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Drigg Wrecks
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Cumbria

Tree-ring Analysis of Oak Timbers

Roderick Bale, Robert Howard, Nigel Nayling, and Cathy Tyers

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Research Report Series no. 239-2020

Front Cover: Kokoarrah Beach Wreck - National Record Historic Environment 1616560. Photograph: CITiZAN

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SUMMARY
In 2018 a total of 20 cross-sectional slices were obtained from three shipwreck locations on the foreshore off Drigg in Cumbria; the fourth location of potential interest being inaccessible. Nine samples were recovered from the Drigg beach wreck (NRHE 1616097), one from the Barn Scarr wreck (NRHE 1616085), and ten from the Kokoarrah beach wreck (NRHE 1616560). Intra- and inter-site cross-matching of the ring-width series resulted in the successful dating of five samples, all of which are at least broadly coeval. Three of the samples from hull planks of the Drigg Beach wreck were felled after AD 1758, AD 1764, and AD 1765. Two of the samples from floor timbers of the Kokoarrah wreck were felled after AD 1768 and AD 1777. The levels of similarity of the individual sample series, as well as the site master sequences, with reference chronologies from across much of England suggests that the sampled timbers are all of British origin, although the variable intra-site matching may suggest that the timbers derive from a number of woodland sources rather than from a single woodland.

CONTRIBUTORS
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INTRODUCTION

Four wreck sites within approximately 400m of each other were identified from mapping and observations on the Drigg foreshore, the village of Drigg lying some 20 km south-east of Whitehaven, Cumbria (Fig 1), for evaluation as part of the Coastal and Intertidal Zone Archaeological Network initiative (www.citizan.org.uk), led by Museum of London Archaeology. The National Grid References provided below are those recorded in the National Record of the Historic Environment (NRHE) entry.

The sites are:

- Site 1 - Drigg beach wreck (NRHE 1616097). A detached mobile fragment of a wreck that was washed in at Drigg in January 2018. It is thought that this fragment may have been dislodged from an offshore wreck. The fragment comprised parts of the keel and planking of a wooden sailing vessel of carvel construction. The fragment has been interpreted as having originated from a late eighteenth- to mid-nineteenth century vessel, possibly a fishing vessel. National Grid Reference: SD 05032 97924.

- Site 2 - Barn Scarr wreck (NRHE 1616085). A wreck located in the inter-tidal zone first recorded in 1999. The remains of this vessel, a possible fishing vessel, comprise the partial outline of a hull from the stern end towards amidships filled in with sand. Its exposure in January 2018 allowed a possible identification as the wreck of the SYREN (NRHE 1368323) fishing smack, built in AD 1864 and recorded as lost at Drigg in AD 1902. National Grid Reference: SD 04628 98130.

- Site 3 - Kokoarrah reef wreck (NRHE 1616118). The reported location of a wreck visible at extremely low tides, not previously formally recorded, and suggested locally to be the origin of the detached wreck fragment (Site 1) above. National Grid Reference: SD 04474 96559.

- Site 4 - Kokoarrah beach wreck (NRHE 1616560). The remains of a wreck in the inter-tidal zone exposed following erosion in February 2018. The remains of this vessel comprise frames with overlying floor planking, lying within a scour pit following erosion of the covering sand. Whilst construction is similar to that of Site 1, the mobile fragment, indicating a similar date for this vessel, examination of construction details concluded that Site 1 and Site 4 were not related as there are structural differences in that they have different keel arrangements and the frame finish is of different quality (CITiZAN pers comm). National Grid Reference: SD 04622 97757.

The sites were the subject of investigation by the CITiZAN team. Dendrochronological input was requested from Historic England, a CITiZAN project supporter, to provide independent dating evidence to aid identifications of the wrecks, and thus inform the assessment of significance for potential designation.

METHODS

During a visit to the Drigg beach wreck (Site 1) by members of the CITiZAN team in January 2018, two samples in the form of cross-sectional slices from oak timbers (*Quercus* spp) were collected to allow an initial basic assessment as to the dendrochronological potential of this wreck, prior to further site work. This initial assessment proved positive and thus more detailed assessment, and sampling as appropriate, was undertaken on the 19th and 20th February 2018 by two of the authors (Robert Howard and Rod Bale). The Kokoarrah reef wreck (Site 3), reportedly only accessible at extreme low tides, was inaccessible at this time, and thus no assessment of its potential for dendrochronology could be undertaken. Access was limited to a small section of the Barn Scarr wreck (Site 2) that was exposed at this time, preventing any detailed assessment of the dendrochronological potential of this wreck. Larger sections of both the Drigg beach wreck (Site 1) and the Kokoarrah beach wreck (Site 4) were, however, accessible and both were assessed as having potential for dendrochronology. Following these assessments further targeted sampling saw the removal of another 18 cross-sectional slices from oak timbers from three of the wreck sites. Thus, in total nine timbers from the Drigg beach wreck (Site 1) were sampled, one from the Barn Scarr wreck (Site 2), and ten from Kokoarrah beach wreck (Site 4). Information is provided about each sample in Table 1 and illustrated in Figures 2–4 (Site 1, Drigg beach wreck), Figure 5 (Site 2, Barn Scarr wreck) and Figures 6 and 7 (Site 4, Kokarrah beach wreck). All sample numbers given in Table 1 have a CITiZAN sample code prefix of CU-DRG and the nomenclature used for the timber elements follows that used by CITiZAN.

Methods employed at the Lampeter Dendrochronology Laboratory in general follow those described in English Heritage (2004). The samples were cleaned using razor blades so that the ring-width sequences could be clearly discerned and measured. The complete sequence of growth rings in each sample was measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 2004). Cross-correlation algorithms (Baillie and Pilcher 1973; Munro, 1984) are employed to search for positions where the ring sequences are highly correlated against each other. The individual ring-width series were also tested against a range of reference chronologies from Britain and elsewhere in northern Europe, as were the mean series obtained where it was appropriate to combine individual series. The *t*-values reported are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that satisfactory visual matching supports these positions. Correlated positions were checked visually using computerised ring-width plots.

The tree-ring dates produced by this process date the rings present in the timbers. Interpretation of any tree-ring date obtained is limited by whether sapwood or bark edge is present in a sample. Sapwood is distinguishable as lighter coloured band around the outer annual rings of a tree and represents the part of the tree that is alive. At a microscopic level, sapwood in oak is recognisable by the open earlywood vessels used for water and mineral transport. Heartwood earlywood vessels appear filled when viewed microscopically as the cell walls have collapsed (tyloses) and no

longer form the living part of the tree. Should a sample contain sapwood and bark edge, the year and even season of felling can be inferred from a dated sample. Should partial sapwood be present, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 46 rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from Britain and are based on observations of many thousands of samples from living trees and archaeological wood (Bayliss and Tyers 2004). In samples where there is no sapwood or microscopic sign of the heartwood/sapwood boundary a date will represent a *terminus post quem* (date after which) the parent timber must have been felled. The *terminus post quem* for felling is obtained by the addition of the minimum expected number of sapwood rings to the date of the last heartwood ring present.

The dates obtained by this technique do not, by themselves, necessarily indicate the date of the vessels. It is essential to incorporate other evidence relating to construction and subsequent repairs before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of the vessels.

RESULTS

Details of the samples from the Drigg wrecks are provided in Table 1, and the data of the measured rings series are provided in the Appendix.

Site 1, Drigg beach wreck (NRHE 1616097)

Three of the samples (18C_01, 18C_02, and 18_C09) were, following preparation of the cross-sectional surface, deemed to have too few rings (<40) for reliable dating purposes. The six measured series from this wreck were compared. Sample 18C_04 produced good statistical agreement with both samples 18C_05 and 18C_08 (Table 2). The poor statistical agreement between 18C_05 and 18C_08, however, led to all three of these individual series being compared with known age oak reference chronologies from throughout the British Isles. All three produced significant statistical agreement with a series of reference chronologies which supported the intra-site cross-matching and thus were combined to produce the site chronology DBW-S1 which spans the period AD 1630–1755 (Table 3).

The remaining three measured series were compared to site chronology DBW-S1, as well as known age oak reference chronologies from throughout the British Isles and elsewhere in Europe, but no conclusive dating evidence was obtained.

Site 2, Barn Scarr wreck (NRHE 1616085)

Following preparation of the cross-sectional surface, the only sample obtained was rejected prior to measurement as it had too few rings for analysis.

Site 3, Kokoarrah reef wreck (NRHE 1616118)

The Kokoarrah reef wreck was inaccessible due to high tides, and thus no assessment of its potential for dendrochronology could be undertaken.

Site 4, Kokoarrah beach wreck (NRHE 1616560)

Two of the samples (18B_04 and 18B_08) were, following preparation of the cross-sectional surface, deemed to have too few rings for reliable dating purposes. The eight measured series from this wreck were compared but no significant cross-matching was noted. Thus, all eight individual series were compared initially with the site chronology DBW-S1 and individual series from the Drigg beach wreck (Site 1) against which some potential cross-matching was noted for several of the Kokoarrah beach wreck samples. This was supported by consistent cross-dating for two of these samples, 18B_06 and 18B_09, when they were compared with known age oak reference chronologies from throughout the British Isles (Table 4). The overlap between these two series is only 35-rings and, in spite of the lack of significant cross-matching, taking into account the often disparate nature of wreck assemblages the two series were combined to produce a mean site chronology, KBW-S4. This site chronology spans the period AD 1682–1767 (Table 4) and produces a *t*-value of 6.51 with the Drigg beach wreck site chronology DBW-S1 (Fig 8).

The remaining six measured series were subsequently also compared to known age oak reference chronologies from elsewhere in Europe, but no conclusive dating evidence was obtained.

INTERPRETATION AND DISCUSSION

All five dated samples are clearly broadly coeval indicating that the Drigg beach wreck (Site 1) mobile fragment and the Kokoarrah beach wreck remains (Site 4) are likely to be of a similar date (Fig 9).

The three dated samples from the Drigg beach wreck (Site 1) are from hull planks. The samples all comprised heartwood only, thus it has only been possible to obtain a *terminus post quem* for felling of the parent trees (Fig 9; Table 1).These vary by only seven years implying that all three dated hull planks are coeval and hence all likely to have been derived from trees felled after AD 1765.

The two dated samples from the Kookarrah beach wreck (Site 4) are from floor timbers. Again both samples comprised heartwood only. The *terminus post quem* for felling of the parent trees varies by only nine years, again implying that these two dated floor timbers are coeval and hence likely to have been derived from trees felled after AD 1777 (Fig 9; Table 1).

All of the sampled floor timbers from the Kokoarrah beach wreck (Site 1) are of very similar scantling. The presence of a few sapwood rings on one of these (18B_02) could be taken to suggest that these floor timbers were only lightly trimmed during conversion and therefore have lost not much more than their sapwood and a small number of heartwood rings. It, therefore, seems reasonable to suggest that felling of these floor timbers probably occurred in the late-eighteenth or relatively early nineteenth century. Whilst the dated hull planks from the Drigg beach wreck (Site 1) may have been slightly less lightly trimmed during conversion the similarity in end date can also be taken to suggest that these may also have been derived from trees felled in the late-eighteenth or relatively early nineteenth century. However, the dating evidence for both of these two wrecks is based on only three and two samples respectively and thus, bearing in mind the complexities in relation to construction and subsequent repairs to vessels, should be viewed with caution.

The high correlations obtained for the two site mean sequences indicate that the dated timbers are all of British origin (Tables 3 and 4). Those for DBW-S1 (Site 1, Drigg beach wreck) are particularly strong with dated material from the Midlands, whilst those for KBW-S4 (Site 4, Kokoarrah beach wreck) tend to be strong across a broader area encompassing southern English material, along with some Midlands and some Welsh material. The correlations obtained for the five individual series are similarly variable. This breadth of correlation across Britain may indicate a more scattered source for the individual timbers for each site than a single woodland, or even regional area, and makes any conclusions with respect to provenance of timber for either vessel within Britain somewhat more difficult.

CONCLUSIONS

The dating evidence obtained through dendrochronological analysis for the Drigg beach wreck (Site 1) and the Kokoarrah beach wreck (Site 4) supports the late eighteenth- to mid-nineteenth century date suggested on constructional evidence derived from comparable, similarly vernacular, vessels and suggests that both vessels may be of a similar date in the late eighteenth- or early nineteenth-century. The analysis also suggests that the timber is of British origin, most likely of English origin, but with the individual timbers potentially representing multiple woodland sources.

The dendrochronological dating of two timbers from the Kokoarrah beach wreck (Site 4) demonstrates the potential for further investigation should more of the Kokoarrah beach wreck be exposed. Similarly, the successful dating of three timbers from the Drigg beach wreck (Site 1) demonstrates the potential, should access to the Kokoarrah reef wreck (Site 3) prove feasible at some point, to address the suggestion that the Drigg beach wreck mobile fragment is a detached section of the Kokoarrah reef wreck. In addition, although the single sample from the Barn Scarr wreck (Site 2) did not contain sufficient rings to warrant analysis, the presence of oak timber on the site was demonstrated, and thus the dendrochronological

potential of the site should not be discounted at this stage as the assessment was confined to a small exposed section of wreck with very limited access. The exposure of a larger section of this wreck might reveal timbers that are suitable for tree-ring analysis.

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TABLES

Table 1: Details of the samples from the Drigg wrecks, Cumbria. All samples are oak (Quercus spp).

Sample number	Timber location / description	Conversion	Cross-sectional dimensions (mm)	Total rings	Sapwood rings	Average ring width (mm)	Date span of measured sequence (AD)	Felling date / date range (AD)
Site 1: Drigg beach wreck (NRHE 1616097)								
18C_01	Hull plank	Tangential	240x 50	25	------	4.80	not measured	------
18C_02	Floor timber	Sub whole	230x210	39	------	3.91	not measured	------
18C_03	Floor timber	Sub quartered	220x190	44	2	4.27	undated	------
18C_04	Hull plank	Tangential	210x50	64	------	1.63	1691–1754	after 1764
18C_05	Hull plank	Tangential	180x50	126	------	1.22	1630–1755	after 1765
18C_06	Lower piece of composite floor timber	Sub halved	100x100	60	12 ?B	1.73	undated	------
18C_07	Floor timber	Quartered	200x190	65	------	2.84	undated	------
18C_08	Hull plank *(sampled by CITiZAN)*	Tangential	200x42	78	------	1.65	1671–1748	after 1758
18C_09	First futtock *(sampled by CITiZAN)*	Sub whole	290x210	*c*25	------	------	not measured	-------
Site 2: Barn Scarr wreck (NRHE 1616085)								
18D_01	Rudder?	Radial	300x150	18	------	1.00	not measured	------
Site 4: Kokoarrah beach wreck (NRHE 1616560)								
18B_01	Floor timber on south side of wreck (easternmost visible)	Halved	230x190	76	------	2.72	undated	------
18B_02	First futtock on south side of wreck	Halved	240x230	54	3	4.32	undated	------
18B_03	Floor timber on south side of wreck	Sub whole	240x200	44	------	3.21	undated	------
18B_04	First futtock on south side of wreck	Halved	240x200	35	------	5.71	not measured	------
18B_05	Floor timber? on south side of wreck (westernmost visible)	Sub whole	180x175	62	------	2.43	undated	------
18B_06	Floor timber on south side of wreck	Halved	250x120	44	------	2.93	1724–1767	after 1777
18B_07	Hull plank between floor timbers 01 and 06 on south side of wreck	Tangential	300x90	41	------	3.06	undated	------
18B_08	Hull plank opposite floor timbers 01	Tangential	260x60	25	------	5.20	not measured	------

	and 06 on north side of wreck							
18B_09	Floor timber on north side of wreck	Sub whole	230x220	77	------	2.18	1682–1758	after 1768
18B_10	Hull plank immediately below floor timber 09 from north side of wreck	Tangential	185x45	40	------	2.01	undated	------

?B = bark edge potentially present

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Table 2: Correlations between dated samples from the Drigg beach wreck and Kokoarrah beach wrecks - = t-values less than 3.00

	t-values			
Samples	18C_05	18C_08	18B_06	18B_09
18C_04	5.14	6.98	3.35	-
18C_05		-	-	-
18C_08			3.41	3.85
18B_06				-

Table 3: Correlations between the individual series 18C_04 (AD 1691–1754), 18C_05 (AD 1630–1755), and 18C_08 (AD 1671–1748) and the site master sequence DBW-S1 (AD 1630–1755) with previously dated site master chronologies

Site Master	*t*-values			
	18C_04	18C_05	18C_08	DBW-S1
Worcester Cathedral, Worcestershire (Howard *et al* 2000a; Arnold *et al* 2003a; Arnold *et al* 2004a)	4.34	7.11	3.98	7.90
Claydon House, Middle Claydon, Buckinghamshire (Tyers 1995)	4.67	6.61	4.82	7.77
Apethorpe Hall, Apethorpe, Northamptonshire (Arnold *et al* 2008)	4.43	7.42	4.05	7.68
Hartlebury Castle, nr Stourport-on-Severn, Worcestershire (Tyers 2008)	3.93	7.30	3.29	7.37
Winchester, Hampshire (Barefoot 1975)	5.16	6.87	4.15	7.25
Clifton Hall Tower, Clifton, Penrith, Cumbria (Arnold and Howard 2015)	5.68	4.77	6.03	7.16
Brampton Manor Barn, Chesterfield, Derbyshire (Arnold *et al* 2016)	6.71	5.18	5.34	7.15
Kirby Hall, Deene, Corby Northamptonshire (Arnold *et al* 2015)	3.64	6.77	4.57	7.00
Kibworth Harcourt post mill, Leicestershire (Arnold *et al* 2004b)	4.19	5.99	4.86	6.84
Croome Court, nr Upton upon Severn, Worcestershire (Arnold *et al* 2004c)	3.83	7.22	3.45	6.76

Table 4: Correlations between the individual series 18B_06 (AD 1724–1767) and 18B_09 (AD 1682–1758) and the site master sequence KBW-S4 (AD 1682–1767) with previously dated site masters. - = t-values less than 3.00

Site Master		*t*-values		
		18B_06	18B_09	KBW-S4
Winchester, Hampshire (Barefoot 1975)		4.57	4.80	7.61
Exeter Cathedral nave roof, Exeter, Devon (Mills 1988)		3.52	4.70	7.14
Worcester Cathedral, Worcestershire (Howard *et al* 2000a; Arnold *et al* 2003a; Arnold *et al* 2004a)		3.28	5.18	6.58
Stoneleigh Abbey, Stoneleigh, Warwickshire (Howard *et al* 2000b)		2.08	4.77	6.22
Kibworth Harcourt post mill, Leicestershire (Arnold *et al* 2004b)		3.59	4.58	6.08
Aberglasney, Llandeilo, Carmarthenshire (Miles and Worthington 1999)		4.85	3.15	5.92
White Tower, Tower of London, London (Miles 2007)		3.55	3.43	5.77
Leigh Barton, Churchstow, Devon (Groves 1998)		-	3.43	5.56
Claydon House, Middle Claydon, Buckinghamshire (Tyers 1995)		-	4.22	5.56
Cobham Hall, Gravesend, Kent (Arnold *et al* 2003b)		3.16	4.14	5.50
Ely Cathedral, Ely, Cambridgeshire (Arnold *et al* 2005)		4.07	-	5.34
Exeter Cathedral St John the Baptist Chapel, Exeter, Devon (Arnold *et al* 2006)		4.44	-	5.25
Savernake Forest, Wiltshire (Briffa *et al* 1986 unpubl)		-	3.47	5.09
Apethorpe Hall, Apethorpe, Northamptonshire (Arnold *et al* 2008)		-	3.96	5.06
Manor Barn, Great Newstead, Staplehurst, Kent (Arnold *et al* 2003c)		3.51	3.07	4.90

FIGURES

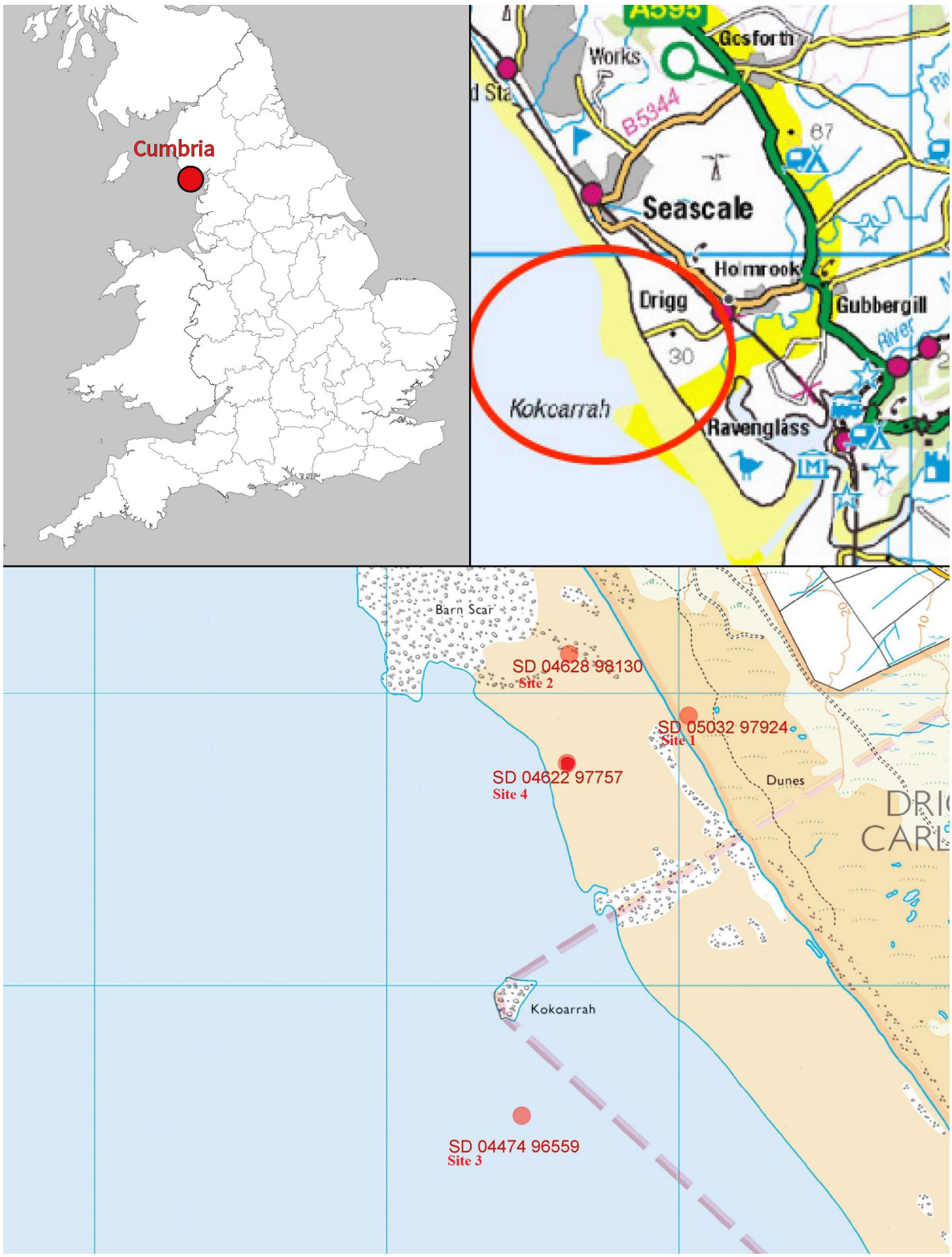

Figure 1: Maps to show the location of the Drigg Wrecks in Cumbria, marked in red. Top right scale 1:105,000, bottom 1:15,000 © Crown Copyright and database right 2022. All rights reserved. Ordnance Survey Licence number 100024900.

Figure 2: Annotated photograph (facing west) to help identify sampled timber 18C_01 (tagged timber) from the Drigg beach wreck (Site 1) (photograph Rod Bale)

Figure 3: Annotated photograph (facing east) to help identify sampled timbers 18C_02 - 18C_05 and 18C_07 from the Drigg beach wreck (Site 1) (photograph Rod Bale)

Figure 4: Annotated photograph (facing west) to help identify sampled timbers 18C_01 - 18C_09 from the Drigg beach wreck (Site 1) (photograph Rod Bale)


Figure 5: Annotated photograph (facing north-east to help identify sampled timber 18D_01 from the Barn Scarr wreck (Site 2) (photograph Rod Bale)

Figure 6: Annotated photograph (facing north-west) to help identify sampled timbers 18B_01 – 18B_08 from the Kokoarrah beach wreck (Site 4) (photograph Rod Bale)

Figure 7: Annotated photograph (facing west) to help identify sampled timber 18B_09 and 18B_10 from the Kokoarrah beach wreck (Site 4) (photograph Rod Bale)

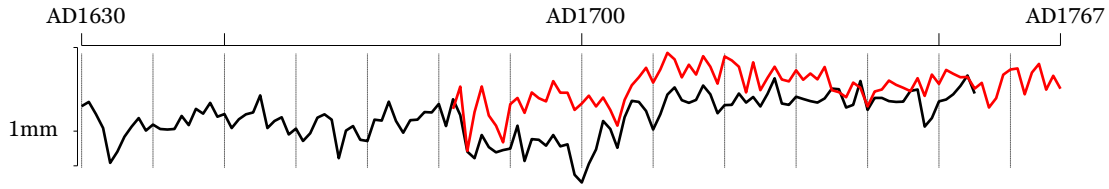

Figure 8: Plots of the two site master chronologies, DBW-S1 (black) and KBW-S4 (red), showing the similarities in growth pattern between the two series, the x-axis is calendar years and the y-axis ring-width (mm) on a logarithmic scale

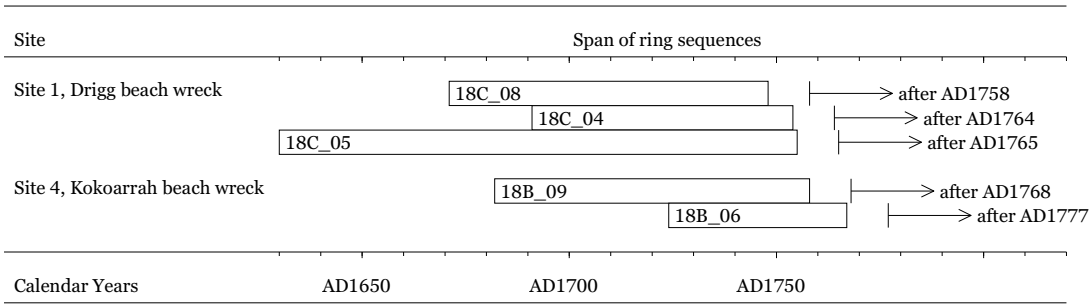

Figure 9: Bar diagram showing the relative positions of overlap of the dated ring series from the Drigg beach wreck and the Kokoarrah beach wreck and their individual felled after dates. White bars = heartwood rings

APPENDIX

Measurements in 0.01mm units

Site 1, Drigg beach wreck

18C_03

187	159	259	128	152	127	124	143	234	157
156	242	457	410	303	426	283	359	393	481
584	576	575	583	531	474	626	756	765	760
769	639	654	684	517	608	497	605	556	437
302	375	388	337						

18C_04

179	55	96	114	100	117	91	98	57	49
55	77	117	101	60	93	96	131	109	93
90	132	163	97	114	129	154	164	132	174
161	229	182	174	167	234	298	200	177	213
161	173	181	206	280	251	225	218	315	225
258	241	238	195	185	223	202	95	121	163
183	205	321	306						

18C_05

160	173	138	106	55	68	90	109	128	101
113	104	103	104	133	112	152	139	170	131
138	106	125	137	142	196	106	121	130	94
105	83	96	129	137	124	60	101	110	85
83	92	97	113	80	70	90	109	108	108
108	69	87	74	53	48	53	53	58	55
72	75	79	73	66	48	57	64	56	40
37	36	42	73	61	78	151	207	148	113
58	137	183	192	69	106	84	138	119	87
110	154	193	113	182	200	159	184	156	135
173	185	184	168	173	253	254	125	124	171
137	145	136	181	191	260	228	261	142	135
187	179	195	148	264	203				

18C_06

83	47	75	47	45	57	38	57	68	68
149	119	103	162	152	178	187	178	170	221
200	236	263	259	228	254	206	223	241	236
212	184	207	173	179	173	149	161	145	254
229	148	185	141	206	218	158	201	213	172
208	185	171	159	171	151	282	349	282	191

18C_07

668	958	664	488	820	729	743	669	538	1042
528	671	656	528	635	876	543	426	125	124
63	78	75	91	91	128	136	115	166	211
260	52	29	65	56	92	102	101	94	74
79	78	116	182	110	84	204	155	169	198
316	185	215	308	245	185	117	152	123	95
157	120	125	107	131					

18C_08

156	147	236	162	125	156	140	179	177	226
151	277	196	83	73	133	95	77	85	72
80	38	90	75	81	107	71	81	37	29
72	94	175	152	83	146	228	241	218	158
184	282	330	372	290	328	418	318	203	205
177	187	220	215	111	215	328	150	180	187
204	171	165	178	137	156	120	150	285	87
160	185	109	135	78	189	196	91		

Site 4, Kokoarrah beach wreck

18B_01

180	360	180	260	222	210	346	229	118	269
97	178	131	110	132	94	69	66	152	181
110	239	173	370	459	599	594	475	423	465
422	159	169	122	292	228	313	613	590	453
405	366	376	425	318	308	333	323	322	131
128	71	137	160	166	369	474	357	275	273
197	237	245	291	291	225	405	255	205	277
327	200	301	125	272	279				

18B_02

381	318	321	317	262	414	481	518	368	107
137	307	334	389	600	579	298	345	337	566
351	435	574	460	657	677	511	375	257	384
404	456	416	439	512	626	700	739	429	684
521	348	391	568	693	437	482	492	397	286
338	351	344	234						

18B_03

193	173	132	107	65	45	61	63	347	338
271	255	156	219	218	227	329	411	716	606
356	218	226	226	301	294	194	171	185	314
281	242	267	362	597	848	896	707	551	400
356	447	429	352						

18B_05

124	126	303	287	196	340	213	181	144	139
197	197	340	505	416	257	346	262	302	237
387	302	223	314	188	225	249	387	194	519
372	209	159	173	149	161	261	160	245	271
201	99	117	142	212	271	220	297	201	189
197	195	225	204	197	233	250	232	275	264
355	268								

18B_06

269	176	278	340	271	253	314	253	254	242
375	288	285	249	382	372	249	315	314	384
279	258	276	415	252	317	317	378	355	292
296	287	325	228	265	289	319	325	200	301
354	218	283	222						

18B_07

342 494 260 376 259 382 317 264 313 402
352 320 339 325 357 339 276 250 244 225
234 214 346 370 315 199 351 336 278 314
312 292 302 295 337 283 256 269 230 274
335

18B_09

152 231 69 143 232 134 111 81 166 187
141 207 186 175 256 206 206 149 168 195
159 188 149 111 180 237 276 329 249 319
436 386 275 349 290 410 336 244 408 378
336 207 462 256 269 332 258 258 315 273
338 289 294 145 132 129 117 81 69 108
125 134 200 195 148 128 136 263 170 255
233 260 259 160 171 84 107

18B_10

160 189 240 179 138 122 215 123 89 123
142 105 199 117 112 269 233 241 235 258
308 299 163 260 308 213 152 141 170 265
303 356 321 214 189 88 68 199 323 222

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