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Quantitative analysis of open-source data on metal detecting for cultural property: Estimation of the scale and intensity of metal detecting and the quantity of metal-detected cultural goods

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Abstract: Through netnographic analysis of online forums and social networks, this study presents quantitative analysis of the scale and intensity of metal detecting and the quantity of metal-detected cultural goods. It adapts open-source data to develop empirical measures; to ensure reliability and consistency of sourcing and interpretation, these data were drawn from English-language forums and networks. Based on a poll of 668 online community members, it infers the size of active detecting communities from the size (93.42%) of online detecting communities. Based on open-source data on the detecting practices of 101 detectorists, the worst tolerable weather for 151 detectorists and seasonal variations in the reporting of 1,089,337 finds to the Portable Antiquities Scheme over 13 years, it determines a pragmatic minimum average of 286.02 h of detecting per person per year. Comparing activity in a wide range of permissive, restrictive and prohibitive regulatory environments - based on local-language forums and networks in Australia, Austria, Flanders and elsewhere in Belgium, Canada, Denmark, England and Wales, Ireland, the Netherlands, New Zealand, Northern Ireland, Scotland, and the United States - it finds that permissive regulation is ineffective in minimising harm to

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PUBLIC INTEREST STATEMENT

It is possible to estimate how many people are metal-detecting, how much detecting they do and how many historic or cultural objects they find, by analysing publicly-available (“open-source”) evidence from online forums, social networks and elsewhere. This study compares activity in Australia, Austria, Flanders and elsewhere in Belgium, Canada, Denmark, England and Wales, Ireland, the Netherlands, New Zealand, Northern Ireland, Scotland, and the United States. These territories apply a wide variety of permissive, restrictive and prohibitive systems of regulation. So, by comparing these, it is possible to evaluate which are most (in)effective in minimising cultural harm and illicit trade. The statistics suggest that more people engage in unethical but legal detecting under permissive regulation than engage in unethical and illegal detecting under restrictive or prohibitive regulation. So, even if illicit trade is technically reduced by the act of legalising it, cultural harm is increased.

heritage assets, whether in the form of licit misbehaviour or criminal damage. Restrictive and prohibitive regulation appear to be more effective, insofar as there is less overall loss of archaeological evidence.

Subjects: Research Methods in Criminology; Governance; Socio-Legal Studies - Public Policy; Crime Control; Criminology and Law; Heritage Management & Conservation

Keywords: cultural property crime; heritage crime; illicit antiquities trade; metal detecting; netnography; open-source analysis; property crime; quantitative analysis

1. Introduction

By comparison with other such activities, metal detecting is understudied, from the motivations and modes of its practice to the legal regulation of its practitioners and their markets. We do not even know "fundamental information" about its practice as a legal hobby, such as "how many people actively metal detect, or how often, and we do not know exactly what they find" (see also Huth, 2013, p. 133; Thomas, 2016, p. 141).

Quantitative analysis of open-source data may reveal this information, from how many person-hours of labour are invested in detecting by licit detectorists; how many licit and/or illicit detectorists are active in various countries; how frequently detectorists find cultural objects; and, if not *which* cultural objects, at least *how many* cultural objects are extracted in those countries through metal detecting, licitly and illicitly. This is significant, because archaeological excavation is a destructive process, where the loss of the archaeological deposit is minimised by the preservation of the scientific data, from the components of the deposit to the spatiotemporal relationships between those components. Much "hobbyist" metal detecting (which inescapably encompasses detecting by commercial entrepreneurs and private collectors as well as by amateur archaeologists) is far more destructive than archaeological excavation, because it is conducted with limited preservation of the components of the deposit and minimal (if any) preservation of the spatiotemporal relationships between the components. It is necessary to understand activity across the spectrum of possible regulatory environments, in order to identify the system that minimises unscientific extraction and maximises preservation.

The present study performs tests with data from the jurisdictions of Austria, Denmark, the United Kingdom (England and Wales, Scotland, and Northern Ireland), the United States and Canada, because they are the jurisdictions that provide most of its evidence for estimating the intensity of detecting activity. In addition, it uses data from Ireland, Australia and New Zealand, because they have comparable English-language evidence bases and comparable economic conditions to the UK, the US and Canada, yet variable legal environments and detecting practices. Furthermore, it uses data from Flanders (and elsewhere in Belgium) and the Netherlands, because England and Wales is supporting the establishment of equivalents to the Portable Antiquities Scheme in Denmark, Flanders and the Netherlands (according to the Deputy Head of Britain, Europe and Prehistory for the Portable Antiquities Scheme, 21st November 2016, cited by Simkins, 2016). It is hoped that the evidence in this study will contribute to empirical assessment of the effectiveness of such regulatory systems, thus to enable those and other jurisdictions to implement measures that minimise cultural harm.

1.1. British peculiarity and international uncertainty: The portable antiquities scheme

The present analysis is not a discussion of the merits and demerits of hobbyist detecting. Nonetheless, with regard to the costs and benefits of licit as well as illicit metal detecting and the effectiveness or ineffectivess of regulation of metal detecting, the United Kingdom is a hub of intense discussion and experimentation across three legal regimes, in England and Wales, in Scotland and in Northern Ireland. Historically, due to the number of metal detectorists, the behaviour of metal detectorists, the freedom with which metal detectorists operate and the level of professional/state facilitation of metal detecting in England, metal detecting for cultural property has been characterised as the "English disease" by continental European observers (see Barford, 2011a).

At least somewhat corroborating testimony for this characterisation has been provided by the system for recording finds of cultural property by the public (overwhelmingly, by detectorists) in England and Wales, the Portable Antiquities Scheme (PAS). Although the statement is no longer available from the PAS, when the PAS conducted a fact-finding mission, it found that "most people in Denmark" were "less favourabl[y] disposed towards" the system in England and Wales, because finders were "greedy" and rewards for finds were "too high" (cited by Heritage Action, 2011; Lewis, 2010). The PAS recognises that "many metal detectorists are well aware of the financial value of their finds", including the finds that can be sold in the low-end market, and are thus "unlikely to give them up without financial compensation" (Lewis, 2016, p. 135).

It is practically impossible to attempt to discuss the level of participation in illicit activity or the amount of harm that is done by illicit activity, because most material that is extracted is not recorded. It is difficult even to know how legal antiquities are handled, as there is evidence that ostensibly licit detectorists have withheld information about looting in surveys by archaeologists (cf. Oxford Archaeology, 2009, pp. 19–20 – 4.1.9) or falsely denied selling antiquities legally (cf. Thomas, 2012, p. 55), in order to maintain an image of hobbyist collectors rather than commercial traders.

Still, alongside the compulsory reporting system under the Treasure Act, the Portable Antiquities Scheme (PAS) has been judged to work "well" (Renfrew, 2000, p. 28). The first system of its kind, even its critics welcome the "substantial number" of participating detectorists (Barford, 2010, p. 22) and the "large numbers" of finds (Gill, 2010b, p. 34). Outside observers have judged that, with regard to the number of objects that are now in the database, it is a "resounding success [durchschlagender Erfolg]" (Huth, 2013, p. 129).

Indeed, detectorists have proclaimed that, in the debate over the costs and benefits of permissively regulated metal detecting, those recorded objects "does [*sic* – do] the talking for us" (Howland, 2013b); it is a "successful" system (European Council for Metal Detecting, 2016). However, the same outside observers argue that the same data demonstrate metal-detecting has reached "unimaginable dimensions [ungeahnte Ausmaße]" (Huth, 2013, p. 136).

If nothing else, the PAS has been a valuable experiment in laissez-faire regulation of hobbyist and commercial extraction of cultural assets. Then again, Florida operated a comparable system of compulsory reporting with private ownership of any and all reported finds, but it cancelled the scheme due to "widespread noncompliance" (seemingly according to the Florida Public Archaeology Network, paraphrased by Conti, 2013).

"All" of the "leading" metal detecting clubs have endorsed the Code of Practice on Responsible Metal Detecting in England and Wales, which expects their members "to report all finds" (Bland, 2009, p. 88). And some detectorists believe that reporting should be a "mandatory part of any code" of ethics (e.g. Broom, 2014), if not law (e.g. Baines, 2014b). Yet the General Secretary of the National Council for Metal Detecting (NCMD), which represents most of the identifiable detectorists in the United Kingdom, has questioned the inference that "finders who do not report their finds or conform to the voluntary Code of Practice are somehow 'irresponsible'" (Austin, 2010, p. 14).

The majority of metal detectorists have long understood that they "need to record and report archaeological finds" (73% according to Chitty & Edwards, 2004, p. 43; 67% according to Edwards, 2006, p. 13 – Table 6). Yet most licit detectorists in England and Wales choose not to do so, not to participate in voluntary recording (the data have been disputed, e.g. Austin, 2010, p. 13; cf. Heritage Action, n.d.; but no contradictory data have been offered).

Indeed, the NCMD General Secretary himself has stated that the PAS has "never" had the capacity to record all of the finds that are made by metal detectorists; that total recording is (currently) "impossible"; and that PAS's own targets for recording only constitute a "token figure", in comparison with the total quantity of material that is eligible for recording (Austin, 2010, p. 13). The PAS acknowledges that its "FLOs, interns and volunteers are unable to record everything" that is extracted by detectorists and that detectorists are anyway "select[ive]" in their submissions to the PAS (Lewis, 2016, p. 131).

Such rates have only been achieved by physically dispatching Finds Liaison Officers (FLOs) to metal detectorists' events. There is an incentive for detectorists to report some finds, in order to make laissez-faire regulation appear effective. Detectorists who reported finds at one FLO-monitored event a year would be counted as finders, even if they conducted unmonitored detecting every other week of the year and reported nothing (Barford, 2010, p. 19). The PAS recognises that there is an incentive for detectorists to defend it, or at least not to disparage it, as its existence "legitimises their hobby, whether they record finds or not" (Lewis, 2016, p. 130). And more than 9% of clubs *refuse to allow* FLOs to attend their activities (Clark, 2008, p. 15).

Furthermore, there is evidence of informal agreements between FLOs and detectorists for finds not to be recorded, precisely because there are too many. For example, an FLO asked a detectorist to start recording the find-spots of musket balls on a potential battlefield of the English Civil War, because the detectorist had found more than 50. Then, they agreed to stop recording, because the detectorist had found many more, which eventually counted more than 500 (Ferguson, 2013, p. 142).

Problems exist for the acquisition of "treasure", too. For example, fifteen silver Roman coins and gold Celtic coins and six small votive objects from Norwood Hill, Charlwood, Surrey were worth £1,000, which was twice as much as the authorised local institution's annual budget for acquisitions, so it could not buy them from Weald and Downland Metal Detecting Club's members (Davison, 2012).

It has been asserted that "maybe a quarter" of detectorists do "not find any archaeological objects at all", in which case "over half of all active detector users" show *some* of their finds (Bland, 2009, p. 71). Even assuming that there are only 8,500–10,000 detectorists, and only 6,375–7,500 of those count, a decade after the launch of the PAS, they still only achieved a rate of participation in partial reporting of 56.43–67.89% (by 4,328 detectorists in 2007, cf. Portable Antiquities Scheme, 2009, p. 274 – Table 6a, or 4,232 detectorists in 2008, cf. Portable Antiquities Scheme, 2010, p. 14 – Table 1a, hence, possibly *just* "over half"). And, as is shown in this study, there at least 14,419 and possibly as many as 27,897. Even if the lower estimate were accepted, still *fewer than half* (30.02%) of detectorists would report *any* of their finds.

Restricting analysis to official data and accompanying estimates, between 2003 and 2008, 67.36% of finders were detectorists (Table 2), while 74.06% of finds were from detectorists (Table 1). Naturally, comparisons of rates of discovery are difficult, because non-detectorist finds are products of all activities by the entire population. Unfortunately, the available numbers do not enable a direct comparison between, for instance, underground finds by detectorists and gardeners or surface finds by detectorists and fieldwalkers.

Nonetheless, non-detectorist finds may serve as base rates. Since fieldwalkers' amateur archaeological surface survey constitutes an intensive and targeted search, while non-detectorist finds also include reports by gardeners and others, altogether non-detectorist finds may serve as underestimates of surface finds by fieldwalkers.

Table 1. Proportions of metal-detected finds amongst reported finds in England and Wales, 2003–2008 (derived from Portable Antiquities Scheme, 2004, p. 80 – Table 6, p. 87 – Table 13; 2005, p. 7, p. 101 – Table 8; 2006, p. 113 – Table 3a, p. 122 – Table 8; 2009, p. 267 – Table 2a, p. 277 – Table 7; 2010, p. 26 – Table 4a, p. 32 – Table 8)

Year	# of finds with identified methods of discovery	# of finds by metal detecting	# of finds while metal detecting	Total # of MD-reported finds with identified methods of discovery	MD-reported finds as percentage of those identified
2003–2004	27,753	17,978	2,576	20,554	74.06
2004–2005	39,736	27,656	3,609	31,265	78.68
2005–2006	57,341	35,288	3,714	39,002	68.02
2006–2007	76,977	61,981	3,023	65,004	84.45
2007–2008	52,995	44,268	1,833	46,101	86.99
Mean avg	50,960.4	37,434.2	2,951	40,385.2	74.06
S. Deviation	18,616.43	16,792.92	776.35	16,711.70	7.70

Table 2. Rate of recovery of reportable finds by metal detectorists in England and Wales (derived from Portable Antiquities Scheme, 2004, p. 80 – Table 6, p. 87 – Table 13; 2005, p. 7, p. 101 – Table 8; 2006, p. 113 – Table 3a, p. 122 – Table 8; 2009, p. 267 – Table 2a, p. 277 – Table 7; 2010, p. 26 – Table 4a, p. 32 – Table 8)

Year	# of MD-reported finds	# of MD reporters	MDs as percentage of reporters	Finds per MD per year
2003–2004	20,554	1,726	72.64	11.91
2004–2005	31,265	1,751	76.93	17.86
2005–2006	39,002	3,439	58.74	11.34
2006–2007	65,004	4,328	63.00	15.02
2007–2008	46,101	4,232	65.47	10.89
Mean avg	40,385	3,095	67.36	13.05
S.D.	16,711.70	1,285.68	7.35	2.97
M. of error				2.60

In 2003–2004, 2005–2006, 2006–2007 and 2007–2008, detectorists reported lower rates of finds than non-detectorists did in 2004–2005; still, detectorists reported higher rates in all of the other years. Overall, the average detectorist reported 13.05 finds per year (Table 2). Or, following the PAS's distinctions, they reported 12 finds *by* metal detecting and 1 find *while* metal detecting (Table 3), whereas the average non-detectorist reported 6.32 finds per year (Table 4). Unless the average detectorist only found 6.73 objects more than the average fieldwalker each year, despite being technologically enabled and digging underground as well as surveying the surface, many detectorists who reported some of their finds must have withheld many others.

Likewise, although there are regional variations in the scale of detecting, which lead to differences in discovery, there are also significant regional variations in the rate of finds per detectorist, which indicate differences in reporting (cf. Gill, 2010a, pp. 2–3). Moreover, a survey of detectorists by archaeologists suggested that 69 detectorists would recover 3,556 finds per year, 51.54 finds per detectorist per year (Dobinson & Denison, 1995; cited by Heritage Action, n.d.). Furthermore, fieldwalking projects may only run for a few days (e.g. Portable Antiquities Scheme, 2004, p. 26) within one month of the year (cf. Portable Antiquities Scheme, 2004, p. 14, 45; 2009, p. 18). The present analysis indicates that detectorists invest many more hours per year in detecting, as well as have greater capacity to find things by detecting.

Table 3. Means of recovery of reportable finds by metal detectorists in England and Wales (derived from Portable Antiquities Scheme, 2004, p. 80 – Table 6, p. 87 – Table 13; 2005, p. 7, p. 101 – Table 8; 2006, p. 113 – Table 3a, p. 122 – Table 8; 2009, p. 267 – Table 2a, p. 277 – Table 7; 2010, p. 26 – Table 4a, p. 32 – Table 8)

Year	# of reporting MDs	# of finds by metal detecting	"Deliberate" finds per MD per year	# of finds while metal detecting	"Incidental" finds per MD per year
2003–2004	1,726	17,978	10.42	2,576	1.49
2004–2005	1,751	27,656	15.79	3,609	2.06
2005–2006	3,439	35,288	10.26	3,714	1.08
2006–2007	4,328	61,981	14.32	3,023	0.70
2007–2008	4,232	44,268	10.46	1,833	0.43
Mean avg	3,095	37,434	12.25	2,951	1.15
S.D	1,285.68	16,792.92	2.61	776.35	0.65

Table 4. Rate of recovery of reportable finds by non-metal detectorists in England and Wales (derived from Portable Antiquities Scheme, 2004, p. 80 – Table 6, p. 87 – Table 13; 2005, p. 7, p. 101 – Table 8; 2006, p. 113 – Table 3a, p. 122 – Table 8; 2009, p. 267 – Table 2a, p. 277 – Table 7; 2010, p. 26 – Table 4a, p. 32 – Table 8)

Year	# of non-MD-reported finds	# of non-MD reporters	Non-MDs as percentage of reporters	Finds per non-MD per year
2003–2004	7,199	650	27.36	11.08
2004–2005	8,471	525	23.07	16.14
2005–2006	18,339	2,416	41.26	7.59
2006–2007	11,973	2,542	37.00	4.71
2007–2008	6,894	2,232	34.53	3.09
Mean avg	10,575	1,673	32.64	6.32
S.D	4,785.61	998.01	7.35	5.23
M. of error				4.59

Of those metal detectorists who were in regular contact with the PAS between 2003 and 2008, only a slight majority of 53.15% reported finds. Of the total number of detectorists who were estimated to operate in England and Wales, only a minority of 30.95% reported finds (Table 5). Hence, it appears that they withhold the vast majority of their finds. This study presents evidence that there is an even greater number of detectorists and, thus, an even lower level of reporting.

1.2. British peculiarity and international uncertainty: The Artefact Erosion Counter

A community group, Heritage Action, has developed an Artefact Erosion Counter (AEC), which projects a running total of the number of objects that *may* have been found by detectorists and *would* be eligible to be registered in the PAS database, *if* detectorists chose to do so. Thus, by comparing the projection with the number of objects that *have* been reported to the PAS, Heritage Action has been able to estimate the number of objects that may *not* have been reported.

Detectorists have dismissed the AEC as "contempt[uous]… drivel" (Austin, 2010, p. 13); "myth[ical] … dross", "bunkum" (nonsense) and "propaganda" (Howland, 2013a); or "phoney" fiction (Baines, 2014a). Reasons include the fact that Heritage Action has been unable to identify an unrecorded object "and the date and time [that] it was dug out of the ground" (Baines, 2014a), even though that would only be possible if Heritage Action documented the object as it was dug out of the ground or

Table 5. Proportion of metal detectorists who report finds in England and Wales (derived from Chitty & Edwards, 2004, p. 3; Portable Antiquities Scheme, 2004, p. 86 – Table 12; 2005, p. 100 – Table 7a, p. 100 – Table 7b; 2006, p. 120 – Table 7a, p. 121 – Table 7b; 2009, p. 274 – Table 7a, p. 275 – Table 7b; 2010, p. 14 – Table 1a, p. 15 – Table 1b)

Year	MDs who were contacted regularly by PAS	MDs who reported any finds to PAS	Percentage of regularly contacted MDs who reported any finds	Percentage of estimated total MDs who reported any finds
2003–2004	4,000	1,726	43.15	17.26
2004–2005	5,358	1,751	32.68	17.51
2005–2006	5,702	3,439	60.31	34.39
2006–2007	6,358	4,328	68.07	43.28
2007–2008	6,876	4,232	61.55	42.32
Mean avg	5,658.8	3,095.2	53.15	30.95
S.D	1,097.09	1,285.68	14.69	12.86
M. of error				11.27

if the detectorist documented the object then made that documentation available to Heritage Action, whether by provision or publication.

Simultaneously, detectorists assert that Heritage Action's counter is an *over*-estimation of detectorists' finds, because it is based on "a series of assumptions" (Howland, 2013a); and they state that the Portable Antiquities Scheme's database is an *under*-representation of detectorists' finds, because its recording system has "never matched" or been able to match "the volume" of material that they find (Austin, 2010, p. 13). Yet, according to foundational figures from detectorist keV Mar on UK Detector Net (UKDN) as well as English Heritage (EH) and the Council for British Archaeology (CBA), also according to subsequent figures from archaeologist David Connolly, the Artefact Erosion Counter is based on *under*-estimates of both the number of detectorists in England and Wales and the rate of finds by detectorists (Heritage Action, n.d.).

During the complete years of its nationwide operation (1st January 2003–31st December 2015), the Portable Antiquities Scheme (2016) *recorded* around 1,089,337 reportable finds by detectorists, fieldwalkers, gardeners and others. Yet in that time, according to the AEC, assuming that there were 8,000 detectorists who found 0.69 recordable objects per detectorist per week (or 35.88 recordable objects per detectorist per year), detectorists alone *recovered* around 3,731,520 reportable finds (Heritage Action, n.d.).

Naturally, both the number of finds in the database and the proportion of finds from detectorists vary from year to year. If it were assumed that *all* reported finds were detectorist-reported finds, in order to further underestimate the disappearance of cultural property into private collections, still then, at least 70.81% of detectorists' finds would not have been reported. As has been asked before (cf. Gill, 2010a, p. 3), how inaccurate would this need to be, to be inconsequential; what rate of reporting would be reassuring, in terms of the gain and loss of knowledge?

Manifestly, it is impossible to know how many of the unrecorded objects are extracted *legally*. It is even impossible to know how many of the *recorded* objects are extracted legally, rather than laundered. Still, it is possible to estimate how many objects are extracted. And, where there are evidence-based estimates of the numbers of licit and illicit detectorists, it may be possible to estimate how many objects are extracted licitly and illicitly. By estimating the quantities of licit unrecorded objects and illicitly excavated goods, it may even be possible to compare the amounts of licit cultural harm and criminal damage, thus to assess the success or failure of different regulatory systems.

1.3. Targets of analysis

This study explores:

(1) the number of detectorists, thereby, the scale of metal detecting in a territory;
(2) the hours of activity that are undertaken by detectorists, thereby, the intensity of metal detecting; and
(3) the quantity of metal-detected cultural goods; therefore,
(4) the effectiveness or ineffectiveness of permissive, restrictive and prohibitive regulation, in order to support efforts to minimise cultural harm.

This study does not establish the most authoritative data with regard to the activity or the territories under discussion. Nonetheless, it does establish empirical bases for national analysis and cross-country comparison.

2. Method for estimating the scale of metal-detecting activity

In order to analyse the impact of detecting, it is first necessary to estimate the number of detectorists in any territory. As part of a parallel global analysis, a range of searches were conducted to identify data on the size of detectorist communities. Following a novel method of open-source analysis of detecting communities in Austria, Germany and the United Kingdom (Karl & Möller, 2016), these included searches that identified online forums and social networks. In all cases where searches were conducted, potentially relevant sources were checked until the search results were exhausted.

Web searches included:
"000 detectorists";
"000 * detectorists";
"thousand detectorists";
"thousand * detectorists";
"000 detecting" (which allowed for references to "detecting hobbyists", etc.);
"000 * detecting";
"000 detector" (which allowed for references to "detector users", etc.);
"000 * detector";

"metal detecting" forum in the relevant country code top-level (internet) domains (ccTLDs); and
"metal detecting" forum and the name of the relevant territory.

Using open-ended search terms, in order to allow for variations in vocabulary and grammar, Facebook searches included:
metal detecting (without speech marks) and the name of the relevant territory; and
treasure hunting (without speech marks) and the name of the relevant territory.

It should be noted that all of the data in the present analysis is open data, which has been willingly provided publicly by its sources; it has also been archived, so it remains available for reanalysis, reproduction and/or reinterpretation.

2.1. The real-life activity of online communities

It is challenging to analyse the real-life activity of online communities, as there is great variation in participants' engagement in activity from day to day, week to week, month to month and year to year; participants' perception of their "normal" levels of activity, which may reflect what is or would be the norm, without regard to everyday, regular and exceptional interferences; and participants' description of their "normal" levels of activity, which may be exaggerated to impress, underplayed to self-deprecate or withheld to avoid embarrassment. It is also challenging, simply because relevant data sets are so few and so small.

Since many of the polls and surveys were insignificantly small on their own, and some identifiable detectorists gave duplicate or contradictory answers in two or more of the samples, they are not informative when compared amongst themselves. Instead, the data have been consolidated; duplicated and contradictory data have been excluded; and individuals' disparate contributions have been unified to generate more evidence. For example, a detectorist's declaration of hours per day in one survey and their declaration of days per week in another survey may be combined to generate an estimate of hours of detecting per week.

The present analysis also identified a few detectorists who indicated very low levels of activity and many who indicated very high levels of activity, all of whom were excluded because their answers were so imprecise that they were unusable. For example, 24 people chose the highest level of activity in Gorgar's (2012) poll of how often forum members went detecting, "every chance that [they had]" (which was above "every day"). There were more such answers in the surveys that invited personal descriptions and even in the comments under polls (e.g. Marc, 2004). It is impossible to count such unquantifiable rates, but it is important to note that their exclusion contributes to the realisation of a secure underestimate of the intensity of metal detecting and thus the quantity of cultural objects that are extracted through metal detecting.

When it was impossible to distinguish between people who had responded both in the poll and on the board and people who had only responded either in the poll or on the board, only the poll results were used. However, in Gorgar's (2012) poll, for example, comments could be cross-referenced with votes and people who had not voted but who had commented could be included. Furthermore, since, by their nature, the discussion boards invited comments that were unusable or irrelevant (as well as multiple comments from individuals who had given answers), only usable responses were counted. Imprecision in poll options (e.g. ClaryCoins2003, 2015; MTLDTKTR, 2014) or survey answers (e.g. Buff4, 2012) made some data points unquantifiable and some data sets entirely unusable.

These challenges extend to analysis of the scale of activity, as well. Although their sample sizes were so small as to be insignificant on their own and their particular numbers were clearly unrepresentative, even those unusably imprecise polls and surveys demonstrated that forum memberships could not automatically be used to infer the sizes of detectorist communities, because some members did not even have a detector (cf. ClaryCoins2003, 2015). Beyond those who would have been active in the territory of the forum, yet had become temporarily or permanently resident in another, there could also have been those who had never resided or even visited there, yet followed metal detecting in places that related to their family history or simply personal interest. Likewise, numbers of active detectorists could not automatically be used to infer the intensity of detecting activity, because some active detectorists were active very rarely (cf. MTLDTKTR, 2014).

As with unquantifiable high rates, it is impossible to count unquantifiable low rates such as "less than once a month". Still, when any estimates are even indirectly derived from online forums or social networks, it is important to produce an estimate that is lower than the apparent level of activity, in order to account for inactive detector owners and non-detecting hobby followers. It is inconceivable that there are no inactive members in any sizeable forum, particularly as it is far simpler (and less final) to disengage from an online community than to delete an account; for example, some forums require an administrator to delete the account on behalf of the withdrawing user. However, there do not appear to be (m)any empirical measures of inactivity, which is naturally a difficult target to identify and measure.

For example, amongst others, the then-1,800-member Detecting Scotland forum was identified by an empirical review of detecting in Scotland. Yet the review's consultations identified non-detecting and non-resident members. Unable to discount those inactive detectorists empirically based on prior research or their own data, the review adapted the Scottish membership of the NCMD and inferred the existence of 520 active detectorists in Scotland (Bailie & Ferguson, 2017, pp. 13–14).

And the implication of this alternative calculation, that 71.11% of online detectorists are inactive offline, is unlikely to be accurate in Scotland, let alone elsewhere. If that level of inactivity was ascribed to just one of the British groups, which then had around 11,053 members (Metal Detecting, 2016), it would suggest that there were only 3,193 detectorists across the UK, far fewer than the 4,232–4,328 (or, now, more) detectorists who report their finds in England and Wales alone (Portable Antiquities Scheme, 2009, p. 274 – Table 6a; 2010, p. 14 – Table 1a), where perhaps 70.81% of detectorists do not report their finds.

The largest identifiable poll related to activity, yet also provided albeit imprecise, singular and dated evidence with regard to inactivity. It is not secure evidence, yet it is evidence nonetheless. In this poll, 17 (2.54%) of 668 had never detected and 27 (4.04%) of 668 had never detected regularly, even at a low frequency (Marc, 2004). Hence, in this analysis, 6.58% of members of online forums and social networks were assumed to be inactive; 93.42% were assumed to be active.

3. Evidence and interpretation of the scale of metal-detecting activity by territory

In Australia, Austria, Belgium, Canada, Denmark, England and Wales, Ireland, the Netherlands, New Zealand, Northern Ireland and Scotland, open data from detecting communities were demonstrably reliable sources; local-language resources corroborated the significance of the identified sources and/or their data. In the United States, however, many of the sources were highly variable if not self-contradictory. At the same time, one measure of the market was available, which was not available for the other territories under discussion. Hence, the number of detectorists was inferred, based on an open data analysis of the consumption of detectors.

3.1. Australia

In Australia, it is illegal to perform “any intrusive archaeological work (including … metal detecting or surface clearance) at a site anywhere … without an excavation permit”, which is only issued to qualified professionals (Smith & Burke, 2007, p. 209). However, apart from indigenous heritage, such protection is “primarily limit[ed]” to registered sites and does not cover archaeological finds that do not have “heritage significance” (North, 2007, p. 176).

Judging by social networks that were identified in the course of researching this paper, there are at least 5,480 metal detectorists (cf. Metal Detecting Australia, n.d.). Using the established estimate that only 93.42% of online detectorists are active detectorists (Marc, 2004), it is possible to infer that there are perhaps 5,119 ostensibly licit detectorists in Australia.

3.2. Austria

In Austria, since 1990–1999, legislative reform has imposed a “complete prohibition on searching for and finding (by digging for) archaeological objects” by non-archaeologists (Karl, 2011, p. 114), thus criminalising a formerly licit activity for a community that apparently donates finds to cultural heritage institutions (e.g. Metal Detecting WWI/WWII Relics, 2015) and wants to conduct scientific excavation and recording (Karl, 2011, pp. 122–124).

Previously, it had been estimated that there were “at least” 1,000, but “probably” between 2,000 and 3,000 (and possibly more) illicit detectorists (Karl, 2011, p. 120). Through a comparison with the estimated number of licit detectorists in England and Wales, it had also been inferred that there were realistically fewer than 1,400 illicit detectorists in Austria (Barford, 2011b).

Evidently, though, according to Karl und Möller’s research (2016, p. 4 – Table 2), there are at least 2,238 illicit detectorists in Austria, based on online forum membership. Using the established estimate that only 93.42% of online detectorists are active detectorists (Marc, 2004), it is possible to infer that there are perhaps 2,091 illicit detectorists in Austria.

3.3. Belgium

In Belgium, archaeological excavations and other such cultural heritage works may only be performed by qualified professionals with government permission (Gouvernment flamand, 1994a; Art. 3; 1994b, Ch. 1, Sub-Sec. B, Art. 6, Ch. 3). All finds of antiquities must be reported. Metal detecting for cultural property without government permission has long been explicitly prohibited (Conseil flamand, 1993; Ch. 2, Art. 9); it has long been restricted to qualified professionals with government permission (Gouvernment flamand, 1994b; Ch. 2, Sec. 1, Art. 5.i, Sub. 2, Ch. 4). However, those regulations do not apply to metal detecting for modern losses.

Before metal detecting became a licensed activity, it was estimated that "up to" 85% of finds were not reported despite an "unofficial policy of tolerance" of illicit detecting in return for the reporting of illicitly-detected finds (Deckers, 2013, p. 14). However, that appears to have been determined in direct relation to the rate of *reported* finds in England and Wales (cf. Deckers, 2013, p. 15 – Table 1), where perhaps more than 79% of finds remain *unreported* (Heritage Action, n.d.). So, the reported number of finds in Belgium may be a miniscule fraction of the total number of finds. Apparently, detectorists "often" do not share finds or information with landowners (Deckers, 2013, p. 16).

In Flanders, since 1st January 2015, persons have been able to become certified metal detectorists as long as they: are at least 18 years old; have not committed any heritage crimes in the previous five years; and "engage in work always in conformity with the decree in relation to immovable heritage of 12th July 2013 and the present order [s'engager à travailler toujours conformément au décret relatif au patrimoine immobilier du 12 juillet 2013 et au présent arrêté]" (Gouvernement flamand, 2014, Ch. 3, Sec. 6, Art. 3.6.1; see also National Council for Metal Detecting, 2015; Van den Bergh, 2016). The code of conduct has been characterised as engaging in work with "a basic knowledge of archaeological heritage conservation and the established code of good practice" (National Council for Metal Detecting, 2015), although it specifically involves carrying the licence at all times and immediately reporting all archaeological artefacts and archaeological sites (Gouvernement flamand, 2014, Ch. 3, Sec. 6, Art. 3.6.6).

Licensed detectorists must preserve their finds and those finds' official registration data and provide professional (official or academic) access to their finds. Even licensed detectorists may not conduct metal detecting on protected areas at any time, anywhere without landowners' permission, anywhere outside daylight hours, anywhere below 30 centimetres (as the depth of already-disturbed ploughsoil, cf. Van den Bergh, 2016; who cited Vlaanderen is Erfgoed, 2016).

Only individuals may receive such licences, since "designation of a corporate body as a licensed metal detectorist is applied only to corporate bodies that are designated as licensed archaeologists [désignation d'une personne morale comme détectoriste de métaux agréé s'applique uniquement aux personnes morales qui sont désignées comme archéologue agréé]" (Gouvernement flamand, 2014, Art. 3.6.2). In other words, institutional licences for metal detecting (by individuals within those institutions) may only be held by archaeological institutions.

There are 300 licensed detectorists in Flanders (according to the President of the Bretagne Detecting Association, Asterix, 2015), but none anywhere else in Belgium; metal detecting for "archaeological artefacts and archaeological sites" remains "forbidden" in Wallonia, Brussels and the German Community (Van den Bergh, 2016). A comprehensive switch to reporting of finds, to complement the legalisation and licensing of metal detecting, was judged "unlikely" (Deckers, 2013, p. 17); however, the 300 detectorists in Flanders are at least ostensibly licit detectorists.

Presumably, many if not most or almost all of the licit detectorists are members of the only recognised detecting NGO that was identified in the course of researching this paper, the National Association of Amateur Detectorists, which has 293 members on Facebook (Nationale Vereniging van Detectoramateurs – Association Nationale des Prospecteurs, n.d.). Although there may be some overlap in membership, there are also about 297 in another social network (Metal-Detecting Belgium, n.d.-b). Perhaps some of these restrict their detecting activity to other territories with more permissive regulation. Yet there are about 750 in yet another social network (Metal-Detecting Belgium, n.d.-a), who are fans of the "fictional character" of a metal detectorist, who indirectly and anonymously post photos of "founds [*sic* – finds] in belgian [*sic*] soil … what you [have] found in Belgium" (Metal-Detecting Belgium, n.d.-a). And there are about 2,098 in an online forum that is specifically for detectorists in Flanders (Detectorvrienden Vlaanderen, [DVVL], n.d.). Although, they may include detectorists elsewhere, who detect (or pretend to detect) in Flanders, because the existence of licit detecting obscures any practice of illicit detecting.

In order to ensure an underestimate, it may be assumed that there is a complete overlap in membership between the licensed detectorists, the network members and the forum members (which, thus, assumes that there are no detectorists anywhere in the country apart from Flanders); the 300 may be discounted from the 2,098, leaving 1,798. Then, in the light of Marc's (2004) finding elsewhere that only 93.42% of online detectorists are active detectorists, it is reasonable to assume that there are 1,680 illicit detectorists in Belgium.

3.4. Canada

In Canada, "all evidence of human occupation" more than 75 years old – underwater or underground (and, in many places, on the ground) – is a protected archaeological resource (Denhez, 2010, p. 9). In many places, the state automatically possesses any archaeological heritage on behalf of society (Denhez, 2010, p. 31). Any even accidental find must be protected *in situ* (in other words, left undisturbed) and reported to the authorities (Denhez, 2010, p. 25).

Any "archaeological exploration requires a permit *if* it will disturb the soil" (Denhez, 2010, p. 19) though, in many places, even "scanning" requires a permit (Denhez, 2010, p. 2). And archaeological investigation may only be conducted by qualified professionals (Denhez, 2010, p. 21).

As metal detectorists observe, in some territories, there is not a law against unlicensed detecting of archaeological finds, but "against putting a shovel in the ground to dig up" those finds (Captcook, 2012). Judging by online forums that were identified in the course of researching this paper, there are at least 6,961 metal detectorists (Canadian Metal Detecting, n.d.).

Presumably, they restrict themselves to location and non-collection of surface finds within those territories where scanning can be conducted without a permit. Nonetheless, by analogy with this online community, in the light of Marc's (2004) finding elsewhere that only 93.42% of online detectorists are active detectorists, it is possible to infer that there are perhaps 6,503 illicit detectorists in Canada.

3.5. Denmark

In Denmark, "metal detectors must not be used … on ancient monuments or within… 2 m [two metres] of them [På fortidsminder og inden for … 2 m fra dem … må heller ikke anvendes metaldetektor]" (Kulturministeriet, 2014, Art. 29F). Otherwise, their use is legal. Since 31 August 1989, any finds of *danefæ* have had to be delivered to the state, for which finders are rewarded (Moesgaard, 1999, p. 75). Hence, any detectorist who does not report *danefæ* is an illicit detectorist.

The Danish legal concept of *danefæ* is translated as "treasure trove" (e.g. National Museum of Denmark, 2015), but is not the same as "treasure" in the British legal sense. Literally, it means "dead goods" (in other words, "ownerless property", cf. Hyllested & Sørensen, 2014) and appears to be similar to "reportable finds" in the British museological sense.

For instance, in 2013, hundreds of detectorists in Denmark found twelve times as much *danefæ* (4,367 objects, cf. National Museum of Denmark, paraphrased by Dobat, 2016, p. 52) as thousands of detectorists in England and Wales found *treasure* (363 objects, cf. British Museum, 2015). In 2008 (the last year for which the Portable Antiquities Scheme published the numbers of the kinds of finders), 4,232 detectorists reported 46,101 finds in England and Wales (Portable Antiquities Scheme, 2010, p. 14 – Table 1a, p. 15 – Table 1b, p. 32 – Table 8), which equates to 10.89 finds per detectorist. Meanwhile in 2011 (the only year for which a precise number of finders was accessible), 202 finders (only a few of whom were non-detectorists) reported 3,032 pieces of *danefæ* in Denmark (Dobat, 2013, p. 712, 2016, p. 52 – Figure 1), which equates to 15.01 pieces of *danefæ* per detectorist.

Notably, pieces of *danefæ* are presented at a greater rate than "reportable finds", which demonstrates a genuine difference in reporting behaviour between Denmark and England and Wales. This corroborates the observation from cultural heritage professionals in England and Wales that there is a distinct, "general belief" in Denmark that "archaeological finds should be in [public] museums ... rather than private collections" (Lewis, 2010; cited by Heritage Action, 2011).

Danefæ encompasses "artefacts and coins from the past which have been found in Denmark and which nobody can rightly claim to be [their] property..., as long as they are made of precious material or are of special cultural-historical value" (*Museumsloven*, 2006, translated by Dobat, 2013, p. 708). So, in any discussion of the scale of licit and illicit activity in Denmark, it must be remembered that an association between non-reporting of *danefæ* and illicit activity is not an assumption that all detectorists find exceptional things, such as ancient gold jewellery or hoards of silver coins.

It is only an assumption that detectorists find ordinary things, as unexceptional as iron objects, fragments of bronze pots and smelted lumps of lead (and, alongside them, shards of glass, sherds of pottery and tools that have been made out of stone, bone, tooth and antler, cf. Nationalmuseet Danmark, 2016a). Notably, *danefæ* include musket balls (*musketkugler*). As discussed, they are so numerous on battlefield sites that a detectorist and an FLO in England agreed to stop recording them (cf. Ferguson, 2013, p. 142).

Based on finders' fees that have been paid by the Danish National Museum, it has been estimated that there are "at least 200 highly active metal detectorists" (Dobat, 2013, p. 712). Based on the number of objects that have been presented to the Danish National Museum (and the number of reports through which those objects have been presented, cf. Dobat, 2016, p. 52 – Figure 1; Nationalmuseet Danmark, 2016b), it has been estimated that there are "several hundred active detectorist[s]" (according to the Head of the Secretariat for Research and Communication at the Danish National Museum, Mads Schear Mikkelsen, personal communication, August 9, 2016).

Yet, based on membership of detecting clubs, it has been estimated that there are around 700 in total (metal detectorist Hans Christensen, personal communication, 2012, paraphrased by Dobat, 2013, pp. 711–712). It seems unrealistic to assume that the non-reporting detectorists are so much "less active (or less lucky)" (Dobat, 2013, p. 712) that *most* (around 500 of the 700) find *nothing* to report in a year (and, concomitantly, that reported finds represent the "majority" of finds in total (Dobat, 2013, p. 709)). This does not reflect on the professionalism and diligence of those detectorists who do report their finds. Potential members of the Thy-Mors Detector Association, for example, are only considered if they follow existing laws and regulations and they are recommended by existing members, who collaborate with museums in Morsø and Thy (Thy-Mors Detektor Forening, n.d.). Nonetheless, this does bring into question whether the "majority" of detectorists are "highly professional" and report "all" of their finds (cf. Dobat, 2013, p. 713).

Moreover, one explicitly non-commercial group who detect finds for their private collections, WW2 Metal Detecting Denmark (n.d.), have about 1,634 fans. Based on membership of online forums that were identified in Dobat and Jensen's research (Dobat & Jensen, 2016, pp. 70–71), it has been estimated that there are around 2,777 detectorists in total, of which between 1,000 and 2,000 are regular detectorists. Even if 1,000 was accurate, it would reaffirm that most detectorists do not report their finds. Yet "one of the largest [en af de største]" face-to-face clubs (Faurskov, 2015) that was identified in the course of researching this paper, Detektor Danmark (n.d.), has around 3,162 members. This brings into question whether the liberal model of "cooperation and inclusion rather than confrontation and criminalization" has been a "success" (Dobat & Jensen, 2016, p. 70, p. 72; see also Dobat, 2013, pp. 718–719; Dobat, 2016, p. 53). Again, it seems unrealistic to assume that many or most forum members are sufficiently enthusiastic and emotionally rewarded that they have joined community forums, yet so much less active or less lucky that they find nothing to report in a year.

If the majority of Denmark's detectorists are professional and report most of their finds, it is also difficult to explain the uninterrupted year-on-year increases in reports of *danefæ* from 2,879 pieces in 2010 to 9,756 pieces in 2015 (cf. Dobat, 2016, p. 52 – Figure 1; Nationalmuseet Danmark, 2016b). Either the 202 individuals who reported finds in 2011 (cf. Dobat, 2013, p. 712) more than tripled their activity through those years, or they more than tripled the share of their finds that they reported, which would indicate that the ostensibly ethical detectorists were not previously reporting their finds.

Otherwise, the detecting community doubled in size (from "two hundred" to "several hundred") and those detectorists either increased their activity by one-and-a-half times or increased the share of their finds that they reported by one-and-a-half times, which would again indicate a previous lack of reporting. Even that would require 85.60% of Denmark's forum members to be *inactive*, when Marc's (2004) poll suggests that 93.42% of forum members are *active*.

The simplest explanation appears to be that most detectorists in Denmark are non-club-based (i.e. unaffiliated or disorganised) detectorists, which has been attested amongst other detectorist communities, such as in Estonia (cf. Ulst, 2012, p. 39) and Germany (cf. Karl & Möller, 2016, pp. 2–4); and that most detectorists in Denmark are non-reporting detectorists, which has also been attested amongst other detectorist communities, such as in England and Wales (as shown in the present analysis) and Finland (cf. Koivisto, 2014, p. 19). Thus, there have long been a greater-than-estimated number of detectorists, some of whom have become increasingly ethical, due to the efforts of cultural heritage professionals and the small core of already ethical detectorists.

Since Detektor Danmark's (n.d.) Facebook page invites participation from people with other roles, from professional archaeologists to amateur historians, it is prudent to base the estimate on Dobat and Jensen's (2016) open-source statistics. Accounting for Marc's (2004) poll, all of this would indicate that there are actually about 2,594 regular detectorists in Denmark.

Although some finds were reported by non-detectorists, if it is assumed that the "original" core of 202 finders of *danefæ* were ethical detectorists who reported all of their finds, and the increased number of reported finds represented an increased number of ethical detectorists who reported all of their finds, then there would be at least 685 licit detectorists. For the sake of argument, in order to achieve an under-estimate of the number of illicit detectorists, it may be assumed that none of the 685 *danefæ* finders were amongst the 700 club members and that none of the 700 club members found any *danefæ*, perhaps because they assisted on excavations, where any finds constituted excavation material, or because they restricted themselves to detecting where they found absolutely nothing of cultural or historical significance. It is prudent to assume that there are 1,385 licit detectorists in Denmark.

However, unless it is argued that the increases in treasure reporting indicate a sudden and continual shift in *detecting* behaviour from *danefæ*-poor areas towards *danefæ*-rich areas, in continual and direct proportion with the increases in treasure reporting, it must be recognised that the increases in *danefæ* reporting do indicate a change in *reporting* behaviour. Hence, it must be assumed that other active detectorists have been finding *danefæ* and continue to find *danefæ* at the same rate as existing reporters, yet do not report it.

It should be noted that the assumption of an increased number of ethical detectorists both asserts the absolutely ethical behaviour of the finders of *danefæ* and minimises the estimate of the number of illicit detectorists. Counting all *danefæ* reporters and club members separately and excluding all of them, this would concomitantly indicate that there are 1,209 illicit detectorists in Denmark.

3.6. England and wales

3.6.1. Licit detectorists

Discounting far out-of-date estimates of 180,000 (by archaeologists in 1980, cf. Dobinson & Denison, 1995, p. 6), 500,000 (by detectorists in the 1980s, cf. Clark, 2008, p. 10) or 30,000 (by archaeologists in 1995, cf. Dobinson & Denison, 1995, p. 6), there are still quite a wide range of estimates of between 9,000 and 50,000 licit detectorists in England and Wales (Robbins, 2014, pp. 13–14), with outliers that reach 250,000 (according to the Chairperson of Norwich Detectors Club, Graeme Simmonds, 2006).

Based on forum membership, it has been estimated that there are at least 7,331 detectorists in the UK (as of 2nd March 2015, cited by Karl & Möller, 2016, p. 3 – Table 1), which would imply 6,520 in England and Wales. Accounting for the number of detecting clubs, the average number of members per club and the fact that some detectorists are members of multiple clubs, it has been estimated that there are between 9,300 and 10,100 club-based (i.e. affiliated or organised) detectorists in England and Wales (Thomas, 2012, p. 58). Yet, although they may span the UK, UK Detector Net (n.d.) has about 7,798 members; the National Council for Metal Detecting (NCMD) has long had more than 11,000 members (Long, 2015; even though the information was already public and he was speaking at PAS Conference 2016, *Can Detectorists Be Archaeologists?*, NCMD Central Register Representative John Maloney “declined” to reveal the number of members, according to Simkins, 2016); and one group on Facebook, which was identified in the course of researching this paper, has around 14,419 members (Metal Detecting, 2017).

Using a survey of detectorists at commercial rallies to identify the proportion who are not club-based (i.e. unaffiliated or disorganised, 39.8%), it has been estimated that the total population of detectorists may be up to between 15,449 and 16,777 (Thomas, 2012, pp. 58–59, previously, the proportion appeared to be around 50%, cf. Dobinson & Denison, 1995; cited by Richards, Naylor, & Holas-Clark, 2009). A related estimate was 12,415 (Robbins, 2012, v. 1, p. 85n52). However, that was produced by averaging: other survey data and analysis (Thomas, 2009, p. 258), foundational points of which represented activity in 2006; the Portable Antiquities Scheme’s published data on 7,220 club-based (i.e. affiliated or organised) detectorists in 177 detecting clubs (Portable Antiquities Scheme, 2010, p. 15 – Table 1b, 2011, p. 4), which represented activity between 2008 and 2010, and its unpublished data on 1,320 of a believed 2,640 non-club-based (i.e. unaffiliated or disorganised) detectorists (in a survey by Vomvyla, 2008, p. 21), which it marginally reduced to 9,750 in total; an estimate that was presented in the form of the proportion of detectorists within the national population (Barford, 2011b; although it was first made as 10,000 in 2003 and later revised upwards to 16,000, cf. Barford, 2015); and Heritage Action (n.d.) deliberate under-estimate of 8,000, which it adopted in 2005 (and has continued to use), “despite every other estimate being far higher”.

There is also a higher estimate of at least 25,000 club-based (i.e. affiliated or organised) detectorists and “many more casual treasure-seekers” in the UK (according to the National Council for Metal Detecting (NCMD), paraphrased by Ashworth, 2015), which would imply about 22,214 club-based (i.e. affiliated or organised) detectorists in England and Wales. It might be suspected of being an over-estimate, because the original source is a member of the metal-detecting community. However, it has also been agreed by an official at Historic England (cf. Milmo, 2015, 2016). Following the same calculation (in Thomas, 2012, pp. 58–59) that 39.8% of (thus, 14,686) detectorists are non-club-based (i.e. unaffiliated or disorganised), this would suggest a total of 36,900 detectorists in England and Wales. Still, the estimate has not changed despite significant changes in the membership of the estimating organisation, which suggests that it may not be derived directly from data.

Notably, Barford’s (2011b) estimation of the scale of licit detecting in England and Wales was used to infer that the scale of illicit detecting in Austria should be smaller, yet Karl and Möller’s (2016, p. 4 – Table 2) empirical data demonstrated that the proportion of *illicit* detectorists within the population of Austria was perhaps around 59.86% greater than the estimated proportion of *licit* detectorists within England and Wales. Reversing the inference, if the proportion of licit detectorists in England and Wales in 2012 were the same as the proportion of illicit detectorists in Austria in 2016 (at least 1 in 4,106), there would have been at least 13,777 (Thomas, 2012, pp. 58–59).

Considering the freedom and support for detectorists that is provided in England and Wales, it is reasonable to expect a proportionally much larger detecting community than in Austria. Furthermore, as shown in the present analysis, the detecting community in Scotland is also larger than was suggested by estimates that were based on the same data as those for England and Wales. Nonetheless, it is prudent to use open data.

Evidently, the NCMD now has at least 15,000 members, including 313 in Scotland (Bailie & Ferguson, 2017, p. 14 – Table 1; it excludes Northern Ireland, cf. National Council for Metal Detecting, n.d.-a, n.d.-b,). Augmenting those 14,687 organised/affiliated detectorists in England and Wales, who are estimated to constitute 60.2% of the detecting population, with another 9,710, as 39.8% of detectorists are estimated to be disorganised/unaffiliated (Thomas, 2012, pp. 58–59), it may be assumed that there are 24,397 licit detectorists in England and Wales.

3.6.2. Illicit detectorists

It has been estimated that there are between 30–40 and 300–400 illicit detectorists in the UK (Oxford Archaeology, 2009, p. 93 – 9.3.10), which would represent between 27–36 and 266–355 illicit detectorists in England and Wales. The suggestion of 27–36 must be dismissed as a guesstimate, since farmer John Browning had caught 50 illicit detectorists on his farm alone in the years immediately preceding the publication of the Nighthawking Survey in which those numbers were presented (cf. Gooderham, 2009). And the higher estimate must be disregarded, due to its "ten per cent" relationship with the lower estimate, as well as the unlikelihood of one (particularly, one famously monitored) site being targeted by 14.08–18.80% of all of the looters within a territory of 151,140 square kilometres.

The question of numbers and harms in England and Wales is complicated by the legal environment in which detectorists operate. Here, the evidence on licit detecting may contribute to debates over the criminalisation, decriminalisation and legalisation of metal detecting, because it may demonstrate the scale of legal harm.

The number of illicit detectorists in England and Wales may genuinely be lower, because much of what would otherwise be defined as looting – the '*illicit* unrecorded and unpublished excavation of ancient sites to provide antiquities for commercial profit' (Renfrew, 2000, p. 15 – emphasis added) – is *licit*. It is a legal requirement for detectorists to have the landowner's permission (in other words, not to trespass or steal from the landowner); not to disturb Scheduled Monuments or Sites of Special Scientific Interest (in other words, not to commit criminal damage); and to report any known or suspected treasure (for which they are rewarded the market value of the treasure by the state anyway). Otherwise, it is not a heritage crime for them to excavate, refrain from documenting, refrain from sharing, then sell antiquities.

As shown by the present analysis of data from the PAS (Tables 1–5), even if its own conservative estimate of the number of active detectorists is used, most detectorists in England and Wales do not conduct scientific excavation, record or report the excavation *or* record or report their finds. Those licit detectorists cause exactly the same cultural harm in exactly the same way as illicit detectorists, yet they have the landowner's permission to metal-detect and thus the state's permission to dig through archaeological layers unscientifically and to destroy knowledge even about the preserved objects.

Moreover, they encompass and obscure an (inevitably) indeterminable number who do commit crime by looting (and laundering) antiquities from sites where they do not have permission to detect. It is practically impossible to prove that those illicit detectorists are heritage criminals, either because it is difficult to identify them amongst the licit detecting community, or because it is difficult to prove that they have laundered looted antiquities by attributing them to sites where they do have permission to detect. Such false reporting and misleading donation of supposedly detected finds also occur as a result of attempts to earn recognition or prestige (cf. Gundersen, Rasmussen & Lie 2016, pp. 167–168).

Yet there are illicit detectorists, despite the opportunities for minimally regulated licit detecting. Even if every "nighthawk" in Suffolk had tried to loot John Browning's farm in Icklingham and he had caught every one (and while some of the 50 will have come from outside the county, some of the nighthawks within the county will not have gone to the farm), that would imply the existence of around 3,500 nighthawks across England's 48 and Wales's 22 counties. In real terms, this is a further under-estimate, because Suffolk is an under-populated county. If the total for the territory were derived from the presence of 50 illicit detectorists within Suffolk's population of 714,000 in 2009, it would imply the existence of 3,866 illicit detectorists within a population of then 55,200,000 across England and Wales.

Demonstrating that 3,500 is not an outlandish estimate (and is perhaps underestimated by 366), in terms of proportion within the population, it would imply nearly four (3.84) times fewer illicit detectorists in England and Wales than in Austria, when it is far easier for illicit detectorists to operate in England and Wales than in Austria. Hence, it is reasonable to assume that there are 3,500 illicit detectorists in England and Wales. Nevertheless, it is critical to acknowledge that this estimate is merely less inadequate than alternative estimates; this inference is weak, even if comparison with Austria suggests that it may be a weak underestimate rather than a weak overestimate.

A more awkward question then follows, as to how to account for the illicit detectorists, amongst or alongside the 24,397 ostensibly licit detectorists. Manifestly, some detectorists conduct both licit and illicit activity (see Barford, 2012b; United Kingdom Crown Prosecution Service, 2012; see also Lynn News, 2010; the Mirror, 2017). Yet, if this overlap was complete, it would suggest that 14.35% of detecting hobbyists were detector-using criminals. This study's estimate for the number of licit detectorists is compatible with cultural property protection officials' as well as metal detectorists' estimate for the number of licit detectorists. So, it is reasonable to count the types separately.

3.7. Ireland
In the Republic of Ireland, both archaeological investigation and metal detecting are licensed activities. Without a detection permit, it is illegal to possess a metal detector within the grounds of a protected site; to use a sensing device to search for archaeological objects; or otherwise to dig for archaeological objects, with or without a metal detector (National Museum of Ireland, 2016).

Paraphrasing legal advice from the National Museum of Ireland, Metal Detecting Ireland (n.d.) "does not promote, whether by advertising or otherwise, the sale or use of detection devices for the purpose of searching for archaeological objects". Yet, in Ireland, "archaeological objects" include common recent objects "such as coins and militaria", "tokens, buttons, clothes fasteners, thimbles, keys, seals, weights, strap ends and belt mounts" (National Museum of Ireland, 2016). With regard to online communities that were identified in the course of researching this paper, while the Irish Metal Detecting Society's forum has around 384 members (2015) and its Facebook page has around 442 members (n.d.), Metal Detecting Ireland (n.d.) has around 1,207 members.

Naturally, as elsewhere, no individual detectorist or detecting group should be characterised as acting illicitly. For example, as the National Museum of Ireland (2016) notes, non-archaeologists may be given a detection permit because they work "under professional on-site archaeological supervision". Presumably, any publicly-active detectorist must be a licit detectorist. Nonetheless, by analogy with this online community, and Marc's (2004) finding elsewhere that only 93.42% of online detectorists were active detectorists, it is possible to infer that there are perhaps 1,128 illicit detectorists in Ireland.

3.8. The Netherlands

In the Netherlands, the state owns all ownerless cultural property and archaeological excavation is a licensed activity for qualified professionals (Netherlands' Department for the Preservation of Monuments and Historic Buildings, 1988, Ch. 5, Sec. 39, Art. 1). All unexcavated finds must be reported within three days of discovery (NVD-ANP, 1988, Ch. 5, Sec. 47, Art. 1). Thus, until very recently, any digging by an amateur detectorist was technically an illicit excavation (Schriek & Schriek, 2014, p. 231). Since 1st July 2016, it has not been illegal to metal-detect and dig for metal-detected finds, "where the soil is not disturbed deeper than up to thirty centimetres below the land's surface [de bodem niet dieper verstoord wordt dan tot dertig centimeter onder het landoppervlak]", outside protected monuments and archaeological excavations (Koninkrijk der Nederlanden, 2016, Ch. 2, Art. 2.2; see also Vlaanderen is Erfgoed, 2016).

Estimates of the number of metal detectorists have ranged from "a few thousand [Een paar duizend]", who look for "lost coins, jewelry and other items [verloren munten, sieraden en andere voorwerpen]" (according to the Association of Amateur Detectorists, Vereniging De Detector Amateur, Vereniging De Detector Amateur, 2001) to between 35,000 and 45,000 (according to the Moderator of the Coins and Archaeological Finds Club Forum, Munten en Bodemvondsten Club Forum, Jozef Herman, 2016) or 45,000 (according to Kropslavinken, 2013). Based on official statistics on the reporting of finds, there are at least 5,000 detectorists (according to archaeological researcher Johan Nicolay, cited by Witschonke, 2009). Yet, with regard to online communities that were identified in the course of researching this paper, there are 5,430 members in an online forum for metal detecting and magnetic fishing (PiepPiep, n.d.); in forums for coins and soil finds, there are 5,430 in one (Munten Bodemvondsten, n.d.) and 5,730 in another (Bodemvondstenwereld, n.d.). With regard to any public benefit from this activity, despite the increased popularity of coin collecting, there has not been a comparable increase in numismatic scholarship by those collectors (according to then Curator of Medieval and Modern Coinage at the Geldmuseum, Arent Pol, 2009, p. 45).

As elsewhere, there are a range of online communities. For instance, there is another forum, for beachcombers and underwater detectorists, which has 136 members (Strand en Waders Forum, n.d.). They are ostensibly licit detectorists, who restrict themselves to beaches and other "non-archaeological" deposits, such as riversides (or go abroad, from Greece to Indonesia, cf. Blauwmarc, 2006, 2010, who would not take his detector if it was not legal to use).

Although there is a recognised problem with under-reporting or non-reporting of finds, it is implausible that the Netherlands has 35,000–45,000, more than ten times as many licit detectorists as Germany (3,350, inferred from cultural heritage offices' data on registered volunteers, cited by Karl & Möller, 2016, p. 2, – Abb. 1) amongst a population that is less than one-fifth the size. By analogy with the online community, in the light of Marc's (2004) finding elsewhere that only 93.42% of online detectorists are active detectorists, it is possible to infer that there are perhaps 5,353 ostensibly licit detectorists in the Netherlands.

3.9. New Zealand

In New Zealand, it is illegal to conduct unlicensed archaeological activity at any archaeological site, which is any place "associated with pre-1900 activity where there may be evidence relating to New Zealand's history" (Bain, 2015). Unlike Australia's restricted protection of registered sites, New Zealand's definition affords protection to deposits "from the mountains to the sea and everything in between" (Bain, 2015). So, "relic hunters" must "leave artefacts where they find them" (Heritage New Zealand, paraphrased by Gillies, 2015). Yet underdocumented and underanalysed looting persists (Palmer, 2006).

Judging by online forums and social networks that were identified in the course of researching this paper, there are disparate small groups of relic hunters – 30 (swinging NZ, n.d.), 166 (New Zealand Gold Mining & Metal Detecting Equipment for Sale or Swap, n.d.), 201 (New Zealand Fossicking/Prospecting/Metal Detecting Group, n.d.), 373 (Metal Detecting NZ Aotearoa, n.d.). There is one much larger forum, Paydirt (n.d.), which has 2,260 members, but they include gold prospectors as well as metal detectorists. Presumably, all of the metal detectorists limit themselves to recovery of modern losses or identification and non-collection of historic materials. Nonetheless, by analogy with this online community (limited to the smaller groups that exclusively comprise metal detectorists), in the light of Marc's (2004) finding elsewhere that only 93.42% of online detectorists are active detectorists, it is possible to infer that there are perhaps 348 illicit detectorists in New Zealand.

3.10. Northern Ireland

In Northern Ireland, without a licence, it is illegal to possess a "detecting device" in a protected place (Government of the United Kingdom, 1995, Art. 29) and, whether or not it is a protected place, it is illegal to "excavat[e] in or under any land… for the purpose of searching generally for archaeological objects or of searching for, exposing or examining any particular structure or thing of archaeological interest" (Government of the United Kingdom, 1995, Art. 41). There is licensed detecting activity as, for example, Ulster Museum has coordinated metal detecting of river-dredged deposits (Hamlin, 2000, p. 72); still, it is extremely limited.

Licences are only issued to archaeologists and other qualified professionals for the performance of professional work. At the same time, it is legal "to search for objects which are clearly modern in origin, and occur above the present ground surface", with the landowner's permission on unprotected land (according to the Historic Monuments Unit of the Northern Ireland Environment Agency, 14th November 2012, cited by Mortyni, 2013).

Judging by social networks that were identified in the course of researching this paper, there are at least 241 detectorists there (NOrN IRON Detecting, n.d.). Presumably, they are all "always… searching for the farmers [*sic* – farmer's] lost hammer that fell off the tractor" (Liamnolan, 2013). By analogy with this online community, in the light of Marc's (2004) finding elsewhere that only 93.42% of online detectorists are active detectorists, it is possible to infer that there are perhaps 225 illicit detectorists in Northern Ireland.

3.11. Scotland

It is illegal to use metal detectors on scheduled monuments, other protected monuments or other protected areas (from the land of the Ministry of Defence to rural development zones) without a government permit or beyond the limits of any permit, such as by removing any finds (Historic Scotland, 2009, p. 3). Metal detecting can be conducted on private land with landowners' permission. Then, it is illegal not to report all finds of portable antiquities (which comprise a greater range of objects than the "reportable finds" in England and Wales) within one month of discovery (Historic Scotland, 2009, p. 6). Ethical finders are rewarded for finds of treasure trove.

It has been estimated that there are 200 regular detectorists and 300 occasional detectorists in Scotland (Ross, 2010); or 340 (Thomas, 2012, p. 60), 500 (Bland, 2013) or between 500 and 1,000 (according to the Head of the Treasure Trove Unit at the National Museum of Scotland, Stuart Campbell, cited by Ferguson, 2013, p. 261). As noted in the discussion of methods of estimation, a recent review inferred the existence of 520 active detectorists in Scotland, based on the Scottish membership of the NCMD and the level of disorganised or unaffiliated detecting in the far larger sample population of England and Wales (Bailie & Ferguson, 2017, pp. 13–14).

Yet, with regard to online communities that were identified in the course of researching this paper, more than 200 detectorists "dig" "every month" as part of "Toddy's Digs" alone (Irvine, n.d.), while Toddy's Digs Forum's (n.d.) has around 1,549 members in total (and the community appears to be growing, as it has long had more than 1,000 members, cf. Dalton, 2014, p. 32). Detecting Scotland (n.d.) now has around 2,024 members (with which other forums' memberships overlap (e.g. Maxwell-Thomson, 2011).

Theoretically, the existence of mandatory reporting might enable the estimation of licit and illicit detectorists from the number who report finds. However, finds can be reported and registered in different ways, so it is difficult or impossible to establish total numbers of reporting detectorists and reported finds (cf. Nicholson, 2012).

Nonetheless, since there is no evidence of a greater preponderance towards illicit detecting in Scotland than in England and Wales, if the total number of reported finds is low, it might suggest that the total number of local detectorists is lower than it appears (cf. Barford, 2012a). It might also suggest, then, that there are numerous metal-detecting tourists from England and Wales who participate in activities in Scotland, some of whom do not report their finds and thereby establish the "balance" of illicit activity. This might also be corroborated by the non-resident members who were identified by Bailie and Ferguson (2017, pp. 13–14). In fact, only 0.5% of people in England live within 40.23 kilometres of the border with Scotland (Commission on Devolution in Wales, 2012, p. 103), perhaps 139 detectorists, perhaps only 78 of whom would consider travelling across the border for detecting tourism on a regular basis (55.88%, cf. Robbins, 2012; v. 1, p. 93, v. 2, p. 30 – Figure 4.16). However, there may be many more irregular detecting tourists. Scotland is advertised by detecting tourism companies as "unlike England where most places have been emptied", "perfect for treasure hunters" (cited by Bailie & Ferguson, 2017, p. 15).

As there are apparently notable numbers of non-resident or otherwise non-detecting members in online communities for detecting in Scotland, it is prudent not to use the membership of the largest forum; it is reasonable to use Toddy's Digs Forum, which thus allows for up to 20.83% inactivity amongst Scotland's detecting community. Since Marc's (2004) poll elsewhere suggests that about 93.42% of online detectorists are active detectorists, it is reasonable to assume that there are at least 1,447 licit detectorists in Scotland.

3.12. United States

In the United States, permits are required for surface collection, metal detecting and/or excavation of cultural property on federal land or state land (and they are only granted to qualified professionals for the conduct of their professional work). Although metal detectorists must stop and report if they find any historical or cultural objects, "no permit" is required for "recreational" use of metal detectors to search for objects that have "no historical value" (United States Forestry Service, n.d.).

Only permission from the landowner and notification of the state is required for surface collection, metal detecting and/or excavation of cultural property on private land, although it is illegal to collect or excavate human remains or burial goods (Georgia Council of Professional Archaeologists, 2009). The principle of the law for activity on private land encompasses the requirement to obtain permission from the indigenous community for surface collection, metal detecting and/or excavation on sovereign tribal land.

A wide range of open-source evidence was identified in the course of researching this paper. It may be possible to estimate the national population of detectorists from a limited geographical sample. For example, in the 1990s, one estimate suggested that there were about 10,000 detectorists in Florida (Green, 1999, p. 2E), which would imply 1 in 1,576 amongst a statewide population of then 15,760,000; that, in turn, would suggest a total of 177,056 detectorists amongst a nationwide population of then 279,040,000.

In the 2000s, one source suggested that there were more than 3,000 detectorists in Connecticut (according to the President of the Nor'easters Club, Jesse Thompson, cited by Cohen, 2009), which would imply 1 in 1,168 amongst a statewide population of then 3,502,932. That, in turn, would imply a total of 262,647 detectorists amongst a nationwide population of then 306,771,529.

However, the same source also suggested that there were only (at least) 100,000 detectorists in the United States (Thompson, cited by Cohen, 2009), which would imply 1 in 3,070. That divergence may reflect a lack of evidence on a national level. However, it may reflect an apparent abundance of metal-detectable finds in Connecticut, which is “one of the oldest” – or, more accurately, earliest-colonised – “parts of the country” (according to the President of the Yankee Territory Coin Shooters Club, Tony Cwikla, cited by Cohen, 2009).

In the 2000s, there were around 250 permit-holding detectorists in New York (according to the New York Parks Department, cited by Berger, 2006); by the 2010s, there were 548 (in 2013, according to the New York Parks Department, cited by Fanelli, 2014). If those 548 in a city population of then 8,406,000 were scaled up to constitute the detecting community within a national population of then 316,427,395, there would be about 20,628 permit-holding detectorists in the United States. As it is, *according to their own declarations* (or lack of them), none of those 548 detectorists found any historical, palaeontological or archaeological object or any object that was worth more than its face value (according to the New York Parks Department, paraphrased by Fanelli, 2014).

These widely diverging data and estimates highlight the need for caution when approaching any inferences from geographical samples.

Based on a count that there are between 300 and 400 metal detecting clubs in the United States (according to the President of the Federation of Metal Detector and Archeological Clubs, Mark Schuessler, cited by Kwiatkowski Radlich, 2013), it may also be possible to estimate the national population of detectorists from a limited organisational sample.

In the 1990s, the FMDAC represented 12,000 detectorists (Green, 1999, 2E). And, into the 2000s, it still represented more than 300 clubs (Yankee Territory Coinshooters, 2008b, p. 9). By the 2010s, however, its club membership had apparently fallen: to 33 by 3rd January 2015 (Federation of Metal Detector & Archaeological Clubs, 2015) and 13 (in the United States) by 7th August 2016 (Federation of Metal Detector & Archaeological Clubs, 2016). Then, when the FMDAC may have represented 33 clubs (cf. Federation of Metal Detector & Archaeological Clubs, 2015), it represented just 1,200 detectorists (according to Schuessler, cited by Kwiatkowski Radlich, 2013).

While there may be far larger clubs, there are clubs with 45 (e.g. the Mid Florida Historic Research and Recovery Association, cf. Latham, 2009), 50 (e.g. the Boise Basin Search and Recovery Club, cf. Murri, 2014), 80 (e.g. the Nor’easters Club, cf. Pesta, 2013) or 120 members (e.g. Staten Island History Hunters, cf. Randall, 2011). And the Yankee Territory Coinshooters (Yankee Territory Coinshooters, 2008a, p. 3) judged their 100-member club to be “large” (Yankee Territory Coinshooters, 2008a, p. 3). Even assuming that the FMDAC had no individual members at all, 1,200 detectorists in 33 clubs would imply about 36 members per club, which would in turn imply between 10,800 and 14,400 detectorists in the 300–400 clubs across the country.

Yet another estimate suggested that there were 300,000 (club-based, i.e. affiliated or organised) licit detectorists in the United States (according to the Task Force for Detecting Rights Foundation, 2014, cited by Stine & Shumate, 2015, p. 293). Perhaps accounting for unaffiliated or disorganised detectorists, a more recent estimate suggested that there were between 300,000 and 500,000 (seemingly derived from the Task Force for Detecting Rights Foundation, according to Linda Stine, stated in Scott et al., 2015; cited by Brock, 2015). Both of those estimates appear unlikely, particularly as a similarly recent estimate suggested that there were instead between 30,000 and 50,000 (according to the President of the FMDAC, Mark Schuessler, cited by Conti, 2013).

With the available data, it is difficult to distinguish between changes in detecting activity and changes in *club-based* detecting activity, as detectorists may stop participating in organised detecting or stop supporting organised lobbying for detecting, yet continue detecting. If the situation in the United States resembled the situation in the United Kingdom, it would reflect a reduction in detecting. Despite the demonstrable problems in inferring nationwide detecting activity from regional or local data, if those data have any significance, they suggest that there has been a shift away from club-based detecting activity, perhaps because regulation has remained relatively permissive and lobbying has lost importance.

If metal-detecting activity in the United States were assumed to resemble metal-detecting activity in Estonia, where as few as 10–25% of detectorists are members of clubs (Ulst, 2012, p. 39), then the 10,800 to 14,400 club-based (i.e. affiliated or organised) detectorists might imply that the total number of detectorists in the United States reached between 43,200 and 144,000. Unfortunately, the effectively single-sourced estimate cannot be corroborated or even reasonably (under)estimated. It is entirely unusable and excluded from further analysis.

However, it has been more reliably estimated that USA-based detector manufacturers altogether sell about 500,000 devices per year (according to once National Accounts Manager for Bounty Hunter detector-manufacturing First Texas Products, Debra Barton, cited by Yoffe, 2009). Applying an established estimate of the consumption of 0.32 detectors per detectorist per year (Hardy, 2016), this would suggest about 160,000 licit detectorists in the USA (which is close to the extrapolation of the data from the FMDAC).

3.13. Low estimates of the scale of metal detecting by population and area

For ease of use, the estimates of the scale of activity in the sampled territories have been collated for illicit detecting, according to the population of the territory at the time of the production of the data (Table 6) and the surface area of the territory in square kilometres (Table 7); licit detecting, according to the population (Table 8) and the area (Table 9); and overall detecting, according to the population (Table 10) and the area (Table 11).

Table 6. Low estimates of illicit metal detecting by population

Territory	Low estimate	Population at time	Scale by population
Austria	2,091	8,584,926	1 in 4,106
Ireland	1,128	4,640,703	1 in 4,114
Australia	5,119	23,781,169	1 in 4,646
Denmark	1,209	5,707,251	1 in 4,721
Canada	6,503	35,851,774	1 in 5,513
Belgium	1,680	11,285,721	1 in 6,718
Northern Ireland	225	1,851,600	1 in 8,229
New Zealand	348	4,595,700	1 in 13,206
England and Wales	3,500	54,809,100	1 in 15,660
Total	21,803	151,107,944	1 in 6,931

Table 7. Low estimates of illicit metal detecting by area (in square kilometres)

Territory	Low estimate	Territory in sq km	Scale by area
Belgium	1,680	30,528	1 in 18.17
Denmark	1,209	42,916	1 in 35.50
Austria	2,091	83,878	1 in 40.11
England and Wales	3,500	151,140	1 in 43.18
Ireland	1,128	70,283	1 in 62.31
Northern Ireland	225	14,130	1 in 62.80
New Zealand	348	268,000	1 in 770.11
Australia	5,119	7,692,000	1 in 1,502.64
Canada	6,503	9,984,670	1 in 1,535.39
Total	21,803	18,337,545	1 in 841.06

Table 8. Low estimates of licit metal detecting by population

Territory	Low estimate	Population at time	Scale by population
United States	160,000	306,771,529	1 in 1,917
England and Wales	24,397	57,885,400	1 in 2,373
Netherlands	5,353	16,936,520	1 in 3,164
Scotland	1,447	5,373,000	1 in 3,713
Denmark	1,385	5,707,251	1 in 4,121
Belgium	300	11,285,721	1 in 37,619
Total	192,882	403,959,421	1 in 2,094

Table 9. Low estimates of licit metal detecting by area (in square kilometres)

Territory	Low estimate	Territory in sq km	Scale by area
England and Wales	24,397	151,140	1 in 6.20
Netherlands	5,353	41,543	1 in 7.76
Denmark	1,385	42,916	1 in 30.99
United States	160,000	9,372,610	1 in 58.58
Scotland	1,447	78,775	1 in 54.44
Belgium	300	30,528	1 in 101.76
Total	192,882	9,717,512	1 in 50.38

Table 10. Low estimates of overall metal detecting by population

Territory	Low estimate	Population at time	Scale by population
United States	160,000	306,771,529	1 in 1,917
England and Wales	27,897	57,885,400	1 in 2,075
Denmark	2,594	5,707,251	1 in 2,200
Netherlands	5,353	16,936,520	1 in 3,164
Scotland	1,447	5,373,000	1 in 3,713
Austria	2,091	8,584,926	1 in 4,106
Ireland	1,128	4,640,703	1 in 4,114
Australia	5,119	23,781,169	1 in 4,646
Canada	6,503	35,851,774	1 in 5,513
Belgium	1,980	11,285,721	1 in 5,700
Northern Ireland	225	1,851,600	1 in 8,229
New Zealand	348	4,595,700	1 in 13,206
Total	214,685	483,265,293	1 in 2,251

Table 11. Low estimates of overall metal detecting by area (in square kilometres)

Territory	Low estimate	Territory in sq km	Scale by area
England and Wales	27,897	151,140	1 in 5.42
Netherlands	5,353	41,543	1 in 7.76
Belgium	1,980	30,528	1 in 15.42
Denmark	2,594	42,916	1 in 16.54
Austria	2,091	83,878	1 in 40.11
United States	160,000	9,372,610	1 in 58.58
Scotland	1,447	78,775	1 in 54.44
Ireland	1,128	70,283	1 in 62.31
Northern Ireland	225	14,130	1 in 62.80
New Zealand	348	268,000	1 in 770.11
Australia	5,119	7,692,000	1 in 1,502.64
Canada	6,503	9,984,670	1 in 1,535.39
Total	214,685	27,830,473	1 in 129.63

4. Method for estimating the intensity of detecting activity

4.1. Evidence-gathering

Once the number of detectorists had been estimated, it was necessary to estimate the number of hours of detecting, in order to estimate the overall amount of detecting that was conducted in any territory. While evidence from discussion in other languages was used, as elsewhere in this study, systematic sampling was limited to discussion in English, in order to ensure that the samples were reliable and manageable. Many of the discussions were at least somewhat international. Again, potentially relevant sources were checked until the search results were exhausted.

In order to find data and analyses of non-professional, licit and illicit use of metal detectors to find historical and cultural goods, a range of Google Scholar searches were conducted:

“metal detecting” and “illicit antiquities”;

“metal detectors” and “illicit antiquities”;

“metal detecting”, “antiquities” and looting;

“metal detectors”, “antiquities” and looting;

“metal detecting” and ethnography;

“metal detecting” and poll; and

“metal detecting” and survey.

In order to estimate the intensity of detecting activity, several Google searches were conducted:

“how long”, metal, detecting and forum;

“how many hours” and metal detecting (without speech marks);

“how much time” and “metal detecting”;

“how often” and “metal detect”; and

“how often” and “metal detecting”.

Those searches identified at least sixteen detectorist-run surveys—fifteen across seven forums and one on a blog—which spanned twelve years. With regard to detecting time, Marc (2004) asked an international community on TreasureNet; Judy (2008) asked a primarily Canadian community on Canadian Metal Detecting; TreasureHunters (2009) asked an international community on

TreasureNet; Bigscoop (2010) asked an international community on TreasureNet; Buff4 (2012) asked an international community on TreasureNet; Gorgar (2012) asked a primarily American community on Liberty Metal Detecting; Creative Detecting (2012) asked an international community on the UK and European Metal Detecting Forum; MetalDetectorDude (2014) asked an international community on TreasureNet; NjNyDigger (2014) asked a primarily American community on TreasureClassifieds; MTLDTKTR (2014) asked a primarily American community on Adventures in Metal Detecting; TripnBils (2014) asked an international community on TreasureNet; ClaryCoins2003 (2015) asked an international community on the Coin Community Family; Crumble (2016) asked an international community on the Friendly Metal Detecting Forum; Lifted Chevy (2016) asked an international community on the Friendly Metal Detecting Forum; The dane (2016) asked an international community on the Friendly Metal Detecting Forum; and Grizzly (2016) asked an international community on the Friendly Metal Detecting Forum.

Reflecting the language restrictions of the searches and the geographical clustering of online detectorist communities, most participants were based in the United States (including overseas territories from Puerto Rico to Guam), Canada and the United Kingdom, although even some of those were detectorists from other countries who were resident abroad (for example, from Ireland in the United States). There were also participants in other countries and their overseas territories, including Mexico, the Caribbean Netherlands, Argentina, Denmark, Sweden and Australia (as well as ones who did not indicate their country of origin or location).

The ranges' imprecision makes the resultant data difficult to use. In order to ensure an underestimate, regardless, this study measured minimum averages. So, when varying levels of activity were indicated, the lowest level of activity was assumed; when ranges of hours were stated, the lowest number was used.

5. Evidence and interpretation of the intensity of metal-detecting activity

5.1. Existing evidence

A number of academic polls and surveyed were identified. In Austria, 24 detectorists gave answers to a poll on hours of detecting per day and days of detecting per year (cf. Karl, 2011, p. 121 – Figure 6, Figure 7). According to this poll, detectorists in Austria conduct a minimum average of 2.83 h of detecting per day (Table 12) and 29.58 days of detecting per year (Table 13), thus a minimum average of 83.71 h of detecting per year. According to a larger but only summarily reported survey of 133 detectorists in Austria, they detect a mean average of 3.9 h per day for 56 days per year, thus 218.4 h per year (Achleitner, 2011, p. 2, cited in Karl, 2013, p. 120).

Table 12. Poll of hours of metal detecting per day in Austria (adapted from Karl, 2011, p. 121 – Figure 6)

Hours per day (HPD)	Number of metal detectorists (MDs)	Total
1–2	2	2
2–4	13	26
4–6	7	28
6+	2	12
Total	24	68
Minimum average HPD		2.83
Standard deviation		1.40
Margin of error		0.56

Table 13. Poll of days of metal detecting per year in Austria (adapted from Karl, 2011, p. 121 – Figure 7)

Days per year (DPY)	Number of metal detectorists (MDs)	Total
0–9	2	0
10–24	1	10
25–49	14	350
50+	7	350
Total	24	710
Minimum average DPY		29.58
Standard deviation		15.25
Margin of error		6.10

In Denmark, 161 detectorists gave quantifiable answers to a poll on hours of detecting per year; unquantifiable (and henceforth excluded) answers of an unknown number of hours per year were given by 5 and an unidentified other number of hours per year were given by 2 (cf. Dobat & Jensen, 2016, p. 76 – Figure 5). According to this poll, detectorists in Denmark conduct a minimum average of 226.09 h of detecting per year (Table 14).

However, the ranges vary in size and some are very imprecise, so this is a severe underestimate. For comparison, the mean average – based on the midpoints of the closed ranges and the base point of the open-ended highest range of 1,000 or more – is 387.42 h of detecting per year. Yet one of the ranges spans 400 h and another spans 500 h.

In the United Kingdom, prior research has collected both open-source data and novel survey data. Robbins (2012, v. 1, p. 69, 87) extensive analysis of open-source data from detectorist publications used 84 articles from 402 issues across two UK-based detecting magazines between January 1995 and July 2009. That literature review identified 466 acts of detecting, across which the average detectorist was inferred to have detected 6.25 h per day (assuming a standard eight-hour day of detecting, cf. Robbins, 2012, v. 1, p. 87, v. 2, pp. 17–19 – Table 4.1). Since that level of activity was inferred from day-long events, it is useful for estimating the intensity of detecting at community events, but it is unrepresentative of any average level of activity.

Robbins (2012, v. 1, pp. 87–88) questionnaire-based survey targeted detectorists in England and Wales through detecting clubs, who were believed to be exceptionally active because they were members of detecting clubs. That questionnaire received 56 quantifiable responses that stated how long they detected per "event", wherein respondents detected for a mean average of 5.5 h per event

Table 14. Poll of hours of metal detecting per year in Denmark (adapted from Dobat & Jensen, 2016, p. 76 – Figure 5)

Hours per year (HPY)	Number of metal detectorists (MDs)	Total
0–10	5	0
10–50	10	100
50–100	18	900
100–500	84	8,400
500–1,000	34	17,000
1,000+	10	1,000
Total	161	36,400
Minimum average HPY		226.09
Standard deviation		264.06
Margin of error		40.79

(Robbins, 2012, v. 2, p. 16 – Figure 4.2); and 55 quantifiable responses that stated how many days they detected per week. The original analysis used averages of ranges so, for example, responses of 3–4 days per week were calculated as 3.5. They implied a total of 89.5 person-days of detecting per week, thus an average of 1.63 days per week and 9.5 h per week or 496 h per year (cf. Robbins, 2012, v. 2, p. 15 – Figure 4.1, v. 2, p. 20 – Table 4.2). The present analysis uses minimum points of ranges so, for example, responses of 3 to 4 days per week are calculated as 3. These imply a total of 87 person-days of detecting per week, thus minimum averages of 5.5 h per day (Table 15), 1.58 days per week (Table 16) and 8.7 h per week or 452.4 h per year.

The average of 496 h per year in England and Wales may be excluded, because it reflects club-based (i.e. affiliated or organised), "rallying" detectorists, who may represent a very distinct "culture" of detecting. Even then, potential average activity ranges from 83.71 h per year in Austria (Karl, 2011, p. 121 – Figures 6 and 7), to 218.4 h per year in Austria (Achleitner, 2011, p. 2; cited in Karl, 2013, p. 120), to 226.09 h per year in Denmark (Dobat & Jensen, 2016, p. 76 – Figure 5).

It is impossible to say whether it is significant that, in Austria, detectorists' responses to archaeologists implied minimum average hours per year that constituted only 38.33% of those that were implied by detectorists' responses to other detectorists. The irreconcilably wide range of these averages reaffirms the tentative nature of all of this evidence. It is important to bear in mind, because the inferences in this study are consequently tentative.

Table 15. Minimum average hours of metal detecting per day in England and Wales (adapted from questionnaire survey by Robbins, 2012, v. 2, p. 16 – Figure 4.2)

Hours per day (HPD)	Number of metal detectorists (MDs)	Total
2	6	12
4	26	104
8	24	192
Total	56	308
Minimum average HPD		5.5
Standard deviation		2.26
Margin of error		0.59

Table 16. Minimum average days of metal detecting per week in England and Wales (adapted from questionnaire survey by Robbins, 2012 v. 2, p. 15 – Figure 4.1, v. 2, p. 20 – Table 4.2)

Days per week (DPW)	Number of metal detectorists (MDs)	Total
0.5	6	3
1	12	12
1	10	10
2	19	38
2	2	4
3–4	5	15
5–7	1	5
Total	55	87
Minimum average DPW		1.58
Standard deviation		0.86
Margin of error		0.23

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5.2. Netnographic analysis

Robbins (2012), who had not had access to Karl's (2011) research, stated that her estimates of days per year and hours per week were the "only available estimates" (with meaningful numbers of respondents and rigour in collection) and believed that they were "probably higher than the real average", because the survey respondents "likely ... reflect[ed] the more active metal detector users" (v. 1, p. 88). The survey data on club-based (i.e. affiliated or organised) detectorists would have been "more relevant if combined with information on the average number of days detecting done each year by all metal detector users", but the evidence was not available (Robbins, 2012, v. 1, p. 87).

By identifying numerous polls and surveys by detectorists (as well as other professionals and academics) in various countries, this study has made such data available. For example, regardless of the limitations that are faced by all of the discussed sources of evidence, Marc's (2004) poll provides a comparatively large sample. For the record, combined with the minimum average of 2.98 h per day that has been determined in this study, the minimum average of 100.26 days per year according to Marc's (2004) poll may be used to infer a minimum average of 298.78 h per year (Table 17).

However, the present analysis also processes open data from the detectorists' polls and surveys to produce pragmatic estimates of the intensity of detecting activity and thereby the quantity of metal-detected cultural goods. It finds corroborating levels of detecting activity amongst detectorists with distinct day-to-day practices. In light of the resultant estimates of the quantities of cultural property that are extracted through metal detecting, it may be more important to note that Robbins found similar levels of detecting activity to those in this study, which corroborate the foundations of the estimates in the present analysis.

Excluding duplicate answers and reconciling contradictory answers by individual detectorists across multiple polls and/or surveys, the present analysis of open-source data from online communities identified: 90 participants who indicated how long they detected per day *on average*; 162 participants who indicated how many days they detected per week *on average*; and 101 participants who indicated how many hours they detected per week *on average*. Accounting for details of detecting activity that were explained alongside average levels of activity (such as variations due to work, weather, family and health), the testimonies of 101 detectorists were used to produce an estimate of how many hours they detected per year *in practice*.

This study had numerically larger samples than Karl (2011) and Robbins (2012) and numerically more precise samples than Marc (2004), Achleitner (2011), Karl (2011) and Dobat and Jensen (2016). This study also had geographically farther-ranging samples, although many responses were from

Table 17. Minimum average days of metal detecting per year (adapted from Marc, 2004) and minimum average hours per year (according to the minimum average hours per day, as determined by the present analysis)

Days per year (DPY)	Number of metal detectorists (MDs)	Total person-days of detecting per year
3	36	108
36	127	4,572
52	110	5,720
104	291	30,264
365	60	21,900
Total	624	62,564
Minimum average DPY		100.26
Standard deviation		92.50
Margin of error		7.26
Minimum average HPY		298.78

the United States and Canada. Plus, it collected information from discussants who were not (or at least did not appear to be) club-based (i.e. affiliated or organised) detectorists. So, its statistics should be more indicative of average metal detecting activity in practice.

Whether compared to Robbins' mean averages of 5.5 h per day, 1.63 days per week, 9.5 h per week or 496 hous per year (cf. Robbins, 2012, v. 2, p. 20 – Table 4.2), or this study's minimum average of that data as 5.5 h per day, 1.58 days per week, 8.7 h per week or 452.4 h per year, the netnographic analysis has generated quite similar numbers from distinct detecting behaviour.

Table 18. Netnographic survey of minimum average hours of metal detecting per day in principle (derived from Bigscoop, 2010; creative detecting, 2012; Crumble, 2016; Gorgar, 2012; Judy, 2008; Lifted Chevy, 2016; Marc, 2004; MetalDetectorDude, 2014; NjNyDigger, 2014; RaymondGrizzly, 2016; The dane, 2016; TreasureHunters, 2009; TripnBils, 2014)

HPD	MDs	Total
1	2	2
1–2	4	4
1–2.5	1	1
1–4	3	3
1–5	2	2
1.5	2	3
2	15	30
2–2.5	2	4
2–3	5	10
2–4	3	6
2–5	2	4
2–6	3	6
2–8	1	2
2.5	1	2.5
3	9	27
3–4	3	9
3–5	3	9
3–6	1	3
3.5	1	3.5
4	7	28
4–5	1	4
4–6	5	20
5	5	25
5–6	2	10
6	1	6
6–7	1	6
6–8	1	6
7.5–10	1	7.5
8–10	2	16
9–15	1	9
Total	90	268.5
Minimum average HPD		2.98
Standard deviation		1.70
Margin of error		0.35

Based on the testimony of 90 detectorists, the present analysis determined a theoretical average of 2.98 hours' detecting per day (Table 18). And, based on the testimony of 162 detectorists, it determined a theoretical average of 3.01 days' detecting per week (Table 19). These numbers suggest a theoretical average of 9.44 h of detecting per week and 490.88 h of detecting per year (Table 20).

Moreover, Robbins' estimate was derived from an estimate of hours per week that did not (and could not) account for irregular changes to routine. Based on testimonies from 101 detectorists, many of whom detailed variations in work, the influence of the weather, family matters and temporary or permanent changes in their health, the present analysis estimates a practical minimum average of 482.94 h per year (Table 21, although it accounts for other factors and determines a lower pragmatic minimum average).

It may seem counter-intuitive for the practical minimum average to be higher than the theoretical minimum average. However, many long-term restrictions on detecting activity are automatically incorporated into detectorists' assessments of their average levels of activity. Meanwhile, for example, the theoretical minimum average would have reduced dawn-to-dusk weekend outings to the

Table 19. Netnographic survey of minimum average days of metal detecting per week in principle (derived from Bigscoop, 2010; creative detecting, 2012; Crumble, 2016; Gorgar, 2012; Judy, 2008; Lifted Chevy, 2016; Marc, 2004; MetalDetectorDude, 2014; NjNyDigger, 2014; RaymondGrizzly, 2016; The dane, 2016; TreasureHunters, 2009; TripnBils, 2014)

DPW	MDs	Total
0.25	1	0.25
0.5	4	2
0.75	1	0.75
0.75–1	1	0.75
1	35	35
1–2	3	3
1–4	1	1
2	22	44
2–3	10	20
3	31	93
3–4	7	21
3.5	1	3.5
4	6	24
4–5	5	20
4–6	1	4
5	1	5
5–6	5	25
5–7	1	5
6	2	12
7	24	168
Total	162	487.25
Minimum average DPW		3.01
Standard deviation		2.04
Margin of error		0.31

Table 20. Netnographic survey of minimum average hours of metal detecting per week in principle (derived from Bigscoop, 2010; creative detecting, 2012; Crumble, 2016; Gorgar, 2012; Judy, 2008; Lifted Chevy, 2016; Marc, 2004; MetalDetectorDude, 2014; NjNyDigger, 2014; RaymondGrizzly, 2016; The dane, 2016; TreasureHunters, 2009; TripnBils, 2014)

HPW	MDs	Total
0.5	1	0.5
0.75	1	0.75
0.75–1.5	1	0.75
1	2	2
1–1.5	1	1
1–2	1	1
1.33	1	1.33
2	1	2
2–3	1	2
2–4	1	2
2–6	1	2
2–12	1	2
2.5	1	2.5
3	2	6
3–4	2	6
3–5	2	6
3–6	1	3
4	4	16
4–5	2	8
4–6	3	12
4–18	1	4
5	2	10
5–6	2	10
5–10	1	5
6	2	12
6–8	1	6
6–9	1	6
6–15	1	6
6–20	1	6
7–28	1	7
8	4	32
8–10	4	32
8–18	2	16
9	2	18
9–12	1	9
9–30	1	9
10	5	50
10–12	2	20
10–20	1	10
10.5	1	10.5

(*Continued*)

Table 20. (*Continued*)

HPW	MDs	Total
12	2	24
12–14	2	24
12–15	1	12
12–18	1	12
12–20	2	24
12–24	1	12
14	2	28
14–20	1	14
14–21	1	14
14–35	1	14
15	3	45
15–17	1	15
15–20	3	45
16	1	16
16–30	1	16
17	1	17
20	3	60
20–24	1	20
20–30	1	20
21–28	1	21
21–35	1	21
24–36	1	24
25	1	25
30	1	30
45	1	45
Total	101	953.33
Minimum average HPW		9.44
Standard deviation		7.20
Margin of error		1.40

shorter winter hours, whereas the practical average would have accounted for the longer spring and autumn hours and the even longer summer hours.

The estimate of 482.94 h per year enables practical averages of 40.24 h per month or 9.29 h per week (Table 21). Assuming the mean average of 37.1 working hours per week across the European Union (Eurostat, 2016), this is equivalent to 13.02 full-time working weeks of labour per year. Once it has been reduced further, to account for other factors that interfere with detecting activity, this estimate may be used to generate a reasonable measure of the intensity of metal detecting and the quantity of metal-detected cultural goods.

Table 21. Netnographic survey of minimum average hours of metal detecting per year in practice (derived from Bigscoop, 2010; creative detecting, 2012; Crumble, 2016; Gorgar, 2012; Judy, 2008; Lifted Chevy, 2016; Marc, 2004; MetalDetectorDude, 2014; NjNyDigger, 2014; RaymondGrizzly, 2016; The dane, 2016; TreasureHunters, 2009; TripnBils, 2014)

HPY	MDs	Total
24	1	24
36	1	36
36–72	1	36
48–72	1	48
52	2	104
52–104	1	52
70	1	70
104	1	104
104–156	1	104
104–208	1	104
104–312	1	104
104–624	1	104
130	1	130
156	2	312
156–208	2	312
156–234	1	156
156–260	2	312
156–312	1	156
208	4	832
208–260	2	416
208–312	3	624
208–936	1	208
240–260	1	240
260	1	260
260–312	1	260
260–520	1	260
300–360	1	300
312	2	624
312–416	1	312
312–468	1	312
312–780	1	312
338–364	1	338
351–585	1	351
364–606.67	1	364
364–1,248	1	364
365–1,460	1	365
416	3	1,248
416–520	4	1,664
416–936	2	832
468	2	936

(Continued)

Table 21. (*Continued*)

HPY	MDs	Total
468–624	1	468
494	1	494
520	5	2,600
520–624	2	1,040
520–1,040	1	520
547.5	1	547.5
624	1	624
624–728	2	1,248
624–780	1	624
624–1,040	1	624
693.33–832	1	693.33
728	1	728
728–1,040	1	728
728–1,820	1	728
730	1	730
730–1,095	1	730
780	3	2,340
780–884	1	780
780–1,040	3	2,340
832	1	832
832–1,560	1	832
884	1	884
1,040	3	3,120
1,040–1,560	1	1,040
1,092–1,456	1	1,092
1,095–1,460	1	1,095
1,248–1,872	1	1,248
1,300	1	1,300
1,560	2	3,120
1,937–2,119	1	1,937
Total	101	48,776.83
Standard deviation		369.43
Margin of error		72.05
Minimum average HPY		482.94
Minimum average HPM		40.24
Minimum average HPW		9.29

5.3. Method of (under)estimating the quantity of metal-detected cultural property from the rate of reporting

It is prudent to assume that, for one reason or another, detectorists do not detect as much as they claim to do. Detecting is almost exclusively an outdoor activity and weather can interfere with the practicability as well as enjoyability of detecting. Hence, it is important to account for moments of bad weather around the year, seasons of extremely bad weather and other such disruptions to detecting. In the course of researching this paper, searches have identified proxy data that may enable analyses to compensate for such factors. For example, according to Leon's (2005) poll of 151 metal

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detectorists, less than a third (27.81%) would go out in anything worse than drizzle, such as steady rain, heavy rain or a storm.

Manifestly, this can only be used as an indication, as rainfall is normally sporadic and periodic and the categories of the measures are different. Nonetheless, anything from heavy drizzle to light rain can produce rainfall of up to 1 millimetre per hour (United States Geological Survey, 2016), anything from 0.5 millimetres of rain per hour upwards can constitute steady or moderate rain (United States Geological Survey, 2016), and England and Wales receive more than 1 millimetre of rain per day around 156.2 days per year (United Kingdom Meteorological Office, n.d.). Particularly considering the common need to fit detecting around other activities, which limits windows of opportunity for detecting, whether it rains too heavily when they would have detected or whether it rains too heavily before they would have detected, it is conceivable that bad weather might deter up to 72.19% of detectorists from detecting on up to 42.79% of their available days. Such a general indication would also allow for frost or snow on the ground and other such deterrences.

Using evidence from the complete years of the Portable Antiquities Scheme's nationwide operation (1st January 2003–31st December 2015, cf. Portable Antiquities Scheme, 2016), it is possible to calculate variations in the levels of activity across months and seasons, which could account for the weather and more. Beyond the effects of the weather, the data appear to meaningfully reflect the effects of work, holidays and other factors on activity, as the two least active months are December and July. (Though, it must be noted, holidays may involve metal-detecting tourism in other territories.) Strikingly, 33.77% of finds are reported in the spring, while activity remains consistently lower throughout the other seasons. Despite the most similar weather to spring in the autumn and despite the greatest variations in weather between summer and winter, 22.33% of finds are reported in the summer, 23.90% in the autumn and 20.00% in the winter. So, the rate of finds in winter is only 59.22% of the rate of finds in spring (Table 22).

The analysed polls and surveys were carried out at various times across the year. And many surveyed detectorists explicitly accounted for varying conditions in their estimations of their levels of activity. Nonetheless, it is prudent to assume that detectorists' theoretical average levels of activity reflect the best conditions in spring, whereas their real average levels of activity resemble those during worse conditions in summer, autumn and winter.

Table 22. Levels of metal detecting across months and seasons, as measured by reporting of finds in England and Wales (1st January 2003–31st December 2015, derived from Portable Antiquities Scheme, 2016)

Month	Finds	Season	Finds	Season's % of year's finds	% of peak season's finds rate
March	176,801				
April	118,193				
May	72,899	Spring	367,893	33.77	100
June	91,416				
July	63,381				
August	88,463	Summer	243,260	22.33	66.12
September	90,348				
October	84,632				
November	85,350	Autumn	260,330	23.90	70.77
December	61,379				
January	87,256				
February	69,219	Winter	217,854	20.00	59.22
Total	1,089,337				

Problematically, some detectorists also hoard finds, then report them seasonally or annually (Suzie Thomas, personal communication 3rd October 2016). This behaviour may produce apparent troughs and peaks in activity that are at least partially artificial, as they reflect periods of withholding and submission of finds. While this may or may not be a significant practice in England and Wales, by assuming that the variations in reporting represent real variations in detecting, and by reducing all estimates by the maximal amount, the calculations further ensure underestimations.

Reducing all estimates by 40.78%, to convert them from "spring" levels to "winter" levels, thereby compensates for weather, work, holidays and other factors. Such a drastic reduction, on top of all of the other measures for reduction and minimisation, should also compensate for any influences that misdirect calculations towards overestimations, such as the boasts and lies of people who are trying to impress other members of their community and the modesty of people who are trying not to embarrass themselves.

Hence, instead of 482.94 h per year, this study presumes 286.02 h per year, which equates to 23.84 h per month or 5.50 h per week. Assuming the mean average of 37.1 working hours per week across the European Union (Eurostat, 2016), this is equivalent to 7.71 full-time working weeks of labour per year. Notably, this calculation infers a level of detecting activity even lower than in Robbins (2012) survey and Marc's (2004) poll.

6. Estimating the quantity of metal-detected cultural property from the rate of recovery and (under)estimating the quantity of metal-detected cultural property from the rate of reporting

6.1. Method of estimating the quantity of metal-detected cultural property from the rate of recovery

Once the scale and intensity of metal detecting have been identified, it is possible to estimate the quantity of metal-detected cultural property, thus to calculate the impact of metal detecting on archaeological heritage. In England and Wales, including reportable finds that have not been reported, prior research has suggested that 265,413 reportable finds are extracted by 7,350 detectorists per year (Robbins, 2012, v. 1, p. 102), which implies 36.11 reportable finds per detectorist per year, which in turn implies that 63.86% of reportable finds are not reported.

As noted, Heritage Action's Artefact Erosion Counter assumes that 0.69 recordable objects are found per detectorist per week and, thus, that 35.88 reportable finds are found per detectorist per year (Heritage Action, n.d.; notably, HA's counter assumes a lower rate of finds than the PAS's evidence indicates). In relation to the reporting rate at the time of the estimate, this implies that at least 79% of detectorists' finds are not reported. (Though, as noted, when base data are restricted to the period of the PAS's nationwide operation, they suggest that perhaps 70.81% of finds are not reported.)

As suggested by the present analysis of data from the PAS, 13.05 recordable finds are reported to have been found per detectorist per year in England and Wales (Table 2). If detectorists actually conducted their claimed minimum average of 482.94 h of detecting per year, and only found their 13.05 reported reportable finds per year, they would only find 0.03 reportable finds per hour. In other words, they would only find one recordable object per 37 h.

Based on four years' documentation from the Isle of Wight, detectorists estimated that 15 detectorists at each of two clubs rallied 94 days per year and recovered an average of 0.73 reportable finds per detectorist per day (Robbins, 2012, v. 1, p. 103n67). The analyst combined her survey-sourced average of 5.5 h per day and publication-sourced average of 6.25 h per day to generate a mean average of 5.88 h per day, which implied 0.13 reportable finds per hour (Robbins, 2012, v. 1, p. 101n64, p. 101n65).

Nonetheless, even that finds rate appears to be unrepresentatively low, since detectorists would find one reportable find per 7.69 h. Still then, if detectorists actually conducted their claimed minimum average of 482.94 h of detecting per year, they would find 62.80 reportable finds per detectorist per year, which would go far beyond the calculation that is the foundation of Heritage Action (n.d.) Artefact Erosion Counter.

Furthermore, based on five years' documentation from Suffolk, collaborating archaeologists and detectorists counted that 4 detectorists recorded 3,809 finds over 1,206 h of volunteering on an archaeological project (Minter et al., 2016, pp. 7–9; see also Minter et al., 2014, p. 51). This implies 3.16 recordable finds per person per day and, using Robbins' mean average of 5.88 h per day, 0.54 reportable finds per hour. In that case, they would find 260.79 reportable finds per detectorist per year.

6.2. Method of estimating the quantity of metal-detected cultural property from the rate of recovery

Understandably, Robbins (2012, v. 1, p. 101) distrusted her open-source data from detecting magazines, because the sources naturally focused on stories of encouraging successes far more than discouraging failures, so their apparent rate of finds was presumed to be misleadingly high. Yet her (2012, v. 2, p. 36 – Table 4.4) survey produced comparatively close results.

The open-source analysis determined that detectorists recovered perhaps 3.03 reportable finds per day, one recordable object every 1.92 h or 0.52 finds per hour (Robbins, 2012, v. 1, pp. 87–88, p. 101n62, p. 101n63, v. 2, p. 17–19 – Table 4.1), which implied that they recovered between 158 and 256 reportable finds per detectorist per year. It also determined that they recovered perhaps 9.86 material finds per day, one every 0.60 h or 1.68 per hour (Robbins, 2012, v. 2, pp. 17–19 – Table 1), which implies that they recovered between 513 and 832 material finds per detectorist per year.

Meanwhile, the survey suggested that detectorists were active a mean average of 84.4 days (495.85 h) per year and a median average of 52 days (305.50 h) per year (Robbins, 2012, v. 1, pp. 87–88). It determined a total average of 123.5 reportable finds per day amongst 53 detectorists, thus a mean average of 2.3 reportable finds per detectorist per day (Robbins, 2012, v. 2, p. 36 – Table 4.4). In other words, they recovered one recordable object every 2.55 h or 0.39 reportable finds per hour, which implies that they recovered between 120 and 194 reportable finds per detectorist per year. The survey also determined that an average total of 606.5 material finds would be recovered amongst 54 detectorists, thus a mean average of 11.2 material finds per day (Robbins, 2012, v. 2, p. 36 – Table 4.4), one every 0.52 h or 1.91 per hour.

Since the open-source data and the survey data coincide reasonably closely, it is reasonable to assume that they are representative. And they span a far greater range than the detecting clubs' archives and the archaeological project's report, personally, geographically and chronologically. The published testimonies of a wide range of detectorists spanned 466 events of different kinds across the United Kingdom over 175 months, as opposed to the two detecting clubs' records, which spanned about 376 rallies on the Isle of Wight over 48 months (cf. Robbins, 2012; v. 1, p. 87, p. 116, v. 2, p. 36n1), or the archaeological project's report, which presented 1,206 person days' surveying over 60 months (cf. Minter et al., 2014, p. 51; 2016, pp. 7–9). So, it is reasonable to assume that the data from across the UK are more representative than the albeit significant data from the Isle of Wight and Suffolk.

It should also be noted at this point that, in presenting Robbins' data, this study has followed Robbins' use of a mean average of the surveyed detectorists' 5.5 h of detecting per day and the published detectorists' 6.25 h of detecting per day. This produced the mean average of 5.88 h per day, which was used in the analysis and had thus already reduced those surveyed detectorists' self-reported recovery rate by 6.46%.

Still, it is prudent to derive a minimum average from Robbins' survey (which itself had a lower mean average than her open-source analysis), which also solves the problem of the exclusion of the answer of "zero" to the question of the number of finds per day (cf. Robbins, 2012, v. 1, p. 101). This implies at least 1.83 reportable finds per day (or 0.31 per hour, see Table 23) amongst at least 6.48 material finds per day (or 1.10 per hour, see Table 24). Over 286.02 h, detectorists would find 88.67 reportable finds per year (thus, would not report 85.28% of reportable finds) amongst a total of 314.62 material finds per year. This secure underestimate can then be used to estimate the quantity of metal-detected cultural property.

It is possible that the analysed polls' and surveys' data are unrepresentative, perhaps due to an over-representation of younger and older detectorists, who are disproportionately unemployed, underemployed or retired, who thus have more freedom and time to invest in detecting. Retired detectorists, though, are disproportionately prone to health problems that give them less freedom to engage in detecting, which may somewhat compensate for any potential overestimate. Either way, it has been impossible to control for these variables with the available information on detectorists.

Still, across the 35 member states that are monitored by the Organisation for Economic Co-operation and Development (Organisation for Economic Co-operation & Development, 2016) and beyond, younger workers are unemployed more frequently than older workers. Yet both the mean average and the median average age range of detectorists in England and Wales appears to be 45–54 (Thomas, 2012: p. 51 – Figure 2). That group is more likely to have more intense commitments to other matters such as work and family, from children to elderly parents, than its younger and

Table 23. Minimum average number of reportable finds per detectorist per day and per hour (adapted from Robbins, 2012, v. 2, p. 36 – Table 4.4)

Number of reportable finds	Number of metal detectorists (MDs)	Total
1–2	39	39
3–4	10	30
5–6	2	10
7–8	1	7
11+	1	11
Total	53	97
Standard deviation		1.82
Margin of error		0.49
Minimum average of RFPD		1.83
Minimum average RFPH		0.31

Table 24. Minimum average number of material finds per detectorist per day and per hour (adapted from Robbins, 2012, v. 2, p. 36 – Table 4.4)

Total number of finds	Number of metal detectorists (MDs)	Total
0–9	27	0
10–19	21	210
20–29	5	100
40–49	1	40
Total	54	350
Standard deviation		8.05
Margin of error		2.15
Minimum average of MFPD		6.48
Minimum average of MFPH		1.10

Table 25. Comparison of polls and surveys on hours per detectorist per year

Territory	Source	Number of MDs	Min avg HPY
UK	Survey (Robbins, 2012)	55	452.40
International	Poll (Marc, 2004)	624	298.78
International	Netnography	101	286.02
Denmark	Poll (Dobat & Jensen, 2016)	156	226.09
Austria	Survey (Achleitner, 2011)	133	218.40
Austria	Survey (Karl, 2011)	24	83.71

older counterparts. Detectorists who were surveyed in England and Wales claimed to detect far *more* than those who were polled internationally by Marc (Table 25). And this study's calculations are made with estimations of detecting that are *lower* than those that were reported in Marc's poll, which involved more participants than all of the other polls and surveys put together.

7. Application of the rate of recovery to estimate how many cultural objects are extracted by metal detectorists every year

To recap, estimates for numbers of detectorists were derived from online communities for ten territories, in Australia, Austria, Belgium, Canada, Denmark, Ireland, the Netherlands, New Zealand, Northern Ireland and Scotland. Those estimates were augmented in light of a detectorist-run survey of 668 detectorists, which established a measure of inactivity within the community (Marc, 2004). For one territory, England and Wales, the estimate was derived from membership of an association that provides insurance for its members in their activities. For another territory, the United States, the estimate was derived from metal detector sales, based on an established relationship between the consumption of detectors and the number of detectorists (Hardy, 2016).

Derived from the testimony of respectively 53 and 54 detectorists (Robbins, 2012, v. 1, p. 101n64), the present analysis assumed a minimum average rate of 0.31 reportable finds per hour, which was 20.51% lower than the mean average rate of 0.39 reportable finds per hour; and it assumed a minimum average rate of 1.10 material finds per hour, which was 42.41% lower than the mean average rate of 1.91 material finds per hour.

Based on a systematic review and consolidation of detectorist-run polls and surveys, this study determined theoretical minimum averages of 2.98 h per day, according to 90 detectorists (Table 18); 3.01 days per week, according to 162 detectorists (Table 19); and 9.44 h per week, according to 101 detectorists (Table 20). Based on the detailed testimony of 101 detectorists in detectorist-run polls and surveys, this study determined a practical minimum average of 482.94 h per year (Table 21).

Based on a poll of 151 detectorists (Leon, 2005), which indicated variations in detecting according to weather, and records of reports of finds per month over 13 years (Portable Antiquities Scheme, 2016), which demonstrated such variations (Table 22), this study reduced the practical minimum average by a further 40.78%. Thus, it established a pragmatic minimum average of 286.02 h per year.

Definitions of significant finds and requirements for reporting of finds vary amongst the sampled territories. Nonetheless, for the sake of providing the most useable data, estimates have been made according to the distinctions in the permissive system in England and Wales. Quantities have been calculated for reportable finds as well as overall material finds through illicit detecting (Table 26), licit detecting (Table 27) and overall detecting (Table 28).

Table 26. Estimates of minimum average person-hours of illicit detecting per year, number of reportable finds per year and total number of material finds per year, ranked by quantity

Territory	Low estimate	Min avg person-hours per year	Min avg number of reportable finds per year	Total number of material finds per year
Canada	6,503	1,859,988	576,596	2,045,987
Australia	5,119	1,464,136	453,882	1,610,550
England and Wales	3,500	1,001,070	310,332	1,101,177
Austria	2,091	598,068	185,401	657,875
Belgium	1,680	480,514	148,959	528,565
Denmark	1,209	345,798	107,197	380,378
Ireland	1,128	322,631	100,015	354,894
New Zealand	348	99,535	30,856	109,488
Northern Ireland	225	64,355	19,950	70,790
Total	21,803	6,236,094	1,933,189	6,859,703

Table 27. Estimates of minimum average person-hours of licit detecting per year, number of reportable finds per year and total number of material finds per year, ranked by quantity

Territory	Low estimate	Minimum average person-hours per year	Minimum average number of reportable finds per year	Total number of material finds per year
United States	160,000	45,763,200	14,186,592	50,339,520
England and Wales	24,397	6,978,030	2,163,189	7,675,833
Netherlands	5,353	1,531,065	474,630	1,684,172
Denmark	1,385	396,138	122,803	435,751
Scotland	1,447	413,871	128,300	455,258
Belgium	300	85,806	26,600	94,387
Total	192,882	55,168,110	17,102,114	60,684,921

Table 28. Estimates of minimum average person-hours of overall detecting per year, number of reportable finds per year and total number of material finds per year, ranked by quantity

Territory	Low estimate	Min avg person-hours per year	Min avg number of reportable finds per year	Total number of material finds per year
United States	160,000	45,763,200	14,186,592	50,339,520
England and Wales	27,897	7,979,100	2,473,521	8,777,010
Canada	6,503	1,859,988	576,596	2,045,987
Netherlands	5,353	1,531,065	474,630	1,684,172
Australia	5,119	1,464,136	453,882	1,610,550
Denmark	2,594	741,936	230,000	816,129
Austria	2,091	598,068	185,401	657,875
Belgium	1,980	566,320	175,559	622,952
Scotland	1,447	413,871	128,300	455,258
Ireland	1,128	322,631	100,015	354,894
New Zealand	348	99,535	30,856	109,488
Northern Ireland	225	64,355	19,950	70,790
Total	214,685	61,404,204	19,035,303	67,544,624

8. Conclusions

8.1. Measures and applicability

Building on foundational work on open-source analysis (Karl & Möller, 2016), the present study has identified an empirical measure with which numbers of regularly active detectorists can be derived from the size of online forums and social networks (93.42%, cf. Marc, 2004). It has then identified empirical counts of detectorists in relevant territories, which are more reliable and more measurable over time than episodic surveys amongst small groups of unrepresentative detectorists.

This study has established evidence-based estimates of the scale and intensity of metal detecting activity and the quantity of metal-detected cultural goods, which can be applied to open-source data, to replace unevidenced guesstimates, such as that there are "12 million detectorists world wide" (according to an active detectorist in the United States, Floater, 2005). The sampled territories are (or are in) wealthy, secure states, which have strong internal as well as international markets for their cultural goods, and which provide comparatively weakly regulated environments for the metal-detecting and trading of cultural goods. If they were representative of the scale of detecting world-wide, there would still only be 1 in 2,094 or 3,533,906 *licit* detectorists worldwide in a population of 7,400,000,000. Including illicit detectorists, there would only be 1 in 2,251 or 3,287,428 licit and illicit detectorists worldwide (which is counter-intuitively lower, due to the number and sizes of sample populations).

Yet relatively poor detectorists in affluent countries may have great purchasing power in comparison with affluent detectorists in poor countries. Hence, data from affluent countries may overestimate the average number of detectors per detectorist and thereby underestimate the number of detectorists in a territory, according to its detector market. At the same time, netnographic analysis is limited by internet access, which is often coincident with inadequate income at a personal level and inadequate technological infrastructure at a community level. Hence, data from netnographic analysis may seriously underestimate the scale of offline activity in (financially or infrastructurally) poor countries.

8.2. Secure underestimates

Even exclusively in relation to affluent countries, while the estimates are quite secure underestimates, they may be greater or lesser underestimates. The data are manifestly the least worst data, rather than the best, which may make them difficult to compare. For instance, Detecting Wales (n.d.) has around 3,356 members. This does not lessen the implications of the impact of permissive regulation on the preservation of archaeological heritage in England and Wales, so it does not undermine the policy analysis. Nonetheless, it is problematic, as it might suggest a greater scale of detecting in Wales than in England or Scotland, and/or unrepresentative data on detecting in Wales, and/or (more simply) inadequate data on detecting in England and Scotland.

According to prior research, perhaps only 10.56% of Scotland-based detectorists would consider detecting anywhere elsewhere in the United Kingdom, the overwhelming majority of whom would only go as far as England (Bailie & Ferguson, 2017, p. 15). That is easily explained by geography: "only 3.7%" of people in Scotland live within 40.23 kilometres of the border with England (Commission on Devolution in Wales, 2012, p. 103). On the contrary, 48% of people in Wales and 10% of people in England live within 40.23 kilometres of their shared border. Moreover, "large numbers commute" across the border between England and Wales every day (Commission on Devolution in Wales, 2012, p. 103), which increases opportunities for cross-border detecting and for the development of an Anglo-Welsh detecting community.

Hence, the statistics for detecting in Wales may be misleading, due to a significant number of England-based detectorists within the community. Still, perhaps 2,790 England-based detectorists live within 40.23 kilometres of the border with Wales, perhaps only 1,559 of whom would consider traveling across the border for detecting tourism on a regular basis (55.88%, cf. Robbins, 2012, v. 1,

p. 93, v. 2, p. 30 – Figure 4.16). Thus, probably at least 53.55% of the online community for detecting in Wales are detectorists in Wales, which still suggests a far larger detecting community (of around 1,797) than has previously been identified.

This again suggests that the estimate of detectorists in England and Wales is a secure estimate. If the data on Wales were representative of the rest of the United Kingdom (apart from Northern Ireland), there would be around 40,260 across the territories. While this would be somewhat higher than the inference of 36,900 from the estimate of the NCMD and Historic England, it may reflect the participation of irregular detecting tourists, non-resident detectorists and other observing "lurkers". It may also indicate that there is a disproportionately large detecting community in Wales, which may relate to disproportionately high levels of poverty and insecurity in Wales. Either way, it highlights the weakness of the available data. However, it seems unlikely that Welsh detectorists are a minority in Detecting Wales, which unlikelihood suggests that established estimates of detecting in England and Wales are misleadingly low underestimates. Thus, it reinforces the wider findings that there is more unscientific extraction of cultural resources under permissive regulation than under restrictive or prohibitive regulation.

8.3. The quantity of unscientifically extracted cultural assets and the effectiveness of regulation

This study has conducted netnographic surveys that established a pragmatic minimum average of 286.02 h of detecting per detectorist per year. In turn, this secure underestimate of the intensity of metal detecting has enabled secure underestimates of the quantity of cultural property that is extracted through metal detecting. A metal detectorist may be assumed to recover 88.67 recordable finds, amongst a total of 314.62 material finds, per year.

Thus, in England and Wales, licit detectorists recover perhaps 2,163,189 recordable objects in one year (Table 27), while they report an average of 83,795 objects (Portable Antiquities Scheme, 2016), so perhaps 2,079,394 (96.13% of) recordable objects are not reported; illicit detectorists recover perhaps 310,332 recordable objects (Table 26), none of which is reported accurately, though some of those may be laundered by being reported inaccurately. Hence, within this permissive regulatory environment, it appears that licit detectorists cause far more licit cultural harm than illicit detectorists commit criminal damage.

Indeed, 24,397 licit detectorists (or, excluding 4,232–4,328 reporting licit detectorists, 20,069–20,165 non-reporting licit detectorists) cause more licit cultural harm in England and Wales (amongst a population of then 57,885,400) than 18,303 illicit detectorists commit criminal damage in the somewhat restrictive, restrictive or prohibitive regulatory environments of Australia, Austria, Belgium, Canada, Denmark, Ireland, New Zealand and Northern Ireland (amongst a combined population of then 96,298,844). Likewise, 23,569–23,665 non-reporting licit and illicit detectorists in England and Wales cause more licit cultural harm and criminal damage than 19,003 non-reporting licit and illicit detectorists in Australia, Austria, Belgium, Canada, Denmark, Ireland, New Zealand and Northern Ireland. This suggests that permissive regulation is ineffective in minimising harm to heritage assets, whether in the form of licit misbehaviour or criminal damage.

"After more than fifteen years of getting as many as possible of their colleagues to record their finds and detect responsibly", detectorists who engage with archaeologists "have seen little sign of attitudes in the profession, as a whole, changing for the better towards the hobby" (Redmayne & Woodward, 2013). The realistic and still-unfalsified estimate that at least 63.63 or 72.46% (according to the gaps between the PAS's data and Heritage Action's estimates), if not 96.13% (according to the gap between the PAS's data and this study's estimate), of reportable finds are not reported, even after fifteen years of advocacy by responsible, successful and influential figures within the detecting community, may explain why.

Comparing activity across the permissive, restrictive and prohibitive regulatory environments of Australia, Austria, Flanders and elsewhere in Belgium, Canada, Denmark, England and Wales, Ireland, the Netherlands, New Zealand, Northern Ireland, Scotland, and the United States, restrictive and prohibitive regulation appear to be more effective, insofar as there is less overall loss of archaeological evidence. The implementation and observation of effective regulation will also contribute to confidence-building between heritage professionals and metal detectorists, which will reinforce ethical behaviour and thus further advance historical understanding.

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