegiances had economic impacts: union with Norway opened greater possibilities for trade, especially of stockfish and woollen cloth, which were traded with English and Hanseatic merchants in the later Medieval period (Barrett 2016, Vésteinsson 2016, Perdikaris and McGovern 2009, Hayeur Smith 2018). Another key influence was religious change: Iceland officially converted to Christianity in AD 1000 (Vésteinsson 2000b). The import of wood from Norway specifically for church construction appears as a recurring motif in the Icelandic sagas, although is this not necessarily supported by the archaeological material (Mooney 2013, Guðmundsdóttir 2013a).

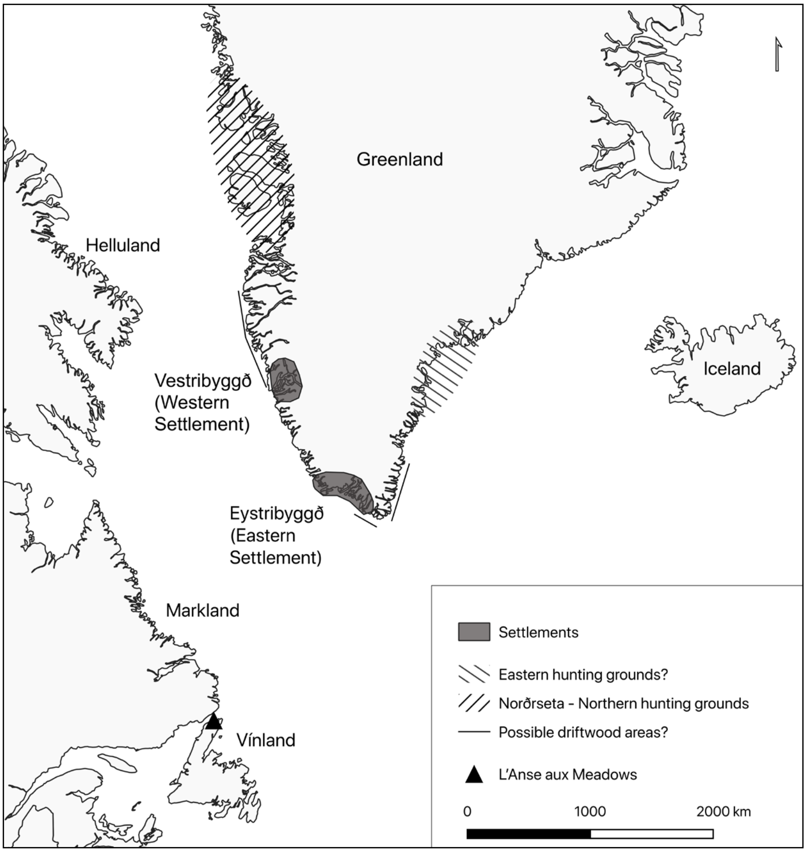

Figure 1. Map showing the locations of Norse settlements and resource regions in Greenland and North America. By Lísabet Guðmundsdóttir.

Norse settlements in Greenland were concentrated in two areas, the *Eystribyggð* and the *Vestribyggð* (Figure 1), with a maximum combined population of 2-3000 (Lynnerup 1998, Arneborg 2004, Madsen 2014). The settlements were likely motivated by the potential for economic exploitation of animals including walrus, polar bear and seal, especially in the óbyggðir, wilderness areas including Disko Bay and the southeastern coast (Seaver 1996, Arneborg 2004, Perdikaris and McGovern 2008, Keller 2010, Frei *et al*. 2015, Star *et al*. 2018, Madsen 2019). The trade of these resources with Europe was vital to the Norse Greenlandic economy (Arneborg 2008). The settlements declined and were ultimately abandoned – the Vestribyggð during the 14th century, and the Eystribyggð by AD 1450 (Arneborg *et al*. 2012).

Around AD 1000, the Greenland Norse voyaged along the North American coast, naming the regions they encountered *Helluland*, *Markland* and *Vínland* (Figure 1). A settlement was established at L'Anse aux Meadows (LAM) in Newfoundland (Ingstad 1977, Wallace 2005, 2009). These expeditions aimed to identify new resource regions, including sources of timber, and both sagas and contemporary medieval sources reference the transport of timber between Markland/Vínland and Greenland (ÍF IV 1985, Storm 1888). It has been argued that LAM was a short-lived, seasonal outpost for resource acquisition (Ljungqvist 2005, Wallace 2005). However, recent research indicates the site may have been used for significantly longer (Ledger *et al*. 2019).

Environmental background

The flora of these islands is limited by their northerly latitude and harsh climate (Olson *et al*. 2001). This is evident in the native woody taxa, many of which are low-growing shrubs rather than trees suitable for construction (Figure 2). One of the drivers of research into wood utilisation in these areas has been the contrast between the limited availability of wood, and the critical role played by wood in material culture in the rest of the Norse world (Ljungkvist 2008, p. 188). The Norse reliance on wood makes their successful colonisation of these windswept islands all the more intriguing.

This is of course not to say that there was no scarcity of wood in the Norse homelands. Although large parts of Norway remain thickly forested in modern times, large swathes of the country's outer coast were deforested during the late Neolithic and early Bronze Age (Hjelle *et al.* 2018). In southwestern Norway adaptations to wood scarcity mostly consisted of developing procurement strategies focusing on inland areas less amenable to agriculture, where forest cover persisted. However, on the coasts and islands of northern and arctic Norway there was a considerable amount of driftwood which has a long history of human exploitation (Alm 2019). The Norse settlers would have brought their experience from these environments, as well as from settlements on the tree-poor Western and Northern Isles of Scotland, to the islands of the North Atlantic.

The Norse *landnám* had an enormous impact on native woodlands across the North Atlantic. Low temperatures and short growing seasons mean that woodlands are slow to recover, and Iceland in particular is often given as an example of human impact on a 'pristine' environment (e.g. Smith 1995, Buckland *et al.* 1991). Unlike Greenland and the Faroes, Iceland had never had a significant human population before *landnám*, and also had no native grazing animals. Woodland cover in Iceland has declined from 25-40% before *landnám* to around 1% in the present day (Jónsson 2005, Dugmore *et al.* 2014, Eysteinsson 2017, Erlendsson and

Edwards 2010). The original extent of woodland in Greenland and the Faroes is less well understood, and more research is needed to understand the environmental impacts of the Norse settlements.

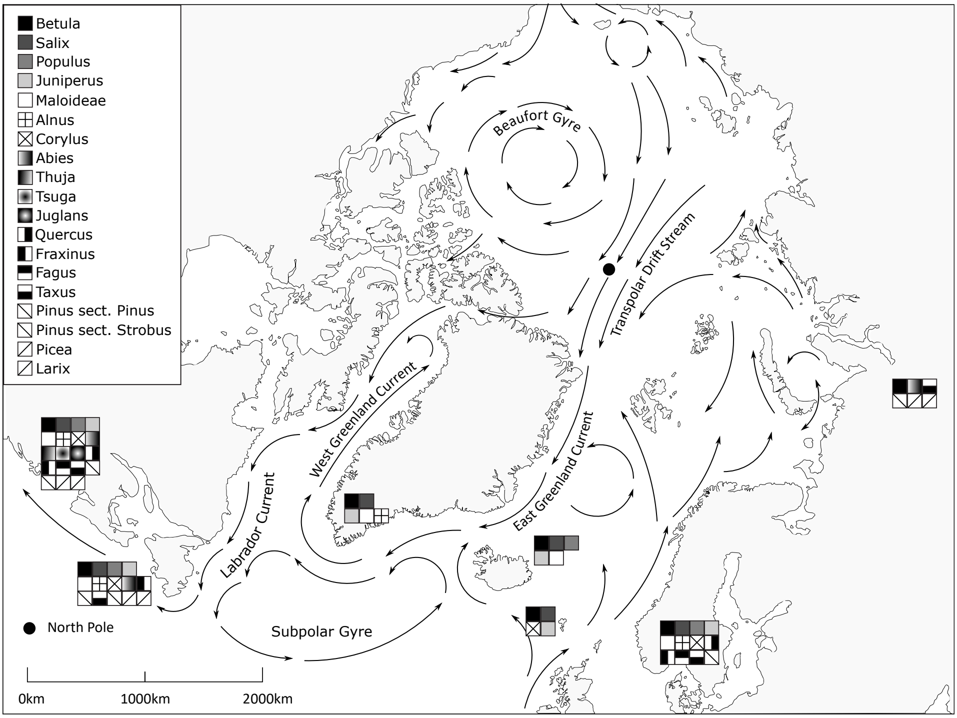

***Figure 2**. Map showing ocean currents affecting the circulation of driftwood in the Arctic and North Atlantic, and the regions in which wood taxa mentioned in the text are native. The taxa listed do not represent a comprehensive list of the tree flora of all regions, nor do they necessarily indicate the presence of any one taxon at the precise location indicated. By Dawn Elise Mooney.*

Woodland decline is generally attributed to the activities of the settlers. They burnt wood as fuel, cleared areas for hayfields, grazed livestock in the woodlands, and collected birch twigs for winter fodder. Deforestation led to widespread soil erosion in Iceland (Dugmore *et al.* 2009, 2014) and Greenland (Massa *et al.* 2012, Schofield *et al.* 2008, 2010, Edwards *et al.* 2008, Ledger *et al.* 2017, Gauthier *et al.* 2010, Bichet *et al.* 2014). Palynological research from southwest Iceland (Hallsdóttir 1987, Hallsdóttir and Caseldine 2005), suggests that most deforestation occurred within 100-150 years (Hallsdóttir 1996). However, later investigations indicate that the speed of woodland decline varied significantly across Iceland, and that areas of woodland survived into the 18th century (Lawson *et al.* 2007, Erlendsson and Edwards 2010). Studies from Greenland are even more divided about the environmental impacts of *landnám*. Most studies from the Eystribyggð suggest woodland clearance occurred very rapidly (Fredskild 1988, Edwards *et al.* 2011, Ledger *et al.* 2014), but some show the opposite trend (Schofield and Edwards 2011, Bichet *et al.* 2014). In the Vestribyggð, the Norse footprint is barely visible beyond the farmstead and its homefield (Schofield *et al.* 2019). At LAM, paleoenvironmental analyses indicate no significant vegetation change following the arrival of the Norse (Henningsmoen 1977, Davis *et al.* 1988).

The native woodlands were not the only source of wood available – ocean currents transport large quantities of driftwood to certain North Atlantic beaches (Figure 2). This wood originates in Siberia and North America, where trees growing on river banks are washed out by erosion and carried out to sea (Eggertsson 1993, Alix 2005, Hellmann *et al*. 2013). Logging now contributes significantly to this system (Hellmann *et al.* 2016), but even at the time of *landnám* a considerable amount of driftwood was reaching Iceland (Kristjánsson 1980). The wood is mostly of conifer taxa, especially pine (*Pinus* sp.), larch (*Larix* sp.) and spruce (*Picea* sp.). This partly reflects the forest composition of source areas (Eggertsson 1993, Hellmann *et al.* 2013, 2017), but also that conifer wood is more buoyant than wood of broadleaf trees (Häggblom 1982) and can float long enough to be incorporated into the sea ice. In contrast to the native trees of the islands, driftwood logs are often long and straight, and were of key importance in construction.

Methods of wood analysis

Given these multiple potential sources of timber, determining the origin of wood remains is essential in understanding wood exploitation in the North Atlantic. The primary method employed is *taxonomic provenancing*. This method uses wood anatomical analysis to identify the taxon to which archaeological wood remains belong (Figure 3), and compares the results with palaeoenvironmental data to determine the potential provenance of the wood. This method is well-suited to environments with limited native taxa, and has been used in the Canadian Arctic (Laeyendecker 1993a, 1993b, Alix 2009a, 2009b, Steelandt *et al.* 2016), Alaska (Lepofsky *et al.* 2003, Alix 2012, Shaw 2012), and Patagonia (Caruso Fermé *et al.* 2015) as well as the North Atlantic. Here the method was pioneered by Claus Malmros (1990, 1994, Andersen and Malmros 1993) and has since been developed by various scholars (e.g. Grønnow 1996, Bishop *et al.* 2013, Christensen 2013, Mooney 2016b, Pinta 2018).

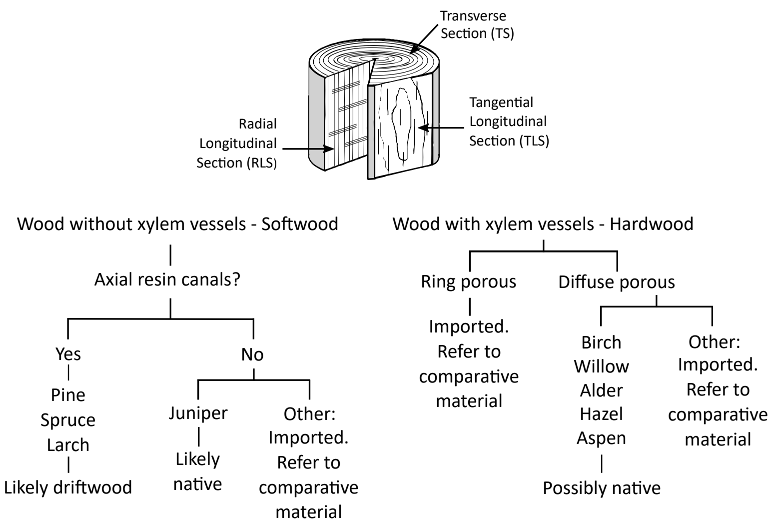

***Figure 3**. Diagram showing simplified process of taxonomic identification and preliminary provenancing in the North Atlantic. Taxonomic identifications should always be conducted through comparison with modern and/or published reference material. By Lísabet Guðmundsdóttir, after Mooney 2016a.*

Wood anatomical analysis is carried out by examining wood remains in three planes (Figure 3) at magnifications of up to 400x (Hather 2000). Taxonomic identifications are assigned by comparing suites of anatomical characteristics visible with published (e.g. Schweingruber 1990, Schoch *et al.* 2004, Hather 2000) and modern reference material.

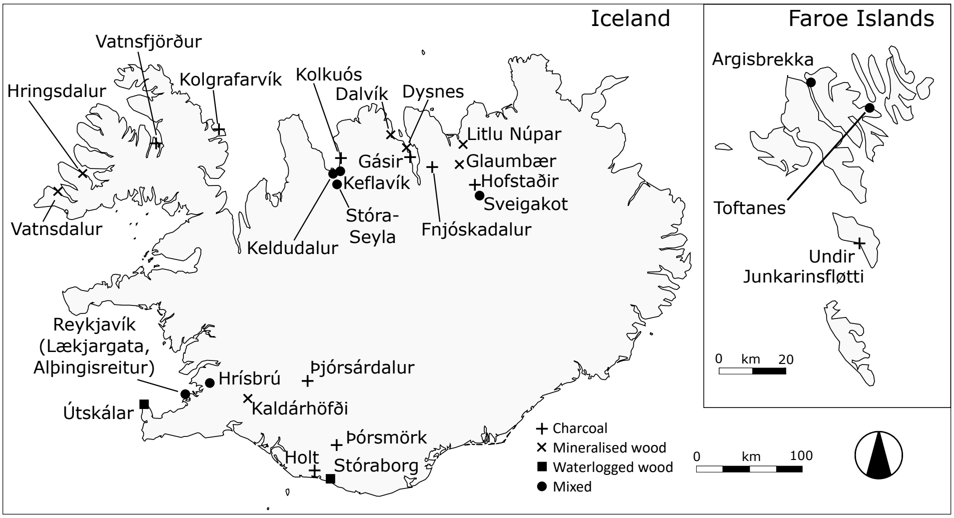

Figure 4. Location of sites in Iceland and the Faroe Islands where analysis of archaeological wood remains has been conducted. Not all sites are mentioned in the text. By Dawn Elise Mooney.

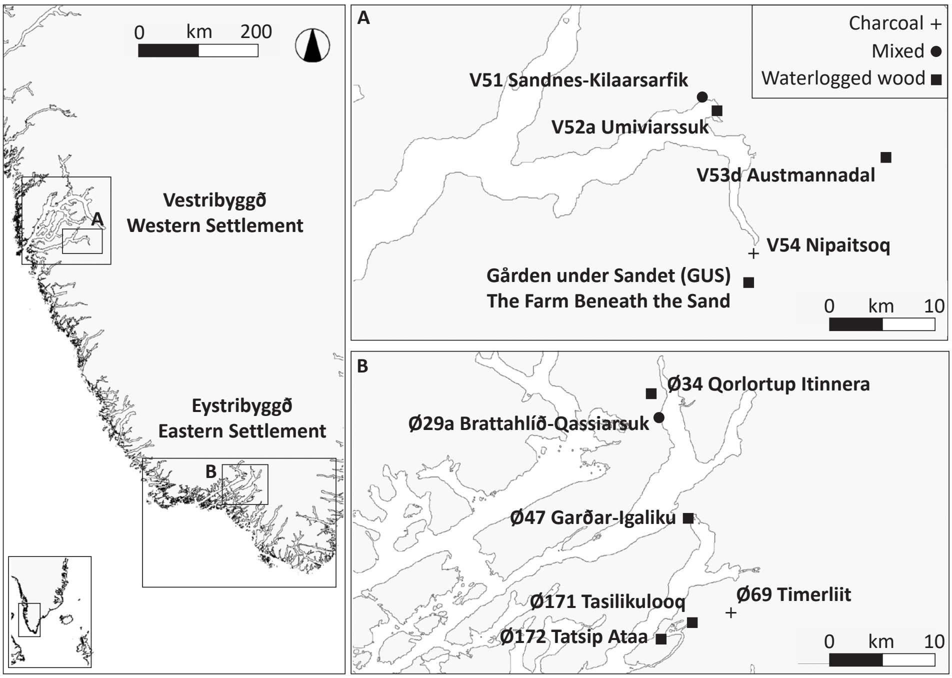

***Figure 5**. Location of sites in Greenland mentioned in the text. By Élie Pinta.*

Not all wood species can be distinguished from one another on the basis of their microscopic anatomy – Iceland's nine native trees correspond to just four 'anatomical' groups. Spruce and larch cannot be identified beyond genus level, and can only be conclusively differentiated by the observation of pit borders in the ray tracheids (Bartholin 1979, Anagnost *et al.* 1994, Talon 1997). Such details are often hard to observe in archaeological material. Despite these limitations, taxonomic provenancing has illuminated patterns of wood use in the North Atlantic (e.g. Malmros 1994, Mooney 2016b, Pinta 2018) through the study of charred, uncharred, and mineralised wood. In order to achieve the most direct comparisons between sites and regions, studies of wood exploitation presented and discussed below are grouped by the preservation conditions of the remains analysed. The origins of the assemblages presented here are shown in Figures 4 and 5.

Charred wood remains

Wood charcoal is near ubiquitous on archaeological sites, due to its chemically inert nature, and provides information about local environment and choice of fuel. Assemblages can be easily compared across different environments and time periods. Charcoal studies in the North Atlantic can generally be divided into those which investigate wood fuel remains, and investigations into charcoal production, although the taxonomic identification of individual fragments for radiocarbon dating is also common.

Charcoal was of key importance in the North Atlantic. Charcoal burns at a high temperature and is used in metalworking, and was therefore essential in the maintenance of metal tools. The value of woodlands which could support charcoal production can be seen in their strategic acquisition by wealthy farms (Pálsson 2018). This may have been a key factor in the abandonment of lower-status farms in Iceland (Dugmore *et al.* 2007). Charcoal in Iceland was generally produced from birch (*Betula* sp.), the main component of the native forests. This can be seen in analyses from Þórsmörk and Þjórsárdalur in the south (Church *et al.* 2007, Dugmore *et al.* 2006, 2007) and Reykjavík and Hrísbrú in the southwest (Guðmundsdóttir 2010, 2012). In Fnjóskadalur, one of the oldest surviving forest areas in Iceland, studies have shown that birch alone was used to produce the vast amounts of charcoal required for large-scale iron production (Guðmundsdóttir 2014, 2016). It is often assumed that only birch was used for charcoal-making in Iceland (e.g. Bishop *et al*. 2018), as driftwood was more valuable for construction. However, charcoal pits are found adjacent to driftwood beaches in northwest Iceland (Lárusdóttir *et al.* 2003), and excavations at Kolgrafarvík have confirmed that driftwood was used in such pits (Mooney 2016d).

Of the trees native to Iceland, birch is by far the best fuel wood (Taylor 1981). At Vatnsfjörður, once one of the wealthiest farms in Iceland, almost all the charcoal from domestic and industrial contexts dated from the 9th-17th centuries AD is of birch (Mooney 2013). The same is true of the farm of Hofstaðir, where birch maintained a dominant presence in the local landscape (Lawson *et al.* 2007, 2009). Despite this, at nearby Sveigakot a decline in availability of birch wood precedes the abandonment of the site in the 13th century AD (Vésteinsson and McGovern 2012, Mooney 2013). Less efficient fuel woods like willow (*Salix* sp.) become more common, along with conifer taxa which may reflect the burning of artefacts or timbers. Birch dominates the assemblages from Keldudalur, Hrísbrú and Reykjavík (Guðmundsdóttir 2010, 2011, 2012), while elsewhere firewood varies between sites and over time. Birch is the main fuel at the trading site of Kolkuós until AD 1104, after which conifer taxa are more common. At another trading place at Gásir, a mix of native wood, imported wood and driftwood was used (Bishop 2016).

Relatively few charcoal studies have been conducted elsewhere in the North Atlantic. In Greenland, charcoal fragments deriving from domestic fuel at V51 and V54 in the Vestribyggð were primarily identified as willow, with occasional finds of conifers and oak (*Quercus* sp.) (McGovern *et al.* 1983, Fredskild and Humle 1991, Buckland *et al.* 1994). At Ø69 in the Eystribyggð, the charcoal assemblage was dominated by local taxa such as birch, alder (*Alnus* sp.) and willow. A few fragments of non-native conifer are interpreted as driftwood, imported wood or wood felled in North America (Bishop *et al*. 2013). Similar trends have been noted at Ø29a (Edvardsson *et al*. 2007). Preliminary studies at Ø47, Ø171 and Ø172 suggest that birch was preferred, supplemented by local willow and juniper (*Juniperus communis* L.).

Native taxa such as birch, juniper and heather (*Calluna* sp.) also dominate the few existing charcoal studies from the Faroes. Larch, spruce and pine in these studies are treated as driftwood, while oak is interpreted as imported (Church *et al.* 2005, Lawson *et al.* 2005, Vickers *et al.* 2005). It is thought that wood was used as domestic fuel and in ironworking (Malmros 1994), probably in combination with turf and peat. Juniper was also used in smoking meat and fish (Hansen 2013). At LAM, a study by Paulssen (1977) indicates a preference for native conifers such as larch, spruce and fir (*Abies* sp.), although birch, alder and heather were also noted.

Uncharred wood remains

Unlike charcoal, uncharred wood requires specific preservation conditions. In the North Atlantic, uncharred wood is only preserved in either waterlogged or highly compacted, anaerobic contexts, or in permafrost. Despite this, numerous studies have been conducted on uncharred wood from the North Atlantic islands. Some of these focus on a single class of artefact (e.g. Mehler and Eggertsson 2006, Pinta 2018), while others are more holistic. These show clear trends which contrast sharply with contemporary assemblages from Europe and southern Scandinavia (Figure 6). Studies of Icelandic artefacts have demonstrated a "North Atlantic island signature" (Mooney 2016b, 287), where conifer wood, most likely driftwood, is dominant. In Iceland and the Faroes conifer wood mostly seems to replace the broad category of 'other taxa', while oak remains a significant component of many assemblages (Figure 6), mostly due to the presence of imported stave-built vessels (Mooney 2016a, 2016b, Mehler & Eggertsson 2006). Some oak may also represent the reuse of boat elements (Mooney 2016b).

Remains of Viking Age structures in Iceland have shown that longhouses were constructed from both native birch and driftwood. For example, timbers from Sveigakot were identified as birch, while both birch and conifers (likely driftwood) were identified among structural timbers from Lækjargata and Hrísbrú. Analysis of timbers from Keldudalur suggests that both the byre and longhouse were constructed of birch (Guðmundsdóttir 2011). Birch seems to be common in construction until the 12th century AD, when it gives way to driftwood. Churches from the 11th-12th centuries AD were mainly constructed from conifer taxa while remains from internal components, such as panelling, were of birch (Guðmundsdóttir 2013a, 2014b).

The Faroes follow a similar trend: driftwood taxa dominate, supplemented by native wood and occasional imported taxa (Malmros 1990, 1994) – although there is some debate about the categorisation of taxa (Christensen 2013). Native juniper was used for the production of ropes and bindings for stave-built vessels (Larsen 1991, Hansen 2013).

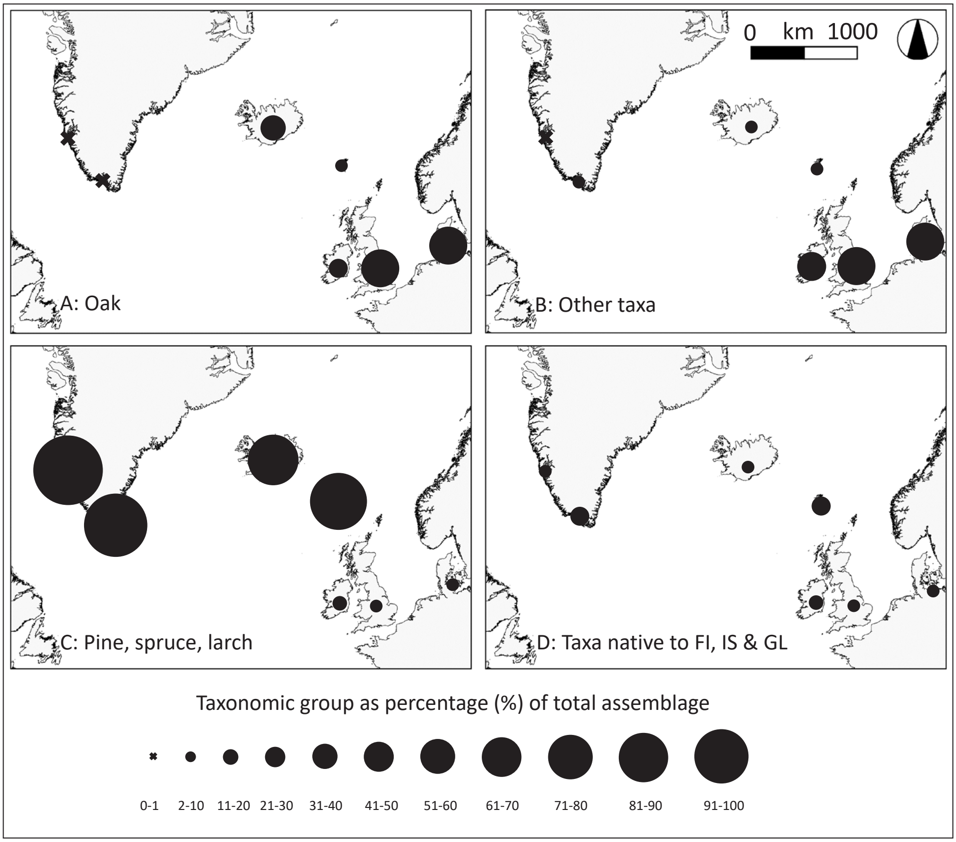

***Figure 6**. Proportions of different taxonomic groupings in medieval wooden artefact assemblages (total n=10413) from Iceland (n=829 [Mehler and Eggertsson 2006; Mooney 2013, 2016a]), Greenland Eystribyggð (n=1818 [Andersen and Malmros 1993, Pinta 2018, Guðmundsdóttir 2021]), Greenland Vestribyggð (n=628 [Andersen and Malmros 1993, Pinta 2018, Laeyendecker 1985]), the Faroe Islands (n=763 [Malmros 1994, pers. comm., Christensen 2013), the British Isles (n=1983 [Morris 2000, Comey 2010, Scannel 1988]) and southern Scandinavia (n=4408 [Sørensen et al. 2001, Christensen 1990, Westphal 2006, Bartholin 1978]). By Élie Pinta, after Mooney 2016a.*

Selected wooden remains from individual Norse Greenlandic sites have been described with precise measurements and illustrations (e.g. Roussell 1941, Arneborg 1998), sometimes as part of a broader analysis (Imer 2017), but never in a holistic way (although one such study is underway at the time of writing [Guðmundsdóttir 2021]). Only one published study focuses exclusively on wooden artefacts (Andersen and Malmros 1993), while an unpublished report from V51 examines a few miscellaneous remains (Laeyendecker 1985). Recently there has been renewed interest in the wooden material culture of the Greenland Norse. Pinta (2018) analysed containers ranging from drinking bowls to buckets and vats used in domestic and agropastoral activities from sites across the Eystribyggð (Ø34, Ø171, Ø172) and Vestribyggð (V51, V52a, V53d, GUS). This study describes a trend towards driftwood exploitation, as seen elsewhere (Malmros 1994, Mooney 2016a), but also fewer imported materials, especially oak (Figure 6).

Figure 7. Examples of wooden artefacts from Norse Greenlandic sites. A: Part of stave-built vessel base, spruce/larch, V52; B: Part of decorated object, spruce, Ø47; C: Broken carved horse figurine, larch, Ø47; D: Spindle, Scots pine, Ø47; E: Toggle, juniper, Ø47; F: Turned vessel, spruce/larch, V51; G: Part of stave-built vessel lid, Scots pine, Ø171; H: Part of handle stave with runic carving or owners mark, larch, Ø47; I: An unidentified object, larch, Ø47. Photographs by Élie Pinta and Lísabet Guðmundsdóttir, illustration by Dawn Elise Mooney.

Studies from both the Eystribyggð and Vestribyggð also show a higher incidence of driftwood in artefact assemblages and woodworking debris. Greater taxonomic variation at Ø47 may indicate more frequent use of imported wood, possibly linked to its high socioeconomic status as the episcopal see. These recent studies from Greenland highlight differences between sites and between classes of artefacts, related to variations in wood availability as well as socioeconomic status and site type. Such variations emphasise the importance of combining provenience analysis with a technological approach (Pinta 2018, cf. Morris 2000, Comey 2010). This approach facilitates the exploration of craft techniques and the choices of the craftsperson in order to better understand the full extent of the *chaîne opératoire*, from the acquisition of the raw material to the finished object, its discard and its reuse (Roux 2019).

Although wood remains from LAM have been analysed, and the presence of butternut (*Juglans cinerea* L.) at the site is given as evidence for Norse voyages south (Wallace 2009), the reports are unpublished and difficult to access. A summary (Wallace 2005, p. 18) indicates that most of the woodworking debris is of local taxa, while a few artefacts of Scots pine must have been imported. Perem (1974) identifies local/drifted taxa such as spruce and fir (*Abies* sp.) along with potentially imported cedar (*Thuja* sp.) and hemlock (*Tsuga* sp.), but neither the artefact types nor their contexts are given in either source. The potential of wood technology in distinguishing indigenous and Norse artefacts at LAM has also been explored (Gleeson 1979).

Mineralised wood remains

The final category of wood remains commonly studied in the North Atlantic is mineralised wood. Mineralisation occurs when minerals in solution in the soil precipitate onto parts of wooden objects (Keepax 1975, Haneca *et al.* 2012). Although the visibility of diagnostic features in mineralised wood is variable, these remains can still be useful in exploring wood use in poor preservation conditions. This method has often been used in studies of boat construction (e.g. Crumlin-Pedersen 1997, Owen and Dalland 1999, Konsa *et al*. 2009, Schanche 1991). The only comprehensive studies of mineralised wood in the North Atlantic are on Icelandic material.

A study of mineralised wood from boat burials in Iceland (Mooney 2016c) showed significant variation. Some produced only oak remains, some only conifer wood. Others contained a mix of these two categories, while birch was also identified at one site. These findings compare well to Scandinavian clinker-built boats built mainly of oak and/or conifer wood but opportunistically repaired with other materials. A higher incidence of conifer wood in the Icelandic examples suggests the use of driftwood (Mooney 2016c). This is backed up by boat graves at Dysnes, where one boat was built entirely of larch (almost certainly driftwood) while the other was built from pine but repaired with larch (Gestsdóttir *et al*. 2017).

Mineralised remains of other artefacts at Dysnes included a wooden chest of birch, knife handles of birch and oak, and a shield constructed from several wood taxa including Scots pine (*Pinus sylvestris* L.) and wood of the apple (Maloideae) group (Gestsdóttir *et al.* 2017). Mineralised wood remains from 11th century church sites suggest that while coffins were mostly of driftwood, oak and birch were also present (Guðmundsdóttir 2013a). Research on coffin remains has also revealed the reuse of boat timber, mostly oak and Scots pine (Guðmundsdóttir 2013b, 2019).

Problems and future directions

While the studies discussed above have identified clear trends in wood exploitation, due to the wide distribution of many taxa and difficulties in their identification there is an overlap in the North Atlantic between drifted and imported taxa (Mooney 2017). For example, Scots pine

(*Pinus sylvestris* L.) could arrive in the Norse North Atlantic settlements as driftwood, or as an import from Europe. It is furthermore indistinguishable from species within the botanical group *Pinus* sect. *Pinus* native to North America and Europe. Taxa within *Pinus* sect. *Strobus*, found in both Siberia and North America, are also identical in terms of microscopic anatomy. Lastly, even when spruce and larch can be distinguished from one another in archaeological material (e.g. Malmros 1990, 1994, Pinta 2018, Mooney 2016b), several species of both genera are present across all potential timber source areas (Figure 2).

For these reasons, along with the fact that human influence on wood availability cannot be disregarded, we advise researchers to be wary when discussing wood provenancing based solely on taxonomic identification. We also recommend greater transparency when disseminating the results of taxonomic identifications, to limit over-interpretation. Where identifications have been made of genera or species which can be challenging to distinguish from one another, ideally the reasoning for making these identifications should also be reported. Furthermore, Christensen (2013) has advised caution in comparing assemblages comprising different artefact classes, noting that the contribution of native and imported wood in the Faroes may have been underestimated due to the nature of the studied corpus. We reiterate here that this concern should be considered across the North Atlantic.

Researchers have attempted to identify archaeological wood remains as driftwood using chemical analysis. However, results indicate that the soluble compounds which give driftwood its 'marine' chemical signature are leached after deposition, and the 'bulk' chemical signature of archaeological wood is more closely related to the depositional environment (Caruso Fermé *et al.* 2015, Steelandt *et al.* 2016, Mooney 2017). These studies recommend other directions in provenancing driftwood, especially isotope analysis.

Although analyses of hydrogen (δ^2H), oxygen ($\delta^{18}O$), and strontium ($^{87}Sr/^{86}Sr$) isotopes have been used to map the past movement of people and animals (Price *et al.* 2012 and references therein), few such studies have examined archaeological wood. $^{87}Sr/^{86}Sr$ has been used to provenance construction timbers (English *et al.* 2001, Reynolds *et al.* 2005) and shipwrecks (Rich *et al.* 2016, Hajj *et al.* 2017). These studies highlight several issues, particularly the modification of the chemical signature of timbers in marine environments (Rich *et al.* 2012, Hajj *et al.* 2017). Hajj *et al.* (2017) demonstrate that mass-dependent fractionation of Sr isotopes ($\delta^{88/86}Sr$) can distinguish between marine Sr vs. Sr from carbonate rocks. They suggest targeting lignin molecules, and developing procedures for removing diagenetic Sr. Overlapping biogeochemical profiles between regions may also limit the identification of source areas (Drake *et al.* 2014).

A recent study in this field addresses the role of remote resource regions in the procurement of timber for the Norse Greenlandic settlements (Pinta *et al.* 2021). This work uses biogeochemical analysis of stable hydrogen (δ^2H), stable oxygen ($\delta^{18}O$), and radiogenic strontium ($^{87}Sr/^{86}Sr$) isotopes in soil, water, and modern plant samples from south Greenland and northeastern Canada to characterize expected local isotopic baselines. Similar $^{87}Sr/^{86}Sr$ values shared by sites in Greenland and Newfoundland are probably in part due to sea spray in coastal zones as well as rainfall derived from seawater (cf. Veizer 1989, Evans *et al.* 2010, Alonzi *et al.* 2020). A pilot study of archaeological wood samples obtained at Ø171, Greenland was conducted to test the effectiveness of the $^{87}Sr/^{86}Sr$ biogeochemical baseline. Results demonstrate that at least in some cases, diagenetic processes were not sufficient to mask a non-local $^{87}Sr/^{86}Sr$

signature. Additionally, δ^2H and $\delta^{18}O$ values demonstrate a clearer distinction between regions (especially between Greenland and the northeastern coast of Canada), and even between specific sites. Using a multi-isotopic approach to distinguish wood sources in Norse Greenland seems promising.

Furthermore, an ongoing study combining dendrochronology, isotope analyses and aDNA to explore the origin of timber in northern Europe during the Medieval period (Daly 2017, Van Ham-Meert and Fernández 2020) is also likely to generate improved provenancing methods. Increased use of dendrochronology in the North Atlantic (where artefact size and preservation permits) may be facilitated by the growing availability of tree-ring chronologies from Siberia (cf. Siborova *et al*. 2017 and references therein). Other future directions may lie in the study of cpDNA (genetic material from the chloroplasts of plant cells) from uncharred archaeological wood (cf. Spiers *et al*. 2009) or in the application of isotope analysis to charred remains. The latter is unproven in archaeological wood charcoal but has shown to be somewhat successful in analysis of Sr isotopes from charred cereal grain (Styring *et al*. 2019, Larsson *et al.* 2020).

Conclusions

Over the past 30 years, there have been significant developments in our understanding of wood resource exploitation in the North Atlantic, driven by increased interdisciplinarity in archaeological research. The Norse sites on these islands display unique and precisely-adapted patterns of wood use which reflect both their cultural identity and environmental conditions. Despite regional and local variations, the islands are characterised by their reliance on driftwood timber: for the Norse in the North Atlantic, wood was a dynamic, unpredictable marine resource.

However, just as we are beginning to understand these patterns, anthropogenic climate change has begun to seriously threaten the preservation of organic material (Harmsen *et al.* 2018, Hollesen *et al*. 2019). Anecdotal evidence from Iceland and Greenland suggests that there has been a considerable decline in the preservation of such remains on archaeological sites in the last 5 years alone. We must therefore do all we can to ensure that this vanishing information is made available to future researchers. One way forward may be to improve the monitoring of known sites (cf. Hollesen *et al*. 2019), but we must also ensure that excavated material is treated in a way that facilitates thorough analysis. So far, the discard of non-diagnostic artefacts has led to a shortage of material available for destructive analysis, however this practice is beginning to change in Iceland and Greenland. Archaeologists working on such sites should discuss the treatment of non-diagnostic wood remains during excavation. We also recommend that uncharred wood remains are analysed before they undergo conservation (which often obscures diagnostic anatomical features), and we encourage policymakers and funding bodies to ensure that adequate funds are allocated to post-excavation analysis of these irreplaceable archives of past human-environment interactions.

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From the 9th century AD onwards, Norse migration resulted in the spread across the North Atlantic of cultural traits originating in Norway. The challenging landscapes of this region rewarded resilience and adaptability, evidenced by complex subsistence strategies incorporating the exploitation of a variety of outfield resources. However, differing methodologies and approaches across the region have limited the extent to which the connections between western Norway and the North Atlantic have been explored in archaeological research. The Expanding Horizons project brought together junior and senior practitioners in archaeology and related fields, from both within and outside of academia, to address this. The papers in this volume present case studies of outfield resource use and its impact on settlement patterns, placed in the wider context of Norse settlement and subsistence across the North Atlantic.

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