Vernacular Architecture, Vol. 48 (2017), 23–43

DENDROCHRONOLOGICALLY DATED PINE BUILDINGS FROM SCOTLAND: THE SCOT2K NATIVE PINE DENDROCHRONOLOGY PROJECT

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The SCOT2K project has extended native pine tree-ring chronology coverage for Scotland to enable reconstruction of past climate and for cultural heritage dating benefits. Using living trees from multiple locations in the Highlands and sub-fossil material from lochs, a network of five regional chronologies has been produced. The project has developed the application of Blue Intensity (BI), a proxy measure for maximum latewood density, which is faster and less costly to obtain than traditional densitometry measurements. The use of both ring-width and BI has been demonstrated to greatly assist historical dendro-dating of pine. This paper presents the dating results for the twenty Scottish pine buildings or sites dendro-dated through the SCOT2K project. They range from the fifteenth to the nineteenth centuries, and from high-status castles to modest cruck cottages. They are mostly located in the Highlands where Scots pine occurs naturally, although an early example of long-distance transport is also identified.

KEYWORDS: *Dendrochronology, pine, timber, historic buildings, Scotland, Scottish Highlands*

INTRODUCTION

The SCOT2K native pine dendrochronology project was supported by NERC under Grant NE/K003097/1 and has revolved around the development of tree-ring chronologies from ancient living trees, sub-fossil material from lochs[1] and timbers from historic buildings.[2] The project's objectives were to build a network of native Scots pine (*Pinus sylvestris* L.) chronologies[3] to reconstruct the past climate of Scotland[4] and to facilitate the dating of historical pine timbers. Focus has been largely on Highland areas with surviving native pine woodland[5] where it is more likely that native pine was used in buildings; more widely in Scotland many historic buildings are dominated by imported timber from the fifteenth century onwards, although native timbers may be under-recognised.[6]

APPROACH

The SCOT2K project has pioneered the application in the UK of the Blue Intensity (BI) method, representing a proxy measure for maximum latewood density which allows us to improve the degree of dating success for pine beyond that which can be achieved with ring width (RW) alone.[7] This is because the signal expressed by BI is dominated more by climate than by site-specific factors and is therefore less noisy than RW. Both RW and BI can be measured from high-resolution scans of the prepared samples' transverse section, recorded simultaneously from the same radial measurement track. Adopting a cautious approach, we have required both RW and BI to indicate the same date for the sample sequence and we generally use a t value of 4.0 as the threshold for acceptable dating, whereas in oak work in the British Isles a t value threshold of 3.5 is traditionally used as a guideline. Ideally, replication of five or more sequences is sought,[8] where there is sufficient material, but we have dated some sites with fewer samples. This combined RW and BI approach has been fruitful, enabling us to build on the start made in the Native Oak and Pine Project (NOAP) on chronology development[9] and dating native pine buildings in Scotland.[10] The development of a network of longer, stronger native pine reference chronologies, using a combination of living tree and sub-fossil material from lochs, has been central to the SCOT2K project and has now allowed pine timbers from as far back as the late medieval period to be dated. Each historic site has had both its RW and BI sequences compared with the five regional master chronologies, each with RW and BI versions, and with the combined regional data in the Scottish Mega Master.

RESULTS

For ease of reference, this paper lists all the native pine buildings so far dated in Scotland, including the two buildings first dated under NOAP (The Red House and Inverey Byre) as listed by Crone and Mills in this journal in 2015.[11] The BI method confirmed the date of those two buildings and, alongside RW, has allowed us to date several other buildings first sampled under NOAP as well as many of those newly sampled for the SCOT2K project, with a total of twenty Scottish pine structures now dated (Table 1 and see individual site records in text below).

A further fifteen or so pine structures have been sampled under SCOT2K but are not yet dated. It seems important to make a public note of them for future reference. The undated sites are listed by region in Table 2. There were limitations on the sample quality for most of these undated sites, with issues such as short sequence lengths, poor

DOI: 10.1080/03055477.2017.1372674

Table 1. ***Dendrochronological dates for buildings from SCOT2K native pine dendrochronology project (archaeological native pine timber dates for comparison in italics)***

No.	*Site name*	*Region*	*NGR*	*Species*	*Span of chronology*	*Felling date(s) or* tpq *AD*	*Source*
1	Allargue House	Aberdeenshire	NJ 2594 0947	Pine	1690–1748	1748	Native
					1722–1783	1783	Native
2	The Red House, crucks, Mar Lodge	Aberdeenshire	NO 0029 8688	Pine	1707–1808	1799, *c.* 1808	Native
3	Inverey cruck	Aberdeenshire	NO 0901 8931	Pine	1667–1801	*c.* 1801, *c.* 1815	Native
4	St John's House, 67–69 South St, St Andrews	Fife	NO 5104 1665	Pine	1159–1454	*tpq* 1458 (close to bark edge)	Native
5	Castle Grant	Highland	NJ 0414 3018	Pine	1393–1512	*tpq* 1512	Native
6	*Eaderloch Crannog, Loch Treig, Lochaber*	*Highland*	*NN 3473 7683*	*Pine*	*1345–1549*	*tpq 1550 (at or very close to bark edge)*	*Native*
7	Foulis Castle	Highland	NH 5893 6411	Pine	1610–1690	*tpq* 1690 (close to bark edge)	Native
8	Wardlaw Mausoleum, crypt hatch boards	Highland	NH 5496 4570	Pine	1592–1721	*tpq* 1721 (close to bark edge)	Native
9	Killiehuntly Farm Cottage, cruck	Highland	NN 7920 9880	Pine	1629–1730	1730	Native
10	Storehouse of Foulis	Highland	NH 5996 6360	Pine	1673–1747	1747	Native
11	The Doune, Rothiemurchus	Highland	NH 8860 0978	Pine	1479–1745	*tpq* 1750	Scandinavian
12	In HFM: Sample HFM04; collar, Unknown site	Highland	NH 5179 4870	Pine	1558–1771	1771	Native
13	Badden Cottage, cruck, Kincraig	Highland	NH 8251 0614	Pine	1704–1801	1771, 1801	Native
14	In HFM: HFM01, Morilemor Farm, cruck, Tomatin	Highland	NH 8043 2837	Pine	1644–1779	1779	Native
15	In HFM: HFM03, collar, Aultvaich cruck	Highland	NH 5179 4870	Pine	1662–1778	*c.* 1800	Native
16	Belladrum Steading	Highland	NH 5204 4144	Pine	1742–1838	*tpq* 1838 (close to bark edge)	Native
17	Killiehuntly Farmhouse	Highland	NN 7910 9870	Pine	1781–1846	*tpq* 1846 (close to bark edge)	Native
18	MacRobert House, Kingussie	Highland	NH 7600 0068	Pine	1724–1848	1849	Native
19	96 High St, Grantown-on-Spey	Highland	NJ 0314 2786	Pine	1775–1852	*tpq* 1852 (close to bark edge)	Native
20	Castle Menzies	Perthshire	NN 8370 4961	Pine	1486–1572	1572	Native

Key: *tpq* is *terminus post quem* for felling; HFM is Highland Folk Museum.

Table 2. ***Sites sampled but not yet dated in the SCOT2K project***

Site name	*Region*	*Comment*
Bellsgrove Cottage near Strontian in Ardnamurchan	Argyll	Two timbers
Shiel Bridge, Acharacle in Ardnamurchan	Argyll	Single timber
52 South Street, St Andrews	Fife	Multiple samples, multi-phase, may contain imports
Wester Kirk, Anstruther	Fife	Two samples, importation possible
Franciscan Friary, Shuttle Street	Glasgow	Archaeological site, must be pre-Reformation, multiple samples, very slow-grown, difficult material, still under analysis
A ruined trestle bridge over the River Feshie, Cairngorms	Highland	Multiple timbers, poor condition, multi-phase structure
Corrimony Grange Barn (cruck) in Glenurquhart	Highland	Multiple samples, reasonably long sequence lengths but condition caused core fragmentation
Croft Roy House (cruck), Newtonmore	Highland	Multiple samples but short sequence lengths, circular saw marks mean *tpq* for construction after *c.* 1820
Croft Roy Byre (cruck), Newtonmore	Highland	Multiple samples but short sequence lengths, circular saw marks mean *tpq* for construction after *c.* 1820
Groam Cottage cruck, in Kirkhill near Beauly	Highland	Cottage has two cruck frames with curved crucks and hipped end, six samples but mostly short sequences and poor condition
Highland Folk Museum (HFM), 10 undated timbers sampled from the collection	Highland	Representing several Highland buildings with low sample numbers and mixed sequence lengths; the best three HFM samples have been dated, see Table 1
Woodside Cottage, Alvie Estate	Highland	Ruined cruck, multiple samples but a very disparate group, with mostly short sequences and poor condition
Blair Castle, Blair Atholl	Perthshire	Four *ex situ* sarking boards, short sequence lengths
Glen Fender cruck in Atholl Country Life Museum	Perthshire	Preliminary sampling revealed very short sequence length, *c.* 20–30 rings
Whitefriars, Perth — medieval coffin boards	Perthshire	Mixed assemblage of oak and pine boards, pine boards have modest sequence lengths, two boards sampled initially but not yet analysed

Figure 1a. Allargue House, its earliest roof, only visible from the rear (photo: Anne Crone)

conditions causing core fragmentation and low available sample numbers. In researching the BI approach, Wilson et al.[12] noted that obtaining more than five samples from the same phase is important in securing dating, and many of these sites had fewer samples available. Many more sites were visited, assessed and rejected for SCOT2K, mainly because of the short sequence lengths which prevail in the majority of structures, an issue which has been noted before for Scottish native pine timbers.[13]

ABERDEENSHIRE

Allargue House, Corgarff, Strathdon (Figs 1a and 1b)

The original house, which was thought by the owners to be late seventeenth century in date, was a two-storey, three-bay structure, one room wide, but it was extended on the sides in the mid nineteenth century and to the front in 1900.[14] The roof over the original part of the house is intact, with simple A-frames throughout, all built of pine; each frame consists of a pair of rafters and collar, with the floor joist jointed into the ends of the rafters. Two phases of construction were visible within the roof, identifiable by differences in scantling, type of conversion and carpentry techniques. All but six of the frames belong to Phase 1, while all the joists and the remaining frames belong to Phase 2. In all, 24 timbers were sampled by coring, twelve from each phase.

The ring-sequences were short, varying between 41 and 61 years in length. Internal correlation between eight of the Phase 1 timbers was strong and a site chronology was constructed in the original NOAP analysis which produced a significant RW correlation against one of the local chronologies, dating it to AD 1691–1748. However, because of the short length of the chronology and the lack of replication, the date was not considered sufficiently robust. Further analysis in SCOT2K using both RW and BI has now added additional sequences into the Phase

Figure 1b. Inside Allargue House roof (photo: Anne Crone)

1 chronology and confirmed that date against the latest reference chronologies. The analysis has also constructed a chronology of five Phase 2 timbers, for both RW and BI, which has been dated to AD 1722–83. A third chronology, spanning 50 years and composed entirely of joist sequences, remains undated. However, structural evidence suggests the joists are also Phase 2.

There is a historical context for the replacement of the roof in AD 1748. The Farquharsons of Allargue were Jacobites[15] and it seems unlikely that the houses of Jacobite sympathisers in the area were left untouched when the Hanoverian army captured nearby Corgarff Castle in 1746. Corgarff was converted into a garrison in 1748, so there was clearly a lot of building activity in the area in that year. The 1748 timbers probably belong to a phase of rebuilding in the aftermath of the uprising, which were then subsequently re-used when the roof was renovated or extended some 35 years later in or shortly after 1783.

The Red House, Mar Lodge (Figs 2a and 2b)

This single-storey stone-built cottage had two main construction phases of nineteenth-century character. Period 1 is represented by four upright cruck-posts embedded in the NW (rear) wall, remnants of a composite cruck-frame building. Most of the Period 1 building was demolished during the Period 2 construction, with the cruck frame largely removed, the building widened to the front and re-roofed. Both phases were sampled, including cruck-posts, lintels and rafters, but many samples had too few rings, and some timbers were in a poor state, causing cores to fragment. Only two of the longer, more intact samples from two Period 1 cruck-posts have been dated against local native pine reference chronologies. Both have bark edge and the sequences end at 1799 and 1808, but the latter has a particularly difficult outer compressed zone and dated better when truncated, so is quoted as felled in *c.* 1808. Several possible explanations for the difference in dates of adjacent posts were put forward, the most likely being that the Mar Estate was stockpiling timber for local use from its then very active forestry operations. The results indicate an early nineteenth-century date for the Period 1 cruck building, similar in date to the nearby Inverey cruck.

Inverey cruck (Fig. 3)

This single-storey cruck outbuilding in the hamlet of Inverey, near Mar Lodge in the Cairngorms, was in use as a store and thought to be a former byre. It has six composite pine cruck frames with all joints pegged. Eleven timbers were sampled, including at least one in each frame, and nine were dated. Some internal grouping was found to build a site chronology, while other sequences were dated

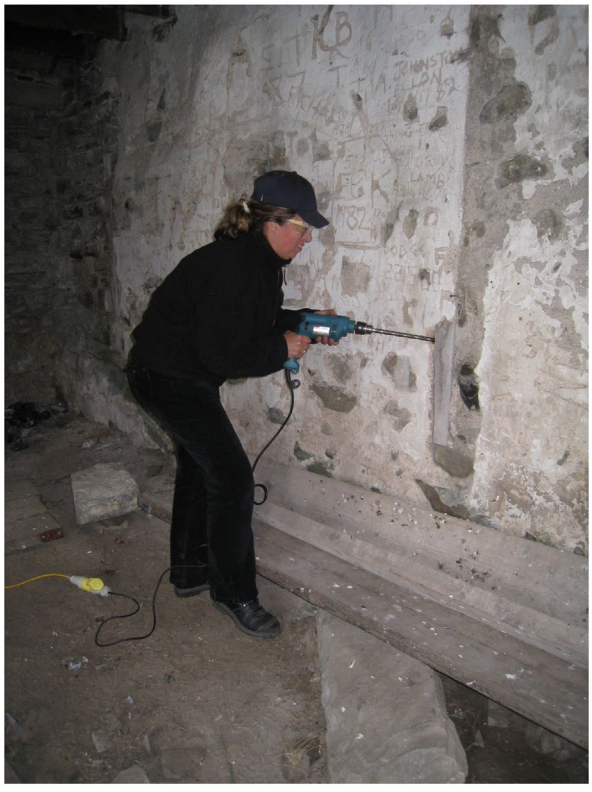

Figure 2a. Sampling a relict cruck post in the rear wall of the Red House (photo: Anne Crone)

Figure 2b. The Red House, Mar Lodge Estate (photo: Coralie Mills)

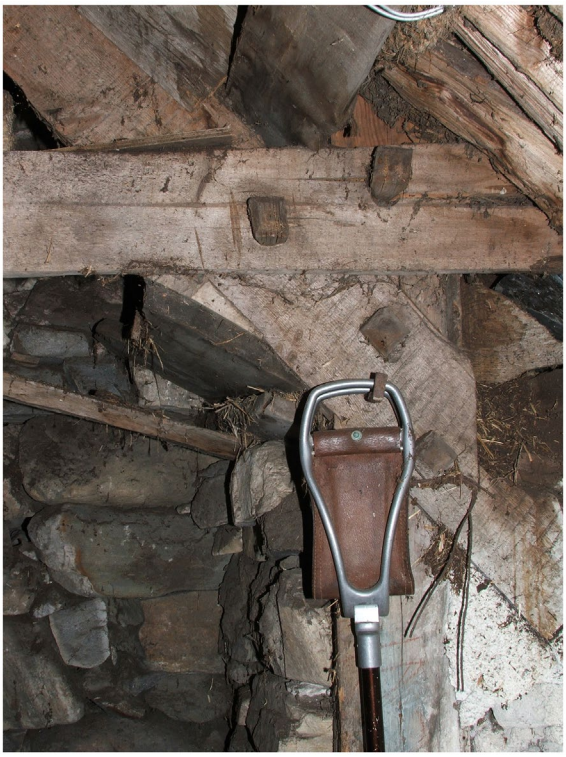

Figure 3. Inverey composite cruck-frame detail (photo: Coralie Mills)

Figure 4. St John's House, St Andrews (photo: Coralie Mills)

individually. Our SCOT2K re-analysis has confirmed the original dating overall but identified a faint missed ring in a key sequence, moving the chronology end date by one year to 1801. Several timbers had bark edges, with a slight spread of end dates (1799–1801) seen in the main phase, but with difficult compressed rings at the outer edges possibly accounting for the variation. Hence the quotation of felling dates as *c.* 1801 and *c*. 1815, the latter from the north east end, based on a core with a dated inner section and an outer fragment not included in the site chronology. The results are interpreted as a main construction of 1801 or soon after, with the north-east end extended or remodelled *c*. 1815. The early nineteenth-century date suggests the cruck is part of the improvement-era reorganisation of the Mar Estate settlement pattern.

FIFE

St John's House, 67–9 South Street, St Andrews (Fig. 4)

Many structural timbers were removed from St John's House in the early 1990s, during refurbishment works by the University of St Andrews. They had already been moved to the back court when sampled and were not seen *in situ*. However, they were reported to have come from the ceiling of the room at the front of the building on the ground floor. Slice samples were taken from 46 timbers, comprising 35 pine and 11 oak samples, all of small scantling. The pine timbers were up to about 12 × 15 cm across, mostly quarter-sawn with the internal faces sawn and the outer faces axe-dressed. Between four and six timbers could have been cut from each pine stem. Most of the oak timbers showed evidence of re-use and were thought to be recycled roof timbers, while the pine timbers did not have evidence of re-use. The oak samples were dated to the second half of the thirteenth century, and are native timber from the east of Scotland.[16] The pine timbers were analysed at the same time, but could not be dated then. The developments of the SCOT2K project have now enabled them to be dated, through a combination of native pine reference chronology development and the new approach of BI analysis in addition to RW.

Twenty-eight of the pine samples were analysed in SCOT2K, and 23 of them were cross-matched into four groups, of which three groups (representing 20 timbers) match with each other and with native pine reference chronologies. Taken together, the three dated groups span AD 1159–1454. Due to a few lost rings at the outside edge of the latest ending sample, the *terminus post quem* (*tpq*) date is 1458 and is probably not far from bark edge. The results indicate that the ground-floor front room ceiling was a mid-fifteenth-century pine construction with elements of a later thirteenth-century oak roof recycled into it. This ties in well with the history of the building which is said to have originated as a stone building in *c*. 1450, and to have been reconstructed *c*. 1600, then further modified in the eighteenth, nineteenth and twentieth centuries.[17] Excavation in the ground floor has revealed archaeological traces of an earlier timber building.[18] Historical evidence

indicates the possible ownership of this early building by the Knights of the Hospital of St John in Jerusalem, explaining the origin of the building's name.[19]

The St John's House timbers are the earliest assemblage of historic native pine timbers so far identified and dated in Scotland. Many of them are from very slow-grown, long-lived material indicative of a primary woodland source. They match most closely with reference material from the northern Cairngorms, indicating long-distance transport of the material. We cannot yet compare them with the southern Cairngorms, as the reference chronology does not stretch back that far. Only three of the six Scottish regional pine reference chronologies currently extend back far enough to date this early material, so further refinement of provenance may become possible as the reference chronologies are extended and, while they currently match Scottish reference material much better than Scandinavian, we will continue to compare them to both regions as new reference data become available.

HIGHLAND

Castle Grant, near Grantown-on-Spey (Figs 5a and 5b)

Castle Grant was built as an L-shaped castle in the mid sixteenth century but was completely enveloped by a later eighteenth-century mansion, with only one wing of the sixteenth-century construction now visible.[20] The sixteenth-century roof was the focus of this study; it has remained remarkably intact under the later roof, but most of it has been fully squared and, despite the large quantity of pine timber surviving, most of it was young and fast-grown, the majority having less than 50 rings. In all, eight timbers were sampled by coring, of which only two retained the bark edge. The longest sequences sampled were from rafters CG5RS (120 years) and CG22RS (146 years). There was very little correlation between the timbers; only those two rafters matched each other on RW, but this was not borne out by BI. In the SCOT2K

Figure 5b. The sixteenth-century roof timbers enveloped under the later roof, Castle Grant (photo: Anne Crone)

Figure 5a. Castle Grant (photo: Anne Crone)

re-analysis it has been possible to date only CG5RS, which spans 1393 to 1512 (*tpq*).

Eaderloch Crannog, Loch Treig, Lochaber (Fig. 6)

The crannog at Eaderloch was comprehensively excavated in 1933 when the loch was drained in advance of dam construction.[21]Artefacts found during the excavation suggested activity in the latter half of the sixteenth century, a date supported by a reference to the crannog in a poem written *c*. 1600. The crannog infrastructure consisted of a rectangular framework of undressed logs, and six of these logs have been stored in the West Highland Museum in Fort William since the excavation, four of which are pine. Another pine timber was retrieved from the crannog during an episode of low water levels in 2007. The pine sequences were exceptionally long, between 170 and 203 rings, and a site chronology incorporating three of the sequences was constructed in the original analysis. Nonetheless, it still could not be dated against any existing chronologies at that time and radiocarbon dates were obtained from one of the pine logs and two birch piles; these indicated that the crannog was built sometime between the late fifteenth century and the early seventeenth century.[22] The SCOT2K re-analysis identified four matching timbers and indicates that the logs were felled within a year or so of AD 1550, thereby confirming the artefactual evidence from the earlier excavation.

Foulis Castle, near Evanton (Figs 7a and 7b)

The Munros of Foulis have retained a small collection of timbers from renovation works at Foulis Castle which was restored in the latter half of the twentieth century. One of these, a sample of a board FCL05 has been dated to give a *tpq* for felling of 1690, and was probably felled in the 1690s. Foulis has been the principal seat of the Clan Munro since the mid fourteenth century. The present neo-classical mansion house replaced an old castle, probably a tower with outbuildings, which was occupied and ransacked by the Jacobites in the rising of 1745. The mansion house and its adjacent ranges bear datestones of 1754, 1777 and 1792, but there are some surviving features which pre-date the eighteenth century; the plan and some upstanding parts of the northern wing behind the kitchen are probably later seventeenth century, while sixteenth- or seventeenth-century architectural fragments are re-used in the central basement area. The board FCL05 was probably a sarking board; it is not known where in the building it came from, but it must belong to the late seventeenth-century elements of the precursor building. The sample had 81 measured rings and matches most closely with reference material from Glen Affric.

Wardlaw Mausoleum, Kirkhill, near Beauly: Crypt hatch boards (Figs 8a and 8b)

Wardlaw Mausoleum was the burial aisle of the Lovat Frasers until the nineteenth century, and is the only intact part of the former Wardlaw parish church of St Mary's. The

Figure 6. Eaderloch Crannog, surveyed when water levels in the reservoir at Loch Treig were lowered (photo: Anne Crone)

aisle was built in 1634, but incorporates fourteenth-century window tracery in its west gable, where it once adjoined the main body of the church. Documentary evidence indicates the aisle was substantially altered and re-roofed in the 1720s by Simon, the then Lord Lovat, who became known as the 'Old Fox' of the Jacobite Rebellion. The aisle's pine roof timbers were assessed but had only *c*. 15–30 rings, and were therefore not sampled. However, the substantial boards of the hatch to the burial vault proved to be longer-lived pine (with up to 91 rings) and were recorded photographically for analysis. Four of the five boards matched each other and with native pine reference chronologies. The results give a *tpq* of 1721, close to the felling date. This ties in with the 1722 date on the belfry and so the construction of the crypt hatch must have been undertaken at the same time as Lord Lovat's other alterations to the mausoleum. The hatch boards appear to be mill-sawn, then finished by adze.

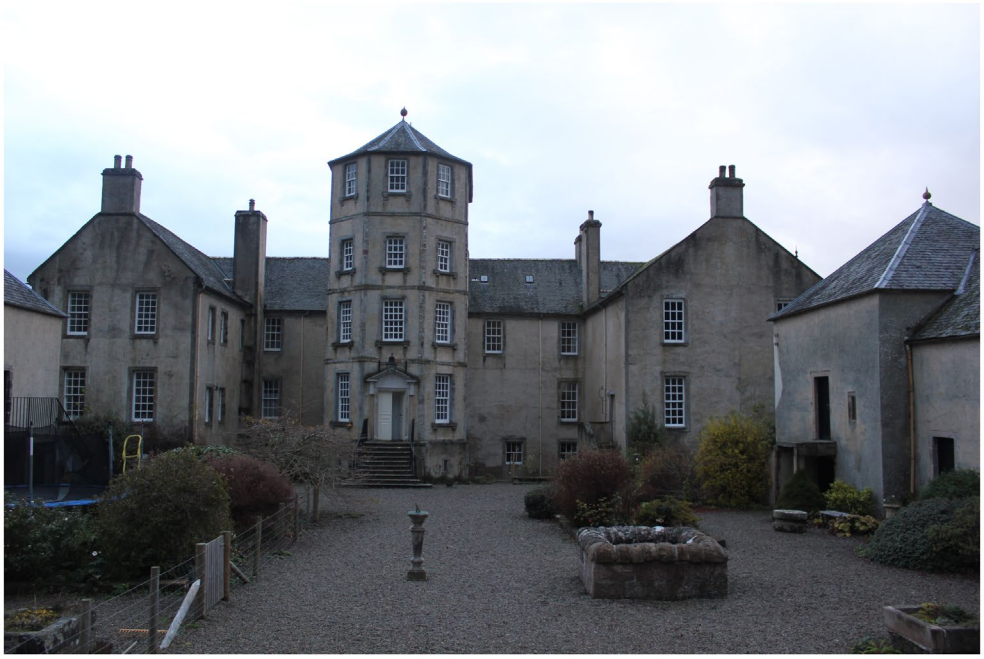

Figure 7a. Foulis Castle, view from the rear courtyard (photo: Coralie Mills)

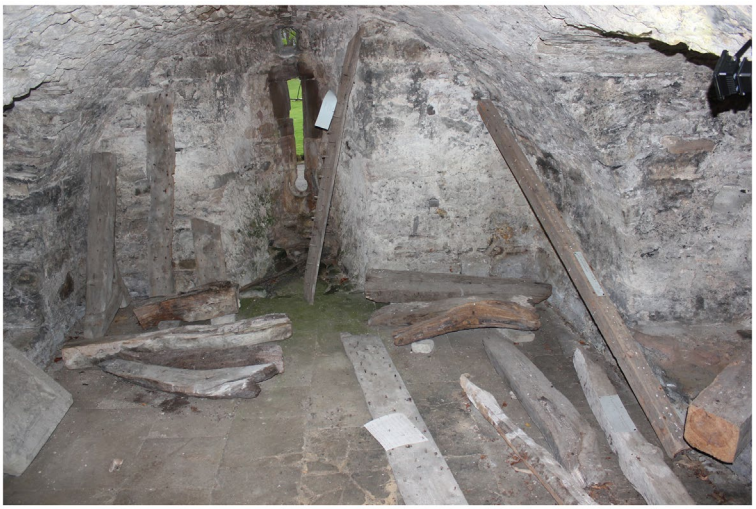

Figure 7b. The timber collection at Foulis Castle (photo: Coralie Mills)

Killiehuntly Farm Cottage, aka The White House, Killiehuntly (Fig. 9)

The timber structure of this building was under wall coverings and not visible during a site visit in 2013. However, a section of a single cruck timber was provided by the estate during renovation work in 2014. This had 102 rings, and gave a felling date of 1730. This is so far the earliest pine cruck building dendro-dated in Scotland, with most others concentrating in the late eighteenth and early nineteenth centuries.[23]

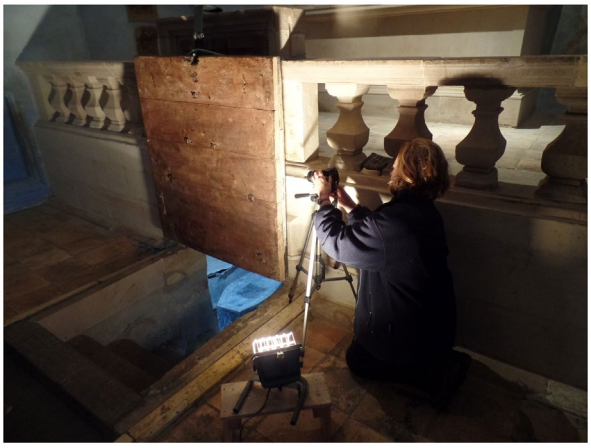

Figure 8a. Photographing the crypt hatch boards at Wardlaw Mausoleum (photo: Erik Lundberg)

Storehouse of Foulis, aka Foulis Rent House or Foulis Point Girnel (Fig. 10)

The Storehouse of Foulis is a large three-storey, six-bay building which has been renovated in recent times to become a visitor centre. The Munros of Foulis have retained a small collection of timbers from renovation works, mostly from Foulis Castle, but also including a pegged pine rafter foot assembly from the storehouse roof. The timbers are six inches square, adze-finished box heart beams and there is a carpenter's mark 'XX' on the rafter. The rafter element was sampled and produced a felling date of 1747. This has refined the known date of the construction of the storehouse from an estimated 1740, in the time of Sir Robert Munro (1684–1746, killed at the Battle of Falkirk), to the time of his son, Sir Harry (1720–81; Hector Munro, pers. comm.). The Storehouse of Foulis is one of several similar girnels or granaries built around the inner Moray Firth in the late seventeenth and eighteenth centuries.[24]

The Doune, Rothiemurchus

The Doune is a large country house, seat of the Grants of Rothiemurchus, of various builds between the late seventeenth and mid-nineteenth centuries. It has been undergoing restoration works in recent times. A section of a large pine joist (31.5 × 7.5cm cross-section), removed during that work, was given to the NOAP project, and has recently been dated to 1750 (*tpq*) in SCOT2K. Surprisingly, for an estate with its own extensive pine woodlands, the results show that this timber came from Scandinavia, matching well with reference chronologies from southern Norway and south central Sweden. It is assumed that Scandinavian

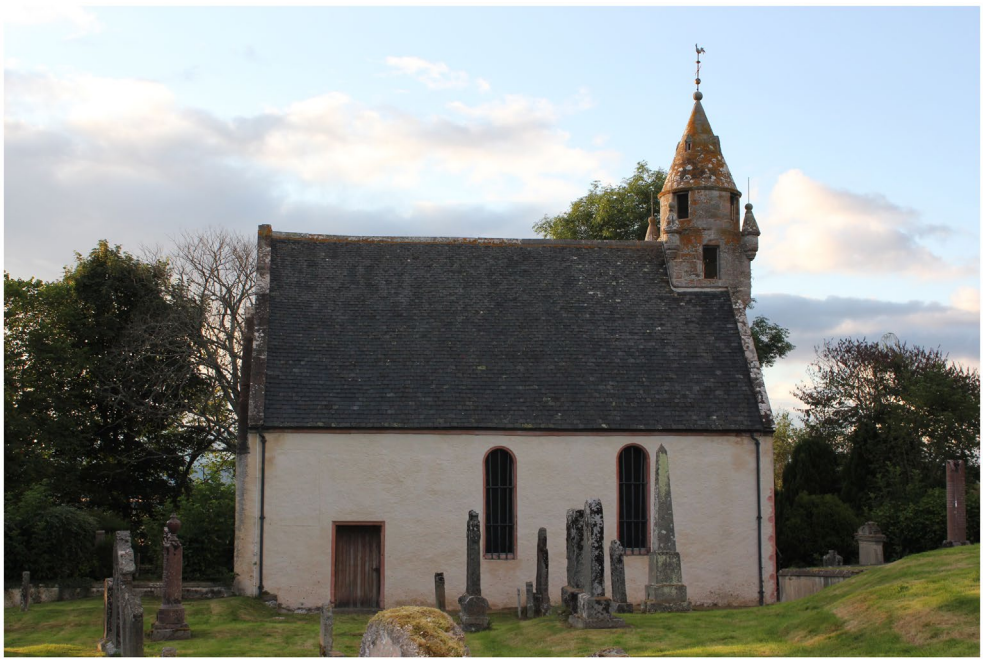

Figure 8b. Wardlaw Mausoleum (photo: Coralie Mills)

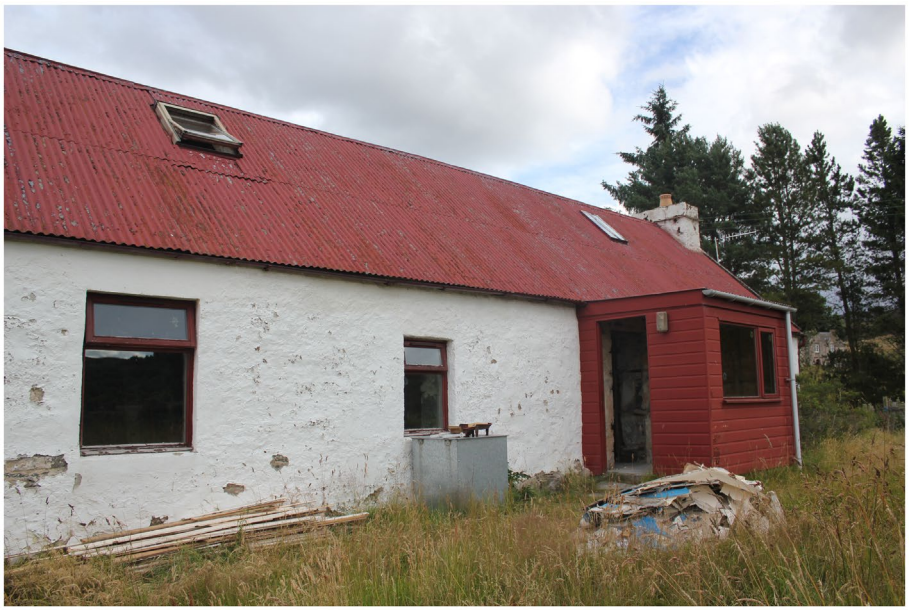

Figure 9. The White House, Killiehuntly (photo: Coralie Mills)

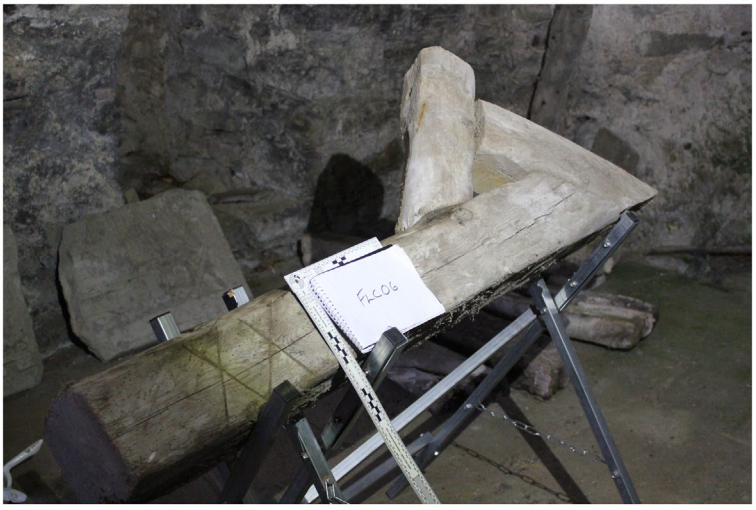

Figure 10. Rafter foot assembly from the Storehouse of Foulis (photo: Coralie Mills)

timber was bought in because there was difficulty in finding sufficiently large timbers locally for this specific purpose at the time. There is some historical context for this possibility. In the mid eighteenth century, Hull timber merchants Andrew Perrott and David Field sought to escape from a long-term cutting contract at Rothiemurchus for 40,000 trees, half of which were to be 10–12 inches square, because they could not find even 500 trees of that size in the whole wood, nor 2000 above six inches square, and they complained that the wood was too young and too small to cut with profit.[25]

Highland Folk Museum Sample HFM04: collar, unknown site

The Highland Folk Museum (HFM) in Newtonmore has a collection of historic Highland building timbers, dismantled and in storage (Fig. 11), including elements of several cruck frames. Most of the timbers were collected from buildings demolished a long time ago, and not all of them have surviving labels. Three of the ten HFM samples have been dated (see also Sites 14 and 15 in Table 1 and below), including this core from unlabelled collar HFM04. It has a felling date of 1771, and is long-lived slow-grown pine

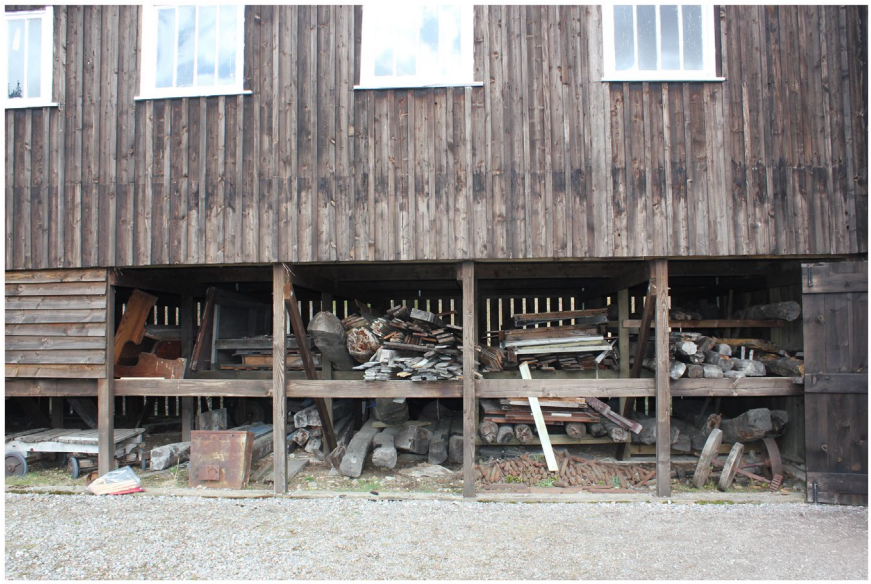

Figure 11. Historic timbers in storage under Joiner's Workshop, Highland Folk Museum, Newtonmore (photo: Coralie Mills)

with over 200 rings. The timber is very similar in form to HFM03, a collar from Aultvaich (Site 15), but it has a slightly earlier felling date.

Badden Cottage, cruck, near Kincraig (Figs 12a and 12b)

Badden Cottage, also known as Baden Cottage, is a single-storey, three-bay cruck cottage with all structural timbers of pine including three jointed and pegged cruck frames, each with two collars.[26] Purlins and roof poles are also of pine, and remnants of a turf and heather thatch survived under parts of the corrugated iron roof when the building was sampled. Some 28 samples were taken from 23 elements, of which only 13 had more than 55 rings and the longest sequence had 87 rings. Some sequences had occasional missing rings. The material was quite difficult to work with and dating involved three phases of sampling and analysis to get an eventual result. The resultant Badden Cottage RW and BI masters both match most closely with northern Cairngorms reference material, indicating a local source. The results show that the main phase of construction employed timber felled in 1801. However, one sample from a short, loose piece of timber found near the east end of the building has a felling date of 1771. It has been shaped into a point at one end but otherwise had no diagnostic features. Either it dates an otherwise undetected earlier phase of building or it was re-used in the 1801 construction. All the timber is from trees which started life *c*. 1700, and the use of plantation material is a possibility.

Highland Folk Museum Sample HFM01: Morilemor Farm cruck, near Tomatin

The sampled timber is a cruck blade from a cottage at Morilemor Farm in Tomatin,[27] elements of which are stored in the Highland Folk Museum collection. The core has 136 rings, and matches well with a range of Scottish pine regional chronologies to provide a felling date of 1779. It thus falls into the emerging cluster of Highland pine cruck dates in the late eighteenth to early nineteenth centuries.

Highland Folk Museum Sample HFM03: Aultvaich cruck, near Muir of Ord

The sampled timber is a collar from a cruck-framed cottage at Aultvaich, elements of which are stored in the Highland Folk Museum collection. The core has 117 rings, spans 1662–1778 and has about a centimetre of the outside edge missing, it having disintegrated on coring. Therefore it is estimated to have been felled around 1800. It falls into the emerging cluster of Highland pine cruck dates in the late eighteenth to early nineteenth centuries.

Belladrum Steading (Figs 13a and 13b)

This is a very grand farm steading at Belladrum Farm, south of Beauly and west of Inverness. It has a long, mainly two-storey, eleven-bay symmetrical south frontage with central clock tower and flanking single bays stepped forward from the main elevation. In its listing designation it is described as early nineteenth century with late nineteenth-century alterations and additions. Renovation works were ongoing when the site was visited in 2014, and samples were taken from four joist ends already removed from the structure. Many of the joists had evidence of mill-sawing, some with circular saw marks. The selected samples were those with the most rings. They had come from the ground floor ceiling to the right-hand side of the central clock tower. There was no cross-matching between the four samples. Thus dating relied on comparing single

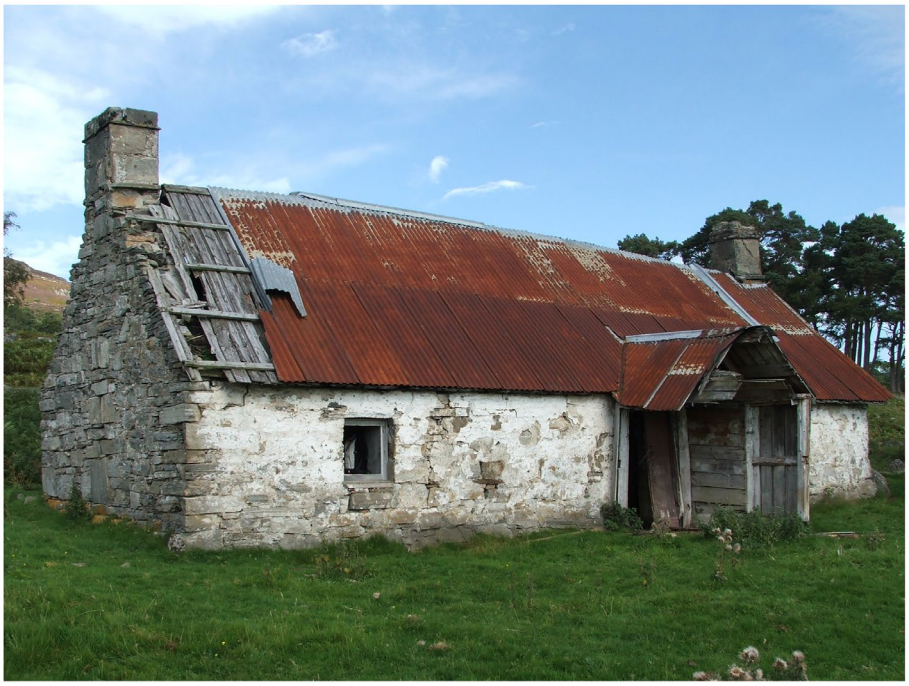

Figure 12a. Badden Cottage (photo: Coralie Mills)

Figure 12b. Roof truss at Badden Cottage, roof cabers (poles) also of pine (photo: Coralie Mills)

sequences with reference chronologies. Consistent dating for both RW and BI was evident for only one sample, BLD03 (97 years), ending in AD1838, not quite at bark edge. A felling date in the 1840s is likely, indicating a building or repair phase between the two dates given in the designation listing. Provenance is uncertain, there is a slightly better match with Cairngorms material, but the t values are fairly even across all of the reference regions.

Killiehuntly Farmhouse (Fig. 14)

The main farmhouse, the two-storey nineteenth-century slated building at Killiehuntly, was undergoing renovation work when visited in 2013. Most visible timbers had too few rings for analysis, but one timber supporting the hall floor on the ground floor had more rings and was sampled. This was a length of unmodified round wood and provided a *tpq* date for felling of 1846 (close to bark edge). The building appears on the First Edition OS 6-inch map, surveyed in 1870, published 1872, where the farm settlement as a whole is spelled Killihuntly.

MacRobert House, Kingussie (Fig. 15)

MacRobert House is a traditional two-storey, three-bay house with porch which now belongs to the Highland Folk Museum and in recent years has been used as a store for their collections. Little is known about the history of the house. The town of Kingussie was established in 1799[28] and on the 1812 Plan of the Village of Kingussie by George Brown there is a building on the plot on which MacRobert House now stands. The only accessible timbers in the roof space were the joists which were all sawn planks, but many with bark edge *in situ*. Some twenty joists were sampled by coring. The measured sequences varied widely in age, from 47 to 124 rings, and there was a lot of variation in growth trends, suggesting multiple sources. Cross-matching produced pairs and trios of sequences which correlated, but it was not possible to construct a robust site chronology using RW. Re-analysis in SCOT2K has dated seven sequences and indicates that they were felled in AD 1849; thus, MacRobert House must have been a rebuild or replacement of the 1812 building on the same plot.

96 High Street, Grantown-on-Spey (Fig. 16)

The post-and-beam cottage which originally stood at 96 High Street had been 'analytically' dismantled in 1995,[29]

Figure 13a. Under repair, the central tower at Belladrum Steading (photo: Coralie Mills)

and its components stored under a purpose-built shelter in the grounds of the Grantown-on-Spey Museum (more recently the timbers have been moved to the Highland Folk Museum). The house walls consisted of a series of load-bearing vertical posts pegged into a wallhead beam; there were nine posts along each wall, with one post placed centrally in each gable. The post-and-beam structure was considered to represent the first phase of construction of the house; cartographic evidence suggests that it cannot have been built on the plot before 1805, and Atkinson[30] had suggested that, on the basis of the more ancient woodworking technology displayed in the structure, the timbers may have been recycled from an earlier building, possibly eighteenth century in date.

The posts were all roundwood logs which had been roughly axe-dressed to a square cross-section; fourteen were sampled by sawing slices off the ends. They were all fast-grown, mostly between 59 and 74 years of age. The original cross-matching produced two groups of three sequences which correlated well together but, like MacRobert House, it was not possible to construct a robust site chronology using RW alone. The re-analysis in SCOT2K has dated twelve of the timbers on both RW and BI, using the latest reference chronologies, and indicates that the logs were felled within a year or so of AD 1852, making this post-and-beam cottage a very late example of this type of construction.

PERTHSHIRE

Castle Menzies, Weem, near Aberfeldy (Figs 17a and 17b)

The oldest part of Castle Menzies is a Z-plan tower house of three storeys plus an attic with richly sculptured dormer heads and angle turrets. An armorial panel above the main doorway bears the date 1571, while one of the dormer heads has the date 1577. Pine is the dominant timber throughout the castle, although the tower at the north-east corner has an oak roof. The pine in the castle is reputed by tradition to come from the Black Wood of Rannoch, which is about 20 miles away to the WNW. Core samples were

Figure 13b. Belladrum Steading ground-floor ceiling, source of the samples (photo: Coralie Mills)

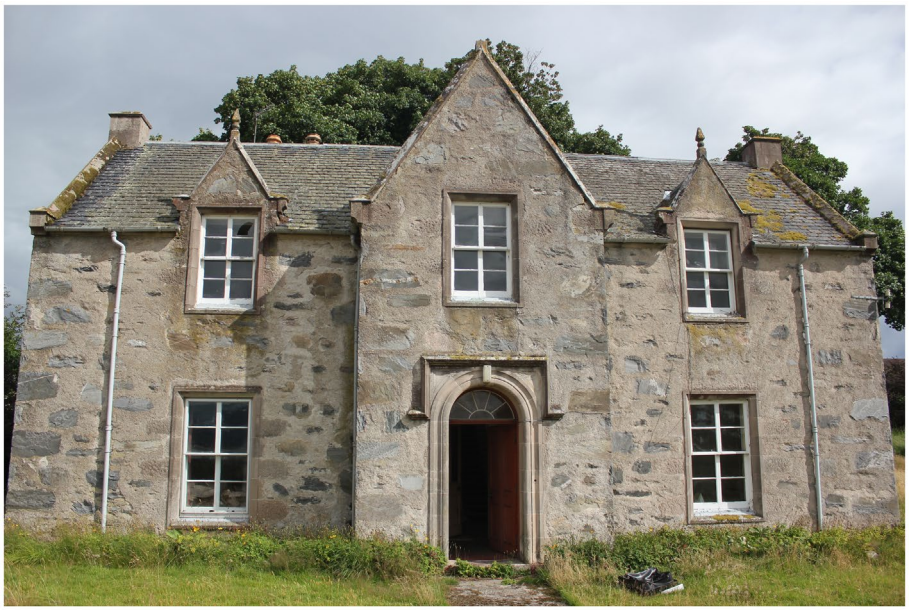

Figure 14. Killiehuntly Farmhouse (photo: Coralie Mills)

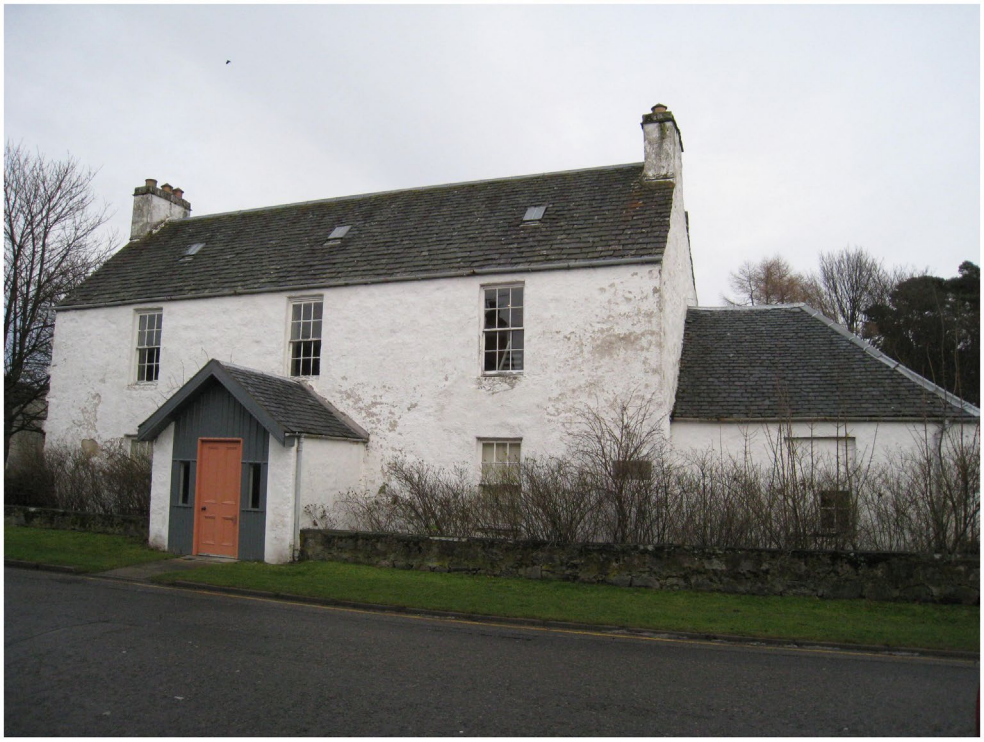

Figure 15. MacRobert House, Kingussie (photo: Anne Crone)

taken from the 'Lang Garret' pine roof, which is in the large main attic space running between the two towers at either end of the 'Z' plan. The longest-living timbers were selected for sampling, but are from trees with only about 55 to 90 rings at most. Six of the ten measurable samples were cross-matched and a felling date of 1572 was obtained for the most complete sample. This ties in closely with the expected date of the building. Dating was strongest against the 'Scottish Mega Master', which has all regional chronologies combined, and thereafter matched most closely with Cairngorms material. However, this is not necessarily the provenance because not all of the regional chronologies go back so far as the sixteenth century, including specifically the reference material from Rannoch.

Figure 16. Timbers from 96 High Street in storage at the Grantown-on-Spey Museum (photo: Coralie Mills)

DISCUSSION

The twenty dated pine sites reported here range from fifteenth to nineteenth century in date. However, of those twenty sites, only eight could be regarded as lower-status or vernacular buildings, and their dates are either eighteenth or nineteenth century. Particularly noticeable is that the dates for the small cruck-frame buildings cluster around the late eighteenth and early nineteenth centuries. Badden Cottage and Inverey Byre, in different parts of the Cairngorms, both date to around 1801 and are both composite crucks where each cruck blade is made up of two elements jointed and pegged together at an angle. The much-altered Red House was probably a composite cruck, too, and has a similar date. The dated elements of pine cruck frames held at the Highland Folk Museum are also late eighteenth century. Only the cruck building at Killiehuntly is significantly earlier, dating to 1730, but unfortunately the cruck form was not visible when the site was visited. The Killiehuntly cruck comfortably fits two storeys of accommodation, so is much larger than the later small composite crucks, and was possibly the main house before the nineteenth-century Killiehuntly farmhouse was built. The impressively large cruck frame at Corrimony Grange Barn (Fig. 18a) remains undated as yet, though the barn is described as late seventeenth to early eighteenth century in its listing designation.[31] It is quite different to the small composite crucks, not only in scale but in form, having five massive pairs of cruck blades, hand hewn into curved shapes, linked by a collar and, at the apex, by a curved 'yoke' tie. There is a surviving timber structure of a hip-cruck at one end, and it is thought both ends were originally hipped. Tradition has it that adjacent Old Corrimony House, built in 1740, was spared from being burned in the reprisals after Culloden, and it has also been suggested that Corrimony Grange Barn may have been the original dwelling superseded by the 1740 house, so, in theory at least, the barn could indeed be one of the earlier Highland crucks. The hipped end is a feature that Corrimony Grange Barn shares with undated Groam Cottage, Kirkhill (Table 2), which also has single-piece curved pine crucks, albeit on a smaller scale (Fig. 18b).

The dated sites from the fifteenth, sixteenth and seventeenth centuries are all high status. The earliest is St John's House in St Andrews, which importantly represents an original fifteenth-century phase for this complex town house. In the sixteenth century, we have dated surviving pine roofs at Castle Menzies and Castle Grant, in the same century as the power centre of Eaderloch Crannog was in use.[32] The seventeenth century is poorly represented, with just one sample of sarking board from Foulis Castle dated, and it is worth noting that the seventeenth century was also difficult to bridge in building the long reference chronologies because very few living trees extend earlier than 1700. The lack of seventeenth-century material may be partly an accident of a random sample of buildings, but it may also reflect the widespread destruction of property in the Highlands after Culloden (in 1746), losses which occurred on both the Jacobite and Hanoverian sides. Allargue House, a Jacobite property, was believed by the owners to be seventeenth century, but the earliest timber in the roof has been dated to 1748, indicating that it was rebuilt shortly after the uprising, like nearby Corgarff Castle. Foulis Castle, a Hanoverian stronghold, was ransacked in Jacobite reprisals after Culloden, and was rebuilt in 1754 (Hector Munro, pers. comm.), incorporating a little remaining seventeenth-century fabric in places, including the sarking board dated to 1690 (*tpq*).

Not long after, in the mid to late eighteenth century, agricultural improvements and their associated social upheaval saw the end of many 'pre-improvement' settlements, and at this time many more vernacular buildings were lost across the Highlands. Many of these pre-improvement houses would have been 'creel houses' with cruck frames, turf walls and thatch roofs.[33] The small composite cruck frames all seem to represent rural buildings of the post-improvement new order. The mid-nineteenth-century MacRobert House in Kingussie and the post-and-beam building at 96 High Street in Grantown-on-Spey both represent the continued development of the improvement-era planned villages, the 'New Towns' of the Highlands, while Belladrum Steading and Killiehuntly Farmhouse, of a similar age, are examples of the improvements continuing in the countryside during the nineteenth century.

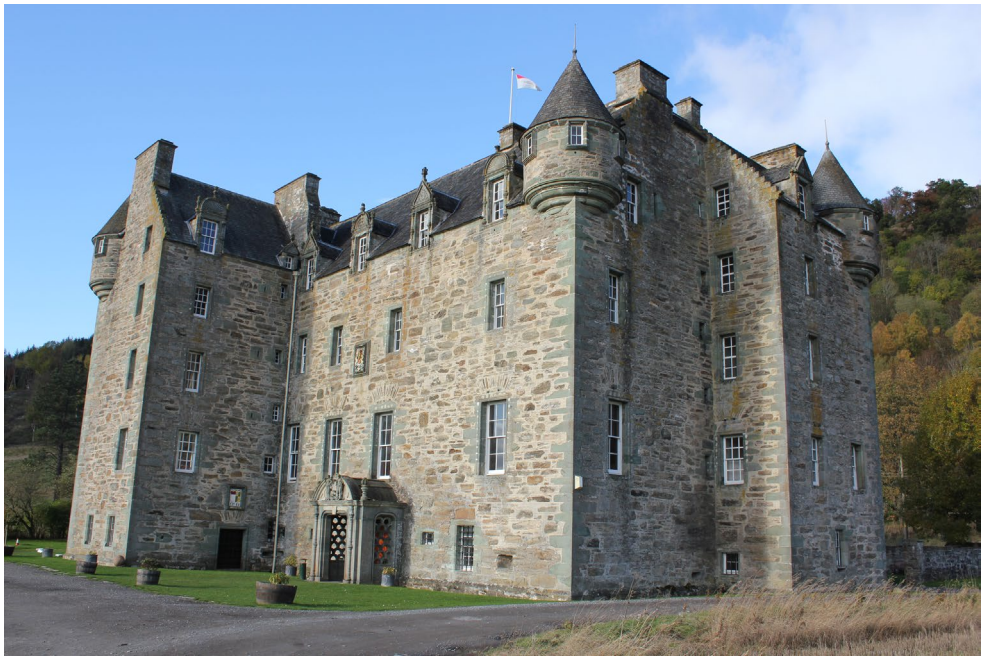

Figure 17a. Castle Menzies from the south-east (photo: Coralie Mills)

Figure 17b. The 'Lang Garret' roof, Castle Menzies (photo: Coralie Mills)

Looking at the type of timber used for construction, in general it seems that longer sequence lengths are more often found in the earlier native pine structures (Table 1). For example, the earliest site, the fifteenth-century phase in St John's House, has many slow-grown pine timbers with around 200 to 300 rings, and sixteenth-century Eaderloch Crannog has pine about 200 years old. The pre-Reformation boards from the Franciscan friary, Shuttle Street, Glasgow, are also slow-grown and long-lived, and probably native. These sites perhaps represent the use of relatively undisturbed woods of slow-grown 'hill pine'. In our search for long-lived living trees for the reference chronologies, we have observed such tight ring patterns only under extreme growth conditions, such as talus slopes (e.g. North Derry, Green Loch), exposed high north-facing slopes (e.g. Glen Loyne) and boggy locations (e.g. Glen Falloch).

It is quite surprising that some other medieval structures assessed but not sampled for SCOT2K had very young pine timbers, with fewer than 60 rings, such as the

Figure 18a. Sampling in Corrimony Grange Barn (photo: Coralie Mills)

Figure 18b. Sampling Groam Cottage cruck (photo: Coralie Mills)

original joists of the sixteenth-century Abertarff House in Inverness and the roof timbers in medieval Erchless Castle near Struy in Strathglass. The sequence lengths in the sixteenth-century pine roof of Castle Menzies are also modest, where the sampled timbers have only 55 to 90 rings, and the majority had far fewer. This evidence for the use of young pine trees in the late medieval period could be interpreted as indicating the use of woods where the age structure was already impacted by exploitation, as reflected in the historical disturbance signals seen in the long chronologies,[34] probably through repeated selective felling based on size and form, as is better documented in the early post-medieval period. In pinewood cutting contracts surviving from before 1770, it was usual, although not universal, to exclude the felling of trees under a certain size[35] to ensure continuity of the woodland, and trees above that threshold could be selected at a size convenient for making beams with minimum dressing.

While there are some examples of native pinewoods which have disappeared since medieval times, many more pinewoods survived despite their history of exploitation which escalated through the seventeenth and eighteenth centuries and reached a peak during the period from about 1780 to 1820.[36] In general, the eastern pinewoods regenerated more readily than those in the wetter west, and the western pinewoods were more heavily exploited.[37] The recovery of historically exploited native pinewoods after felling episodes relied on the youngest trees being spared and on seed source trees being retained.[38] However, good forestry practice was far from universal, as for example documented in the mid eighteenth century at the Black Wood of Rannoch, where the selective felling process used locally was wasteful and damaging.[39] The Commissioners of the Annexed Estates took over a number of pinewoods, including Rannoch, after the 1745 Rising, and introduced more control, not just in harvesting methods but also by enclosing the woods and encouraging regeneration.[40] Similar developments occurred more generally across the Highlands around this time, reversing the tenantry's widespread customary rights of taking certain types of

wood and of grazing and sheltering their livestock within the pinewoods.

It is interesting to note that medieval long-distance transport of native pine within Scotland is demonstrated at St John's House and probably at Shuttle Street. This would have relied on water transport in those times long before a good road network existed. In general, it is thought that the native pinewoods were little known outside of the Highlands before 1600.[41] However, there are a few early documented examples of native pine timber being transported a fair distance, for example there is a record from 1539 of the long-standing arrangement of providing the Bishop of Moray, in Elgin, with a consignment of timber from Rothiemurchus. Each year 160 fir (the Scots name for pine) tree trunks big enough to serve as joists were to be delivered to the bank of the Spey, below Rothiemurchus kirk, from where the timber could be pitched into the river as a float.[42] When Bishop Brown of Dunkeld required timber for building work in and around Dunkeld in the early sixteenth century, spars and larger timbers for a bridge came by river from Rannoch and Glen Lyon, more than 30 miles away.[43] Occasionally shipments beyond Scotland are recorded. However, despite the increasing involvement of merchants and outsiders in the exploitation of the native pinewoods in the seventeenth and eighteenth centuries, native pine timber was still predominantly a locally used resource, as is beautifully demonstrated in records from Rannoch, under the Commissioners of the Annexed Estates, where in 1779–81 half the timber was sold to buyers within a 10 mile radius and only 6% went further than 20 miles.[44]

Much of the native pine structural timber seen in both late medieval and post-medieval buildings is either used in the round, with just the bark stripped off, or has faces roughly squared by adze or axe, and so required relatively little work to convert into beams.[45] Any larger trees would be more difficult to work into beams, and would more likely either be left as seed source trees, where the cutting contracts were well managed or, especially if regular in form, selected for making sawn deals (boards). This goes some way to explain the preponderance of younger timber in the built heritage of the Highlands. We do occasionally see pine beams which have been converted by being hand-sawn, for example at St John's House where there is very economical use of the slow-grown pine timbers in the fifteenth century; they are small scantling and four to six beams could have been produced from a single stem. In general, there is more evidence of hand-sawn beams in eighteenth-century and later buildings, while the rarer earlier examples are usually in higher-status buildings,[46] although that may be as much an artefact of the greater survival of early high-status buildings.

Sawmills, with frame-saws, were introduced to the Highlands in the seventeenth century,[47] but we see little evidence of their use in the pine beams dated in this project, with the only example being the nineteenth-century MacRobert House. The sawmills were probably more often used to create deals or boards.[48] The early eighteenth-century substantial crypt hatch boards at Wardlaw Mausoleum appear to be mill-sawn, and milled timber has also been noted in the sarking and floorboards of the eighteenth-century roofs at Castle Grant.[49] Circular saws were present in the Highlands, including one at Rothiemurchus, by about the 1820s,[50] the earliest known reference being at Garmouth in 1815.[51] Circular saw marks were seen on the two undated composite cruck buildings of very young pine at Croft Roy in Newtonmore, providing a useful *tpq* date. Circular sawn timber was seen in several other nineteenth-century buildings, for example at MacRobert House, Kingussie, 96 High Street, Grantown-on-Spey and Belladrum Steading, and in many of the later assessed buildings where the ring counts were too low for sampling.

The preponderance of young, fast-grown pine timbers in the historic building stock of the Highlands begs the question as to how early on pine plantations were being established. It was noticeable in the eighteenth-century buildings that, either when a building was dendro-dated or where the timbers were too young but the date of construction was known, the 'birth date' of the structural timbers was often within a decade either side of 1700. Steven and Carlisle[52] quote examples of native Scots pine seed being collected and distributed in the seventeenth century, in some cases to England, but they say that it was not until the beginning of the eighteenth century that relatively large-scale planting began in Scotland. This ties in well with the observed concentration of sprouting dates around then in the Scottish historic pine timbers. It also coincides with the start dates of many of the living stands of old pine, and with evidence for intense felling in several of our chronology-building locations, including Rothiemurchus, Green Loch/Abernethy and Glen Affric, more intense even than felling impacts of the Napoleonic Wars period.

As a final point, the outcomes of the SCOT2K project are a testament to the importance of preserving historic pine timbers, either *in situ* or archived in collections. Some groups of the rare early native pine timbers now dated had been taken decades ago; the Eaderloch timbers had been kept in Fort William Museum since their excavation in the 1930s, the St John's House samples were taken during renovation works in the early 1990s and the cottage at Grantown-on-Spey was carefully dismantled in 1995 and its timbers retained for posterity. No doubt, similar material has been lost from many other sites over that period, and the importance of retaining historic pine timber which comes to light in future is highlighted.

CONCLUSION

The SCOT2K project has extended both spatially and temporally the network of pine reference chronologies for Scotland; they have been strengthened, lengthened

and have had BI measured as well as RW. This use of both BI and RW data has assisted with the dating of historic pine timbers, in conjunction with the availability of these new reference chronologies. This is because the BI signal is generally cleaner, more regional and less noisy than the RW signal. Until recently, it has been much more straightforward to date and provenance imported pine than it has been for native material. Two native pine buildings were first tentatively dated on RW alone some eight years ago, the first native pine structures to be dated in the UK. The developments of SCOT2K have confirmed those dates, and allowed a further seventeen or so native pine buildings to be dated, alongside one surprising eighteenth-century instance of importation from Scandinavia to Rothiemurchus in the heart of the Cairngorms.

The identification, assessment and sampling of historic pine buildings focused mainly on the Cairngorms and the area from Strathglass down to Beauly and Inverness, as these were the areas which saw most work on reference chronology development during SCOT2K. More limited work went on in upland Perthshire, relating to our chronology building work at the Black Wood of Rannoch, and occasionally candidate assemblages presented themselves from prior work, as at Eaderloch Crannog, Loch Treig, Shuttle Street, Glasgow and St John's House in St Andrews. These have rare and therefore important medieval pine assemblages. Thus the search for suitable candidate buildings has been in selected areas and is not a comprehensive sweep across Scotland or even the Highlands. Some key areas for any future work must include upland Perthshire, Aberdeen, and in and around Garmouth at the mouth of the Spey. The far north and the west Highlands need to be explored in greater depth, too. With the cleaner BI signal it may even be possible to date historic timbers which come from woodlands which no longer exist. Undoubtedly, there will be further examples of datable historic native pine structures to be discovered, and there will be even more buildings where the pine is typically too young, with too few rings for dating, but this work has shown the potential for a much greater level of native pine dating than has been possible before.

ACKNOWLEDGEMENTS

We are very grateful to the many people who allowed us to assess and sample their buildings and to those who shared information about prospective buildings and their histories. We encountered much generous Highland hospitality along the way. We are also grateful to our colleagues who have assisted with the project work, especially Stacey Averill, Bjorn Gunnarson, Neil Loader and Milos Rydval, and with the provision of data, including Hans Linderholm who supplied the Norwegian reference chronology which was key to dating and provenancing the timber from the Doune. We are grateful for the insightful comments of the peer reviewers. Thanks are due to Historic Environment Scotland who funded the precursor NOAP work which provided an important stepping stone towards this NERC-funded SCOT2K project (NE/K003097/1).

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

FUNDING

This work was supported by the NERC under Grant [grant number NE/K003097/1].

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1. Rydval et al., "Reconstructing 800 Years of Summer Temperatures."
2. Wilson et al., "Facilitating Tree-Ring Dating of Historic Conifer Timbers."
3. Ibid.
4. See note 1.
5. Wilson et al., "Reconstructing Holocene Climate from Tree Rings."
6. Crone and Mills, "Timber in Scottish Buildings, 1450–1800"; Mills and Crone, "Dendrochronological Evidence for Scotland's Native Timber Resources."
7. Rydval et al., "Blue Intensity for Dendroclimatology"; Wilson et al., see note 2.
8. See note 2.
9. Mills, "Historic Pine and Dendrochronology in Scotland".
10. Crone and Mills, "The Native Oak and Pine Project"; Crone and Mills, "List 279: Dendrochronologically Dated Buildings from Scotland."
11. Crone and Mills, "List 279: Dendrochronologically Dated Buildings from Scotland."
12. See note 2.
13. See note 6.
14. RCAHMS, CANMORE record for Allargue House.
15. Taylor and Taylor, *Jacobites of Aberdeenshire and Banffshire.*
16. Mills, "Dendrochronology of Historic Buildings in St Andrews."
17. Brooks, "St John's House," 11–15; Pride, *The Kingdom of Fife*, 128.
18. Kelly and Proudfoot, "69 South St."
19. Henry, *The Knights of St John in St Andrews*; Brooks, *St John's House.*
20. MacGibbon and Ross, *The Castellated and Domestic Architecture of Scotland.*
21. Ritchie, "The Lake Dwelling or Crannog in Eaderloch."
22. Crone, "Late Beginnings: An Early Modern Crannog at Eaderloch."
23. Following Walton's *Cruck-Framed Buildings in Scotland,* the site appears in Stell's "Crucks in Scotland. A Provisional List."
24. Beaton, "Late Seventeenth and Eighteenth Century Estate Girnals."
25. Smout, "The History of the Rothiemurchus Woodlands."
26. RCAHMS, Unpublished survey of Badden Cottage which includes a typescript description/analysis (INR/32) and three sheets of survey drawings (DC 9545–7, the first digitised twice as DP 166411 and SC 1351338), focusing mainly on the crucks and hanging chimney.
27. RCAHMS, Unpublished survey of the cruck cottage at Morile Mor, Tomatin, prior to its demolition and the removal of the crucks; it includes a typescript description/analysis (INR/5/1) and a sheet of survey drawings (IND 171/1 digitised as DP 209357), focusing on the (base-)cruck frames; Stell, "Crucks in Scotland. A Provisional List."
28. Partridge, "Settlement Patterns in the Spey Valley."
29. Atkinson, "Demolishing the Past."
30. Ibid., 18.
31. Listing designation is based on Hay, "The Cruck Building at Corrimony," which in turn is based on RCAHMS 1972b, a detailed survey of the cruck-framed barn at Corrimony; it includes a typescript description/analysis (INR/6/1) and five sheets of survey drawings (IND/175/1–4 and 6, IND/175/3 and 175/6 having been digitised as DP 209359 and DP 209360.
32. See note 22.
33. Stewart, "Using the Woods, 1600–1850 (1) The Community Resource".
34. Rydval et al., "Detection and Removal of Disturbance Trends."
35. Smout, MacDonald and Watson, *A History of the Native Woodlands of Scotland*, 182–3.
36. Stewart, "Using the Woods, 1600–1850 (2) Managing for Profit", 113–22.

37. Rydval et al., "Detection and Removal of Disturbance Trends"; Smout, MacDonald and Watson, *A History of the Native Woodlands of Scotland*, 222.
38. Smout, MacDonald and Watson, *A History of the Native Woodlands of Scotland*, 223.
39. Ibid., 186.
40. Ibid., 186–7.
41. Stewart, "Using the Woods, 1600–1850 (2) Managing for Profit", 113.
42. Barrow, "The Background to Medieval Rothiemurchus", 4.
43. Lindsay, *The Use of Woodland in Argyllshire and Perthshire*, 299–300.
44. Ibid., 300.
45. Crone and Mills, "The Native Oak and Pine Project."
46. Ibid.
47. Smout, MacDonald and Watson, *A History of the Native Woodlands of Scotland*, 151–2.
48. See note 45.
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