



Coconut Shells Recovered from the Goodwin Sands in the Vicinity of the Wreck of the *Rooswijk*

Radiocarbon Dating

Alex Bayliss, Serena Cant, Sanne Palstra, and Ruth Pelling

Discovery, Innovation and Science in the Historic Environment



Front Cover: Three coconut shells associated with the wreck of the *Rooswijk*. *Photograph source Ruth Pelling.*

COCONUT SHELLS RECOVERED FROM THE GOODWIN
SANDS IN THE VICINITY OF THE WRECK OF THE
ROOSWIJK

Radiocarbon Dating

Alex Bayliss, Serena Cant, Sanne Palstra, and Ruth Pelling

NGR: TR 49516 58901

© Historic England

ISSN 2059-4453 (Online)

The Research Report Series incorporates reports by Historic England's expert teams and other researchers. It replaces the former Centre for Archaeology Reports Series, the Archaeological Investigation Report Series, the Architectural Investigation Report Series, and the Research Department Report Series.

Many of the Research Reports are of an interim nature and serve to make available the results of specialist investigations in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation. Where no final project report is available, readers must consult the author before citing these reports in any publication.

*For more information write to Res.reports@HistoricEngland.org.uk
or mail: Historic England, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth
PO4 9LD*

Opinions expressed in Research Reports are those of the author(s) and are not necessarily those of Historic England.

SUMMARY

Five coconuts were recovered during excavation at the wreck site of the *Rooswijk*, an eighteenth-century ship of the Dutch East India Company (*Verenigde Oostindische Compagnie*, 'VOC'), wrecked on the Goodwin Sands off the coast of Kent, South East England, in January AD 1740. The highly mobile sea-bed environment has resulted in scattered ship debris across the area of the site. Dating of the coconuts was required to establish if they were part of the cargo of the *Rooswijk*, in which case they will date from shortly before AD 1740 and potentially hail from Indonesia. If they are not associated with the *Rooswijk* they must be related to a different, more recent historic wreck or cargo loss, more likely to have been returning from the Caribbean. Alternatively, the coconuts could be modern.

CONTRIBUTORS

Alex Bayliss, Serena Cant, Sanne Palstra, and Ruth Pelling

ACKNOWLEDGEMENTS

The #Rooswijk1740 project is funded and led by the Cultural Heritage Agency of the Netherlands (Ministry of Education, Science and Culture), in collaboration with project partner Historic England and UK-contractor MSDS Marine.

ARCHIVE LOCATION

Historic England Archive,
The Engine House,
Fire Fly Avenue,
Swindon SN2 2EH

HISTORIC ENVIRONMENT RECORD OFFICE

Kent Historic Environment Record,
Heritage Conservation,
Kent County Council,
Invicta House,
County Hall,
Maidstone,
Kent ME14 1XX

DATE OF INVESTIGATION

2017–2022

CONTACT DETAILS

Alex Bayliss
Historic England
Cannon Bridge House
25 Dowgate Hill
London EC4R 2YA
alex.bayliss@historicengland.org.uk

Serena Cant
Historic England
Engine House
Fire Fly Avenue
Swindon SN2 2EH
serena.cant@historicengland.org.uk

Sanne Palstra
Centre for Isotope Research
University of Groningen
Nijenborgh 6
9747 AG Groningen
The Netherlands
s.w.l.palstra@rug.nl

Ruth Pelling
Historic England
Fort Cumberland
Fort Cumberland Road
Eastney
Portsmouth PO4 9LD
ruth.pelling@historicengland.org.uk

CONTENTS

Introduction	1
Radiocarbon Dating	1
Calibration	1
Discussion.....	2
References	4
Online list descriptions	6
Tables.....	7
Figures	8

INTRODUCTION

The *Rooswijk* was an eighteenth-century ship of the Dutch East India Company (*Verenigde Oostindische Compagnie*, 'VOC'), wrecked on the Goodwin Sands in January AD 1740 (Fig 1) and designated under the Protection of Wrecks Act, 1973 ([LEN 1000085](#)). The ship was outward-bound for Batavia (modern-day Jakarta) for the second time when it sunk in treacherous conditions (Dunkley 2009; van Popta 2014). Excavation of the wreck site was conducted by MSDS Marine Ltd on behalf of The Cultural Heritage Agency of the Netherlands, RCE, (on behalf of the Ministry of Education, Science and Culture) and Historic England (on behalf of the Department of Digital, Culture, Media and Sport) in 2017 and 2018. The highly mobile sea-bed environment has resulted in scattered ship debris across the area of the site, from which five coconuts were recovered during two seasons of excavation. These were not, however, directly associated with any particular context relating to the vessel.

Dating is required to establish if the coconuts were part of the cargo of the *Rooswijk*, in which case they will date from shortly before AD 1740 and potentially hail from Indonesia. If they are not associated with the *Rooswijk* they could be related to a different, more recent historic wreck or cargo loss, more likely to have been returning from the Caribbean. Alternatively, the coconuts could be modern.

RADIOCARBON DATING

Radiocarbon dating was undertaken on samples of seed testa from two waterlogged coconut shells (artefacts RK17 A00246 and RK18 A00200) by the Centre for Isotope Research, University of Groningen, the Netherlands in 2020. Each sample was pretreated using an acid-base-acid protocol (Dee *et al* 2020) and combusted in an elemental analyser (IsotopeCube NCS), coupled to an Isotope Ratio Mass Spectrometer (Isoprime 100). The resultant CO₂ was graphitised by hydrogen reduction in the presence of an iron catalyst (Aerts-Bijma *et al* 1997). The graphite was then pressed into aluminium cathodes and dated by AMS (MICADAS; Synal *et al* 2007; Salehpour *et al* 2016).

Data reduction was undertaken as described by Wacker *et al* (2010). The facility maintains a continual programme of quality assurance procedures (Aerts-Bijma *et al* 2021), in addition to participation in international inter-comparison exercises (Scott *et al* 2017). These tests demonstrate the reproducibility and accuracy of these measurements.

The results are conventional radiocarbon ages, corrected for fractionation using $\delta^{13}\text{C}$ values measured by Accelerator Mass Spectrometry (Stuiver and Polach 1977; Table 1). The quoted $\delta^{13}\text{C}$ values were measured by Isotope Ratio Mass Spectrometry, and more accurately reflect the natural isotopic composition of the sampled plant macrofossils.

CALIBRATION

Calibration of these results to accurate calendar ages is complex, since it depends on the location where the coconut palms that produced these nuts grew. Cultivated coconuts are globally distributed within the tropics (Gunn *et al* 2011) and were historically imported to northern Europe from India via Portugal or the

Mediterranean (Kennedy 2017; Fritz 1983) and increasingly from the sixteenth century onwards, the Caribbean (Laurance 2019). Eighteenth-century Dutch trading vessels could presumably also bring back coconuts from Indonesia.

The Inter-Tropical Convergence Zone (ITCZ) is an asymmetric area of low pressure around the thermal equator where the northeast and southeast trade winds converge. The ITCZ migrates on seasonal and longer timescales (Haug *et al* 2001; Schneider *et al* 2014), and plants growing within the ITCZ are potentially subjected to air masses from different hemispheres at certain times of the year (Marsh *et al* 2018; Hogg *et al* 2020). The present extent of the ITCZ, after the reconstruction of the present zonal boundaries based on wind data discussed by Hogg *et al* (2020), is shown in Reimer *et al* (2020, fig 1).

The Caribbean is clearly north of the ITCZ throughout the year, and Indonesia is clearly within the ITCZ throughout the year. If the sampled coconuts come from the Caribbean, it is appropriate to calibrate these measurements using the atmospheric calibration curve for the northern hemisphere, IntCal20 (Reimer *et al* 2020). Samples that grew within the ITCZ need to be calibrated with a mixture of the northern and southern hemispheric calibration curves, IntCal20 (Reimer *et al* 2020) and SHCal20 (Hogg *et al* 2020). Hogg *et al* (2020, 773–4) suggest a 50%:50% mixture for vegetation, like coconut palms, which grow throughout the year as they should receive northern air masses in December–February and southern air masses in June–August. In contrast, Marsh *et al* (2018, 932–3) suggest a more conservative mixture which allows for the full possible range of ¹⁴C input from 100% northern hemisphere to 100% southern hemisphere based upon geographical variations in the mixture of air masses.

The radiocarbon measurements on the two coconut shells have been calibrated using the probability method (Stuiver and Reimer 1993; Bronk Ramsey 2009), and the three different calibration datasets described above (Fig 2; Table 2). Clearly, all the probability distributions of the calibrated dates are multi-modal, allowing the possibility that the sampled coconuts grew at the very end of the seventeenth century or in the early decades of the eighteenth century, or in all but the earliest part of the nineteenth century or the first decades of the twentieth century (Fig 2).

DISCUSSION

Cultivated coconuts originate from the Old-World tropics. Genetic, geographic, and phenotypic diversity of coconuts are consistent with two centres of origin, one in the Indian Ocean, and one in the Pacific Ocean (Gunn *et al* 2011). A population was established around the Indian Ocean by 1000–500 BC, which spread westward via human agency reaching the Caribbean during the sixteenth century (Gunn *et al* 2011; Sauer 1971). A second population, based in the south-west Pacific islands, spread by natural sea born processes across the Pacific Ocean and may have reached the west coast of central America significantly prior to the arrival of Europeans (Baudouin *et al* 2009).

Coconuts were first brought to northern Europe as early as the thirteenth or fourteenth century (Kennedy 2017; Laurance 2019), where they were used for medicines and food, and the empty shells were used as, sometimes elaborate, cups. Examples of carved beakers, mounted cups and fragments of shell, are known from the Netherlands from the sixteenth to the eighteenth centuries (Rijkelijhuizen and van Wijngaarden-Bakker 2006; Manders and Kuiper 2015; <https://www.rijksmuseum.nl/>), and from Britain from as early as the thirteenth or fourteenth century (Campbell, 2002, 127–8, n. 4; Kennedy 2017), and more commonly in the fifteenth to nineteenth centuries (Kennedy 2017; Laurance 2019;

<https://collections.vam.ac.uk/>). By the time the *Rooswijk* was in operation, coconuts would have been available from the Caribbean, the Indian Ocean, and the south-west Pacific Ocean islands. Twelve shipwrecks in the Historic England Research Records database from AD 1763 onwards reference coconuts (or cocoanuts) as cargo, all being homeward bound, mostly returning from the Caribbean, with two dating from 1939 returning from the Far East (Historic England Research Records accessed 2020 and 2022; Larn and Larn 1995). In AD 1889, the Norwegian barque, *Ala*, returning from Jamaica and carrying a cargo of coconuts amongst other goods, was burnt off the North Sand Head, some 4km to the north-northwest of the site of the *Rooswijk* wreck; rigging and coconuts were found floating in the sea ([Historic England Research Records 881477](#)).

The *Rooswijk* was outward bound, on its second voyage to Indonesia when it sunk on the Goodwin Sands (MSDS Marine Ltd 2017; van Popta 2014). It would, therefore, be hard to explain how the coconuts would be part of its cargo, but if they had, it would be reasonable to assume they derived from Indonesia. The Dutch East Indies company were trading regularly and directly to Indonesia along the Brouwer route, a southerly route that by-passed Madagascar and any Indian or Sri Lankan ports (Parthesius 2010). If the coconuts were part of the cargo of the *Rooswijk*, and derived from Indonesia, then the radiocarbon dating suggests that they would have had to have been a decade or two old when the vessel sank. As there is no evidence that these shells had been mounted as objects, this seems unlikely. In contrast, if the coconuts come from the Caribbean, the source of most imported coconuts recorded from wreck sites in British waters, then the calibrated radiocarbon dates are clearly compatible with them coming from the cargo spillage off the Goodwin Sands in AD 1889. We suggest that the latter interpretation is the more plausible.

REFERENCES

- Aerts-Bijma, A T, Meijer, H, and van der Plicht, J, 1997 'AMS sample handling in Groningen', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, **123**, 221–5 ([https://doi.org/10.1016/S0168-583X\(96\)00672-6](https://doi.org/10.1016/S0168-583X(96)00672-6))
- Aerts-Bijma, ATh, Paul, D, Dee, MW, Palstra, SWL, and Meijer, HAJ, 2021 'An independent assessment of uncertainty for radiocarbon analysis with the new generation high-yield Accelerator Mass Spectrometers', *Radiocarbon*, **63**, 1–22 (<https://doi.org/10.1017/RDC.2020.101>)
- Baudouin, L, and Lebrun, P, 2009 'Coconut (*Cocos nucifera* L.) DNA studies support the hypothesis of an ancient Austronesian migration from Southeast Asia to America', *Genetic Resources and Crop Evolution*, **56**, 257–62 (<https://doi.org/10.1007/s10722-008-9362-6>)
- Bronk Ramsey, C, 2009 'Bayesian analysis of radiocarbon dates', *Radiocarbon*, **51**, 37–60 (<https://doi.org/10.1017/S0033822200033865>)
- Campbell, M 2002 'Medieval founders' relics: royal and episcopal patronage at Oxford and Cambridge colleges' in Coss, P and Keen, M (eds) *Heraldry, Pageantry and Social Display in Medieval England*, Woodbridge: The Boydell Press, 125-142
- Dee, M W, Palstra, S W L, Aerts-Bijma, A T, Bleeker, M O, de Bruin, S, Ghebru, F, Jansen, H G, Kuitens, M, Paul, D, Richie, R R, Spriensma, J J, Scifo, A, von Zonneveld, D, Verstappen-Dumoulin, B M A A, Wietzes-Land, P, and Meijer, H A J, 2020 'Radiocarbon dating at Groningen: new and updated chemical pretreatment procedures', *Radiocarbon*, **62**, 63–74 (<https://doi.org/10.1017/RDC.2019.101>)
- Dunkley, M, 2009 *Rooswijk, Goodwin Sands, off Kent Conservation Statement & Management Plan*. English Heritage, Swindon
- Fritz, R, 1983 *Die Gefäße aus Kokosnuß in Mitteleuropa, 1250–1800*, Mainz am Rhein: Phillip von Zabern
- Gunn, B F, Baudouin, L, and Olsen, K M, 2011 'Independent Origins of Cultivated Coconut (*Cocos nucifera* L.) in the Old World Tropics', *PLoS ONE* **6(6)**: e21143. (<https://doi:10.1371/journal.pone.0021143>)
- Haug, G H, Hughen, K A, Sigman, D M, Peterson, L C, and Röhl, U, 2001 'Southward migration of the Intertropical Convergence Zone through the Holocene', *Science*, **293**, 1304–8 (<https://www.doi.org/10.1126/science.1059725>)
- Hogg, A G, Heaton, T J, Hua, Q, Palmer, J, Turney, C, Southon, J, Bayliss, A, Blackwell, P G, Boswijk, G, Bronk Ramsey, C, Petchey, F, Reimer, P J, Reimer, R, and Wacker, L, 2020 SHCAL20 'Southern Hemisphere calibration, 0-55,000 years cal BP', *Radiocarbon*, **62**, 759–78 (<https://doi.org/10.1017/RDC.2020.59>)
- Kennedy, K E, 2017 'Gripping it by the husk: the medieval English coconut', *The Medieval Globe*, **3(1)**, 1–25. *Project MUSE* muse.jhu.edu/article/758503.
- Larn, R, and Larn, B, 1995 *Shipwreck Index of the British Isles Vol.2 Hampshire, Isle of Wight, Sussex, Kent (Mainland), Kent (Downs), Goodwin Sands, Thames*, London, Lloyd's Register of Shipping

Laurance, R 2019 *Coconut: How the Shy Fruit Shaped our World*, Stroud: The History Press

Manders, M, and Kuijper, W, 2015 'Shipwrecks in Dutch waters with botanical cargo or victuals', *Analecta Praehistorica Leidensia*, **45**, 141–73

Marsh, E J, Bruno, M C, Fritz, S C, Baker, P, Capriles, J M, and Hastorf, C A, 2018 'IntCal, SHCal, or a mixed curve? Choosing a ^{14}C calibration curve for archaeological and paleoenvironmental records from tropical South America', *Radiocarbon*, **60**, 925–40 (<https://doi.org/10.1017/RDC.2018.16>)

MSDS Marine Ltd 2017, *Rooswijk Protected Wreck Site, Goodwin Sands: Archaeological Excavation and Preservation Project Design*, unpublished Project Design prepared for Rijksdienst voor het Cultureel Erfgoed and Historic England

Parthesius, R, 2010 *Dutch Ships in Tropical Waters: the Development of the Dutch East India Company Shipping Network in Asia 1595–1660*, Amsterdam: Amsterdam University Press (<https://archive.org/details/dutchshiptropic00part>)

Rijkelijkhuisen, M, and van Wijngaarden-Bakker, L, 2006 'Nuts in the Netherlands: *Attalea* and other nuts from archaeological contexts, dating from the 16th to 19th century AD', *Environmental Archaeology*, **11**, 246–51 (<https://doi.org/10.1179/174963106x123241>)

Reimer, P J, Austin, W E N, Bard, E, Bayliss, A, Blackwell, P, Bronk Ramsey, C, Butzin, M, Cheng, H, Edwards, R L, Friedrich, M, Grootes, P M, Guilderson, T P, Hajdas, I, Heaton, T J, Hogg, A G, Hughen, K A, Kromer, B, Manning, S W, Muscheler, R, Palmer, J G, Pearson, C, van der Plicht, J, Reimer, R W, Richards, D A, Scott, E M, Southon, J R, Turney, C S M, Wacker, L, Adolphi, F, Büntgen, U, Capano, M, Fahrni, S, Fogtmann-Schultz, A, Friedrich, R, Kudsk, S, Miyake, F, Olsen, J, Reinig, F, Sakamoto, M, Sookdeo, A, and Talamo, S, 2020 'The IntCal20 Northern Hemispheric radiocarbon calibration curve (0–55 kcal BP)', *Radiocarbon*, **62**, 725–57 (<https://doi.org/10.1017/RDC.2020.41>)

Salehpour, M, Håkansson, K, Possnert, G, Wacker, L, and Synal, H-A, 2016 'Performance report for the low energy compact accelerator mass spectrometer at Uppsala University', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, **371**, 360–4 (<https://doi.org/10.1016/j.nimb.2015.10.034>)

Sauer, J D, 1971 A re-evaluation of the coconut as an indicator of human dispersal, in Riley, C L, Kelley, J C, Pennington, C W, and Rands, R L (eds) *Man across the sea: Problems of Pre-Columbian Contacts*, Austin: University of Texas Press, 309–19

Schneider, T, Bischoff, T, and Haug, G H, 2014 'Migrations and dynamics of the Intertropical Convergence Zone', *Nature*, **513**, 45–53 (<https://doi.org/10.1038/nature13636>)

Scott, E M, Naysmith, P, and Cook, G T, 2017 'Should archaeologists care about ^{14}C intercomparisons? Why? A summary report on SIRI', *Radiocarbon*, **59**, 1589–96 (<https://doi.org/10.1017/RDC.2017.12>)

Stuiver, M, and Polach, H A, 1977 'Reporting of ^{14}C data', *Radiocarbon*, **19**, 355–63 (<https://doi.org/10.1017/S0033822200003672>)

Stuiver, M, and Reimer, P J, 1993 'Extended ^{14}C data base and revised CALIB 3.0 ^{14}C age calibration program', *Radiocarbon*, **35**, 215–30
(<https://doi.org/10.1017/S0033822200013904>)

Synal, H A, Stocker, M, and Suter, M, 2007 'MICADAS: a new compact radiocarbon AMS system', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, **259**, 7–13
(<https://doi.org/10.1016/j.nimb.2007.01.138>)

van Popta, Y T, 2014 *Management Plan: The Rooswijk*, Dutch Cultural Heritage Agency Report

Wacker, L, Christl, M, and Synal, H A, 2010 'Bats: A new tool for AMS data reduction', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, **268**, 976–9
(<https://doi.org/10.1016/j.nimb.2009.10.078>)

Online list descriptions

Historic England Research Record entry 1000085, Rooswijk,
<https://historicengland.org.uk/listing/the-list/list-entry/1000085>
(accessed 8th September 2022)

Historic England Research Record entry 881477, Ala
https://www.heritagegateway.org.uk/Gateway/Results_881477
(accessed 2020 and 8th September 2022)

TABLES

Table 1: Radiocarbon measurements and associated stable isotope values from the two coconut shells recovered in the vicinity of the wreck of the *Rooswijk*

Laboratory Number	Sample and context details	Radiocarbon Age (BP)	$\delta^{13}\text{C}_{\text{IRMS}}$ (‰)
GrM-22140	<i>Cocos nucifera</i> seed testa from one of five coconut shells recovered from the mobile seabed within the wreck debris of the <i>Rooswijk</i> vessel on the Goodwin Sands in 2017–18 (artefact RK18 A00200)	108±24	-27.84±0.15
GrM-22141	<i>Cocos nucifera</i> seed testa from one of five coconut shells recovered from the mobile seabed within the wreck debris of the <i>Rooswijk</i> vessel on the Goodwin Sands in 2017–18 (artefact RK17 A00246)	119±24	-25.91±0.15

Table 2: Calibrated radiocarbon dates of the radiocarbon measurements from the two coconut shells recovered in the vicinity of the wreck of the *Rooswijk*, if derived from Jamaica (*IntCal20*) or Indonesia (50%:50% (*Hogg et al 2020*) or 0–100% (*Marsh et al 2018*) mixture of *IntCal20* and *SHCal20*)

	GrM-22140	GrM-22141
	95% probability	95% probability
Jamaica (<i>IntCal20</i>)	1685–1733 cal AD (25%) or 1805–1928 cal AD (70%)	1683–1738 cal AD (25%) or 1755–1761 cal AD (1%) or 1801–1939 cal AD (69%)
Indonesia <i>Marsh et al (2018)</i>	1692–1728 cal AD (20%) or 1809–1927 cal AD (75%)	1689–1730 cal AD (21%) or 1808–1931 cal AD (73%) or 1934–1941 cal AD (1%)
Indonesia <i>Hogg et al (2020)</i>	1694–1727 cal AD (20%) or 1810–1926 cal AD (75%)	1690–1729 cal AD (22%) or 1808–1930 cal AD (73%)

FIGURES

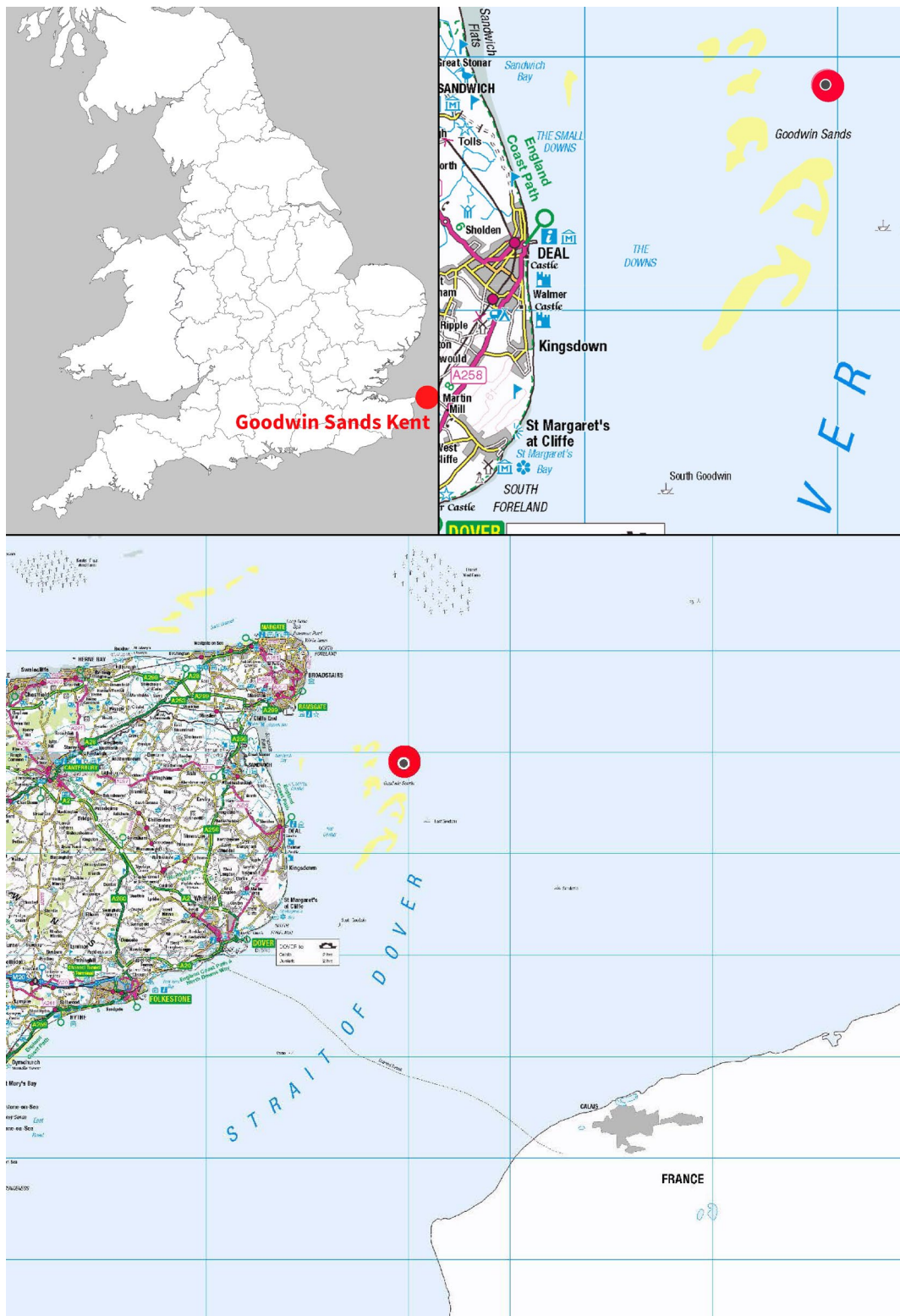
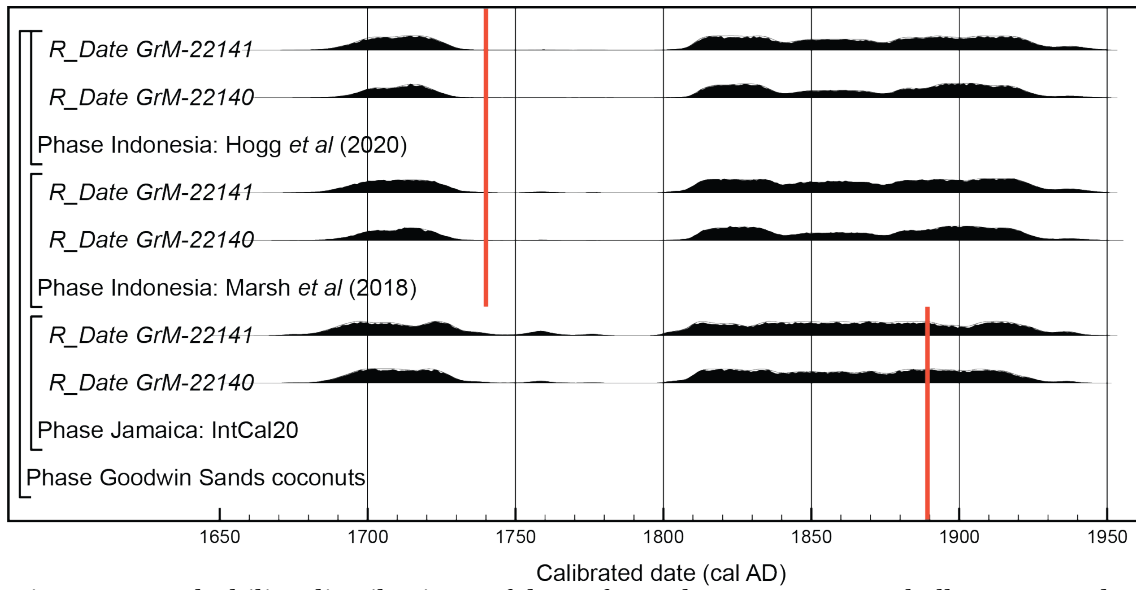


Figure 1: Maps to show the location of Rooswijk on the Goodwin Sands off the coast of Kent, South East England, marked in red. Scale: top right 1:200,000, bottom 1:500,000 © Crown Copyright and database right 2023. All rights reserved. Ordnance Survey Licence number 100024900



*Figure 2: Probability distributions of dates from the two coconut shells recovered on the Goodwin Sands in the vicinity of the wreck of the Rooswijk, if derived from Jamaica (IntCal20) or Indonesia (50%:50% (Hogg *et al* 2020) or 0-100% (Marsh *et al* 2018) mixture of IntCal20 and SHCal20). The red lines indicate the sinking of the Rooswijk in AD 1740 and the spillage from the Norwegian vessel in AD 1889.*



Historic England Research and the Historic Environment

We are the public body that looks after England's historic environment. We champion historic places, helping people understand, value and care for them.

A good understanding of the historic environment is fundamental to ensuring people appreciate and enjoy their heritage and provides the essential first step towards its effective protection.

Historic England works to improve care, understanding and public enjoyment of the historic environment. We undertake and sponsor authoritative research. We develop new approaches to interpreting and protecting heritage and provide high quality expert advice and training.

We make the results of our work available through the Historic England Research Report Series, and through journal publications and monographs. Our online magazine Historic England Research which appears twice a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities.

A full list of Research Reports, with abstracts and information on how to obtain copies, may be found on www.HistoricEngland.org.uk/researchreports

Some of these reports are interim reports, making the results of specialist investigations available in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation.

Where no final project report is available, you should consult the author before citing these reports in any publication. Opinions expressed in these reports are those of the author(s) and are not necessarily those of Historic England.

The Research Reports' database replaces the former:

Ancient Monuments Laboratory (AML) Reports Series
The Centre for Archaeology (CfA) Reports Series
The Archaeological Investigation Report Series and
The Architectural Investigation Reports Series.