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Metal-Detecting for Cultural Objects until 'There Is Nothing Left': The Potential and Limits of Digital Data, Netnographic Data and Market Data for Open-Source Analysis

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Abstract: This methodological study assesses the potential for automatically generated data, netnographic data and market data on metal-detecting to advance cultural property criminology. The method comprises the analysis of open sources that have been identified through multilingual searches of Google Scholar, Google Web and Facebook. Results show significant differences between digital data and market data. These demonstrate the limits of restricted quantitative analysis of online forums and the limits of extrapolation of market data with "culture-bound" measures. Regarding the validity of potential quantitative methods, social networks as well as online forums are used differently in different territories. Restricted quantitative analysis, and its foundational assumption of a constant relationship between the size of the largest online forum and the size of the metal-detecting population, are unsound. It is necessary to conduct extensive quantitative analysis, then to make tentative "least worst" estimates. As demonstrated in the sample territories, extensive analyses may provide empirical data, which revise established estimates. In this sample, they corroborate the detecting community's own perception that they are 'beat[ing these sites] to death'.

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

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1. Introduction

Unscientific extraction and private collection of cultural property reduce and distort the archaeological evidence that informs scientific study (e.g., surface-collecting of the archaeological remains of indigenous society in the United States, cf. Shott 2017; for metal-detecting in France, see also Lecroere 2016, pp. 182–84, 188–91). Yet there is a paucity of data (Thomas 2016, p. 141) and the available data are inconsistent. For instance, estimates of the number of metal-detectorists in Europe range from 10,000–15,000 (Rogers 2016), to 100,000 (ARTE 2016), to 200,000–300,000 (André 2004). Moreover, the available data display certain peculiarities, partly due to the neglect in research on the activity, partly due to its situation in a grey market, where it is inherently difficult to distinguish licit from illicit activity, and licit from illicit commodities (Daubney 2017, p. 792). Nonetheless, many cultural objects have been extracted, and are being extracted, by metal-detectorists around the world (Hardy 2017a, p. 40, Tables 26–28). For example, in France, one estimate suggests that at least '520,000 objects ... are looted each year [520,000 objets ... sont pillés chaque année]' (Compagnon et al. 2010, p. 224).

Regarding the countries that have been reviewed in other studies, some sites of the Second World War in Belgium have been 'cleaned out' (WW2Hunter 2012; cf. Hardy 2017a). A range of sites across Belarus, Russia, and Ukraine have been 'empt[ied]' (Hardy 2016b, p. 215). Regarding the countries that have been sampled in this study, in the United States, the number of metal-detectorists is 'growing' (according to historical archaeologist Linda Stine, stated in Scott et al. 2015, cited by Brock 2015). In France, there is 'more and more [plus en plus]' illicit excavation by 'looters [who are] armed with metal-detectors [pilleurs armés de détecteurs de métaux]' (Brun and Triboulot 2017), a 'proliferation of thefts of ancient objects that irremediably damage historical evidence [multiplication des vols d'objets anciens qui détériorent irrémédiablement des témoignages historiques]' (according to archaeo-anthropologist Dominique Corde, cited by Morin 2018). In Hungary, looting by treasure-hunters with metal-detectors has 'seriously grown' (HNCUNESCO 2011, p. 2).

Many practitioners follow the poorly-written letter of the law, but not the manifest spirit, or they violate the letter of the law, but are difficult to prosecute. Some legal and illegal practitioners conduct activity in online communities and/or on other online platforms, where they leave traces of their activity. These data can provide the foundations for preliminary policy analysis, then a reliable evidence base. However, an established method for collecting data has not even been developed for this analysis.

In an attempt to advance knowledge in cultural heritage studies and cultural property criminology, this paper evaluates the potential methods of quantitative and qualitative analysis of metal-detector markets and metal-detecting communities. It is founded on an attempt to use community data to interpret market data, thereby to inform the understanding of community activity. In the course of an ongoing global review, potentially relevant data have been identified for a range of territories. However, the alleged data for Belarus, Russia and Ukraine were unreliable and excluded from further analysis through a study of Eastern Europe (Hardy 2016b, pp. 219–22); other data will be analysed in further regional studies. As noted, this methodological study employs data from France, Hungary and the United States.

1.1. Reasons for Analysis

A standard method—or a standard approach to methods—for gathering open-source evidence has not been established. Quantitative data analysis has been performed as part of longer-standing, primarily qualitative research, wherein official statistics of offline associations have been augmented with insights from survey and ethnography (e.g., Robbins 2012; Thomas 2012). This mixed-methods research has been expanded to consider data from online forums and social networks (e.g., Bailie and Ferguson 2017, although they dismiss their digital data).

Such research enables the observation of behaviour that may otherwise be invisible. However, survey and ethnography are time-consuming, resource-intensive and dependent upon inference from information that has been given by participants. Thus, it may overestimate or underestimate activity when informants' guidance has been misleading, whether due to their vested interests in the findings of the research or the observation bias in their personal experience. While it is another form of ethnography, which faces those and other challenges, netnography may offer a viable alternative research method. Two emerging approaches may be characterised as restricted quantitative analysis and extensive quantitative analysis.

1.1.1. Restricted Quantitative Analysis

Primarily quantitative analyses include restricted studies of online forums. Such research prioritises consistency in the type of source, down to the architecture of the platform: 'it is necessary to restrict comparisons to membership data gathered from the same, rather than different kinds of social media' (Karl 2017, p. 3, note 2; e.g., Karl and Möller 2016). Technically, such research measures interest rather than participation. Implicitly, it assumes a significant correspondence between interest and participation. Otherwise, the level of interest would be irrelevant to any assessment of the efficacy of the regulatory system.

Naturally, such restricted research may include more voluminous, more contemporary and more precise data in relation to online forums than extensive research. However, its methods may be more difficult to reproduce and it intentionally excludes masses of data on the basis of the type of source.

Restricted quantitative analysis may preclude any analysis of activity in territories where the only online communities are social networks, not online forums (e.g., Malaysia, cf. Hardy 2018b; Mongolia, cf. Hardy 2018c). It may severely underestimate the scale of activity in other territories, where the largest online communities interact through smartphone apps or social networks rather than online forums, where offline associations offer goods and services that appeal to more detectorists than the interests and activities of any one online forum, and/or where other empirical indicators register a greater number of detectorists than online forums. For instance, when the seemingly largest online forum at the time had around 4182 members across the United Kingdom (UK Detector Net 2009, as of 10 August 2009), the Portable Antiquities Scheme registered around 4232 detectorists who voluntarily reported finds of a restricted class of cultural objects in England and Wales (PAS 2010, p. 14, Table 1a, for the year of 2008)—and detectorists who report finds are known to constitute only a minority of those who should report finds (cf. Hardy 2017a, p. 4; Robbins 2012, vol. 1, p. 106, note 77). When the seemingly largest online forum in the United Kingdom had around 7760 members at the time (UK and European Metal Detecting Forum 2015, as of 30 June 2015), the National Council for Metal Detecting (NCMD) had more than 11,000 members (Long 2015, as of 20 July 2015). When the same online forum, which explicitly served Europe as well, had around 12,821 members (UK and European Metal Detecting Forum 2017, as of 4 September 2017), one Facebook group, which specifically served the United Kingdom, had around 18,234 members (Metal Detecting 2017, as of 4 September 2017). Indeed, one monitor has observed that online activity in the United Kingdom has recently 'shifted away from forums to Facebook' (Barford 2018a); another has observed that militaria sales in Finland have 'largely' shifted to 'closed Facebook forums [groups or pages]' (Seitsonen 2018, p. 142). Likewise, when the largest online forum for South-East Asia had around 972 members, the largest social network—a Singapore-administered Facebook page for "metal-detecting fanatics" in 'Singapore, Malaysia, Thailand, India, Indonesia, Hong Kong, Japan, Vietnam, Myanmar[/Burma]', and elsewhere (MDFanatic 2016)—had around 52,558 fans (Hardy 2018b); for evidence that an insignificant number of its fans were from India, Hong Kong or Japan, see (Hardy 2018a, 2018c).

Restricted quantitative analysis may even significantly underestimate the scale of activity in territories where the largest online community is an online forum, for which statistics have been published, but to which statistics it does not have direct access. For example, as of 3 November 2017, the seemingly largest online forum with openly-accessible data in Poland had around 24,560 members. Yet the seemingly largest social network with openly-accessible data had around 35,550 fans. Furthermore, the largest online forum with publicly-inaccessible data, for which data had been published in a peer-reviewed article by members of the National Heritage Board of Poland, already had exceeding 58,000 members before 20 October 2016 (Makowska et al. 2016, p. 174; Hardy 2016b, p. 220, for a comparison of the data). So, a restricted analysis of online forums for Poland might underestimate the minimum number of detectorists by 57.66 percent.

1.1.2. Extensive Quantitative Analysis

Primarily quantitative analyses also include extensive studies of not only online forums, but also social networks, smartphone apps and offline associations, plus other empirical indicators as well, such as statistics on detectorist reporters of cultural objects, owners of detectors and sales of detectors. They are even more extensive in data collection, as they include publications of data for any and all such indicators in secondary sources. Such research prioritises consistency in the method of identification of sources (e.g., Hardy 2016b, 2017a, 2017b, 2018a, 2018b, 2018c).

Equally naturally, such research necessarily includes more voluminous, more contemporary and more precise data in relation to social networks, smartphone apps, offline associations and other empirical indicators than restricted research, because it includes any at all. However, its methods are potentially more limited in identification of some data, due to incidental failures to find sources.

Extensive quantitative analysis may significantly underestimate the scale of activity in territories where it fails to find the best sources of data on the largest communities. For instance, a prior, proof-of-concept, open-source analysis identified a range of quantitative data for a range of territories, including another quantitative analysis that covered Austria, where the largest online forum had 2238 members (Hardy 2017a, p. 10; cf. Karl and Möller 2016, p. 4, Table 2, as of 2 March 2015). However, when the data were collected from the online forums and social networks that appeared in the search results (over 11–16 October 2016), the largest forum in Austria then had 2957 members (Ferrum Noricum 2016, on 9 October 2016). The extensive analysis thus did underestimate the minimum number of detectorists by 24.32 percent. Accounting for inactive members (cf. Marc 2004), this would imply that a minimum of 2762 active detectorists exist among a population of 8,584,926 (1 in 3108).

Nevertheless, this method's extensive sources insulate it from severe underestimates. Its open methods and open data enable other research to expand and refine the data on any particular territory or community and, indeed, to expand and refine the methods for all territories and communities. For example, samples could be taken from the identified primary sources (rather than from the published data in the identifying secondary sources) in and/or across geographical, economic or legal clusters. This would eliminate as many variables as possible.

Unfortunately, some sources—such as periodic governmental reports to intergovernmental organisations—will always be somewhat out of date. Still, even those variations can be managed somewhat, through the use of national population data from the time of the metal-detecting data, in order to accurately estimate the scale of activity in the territory.

This paper conducts extensive quantitative analysis with automatically-generated data on online activity amongst metal-detectorists, plus netnographic data and market data on the possession and consumption of metal-detectors, in order to test the potential for their application.

1.2. Targets of Analysis

This proof-of-concept study considers the potential for digital data that are automatically generated by community activity, netnographic data and market data to illuminate the scale of licit and illicit metal-detecting. It:

- considers emerging approaches to quantitative analysis;
- explores the nature of open-source data;
- considers the identification of open-source evidence;
- presents the searches that were conducted for the identification of sources of evidence;
- considers the economic, cultural and statistical factors in interpreting the data;
- presents a method for estimation of the number of metal-detectorists from the number of metal-detectors in a market;
- presents a method for estimation of the number of metal-detectorists from the rate of consumption of metal-detectors in a market;
- uses data from the United States, France and Hungary to empirically assess the potential of these methods;
- discusses methodological flaws and minimum requirements in restricted quantitative analysis and extensive quantitative analysis; and
- discusses the potential for such mixed-methods research to refine understanding of the activity and its impact.

2. Methods

2.1. Nature of Open-Source Evidence

Specifically, open data must be freely accessible, usable, modifiable and shareable 'by anyone for any purpose', possibly under the obligation to attribute the data to their sources and/or to share the data in an equally open way (OKI 2010). It must be "legally open", inasmuch as it is 'available under an open (data) license that permits anyone freely to access, reuse and redistribute' it; and it must be "technically open", inasmuch as it is 'available for no more than the cost of reproduction and in machine-readable and bulk form' (OKI 2010). Generically open-source data—which is also known by terms such as open-source evidence, open-source information, open-source intelligence and open-source material—comprises 'any and all information that can be derived from overt collection: all types of media, government reports and other documents, scientific research and reports' and other documentation, including internet content (Lowenthal 1998). This information 'does not require any type of clandestine collection techniques to obtain' and it is 'obtained through means that entirely meet [any] copyright and commercial requirements' (Lowenthal 1998). So, it may be considered the target of extensive yet traditional library research.

The research method commonly expects scientific verifiability and reproducibility by users who only have access to open-source data—and even researchers, if they are not securely employed by wealthy institutions with expansive libraries, may lack access to much closed-source data. So, open-source research is often limited to online research; and the results are often limited to open-access materials, which are 'free[ly available] for all users with an internet connection' and 'for all legitimate scholarly uses' (Suber 2004). Although, due to everyday findings during research and standard expectations for publications, research materials typically include technically closed-access materials that are freely available in commercial formats, such as texts in externally-searchable Google Books (and, subsequently, internally-searchable online bookshops), plus completely closed-access materials that are practically accessible, such as texts in academic libraries to which researchers have institutional access.

This study concentrates on automatically-generated data, netnographic data and market data. Also known as machine-generated data, automatically-generated data comprise all 'information' that is 'automatically generated from a hardware or software' (Hashem et al. 2015, p. 102, Table 2). Examples include statistics on participation in online forums and social networks, and geodata on locations of participants. Netnographic data comprise ethnographic data from online activity. They are the findings of digital ethnography or virtual ethnography, which seek to 'understand cultural groups' and communities 'within their own environment', including their 'relationships and identities', the 'cultural phenomena that reflect the knowledge and meanings that guide their life' (Gray 2017, p. 14). Examples include the exploration of the practice of metal-detecting for dark heritage in Finland (Thomas et al. 2016). In this context, market data comprise trade data on the detector market. Examples include statistics on types, prices and sales of detectors, plus the location, demographics and consumption of detectorists.

As in any analysis, this evidence may be difficult or impossible to collect or use. Sometimes, it is not possible to collect immediate data from the membership statistics of offline organisations, or to collect proxy data from the membership statistics of online communities. Other times, it is possible to collect such data, yet those data may be unrepresentatively low. For instance, due to the threat of the death penalty for cultural property crime (e.g., in China and North Korea, cf. Hardy 2018c), it may be incredibly risky to organize training, looting, trading and/or trafficking visibly online. Due to a dearth of internet infrastructure (e.g., in Afghanistan and Nepal, cf. Hardy 2018a) or the disruption of internet access (e.g., in Tibet and Xinjiang, cf. Hardy 2018c), it may be very difficult to organise visibly online. Due to expansive geographical ranges, it may be uncommon to organise visibly online in national rather than (internal) regional communities (e.g., in Russia, cf. Hardy 2016b, p. 221, and in the United States, cf. Hardy 2017a, pp. 20–22). Furthermore, due to differing geographical distributions and cultural habits amongst detecting communities, it may be uncommon to organise visibly online in national rather than (international) regional communities (e.g., across South-East Asia, cf. Hardy 2018b), or it may simply be uncommon to organise visibly online at all (e.g., in many territories across South Asia, South-East Asia and East Asia, cf. Hardy 2018a, 2018b, 2018c). In these cases, due to the limited networks of knowledge and practice, it would accordingly be less productive to organise visibly online for those who would do so.

Due to the often fractious nature of community relations, online communities may even be 'formed in opposition to each other' (e.g., in the United Kingdom, cf. Barford 2018a). This reinforces an obvious point. The apparent size of online communities may be increased by the presence of some friends and family of administrators and other organisers, plus some cultural heritage workers who are performing public engagement and/or monitoring those communities. Yet, realistically, significant numbers of online detectorists only participate in smaller online communities and do not participate in the largest online community. Likewise, realistically, significant numbers of active detectorists only participate in offline activity and do not participate in any online community. So, it is unrealistic to assume that the membership of the largest online community is larger than the size of the detecting population. For all of these reasons, the membership of the largest online community is likely to represent a minimum estimate of the detecting population.

However, with other cases, those data may be unrepresentatively high. There may be systematic seeding of fake accounts. For instance, activists may deliberately manipulate statistics, in order to give the impression that there are too many individuals to be managed with prohibitive or restrictive regulations, or cybercriminals may incidentally distort memberships, by the process of making their fake accounts perform human-like behaviour, in order to evade fraud sensors (Hardy 2017b, p. 10). Nevertheless, with due care and attention, it may be possible to collect informative evidence.

In the three sampled countries, the absolute majority of adults use social media. Only counting Facebook, in France, at least 50.59 percent use it (MMG 2017b, as of 31 December 2017); in Hungary, at least 54.70 percent use it (MMG 2017b, as of 31 December 2017); and, in the United States, at least 73.51 percent use it (MMG 2017a, as of 30 June 2017). So, although the quantity and quality of evidence cannot be predicted, it is reasonable to assume that there will be significant evidence of metal-detecting in social media.

2.2. Identification of Sources of Evidence

This material was part of a trawl for evidence around the world. Initial results have already been analysed for Australia, Austria, Belgium, Canada, Denmark, Ireland, the Netherlands, New Zealand, the United Kingdom (for the jurisdictions of England and Wales, Northern Ireland, and Scotland) and the United States (Hardy 2017a); Belarus, Poland, Russia and Ukraine (Hardy 2016b, 2017b); South Asia (Hardy 2018a); South-East Asia (Hardy 2018b); and East Asia (Hardy 2018c).

Initial, English-language Google Web searches in early 2016 included:

- "thousand detectors"
- "thousand * detectors"
- "000 detectors"
- "000 * detectors"
- "million detectors"
- "million * detectors"
- "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)
- "metal detecting" forum, plus the name of the relevant territory

Where these identified estimates for non-Anglophone territories, the relevant searches were repeated in the local languages.

Using open-ended search terms, in order to allow for variations in vocabulary and grammar, and reviewing the first 100 results for each of the searches, further English-language Google Web searches in early 2017 included:

- 50,000 metal detectors sold
- 100,000 metal detectors sold
- 150,000 metal detectors sold
- 200,000 metal detectors sold
- 250,000 metal detectors sold
- 300,000 metal detectors sold
- 350,000 metal detectors sold
- 400,000 metal detectors sold
- 450,000 metal detectors sold
- 500,000 metal detectors sold
- 550,000 metal detectors sold
- 600,000 metal detectors sold
- 650,000 metal detectors sold
- 700,000 metal detectors sold
- 750,000 metal detectors sold
- 800,000 metal detectors sold
- 850,000 metal detectors sold
- 900,000 metal detectors sold
- 950,000 metal detectors sold
- 1,000,000 metal detectors sold

Due to search algorithms' identification of variations of 'bought' as well as 'sold', these should have identified sources that enumerated either the number of detectors that had been sold, or the number of people who had bought detectors. They were particularly significant in refining the evidence in relation to the United States, but they were generally useful in expanding the international evidence base.

To compensate for the false positive results in the open-ended searches, the first 10 results were reviewed for yet more English-language Google Web searches in early 2017:

- "50,000" metal detectors sold
- "50,000 metal detectors" sold
- "100,000" metal detectors sold
- "100,000 metal detectors" sold
- "150,000" metal detectors sold
- "150,000 metal detectors" sold
- "200,000" metal detectors sold
- "200,000 metal detectors" sold
- "250,000" metal detectors sold
- "250,000 metal detectors" sold
- "300,000" metal detectors sold

- "300,000 metal detectors" sold
- "350,000" metal detectors sold
- "350,000 metal detectors" sold
- "400,000" metal detectors sold
- "400,000 metal detectors" sold
- "450,000" metal detectors sold
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- "900,000" metal detectors sold
- "900,000 metal detectors" sold
- "950,000" metal detectors sold
- "950,000 metal detectors" sold
- "1,000,000" metal detectors sold
- "1,000,000 metal detectors" sold

Again, these searches should have identified sources that enumerated either the number of metal detectors that had been sold, or the number of people who had bought metal detectors.

Furthermore, due to U.S. Americans' generation of so much of the netnographic data that enabled the interpretation of the market data, in early 2017, exhaustive Google Web searches were conducted for:

- "detectors sold" "coin shooting"
- "detectors sold" "metal detecting"
- "detectors sold" "metal detectors"
- "detectors sold" "relic hunting"
- "detectors sold" "treasure hunting"
- "detectors sold" United States
- "detectors * sold" "coin shooting"
- "detectors * sold" "metal detecting"
- "detectors * sold" "metal detectors"
- "detectors * sold" "relic hunting"
- "detectors * sold" "treasure hunting"
- "detectors * sold" United States
- "metal detectors * sold"

- “sale * detectors” “coin shooting”
- “sale * detectors” “metal detecting”
- “sale * detectors” “metal detectors”
- “sale * detectors” “relic hunting”
- “sale * detectors” “treasure hunting”
- “sale * detectors” United States
- “sale * metal detectors”
- “sales * detectors” “coin shooting”
- “sales * detectors” “metal detecting”
- “sales * detectors” “metal detectors”
- “sales * detectors” “relic hunting”
- “sales * detectors” “treasure hunting”
- “sales * detectors” United States
- “sales * metal detectors”
- “sell * detectors” “coin shooting”
- “sell * detectors” “metal detecting”
- “sell * detectors” “metal detectors”
- “sell * detectors” “relic hunting”
- “sell * detectors” “treasure hunting”
- “sell * detectors” United States
- “sell * metal detectors”
- “selling * detectors” “coin shooting”
- “selling * detectors” “metal detecting”
- “selling * detectors” “metal detectors”
- “selling * detectors” “relic hunting”
- “selling * detectors” “treasure hunting”
- “selling * detectors” United States
- “selling * metal detectors”
- “sells * detectors” “coin shooting”
- “sells * detectors” “metal detecting”
- “sells * detectors” “metal detectors”
- “sells * detectors” “relic hunting”
- “sells * detectors” “treasure hunting”
- “sells * detectors” United States
- “sells * metal detectors”
- “sold * detectors” “coin shooting”
- “sold * detectors” “metal detecting”
- “sold * detectors” “metal detectors”
- “sold * detectors” “relic hunting”
- “sold * detectors” treasure
- “sold * detectors” “treasure hunting”
- “sold * detectors” United States
- “sold * metal detectors”

Again, excluding the U.S.-specific searches, these also served to expand the international evidence base.

Using open-ended search terms, in order to allow for variations in vocabulary and grammar, English-language Facebook searches in early 2017 included:

- metal detecting France
- metal detecting Hungary
- metal detecting United States
- treasure hunting France
- treasure hunting Hungary
- treasure hunting United States

Also using open-ended search terms, French-language, Hungarian-language and English-language Google Scholar, Google Web and Facebook searches included:

- in English, metal detecting and treasure hunting
- in French, chasseur trésor (treasure-hunter) and détecteur metaux (metal-detector)
- in Hungarian, fémdetektor (metal-detector), fémkereső (metal-detectorist), kincsvadász (treasure-hunter) and kincsvadászat (treasure-hunting)

The Google Web searches were augmented with 'forum'. As for the research for Belarus, Poland, Russia and Ukraine (Hardy 2016b, pp. 218–19), the number and nature of the search terms varied slightly between languages, due to practically redundant searches. These were conducted partly to compensate for any limitations in the researcher's understanding and partly to avoid any quirks in results from the search engines' readings of grammatical differences, such as between "treasure-hunter" and "treasure-hunting" in Hungarian. When collecting the population statistics, all of the relevant online communities were reviewed on 4 September 2017.

2.3. Estimation of the Detectorist Population from the Detector Market

Depending upon the specificity of the data, it may be difficult to infer useful information from changes in the size of certain detector markets, like the United States and Australia. Some consumers may prospect for raw metals rather than worked metals (cf. Nicas 2011). Some producers may also have significant export markets. Manufacturers are reluctant to release useful data, because it is commercially-sensitive information (e.g., Garrett 2005, p. 1). Furthermore, it is difficult or impossible to account for some corners of the market. One such corner is the trade in used detectors. For instance, in Russia, a detectorist recommended one edition of a detector as a first purchase, partly because it sold well on the second-hand market (cf. WalkerSPb 2011). Although it may be a statistically insignificant niche, another corner is the manufacture of home-made, hand-built metal-detectors (e.g., in Indonesia, cf. Hardy 2018b; in China, cf. Hardy 2018c).

Certain detectors are manufactured or sold as toys for children, which may not be commonly used. So, these may distort the apparent size of the visible market, as the data are assumed to represent the sale of detectors as tools for adults. However, a snapshot study found 986 detectors on sale on eBay in the UK: 836 were new tools, 141 were used tools and nine needed to be repaired or to be used as parts to repair other devices; only 38 (3.85 percent) of the 986 were 'detector toys' (Barford 2018b, as of 16 July 2018). Of the 977 functioning devices, 85.57 percent were new, while 14.43 percent were used. It is difficult to use data from eBay to infer the state of the overall market, as some manufacturers and dealers may not sell anything via eBay, while other traders (particularly detector-users) may sell a disproportionately large number of used detectors. Still, these data do suggest that toy detectors are an insignificant component (at most, 4.55 percent) of the occasionally statistically-measured market for new detectors. Accounting for the typically statistically-unmeasured market in used detectors, these data suggest that the overall market for new and used devices may be up to 16.87 percent larger than the visible market in new detectors. So, they offer some reassurance that market data may provide a secure (under)estimate of detector consumption.

It is also difficult to infer useful information from changes in the size of metal-detecting clubs, as they may reflect the impact of public archaeology such as Time Team or fictional media such as the Detectorists, due to which club-based detecting has 'exploded' in the United Kingdom (Lythe 2015; see also Express 2015). Likewise, it is difficult to infer useful information from changes in the size of online forums, social networks and smartphone apps, as they may reflect changes in online engagement amongst those who are already metal-detecting, rather than changes in metal-detecting amongst those who are already engaging online. In other words, some changes may reflect increased or decreased clubbability amongst existing users. They may simply reflect altered clubbability, as existing users change in which clubs, forums and networks they participate.

Nonetheless, from the United States to Australia, detector sales "spike" whenever a "treasure" is found and are "stoked" throughout its recovery (according to the President of Kellyco Metal Detectors, David Auerbach, cited by Garver 2015). In France, 'every report on detecting, even on looting, provokes an increase in sales of metal-detectors [chaque reportage sur la détection, même axé sur le pillage, provoque une augmentation des ventes de détecteurs de métaux]' (according to metal-detector dealers, paraphrased by Compagnon et al. 2010, p. 222; see also Desforges 2009). Thus, there is a relationship, albeit difficult to track, between the number of detectors and the number of detectorists. On the rare occasions where the size of the detector market or the rate of detector sales is known, then, it may be possible to estimate the users of detectors. The number of users can be calculated either by dividing the number of detectors in use by the average number of detectors per user, or by dividing the rate of sales by the rate of consumption.

2.3.1. Economy

Inevitably, once such measures have been developed for one territory, their potential to accurately infer numbers of detectorists in other territories is somewhat dependent upon the existence of similar socio-economic and socio-political conditions. It should be remembered that even relatively poor detectorists in more affluent countries may have significantly greater capacity to augment their toolkits than even relatively affluent detectorists in poor countries. The mean average annual net earnings (take-home pay) are around €33,723 in the United Kingdom, and €28,331 in the United States, from which most of the survey responses came; by contrast, they are around €26,619 in France and €6385 in Hungary (as of 2014, cf. Eurostat 2016; median average annual net earnings are lower).

In relatively poor, relatively insecure societies, the overestimated rate of consumption of detectors will produce an underestimate of the number of detectorists. This underestimation will contribute to the security of the calculations of the scale of detecting. In some cases, the estimated rate of consumption may be inapplicably high, although the prices of detectors may also vary, according to the markets in which they are sold.

In addition, these estimates of ownership and consumption may constitute overestimates, if they are applied to growing markets, where a disproportionate number of consumers are novice detectorists who are assembling a toolkit. Likewise, they may constitute underestimates, if they are applied to shrinking markets, where a disproportionate number of consumers are experienced detectorists who are merely maintaining a toolkit.

2.3.2. Culture

Outside the territories of the sources of its data, any measure's applicability is also somewhat dependent upon the existence of similar detecting practices. Yet detecting "cultures" vary, even among socio-economically similar territories. The market may be influenced by the existence of a cooperative/competitive "culture" of detecting, wherein there is a personal drive to collect detecting devices, in a similar fashion to the drive to collect detected antiquities. There may be a social reward for amassing a personal collection of detecting devices, as they denote investment, expertise and capacity. As evidenced by the sources of the data for the estimations in this study, there appears to be such a cooperative/competitive culture of detecting in the United Kingdom, the United States and Canada.

These estimates of ownership and consumption may thus constitute overestimates, if they are applied to territories where detectorists tend to operate outside "hobbyist" communities. They may also constitute overestimates, if they are applied to territories where there are significant numbers of detector-using career criminals, who do not have a similar emotional investment in the tools of their trade. Such criminals may not even have one detector per detectorist, if they loot in teams and maintain an efficient division of labour, like those who conduct 'trenching' with tractors in Bulgaria (cf. Dikov 2016) and Serbia (cf. Ćirić et al. 2005).

2.3.3. Bias

Membership of an online community may indicate a greater commitment to the activity than non-membership, as is suspected of membership of a face-to-face detecting club (Robbins 2012, vol. 1, p. 88). This may produce an overestimate of the number of detectors per detectorist. However, membership may also reflect social norms around the activity in different countries. Only a small minority of detectorists in Estonia are members of clubs (cf. Ulst 2012, p. 39), yet there is no evidence to indicate that they are "culturally" less active than detectorists in England and Wales, where a far greater proportion are members of clubs (cf. Thomas 2012, p. 58).

There appear to be trends towards cooperative/competitive "cultures" of detecting in North America, Western Europe (Hardy 2017a) and Eastern Europe (Hardy 2016b), wherein significant numbers of detectorists participate in online community activity. Meanwhile, there appear to be trends towards individualistic/secretive "cultures" of detecting in South Asia (Hardy 2018a), South-East Asia (Hardy 2018b) and East Asia (Hardy 2018c), wherein significant numbers of detectorists abstain from online community activity.

Still, these trends vary amongst otherwise comparable countries, as well as between socio-economic and socio-political clusters. So, it cannot be assumed, as in Karl and Möller (2018), that countries that have similar gross domestic product (GDP), internet access and 'other such general indicators' can necessarily be compared to measure the effectiveness of regulation. For instance, evidence indicates higher rates of metal-detecting in Eastern Europe than Western Europe (Hardy 2016b), which correlate with significant differences in legal regulations, economic conditions, internet access and political conditions between Eastern Europe and Western Europe. Yet rates of metal-detecting in Eastern Europe do not correlate directly with differences in legal regulations, economic conditions, internet access or political conditions within Eastern Europe.

Regardless, in any such poll/survey, the evidence will be somewhat skewed, because of status-asserting responses from more senior detectorists, who have had the opportunity to amass large collections; envious responses from more junior detectorists to those more senior detectorists; lamenting comments by long-term detectorists, who have not been able to afford to amass large collections; and defensive comments by long-term detectorists, who do not feel a technical need to acquire more detectors to find more objects or a personal need to keep disused detectors. A desire to impress may lead to the over-representation of detectorists who (claim to) possess or consume an unrepresentatively large number of detectors. This, too, may lead to an overestimate of the number of detectors per detectorist.

Still, most of this study's polls were anonymous, so there was no social reward for an exaggerated answer. Plus, many of the polls' categories encompassed bounded sets or infinite ranges of numbers (such as "between two and five" or "six or more"), which must be assumed to be the lowest possible number, when used in the present analysis. This means that they obscure larger collections and lead to an underestimation. Ultimately, the causes of overestimation and underestimation must at least somewhat counterbalance one another.

More fundamentally, beyond an initial "beginner's" detector and a later "enthusiast's" detector, there are technical reasons for expecting individuals to possess or purchase numerous detectors per detectorist (see Compagnon et al. 2010, p. 200). They could have one or more "sweeping" detectors for identifying targets in various soils and/or water, plus "pinpointing" detectors for extracting targets. Some detectorists may have a different pinpointing detector to complement each sweeping detector (e.g., Rickman 2013). Some transnational detectorists may even keep a range of detectors in each of their hunting grounds (e.g., the United States and the Philippines, cf. kenneth ward 2014).

2.4. Identification of Sources of Evidence: Estimation of the Number of Detectorists from the Number of Detectors in a Market

In order to establish an average number of detectors per user, two Google Web searches were conducted in English:

- "how many detectors" "metal detecting"
- "how many metal detectors" "metal detecting".

The qualifier of "metal detecting" was included to exclude material on security at ports and other checkpoints.

Following the identification of market data for the territories that are discussed in this study, equivalent Google Web searches were conducted in French and Hungarian:

- "combien de détecteurs de métaux" ("how many metal-detectors")
- "combien de détecteurs" "détection de métaux" ("how many detectors" "metal-detecting")
- "combien de détecteurs" "metal" ("how many detectors" "metal")
- "combien de détecteurs" "métaux" ("how many detectors" "metals")
- "hány fémdetektor" ("how many metal-detectors")
- "hány detektor" "fémkeresők" ("how many detectors" "metal-detecting")
- "hány detektor" "fém" ("how many detectors" "metal")
- "hány detektor" "fémek" ("how many detectors" "metals")

3. Results and Discussion of Measures for Estimation of the Detectorist Population from the Detector Market

3.1. Estimation of the Number of Detectorists from the Number of Detectors in a Market

The searches identified at least eight English-language polls and/or surveys across seven forums over the course of seven years, yet no French-language or Hungarian-language equivalents. The identified polls/surveys were conducted by: Judy (2007) in Canadian Metal Detecting, which is predominantly populated by detectorists in Canada; hedgehog (2009) in Detecting Wales, which is predominantly populated by detectorists in the United Kingdom, although hedgehog's survey was excluded, as it enquired how many detectors any participants had had since they first detected; Steve in PR (2009) in TreasureQuest, which is predominantly populated by detectorists in the United States; Kevin (2011) in the Alberta Metal Detecting Forum, which is predominantly populated by detectorists in Canada; charlotte49er (2011) in the Metal Detecting Association of the Carolinas, which is predominantly populated by detectorists in the United States; timesearch (2011) in the UK and European Metal Detecting Forum, which appears to be predominantly populated by detectorists in the United Kingdom; Viking (2011) in American Detectorist, which is predominantly populated by detectorists in the United States; and teamroper (2014) in TreasureQuest. Thus, seven polls were used.

In five, it was impossible to distinguish between the voters in the poll and authors of the comments on the board, so only the votes in the poll were counted (charlotte49er 2011; Kevin 2011; Steve in PR 2009; teamroper 2014; Viking 2011). In two, either participants did not use the poll function (Judy 2007) or the surveyor did not provide one (timesearch 2011), so the data was collated from comments on the discussion board.

Answers of "none" by inactive forum members, and imprecise answers such as "too many" by active forum members, were excluded. In total, at least 2322 detectors were owned by 731 detectorists, wherein the mean average ownership count was 3.18 detectors per detectorist (Table 1).

Table 1. Netnographic surveys of the average ownership of metal detectors (charlotte49er 2011; Judy 2007; Kevin 2011; Steve in PR 2009; teamroper 2014; timesearch 2011; Viking 2011).

# of Devices	# of Owners in Judy (2007)	# of Owners in Steve in PR (2009)	# of Owners in Kevin (2011)	# of Owners in charlotte49er (2011)	# of Owners in timesearch (2011)	# of Owners in Viking (2011)	# of Owners in teamroper (2014)	Total
1+	22	101	1	3	5	12	4	148
2+	21	120	6	10	2	23	12	388
3+	8	92	2	0	1	14	26	429
4+	4	76	0	0	1	24	0	420
5+	2	47	1	0	1	0	0	255
6+	0	31	0	1	0	0	0	192
7+	1	24	3	0	0	0	0	196
8+	0	8	0	0	0	0	0	64
9+	0	3	0	0	0	0	0	27
10+	2	16	0	0	0	0	0	180
23+	1	0	0	0	0	0	0	23
Total	61	518	13	14	10	73	42	
Minimum number of metal-detectors								2322
Minimum number of metal-detectorists								731
Average number of metal-detectors per metal-detectorist								3.18

3.2. Estimation of the Number of Detectorists from the Rate of Consumption of Detectors in a Market

hedgehog (2009) consumption survey in Detecting Wales is augmented with usable evidence from commenters on polls and respondents to surveys by Judy (2007) in Canadian Metal Detecting, Steve in PR (2009) in TreasureQuest, timesearch (2011) in the UK and European Metal Detecting Forum, Viking (2011) in American Detectorist and teamroper (2014) in TreasureQuest, so the sources span Europe and North America.

The sample is insignificant in size, but there is no reason to assume that it is unrepresentative in content, as the sources were general forums with wide ranges of participants, from poor to more affluent, in a range of countries. Plus, of those detectorists who specified the duration of their activity, 76 percent had been active for at least a decade; 60 percent had been active for at least two decades. Such long-term counts should cancel out any peaks and troughs in detector consumption. Also, the compilation of the surveys on the possession of detectors, which was significant in size, concomitantly established the consumption of at least 3.18 detectors per detectorist.

A total of 93 respondents indicated that they had consumed 465 detectors over the course of their engagement in detecting, or 5.00 detectors per detectorist (Table 2). With regard to the respondents who did not specify the duration of their detecting, 298 detectors were consumed by 68 detectorists, or 4.38 detectors per detectorist. With regard to those who did specify, 167 detectors were consumed by 25 detectorists over 530 person-years of detecting, or 6.68 detectors per detectorist over 21.2 years. This very tentatively suggests that there are around 3.17 years between acquisitions, or that 0.32 detectors are consumed per detectorist per year.

Albeit hyperbolically, one detector dealer observed that annual sales of detectors were not immediately representative of the scale of the detector market, because some consumers would lose interest or enthusiasm due to the rarity of high-value finds (cf. Stiles and Piper 2014). It is difficult to account for beginners, some of whom will give up the hobby as insufficiently enjoyable and/or insufficiently rewarding. Some of the disused detectors will remain unused, while some will be resold as used detectors. Nonetheless, excluding beginners, there is an average of 7.52 detectors per detectorist over 25.05 years, or 3.33 years between acquisitions of detectors, or 0.30 detectors per detectorist per year (Table 2). This difference is negligible. Although the wastage of disused yet unresold detectors is inestimable, some detectors are resold and reused by other detectorists, including detectorists who have not bought any new equipment, who are therefore not visible in the market data. The difference between the two averages is thus even smaller than it initially appears. Furthermore, market data include consumption by detectorists who give up the hobby, so exclusion of beginners from the consumption rate might distort the estimate of the scale of detecting. In order to contribute to a secure estimation of the detecting population, this study uses the higher consumption rate of 0.32 detectors per detectorist per year.

Table 2. Netnographic survey of the average consumption of metal detectors (Judy 2007; Steve in PR 2009; teamroper 2014; timesearch 2011; Viking 2011).

Detectorist	Number of Detectors	Years of Detecting
F-I-X	1	N
fsa46	1	N
FULLTIMER	1	N
Glenn	1	N
goldmind	1	N
GPSMapNut	1	N
jbowl101	1	N
Marty	1	N
Mudder	1	N
timesearch	1	N
Tomcat-uk	1	N
zachattack	1	N

Table 2. *Cont.*

Detectorist	Number of Detectors	Years of Detecting
CODY	2	N
coinnut	2	N
cyndy j	2	N
Dano	2	N
Drenthe	2	N
gaz1969	2	N
Jkress	2	N
kestrel	2	N
Kev	2	N
MartinL	2	N
nova74	2	N
PL8MAN	2	N
woody_g	2	N
firstring	3	N
Funkman	3	N
JimD	3	N
Ol Gringo	3	N
Paul Fortier	3	N
Tony Two-Cent	3	N
Vito	3	N
waltonbasinman	3	N
Beachhead	4	N
Bell-Two	4	N
blueonceagain	4	N
Company F	4	N
Cruces Nomad	4	N
Dimeman	4	N
Indeep	4	N
Kenfen	4	N
Philthy Phil	4	N
PIRATE	4	N
DigginDoc	5	N
fertlingjohn	5	N
homefire	5	N
James	5	N
Krose	5	N
RaZR	5	N
reaction	5	N
Rob L	5	N
RobW	5	N
BottyBurp (Kris)	6	N
Ill Digger	6	N
itsaawgood	6	N
plehbah	6	N
r49miner	7	N
Tabdog	7	N
litrfree	8	N
Trys	8	N
Cjtuffy	9	N
Jimbo1965	9	N
charlotte49er	10	N
Monty	10	N
Relic Reaper	10	N
Ytcoinshooter	10	N
dragonsbreath(Paul)	14	N
Calibil	25	N
Howey01	2	1
jrinfoley	2	1
Switch	2	1
Jerry-Wi	3	1
TDWDFX	1	2
majakldragon	4	4
PHIL YNYSBOETH	3	10
ROOSTRTALE	5	14

Table 2. *Cont.*

Detectorist	Number of Detectors	Years of Detecting
coinshooter	2	15
Neilo	7	15
grumpyjohn	3	20
1776	2	23
Lake Simcoe Steve	6	26
hedgehog	7	26
simon c	10	28
Jonola (Jon)	4	30
Neil	5	32
The Doc	5	33
sojourner	11	33
Mole	18	33
Chef Geoff	15	34
Jeb	32	35
CaptKirk	5	37
Kamogawa	6	37
Richy	7	39
Detectorists, total		
Detectors	465	
Detectorists	93	
Detectors per detectorist	5.00	
Detectorists who did not specify duration		
Detectors	298	
Detectorists	68	
Detectors per detectorist	4.38	
Detectorists who specified duration		
Total consumption of detectors and years of detecting	167	530
Detectorists	25	25
Average consumption of detectors and years of detecting per detectorist	6.68	21.2
Years per detector per detectorist		3.17
Detectors per year per detectorist		0.32
Total consumption of detectors and years of detecting per detectorist, excluding beginners	158	526
Detectorists, excluding beginners	21	21
Average consumption of detectors and years of detecting, excluding beginners	7.52	25.05
Years per detector per detectorist, excluding beginners		3.33
Detectors per year per detectorist, excluding beginners		0.30

4. Results and Discussion of the Application of the Methods of Estimation to Detector Market Data

4.1. United States of America

4.1.1. Law

In the United States, it is illegal to 'appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity', on federal lands without federal permission since the Antiquities Act (GUSA 1906, sct. I), which has been reinforced by the Historic Sites Act (GUSA 1935). Only scientific or educational institutions, which deposit their finds in public collections, may receive permits (GUSA 1906, sct. III). The moral right of federal regulation through the Antiquities Act has been challenged by 'artifact hunters' (cf. Goddard 2011, p. 177), while legal opinion on the applicable specificity and 'unconstitutional vagueness' of the Antiquities Act has varied from court to court (cf. Walsh 2003, p. 915). Problematically, this act does not criminalise improper 'sale, purchase, transfer, or transport' (De Meo 1994, p. 27).

Supported by the National Historic Preservation Act, which uses information and funding to 'encourage' the private protection of cultural property (GUSA 1966, art. 306131), the Archaeological

Resources Protection Act (ARPA) covers 'any material remains of past human life or activities' on federal lands that are 'archaeological[ly] interest[ing]' (USDI 1979, sct. 3). A permit from federal authorities is required for any 'excavation or removal', or activity that is 'associated' with the excavation or removal, of archaeological resources (USDI 1979, sct. 4). A permit may only be issued to 'qualified' persons for scientific research; and no permit transfers ownership of archaeological resources (USDI 1979, sct. 4; see also USFS n.d.). It is illegal to 'excavate, remove, damage, or otherwise alter or deface' archaeological resources or to attempt to do so; to 'sell, purchase, exchange, transport, [or] receive' archaeological resources that have been handled illegally or to attempt to do so; or to 'couns[el], procur[e], solic[it], or empl[oy]' others to commit any such violations (USDI 1979, sct. 6). While ARPA excludes less-than-100-year-old objects from the technical category of "archaeological resources", it does not exempt collectors from 'other federal statutes and regulations' against 'trespassing, stealing federal property, etc.'; and federal property that is 'less than 100 years old . . . is still federal property' (Brown 2014).

Although state laws vary, according to metal-detectorists in the United States, state laws are 'model[led]' on federal laws, so they are 'similarly' restrictive, if not more prohibitive (Wiese 2013). Thus, on federal or state lands, surface-collecting, metal-detecting and excavation of cultural objects require permits from federal or state authorities (USFS n.d.). Permits are required to search for 'historic or prehistoric artifacts', to search for 'treasure trove[s]' of deliberately-hidden money, precious-metal coins, plate and bullion (and 'uncounted gems'), and to prospect for raw minerals (USFS n.d.). Archaeological and historic sites on state lands are, '[g]enerally, . . . off limits to metal detecting' (Wiese 2013). Indeed, in Indiana and at least 'a dozen' other states, state permission is required for any intentional 'dig[ging] into an[y] archaeological site[s]', on private lands as well as state lands (Hollowell 2006, p. 104). Nevertheless, "recreational"/hobbyist metal-detecting, which solely targets objects without 'historical value' on federal (or state) lands, (probably) does not require a permit (USFS n.d.).

Federal and state lands encompass most American Indian or Native American (including Alaska Native) and Native Hawaiian lands. Native American tribes, Native Hawaiian organisations and their members typically only require permission from indigenous authorities for excavation or removal of 'archaeological resources' on their own Indian lands (USDI 1979, sct. 4). If there is no indigenous law, then community members require permits from the relevant federal or state authorities. Any permit from federal or state authorities, for excavation or removal of archaeological resources on Indian lands, also requires permission from the relevant community members and/or indigenous authorities (USDI 1979, sct. 4).

The Native American Graves Protection and Repatriation Act (NAGPRA) covers the tangible heritage of Native Americans (including Alaska Natives) and Native Hawaiians on federal and Indian lands. Indigenous human remains and associated funerary objects belong to or are otherwise controlled by descendants or their communities; 'unassociated funerary objects, sacred objects, and objects of cultural patrimony' belong to or are otherwise controlled by their communities (USDI 1990, sct. 3). Any excavation or removal requires a permit from federal authorities, plus consultation with indigenous authorities on federal lands or permission from indigenous authorities on Indian lands (USDI 1990, sct. 3). No federal permit or indigenous permission transfers the ownership of indigenous cultural objects, though indigenous authorities may waive any ownership or control (USDI 1990, sct. 3). Unauthorised commercial handling of indigenous human remains and cultural objects is illegal (USDI 1990, sct. 4).

On private lands, surface-collecting, metal-detecting and excavation of cultural objects require permission from the landowner, as well as prior notification of the state. Still, it is 'generally illegal' to collect or exhume human remains or burial goods (GCPA 2009). These include some indigenous lands.

4.1.2. Statistics

There are numerous local and regional claims for detector-users in general or club members in particular, which do not converge when they are scaled up to a national level. They imply the existence of rates between 1 in 35 (cf. Cardwell 2013), 1 in 1168, and 1 in 15,340 (cf. a collation of open-source statistics in Hardy 2017a, pp. 20–22).

One national claim has asserted that there are 300,000 club-based detectorists (according to the Task Force for Detecting Rights Foundation, as of 2014, cited by Stine and Shumate (2015, p. 293); this appears to have informed an overall estimate of between 300,000 and 500,000, according to Linda Stine, stated in Scott et al. 2015, cited by Brock 2015). Among a population of around 318,563,456 at the time, this implies that the scale of detecting is between 1 in 1062 and 1 in 637. As an outlier without corroborating evidence, this claim has been deemed 'unlikely' (Hardy 2017a, p. 21).

While the largest social network appears to have around 10,955 members (Metal Detecting U.S. Only 2017), mid-sized online forums span 14,289 (cf. Treasure Depot 2017, which displays activity statistics for each theme, yet membership statistics for the platform), 15,863 (TreasureQuest 2017), 24,771 (Thunting 2017), and 46,690 (Friendly Metal Detecting Forum 2017, as of 4 September 2017). Meanwhile, the largest online forum has around 118,367 members (TreasureNet 2017, as of 4 September 2017).

By analogy with this online community, in the light of the then TreasureNet webmaster Marc Austin's poll finding that only 93.42 percent of online detectorists are active detectorists (Marc 2004), it is possible to infer that there are at least 110,578 active detectorists in the United States. Among a population of now around 323,127,513, this suggests that the scale of detecting is at least 1 in 2922.

As an exceptionally expansive territory, these variations in local, regional and national statistics may be due to exceptionally local or regional (as opposed to national) organisations and exceptionally variable rates of detection, between geographically and historically divergent localities and regions. However, it may be possible to infer the number of detectorists from the size of the detector market.

4.1.3. Estimation of the Number of Detectorists from the Size of the Detector Market

Such an inference would still be difficult. The 'world's largest manufacturer of metal detection equipment' (Garrett 2015), for instance, has publicly stated that it would not 'reveal competitive information on the sales' of its detectors (Garrett 2005, p. 1). In the interests of affirming or querying the open-source method's potential to generate proxy data for community statistics, a range of market operators were requested to officially or unofficially corroborate or discount the open-source market statistics. Seven manufacturers did not answer or refused repeated requests for information to confirm or disqualify the open-source data, even in the most generic terms or in the form of private guidance. Nevertheless, some statistics and inferences have been published.

When the hobby was establishing itself across the country, one detector manufacturer alone, White's Electronics, which was then the United States' largest manufacturer, was selling at least 40,000 detectors per year (Franklin 1975, p. 31). According to the established rate of consumption, those sales would imply that this brand alone had a long-term customer base of at least 125,000. Soon after, in total, it was estimated that around 600,000 detectors were consumed by around 1,000,000 hunters of 'coins, jewelry and artifacts' per year (UPI 1979, p. 71), at a rate of 0.6 detectors per detectorist per year. However, at the time of those statistics, hobbyist metal-detecting was still becoming established across the United States (according to the spokesperson for detector manufacturer Wilson-Neuman, Pat Bryan, interviewed by the Cincinnati Enquirer 1984, p. 45). So, there would have been disproportionately many novice detectorists who were assembling toolkits and disproportionately few experienced detectorists who were merely maintaining toolkits. Thus, the apparent consumption rate would have been unrepresentatively close to one detector per detectorist per year. Moreover, that statistic is far out-of-date. It may not reflect either the practices and disposable incomes of detectorists or the quality and variety of detectors anymore.

According to the Associate Director of Consumer Sales for Garrett Metal Detectors, in the early 2000s, around '100,000 recreational metal detectors [we]re sold annually to people who [we]re engaged in the hobby' in the United States (on 12 February 2002, paraphrased by Walsh 2003, p. 905). During the same period, according to the then Corporate Manager for White's Electronics, Alan Holcombe, 'about 150,000 metal detectors [were] sold every year in the United States'; and '99 percent of those

[were] purchased by hobbyists' (paraphrased by Stahlberg 2002). Likewise, a decade earlier, according to the founder of detector distributor Warner Distributing, Scott Warner, '[m]ost [were] in the hands of amateurs' (cited by Golin 1992).

According to former National Accounts Manager for First Texas Products, Debra Barton, in the late 2000s, around 500,000 devices were sold per year ('a half-million a year', paraphrased by Yoffe 2009). There is piecemeal evidence that these numbers could be complementary, as the world's largest detector distributor stated that its 'annual sales ha[d] been growing in the double digits for [those intervening] seven years' (according to the Founder and Chief Executive of Kellyco Metal Detectors, Stuart Auerbach, cited by Wong 2010).

Applying the average consumption rate of 0.32 detectors per detectorist per year (Table 2), sales of between 100,000 and 150,000 detectors per year around 2002 would suggest that an active detecting community of between 312,500 and 468,750 existed. Among a population of around 287,625,193 at the time, this would suggest that the scale of detecting was between 1 in 920 and 1 in 614. Sales of around 500,000 detectors per year around 2009 would suggest an active detecting community of around 1,562,500 (not 160,000, as initially published, due to a misstep in calculation, cf. Hardy 2017a, pp. 20–22). Among a population of then around 306,771,529, this would suggest that the scale of detecting was around 1 in 196.

As suggested by the growth between the early 2000s and the late 2000s, it is prudent to assume that the highest rate is a peak in the market. As when the hobby was establishing itself, the growth indicates that the highest apparent consumption rate will have been distorted by the disproportionately large number of novice detectorists who are assembling toolkits, and the disproportionately small number of experienced detectorists who are merely maintaining toolkits. So, it is prudent to assume that there is a long-term customer base of around 312,500 active detectorists, wherein the scale of detecting is around 1 in 920.

4.2. France

4.2.1. Law

In France, unlicensed excavation has been prohibited since 1945 at the latest, under the Carcopino Law of 1941; metal-detecting for historical and cultural objects has been a licensed activity for scientific investigation by qualified persons since 1991 at the latest, under Law 89–900 of 1989 (Desforges 2009); and metal-detecting on archaeological sites has been a licensed activity since 2001 at the latest (on property that has been acquired since 17 January 2001), under the Civil Code (HAPPAH 2017). However, since an amendment on 24 February 2004, which was intended to strengthen the prohibition on unlicensed metal-detecting of monuments (cf. Legifrance 2004; Service Régional de l'Archéologie n.d.), detectorists have 'used' the amendment 'to get round the ban on detectors' by targeting land without any documented archaeological site (according to a detectorist from the United Kingdom, who resides part-time in France and is a member of metal detecting clubs in France, biro 2012a; see also biro 2012b; they still require permission from landowners).

So, regardless of the body of the 1989 law, technically, 'according to the 2004 appendix', 'they are not on a historical site' (biro 2012a; see also biro 2012b). There, they appear to believe that they cannot be accused of expecting to find 'monuments and objects that may be of interest to prehistory, history, art or archaeology [de monuments et d'objets pouvant intéresser la préhistoire, l'histoire, l'art ou l'archéologie]' (Legifrance 2004, art. L542-1). Nonetheless, as has been demonstrated by data from the Portable Antiquities Scheme (PAS) in England and Wales, 'even in supposedly find-poor regions, numerous hoards still are detected, only that official bodies apparently know nothing about them [Auch in den vermeintlich fundarmen Gegenden werden immer noch zahlreiche Horte entdeckt, nur erfahren die offiziellen Stellen davon offenbar nichts]' (Huth 2013, p. 135).

Under the Law on the Freedom of Creation, Architecture and Heritage, cultural objects 'are presumed to belong to the State [sont présumés appartenir à l'État]' when they are found, either scientifically or accidentally, on properties that have been acquired since 7 July 2016 (Legifrance 2016). The landowners may be compensated for any appropriated objects, to discourage 'concealment [dissimulation]' of cultural property (according to the President of the National Institute for Preventive Archaeological Research (INRAP), Dominique Garcia, quoted in Garcia and Arnaud 2016). On properties that have been acquired before 7 July 2016, cultural objects 'are [temporarily] entrusted, in the public interest, to state services [sont confiés, dans l'intérêt public, aux services de l'Etat]' for scientific study; if the landowners/finders do not assert their property rights after two notifications over two years, the objects may be appropriated without compensation (Legifrance 2016). And the state may 'claim, in the public interest, . . . the ownership of movable archaeological goods [revendiquer, dans l'intérêt public, . . . la propriété des biens archéologiques mobiliers]', for which it will pay compensation (Legifrance 2016). As Leisure Detecting reassured its online community, it is merely a change in property law; 'contrary to the discourse of fear of certain fede[rations] or associations [contrairement aux discours de peurs de certaines fédé ou associations]', metal-detecting 'never has been nor will be prohibited [n'a jamais été ou ne va pas être interdite]' (Détection de Loisir 2017).

It can only be assumed that publicly-active detectorists such as biro are licit detectorists, who operate within the, albeit dysfunctional, law. Nonetheless, it is only permissible to search for 'recently lost objects [objets perdus récemment]'; it is not permissible to 'hunt for treasure [partir à la chasse au trésor]', as is claimed by 'certain dealers and manufacturers [certains vendeurs ou constructeurs]', who 'misinform their clients [désinforment leurs clients]' (according to then President of the National Federation of Metal Detector Users, Pierre Angeli, cited by Thivent 2014). This means that those other detectorists, who do not genuinely restrict themselves to searches for modern losses, are illicit detectorists.

For example, United States-based detectorist Thomas Tanner coyly explained on TreasureNet that he had sold a detector via eBay to a detectorist from 'one of those countries on the European list' of metal-detecting laws that had '"dire sounding" wording[s]' (Tom_in_CA 2012). On another occasion, he revealed that country was France. There, he relayed, the laws 'only applie[d] to public lands, or historic monuments, etc.', so the buyer 'and his friends hunt[ed]' ancient villas on private lands, underneath farmers' fields (anonymous detectorist, paraphrased by Tom_in_CA 2007). 'Or . . . quite frankly', they were 'hunting so far out in the forests that there [was] no one around to "care" anyhow' (anonymous detectorist, paraphrased by Tom_in_CA 2012).

Forest detecting was presented as an alternative to field detecting with the landowner's permission, the discussion of which required surprising "frankness". This suggests that detecting was conducted either on public land or on private land without the landowner's permission. After all, it would not make sense to say that no-one was there to care if it was done, if the landowner had been there and had granted permission for it to be done. In other words, sometimes, the detector-buyer and his friends appeared to have been detecting illegally, as well as unethically.

In addition to metal-detectorists who supply their own collection or sell to other collectors, there are commercial operators who contract metal-detecting services to others (Compagnon et al. 2010, pp. 222–24). There are also metal-detecting tourists, who engage in transnational looting, notably from Belgium, Germany and the Netherlands (Compagnon et al. 2010, p. 205).

4.2.2. Statistics

In France, historic estimates for the number of metal-detectorists include 45,000, 60,000, 80,000 (according to representatives of the trade and the hobby in the 1980s, cited by Compagnon et al. 2010, p. 199) and 100,000 (according to the metal-detector trade, in response to the report and recommendation on Metal Detectors and Archaeology by the Parliamentary Assembly of the Council of Europe in 1981, cited by Compagnon et al. 2010, p. 199), as well as between 50,000 and 70,000 (Birocheau 1983, p. 35). However, they can be discounted, as they are long out of date.

More recent estimates of the number of metal-detectorists range from 6400–6800 (according to numismatist Louis-Pol Delestrée in 2009, cited by Compagnon et al. 2010, p. 200), to 10,000 'very active [très actifs]' ones (according to HAPPAH, paraphrased by Compagnon et al. 2010, p. 200; an archaeologist at INRAP, Jean-Jacques Grizeaud, cited by Challier 2013, and seemingly, the National Council for Archaeological Research, cited by Dubreuil 2013), to 25,000 at most (according to former president of the National Federation of Metal-Detector-Users (FnUdeM), Pierre Angeli, cited by Compagnon et al. 2010, p. 199), to between 25,000 and 80,000 (according to an archaeologist at INRAP, Eric Champault, cited by Thivent 2014), to between 40,000 and 45,000 (according to the President of Halt the Pillage of Archaeological and Historical Patrimony (Happah), Jean-David Desforges, cited respectively by Charrier 2015; AFP 2014), to 60,000 (Dauphiné Libéré 2009); to 70,000 (Conseil de la Concurrence 1997, I.A.2.B.), to 300,000 (according to defence lawyer Antoine Béguin, during the unsuccessful appeal of convicted looter Louis Fontenay in 2001, cited by Compagnon et al. 2010, p. 199). It has also been noted that around 4000 detectorists are very active on detecting forums and trading sites (according to an archaeologist at INRAP, Eric Champault, cited by Thivent 2014).

Between 30 and 50 of those numbers are licensed detectorists, including professional archaeologists (Compagnon et al. 2010, p. 202). However, these are negligible numbers, and archaeologists who use metal-detectors must also comprise some portion of the detector market in other countries, including the detector markets from which the data for possession and consumption of detectors were derived. So, in this case, it is prudent not to augment the estimate.

France has a wide range of local, regional and national online forums and social networks for detectorists. Two seemingly exceptionally large national forums have around 18,436 members (Détecteur 2017) and 21,821 members (Fouilleur 2017a), while the largest social network only has about 4953 fans (Fouilleur 2017b, as of 4 September 2017). It is also the social network of the largest online forum, which reaffirms that detecting communities' visibility in social media may be far less than in reality, as has been documented in Eastern Europe and South-East Asia (Hardy 2016b, 2018b).

By analogy with the largest online community, in the light of Marc's (2004) finding elsewhere that only 93.42 percent of online detectorists are active detectorists, it is possible to infer that there are at least 20,385 active detectorists in France. Among a population of around 66,896,109, this would suggest that the scale of detecting is at least 1 in 3282.

4.2.3. Estimation of the Number of Detectorists from the Size of the Detector Market

In France, in 1987, one metal-detector importer claimed that '60,000 detectors [were] in circulation [60,000 détecteurs sont en circulation]' (cited by Compagnon et al. 2010, p. 199). The average ownership count of 3.18 detectors per detectorist (Table 1), then, would have suggested around 18,868 detectorists. However, that alleged statistic is long out of date. Furthermore, it has been observed that professional and amateur metal-detecting activists first overestimated the number of metal-detectorists, in response to attempts to regulate it, then underestimated the number, in response to challenges by cultural heritage activists (Compagnon et al. 2010, p. 199). At least in the early 1980s, there were only 'some thousands [quelques milliers]' of owners and 'some hundreds of very regular users [quelques centaines d'utilisateurs très réguliers]' (according to an unpublished report by detector dealer Laurent Felices, cited by Compagnon et al. 2010, p. 199).

Between 2011 and 2012, one hobbyist detector manufacturer alone 'sold 25,000–35,000 metal detectors per year—which [was] twice more than the average [s'est vendu 25 000 à 35 000 détecteurs de métaux par an—soit deux fois plus que la moyenne]', which implies that average sales of 12,500–17,500 detectors are made per year (according to the country's first detector manufacturer, Director of Xplorer or XP, Alain Loubet, cited by Thivent 2014). Applying the average consumption rate of 0.32 detectors per detectorist per year (Table 2), this sale rate would imply that Xplorer then had a regular customer base of between 39,063 and 54,688, and a peak customer base (somewhat fewer than) of between 78,125 and 109,375. Then, among a pre-peak population up to 65,027,512, it would have a regular rate between 1 in 1665 and 1 in 1189; among a peak population between 65,342,776 and 65,659,790, it would have a peak rate (somewhat lower than) between 1 in 840 and 1 in 597.

Again, in the interests of affirming or querying the open-source method's potential to generate proxy data for community statistics, market operators were asked to corroborate or discount the open-source market statistics. Currently, on the basis of registered sales, the manufacturer has stated that they 'don't know exactly', but 'are led to believe' that the entire 'French market is around 10,000/20,000 detectors' (XP Metal Detectors 2017), which encompasses the range of its regular customer base before the peak of 2011–2012. While this method is based on open sources, it would be irresponsible not to publish and apply such evidence when it is known to exist. Again applying the average consumption rate of 0.32 detectors per detectorist per year (Table 2), this would imply a long-term domestic market of between 31,250 and 62,500 customers.

It thus would appear that estimates of a total detecting population of 10,000 can be discounted. Inevitably, as the ranges demonstrate, these numbers remain imprecise and inconstant. Still, as in the United States, whatever the actual numbers are, it would appear that exclusive analyses of digital data are inadequate. Among a population of around 66,896,109, this would suggest that the scale of detecting is between 1 in 2141 and 1 in 1070. This would complement the estimation of archaeologists that the scale of detecting in rural areas is around 1 in 1500 (paraphrased by Compagnon et al. 2010, p. 200).

4.3. Hungary

4.3.1. Law

In Hungary, there is some leeway for detecting outside areas of archaeological interest, since some museums cooperate with ostensibly licit detectorists and accept metal-detected archaeological finds; there is some leeway for detecting in areas of archaeological interest as part of scientific research, since some archaeologists collaborate with detectorists on scientific projects (Ujhelyi 2016, pp. 33, 43). Nonetheless, all archaeological heritage that is above ground, underground, or underwater is state property; private ownership is prohibited. Archaeological heritage can only be removed from archaeological sites or "areas of archaeological interest" through licensed scientific excavations or surveys (Ujhelyi 2016, p. 21). Export of any more-than-50-year-old cultural object is a licensed activity, while 'traffic in archaeological objects is practically in its entirety a part of the black market', primarily the international market (HNCUNESCO 2011, p. 2).

4.3.2. Statistics

Although the sources are not specified, the Hungarian National Commission for the United Nations Educational, Scientific and Cultural Organization has reported estimates of 'more than a thousand fortune hunters ... with metal detectors', who 'destroy sites through quick predatory excavations' (HNCUNESCO 2011, p. 2). The seemingly largest online forum appears to have around 967 members (Fémkeresők Honlapja Fóruma 2017). Meanwhile, social networks include a group for the sale-purchase or exchange of detectors and accessories amongst users, which has around 2226 members (Fémkereső és tartozékai adásvétel-cserebere 2017), and a Budapest-based online shop for detectors, which has around 3059 fans (Fémdetektor webáruház 2017, as of 4 September 2017).

By analogy with the largest social network, in the light of Marc's (2004) finding elsewhere that only 93.42 percent of online detectorists are active detectorists, it is possible to infer that there are at least 2858 illicit detectorists in Hungary. Among a population of around 9,817,958, this would suggest that the scale of detecting is at least 1 in 3435.

4.3.3. Estimation of the Number of Detectorists from the Size of the Detector Market

Sellers have estimated that at least 4000 detectors are privately owned in Hungary (Szabó 2009, p. 129, translated by Ujhelyi 2016, p. 3). The average ownership count of 3.18 detectors per detectorist (Table 1), then, would have suggested only 1258 detectorists. Among a population that was then around 10,022,650, it would have suggested that the scale of detecting was around 1 in 7967. However, the automatically-generated data suggest a significantly greater number of detectorists. Since Hungary had the lowest median average annual net earnings of the territories under discussion, it is logical that detectorists in Hungary would consume fewer detectors than detectorists in the countries that were the sources of the netnographic data. Thus, it is predictable that these measures are inapplicable with data from affluent societies. In Hungary as elsewhere, some detectorists also use home-made, hand-built metal-detectors (e.g., discussion under figuraferi 2007).

5. Discussion

5.1. Methodological Flaws and Minimum Requirements

5.1.1. Online Forums and Social Networks

Restrictive quantitative analysis only analyses online forums, because they supposedly 'serve particular needs' that other platforms do not and cannot (Karl 2017, p. 3). Yet, when one online forum for France had more than 7500 members, it was judged that 'only 400 or 500 people were truly active on all of the forums [seules 400 ou 500 personnes sont vraiment actives sur l'ensemble de ces forums]' (Compagnon et al. 2010, p. 214). Apart from the primary need that is fulfilled by social networks, unified online social life, many online detectorists do not significantly use any special functions; many limit themselves to private messaging and other general functions, or simply lurk as readers.

It is important to note that a lack of visible online activity by online community members is not evidence of a lack of online activity, let alone a lack of offline activity. In general, online community members who lurk invisibly appear to outnumber members who post visibly. However, while posters 'are more engaged and may have higher expectations' than lurkers, there are 'no significant differences' in their reasons for membership; and, while some online communities organise offline activities, those activities have 'no significant affect [sic–effect]' on engagement in posting and lurking (Nonnecke et al. 2006, p. 11, Table 1). Based on a survey across 375 online communities, 53.9 percent of lurkers found that 'just reading/browsing [was] enough'; only 7.3 percent of lurkers did not post in those communities because they were the 'wrong' places for them to post (Nonnecke et al. 2006, p. 13, Table 4). In other communities, such wrongness may indicate an unclear name and/or purpose for the community (Preece et al. 2004, p. 220). However, that is unlikely when communities for metal-detectorists and treasure-hunters invariably identify themselves as communities of metal-detectorists and treasure-hunters. Instead, that wrongness may have significantly encompassed 5.9 percent who felt 'concern about aggressive or hostile responses', and 1.4 percent who felt that the community 'treat[ed] new members badly' (Nonnecke et al. 2006, p. 13, Table 4), rather than any whose identity or activity was not represented by the community in any way. A greater proportion, 7.8 percent, did not post because they simply did 'not know how to post' (Nonnecke et al. 2006, p. 13, Table 4). Indeed, again 7.8 percent did not post because of the 'poor quality of [the] messages or [the] group' (Nonnecke et al. 2006, p. 13, Table 4), which indicated online inactivity because of exceptional enthusiasm for the target activity. This survey appears to corroborate the assumption that online membership statistics significantly represent offline community populations.

Furthermore, as demonstrated, online detectorists do not only use online forums. Detectorists not only use different structures for online social organisation, but themselves identify the use of different structures in different territories, such as online forums in the United Kingdom and the United States and social networks and smartphone apps in Malaysia (e.g., Borneo_Bleeper, 12 December 2016, paraphrased by Hardy 2018b). Indeed, in comparison with Europe and North America (Hardy 2016b, 2017a), there appears to be a dearth of online forums in territories across Asia (Hardy 2018a, 2018b, 2018c), Africa, and South America (Hardy 2016a).

Other citizens and businesses in developing countries are leapfrogging "traditional" stages of information and communications technology (ICT), such as landline telephones and desktop computers, and immediately adopting advanced ICT, such as smartphones and Wi-Fi internet (cf. Rice-Oxley and Flood 2016). It appears that, in the same way, detectorists in developing countries are leapfrogging "traditional" stages of social organisation, such as online forums, and immediately establishing social networks.

So, unless they are studying particular communities, it is illogical for researchers to analyse only online forums. Extensive research is not just beneficial, but essential. Furthermore, as demonstrated by the evidence from South-East Asia, even extensive analysis of trends in national social organisation may underestimate activity in territories with trends towards transnational social organisation (Hardy 2018b).

5.1.2. Digital Data Analysis

It has been argued that, 'if his [Hardy 2017a, pp. 15–17, 20–22] data and "estimates" for England and Wales, and the United States, were correct, the number of members of the largest "national" discussion board would be utterly useless for any transnational comparisons' (Karl 2017, p. 11), because it 'could represent anything between c. 107% of all active metal detectorists in any country, and as little as 7% of them, a difference of over one and a half orders of magnitude' (Karl 2017, p. 11). This would appear to approach the analysis backwards, as it assumes that its chosen data set is accurate, then rejects contrary data, rather than trying to understand any disparity. Contrary to claims that restricted quantitative analysis has been 'seriously misused' (Karl and Möller 2018), it has been superseded by extensive quantitative analysis.

As documented in the original study (Hardy 2017a, pp. 15–17, 41–42) and corroborated in the introduction, with digital data that had been automatically generated by the community's own activity, exclusively forum-derived data are inadequate for analysing the situation in England and Wales and the United States. For instance, for the United States, the largest online forum is currently around 1080.48 percent of the size of the largest social network (cf. Metal Detecting U.S. Only 2017; TreasureNet 2017); for France, it is 440.56 percent (cf. Fouilleur 2017a, 2017b); for Poland, it is 163.15 percent (cf. Hardy 2016b, p. 220); for Russia, it is 111.17 percent (cf. Hardy 2016b, p. 221). Yet, for Ukraine, it is 93.92 percent (cf. Hardy 2017b, p. 9, Table 8, based on the sizes of those online communities before artificial surges in population); for the United Kingdom, it is 70.31 percent (cf. Metal Detecting 2017; UK and European Metal Detecting Forum 2017); for Hungary, it is 31.61 percent (cf. Fémkeresők Honlapja Fóruma 2017; Fémdetektor webáruház 2017). Unless it is asserted that the appeal and functionality of different forums remain constant between the United Kingdom and the United States, while the appeal and functionality of Facebook vary massively, it must be accepted that neither architecture has a determinative and constant relationship with the communities that use it.

Returning to the data in the methods, between 2 March 2015 and 9 October 2016, the membership of the largest forum community for Austria grew by 24.32 percent (Ferrum Noricum 2016; Karl and Möller 2016, p. 4, Table 2). Do those statistics indicate an equal increase in the number of detectorists, as is implied by the assumption that they represent a constant fraction of the actual number of detectorists? Between 2009 and 2017, the largest forum community for the United Kingdom not only grew by around 206.58 percent, but also shifted to a different forum (cf. 4182 members of UK Detector Net 2009, as of 10 August 2009, and 12,821 members of UK and European Metal Detecting Forum 2017, as of 4 September 2017). Meanwhile, the largest forum community for the United States grew by around 237.50 percent (cf. 35,072 users of TreasureNet 2009, as of 27 June 2009, and 118,367 members of TreasureNet 2017, as of 4 September 2017). Do those statistics indicate a tripling of the numbers of detectorists in the United Kingdom and the United States? Or do they suggest an increase in the number of detectorists who train and organise themselves via the internet, and/or a concentration of online detectorists on the platforms of exceptionally rewarding online services, which encompasses any growth in the detecting population? Detectorists themselves recognise that the 'internet has allowed enthusiasts to find each other' (Taff McAuliffe, paraphrased by Merz 2014).

Obviously, although TreasureNet is the largest online forum for metal-detectorists in the United States and was one of the earliest such forums, the size of the forum was not an accurate reflection of interest in the hobby in 2003, when it had around 238 users (TreasureNet 2003, as of 11 April 2003, the earliest archived date), because nearly no potential users then knew that it existed. Concomitantly, the 14,636 percent growth of the forum was not an accurate reflection of the growth of interest in the hobby between 2003 and 2009, when it had around 35,072 users (TreasureNet 2009, as of 27 June 2009), because it had grown from near zero. Rather, the growth of that forum was a reflection of interest in that forum, which encompassed a reflection of interest in the hobby.

It has been asserted that the sizes of countries' largest online forums 'represent roughly the same percentage of the overall number of metal detectorists in all transnationally compared [i.e., comparable] countries' (Karl 2017, p. 2) and that it would be 'ridiculous' to assume the 'exceedingly unlikely' alternative (Karl and Möller 2018). Contrarily, the proportions of communities who participate in any and all venues do vary.

As demonstrated here with testimony from market actors and community members, even between otherwise comparable countries, online participation and clubbability vary according to factors such as the range and reward of opportunities that are available via online participation, as well as the amount and tone of factual news coverage and fictional media representation of metal-detecting in general and offline organisations in particular. For instance, there are fewer online forums for Germany than for the United Kingdom (Karl and Möller 2018), and fewer online communities for Belarus than for Russia (Hardy 2016b). While these differences may somewhat reflect different numbers of detectorists, they may also somewhat distort the measurable size of the online community. A greater proportion of online detectorists in Belarus are squeezed into the largest of the few available venues. A greater proportion of online detectorists in Russia dissipate into the many options other than the largest.

5.1.3. Digital Data and Market Data Analysis

Moreover, it is possible to compare the difference between digital data and market data across territories. The evidence does not yet enable the comparison of data from the same point in time. Also, the disparity within countries would vary if the comparison used alternative data points, such as the digital data without compensation for the presence of inactive detectorists. Likewise, the disparity between countries would vary if the comparison used alternative data points, such as the published market data for France. Nonetheless, that disparity would not disappear.

In the United States, the digital data suggest that there are at least 110,578 active detectorists. The market data suggest that there are perhaps 312,500. So, the largest online community represents perhaps 35.38 percent of the detecting population. In France, the digital data suggest that there are at least 20,385 active detectorists. The market data suggest that there are perhaps 31,250. So, the largest online community represents perhaps 65.23 percent of the detecting population.

Even if the peak market data were used for both countries, since they refer to relatively close periods of market activity, the disparity would not disappear. Then, 110,578 online detectorists would constitute (somewhat more than) 7.08 percent of (somewhat fewer than) 1,562,500 active detectorists in the United States, while 20,385 online detectorists would constitute (somewhat more than) 18.64 percent of (somewhat fewer than) 109,375 active detectorists in France. This provides yet more evidence that the largest online communities—which, in the cases of the United States and France, are the largest online forums—do not represent a constant fraction of detecting populations.

At the same time, in Hungary, the market data suggest that there around 1258 active detectorists. The digital data suggest at least 2858. So, the market data analysis, which was derived from data from affluent societies in North America and Europe, only identified perhaps 44.02 percent of the detecting population. This demonstrates that the measure of market activity is "culture-bound". If it is not based on comparable market data, market data analysis may severely misrepresent the scale of metal-detecting.

5.1.4. Restricted Quantitative Analysis and Extensive Quantitative Analysis

The results of restricted quantitative analysis 'can' theoretically 'be accepted as sound and conclusive' if the number of online forum members is 'reasonably representative of the number of metal detectorists' (Karl and Möller 2018). So, by their own logic, the results of restricted quantitative analysis must be rejected as unsound (Neither method is conclusive).

Consequently, restricted quantitative analysis cannot 'be considered to have ... falsified' the hypothesis that restrictive regulation '(significantly) reduces the number of metal detectorists ... and thus (also significantly) reduces the damage [that is] done', while permissive regulation 'encourage[s]' activity and 'thus, necessarily, cause[s] a rise in the total numbers of metal detectorists' and, 'naturally, also increases the total damage [that is] done' (Karl and Möller 2018). In fact, the construction of this hypothesis would appear to be false (or meaningless), insofar as it is formulated so strictly that it effectively precludes the potential significance of other factors; it is falsified in any case where the technical model of regulation has 'much lesser significance than' any 'other factors' (Karl and Möller 2018).

It fails to account for the practical implementation of regulation, let alone all of the other factors that might be considered in metal-detectorists' complex decision-making processes. Some metal-detectorists reassure the community that there are 'laws for "everything", yet almost no enforcement of any of those laws' (e.g., an anonymised detectorist in China, paraphrased by Hardy 2018c). In one territory, the media may help law enforcement agents to catch cultural property criminals (e.g., in Malaysia, cf. Hardy 2018b) while, in another territory, the media may help cultural property criminals to avoid being caught (e.g., in Russia, cf. Hardy 2016b, p. 217). Different metal-detectorists reach different conclusions in their cost-benefit analysis of the risk of death while handling unexploded ordnance against the reward from the market for supplying unexploded ordnance (in Eastern Europe, South Asia, South-East Asia, and East Asia, cf. Hardy 2016b, 2018a, 2018b, 2018c). In France, there were at least 30 deaths from illicit excavation of explosive munitions within 11 years, yet perhaps 40 percent of illicit excavators persisted in hunting militaria (cf. Desforges 2009).

Where loopholes in the legislation or a lack of capacity for enforcement undermine the application of the law, regulation may not be restrictive in practice. Some metal-detectorists explicitly state that they refrain from metal-detecting in territories with prohibitive regulation, unless 'it [is] not possible legally, but it [is] "possible practical[ly]"' (e.g., in Russia and China, cf. SilverReciever, 13 April 2017, paraphrased by Hardy 2018c; see also in Finland, cf. Thomas et al. 2016, p. 338). Whether under permissive regulation in the United Kingdom or restrictive regulation in France, the punishment may be too weak to constitute a disincentive or deterrent (cf. Lecroere 2016; Shelbourn 2008). Some law enforcement officials engage in metal-detecting (e.g., in France, cf. Compagnon et al. 2010, p. 237; Lecroere 2016, p. 185; in Poland and Ukraine, cf. Hardy 2016b, p. 217), which may interfere with law enforcement. Where experiences of economic insecurity and/or political instability rival fears of punishment, regulation may not be restrictive in practice. The complexities of the post-socialist transition have produced a state of 'legal nihilism' in Eastern Europe (Hardy 2016b, pp. 226–27). The number of metal-detectorists may not reflect the effectiveness of the technical model of regulation in any of those cases.

Indeed, if a(n as yet impossible) meta-analysis of the scale of metal-detecting around the world were conducted, it might find a *positive* correlation between the number of metal-detectorists and the severity of the technical model of regulation. Yet, this might reflect positive correlations, first between the intensity of market demand and the intensity of resource extraction, and then between the intensity of resource extraction and the intensity of policing. The interpretation might thus be confused by market tastes, wherein low-demand sources are governed by permissive regulation, coincident with the intensity of resource extraction. The interpretation might be further confounded by state attitudes, wherein anti-market states maintain restrictive regulation, and pro-market states maintain permissive regulation, regardless of the intensity of resource extraction.

For all of the reasons that have been presented in this discussion, it is necessary to make tentative, "least worst" estimates of actual numbers, which are derived from an extensive range of sources. Equally, it is necessary to recognise that those least worst estimates that are derived from automatically-generated data are only minimum numbers, not constant fractions of actual numbers.

5.2. Eyewitness Testimony and Digital Data: Metal-Detectorists Recognise That They Are "Beating Sites to Death"

This study also demonstrates that, as significant automatically-generated data and market data may be identified through extensive quantitative analysis, so significant netnographic data may be identified through extensive qualitative analysis. Even though 'thousands of compromising [self-incriminating] pages have been removed [des milliers de pages compromettantes ont été supprimées]' from online forums for France alone (Compagnon et al. 2010, p. 215), masses of qualitative as well as quantitative data remain. 'Hunted out' is being 'hear[d] more and more' in the United States (electricmetal21 2015), for example, as '[a] lot of good places were cleaned out of the decent stuff long ago' (joe4077 2015). Indeed, 'hunted out' and 'beat to death' are such commonly used expressions for intensively metal-detected sites that they are listed in metal-detecting glossaries (e.g., mdgear n.d.). This is particularly striking as, at least with regard to some archaeological sites, such as campsites of the American Civil War, 'people don't share locations . . . until they are considered' to have been 'hunted out' (Joel Hegwood, cited by Tesoro 2012, emphasis added). So, those sites are not identified until it is too late to study them comprehensively.

Detectorists complain that their areas of operation have been 'detected to death' (e.g., team sidewinder 2013). Yet, when museum rangers complain that their historic sites have been 'detected to death' and that 'there is nothing left' in the ground, detectorists may 'doubt' that those places really have been depleted of their metal artefacts, and suspect that it is an attempt to deter further detecting (e.g., Freakonate 2003). Many sites in Hungary were 'looted to ground zero' two decades ago by metal-detecting tourists from Austria and Germany (according to an anonymous detectorist, paraphrased by Ujhelyi 2016, p. 46).

These extensive analyses provide empirical data to understand the problem, plus netnographic data with which to refine the interpretation of the empirical data. In this sample, the results appear to revise established estimates and corroborate the detecting community's own perception that they are "beating these sites to death".

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References

AFP (Agence France-Presse). 2014. Lourde amende réclamée contre un viticulteur jugé pour pillage archéologique [heavy fine requested for winemaker tried for archaeological looting]. *Midi Libre*, July 30. Available online: http://www.midilibre.fr/2014/07/30/lourde-amende-reclamee-contre-un-viticulteur-juge-pour-pillage-archeologique,1031603.php (accessed on 4 September 2017).

André. 2004. Different goals, *Metal Detecting Equipment*. December 13. Available online: https://web.archive.org/web/20160726054610/http://www.detectingequipment.com/archive/Dec15-2004/21523.htm (accessed on 4 September 2017).

ARTE. 2016. Les chasseurs de trésor [treasure-hunters]. *ARTE*, June 11. Available online: https://info.arte.tv/fr/les-chasseurs-de-tresor (accessed on 4 September 2017).

Bailie, Warren, and Natasha Ferguson. 2017. *An Assessment of the Extent and Character of Hobbyist Metal Detecting in Scotland*. Edinburgh: Historic Environment Scotland and the Treasure Trove Unit of the National Museums of Scotland.

Barford, Paul. 2018a. Examining the Karl/Moller premise. *Portable Antiquity Collecting and Heritage Issues*, March 4. Available online: https://paul-barford.blogspot.com/2018/03/bangor-bloggers-versus-preservationists.html (accessed on 13 March 2018).

Barford, Paul. 2018b. Metal detectors on sale in the UK right now. *Portable Antiquity Collecting and Heritage Issues*, July 16. Available online: https://paul-barford.blogspot.com/2018/07/metal-detectors-on-sale-in-uk-right-now.html (accessed on 16 July 2018).

biro. 2012a. Re: Metal detecting in France. *UK and European Metal Detecting Forum*, May 15. Available online: http://www.metaldetectingforum.co.uk/viewtopic.php?p=244741#p244741 (accessed on 4 September 2017).

biro. 2012b. Re: Metal detecting in France. *UK and European Metal Detecting Forum*, May 17. Available online: http://www.metaldetectingforum.co.uk/viewtopic.php?p=245837#p245837 (accessed on 4 September 2017).

Birocheau, Patrice. 1983. À propos des détecteurs de métaux [about metal-detectors]. *Bulletin du Groupe Vendéen d'Études Préhistoriques* 9: 29–36. Available online: http://gvep.fr/bulletins/archives/GVEP_1983_09/GVEP_9_1983_Birocheau.pdf (accessed on 4 September 2017).

Brock, Terry. 2015. Stine: Why interact w detectorists: 300–500,000 detectorists. And growing. #SHA2015. *Twitter*, January 9. Available online: https://twitter.com/brockter/status/553615081234120704 (accessed on 4 September 2017).

Brown, Tracy. 2014. The Jimmy Carter clause in ARPA—Part IV: The 'less than 100 years old' argument. *Archaeology in Tennessee*, August 18. Available online: https://contextintn.wordpress.com/2014/08/18/the-jimmy-carter-clause-in-arpa-iv-less-than-100-years-old-argument/ (accessed on 4 September 2017).

Brun, Yann, and Bertrand Triboulot. 2017. La lutte contre les atteintes au patrimoine archéologique et le trafic illicite des biens culturels [the fight against damage to archaeological heritage and illicit trafficking of cultural property]. *Les nouvelles de l'Archéologie* 149: 43–45. Available online: https://doi.org/10.4000/nda.3781 (accessed on 28 March 2018). [CrossRef]

Cardwell, Shawn. 2013. Metal treasures: The thrill of the hunt. *The Columbia Basin Herald*, October 28. Available online: http://www.columbiabasinherald.com/community/article_5a39e712-3dc3-11e3-914a-001a4bcf887a.html (accessed on 4 September 2017).

Challier, Pierre. 2013. Halte au pillage du patrimoine [Halt to the pillage of patrimony]. *La Dépêche*, April 14. Available online: http://www.ladepeche.fr/article/2013/04/14/1605468-archeologie-halte-au-pillage-du-patrimoine.html (accessed on 4 September 2017).

charlotte49er. 2011. How many metal detectors do you own? *Metal Detecting Association of the Carolinas*, May 14. Available online: http://mdac.myfreeforum.org/How_many_metal_detectors_do_you_own__about1575.html (accessed on 4 September 2017).

Charrier, Pascal. 2015. Archéologues contre pilleurs, le combat continue [archaeologists against pillagers, the fight continues]. *La Croix*, August 20. Available online: http://www.la-croix.com/France/Archeologues-contre-pilleurs-le-combat-continue-2015-08-20-1346386 (accessed on 4 September 2017).

Cincinnati Enquirer. 1984. Detectors revive treasure hunting. *The Cincinnati Enquirer*, July 15, p. 45. Available online: https://www.newspapers.com/newspage/101403106/ (accessed on 4 September 2017).

Ćirić, Aleksandar, Dejan Anastasijević, Slobodanka Dekić, Ivica Điki, Slobodan Georgijev, Zana Limani, Gostimir Popović, Paul Radu, Altin Raxhimi, Tamara Skrozza, and et al. 2005. Poluostrvo s blagom [a peninsula with a commodity]. *Vreme*, November 3. Available online: http://www.vreme.co.rs/cms/view.php?id=432410 (accessed on 4 September 2017).

Compagnon, Grégory, Yves Pautrat, Nicolas Minvielle Larousse, and Mathieu Rué. 2010. Détecteur de métaux, le cas français [metal detecting, the French case]. In *Halte au pillage!* Edited by Grégory Compagnon. Paris: Errance, pp. 189–242.

Conseil de la Concurrence. 1997. Décision n° 97-D-21 du 25 mars 1997 relative à des pratiques relevées sur les marchés des appareils de détection des métaux et de la presse spécialisée dans l'information portant sur la prospection de métaux et trésors [Decision No. 97-D-21 of 25 March 1997 relating to practices in the markets for metal-detecting devices and the trade press for prospecting for metal and treasures]. *Conseil de la Concurrence*, March 25. Available online: https://www.autoritedelaconcurrence.fr/pdf/avis/97d21.pdf (accessed on 4 September 2017).

Daubney, Adam. 2017. Floating culture: The unrecorded antiquities of England and Wales. *International Journal of Heritage Studies* 23: 785–99. [CrossRef]

Dauphiné Libéré. 2009. Condamnés pour fouilles illégales [condemned for illegal excavations]. *Le Dauphiné Libéré*, October 15. Available online: http://www.ledauphine.com/haute-provence/2009/10/15/condamnes-pour-fouilles-illegales (accessed on 4 September 2017).

De Meo, Antonia. 1994. More effectve protection for Native American cultural property through regulation of export. *American Indian Law Review* 19: 1–72.

Desforges, Jean-David. 2009. Le pillage des sites archéologiques français [looting of French archaeological sites]. *Bulletin de la Société d'Archéologie et d'Histoire du Pays de Lorient* 38: 7–23. Available online: http://www.sahpl.asso.fr/SITE_SAHPL/images/Bulletin%2038/Desforges%20Jean-David%20-%20Le%20pillage%20des%20sites%20archéologiques%20français%20SITE%20SAHPL.pdf (accessed on 4 September 2017).

Détecteur. 2017. Forum des particuliers sur le détecteur de métaux et la détection de loisir [forum of particulars on metal detectors and hobby detecting]. *Détecteur*, September 4. Available online: http://web.archive.org/web/20170904071310/http://www.detecteur.net/forum/ (accessed on 4 September 2017).

Détection de Loisir. 2017. Petit rappel, la détection de métaux n'a jamais été ou ne va pas être interdite contrairement aux discours de peurs de certaines fédé ou associations [Little reminder, metal-detecting never has been nor will be prohibited, contrary to the discourse of fear of certain feds or associations]. *Détection de Loisir*, January 9. Available online: https://www.facebook.com/DetectionResponsable/posts/735356369974420 (accessed on 12 June 2018).

Dikov, Ivan. 2016. 5 treasure hunters arrested while 'trenching' Late Antiquity settlement with tractor near Bulgaria's Petarnitsa. *Archaeology in Bulgaria*, August 6. Available online: http://archaeologyinbulgaria.com/2016/08/06/5-treasure-hunters-arrested-while-trenching-late-antiquity-settlement-with-tractor-near-bulgarias-petarnitsa/ (accessed on 4 September 2017).

Dubreuil, Marion. 2013. Les chercheurs de trésors sous la menace d'une interdiction de prospecter en France [treasure-hunters under threat of ban on prospecting in France]. *France Bleu*, November 3. Available online: https://www.francebleu.fr/infos/societe/les-chercheurs-de-tresors-sous-la-menace-d-une-interdiction-de-prospecter-en-france-1383456600 (accessed on 4 September 2017).

electricmetal21. 2015. Hunted out??????? *Find's Treasure Forums*, August 18. Available online: http://web.archive.org/web/20170505142136/http://www.findmall.com/read.php?86,2227209,2227289 (accessed on 4 September 2017).

Eurostat. 2016. Annual net earnings. *Eurostat*, August 2. Available online: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=earn_nt_net&lang=en (accessed on 4 September 2017).

Express. 2015. Metal detecting so sexy on back of TV show that clubs can't cope. *The Express*, December 4. Available online: http://www.express.co.uk/news/uk/624379/metal-detector-club-turns-down-members-BBC-drama-detectorists-numbers-up (accessed on 4 September 2017).

Fémdetektor webáruház. 2017. Fémdetektor webáruház [metal detector web-shop]. *Fémdetektor webáruház*, September 4. Available online: https://web.facebook.com/femdetektor (accessed on 4 September 2017).

Fémkereső és tartozékai adásvétel-cserebere. 2017. Fémkereső és tartozékai adásvétel-cserebere [sale-swap of metal detectors and accessories]. *Fémkereső és tartozékai adásvétel-cserebere*, September 4. Available online: https://web.facebook.com/groups/562048230546343/ (accessed on 4 September 2017).

Fémkeresők Honlapja Fóruma. 2017. Statisztika [statistics]. *Fémkeresők Honlapja Fóruma*, September 4. Available online: http://web.archive.org/web/20170904072547/http://metaldetector.hu/phpBB3/index.php (accessed on 4 September 2017).

Ferrum Noricum. 2016. Statistiken [statistics]. *Ferrum Noricum*, October 9. Available online: http://web.archive.org/web/20161009125555/http://www.sondengaenger.at:80/ (accessed on 4 September 2017).

figuraferi. 2007. Házilag építhető fémkereső [home-mase metal detector]. *Hobbi Elektronika*, April 5. Available online: https://www.hobbielektronika.hu/forum/topic_3027.html (accessed on 4 September 2017).

Fouilleur. 2017a. Statistiques [statistics]. *Le Fouilleur*, September 4. Available online: http://web.archive.org/web/20170904071037/http://www.lefouilleur.com/forum/ (accessed on 4 September 2017).

Fouilleur. 2017b. Le Fouilleur [the Digger]. *Le Fouilleur*, September 4. Available online: https://web.facebook.com/lefouilleur/ (accessed on 4 September 2017).

Franklin, Ben. 1975. An army of relic hunters is despoiling Civil War battlegrounds. *The New York Times*, August 12, p. 31. Available online: http://www.nytimes.com/1975/08/12/archives/an-army-of-relic-hunters-is-despoiling-civil-war-battlegrounds.html (accessed on 4 September 2017).

Freakonate. 2003. Almaden park. *The Old California Metal Detecting Forum*, August 1. Available online: http://web.archive.org/web/20170505144339/http://cadetecting.proboards.com/thread/2289/almaden-park?page=1 (accessed on 4 September 2017).

Friendly Metal Detecting Forum. 2017. Friendly Metal Detecting Forums Statistics. *Friendly Metal Detecting Forum*, September 4. Available online: http://web.archive.org/web/20170904021149/https://metaldetectingforum.com/index.php (accessed on 4 September 2017).

Garrett, Charles. 2005. Excitement for ACE detectors shows no signs of slowing. *The Garrett Searcher* Fall, pp. 1–2. Available online: http://www.garrett.com/hobbysite/searcher_pdf/fall05.pdf (accessed on 4 September 2017).

Garrett. 2015. In memory of Charles Lewis Garrett, 1932–2015. Inventor. Treasure hunter. Patriot. An American legend. *Garrett Metal Detectors*, April 5. Available online: http://www.garrett.com/mediasite/charles_garrett_obituary.aspx (accessed on 4 September 2017).

Garver, Abe. 2015. Metal detector sales strike gold after 'Holy Grail' of shipwrecks found. *Forbes*, December 16. Available online: http://www.forbes.com/sites/abegarver/2015/12/16/metal-detector-sales-strike-gold-after-holy-grail-of-shipwrecks-found/ (accessed on 4 September 2017).

GCPA (Georgia Council of Professional Archaeologists). 2009. Metal detecting, archaeology sites, and the law. *Society for American Archaeology*, June 17. Available online: http://www.saa.org/ForthePublic/Resources/MetalDetectingInArchaeology/METALDETECTINGARCHAEOLOGYSITESANDTHELAW/tabid/1031/Default.aspx (accessed on 4 September 2017).

Goddard, Jennifer. 2011. Anticipated impact of the 2009 Four Corners raid and arrests. *Crime, Law and Social Change* 56: 175–88. [CrossRef]

Golin, Marlene. 1992. The treasure hunters. *The Chicago Tribune*, August 23. Available online: http://articles.chicagotribune.com/1992-08-23/features/9203160708_1_metal-detectors-treasure-hunters-silver-coin (accessed on 4 September 2017).

Gray, David. 2017. *Doing Research in the Business World*. London: Sage.

GUSA (Government of the United States of America). 1906. Antiquities Act [8 June 1906]. *National Park Service*. Available online: https://www.nps.gov/subjects/legal/the-antiquities-act-of-1906.htm (accessed on 4 September 2017).

GUSA (Government of the United States of America). 1935. Historic Sites Act [16 U.S.C. Sec. 461–467, 21 August 1935]. *National Park Service*. Available online: https://www.nps.gov/history/local-law/hsact35.htm (accessed on 4 September 2017).

GUSA (Government of the United States of America). 1966. The National Historic Preservation Act. *Advisory Council on Historic Preservation (ACHP)*. Available online: https://www.achp.gov/nhpa.pdf (accessed on 4 September 2017).

HAPPAH. 2017. Dépôt monétaire de Plouagat (Côtes-d'Armor): L'Association HAPPAH émet de sérieux doutes sur la légitimité de la découverte et de la vente [Monetary deposit of Plouagat (Côtes-d'Armor): HAPPAH Association emits serious doubts on the legitimacy of the discovery and the sale]. *Halte Au Pillage du Patrimoine Archéologique et Historique (HAPPAH)*, July 10. Available online: https://halte-au-pillage.org/wp-content/uploads/2015/03/Com-presse-HAPPAH-dépôt-monétaire-de-Plouagat.pdf (accessed on 12 June 2018).

Hardy, Samuel. 2016a. 'Half-arsed organization' of crime: Open-source analysis of metal detecting and antiquities trafficking. Paper presented at the Illicit Networks Workshop, London, UK, December 7–8.

Hardy, Samuel. 2016b. 'Black archaeology' in Eastern Europe: Metal detecting, illicit trafficking of cultural objects and 'legal nihilism' in Belarus, Poland, Russia and Ukraine. *Public Archaeology* 15: 214–37. Available online: https://doi.org/10.1080/14655187.2017.1410050 (accessed on 23 March 2018). [CrossRef]

Hardy, Samuel. 2017a. 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. *Cogent Social Sciences* 3: 1–49. Available online: http://dx.doi.org/10.1080/23311886.2017.1298397 (accessed on 13 March 2018). [CrossRef]

Hardy, Samuel. 2017b. Illegal finders of antiquities in Ukraine: Do digital data indicate grassroots growth, coincidence, false advertising, astroturfing, trolling or sockpuppetry? *Ukrainian Archaeology* 2016: 3–14. Available online: https://archaeologyen.files.wordpress.com/2018/03/engl_2016-3-14.pdf (accessed on 23 March 2018).

Hardy, Samuel. 2018a. To get a good price, 'you have to sell in international bidding sites': Trafficking of metal-detected cultural goods from South Asia. In *Criminal Networks and Law Enforcement: Global/International Perspectives on Illicit Enterprise*. Edited by Saskia Hufnagel and Anton Moiseienko. London: Routledge, Available online: https://conflictantiquities.wordpress.com/2018/03/26/south-asia-metal-detecting-online-trafficking-illicit-antiquities/ (accessed on 28 March 2018).

Hardy, Samuel. 2018b. 'You just have to wear it': Trafficking of metal-detected antiquities from South-East Asia. In *Policing Transnational Crime: Law Enforcement of Criminal Flows*. Edited by Saskia Hufnagel and Anton Moiseienko. London: Routledge, Available online: https://conflictantiquities.wordpress.com/2018/03/27/south-east-asia-metal-detecting-online-trafficking-illicit-antiquities/ (accessed on 28 March 2018).

Hardy, Samuel. 2018c. 'Paint it black': 'Simple' and increasingly 'professional' looting of antiquities with metal detectors in East Asia. In *Transnational Crime: European and Chinese Perspectives*. Edited by Valsamis Mitsilegas, Saskia Hufnagel, Yanan Shi, Mingxiang Liu and Anton Moiseienko. London: Routledge, Available online: https://conflictantiquities.wordpress.com/2018/03/28/east-asia-metal-detecting-online-trafficking-illicit-antiquities/ (accessed on 28 March 2018).

Hashem, Ibrahim, Ibrar Yaqoob, Nor Anuar, Salimah Mokhtar, Abdullah Gani, and Samee Khan. 2015. The rise of 'big data' on cloud computing: Review and open research issues. *Information Systems* 47: 98–115. [CrossRef]

hedgehog. 2009. How many detectors have you had, what were they? *Detecting Wales*, January 6. Available online: http://www.detectingwales.com/index.php?topic=392.0 (accessed on 4 September 2017).

HNCUNESCO (Hungarian National Committee for the United Nations Educational, Scientific and Cultural Organization). 2011. *Report on the Application of the 1970 Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property*. Paris: United Nations Educational, Scientific and Cultural Organization (UNESCO), Available online: http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CLT/pdf/hungary_2010-11natrep_1970_en.pdf (accessed on 4 September 2017).

Hollowell, Julie. 2006. St. Lawrence Island's legal market in archaeological goods. In *Archaeology, Cultural Heritage, and the Antiquities Trade*. Edited by Neil Brodie, Morag Kersel, Christina Luke and Kathy Walker Tubb. Gainesville: University Press of Florida, pp. 98–132.

Huth, Christoph. 2013. Vom rechten Umgang mit Sondengängern: Das 'Portable Antiquities Scheme' in England und Wales und seine Folgen [From correct dealing with detectorists: The 'Portable Antiquities Scheme' in England and Wales and its consequences]. *Archäologische Informationen* 36: 129–37.

joe4077. 2015. Nothing but left overs? *Friendly Metal Detecting Forum*, April 19. Available online: http://web.archive.org/web/20170505143903/https://metaldetectingforum.com/showpost.php?p=2333593&postcount=6 (accessed on 4 September 2017).

Judy. 2007. How many metal detector models do you have? *Canadian Metal Detecting*, August 24. Available online: http://www.canadianmetaldetecting.com/phpBB3/viewtopic.php?nomobile=1&f=27&t=5743 (accessed on 4 September 2017).

Karl, Raimund. 2017. Metal detecting and the lack of efficacy of any kind of regulation. A response to a paper by Samuel A. Hardy. *Academia*. Available online: http://web.archive.org/web/20170918234314/https://www.academia.edu/33077783/Metal_detecting_and_the_lack_of_efficacy_of_any_kind_of_regulation._A_response_to_a_paper_by_Samuel_A._Hardy_forthc._ (accessed on 13 March 2018).

Karl, Raimund, and Katharina Möller. 2016. Empirische Untersuchung des Verhältnisses der Anzahl von MetallsucherInnen im deutsch-britischen Vergleich. Oder: Wie wenig Einfluss die Gesetzeslage hat. [Empirical investigation of the ratio of the number of metal detectorists in German-British comparison. Or: How little influence the law has]. *Archäologische Informationen* 39: 1–12.

Karl, Raimund, and Katharina Möller. 2018. An empirical examination of metal detecting: Per capita numbers of metal detectorists in a British-German comparison. *Archäologische Denkmalpflege*, March 3. Available online: https://archdenk.blogspot.com/2018/03/an-empirical-examination-of-metal_3.html (accessed on 13 March 2018).

kenneth ward. 2014. How many metal detectors do you own... *TreasureQuest*, November 26. Available online: http://www.treasurequestxlt.com/community/index.php?threads/how-many-metal-detectors-do-you-own.62910/page-2#post-858664 (accessed on 4 September 2017).

Kevin. 2011. How many detectors do you own? *Alberta Metal Detecting Forum*, March 30. Available online: http://members3.boardhost.com/amdf2/msg/1301535086.html (accessed on 4 September 2017).

Lecroere, Thomas. 2016. 'There is none so blind as those who won't see': Metal detecting and archaeology in France. *Open Archaeology* 2: 182–93. [CrossRef]

Legifrance. 2004. Code du patrimoine. *Legifrance*, February 24. Available online: https://www.legifrance.gouv.fr/affichCode.do;jsessionid=0C18105A88282B607701CF3110089783.tpdila22v_2?cidTexte=LEGITEXT000006074236&dateTexte=20160821 (accessed on 4 September 2017).

Legifrance. 2016. Loi no. 2016-925 du 7 juillet 2016 relative à la liberté de la création, à l'architecture et au patrimoine [Law No. 2016-925 of 7 July 2016 on the Freedom of Creation, Architecture and Heritage]. *Legifrance*, July 7. Available online: https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000032854341&categorieLien=id (accessed on 12 June 2018).

Long, Andy. 2015. The National Council for Metal Detecting currently has 11,000 members. These 11,000 can help us stop the criminals #nighthawking. *Twitter*, July 20. (@PcAndyLong). Available online: https://twitter.com/PcAndyLong/status/623075502845218816 (accessed on 4 September 2017).

Lowenthal, Mark. 1998. Open source intelligence: New myths, new realities. *Defense Daily Network*, November 5. Available online: https://www.oss.net/dynamaster/file_archive/040319/ca06aacb07e5cb9f25f21babf7ef2bf0/OSS1999-P1-08.pdf (accessed on 4 September 2017).

Lythe, Ruth. 2015. Is there a fortune buried in your back garden? As metal detector sales soar, we join Britain's treasure-hunting boom. *This is Money*, December 22. Available online: http://www.thisismoney.co.uk/money/news/article-3371065/Is-fortune-buried-garden-Metal-detector-sales-soaring-treasure-hunting-boom-hits-Britain.html (accessed on 4 September 2017).

Makowska, Agnieszka, Agnieszka Oniszczuk, and Marcin Sabaciński. 2016. Some remarks on the stormy relationship between the detectorists and archaeological heritage in Poland. *Open Archaeology* 2: 171–81. [CrossRef]

Marc. 2004. How often do you metal detect? *TreasureNet*, February 16. Available online: http://web.archive.org/web/20160731011224/http://www.treasurenet.com/forums/voting-booth/720-how-often-do-you-metal-detect.html (accessed on 4 September 2017).

MDFanatic. 2016. MDFanatic. *Facebook*, October 17. Available online: https://web.archive.org/web/20161017215908/https://www.facebook.com/MDFanatic (accessed on 17 October 2016).

mdgear. n.d. Glossary. *Mdgear*. Available online: http://web.archive.org/web/20170505141758/http://mdgear.com/metal-detecting-glossary/ (accessed on 4 September 2017).

Merz, Theo. 2014. History hunters: Meet the real-life 'detectorists'. *The Telegraph*, October 2. Available online: http://www.telegraph.co.uk/men/active/11128106/History-hunters-meet-the-real-life-detectorists.html (accessed on 4 September 2017).

Metal Detecting. 2017. Metal Detecting. *Facebook*, September 4. Available online: https://www.facebook.com/groups/AFUDGE/ (accessed on 4 September 2017).

Metal Detecting U.S. Only. 2017. Metal Detecting U.S. Only. *Facebook*, September 4. Available online: https://www.facebook.com/groups/USDETECTING/ (accessed on 4 September 2017).

MMG (Miniwatts Marketing Group). 2017a. Internet usage and 2017 population statistics for North America. *Internet World Stats*, June 30. Available online: https://www.internetworldstats.com/stats14.htm (accessed on 12 June 2018).

MMG (Miniwatts Marketing Group). 2017b. Internet, Facebook and population stats for Europe. *Internet World Stats*, December 31. Available online: https://www.internetworldstats.com/stats4.htm#europe (accessed on 12 June 2018).

Morin, Benjamin. 2018. Pillage de patrimoine: 'Il y a urgence, toute la France est touchée' [Looting of heritage: 'There is an urgency, all of France is affected]. *Le Parisien*, July 12. Available online: https://www.leparisien.fr/faits-divers/pillage-de-patrimoine-il-y-a-urgence-toute-la-france-est-touchee-12-07-2018-7818171.php (accessed on 12 July 2018).

Nicas, Jack. 2011. Metal detectors hit the jackpot. *The Wall Street Journal*, July 30. Available online: http://www.wsj.com/articles/SB10001424053111904233404576462161651031814 (accessed on 4 September 2017).

Nonnecke, Blair, Dorine Andrews, and Jenny Preece. 2006. Non-public and public online community participation: Needs, attitudes and behaviour. *Electronic Commerce Research* 6: 7–20. [CrossRef]

OKI (Open Knowledge International). 2010. Open data. *Open Data Handbook*. Available online: https://opendatahandbook.org/glossary/en/terms/open-data/ (accessed on 4 September 2017).

PAS (Portable Antiquities Scheme). 2010. *Portable Antiquities and Treasure Annual Report 2008*. London: Portable Antiquities Scheme.

Preece, Jenny, Blair Nonnecke, and Dorine Andrews. 2004. The top five reasons for lurking: Improving community experiences for everyone. *Computers in Human Behavior* 20: 201–23. [CrossRef]

Rice-Oxley, Mark, and Zoe Flood. 2016. Can the internet reboot Africa? *The Guardian*, July 25. Available online: https://www.theguardian.com/world/2016/jul/25/can-the-internet-reboot-africa (accessed on 4 September 2017).

Rickman, Clark. 2013. Handheld vs detector mounted pinpointer probes. *Detecting 365*, November 7. Available online: http://detecting365.com/handheld-detector-mounted-pinpointers/ (accessed on 4 September 2017).

Robbins, Katherine. 2012. From Past to Present: Understanding the Impact of Sampling Bias on Data Recorded by the Portable Antiquities Scheme. Ph.D. thesis, University of Southampton, Southampton, UK.

Rogers, Thomas. 2016. Rise of the Nazi-grave robbers. *Bloomberg Businessweek*, August 23. Available online: http://web.archive.org/web/20160823105946/https://www.bloomberg.com/features/2016-latvia-nazi-memorabilia (accessed on 4 September 2017).

Scott, Douglas, Matthew Reeves, Wade Catts, Scott Clark, Charles Ewen, Chris Espenshade, Michelle Sivilich, and Linda Stine. 2015. Building consensus: Archaeologists and metal detectorists working towards a common goal. Panel discussion held at the 48th Annual Conference on Historical and Underwater Archaeology, Seattle, WA, USA, January 6–11.

Seitsonen, Oula. 2018. *Digging Hitler's Arctic War: Archaeologies and Heritage of the Second World War German Military Presence in Finnish Lapland*. Helsinki: Unigrafia.

Service Régional de l'Archéologie. n.d. Détecteurs de métaux [metal detectors]. *Ministère de la Culture et de la Communication*. Available online: http://www.culturecommunication.gouv.fr/Regions/Drac-Pays-de-la-Loire/Mini-site/Archeologie/Porter-a-connaissance-et-reglementation/Detecteurs-de-metaux (accessed on 4 September 2017).

Shelbourn, Carolyn. 2008. 'Time crime'—Looting of archaeological resources and the criminal law in England and the United States. *Criminal Law Review* 3: 204–13.

Shott, Michael. 2017. Estimating the magnitude of private collection of points and its effects on professional survey results: A Michigan case study. *Advances in Archaeological Practice* 5: 125–37. [CrossRef]

Stahlberg, Mike. 2002. Metal detectives. *The Register-Guard*, July 18. Available online: https://www.thefreelibrary.com/Metal+detectives.-a090213204 (accessed on 4 September 2017).

Steve in PR. 2009. How many detectors and/or probes do you currently own? *TreasureQuest*, January 6. Available online: http://www.treasurequestxlt.com/community/index.php?threads/how-many-detectors-and-or-probes-do-you-currently-own.22164/ (accessed on 4 September 2017).

Stiles, Norman, and Rachel Piper. 2014. Treasure-hunter Norman Stiles giving advice on treasure-hunting with a metal detector. *Salt Lake City Weekly*, May 7. Available online: http://www.cityweekly.net/utah/treasure-hunter-norman-stiles/Content?oid=2413146 (accessed on 4 September 2017).

Stine, Linda, and Darren Shumate. 2015. Metal detecting: An effective tool for archaeological research and community engagement. *North American Archaeologist* 36: 289–323. [CrossRef]

Suber, Peter. 2004. Praising progress, preserving precision. *Open Access Newsletter*, September 2. Available online: https://legacy.earlham.edu/~peters/fos/newsletter/09-02-04.htm#progress (accessed on 4 September 2017).

Szabó, Miklós. 2009. Kincsek a föld alatt. Elrejtett bronzkori fémek nyomában. [Treasures underground. In search of hidden Bronze Age metals]. In *Régészeti dimenziók. Tanulmányok az ELTE BTK Régészettudományi Intézetének tudományos műhelyéből*. Edited by Alexandra Anders, Miklós Szabó and Pál Raczky. Budapest: L'Harmattan, pp. 123–38.

team sidewinder. 2013. Any Montana diggers out there? *TreasureNet*, October 21. Available online: http://web.archive.org/web/20170505145846/http://www.treasurenet.com/forums/metal-detecting/354803-any-montana-diggers-out-there-4.html#post3651080 (accessed on 4 September 2017).

teamroper. 2014. How many metal detectors do you own... *TreasureQuest*, September 18. Available online: http://www.treasurequestxlt.com/community/index.php?threads/how-many-metal-detectors-do-you-own.62910/ (accessed on 4 September 2017).

Tesoro. 2012. Testimonials. *Tesoro*, January 16. Available online: http://web.archive.org/web/20120116135623/http://www.tesoro.com/info/testimonials/testimonials.html (accessed on 4 September 2017).

Thivent, Viviane. 2014. Archéologie: La France, zone de pillage [Archaeology: France, looting zone]. *Le Monde*, June 3. Available online: http://www.lemonde.fr/sciences/article/2014/06/03/archeologie-la-france-zone-de-pillage_4430964_1650684.html (accessed on 4 September 2017).

Thomas, Suzie. 2012. Searching for answers: A survey of metal detector users in the UK. *International Journal of Heritage Studies* 1: 49–64. [CrossRef]

Thomas, Suzie. 2016. The future of studying hobbyist metal detecting in Europe: A call for a transnational approach. *Open Archaeology* 2: 140–49. [CrossRef]

Thomas, Suzie, Oula Seitsonen, and Vesa-Pekka Herva. 2016. Nazi memorabilia, dark heritage and treasure hunting as 'alternative' tourism: Understanding the fascination with the material remains of World War II in Northern Finland. *Journal of Field Archaeology* 41: 331–43. [CrossRef]

Thunting. 2017. Forum stats. *Thunting*, September 4. Available online: http://web.archive.org/web/20170904020936/http://www.thunting.com/smf/index.php (accessed on 4 September 2017).

timesearch. 2011. How many detectors do you own and why do you keep them. *UK and European Metal Detecting Forum*, June 14. Available online: http://www.metaldetectingforum.co.uk/viewtopic.php?f=10&t=12549 (accessed on 4 September 2017).

Tom_in_CA. 2007. Re: Metal detecting laws for different countries? *TreasureNet*, June 2. Available online: http://web.archive.org/web/20160821222247/http://www.treasurenet.com/forums/general-discussion/48244-metal-detecting-laws-different-countries.html#post491540 (accessed on 4 September 2017).

Tom_in_CA. 2012. Detecting in India? The gold must fall like leaves in autumn. *TreasureNet*, August 1. Available online: https://web.archive.org/web/20170223035405/http://www.treasurenet.com/forums/beach-shallow-water/305469-detecting-india-gold-must-fall-like-leaves-autumn.html#post2876979 (accessed on 4 September 2017).

Treasure Depot. 2017. Metal Detecting Forum Statistics. *Treasure Depot*, September 4. Available online: http://web.archive.org/web/20170904020236/http://www.thetreasuredepot.com/cgi-bin/bbs62x/detecting_config.pl?md=topstats (accessed on 4 September 2017).

TreasureNet. 2003. Who is online? *TreasureNet*, April 11. Available online: http://web.archive.org/web/20030411092451/http://www.treasurenet.com/forum/ (accessed on 4 September 2017).

TreasureNet. 2009. Forum stats. *TreasureNet*, June 27. Available online: http://web.archive.org/web/20090627013114/http://forum.treasurenet.com/ (accessed on 4 September 2017).

TreasureNet. 2017. Stats. *TreasureNet*, September 4. Available online: http://web.archive.org/web/20170904021430/http://www.treasurenet.com/forums/forum.php (accessed on 4 September 2017).

TreasureQuest. 2017. Forum statistics. *TreasureQuest*, September 4. Available online: http://web.archive.org/web/20170904020807/http://www.treasurequestxlt.com/community/index.php (accessed on 4 September 2017).

Ujhelyi, Nóra. 2016. The Relationship between Archaeology and Metal Detecting in Present Day Hungary. Master's dissertation, Central European University, Budapest, Hungary.

UK and European Metal Detecting Forum. 2015. Statistics. *UK and European Metal Detecting Forum*, June 30. Available online: http://web.archive.org/web/20150630195735/https://www.metaldetectingforum.co.uk/ (accessed on 4 September 2017).

UK and European Metal Detecting Forum. 2017. Statistics. *UK and European Metal Detecting Forum*, September 4. Available online: http://web.archive.org/web/20170904022313/https://www.metaldetectingforum.co.uk/ (accessed on 4 September 2017).

UK Detector Net. 2009. Statistics. *UK Detector Net*, August 10. Available online: http://web.archive.org/web/20090810170346/http://www.forumukdetectornet.co.uk/phpBB3/portal.php (accessed on 4 September 2017).

Ulst, Ingrid. 2012. The Role of Community Archaeology in Heritage Protection: Responsible Metal Detecting as a Tool for Enhancing the Protection of Archaeological Heritage. Master's dissertation, University of Tartu, Tartu, Estonia.

UPI (United Press International). 1979. Million track buried riches with detector. *The New York Times*, December 2, p. 71. Available online: http://www.nytimes.com/1979/12/02/archives/million-track-buried-riches-with-detector-more-spent-on-equipment.html?_r=0 (accessed on 4 September 2017).

USDI (United States Department of the Interior). 1979. *Archaeological Resources Protection Act [31 October 1979]*; Washington, D.C.: United States National Center for Cultural Resources, National Park Service, Department of the Interior. Available online: https://www.nps.gov/history/local-law/fhpl_archrsrcsprot.pdf (accessed on 4 September 2017).

USDI (United States Department of the Interior). 1990. *Native American Graves Protection and Repatriation Act [16 November 1990]*; Washington, D.C.: United States National Center for Cultural Resources, National Park

Service, Department of the Interior. Available online: https://www.nps.gov/history/local-law/FHPL_NAGPRA.pdf (accessed on 4 September 2017).

USFS (United States Forestry Service). n.d. Metal detecting policy. In *United States Forestry Service (USFS)*. Available online: http://www.fs.usda.gov/detail/hoosier/learning/history-culture/?cid=stelprdb5406465 (accessed on 4 September 2017).

Viking. 2011. How many metal detectors do you own? *American Detectorist*, July 18. Available online: http://www.americandetectorist.com/forum/showthread.php?6074-How-many-metal-detectors-do-you-own (accessed on 4 September 2017).

WalkerSPb. 2011. Kladoiskatelstvo [treasure-hunting]. *Taker*, May 24. Available online: https://www.taker.im/community/threads/kladoiskatelstvo.29385/page-8#entry1055674 (accessed on 4 September 2017).

Walsh, Charles. 2003. Sovereign ownership of private property in the name of preservation: A contradiction in terms and of the Constitution. *The New York Law Review* 46: 899–925.

Wiese, Lee. 2013. Where is it legal to metal detect? *Metal Detecting Hobby Talk*, December 31. Available online: http://www.mdhtalk.org/articles/legal-to-detect/legal-to-metal-detect.pdf (accessed on 4 September 2017).

Wong, Vanessa. 2010. In tough times, dreams of easy money. *Bloomberg Businessweek*, August 24. Available online: http://www.nbcnews.com/id/38787116/ns/business-us_business/t/tough-times-dreams-easy-money/ (accessed on 4 September 2017).

WW2Hunter. 2012. Re: Bastogne tips. *War Relics Forum*, February 26. Available online: http://web.archive.org/web/20170505142428/http://www.warrelics.eu/forum/battlefield-history-relics/bastogne-tips-152037/ (accessed on 4 September 2017).

XP Metal Detectors (Castanet-Tolosan, Haute-Garonne, France). 2017. Personal communication.

Yoffe, Emily. 2009. Full metal racket. *Slate*, September 25. Available online: http://www.slate.com/articles/news_and_politics/recycled/2009/09/full_metal_racket.html (accessed on 4 September 2017).