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In search of sealed Palaeolithic and Mesolithic sites using core sampling: the impact of grid size, meshes and auger diameter on discovery probability

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ABSTRACT

Since the 90s core sampling, particularly within Dutch and Belgian wetland research, has increasingly become important for detecting covered prehistoric hunter-gatherer sites, comprised mainly of scatters of lithic artifacts of variable size and find density. Several methodological studies (Tol et al., 2004; Verhagen et al., 2013) have tried to develop standard sampling protocols differentiating grid size, core diameter and sieving mesh width according to the expected site-types. These studies are all based on a statistical analysis of excavation data, using simulations. However, these theoretical models have never been fully tested against empirical data coming from augering projects. In this paper core sampling data from 11 cored sites, some of which were subsequently excavated, are used in view of developing a core sampling strategy which allows the detection of the broadest possible range of prehistoric sites. The study concludes that in most cases, augering within a 10 m grid with a 10 cm–12 cm core and sieving through 1 mm–2 mm meshes allows the detection of buried sites, eventually even small and low-density ones. In order to further increase the discovery chances a two-step gridding approach is recommended.

1. Introduction

In the last few decades core sampling has become the most frequently applied survey method for detecting prehistoric sites in the lowlands of the Netherlands and Belgium, especially in river floodplains and coastal plains. In these wetland environments prehistoric remains, mostly consisting of lithic artifacts, are usually situated at considerable depths, covered by younger deposits such as peat and alluvial/marine clay. As a result traditional survey techniques, e.g. field-walking, test-pitting and trial-trenching, are generally inappropriate for these areas. In the framework of his PhD thesis Bert Groenewoudt (1994) developed in the mid-90s an augering strategy, which was based on the theoretical statistical models of shovel probes sampling, also called shovel testing, a technique frequently used in the US (Lovis, 1976; Kraker et al., 1983; Shott, 1985; Orton, 2000; Banning, 2002). These models calculate the probability of intersection and detection of archaeological sites of a certain dimension and find density. Based on his findings, Groenewoudt recommended the use of large cores (preferably 25 cm diameter) within a staggered grid of 22.5 × 22.5 m and sieving of the soil samples. The latter should be done through small meshes (1–2 mm) if cores with a diameter smaller than 20 cm are used. Since Groenewoudt's study, core sampling has increasingly been applied within Dutch archaeology, not only within wetland contexts but also for surveying areas covered by vegetation (forests, meadows), aeolian sediments or anthropogenic soils (so called *eerdgronden*).

In an attempt to refine the core sampling strategy, two major studies were performed based on simulations of excavation data from the Netherlands and Belgium. A first study conducted by Tol et al. (2004) suffered from a lack of mutually comparable data as only 9 prehistoric sites, some of them partially excavated, were available. Almost a decade later Verhagen et al. (2013) could select 12 Palaeolithic and Mesolithic sites which were well enough excavated to be suited for a statistical approach of grid size and core diameter. In the latter study simulations were performed by placing an equilateral triangular grid randomly placed on top of each site 100,000 times, and for each "virtual" core sample hitting the site, detection probabilities were calculated on the basis of the counted flint fragments per 50 × 50 cm (Verhagen et al., 2013, 245). Both studies resulted in the formulation of different core sampling

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Table 1
Core sampling strategies according to Tol et al., 2004.

Site type	Low density <40 per m^2	Medium density 40–125 per m^2			(Very) high density >125 per m^2		
		Grid	Core diam	Sieve mesh	Grid	Core diam	Sieve mesh
Small <200 m^2	Test-pits	4 × 5	15–20	3–4	7.5 × 10	15–20	1–2
Medium 200 –2000 m^2	Test-pits	10 × 12.5 15 × 20	15–20	3–4	15 × 20	15–20	1–2
Large >2000 m^2	Test-pits	30 × 40 40 × 50	15–20	3–4	40 × 50	15–20	1–2

strategies depending on the expected size and find-density of prehistoric sites (Tables 1 and 2).

Although both simulation studies yielded interesting insights into the intersection and detection probability of stone age sites, they are hampered by a number of limitations and problems inherent to simulations and the type of data used. First, the simulations have been conducted on excavation data with a spatial resolution of 0.25 m^2, corresponding to the smallest excavation unit. They are based on the assumption that artifacts are distributed randomly and uniformly within each square. However, a test performed at one of the sites included in Verhagen's study, Oudenaarde-Donk (Bats et al., 2006; Bats, 2007), has demonstrated that some core samples that hardly contained lithic finds yielded a high number of finds during subsequent excavation of the related square, or vice-versa. The percentage of drilled artifacts in relation to the excavated finds on this site varies from just 1% to a maximum of ca. 40%. This clearly demonstrates the uneven or clustered distribution of finds not only on site level but even within a small unit of 0.25 m^2, something which undoubtedly has an important effect on the discovery rate.

Second, the effects of sieving on the detection of lithic artifacts, although recognized in both simulation studies as being one of the major determining factors, has not yet been investigated properly. This is mainly due to the fact that the prehistoric sites included in these studies were sieved using different meshes ranging between 1 mm and 4 mm, which so far has hindered a reliable intersite comparison. As Verhagen et al. admit (2013, p. 246) the data are not extremely accurate allowing only to make an educated guess of the effect of sieving on detection probabilities.

Third, both studies aim at a detection rate of 75%, obtained by summing all positive core samples per site, meaning the sum of all cores yielding artifacts. However, as Verhagen et al. (2013, 246–247) correctly state, one may seriously question whether this high rate is really necessary. Theoretically one just needs a single positive borehole to detect a site.

Fourth, there is a serious problem of feasibility with respect to some of the core sampling strategies proposed by Tol et al. (2004) and Verhagen et al. (2013). In particular the use of manual cores with a diameter of 15 cm or larger can be problematic due to soil conditions (e.g. watersaturated sands, dry compact clay, woody peat, etc.) or the depth of the potential prehistoric level (>3 m). Furthermore, in these specific situations nowadays manual augering is often replaced by mechanical drilling, using e.g. a sonic drill aqualock system (Hissel et al., 2005), but these are generally limited to 7–10 cm diameter. Also the use of large cores can cause serious damage to the site, prior to its excavation, so optimizing the core diameter is most desirable.

Last but not least one can question whether it is desirable to adjust the core sampling strategy according to the site type which can be expected in a given project area. Due to post-depositional burial by fluvial and/or aeolian sediments there is often no prior knowledge about the types of sites, so how to choose the right sampling strategy? Furthermore this predictive approach includes a certain risk in just finding what is "expected" based on current knowledge about the prehistoric settlement system and the palaeoenvironment and missing what is not known or not expected. In the end this may lead to a totally biased reconstruction of the prehistoric land-use, as the sampling strategies are mainly oriented towards finding what is expected.

In this paper we will investigate whether it is possible to develop an optimal core sampling strategy, which allows the detection of an as broad as possible spectrum of Palaeolithic and Mesolithic sites and which is applicable to all environmental circumstances, even the deeper contexts. Contrary to all mentioned earlier studies, this investigation will not be based on simulations of excavation data but will use empirical data from several augering projects on prehistoric sites, some of which were subsequently partially excavated. By doing this we hope to encompass some of the above stated problems and limitations related to simulation models.

2. Dataset

Augering data from 11 prehistoric sites were available for this study, 10 of which are situated in the floodplains of the Scheldt River in NW Belgium and the Netherlands (Fig. 1). Prior to the archaeological survey all sites were drilled with a 3 cm gouge within a grid of 30 m–50 m in order to reconstruct the covered palaeotopography and acquire litho-stratigraphical data. These data were used to define zones and levels in which sealed prehistoric sites could reasonably be expected, such as sand dunes, river banks, scroll bars, etc. These smaller areas were subsequently drilled in order to detect sealed prehistoric sites. The latter was done more or less in the same way on all sites, i.e. within a 5 × 5 m or 10 × 10 m staggered (isosceles triangular) grid, using a manual Edelman (spiral) auger with a diameter of 10 cm–12 cm and subsequent wet sieving through 1 mm meshes (Table 3). Selection of archaeological finds (lithic artifacts, carbonized plant remains, bone fragments, etc.) was carried out by a stone-age specialist after the sample residues were completely dry. Due to particular project circumstances (some projects were conducted within the context of developer-led salvage operations, others within scientific research projects), some sites were surveyed in a slightly different way. For example, at Verrebroek-Dok 1 a 15 cm auger was used, while at Kerkhove-Stuw the grid was enlarged to 15 × 15 m.

Table 2
Core sampling strategies according to Verhagen et al., 2013.

Site type	Very low density <40 per m^2			Low density 40–80 per m^2			Medium density 80–160 per m^2		
	Grid	Core diam.	Sieve mesh	Grid	Core diam.	Sieve mesh	Grid	Core diam	Sieve mesh
Very small <50 m^2	–	–	–	–	–	–	–	–	–
Small 50–200 m^2	4x5 + test-pits	–	–	4 × 5	15	3	–	–	–
Medium 200–1000 m^2	4x5 + test-pits	–	–	8 × 10	15	3	13 × 15	12	3
Large >1000 m^2	–	–	–	13 × 15	12	3	20 × 25	12	3