

## Dendrochronological analysis of altarpiece, Kvæfjord 1, Norway C3215

**Aoife Daly**

CATS dendro report 6 (6th February 2014)

In this report, the dendrochronological analysis of the altarpiece called Kvæfjord 1, Norway is described. This research was commissioned to contribute to the PhD research of Kristin Kausland, within the research project, 'After the Black Death: Painting and Polychrome Sculpture in Norway, 1350–1550'. This project is co-led by Noëlle Streeton and Tine Frøysaker, based in Conservation Studies, University of Oslo (UiO). Funding for this study was issued to Noëlle Streeton and Kristin Kausland in 2013 by the Department of Archaeology, Conservation and History (IAKH) and the Faculty of Humanities, UiO.



Fig. 1. Kvæfjord 1 altarpiece. View of the corpus and wings.

The altarpiece consists of a corpus and two hinged wings. The wings are too heavily painted to allow examination of the timber beneath so these were not analysed dendrochronologically. The corpus consists of a box built of oak, with four equally dimensioned backing planks and four narrower planks forming the sides (fig. 1 and fig. 2). The corpus is adorned with tracery and three carved wooden figures. The timber of these carvings could not be seen under the paint, so no dendrochronological analysis was undertaken here.

All four backing planks and two side planks were analysed, five from macro photographs of the longitudinal timber section (fig. 3) while a sixth was measured from photographs of the transverse section, at the dovetail join (fig. 4). All the analysed elements are dated.

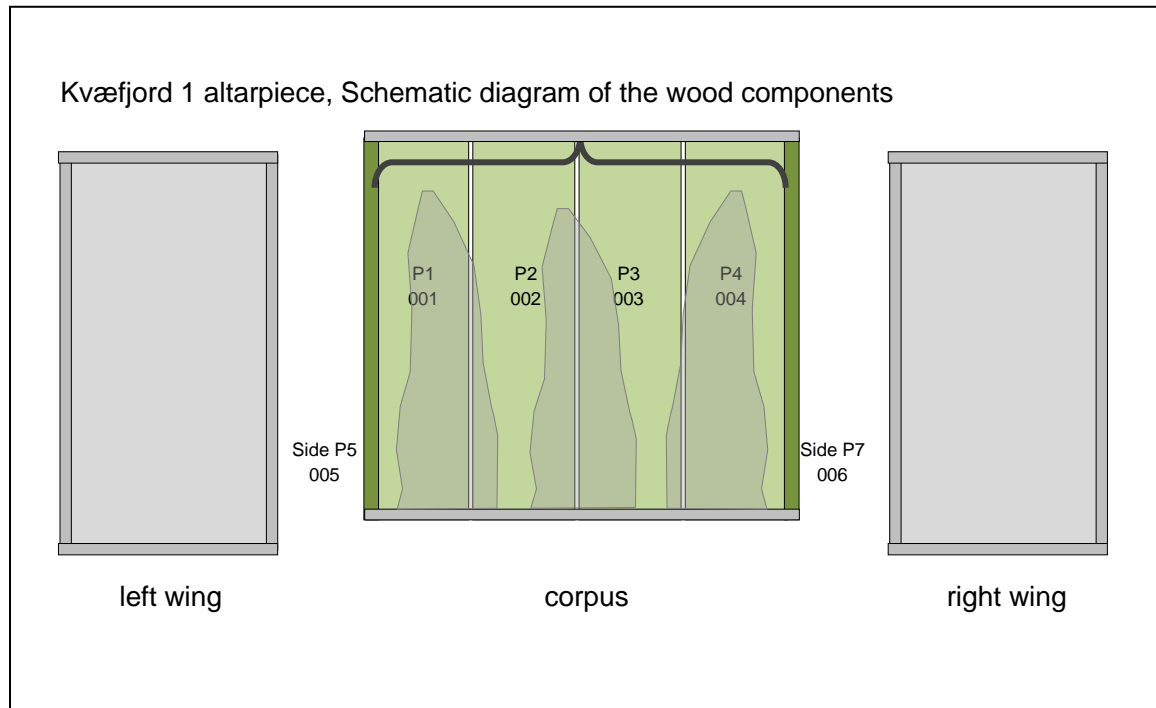


Fig. 2. Kvæfjord 1 altarpiece. Schematic diagram of the wood elements in the altarpiece. The elements analysed are marked in green.

### Measuring

As described in the report on the dendrochronological analysis of the Slagen altarpiece (*CATS dendro report 2*, Daly 2013b), non-invasive analysis can be carried out in certain circumstances, and this was a priority for the altarpieces being analysed in this project. Tree-ring measurements from the Kvæfjord 1 altarpiece were taken from parts where the wood grain was already exposed, and no invasive methods were necessary. The transverse section of the wood was exposed on all the back planks (e.g. see figs. 6 & 7), and one side plank, while the transverse section could be used for a second side plank (fig. 4). These were all photographed and measured from these sections. Macro photographs of the surfaces, along with a ruler for scale, were taken (fig. 3). These photos were then stitched together using Adobe Photoshop (version 11.0.2), and measured using an application "Able Image Analyser". Here, the scale is used to calibrate the picture, and the measurements are made to 1/100mm precision. For calculation of the t-value ("t-test") "CROS" (Baillie & Pilcher, 1973) is

used, embedded in the program "DENDRO" (Tyers, 1997). Ian Tyers, Sheffield, has contributed to this analysis with data comparison and invaluable discussion.



Fig. 3. Kvæfjord 1 altarpiece. Attaining macro photographs of the tree-rings of the altarpiece in the museum exhibition. Three people are occupied here, one to hold the lamp at an oblique angle, one to hold a ruler for scale and one to take the photograph series.

## The results

### The back planks

The four backing planks are of very uniform dimensions, and are mounted vertically. Rough tool marks are still visible on the back surfaces of these planks (figs. 6 & 7) but in spite of this, tree-ring measurement of all four planks was successful. No sapwood is observed on any of the backing planks. The tree-ring curves from the four backing planks are so similar to each other (see for example table 1), it can be suggested that they are all from the same tree. They are averaged to a single tree-ring curve (Z101M001), representing that tree. The tree-ring curve for the tree used to make the backing planks is 177 years long (with an average tree-ring width of 160 mm) and covers the period AD 1317-1493. Allowing for missing sapwood, the felling date for the tree used for these planks is estimated at after AD1503 (fig 5).





Fig. 4. Kvæfjord 1 altarpiece. Tree-rings on one of the side planks (P7) were measured from the transverse section exposed at the corner dovetail joint.

#### The side planks

Two of the side planks were analysed. One is measured on the longitudinal and one on the transverse section (fig. 4). Both are dated. Only heartwood can be seen on these planks. The outermost preserved tree-ring is on side plank 5, and this ring was formed in AD 1487. Allowing for missing sapwood, the trees from which the side planks were made is estimated to after AD 1497 (fig. 5).

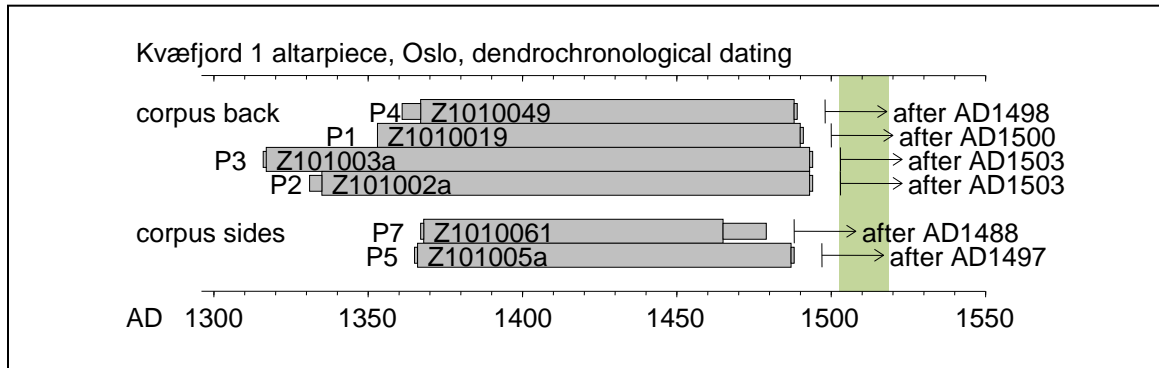


Fig. 5. Kvæfjord 1 altarpiece. Diagram showing the chronological position of the dated elements. The green shading indicates the interpretation of the dating results.



Fig. 6. Kvæfjord 1 altarpiece. Tool marks on the backing planks, probably made with a broad side axe.

			Z101002a	Z1010019	Z101003a	Z1010049	Z101005a	Z1010061
Same tree Z101M001	back plank 2	Z101002a	*	9.91	9.99	8.50	3.53	-
	back plank 1	Z1010019	9.91	*	11.80	10.25	3.40	-
	back plank 3	Z101003a	9.99	11.80	*	10.41	-	-
	back plank 4	Z1010049	8.50	10.25	10.41	*	3.11	3.44
Z101 M002	side plank 5	Z101005a	3.53	3.40	-	3.11	*	7.72
	side plank 7	Z1010061	-	-	-	3.44	7.72	*

Table 1. Kvæfjord 1 altarpiece. Correlation between the tree-ring curves from each timber element with each other.

### Interpretation

As only heartwood is preserved on the wood components analysed it is not possible to determine the precise felling date for the trees used to build the Kvæfjord 1 altarpiece. However, considering the dating of the preserved planks, where the outermost preserved rings on each element analysed falls within just a few years of each other, we might suggest that trimming of the planks entailed not much more than the removal of sapwood. If this is the case, the date for the felling of the trees used can be placed at c. AD 1503-1518 (marked in fig. 5 in green).

### Oak provenance

Table 1 shows the correlation (t-value) between each tree-ring curve from the altarpiece with each other, at their cross-matched position. The statistical agreement between the tree-ring curves from the four back planks is so high, that they might come from a single tree (Z101M001). The correlation between the tree-ring curves from the two side planks is also good, but they are not similar enough to allow the suggestion that they are from the same tree. They are averaged to form a mean curve (Z101M002) of 122 years length.

The correlation between these two averages and diverse oak chronologies and datasets from Northern Europe is shown in tables 2 and 3. The tree used for the backing planks is clearly dating with the southern Baltic region, achieving highest correlation with the so-called Baltic 1 group (table 2). The curve from the side planks is dating against a range of tree-ring data from the Southern Baltic region, but a more precise indication of the provenance of the trees used for the sides cannot currently be suggested (table 3).

As the Kvæfjord 1 altarpiece is made from Southern Baltic oaks a sapwood estimate for the region around the mouth of the Vistula River is used (c. 15 sapwood years (-6 +9) (Wazny 1990)).

Filenames	-	-	Z101M001	
-	start	dates	AD1317	
-	dates	end	AD1493	
Art-historical tree-ring data, Southern Baltic region				
0M040004	AD1156	AD1597	9.56	Baltic 1 (Hillam & Tyers 1995)
SUTYPE14	AD1259	AD1516	8.30	London Sutton House SUT91 panels (Tyers pers comm.)
BOWHILLB	AD1161	AD1483	8.24	Exeter Bowhill ceiling boards (Tyers pers comm.)
H11EOM01	AD1260	AD1495	8.05	Bordesholmer Altar (Hamburg uni., revised Daly 2007)
OS080_T5	AD1268	AD1517	7.10	Henry VIII Holbein Petworth 5boards (Tyers pers comm.)
os181	AD1280	AD1505	7.07	Soc Antiqs Ferdinand (Tyers pers comm.)
os532l	AD1406	AD1609	7.07	GD-100 Portrait of a Man with a Hat Gerrit Dou (Tyers pers comm.)
os652_B	AD1352	AD1501	7.00	Trinity Door (Tyers pers comm.)
OS084_T5	AD1255	AD1498	6.98	Bosch Adoration Triptych Upton House (Tyers pers comm.)
os500ac	AD1349	AD1513	6.94	Thomas Howard Holbein Windsor boards (Tyers pers comm.)
OS081_T5	AD1198	AD1522	6.86	Ashmolean Battle of Pavia 5 boards (Tyers pers comm.)
Os112l	AD1350	AD1516	6.83	Man of Sorrows left side (Tyers pers comm.)
OS107_T3	AD1394	AD1522	6.82	Story of Lot Hans Baldung 3 boards (Tyers pers comm.)
os697ac	AD1327	AD1498	6.74	WAG9864 van Cleve Madonna & cherries (Tyers pers comm.)
os509510a	AD1288	AD1471	6.73	Head of Christ/Virgin Metsys (Tyers pers comm.)
os353ac	AD1369	AD1558	6.66	NPG1852 Wentworth boards (Tyers pers comm.)
os693u	AD1320	AD1518	6.54	Reginald Pole Oxford (Tyers pers comm.)
Z103M003	AD1234	AD1495	6.34	Slagen altertavle Norge (Daly 2013b)
HEADSx11	AD1304	AD1521	5.64	Stirling heads Baltic timber (Crone pers comm.)
stirlingdoorsM1	AD1270	AD1524	5.64	Stirling doors Baltic timber (Crone pers comm.)
PERTHM6	AD1225	AD1499	5.44	Perth Museum panels Baltic timber (Crone pers comm.)
se613m01	AD1197	AD1464	5.16	Hull Blaydes Staithe Baltic timber (Tyers pers comm.)
Z080M001	AD1367	AD1520	5.09	"Money-lenders" in private ownership (Daly 2011)
GAPCX7	AD1283	AD1450	5.07	Guthrie Aisle panels Baltic timber (Crone pers comm.)
0EQKTVM001	AD1295	AD1549	4.67	Tallinn: Christ Money-lenders (Daly & Läänelaid 2012)
Z112M001	AD1373	AD1505	4.27	Veien altarpiece Oslo side planks (Daly 2014)
Z112M002	AD1287	AD1497	4.22	Veien altarpiece Oslo 2 planks (Daly 2014)
Ship and barrel chronologies				
0075M001	AD1113	AD1463	7.10	Vejdyb ship 16 timber (Daly 1997)
B019M002	AD1374	AD1574	5.43	Helsingør Kulturværft two barrels (Daly 2009)
Z084M001	AD1152	AD1437	5.04	Skaftø wreck barrels 9 timber (Daly 2013a)
Site and master chronologies				
P815001M	AD1262	AD1503	4.67	Bielsk Podl. (Wazny pers comm.)

Table 2. Kvæfjord 1 altarpiece, Oslo. Result of the correlation between the average of the four back planks from the altarpiece (Z101M001) and diverse Northern European site and master chronologies. The source of the chronologies is given. The grey tone highlights the high t-values.

## Conclusion

The dendrochronological analysis of the Kvæfjord 1 altarpiece has been carried out wholly non-invasively, with success. Measurement of the tree-rings could be taken at places where no paint obscured the timber, but this was thus restricted to analysis of the back and side planking. Due to paint, none of the sculptures or carvings, and neither of the wings were analysed. The success of the analysis is due to a large part to the fact that the timbers used for the planking are very similar, in terms of their



growth pattern, allowing confirmation of each measurement series against each other. This enables mistakes in the measurements on the longitudinal surfaces to be corrected, and shorter series derived from the rings exposed at the join (fig. 4) to be placed correctly. Additionally, all the analysed timbers contain relatively wide and numerous rings, giving optimal conditions for non-invasive analysis (fig 9). The rough appearance on the back surface of the backing planks did not hinder the measurement process (figs. 6 & 7). Sometimes in fact, the tool marks, probably made using a very broad side axe (Wadum pers comm), straddle two planks (fig. 8) indicating that the backing was trimmed after the planks had been joined together. This observation, along with the dendrochronological results indicating that the back planks come from the same tree, allow a rare glimpse into the manufacture of the altarpiece, from raw material in a forest in the Southern Baltic region to the carpenter at work shaping the boards in the final piece.

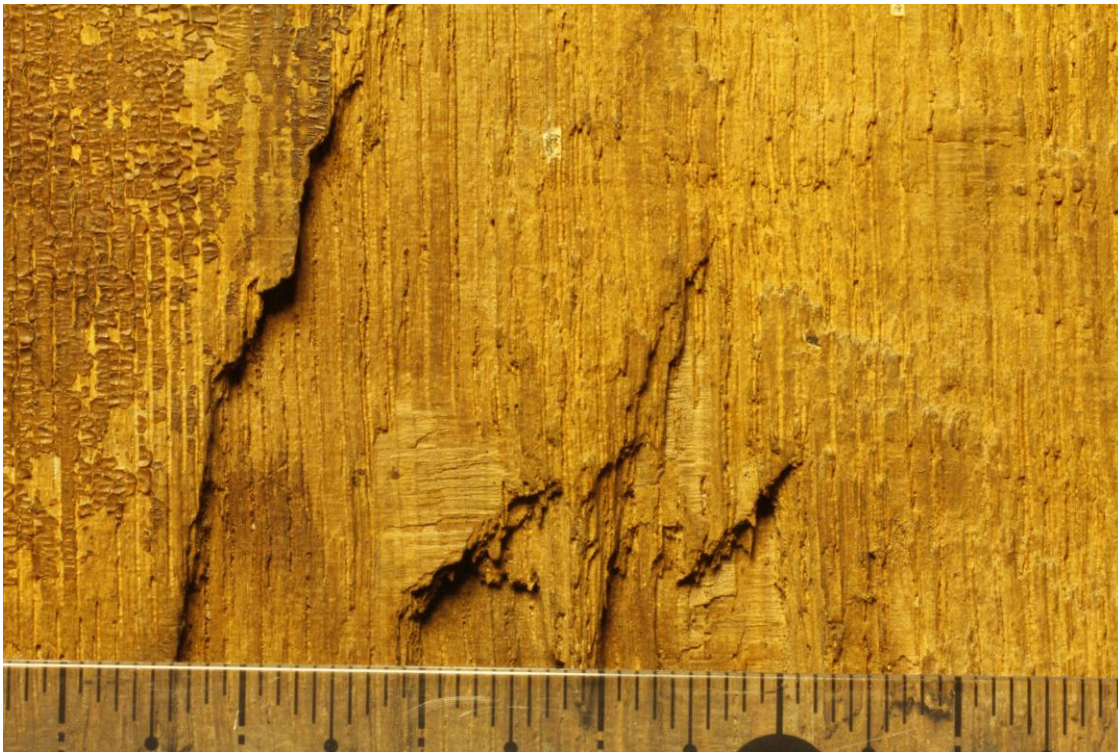


Fig. 7. Kvæfjord 1 altarpiece. In spite of the rough condition of the plank surface (back plank 3) tree-ring measurement from the macro photographs was possible, allowing successful non-invasive dendrochronological analysis.



Filenames	-	-	Z101M002	
-	start	dates	AD1366	
-	dates	end	AD1487	
Art-historical tree-ring data, Southern Baltic region				
os884_tp2	AD1341	AD1481	6.05	Winchester St Cross tracery panel (Tyers pers comm.)
os484ab	AD1391	AD1559	5.82	William Cecil Baron Burghley boards (Tyers pers comm.)
os232b	AD1386	AD1541	5.65	Marinus van Reymerswaele St Jerome board (Tyers pers comm.)
os297au	AD1390	AD1516	5.47	NPG4451 Catherine Parr board (Tyers pers comm.)
os395bl	AD1393	AD1566	5.46	Eton Henry VI arched board (Tyers pers comm.)
os687e	AD1253	AD1440	5.46	An Allegory of Beauty van Heemskerck board (Tyers pers comm.)
os170_t4	AD1369	AD1594	5.38	Guernsey Mona Lisa (Tyers pers comm.)
os208_t4	AD1380	AD1581	5.27	Liverpool Judgment of Paris (Tyers pers comm.)
os283	AD1267	AD1480	5.27	NPG416 Henry VII (Tyers pers comm.)
os285au	AD1243	AD1460	5.25	NPG4953 John Bourchier (Tyers pers comm.)
os184	AD1278	AD1490	5.24	Soc Antiqs Henry VII Scharf XXII (Tyers pers comm.)
OS080_T5	AD1268	AD1517	5.22	Henry VIII Holbein Petworth 5boards (Tyers pers comm.)
os369cuo	AD1388	AD1549	5.19	Lambeth Warham board (Tyers pers comm.)
os866b	AD1360	AD1494	5.18	Christies Jean Grusset van Dyck board (Tyers pers comm.)
os509510a	AD1288	AD1471	5.16	Head of Christ/Virgin Metsys board (Tyers pers comm.)
Os092	AD1293	AD1492	5.15	Anglesey Abbey Henry VIII as a young man (Tyers pers comm.)
0M040004	AD1156	AD1597	4.81	<b>Baltic 1</b> (Hillam & Tyers 1995)
Z112M002	AD1287	AD1497	4.31	Veien altarpiece Oslo 2 planks (Daly 2014)
Z080M001	AD1367	AD1520	4.13	"Money-lenders" in private ownership (Daly 2011)
Ship and barrel chronologies				
0075M001	AD1113	AD1463	5.01	Vejdby ship Baltic 1 group (Daly 1997)
Z084M001	AD1152	AD1437	4.54	Skaftö wreck barrels 9 timber (Daly 2013a)

Table 3. Kvæfjord 1 altarpiece, Oslo. Result of the correlation between the average of the two side planks from the altarpiece (Z101M002) and diverse Northern European site and master chronologies. The source of the chronologies is given. The grey tone highlights the high t-values.



Fig. 8. Kvæfjord 1 altarpiece. Marks from wood working tools indicate that some shaping of the backing of the altarpiece was carried out after the planks had been joined together.

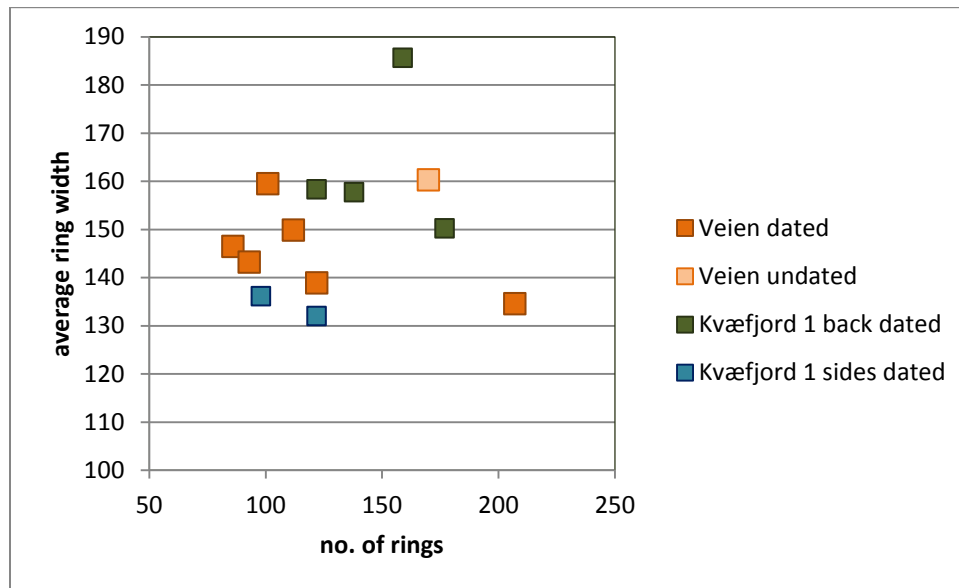


Fig. 9. Kvæfjord 1 and Veien altarpieces. Chart summarising the tree-ring data derived from the six timber elements analysed from Kvæfjord 1, and the seven from Veien (Daly 2014) for comparison. All the planks analysed from the Kvæfjord 1 altarpiece are dated. All timbers contain relatively wide rings, giving optimal conditions for non-invasive analysis.

## Literature

- Baillie, M.G.L. and Pilcher, J.R., 1973: A simple crossdating program for tree-ring research. *Tree-Ring Bulletin* 33, 7-14.
- Daly, A., 1997. Dendrokronologisk undersøgelse af skibsvrag fra Vejdyb udfor Hals, Aalborg Amt. *Nationalmuseets Naturvidenskabelige Undersøgelser rapport 12*, 1997, København.
- Daly, A., 2007. *Timber, Trade and Tree-rings. A dendrochronological analysis of structural oak timber in Northern Europe, c. AD 1000 to c. AD 1650*. Ph.D. thesis submitted February 2007, University of Southern Denmark.
- Daly, A., 2009. Kulturværft Helsingør. *dendro.dk rapport nr. 2009 : 21*, Copenhagen.
- Daly, A., 2011. Dendrochronological analysis of a painting on an oak panel, Christ Driving the Moneylenders from the Temple. *Chronology, Culture and Archaeology Report 05* (2011). University College Dublin.
- Daly, A., 2013a. Barrels from the Skaftö shipwreck. *Dendro.dk report 2013:4*, Copenhagen.
- Daly, A., 2013b. Dendrochronological analysis of altarpiece from Slagen church, Norway, C2124. *CATS dendro report 2*, Copenhagen
- Daly, A., 2014. Dendrochronological analysis of altarpiece from Veien church, Norway, C5908. *CATS dendro report 5*, Copenhagen
- Daly, A & Läänelaid, A., 2012. The dendrochronological dating of three paintings in the style of Bosch/Bruegel. in E. Hermens (ed.) *On the Trail of Bosch and Bruegel: Four Paintings under Magnification*. Archetype Publications/SMK.

Hillam J. & Tyers I., 1995. Reliability and repeatability in dendrochronological analysis: tests using the Fletcher archive of panel-painting data, *Archaeometry* 37, p. 395–405.

Tyers, I.G., 1997. Dendro for Windows Program Guide, *ARCUS Report* 340, Sheffield.

Wazny, T., 1990. *Aufbau und Anwendung der Dendrochronologie für Eichenholz in Polen*. PhD Thesis. Universität Hamburg, pp. 213.

Filename	sample title and number	rings	start yr.	end yr.	conversion	pith	sapwood	bark?	extra start	extra end	interpretation / felling
Z1010019	Kvæfjord 1 altertavle Norge corpus back plank1	138	AD1353	AD1490	T	G	0	N	N	H1	after AD1500
Z101002a	Kvæfjord 1 altertavle Norge corpus back plank2	159	AD1335	AD1493	T	G	0	N	H4	H1	after AD1503
Z101003a	Kvæfjord 1 altertavle Norge corpus back plank 3	177	AD1317	AD1493	T	G	0	N	H1	H1	after AD1503
Z1010049	Kvæfjord 1 altertavle Norge corpus back plank 4	122	AD1367	AD1488	?	G	0	N	H6	H1	after AD1498
Z101005a	Kvæfjord 1 altertavle Norge corpus side plank 5	122	AD1366	AD1487	?	G	0	N	H1	H1	after AD1497
Z1010061	Kvæfjord 1 altertavle Norge corpus side plank 7	98	AD1368	AD1465	T	G	0	N	H1	H14	after AD1488
Z101M001	Kvæfjord 1 altertavle Norge corpus back planks same tree 4 timber mean	177	AD1317	AD1493							
Z101M002	Kvæfjord 1 altertavle Norge corpus side planks 2 timber mean	122	AD1366	AD1487							
Conversion: R = radial split plank, T = tangential plank, W = whole timber, S = squared whole timber, H = half timber, Q = quarter timber, O = other conversion. Pith: C = centre, V = less than 5 rings, F = 5 – 10 rings, G = greater than 10 rings.											
Aoife Daly, ph.d.			6th February 2014								

Table 4. Kvæfjord 1 altarpiece, Oslo. List of objects analysed.