



# Assessing the ploughzone: The impact of cultivation on artefact survival and the cost/benefits of topsoil stripping prior to excavation



Gordon Noble\*, Peter Lamont, Edouard Masson-Maclean

Department of Archaeology, School of Geosciences, University of Aberdeen, Elphinstone Road, Aberdeen AB243UF, United Kingdom of Great Britain and Northern Ireland

## ARTICLE INFO

**Keywords:**  
Ploughsoil  
Cultivation  
Truncation  
Artefact preservation  
Strip-and-map excavation  
Destruction of archaeological sites

## ABSTRACT

Thousands of archaeological sites in Europe lie under the ploughzone. Previous studies and experiments have highlighted the impact that arable agriculture has on the preservation of archaeological sites, yet the ploughzone has also been shown in some cases to preserve important information. In this study, the value of the ploughzone was assessed through metal detecting and through sieving of the ploughsoil directly over one of the most productive areas for artefacts at an important early medieval site in Scotland. The purpose of the assessment was to gauge the extent to which removing the topsoil may lead to the loss of important information and to evaluate the extent to which strip-and-map approaches to excavation might contribute to information loss. It is the largest such experiment of its kind in Scotland and the experiment allowed an assessment of the type and condition of artefacts found in excavation compared to that in the ploughsoil. The study showed very few artefacts survived in the topsoil at this site with certain artefact types entirely absent. The study also showed the significant impact that even light ploughing has had on categories of objects such as metalworking moulds. The conclusions are that while cropmarks remain a diminishing resource, strip-and-map allows rapid assessment of these sites and where artefact densities are low this approach is unlikely to lead to loss of significant information.

## 1. Introduction: assessing the ploughzone

The ploughsoil or the Ap Horizon, usually the top 0.2–0.4 m of soil in cultivated fields, is found in areas throughout the world where arable plays a role in agricultural practices (Gingell and Schadla-Hall, 1980:109–111; Goldberg and Macphail, 2006:48). The ploughzone can be beneficial to the identification of sites and the mapping of past activity at the landscape scale (e.g. the production of cropmarks) and through methodologies that target artefacts brought to the surface through ploughing such as fieldwalking (Haselgrove, 2007:7–9; Brooks, 2008; Carver, 2009:69). In some cases the ploughzone can retain important information no longer preserved on site. For example, at Bishops Cannings Down, Wiltshire, England, 90% of the small finds from a Bronze Age site were found in the ploughzone, along with important information on metalworking (Gingell and Schadla-Hall, 1980:111). On densely occupied sites, practices such as metal detecting can also characterize the presence of craft activities and settlement zones prior to full excavation with important information preserved in the ploughsoil. These practices can also contribute to identifying difficult-to-detect sites such as battlefields and can be an incredibly effective information source for artefact rich sites such as early urban centres (e.g. Pilø, 2007:143; Banks and Pollard, 2011; Scull et al., 2016).

Nonetheless, studies of the ploughzone carried out over the last few decades have also left little doubt that the ploughzone is a destructive force for archaeological remains. The obvious loss is that of upstanding sites where ploughing can rapidly remove occupation horizons and earthworks, causing irreparable damage to archaeological sites (e.g. Reynolds and Schadla-Hall, 1980:114, 118; Barker, 1993:75; Lambrick, 2004:188–190). This has been demonstrated through in-situ measurements (e.g. Lambrick, 1977; Drewett, 1980; Reynolds, 1982:316–320), experimental work (e.g. Wilkinson et al., 2006; Oxford Archaeology, 2010) and laboratory analysis (Reynolds and Schadla-Hall, 1980; McBride, 1989; McBride and Watson, 1990; Dain-Owens et al., 2013; Leskovar and Bosiljkov, 2016). Plough attrition appears to have accelerated from the 19th century onwards, though earlier agricultural practices including those of the prehistoric period have also had an effect (Dunwell and Ralston, 2008:38, 43).

Experiments have also shown the very negative effects the ploughzone has on artefacts or materials that end up in the ploughsoil. This is due to the increased aeration of the soil and alteration to soil chemistry (Pilø, 2007:146; Kibblewhite et al., 2015:250–251), and through compaction and fragmentation from farm machinery (Reynolds, 1987, 1989:25–6; Dain-Owens et al., 2013:1184; Oxford Archaeology, 2010:8; Leskovar and Bosiljkov, 2016). These are all processes that are

\* Corresponding author.

E-mail addresses: [g.noble@abdn.ac.uk](mailto:g.noble@abdn.ac.uk) (G. Noble), [peter.lamont.14@abdn.ac.uk](mailto:peter.lamont.14@abdn.ac.uk) (P. Lamont), [edouard.masson-maclean@abdn.ac.uk](mailto:edouard.masson-maclean@abdn.ac.uk) (E. Masson-Maclean).

likely to have increasingly negative effects through time (e.g. Reynolds, 1982:318; Dunell and Simek, 1995:308). Numerous earlier studies have also shown artefacts can move in the ploughzone leading to displacement in relation to original locations and a blurring of distributional patterns (e.g. Rick, 1976; Yorston et al., 1990:69–70). National surveys in the UK, such as the Monuments at Risk Survey of England in 1995 (Darvill and Fulton, 1998) and the English Heritage COSMIC surveys (Oxford Archaeology, 2002, 2005, 2010, 2014), have consequently identified ploughing as the greatest threat to archaeological remains. The threats of arable agriculture inspired both the original Ancient Monuments Act of 1882 and its update in 1979 (Darvill and Fulton, 1998; Trow, 2004:37). Yet thousands of sites are currently under cultivation including many scheduled monuments. Scheduling sites is an ineffective means of protecting them unless there is also controls on cultivation, as it is the “continuation of normal farming practices that forms the only detectable uncontrolled and unmitigated threat” to these sites (Dunwell and Ralston, 2008, 69). Under the Ancient Monuments (Class Consents) 1994/Ancient Monuments (Class Consents) (Scotland) Order 1996, agricultural practices are not controlled if it can be shown that such activities occurred during the use of the land in the previous ten years.<sup>1</sup> Thus, ploughing remains a great threat to sites even if scheduled and mitigation of this threat is required for long-term preservation of the resource.

## 2. Cropmark archaeology in Scotland

In the majority of lowland Scotland there are few upstanding archaeological sites today. Intensive cultivation, especially since the 18th century has removed the above ground elements of sites, leaving little surface trace apart from a very few survivors that have endured due to their marginal landscape position or size (Cowley, 2011:44). Nonetheless, the well-drained lowland soils of Scotland can help to reveal some of these sites with aerial reconnaissance one highly effective methodology of recording plough-truncated sites (Cowley, 2011:45). Pioneering aerial reconnaissance in Scotland was undertaken by Crawford and Insall in the 1930s and by J. K. S. St Joseph in the 1940s, but it was the Royal Commission for Ancient and Historical Monuments of Scotland (RCAHMS) programme established in 1976 by Gordon Maxwell, along with regional programmes of flying, that led to a huge increase in numbers of cropmark sites identified in Scotland. Through the 1970s and 1980s the spread of identified cropmark sites expanded rapidly creating distributions that still broadly hold today (Cowley, 2016:62). The success has been such that to date over 7500 cropmark sites have been recorded (Cowley, 2011:44), the majority of which remain in cultivated fields. Over 1000 of these are Scheduled Ancient Monuments (Dunwell and Ralston, 2008:69).

## 3. A cropmark complex in eastern Scotland

The site of Rhynie, Aberdeenshire, is an important early medieval site interpreted as a Pictish power centre based on place-name, structural and artefactual associations (Noble et al., 2013). The site has long been known as a concentration of Pictish Class I sculpture with eight monuments known from the site, the largest surviving total in Scotland from a single site (RCAHMS, 2008:38–41; RCAHMS, 2007:119–22). Two of these carved stone monuments were found in ploughing in recent decades. One of these, known as the Rhynie Man, an unusual carving of a human or human-like figure carrying an axe, was found during ploughing in 1978. Rhynie No 8, a smaller monument, was found in the subsequent year. Aerial photography in 1978 identified a complex of cropmarks around the Rhynie No 1, the Craw Stane, which is carved with a salmon and a ‘Pictish beast’. The enclosure complex

identified around the Craw Stane comprised a series of enclosure boundaries surrounding the site of the in situ symbol stone, enclosing a distinctive knoll at the end of the sand-and-gravel ridge upon which the symbol stone stands. Analysis of the aerial photographs suggested the complex consisted of an inner and outer ditched enclosure and a surrounding palisaded boundary (Fig. 1). Excavations from 2011 to 17 confirmed this, identified a series of internal buildings, and recovered an artefact assemblage of over 1000 artefacts (Fig. 2). The artefact assemblage includes imported pottery, glass, metalwork and evidence for metalwork production including sherds of Late Roman Amphorae of the late 5th or early 6th century and sherds of Group C Atlantic glass vessels (Campbell, 2007:18–24, 64–69). The metalworking and artefact assemblage represents one of the richest from early medieval northern Britain.

The site lies in what is currently a pasture field, but farm records show that the site was ploughed 14 times from 1977 to 1997, with the field being ploughed before then too, but no records were kept. The site was scheduled in 2003 (Scheduled Monument SM69), and is currently not ploughed. Excavation at the Craw Stane enclosures from 2011 to 17 followed a strip-and-map methodology with large trenches opened, cleaned and mapped with select features excavated (Carver, 2009:101). This approach characterized a large proportion of the complex, but left more than 80% of the archaeology in situ (Tables 1 and 2). The initial 2011 trench established the methodology with an area of 382 m<sup>2</sup> opened by machine prior to hand cleaning by hoes and trowel and subsequently all features were excavated by hand via half-sections and sondages. Similar procedures were followed during larger interventions in 2012, 2015 and 2016. Ploughing had undoubtedly seriously affected the archaeological deposits on site (Fig. 3). The excavation at the Craw Stane complex showed high levels of plough attrition at the complex with features on the summit of the sandy knoll particularly truncated. Deeper ditch sections and palisade depths were found on the slopes of the knoll where deeper ploughsoils and hillwash had partly protected the archaeology.

During the course of the site investigations various steps were taken to assess the impact of the excavation approach adopted, with a particular focus on the potential impacts on any artefact assemblages in the ploughzone and the extent to which strip-and-map was an appropriate approach to adopt at a site of this nature. From 2012 onwards, test pits were dug prior to topsoil stripping to assess the depth of ploughsoil in advance of machine stripping and the soil sieved to assess the presence/absence of artefacts in the ploughzone. Metal detecting was conducted in all years. In 2011, 2012 and 2016 this involved metal detecting of spoil heaps and prior to cleaning of the trenches. In 2015 the 43 × 36 m area of excavation was metal detected prior to topsoil stripping. The small-scale sampling of the ploughzone from 2011 to 16 produced no artefacts other than modern finds. The metal detecting of spoil heaps detected no diagnostic metal finds of early medieval date. Metal detecting prior to the topsoil strip of 2015 again produced no definitive early medieval finds with a small assemblage of mainly modern finds retrieved.

## 4. Ploughzone sampling 2017 methodology

Larger scale investigation of the ploughzone was difficult due to the costs, time investment and labour that larger sampling exercises would have taken and is not something that has been undertaken in any sizeable way in Scotland previously (Dunwell and Ralston, 2008:4). Fieldwalking was not possible due to the fact that the field has been in pasture since 1997. However, in 2017 a large ploughzone sampling exercise was mobilised through student and community effort. As part of a 2017 student dissertation project at the University of Aberdeen the 2017 excavation trench was targeted for a larger ploughzone sampling exercise. The 2017 trench was more modest than in previous years, but still provided an area of 64 m<sup>2</sup> to assess with an average depth of ploughsoil of around 0.3 m. The trench was also targeted over the most

<sup>1</sup> The Cosmic 2005 project found that a significant proportion of farmers broke their class consent agreements (Oxford Archaeology, 2005).



Fig. 1. The cropmark complex at Rhynie, Aberdeenshire© Aberdeenshire Council Archaeology Service.

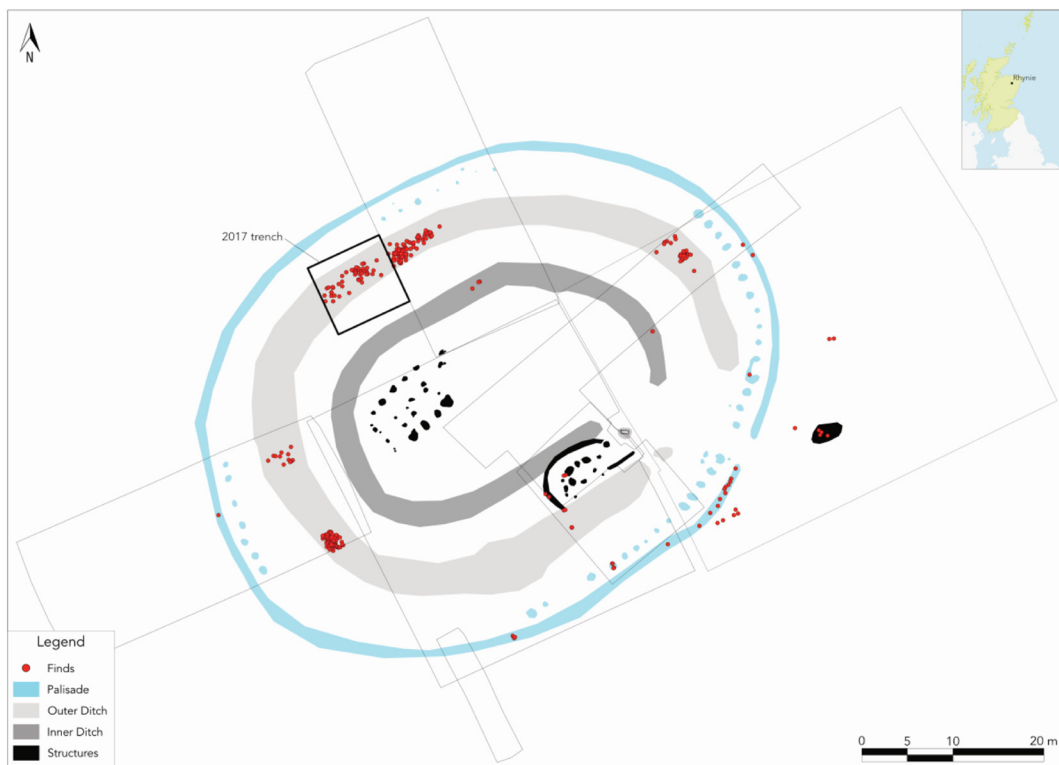


Fig. 2. The excavated complex at Rhynie with all trenches and dGPS located finds marked. The 2017 trench, which was the target for the ploughzone sampling is also highlighted.

**Table 1**

Trenches excavated at Rhynie 2011–17. The depth of each trench to the subsoil was around 0.3 m (the average depth of the ploughsoil), with features surviving in the subsoil to 1.5 m in depth.

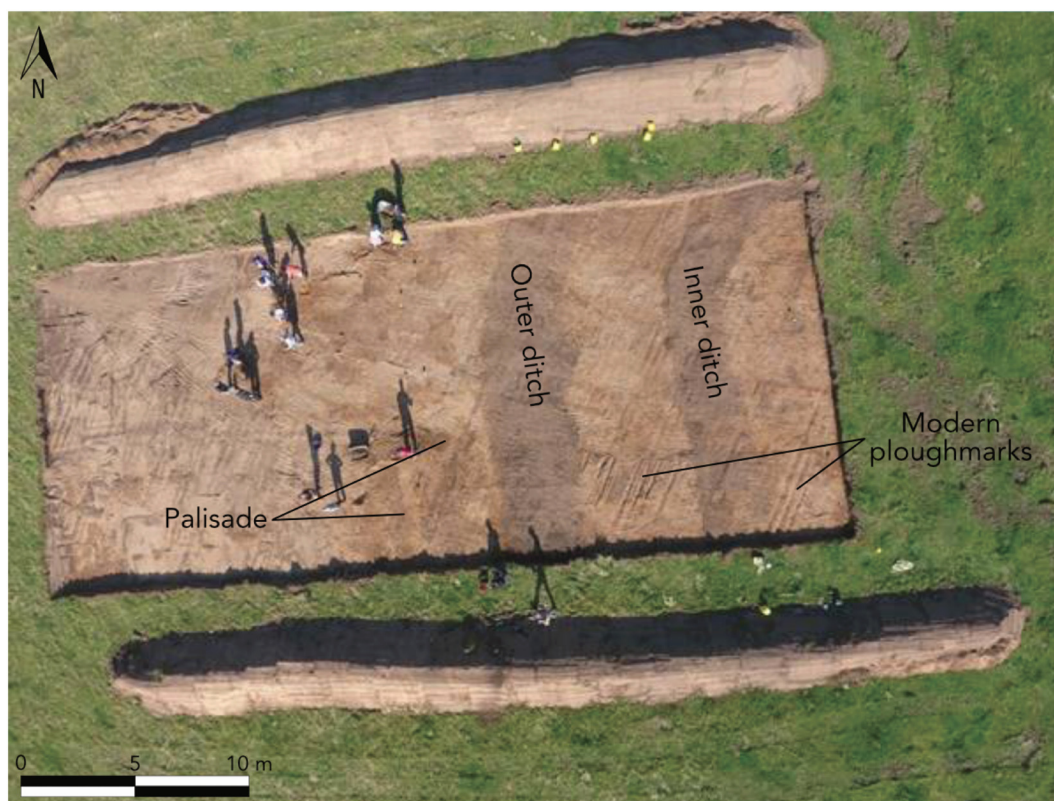
Year	Trench	Area (m <sup>2</sup> )	Max length (m)	Max width (m)
2011	1	382	45	16
2012	1	1017	33	30
2015	1	1533	43	36
2016	1	512	35	15
2016	2	535	36	15
2016	3	46	15	3
2016	4	204	17	13
2016	5	396	21	19
2017	1	64	8	8

**Table 2**

Percentage of enclosure complex revealed by strip-and-map and percentage of deposits excavated.

Total area stripped	2025
Total estimated area of site	2793
% site stripped	72.5%
% excavated of stripped features	18.83%

overview of the site and types of material culture that may be encountered, the risk assessment, and a description of the methodology that was also summarised in a site handout. During the excavation the participants were given a brief on the method at the start of the week and supervised throughout the programme of investigation. Due to the size of the area to be stripped, spits were not used as has been undertaken in other ploughzone surveys such as the Bishops canings Down survey (Gingell and Schadla-Hall, 1980:109). Instead the ploughsoil was removed as one context via shovels and directly passed through 5 mm sieves (Fig. 4). Artefacts were plotted on a 0.5 m grid. Each grid and artefact were given unique identifier numbers. While some artefacts were recovered in situ, the majority were found through sieving. Standing sieves were used for easier and faster sieving. The 5 mm mesh matched the size of sieve used during the full excavation. Appropriate steps were taken to limit any biases introduced by the experience of the diggers with inexperienced participants paired with experienced diggers. Participants were also logged with unique identifiers to allow any discrepancies in artefact retrieval to be assessed. The fact that all deposits were sieved reduced the potential for sample bias (Pilø, 2007:144–146). The removal of the topsoil and sieving took seven full days of effort.



**Fig. 3.** One of the 2016 Rhynie trenches showing the impact of ploughing on the archaeological deposits. Extensive ploughmarks were found during the excavation cutting into the upper horizons of the archaeology. The soil fill of the ploughlines had to be removed prior to full excavation.

productive area of the site for artefacts as identified during the previous four seasons of excavation meaning that artefact recovery from the ploughzone was more likely than elsewhere on site. The area targeted was a portion of the outer ditch of the Craw Stane complex with the upper fills of the outer ditch having produced the majority of finds during the 2011–16 excavations.

During the project, participants for the excavation were assembled using social media and university mailing lists. A total of 12 participants were identified, a mix of students and volunteers. Prior to the dig, participants were sent an introduction pack which included an

## 5. Results of the 2017 ploughzone sampling exercise

After obvious modern finds were removed, a total of 30 artefacts were logged (Fig. 5). These included 14 pieces of metalworking slag, 10 fragments of metalworking moulds, two small crucible fragments, a small sherd of Late Roman amphora and a fragment of a rotary quern. This averages around 1.5 artefacts per cubic metre of soil. The artefacts included categories of finds found during the full excavation such as moulds and imported pottery, but other finds categories were absent such as metal or glass. The other obvious factor about the finds



Fig. 4. The ploughzone sampling underway in 2017. The standing sieves can be seen in the background.

recovered from the intensive ploughzone soil sampling was perhaps unsurprisingly the highly fragmented nature of the objects retrieved. This was particularly true of the mould assemblage. The ten mould fragments found in the ploughzone were compared to a random selection of mould fragments found in the same area of the excavation – this showed an average maximum length of 215 mm for the ploughzone assemblage compared to 349 mm for the excavation assemblage, i.e. a 40% reduction in size. This was not a bias of recovery – many moulds from the excavation were also found in sieving using the same mesh diameter. Clearly if moulds were incorporated into the ploughzone through agricultural activity they had become heavily fragmented and rolled through time. An assessment of damage levels using Lambrick's assessment of compression damage using a scale of 0–5 (0 being no damage, 5 almost indistinguishable (1977:51–52)), produced a mean damage score of 2.22 for the full excavation and 3.70 for the ploughzone, in this case 29.6% more visible damage occurred on average in the ploughzone than the full excavation. Indeed, abrasion on the ceramic moulds recovered from the ploughzone were such that the majority did not preserve any diagnostic morphological or design feature (many were only identified by their ceramic texture and matrix) (Fig. 6).

## 6. Discussion

At Rhynie characterizing the ploughsoil has confirmed many of the observations on the destructive nature of the ploughzone identified in other surveys. The 2017 experiment showed that while some artefacts do survive in the ploughsoil at the site, these are relatively small in number, are very poorly preserved, and do not give a full picture of the materials that can be recovered during excavation with whole artefact types absent. Indeed, given the poor preservation of the artefacts, the contribution of the ploughzone to interpretation of the artefact assemblage is likely to be slight. The experiment was conducted over one of the richest artefact-bearing features and zones identified in the full excavation – a ploughzone survey in other areas of the site is likely to have produced few, if any, artefacts.

One notable element of the study of the ploughzone at Rhynie has

been the lack of recovery of demonstrably early medieval metalwork from the ploughzone, through test pitting, open area stripping of topsoil by hand, or through metal detecting. Discussion with the farmer and wider community makes it clear that no metal detecting or any form of surface collection or sampling by individuals other than project members had taken place prior to excavation. This suggests that when early medieval metalwork is incorporated into the ploughzone at the site it does not survive long-term. In England, an important study by Haldenby and Richards (2010) has demonstrated the 'hostile context' of the ploughsoil for metalwork. In their study they compared metal detecting finds with assemblages recovered by excavation. Their evidence suggested that severe damage occurred to metalwork finds as soon as they entered the ploughzone (Haldenby and Richards, 2010:1160).

The lack of metalwork finds from Rhynie suggests that the ploughzone has had a very serious effect on the survival of objects disturbed by ploughing and that topsoil studies would have limited or no success in characterizing the presence of high status metalwork at the site. The highly acidic nature of soils in Scotland may be a significant contributing factor to the lack of metal objects. Phosphate sampling of the soils at Rhynie shows an average pH of 5.8 (Gross, 2017), and the soils are sandy and well drained like much of lowland Scotland (Soil Map of Scotland, 2018), factors that are likely to contribute to the dissolution of metalwork, particularly when broken up in the ploughsoil. Mould fragments did survive to attest to metalworking on site, but the very degraded small lumps of clay that survive in the topsoil (Fig. 6) would hardly be diagnostic or significant for mapping the scale or character of metalworking activity on site. In the case of the moulds the acidic soils of regions such as Scotland is also likely to further affect the survival of this object type with the combination of acidic, well-drained soils promoting the leaching of calcium, potassium, and magnesium from objects and likely to contribute to the eluviation of clay from poorly fired ceramics as is the case with the moulds from Rhynie (Karen Milek pers. comm.).

Overall, the ploughzone sampling showed very low numbers of artefacts survived in the ploughzone. The density of artefacts of around 1.5 per cubic metre of ploughsoil means that the possibilities of mapping activity areas or even identifying sites through a methodology that

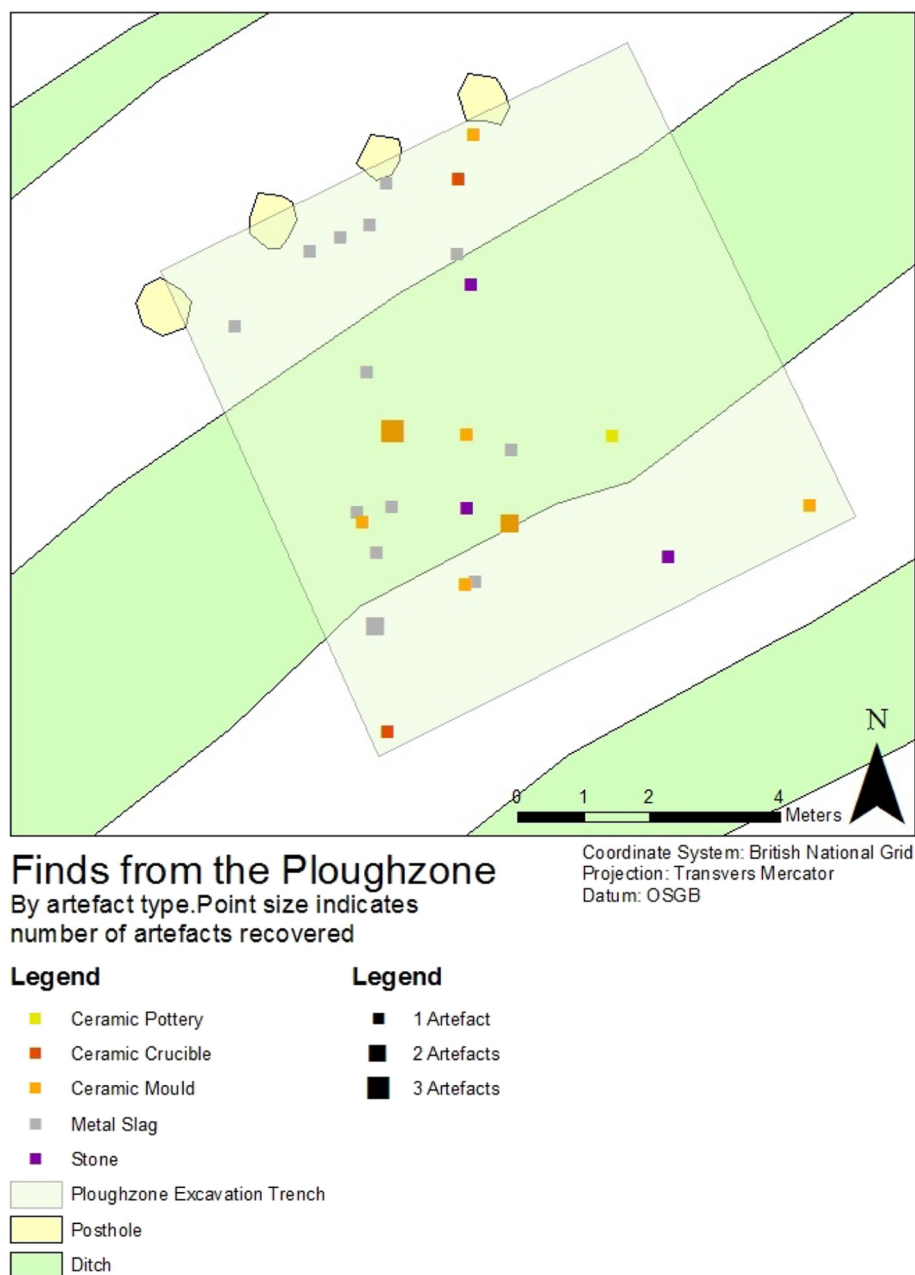


Fig. 5. Results of the ploughzone sampling showing the distribution of finds by material type.

involved sampling the ploughzone on a large-scale would be very limited and would require the removal by hand, and sifting, of large volumes of soil, which the Rhynie assessment shows to be very labour intensive. Larger sieves could speed up the process undertaken in the Rhynie experiment, but considering the small size, poor condition and generally un-diagnostic nature of the material recovered, the benefits of attempting to characterize the site from the ploughzone would be questionable. Intensive water-sieving could increase artefact recovery, but this is even more intensive than dry-sieving and often logistically difficult (Pilo, 2007:146). The artefacts that did survive in the ploughsoil could allow presence/absence of specific activities within particular areas of the site, but this would require very extensive sampling indeed and the information gain would be limited. At some sites it has been shown that the ploughzone can be used to describe the deposits which lie in undisturbed deeper soil horizons (e.g. Dunell and Simek, 1995:317), but in Scotland where the vast majority of excavated cropmark sites have been shown to be very artefact poor (with often

much smaller assemblages than Rhynie), the opportunities are likely to be restricted.

One further negative factor to consider is that the Craw Stane site at Rhynie is one that has actually been subject to relatively few ploughing events in recent years. The fragmentation of artefacts in the ploughzone is cumulative through time (See Oxford Archaeology, 2010) and detailed records retained by the landowner documents that the field at Rhynie was only ploughed 14 times in 21 years from 1977 to 97, a low occurrence compared to more intensive arable fields in Scotland and elsewhere in the UK that can be ploughed two or three times per year. A study by Dunell and Simek (1995:308) has shown that artefact size initially decreases very quickly after artefacts enter the ploughzone, and processes such as abrasion increase through time. Despite the relatively low rate of ploughing at Rhynie the metalworking moulds recovered from the ploughzone had already been reduced in size by 40%, with the resulting mould fragments largely undiagnostic. Further ploughing would undoubtedly lead to greater abrasion on the moulds and would



**Fig. 6.** A comparison of some of the moulds found during excavation of the outer ditch during the full-scale excavation (top row) and from above the outer ditch during the ploughzone sampling exercise (mid and bottom rows).

likely lead to the complete disintegration of many.

Other elements of the history of the site also show the cumulative impact of ploughing. The fact that at Rhynie ploughing in 1978 and 1979 led to the discovery of two hitherto symbol stones indicates that ploughing was having an increasing impact on subsoil deposits prior to the site being taken out of cultivation in 1997. The history of discovery of other sites with early medieval stones in Northeast Scotland suggests similar processes of increasing impact of ploughing through time. At Tillytarmont, also in Aberdeenshire, five Pictish Class I symbol stones are known. All were found during ploughing: two in 1867, one in 1944 and the last two in 1972 to 1974. The latter two were the largest stones of the assemblage, suggesting that more intensive and deeper ploughing of the haughland on which all of the stones were found had a steadily worsening impact through time on subsoil deposits. As many other studies have highlighted it is clear that the ploughzone is a destructive force and that the best way to preserve sites and subsoil features is to cease all ploughing practices on the site (Lambrick, 1977:32–40; Oxford Archaeology, 2002, 2010; Lambrick, 2004:188–192; Dunwell and Ralston, 2008:70). The cumulative effects of ploughing might mean that if the site at Rhynie had been as intensively ploughed as some sites in recent years, there would have undoubtedly been less evidence to assess the character of the site, with subsoil deposits even more truncated and perhaps even less surviving in the topsoil.

As it stands, there is no doubt that the majority of cropmark sites that remain under the plough in Scotland and elsewhere are a diminishing resource (cf. Wilkinson et al., 2006; Dunwell and Ralston, 2008:46; Oxford Archaeology, 2010:18). In England, a study by Wilkinson et al. (2006) showed that the life expectancy of nationally important sites could be measured with significant and increasing impacts and loss of sites happening over a decadal duration (Wilkinson et al., 2006:667). Experimental work by Oxford Archaeology suggests archaeological truncation of 0.07–0.1 m over a 30 year period (Oxford Archaeology, 2010:18). Studies in East Lothian, Scotland, also suggest that plough attrition since the 1970s has been getting worse, with features such as rig and furrow evident on early aerial photographs no longer visible, suggesting that “earlier archaeological deposits that might once have been afforded some protection by the medieval plough ridges are now under active erosion” (Cowley, 2016:68; See also Dunwell and Ralston, 2008 for similar observations in Angus and Aberdeenshire). Studies of cropmarks also suggest that well-defined cropmarks such as those at Rhynie are those most damaged by truncation (Cowley, 2011:51; Dunwell and Ralston, 2008:50–1). Sites that lay within or adjacent to areas of pronounced topographic variation, particularly those on crests of terraces or knolls and sites and features in loose sandy soils (like the Rhynie Craw Stane complex) are also particularly vulnerable to further plough damage (Dunwell and Ralston,



Fig. 7. Strip and map underway at the Crawl Stane complex, Rhynie 2016.

2008:25, 42). Nonetheless, the structural and artefactual detail from cropmark sites like Rhynie show that nationally and internationally important information can be preserved at cropmark sites, but that information is increasingly compromised through time. The percentage of arable land in cultivation in Scotland went down from the 1980s to 1990s, but that process may be beginning to reverse, meaning that the threats from cultivation are ever present (Cowley, 2016:65; Scottish Government, 2012). The evaluation of sites is an activity that should be prioritised before information loss is so great that sites become worthless, destroyed without any details of their character recorded.

All of this leads to questions about how to best evaluate sites in arable contexts. As highlighted above ploughzone sampling is unlikely to be an answer. At Rhynie strip-and-map was used to evaluate the site, with the majority of the complex mapped, but only a small percentage excavated (Figs. 2 and 7). This has produced a detailed plan of the complex, with internal buildings and structures revealed and a rich artefact assemblage recovered from targeted slots, but the majority of deposits (Tables 1 and 2) were left in situ for future investigation. Strip-and-map thus proved to a very effective way for assessing the character of a cropmark complex in this particular region and the ploughzone experiment suggests that minimal information was lost through the displacement of the topsoil through its removal by machine. Geophysics could be a further way to clarify cropmark sites, but has limited effectiveness in many areas such as the gravels of lowland Scotland, though combined soil chemistry and geophysical approaches can improve results (See Cuenca-García, 2012; Cuenca-García, 2018).

Strip-and-map is a technique that has seen limited uptake in commercial evaluations as it requires a relatively large work force to clean large areas, but it is used in full evaluations. In commercial contexts test pits and trial trenches dug by machine are often used in evaluative phases, but as Carver (2009:101) points out these methods can be more damaging and less informative giving only keyhole glimpses into the archaeology below the ploughzone. Strip-and-map can of course damage a site if not done carefully, but this can be mitigated by

experienced machine drivers being used and the last few centimetres of ploughsoil being left in site for hand-cleaning. If carried out in a controlled manner by experienced excavators and machine operators, strip-and-map offers “a much more reliable and non-destructive forecast of what lies beneath”, than many current methods (Carver, 2009:101). Of course, the effects of stripping and then backfilling in terms of future impacts on ploughing and truncation would be useful to assess. The removal of topsoil on a large scale could lead to issues with compaction of the soil, but this can be mitigated. At Rhynie, during backfilling the returned soil was compacted by machine to ensure that the resulting backfilled areas were not more vulnerable to future ploughing than the surrounding areas.

## 7. Conclusions

The Rhynie case study confirms that, as many other studies have shown, that ploughing is one of the greatest threats to archaeological sites and deposits. In Scotland, many cropmark sites are Scheduled Ancient Monuments, but unless there are active agreements in place to remove them from agricultural ploughing and planting, the scheduling will not stop ongoing damage to these sites through time. Removing the class consent could be one way of addressing cultivation damage, but would take a very significant input of resources to compensate land-owners (Trow, 2004:38; Dunwell and Ralston, 2007:70).

The ploughzone study here and those undertaken elsewhere suggest that any important artefact assemblages preserved at cropmark sites will see irreparable damage to the artefacts once they enter the ploughzone and in some cases whole categories of artefact types such as metal objects are likely to completely disintegrate within the harsh conditions of the ploughzone environment meaning that any assessment of a site from the ploughzone is likely to be partial at best. A programme of active evaluation of cropmark sites would at least help mitigate some of this loss as without active cessation of ploughing these sites will become increasingly damaged through time.



In terms of evaluating these sites, the Rhynie example shows that even at relatively artefact rich sites, the value of any artefacts in the ploughzone is at least in some cases questionable given the very damaged and partial picture this would give of the site and the huge investments in labour stripping ploughsoil would entail even within relatively modest trenches. Any information recovered through this means would be outweighed by the labour and financial costs of ploughzone survey and the continued threat that sites are under when in an active ploughing regime. Metal detecting prior to topsoil stripping is a useful undertaking, but again may be of limited success given the changes in soil chemistry and aeration that ploughing brings, the acidic soils of many areas and the clear affects certain soil conditions has on iron and non-ferrous metals at sites such as Rhynie. Topsoil strip by hand and sieving of the topsoil is something that student or community groups could undertake with little threat to sites, but again the information gain from any such undertaking at many sites is likely to be limited. Unless targeting likely artefact bearing features, e.g. the ploughsoil above ditches or other likely discard zones (Haselgrove, 2007:15), sampling the ploughsoil may produce very few artefacts unless the site is very rich in material culture, e.g. as at early urban centres (e.g. Skre et al., 2007; Scull et al., 2016).

In lowland areas such as eastern Scotland, a programme of investigating cropmark sites given the continuing impact of ploughing would be very valuable. At Rhynie strip-and-map has provided an effective means of assessing a cropmark site, characterizing the date, structural components, material assemblages and preservation conditions of the site. This technique seems particularly suited to research excavations where large student and volunteer work forces can be assembled, but the methodologies could also be adopted in a commercial context on a more routine basis for evaluating sites.<sup>2</sup> Assessments using strip-and-map can provide effective characterisation of cropmark sites rarely provided by keyhole intervention, can help prioritise cropmark sites that should be removed from cultivation and can identify sites that will be particularly important information sources for archaeological research, deserving of protection long-term. Where opportunities are present to test ploughzone assemblages through fieldwalking and metal detecting these should also be pursued, but in many cases this may produce a limited return that must be balanced against effective use of project resources.

## Acknowledgements

Fieldwork at Rhynie has been funded by the University of Aberdeen Development Trust, British Academy, Historic Environment Scotland, the Society of Antiquaries of Scotland, and Aberdeenshire Council Archaeology Service. The writing of this article was also supported by a Leverhulme Trust Research Leadership Award (RL-2016-069). Staff from Historic Environment Scotland and Dr. Karen Milek, University of Durham read and commented on drafts of the text and we extend our thanks to them. Thanks also to two anonymous reviewers for their comments on the text. As always any remaining errors are our own.

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<sup>2</sup> See Evans et al. (2014:253) for a critique of ‘hard-machining’ where buried soils are present – this is another factor that should be evaluated prior or during any larger-scale strip-and-map. However buried soils tend not to be a feature in many lowland landscapes and this should be assessed on the likelihood of these occurring on a local/regional scale, e.g. in floodplain locations.

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