

PART 7

Fieldwork

'The physical remoteness of the site and its extreme unattractiveness, compounded by mud, ooze, rising water, and all too attentive clegs (small horseflies), only served to enhance the morale of the party. Under such conditions concentration on the job was the only way out.'

(Clark 1972, 10–18)



CHAPTER 15

Methods, Aims and Objectives

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Introduction

The fieldwork methods were, by necessity, reflexive, evolving over time, as the results from one season went on to inform the strategy that was adopted in the following year. The fieldwork strategy and methodology were enhanced further by the close working relationship that was established with the specialists who worked on the project, many of whom had become an integral part of the excavation team by 2013, and some considerably earlier. From 2013–2015, drawing on the experiences of the previous phase of work, many of the specialists that would be involved in the post-excavation analysis were on site throughout each season and worked in an on-site laboratory (Figure 15.1). They also took a lead role in the excavations: this included the project zooarchaeologist, and the antler, wood and flint specialists. Detailed methodologies for the collection of samples and materials were provided by the other relevant specialists who provided training for members of the excavation team and regularly visited the site.

This approach has had several important benefits for the project. First, it meant that material was excavated and recorded either by the relevant specialist or under their direct supervision, which ensured that all necessary data was collected on site and that the specialist was already familiar with the material prior to post-excavation analysis. Second, material that might be damaged through the process of excavating it could be recorded in situ and then lifted by specialists. Third, it meant that recording and sampling strategies for specific deposits or assemblages, grounded in both specialist knowledge and prior experience, could be quickly and effectively established on site. Finally, the integration of specialists within the excavation team allowed them to share knowledge and experience with other site staff. This helped to create a confident, well-informed and highly motivated excavation team, who could provide considerable assistance to the specialists. Altogether, this reflexive approach was to prove invaluable during the excavations given the large quantities of worked wood and faunal material encountered in the wetland areas.

Figure 15 (page 1): Maisie Taylor and Michael Bamforth recording wood on site (Copyright Star Carr Project, CC BY-NC 4.0).

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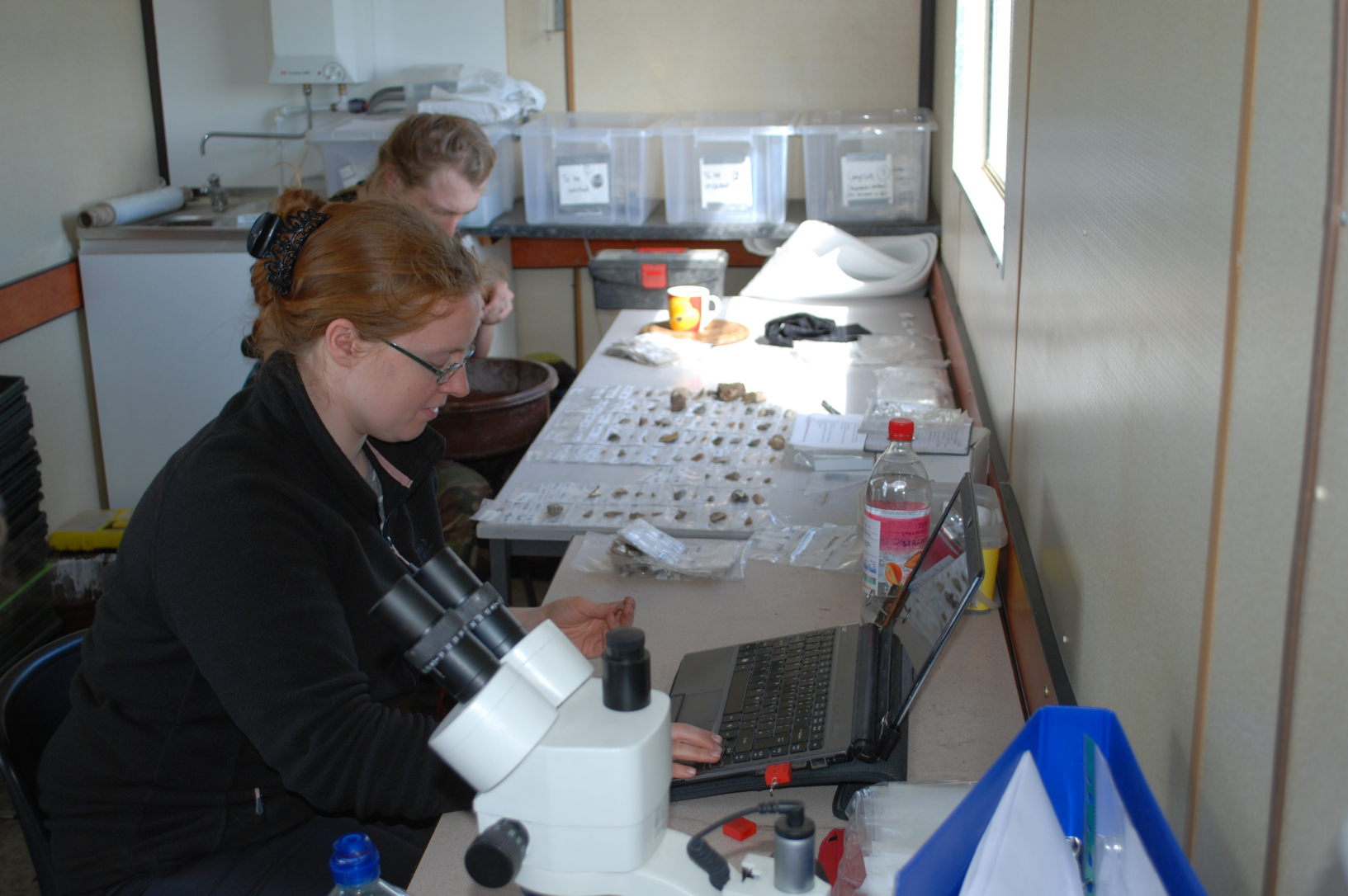


Figure 15.1: Analysis being conducted in one of the on-site laboratories by Charlotte Rowley (Copyright Star Carr Project, CC BY-NC 4.0).

The project design for the second phase of excavation, written in 2011 for the European Research Council grant, and for English Heritage, aimed at going beyond ‘state-of-the-art’ and implementing a range of methods that could aid in mapping activity areas across the site of Star Carr through time. This involved the integrated analyses of, for example, 3D plotting of all finds and examination of artefacts and ecofacts using ‘forensic approaches’ such as geochemistry, microwear and residue analysis.

This chapter first sets out the aims and objectives for the work at Star Carr. It then presents the main methods used on site for collecting data and the approach taken for sampling sediments. In most cases, post-excavation methods are provided in individual chapters; however, some methods have been applied in several chapters and so are reported here to avoid repetition. Project designs, assessment reports and specialist reports are archived in the Archaeological Data Service (<https://doi.org/10.5284/1041580>).

Aims and objectives

The principal aim of the phase 2 investigations, as part of the Historic England and European Research Council funded POSTGLACIAL project, has been to implement an interdisciplinary, high-resolution approach to understanding hunter-gatherer lifeways within the context of climate and environment change during the early part of the postglacial period (c. 9600–8000 cal BC), with five major objectives:

1. To push forward the frontiers of knowledge of postglacial archaeology;
2. To conduct high-resolution, multi-proxy analyses of climatic and environmental change;

3. To set a new benchmark for the analysis of archaeological deposits by developing an integrated 'forensic' approach to the analysis of the artefactual and molecular debris left by human activity;
4. To integrate climate signals with environmental change and human activity;
5. To identify and implement best practice for improving public understanding of the Mesolithic period and Star Carr and to ensure long term public benefit.

Climate and environmental change

Key questions:

- What is the climatic and environmental sequence from the Younger Dryas to the mid Holocene in this region?
- Can we detect and define a chronologically high-resolution temperature signal for abrupt environmental signals seen in ice core records within the palaeo-lake records?
- Can we link this to local environmental responses such as open grassland and birch woodland, and if so, how does this link with human occupation at Star Carr?

Objectives:

- To produce two deep master records for the lake covering the Holocene and Lateglacial;
- To examine palaeoenvironmental change through the analysis of pollen, plant macrofossils and geolithology;
- To determine lake hydrology and palaeoclimate through lake analysis of carbonates, carbonate-clays and oxygen isotopes;
- To estimate palaeotemperature through the examination of chironomid fossils;
- To determine chronology from microtephra analyses, radiocarbon dating and Bayesian age modelling;
- To link results with the archaeological record.

Spatial and temporal mapping of occupation activities at Star Carr

Key questions:

- What is the spatial patterning of activities and occupation on the dryland?
- What types of structures can be found on the dryland and what was their function?
- How are the flint tools and debris distributed?
- What were the tools used for and what is the relationship between tool form and function?
- What other 'invisible' activity areas can be detected?
- How was the timber platform/trackway constructed and what was its function?
- How do temporal changes in activity relate to changing climate and local environmental conditions?
- What is the nature of the relationship between the dryland and the lake shore activities?

Objectives:

- To ground-truth geophysical anomalies on the dryland and to determine whether other structures exist;
- To use forensic approaches for reconstructing the cultural biography of the stone and organic tools through the microwear and residue analysis;
- To examine the patterning of micro-debris (bone chips, flint flakes, burnt flint, etc);
- To distinguish discrete episodes of human activity through geochemical survey and micromorphology of the sediments;
- To conduct fine-resolution palaeoenvironment analysis;
- To sample for microtephra in order to link with climatic records from the lake sequence;
- To excavate the extent of the timber platform;

- To create a 3D model of activities across the excavated area;
- To continue to interrogate the degradation processes.

Public benefit

Key questions:

- In what ways is the Mesolithic presented to the public in Britain?
- In what ways is the Mesolithic presented to the public in other European countries, particularly Denmark?
- Which methods of presenting the past are best applicable to the Mesolithic?
- Which aspects of Mesolithic lifeways are more likely to engage a public audience?
- How effective are different types of outreach activities?

Objectives:

- To investigate the ways in which Mesolithic research is best communicated in Europe;
- To devise and put in place a comprehensive outreach strategy for the entire course of the archaeological excavation;
- To engage a wide range of groups including local school children, local societies and national and international audiences through the media;
- To measure the impact of activities on public value;
- To raise the profile of the Mesolithic period, both locally in the Vale of Pickering and nationally.

Field methods

Survey

Throughout the project all surveying was undertaken using Leica TC407 and Leica TS02 total stations set up on a network of fixed points that had been tied into the British Ordnance Survey grid using a Leica System 500 GPS using realtime kinematic correction (10–20 mm precision). This allowed all spatial data (including the locations of finds, planning points, section nails, spot heights, trench edges, samples etc) to be collected using a common coordinate system. Each survey point was coded with a unique numeric identifier, a brief description (e.g. Find, Spot Height, Sample etc) and the relevant identifier for the point being taken (e.g. Find or Sample Number). The survey records were then linked to the various specialist databases and the combined data managed using ArcGIS. All final registers are archived in the Archaeological Data Service (<https://doi.org/10.5284/1041580>).

The basal topography of the area around the site, and the sequence of deposits that had formed over it, was recorded by augering, using a 25 mm diameter gouge auger. The dryland areas and lake margins were mapped at 10 m intervals, and two long transects were recorded into the deeper parts of the Star Carr embayment. The character of each deposit and its depths from the modern ground surface was recorded by hand, and the three-dimensional location of the auger point was recorded using the total station. The data for the heights of the basal topography were added to the results of auger surveys carried out by the Seamer Carr Project and the Vale of Pickering Research Trust at sites in the surrounding area (Lane & Schadla-Hall forthcoming) and more surveys of Flixton School House Farm and the eastern end of the lake basin (Taylor 2012). This was then processed in ArcGIS to produce a Digital Terrain Model and contour maps for the site and the surrounding area. Geomagnetic and resistance surveys were conducted in 2009 and 2010 (as reported in Chapter 16).

Excavation

All trenches on the dryland were de-turfed by hand, and then excavated by trowel, due to the presence of worked flint within the topsoil and peat. This was carried out in controlled, single-surface excavation of c. 20 mm

spits; however, where sedimentological boundaries were evident these were followed. The only exceptions were the parts of the site where redeposited sand and gravel, dredged from the River Hertford, had been dumped onto the old topsoil. This deposit was removed by a mechanical excavator under archaeological supervision, down to the level of the buried topsoil, which was then hand excavated as with other trenches on the dryland. Excavation continued into the basal, mineral substrate until no finds were recorded in five successive spits.

Between 2004–2007, the wetland trenches were de-turfed and excavated entirely by hand; the topsoil and upper humified peats removed by careful shovelling, the lower peats excavated by trowel. By 2008 it was clear that there were no finds within the upper peats, and after this date these deposits were removed by mechanical excavator under archaeological supervision. As with the dryland areas, the lower peats were excavated over a single, flat surface until a new context boundary was encountered. The context was then exposed in full before excavation continued.

Each context was given a unique number. Detailed sediment descriptions were undertaken of all contexts encountered, and context descriptions were written on a pro forma context record sheet. Mineral sediments were described on the basis of their principal grain size (gravel, coarse sand, fine sand, silt and clay, or combinations thereof), sorting (well sorted to poorly sorted) and inclusions (material forming less than 10% of the deposit), following the procedures outlined in the MoLAS handbook (Museum of London Archaeology Service 1994). From 2010 the recording of the wetland deposits followed a simplified, longhand version of the Troels-Smith method (1953). All cut features were recorded in plan, half sectioned, and the section was hand drawn at an appropriate scale. Plans were drawn in relation to planning points that were recorded three dimensionally using the total station. Likewise, all section datum points were recorded using the total station. Registers for contexts, drawings, samples, photographs, levels and recorded finds were kept on recording sheets. All records were entered into Excel spreadsheets during each season and checked in post-excavation.

Finds recording on site

Protocol

All wood, bone and antler was excavated using wooden tools to avoid damage. All finds from stratified contexts were bagged as an individual find with a unique number (using pre-printed labels and pre-written bags) and tagged in the ground for recording using the total station (Figure 15.2).

Lithics

Lithics found whilst removing or sieving topsoil were bagged by grid square, as was flint spall (small flint chips smaller than 10 mm). For all lithic material, excavators were asked to minimise the amount of handling the object encountered as this can potentially be damaging to the surface of the object, which can cause problems for microwear analysis. Lithics were washed as soon as possible to ensure that the sediment did not adhere, and as carefully as possible using clean water and fingertips rather than brushes, again to avoid damage. Hundreds of lithics were collected on site for residue analysis. Each lithic for residue analysis was not touched but lifted out of the ground by inserting the trowel into the deposit below the flint and levering the flint and adhering soil into a finds bag. In a separate bag, c. 5 g of the surrounding matrix was sampled. The lithics and soils were kept in cold storage prior to analysis. A sample of the lithics was selected for microscopic and chemical residue analyses, choosing artefacts with a high likelihood of containing anthropogenic residues, but also representing all major typological categories.

Wood

Assemblages of worked wood were excavated under the supervision of the wood specialists, MT and MB. All wood encountered was hand excavated using fingertip techniques and non-metal implements; usually wooden clay modelling tools. The excavation and analysis was carried out in accordance with Historic England



Figure 15.2: Tagging flint and recording it using a total station (Copyright Star Carr Project, CC BY-NC 4.0).

guidelines for the treatment of waterlogged wood (Brunning and Watson 2010) and recommendations made by the Society of Museum Archaeologists (1993) for the retention of waterlogged wood. Each discrete item was recorded individually using a pro forma wood recording sheet, based on the sheet developed by Fenland Archaeological Trust for the post-excavation recording of waterlogged wood. Every effort was made to refit broken or fragmented items. However, due to the nature of the material, the possibility remains that some discrete yet broken items may have been processed as their constituent parts as opposed to as a whole. The system of categorisation and interrogation developed by Taylor (1998a; 2001) has been adopted for the work reported in this volume.

Where possible, discrete structures and accumulations of wood were revealed fully in plan. Extensive root scatters were present along much of the lake edge, particularly in the base of the wood peat. Where present these were roughly revealed, sub-sampled and removed. Where in situ tree boles were encountered, these were individually recorded and located. All excavated wood was assigned a unique finds number and 3D located.

All extensive spreads and discrete structures were photographed and 3D models were produced using Agisoft Photoscan Pro. This was generally undertaken using DSLR cameras mounted on a tripod or an extendable pole, the exception to this being the eastern platform which was modelled by Dominic Powlesland using a drone-mounted compact digital camera. In addition, all spreads and structures were hand planned at 1:10. Prior to the 2014 season this was undertaken using planning points, hand tapes and planning frames. During the 2014 and 2015 seasons orthophotos were printed out at 1:10 and used as an underlay to produce a hand-drawn plan on site.

The wood was recorded by MT and MB, using a three-stage 'triage' system of data selection (Table 15.1). This concentrated the recording, sub-sampling and retention/discard process at the point of excavation. The metric

Type	Method	Location	Retained?	Information	Criteria	Aims	Typical Item
Basic	wood sheet	on site	sub-sample and discard	metric and conversion data	poor condition and/or no toolmarks or evidence for nature of woodworking	to provide data for statistical analysis of woodworking assemblage	roundwood
Full	wood sheet	on site	may be retained	metric, conversion and surface data	moderate condition and/or evidence for nature of woodworking	as above and to inform in terms of woodworking techniques	worked timber
Enhanced	wood sheet and illustration	on site and lab	retained for cleaning and further analysis	metric, conversion and surface data	good condition and/or toolmarks or evidence for nature of woodworking	as above and to inform in terms of woodworking techniques	heavily worked timber or artefact

Table 15.1: Details of three-stage ‘triage’ recording system.

data were measured with hand tools including rulers and tapes. The tool marks were measured using a profile gauge. All recorded items were sub-sampled to allow later identification to taxa via microscopic identification as necessary.

The rapid degradation of waterlogged wood of this antiquity when removed from the burial environment necessitated a rapid workflow. Several exceptions were made to the standard recording process. Where extensive spreads of natural roundwood were present, these were characterised and recorded via a c. 10% subsample. Where diffuse scatters of natural roundwood were encountered throughout deposits these were also subjected to characterisation and a c. 10% sub-sample was recorded in detail. Finally, the extensive layer of brushwood located around the western end of the western timber platform was subjected to rapid recording whereby each item was recorded only in terms of diameter, condition and presence/absence of bark.

Faunal remains

During the 2007 and 2008 seasons on the dryland some of the particularly friable faunal remains were lifted within small blocks of sediment for further cleaning in the laboratory. However, the sediment tended to turn to a concrete-like consistency which became virtually impossible to remove at a later date, even in conservation. Therefore, from 2013, where faunal remains were encountered on the dryland, the surrounding sediments were cleaned down to the base of the specimen to reveal the full extent of the remains. They were then assessed and recorded, i.e. identifications made where possible, by a zooarchaeologist or antler specialist and photographed. The specimen was then plinthed before lifting. Very poorly preserved specimens were covered in cling film and then several layers of wetted, plaster impregnated bandages, before being left to dry, and then lifted (Figure 15.3). In some cases wooden skewers were used within the bandages to strengthen them. In order to lift the specimens, they were undercut with a thin sheet of steel or a stiff plastic sheet and inverted onto its supportive mould. It was then left to completely harden in the on-site finds laboratory before removing the soil from the newly exposed underside and placing the whole mould into a storage bag, or a box with a bag round it. The bag was pierced several times to allow the specimen to breathe to avoid condensation and the build-up of mould.



Figure 15.3: Dryland bone being covered in plaster impregnated bandages by Becky Knight (Copyright Star Carr Project, CC BY-NC 4.0).

Faunal remains from the wetland were cleaned and recorded in situ before lifting, but generally did not need the plaster bandages because they were more robust. Because they were waterlogged they were bagged with some water from the trench and then stored in a refrigerator or cold store room.

In the laboratory, specimens were carefully washed using water, and specimens that had been excavated from the dryland were dry brushed using a very soft silicon brush. The waterlogged specimens were retained in bags of water and kept in the refrigerator or cold store. At various intervals, the water within the bags was discarded and exchanged with clean tap water so that the high levels of acid encountered within the specimens could be flushed away in an attempt to minimise further demineralisation.

Sieving and flotation strategy

Artefact retrieval

The sieving strategy on the dryland evolved through phase 1 as different types of context were encountered. Excavation spoil was sieved through a 4 mm mesh by grid square, employing a sampling strategy of one bucket in two, or sometimes one in three or four depending on the nature of the sediment and the density of finds. The backfill from Clark's trench was dry sieved in 2007 and 2010 in order to look for discarded artefacts or ecofacts but with very little success, and the artefacts which were found were fairly large bones or flint which had generally been dumped in a discrete area (Chapters 7 and 8). In addition, features and areas of interest (e.g. around artefact spreads such as flint or antler and in Clark's baulk) were 100% bulk sampled where possible for

flotation. Random samples for flotation were also taken across the site on several occasions, particularly when the dryland Mesolithic land surface began to emerge (see Chapter 32). In all cases the residues as well as the flot were sorted for the retrieval of, for example, microdebitage and microfauna as well as charred palaeobotanical remains (results in Chapters 7, 8 and 32).

During the first phase of fieldwork there was some controversy as to whether the methods of excavation employed on the site, and particularly in the wetland, would pick up small and delicate finds e.g. small or broken beads, microfaunal remains especially teeth, amber, fish bones, leather clothing, containers, fragments of string, thong or twine, traces of mastic for hafting tools or remnants of woven textiles. In response, two methods were tested: block lifting of sediment and wet sieving.

In 2007 a block of sediment was lifted from SC24, measuring approximately 0.6 m square and 0.5 m in height. The excavation was carried out at the University of York by PH under the supervision of NM. The sediment was removed in spits of c. 10 mm thickness and 53 layers were excavated in total. Overall the excavation took over 20 working weeks to complete and no data was recovered that had not been recovered by other means within the trench (Hadley et al. 2010). One of the key arguments against using this method again was that the sediments had become so susceptible to oxidation that excavating them slowly in a laboratory was creating further extensive damage. In addition, the kinds of materials that were found in the block could have been found through other methods, including excavation in the field and flotation. There was also clear evidence that the damage from cutting the block distorted the metrical data for wood needed for statistical analysis. Finally, the reduction of the site to small blocks obscures the more extensive pattern of deposition, which has since proved crucial in the interpretation of how and why the material was originally deposited.

In 2010, wet sieving was carried out for trowelled sediment from all trenches by collecting buckets of spoil (Figure 15.4). Column samples were also taken in blocks from SC24, VP85A and SC33. Here blocks of sediments were removed and carefully disaggregated at the sieves. Peat is a very difficult material to pass through sieves; it has variable buoyancy, individual clasts absorb and release water very slowly and the clasts are often fairly durable and do not break down in water in the way a concretion of mineral soil will. Sample processing, therefore, requires a great deal of manual disaggregation. This took place in tank 1. The division of the samples into >20 mm, 20–10 mm and 10–4 mm fractions took place in tank 2. The careful manual disaggregation of the sediment provided the opportunity to look for any unusual and fragile material. The speed of the manual disaggregation of a sample was very variable, depending on the nature of the sediment, the excavator, the sievers and conditions (e.g. weather and light levels). The tank fitted with a 1 mm mesh was also significantly slower than the one with a 2 mm mesh. The less-experienced sievers tended to be over-cautious and thus much material was retained that the specialists subsequently deemed natural or undiagnostic.

The initial plan to sieve 50% of the excavated sediment was reduced to 33% after the first day of processing and 25% halfway through the second day because of the time-intensive nature of the activity. An exception to this was made for the flint scatter encountered in SC33 from which 100% of the excavated material was sieved.

Chemical disaggregators are used by many environmental archaeologists, particularly in the processing of heavy clay soils. Tests were run to see whether the addition of sodium phosphate affected the processing or results from one of the column samples. Half the divided sample was soaked for approximately 72 hours in water and the other half in a 4% sodium phosphate solution. No significant differences were noted in the ease or speed of processing.

Of the 12 column samples the sieve teams examined, possible finds from 11 of the samples were retained for specialist analysis; however, on examination none of them turned out to be of archaeological value (e.g. natural pieces of wood as opposed to wood chips). From the 141 spoil samples processed there were three types of finds: flint, worked wood and charcoal. The sievers produced 99 possible finds but the specialists reduced the overall number of finds to 30, most of which was flint which came from a scatter in trench SC33 and could have been sieved using conventional methods much more quickly and efficiently. The five pieces of charcoal found in the sieve are not particularly useful out of context and it was deemed more sensible to hand-pick these on site and 3D locate them. Importantly, fragments of potentially worked wood in the samples were far less informative than those recovered in the trenches; this is due to the loss of spatial information but also because even the gentlest sieving abraded key surfaces. It was agreed with English Heritage/Historic England that wet-sieving (using a 4 mm mesh) would be limited to areas where flint scatters are present or where the deposits were observed as being different to those previously excavated.



Figure 15.4: Wet sieving. From left to right: Keith Emerick (English Heritage/Historic England), James Rackham and Pat Hadley (Copyright Star Carr Project, CC BY-NC 4.0).

Palaeoenvironmental sampling

Contiguous sequences of samples were taken for insect and plant macrofossils through the entire sequence of wetland deposits at three locations in order to establish the character of the local environment throughout the period the site was occupied. Shorter and less complete sets of samples were taken from deposits containing significant assemblages of archaeological material to provide more information on the local environmental context (see Chapter 19). In addition, 75 centimetres of sediment were recovered in aluminium alloy monolith tins from the exposed section from SC24 in 2010 for pollen analysis which further demonstrated degradation of the deposits and which has been published elsewhere (Albert et al. 2016).

Carbonised plant material

In order to sample all archaeological features with strong potential for the recovery of charred remains, a sampling strategy and flotation programme was adopted following English Heritage/Historic England guidelines (Campbell et al. 2011), supervised by BT and AR. In total 411 bulk samples were taken and 172 charcoal fragments were handpicked (Chapter 32). Sampling was undertaken on the deposits from archaeological features (fills of pits and postholes), sediments containing dense scatters of lithic material and spot-checks across the dryland part of the site (Peterson 2009). In each case, bulk samples were taken during the excavations of the archaeological feature or finds scatters and stored in sample bags or sealed tubs.

Soil samples that were below four litres in volume were sieved using the bucket flot method, to maximise the recovery of remains: 1) the entire sample is placed in a small bucket, 2) warm water is then added to the sample, 3) it is allowed to sink into the soil, and a gentle swirling movement is then applied and in this way the sample is gently washed over a 0.3 mm sieve, allowing charred remains to be collected and the fraction in the bucket

washed, 4) the operation is repeated until nothing floats anymore, 5) the two fractions, the one in the 0.3 mm sieve and the one at the bottom of the bucket, are then dried and sorted.

Larger samples were sieved in a tank using 0.5 mm mesh and flotation into a 0.3 mm mesh sieve. Initially a slightly larger mesh was tried; however, this was found to be inadequate for capturing the very small charcoal fragments. Residues were all air dried and separated on a 4 mm mesh riddle. The flotation fractions were transferred from the sieve into plastic boxes and air dried. All fractions were scanned and sorted for analysis by ET. An acupuncture needle was used to fracture charcoal fractions in the correct sections needed to view anatomical features and IDs were made using the criteria presented in the wood section below.

Soils analysis

A number of micromorphological studies have been carried out: by Richard MacPhail in 2006 and 2007 and Charles French in 2008, 2010, 2014 and 2015 (reports archived in ADS). Judgemental samples were taken where the excavations exposed suitable but thin buried soil contexts, especially associated with the possible structures on the dryland. These samples were prepared for thin section analysis (after Murphy 1986) and described using the accepted terminology of Bullock et al. (1985) and Stoops (2003).

Soil geochemistry was carried out in 2008 and 2010 by Steve Boreham and colleagues (2011a; 2011b), which involved analysing sediments which had been augered prior to excavation and the investigation of possible 'halo' effects caused by excavation trenches (see Chapter 22). Geochemical analysis was also undertaken around the central structure and western structure as described in Chapter 21.

Post-excavation methods

Microwear

Microwear is used here instead of use-wear as the former places emphasis on the full range of wear traces visible on a tool, inclusive of manufacture, hafting, post-depositional modification and so forth. Microwear traces were first analysed at low power ($\times 10$ – $\times 100$) followed by high-power magnification at $\times 100$ – $\times 500$, with eye-piece magnifications at $\times 16$. This combined approach (low and high power) has long been recommended as best practice by most microwear specialists (e.g. Keeley 1980; Tringham et al. 1974; van Gijn 1990). High-power analysis was undertaken on a Leica DM1750M reflected light microscope for the smaller pieces and a Leica DM2500 MH long working distance microscope for larger pieces. Micrographs were taken, when relevant, using Leica LAS Z-stack software. The Leiden University Laboratory for Artefact Studies co-ordinate system was used to record the location of wear traces. An extensive experimental programme was undertaken at the York Experimental Archaeology Research (YEAR) Centre in conjunction with the microscopic analysis.

Flint was washed as part of the post-excavation procedure; however, to remove any remaining surface grime, some pieces were placed into plastic bags with detergent and water before being placed into an ultrasonic tank to agitate for 15 minutes. Cotton wool dipped in acetone was also used to clean the surface when necessary. Regular cross-reference was made with replica flint tools used in actualistic tasks involving contact materials which we know existed at Star Carr, either directly (e.g. birch wood) or indirectly (e.g. hide from deer), which helped confirm the identification of specific wear traces.

A number of osseous artefacts and wooden artefacts were analysed for wear traces. These artefacts are stored in cool, wet conditions, mimicking their burial environment. Therefore, before an organic artefact could be analysed for microwear, it was first necessary to let it dry out to a state in which micropolish, if present, could be detected. However, if left to dry for too long the condition of the artefact is compromised. This presented a very narrow window of opportunity between when the artefact was dry enough to view surface detail and the point at which it over-dried, potentially causing irreparable damage. This required careful management, involving limited air drying and rewetting, seeking an optimum working window whilst limiting physical damage due to drying.

only, since most hypotheses of residue identity based on microscopic observations were unsupported by the chemical data (Croft 2017).

Wood identification

Sub-samples of wood for identification were analysed in the laboratory. In the first phase of excavation a small sample of the wood was identified by Allan Hall. The rest of the wood and charcoal has been identified by AR, with the exception of SA, who identified the wooden artefacts (Chapter 29), and Dana Challinor, who identified some of the wood prior to dating (Chapter 17). Preservation of waterlogged wood varied, but overall the identification procedures were challenging due to the presence of pyrite growing in the wood. Fungal spores and hyphae had also produced damage and iron and manganese deposits had made the wood very dark. The extensive damage of the wood made sectioning, necessary for the identification, very difficult if not impossible.

In order to maximise the identifications, the following protocol was developed. Waterlogged wood samples were inspected at magnification up to $\times 20$, to first assess ring curvature and counts, and second to identify areas of the wood where damage was minimal. Less damaged areas of wood were sub-sampled in the form of small blocks. The blocks were kept overnight in a solution of 20% HCl, in order to remove the deposit of pyrite (soluble in this solution) and to 'bleach' the wood. The block was then removed and put into a warm solution of 80% glycerol and ultrapure water, to penetrate the wood. The block was then placed in a petri dish, covered with aluminium foil and placed in a refrigerator at 2°C. This allowed the glycerol to become almost solid, while still tender, and it made it possible to take radial, tangential and transversal sections of the wood necessary to observe the structural organisation of wood elements, and to allow identification.

Wood as well as charcoal identifications were made following the anatomical keys by Schweingruber (1982; 1990), and these were complemented by online resources: <http://www.woodanatomy.ch/> (accessed 1st March 2017). Identifications were also confirmed with a specially built reference collection of modern material of British wood species available at the Archaeobotany Lab at the University of York. This reference collection consists of both mounted slides (for waterlogged wood identification) and artificially charred fragments of wood necessary for comparison when identification is conducted on charcoal fragments. The age of the wood is based on absolute ring count wherever possible, or for charcoal on ring curvature when the pith was missing. Samples were viewed using a Zeiss AX10 compound microscope fitted with both incident and transmitted light, and at magnification up to $\times 500$ as well as a Leica SM-LUX transmitted light microscope with $\times 20$, $\times 40$, $\times 200$ and $\times 400$ magnification. Botanical names follow Stace (2010).

Many species of wood do not have anatomical features that allow precise identification; for example, oaks (*Quercus* spp.), willows (*Salix* spp.), poplars (*Populus* spp.) and birches (*Betula* spp.). Likewise, it is not always possible to distinguish between willow and poplar, as both belong to the same botanical family (Salicaceae, here described as *Salix/Populus*) and have similar anatomical characteristics. Indeed, willow and poplar are often considered impossible to separate in the archaeological record; however, in willows, the presence of both procumbent and upright ray cells gives it heterocellular rays, and where these cells are missing or not clearly visible identification is not possible. Aspen catkin scales were found on site, pointing to the presence of aspen. Wood with securely heterogeneous ray cells is *Salix* spp. Wood with securely homogenous ray cells is *Populus* spp., which has been interpreted as aspen (*Populus tremula*) based on the presence of its distinctive catkin scales in the macrofossil samples taken from the lake edge peats. Where wood or charcoal were badly preserved and secure identification was not possible, we assigned the remains to *Salix/Populus*. Finally, while it was often possible to distinguish birch wood and charcoal (*Betula* sp.), where this was not achieved due to preservation, the identification is presented as birch/alder/hazel (*Betula/Alnus/Corylus*).

Conclusions

The methods used in this project have developed over time, using a reflexive method as encouraged by English Heritage/Historic England. The fact that specialists have been actively involved from the project design stage, and have worked alongside the excavation team on site, has made a very positive contribution to the project and all parties have substantially benefited. Hopefully, in future Mesolithic excavations this approach will be used again.

