Landscapes

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ylan20

Integrating Nature and Heritage in the Boreal Forests of Scandinavia? Exploration of a Low-Budget Method

Eva Svensson, Jan Haas & Rolf Lutz Eckstein

To cite this article: Eva Svensson, Jan Haas & Rolf Lutz Eckstein (2020) Integrating Nature and Heritage in the Boreal Forests of Scandinavia? Exploration of a Low-Budget Method, Landscapes, 21:1, 72-92, DOI: 10.1080/14662035.2020.1905202

To link to this article: https://doi.org/10.1080/14662035.2020.1905202

Published online: 19 Apr 2021.

LANDSCAPES
2020, VOL. 21, NO. 1, 72–92
https://doi.org/10.1080/14662035.2020.1905202

Routledge
Taylor & Francis Group

Integrating Nature and Heritage in the Boreal Forests of Scandinavia? Exploration of a Low-Budget Method

Eva Svensson [a], Jan Haas [b] and Rolf Lutz Eckstein [b]

[a]Department of Political, Historical, Religious and Cultural Studies, Karlstad University, Karlstad, Sweden; [b]Department of Environmental and Life Sciences, Karlstad University, Karlstad, Sweden

ABSTRACT
The concepts landscape and biocultural heritage are based on an integrated view of nature and cultural heritage. This paper investigates the potential of using a low-budget method for integrating information on human impact and natural responses in the vegetation of boreal forested Scandinavia. The information from two national databases in Sweden – the National Inventory of Landscapes in Sweden (NILS) covering surveyed vegetation, and the Register of Ancient Monuments (*Fornsök*) – were combined and visualised using a Geographical Information System (*GIS*). In total, five sites were investigated. No connection between human impact and vegetation was detected at any of them. This negative result is partly due to gaps in time and scale, but mainly to sectorised survey methods not paying attention to biocultural heritage, landscape perspectives or long-term processes. The paper concludes that further development of survey methods and registers targeting contexts and processes are called for.

KEYWORDS
Biocultural heritage; integrated landscape studies; boreal forests; national survey databases; GIS

Introduction

Landscape ecology has a focus on the interrelationships between natural and cultural processes and how these have contributed to spatial heterogeneity (Turner and Gardner 2015). While these interrelationships are evident in cultivated landscapes, they are less easily identifiable in the boreal forests of central and northern Scandinavia, which are therefore often perceived as predominantly natural. Surveys have shown, however, that they have a long history of human impact and are rich in cultural as well as natural values. For example, the forest has been used for grazing cattle and trees have been turned into heat and energy. Some activities have been of large-scale industrial character, others of small scale for subsistence (Liljewall ed. 1996; Svensson 1998).

Thus forests were not wilderness, but arenas for a different kind of land use than in cultivated landscapes, resulting in the construction of different kinds of niches with various types of biocultural heritage (Eriksson 2018; Eriksson and Arnell 2017; Eriksson *et al.* 2021). The human use of forests, and the distinctive strategies and practices

CONTACT Eva Svensson eva.svensson@kau.se Department of Political, Historical, Religious and Cultural Studies, Karlstad University, SE-65188 Karlstad, Sweden

employed in them, have left different traces in the shape of ancient monuments and in 'natural' responses in vegetation and soil. These traces taken together are labelled as the 'biocultural heritage' of the forest. It is expressed at different scales, from landscape to individual sites, and can be highly diverse. In a boreal forest, biocultural heritage can, for instance, include substantial areas with historical fire regimes and forest grazing, mires dammed to promote sedges for haymaking, swiddens and fields for outland cereal cultivation, sites for permanent and seasonal settlement such as crofts and shielings, and work places such as bloomery iron production sites, mills, tar production sites and pitfalls for catching game. All of these may affect plant community composition and soils (Emanuelsson 2003; Eriksson 2018; Lindholm and Ekblom 2019; Svensson 2008).

Forest was also used for performing activities equally associated with cultivated landscapes. In forested landscapes, the biocultural heritage can thus roughly be divided into biocultural heritage *of* the forest and biocultural heritage *in* the forest. Biocultural heritage *of* the forest refers to the outcome of the interaction between humans and nature when using the forest and its resources, whereas biocultural heritage *in* the forest was created when agrarian activities were moved into the forest (Svensson 2006, 108–9). In this study we did not make a distinction between these two.

Easily accessible documentation of biocultural heritage ought to be a valued resource for landscape researchers and managers, whether from heritage or nature conservation starting points. However, that is not the case, partly because of the technical problems of dealing with the different scales and different chronological phases, but also because nature conservation and heritage management, and their associated academic disciplines, tend to follow different trajectories in documentation, research and management (Nilsson *et al.* 2008). This is an especially strong tradition in environments such as boreal forests where the mutual impact of nature and culture is not salient at first glance but needs to be uncovered through fieldwork and research. An additional factor is that such fieldwork and research often require (expensive and difficult) interdisciplinary efforts to be successful.

Adding to the problem is that human impact is rated differently from an ecological perspective and the concept of biocultural heritage is thus not always desired. For instance, older human impact such as grazing cattle and haymaking are considered 'positive' and contributory to a richer biodiversity in the boreal forest (Axelsson Linkowski 2010; Axelsson Linkowski 2017; Tunón and Bele 2019). In contrast, more recent human large scale activities, such as industrial activity, commercial forestry and the increased demand on the forest to produce more energy to replace fossil fuels is considered to have negative effects (Pedersen *et al.* 2020; Skogsstyrelsen 2020; Svensson 2014).

Our vantage point is that an understanding of biocultural heritage, the entanglement of nature and heritage, is beneficial in both landscape research and sustainable landscape management. It ought to be possible to integrate information on natural and cultural-historical conditions and processes on a more routine basis in management and in research, but there is no specific database for biocultural heritage, only separate databases for recorded vegetation and heritage sites. Surveys have been carried out by their respective sectors, and the database methods used thus reflect different management traditions, not an attempt to integrate nature-cultural studies. We know from experiences of working with international colleagues that such separation and differentiation is by no means unique to Sweden. With technology such as GIS, however, it ought now to be feasible to combine several spatial data sets (as layers), and there should be desk-based possibilities to integrate nature conservation and heritage management to some degree. The aim of this paper is therefore to explore such a desk-based method for studying biocultural heritage.

Using GIS, we spatially combined information from two separate botanical and archaeological databases in five 5 × 5 km squares in the boreal forests of northern Värmland in western Sweden (Figure 1), an area where a larger archaeological project was already being conducted. We then evaluated whether the recorded vegetation can be considered as affected by, or responding to, the human impact that can be reconstructed on the basis of recorded archaeological sites.

Previous studies

Before describing our study area, data and methods, we will present a few examples of previous studies on vegetation responses to human impact in boreal forest conditions.

Sites affected by human activities tend to become overgrown when deserted, as human impact on vegetation wanes and gives room for expansion of other species, thus constructing different successive ecological niches (Eriksson and Arnell 2017; Eriksson *et al.* 2021). Sites with remains of settlement such as crofts and farmsteads fairly recently deserted are generally characterised by relics of culture plants. Surveys of these sites have

Figure 1. The study area in northern Värmland with the five NILS squares. The municipalities of Torsby, Sunne, Hagfors and Malung-Sälen (in Dalarna) are marked. (Map: Jan Haas).

shown a variety of plants used for both food production and aesthetic values. The relics of culture plants seem to be mostly confined to settlement sites, and not to have spread beyond these to any great extent (Andersson *et al.* 2007; Eriksson and Glav Lundin 2020; Lind and Svensson 2001; Lötberg 2003; Panfalk and Österberg 2015).

The use of shielings (sites in the forested outlands used seasonally mainly for cattle grazing and haymaking), including grazing in the forest, haymaking and regular burning of the forest to promote grazing, had effects on the vegetation, resulting in a higher degree of grassland species in the used forests. Pollen analyses of mires for haymaking and shielings have also demonstrated that sporadic cereal cultivation in small, manured fields was common in the forest, but archaeological remains of such fields have rarely been detected (Axelsson Linkowski 2010; Emanuelsson 2001; Emanuelsson *et al.* 2003; Milberg *et al.* 2019). Shielings as such are sites rich in biological diversity, as shown in different reports on the biocultural heritage of specific surveyed shielings (Länsstyrelsen i Värmland 2014a and 2014b for Torsby municipality).

Detecting vegetation responses to human impact is more complex in niches more distant in time and space. An important question is how long the human impact indicated by lingering cultivated plants remains after desertion. In a longitudinal investigation of cultural plants relics at deserted crofts, the rate of disappearance of single species occurrences was about 1% annually (Eriksson and Glav Lundin 2020). With such a disappearance rate, indicators of human land use cannot be expected to last on sites deserted several hundred years ago. However, the concept of biocultural heritage includes not only direct human impact but also natural responses to human impact, and such responses could include more structural changes, especially in cases of long-term human impact. Presumably such long-term responses are more visible in cultivated than in forested landscapes. For instance, in north-eastern France, Dupouey *et al.* (2002) showed that effects of a 200-year period of Roman agriculture between A.D. 50 and 250 can still be detected in current plant species richness and community composition. Likewise, Plue *et al.* (2008) found landscape legacies of Gallo-Roman land use in soil (higher phosphorus levels and pH) and seed banks in northern France.

We are not aware that such long-term responses have been detected in the boreal forests in Scandinavia. But responses might not be associated with cultural plants or direct effects of human land use, but rather with processes of vegetation change. For instance, more mosaic forests may be the result of long-term agrarian activities, albeit far back in time, and growth of Norway spruce may increase in pine forest after logging. Linking forest history and ecological data is thus important for understanding the ecology and design management (Ericsson *et al.* 2000; Josefsson *et al.* 2010; Segerström *et al.* 1994).

An important example of more complex biocultural heritage are natural responses to iron production when it was widespread, large-scale and conducted over more than a thousand years. Bloomery iron production required charcoal, produced in the numerous charcoal pits, and pig iron production, in blast furnaces and associated iron mills, required even more charcoal produced in charcoal stacks. The large-scale charcoal production was bound to have effects on the forest at that time. Vegetation-historical studies of bloomery iron production in southern Sweden and of blast furnace iron production in central Sweden have demonstrated that deforestation took place, visible in diminishing amounts of tree pollen in pollen diagrams. In southern Sweden, birch and other deciduous trees were taxed higher than coniferous trees for charcoal. However, with the regrowth of the forest, coniferous trees, especially spruce, gained a stronger foothold, thus changing the forests (Berg 2004; Ericsson *et al.* 2005; Grundén 1997; Karlsson *et al.* 2015, 2016; Lagerås 2007, 119).

Northern Värmland

Northern Värmland is morphologically a part of the North Swedish Highlands, with the narrow valley of the meandering Klarälv cutting the area in half from NNW to SSE. Most settlements and fields have been, and still are, located on the valley's alluvial soils. There are steep slopes on both sides of the river valley, and considerable height differences up to almost 200 metres between the bottom of the river valley and the moraine plateaus making up most of the area of northern Värmland. These forested plateaus are of undulating character, rich in mires, with some lakes and rivers, mostly tributaries to Klarälven. Further south, the narrow lake system Frykensjöarna and some other smaller lakes are important features in the landscape with alluvial soils, settlements and fields on many of the shores and with deep forests outside the agrarian land.

The study area belongs to the southern subzone of the boreal zone (taiga region; Sjörs 1999) with a 'warm-summer humid continental climate', as in the town of Torsby with an annual temperature of 5°C and an annual precipitation of 668 mm. The vegetation is characterised by a mosaic of different types of coniferous forests on humid to dry substrates. Most common is the *Picea abies-Vaccinium myrtillus* community, a coniferous forest type dominated by Norway spruce and blueberry with interspersed birch, aspen, willows and rowan in the tree layer (Påhlsson 1998). Vegetation on drier soils is mostly characterised by the *Pinus sylvestris-Vaccinium vitis-idaea* community, a forest type dominated by pine in the tree layer, and with lingonberry, heather and crowberry in the field layer (Påhlsson 1998). In wet depressions, these forest communities may be interwoven with various types of mires, i.e. fens or bogs.

The northern part of the area is extremely rich in ancient monuments, whereas there are fewer in the southern part. Most of the ancient monuments originate from an intensive outland use practised by the forest peasants. Bloomery iron production sites with charcoal pits, pitfalls for elks, both single and in systems, and shielings are the dominant categories of ancient monuments. Shielings also included forest grazing in areas outside the shielings. Pitfalls for elks were in use from ca. 3000 B.C. to the seventeenth century A.D., and bloomery iron was produced from ca. A.D. 400 to the seventeenth century, although most sites date to the ninth to thirteenth centuries A.D. Shielings appear around A.D. 1 and were used up until the twentieth century. A few still survive. There are also remains of crofts, mills, sawmills, various other industrial remains mostly dating from the eighteenth and nineteenth centuries, Stone Age, mostly Mesolithic, settlement sites and a few other kinds of ancient monuments (Emanuelsson *et al.* 2003; Fornsök 2020; Svensson 1998, 2008). It should also be noted that the western part of the area is called *Finnskogen* due to the settlement colonisation of Forest Finns in the seventeenth century. Initially, they practised large-scale swidden cultivation, but also cultivation on infields and husbandry. However, the practice of swidden cultivation was successively abandoned (Bladh 1995).

As of today, land-use in the four municipalities covering the study area is still shaped and heavily dominated by extensive forest industry (72 per cent). Forest not industrially used for timber production is partly protected (eleven per cent) and contributes to tourism and recreation as do lakes and rivers (six per cent). Land used for agriculture and grazing only make up two per cent of the total area. Settlements and built-up areas also account for two per cent. The remaining percentages are defined by minor other categories, amongst others mining and sports facilities.

Data and methods

Two major data sources were used in this investigation: NILS, the National Inventory of Landscapes in Sweden responsible for national environmental monitoring (Ståhl *et al.* 2011) and *Fornsök*, the Register of Ancient Monuments. The data from the two sources were spatially combined using GIS and interpreted contextually. In addition one important historical map (the late nineteenth century economical map *häradsekonomiska kartan*), was investigated, but it yielded no additional information on historical human impact (Lantmäteriet, Historiska kartor 2021). Furthermore, the Swedish Species Information Centre data – Artdatabanken, Sweden's largest species repository with over 80,000,000 public observations of (often unvalidated) species based on volunteered geographic information (VGI) – was investigated regarding indicator species, but it did not contain meaningful information for our study (Artdatabanken 2021).

NILS was initiated in 2003 by the Swedish Environmental Protection Agency with the main aim of supplying national data for biodiversity monitoring at different spatial scales. The database is hosted by the Department of Forest Resource Management at the Swedish Agricultural University (SLU) in Umeå. Across Sweden, a stratified regular grid of 631 permanent sampling units was established. Each sampling unit is a square of 5 km × 5 km with one 1 km × 1 km square in its centre. Along the perimeter of the centre square, twelve regularly spaced circular sampling plots (20 m radius) are located (one in each corner of the square and two each between corner points) (see Figure 2). In each of these circular sampling plots, subplots of 10 and 3.5 m radius, respectively, are nested for inventories with different levels of details. The 3.5 m radius sub-plot contains the smallest NILS sampling units, i.e. three subplots of 0.28 m radius (Ståhl *et al.* 2011). One fifth of all sampling units is inventoried each year, so that each sampling unit will be re-inventoried after five years to enable estimation of changes in these permanent plots. Inventories are based on detailed monitoring protocols (Sjödin 2019). Vegetation is documented in detail in the 36 0.28 m radius (0.5 m^2) plots per sampling unit. The monitoring protocol (Sjödin 2019) lists 35 taxa of graminoids and 97 taxa of forbs whose presence is registered in the field layer of the smallest subplots. A number of these taxa are either typical, common species or rarer and specialist indicators of open grasslands, i.e. hay meadows or pastures. Examples of the first group are *Festuca ovina*, *Nardus stricta*, *Deschampsia cespitosa*, *Rumex acetosa/acetosella*, *Galium boreale/mollugo* and *Achillea millefolium*; the second group is represented by species such as *Antennaria* spp., *Anthyllis vulneraria*, *Bistorta vivipara*, *Euphrasia* spp. and *Pinguicula vulgaris*. We obtained species data of five NILS sampling squares (267, 268, 288, 304 and 305). The analysis was restricted to the inventory years 2014–2017, in which each sampling unit was inventoried

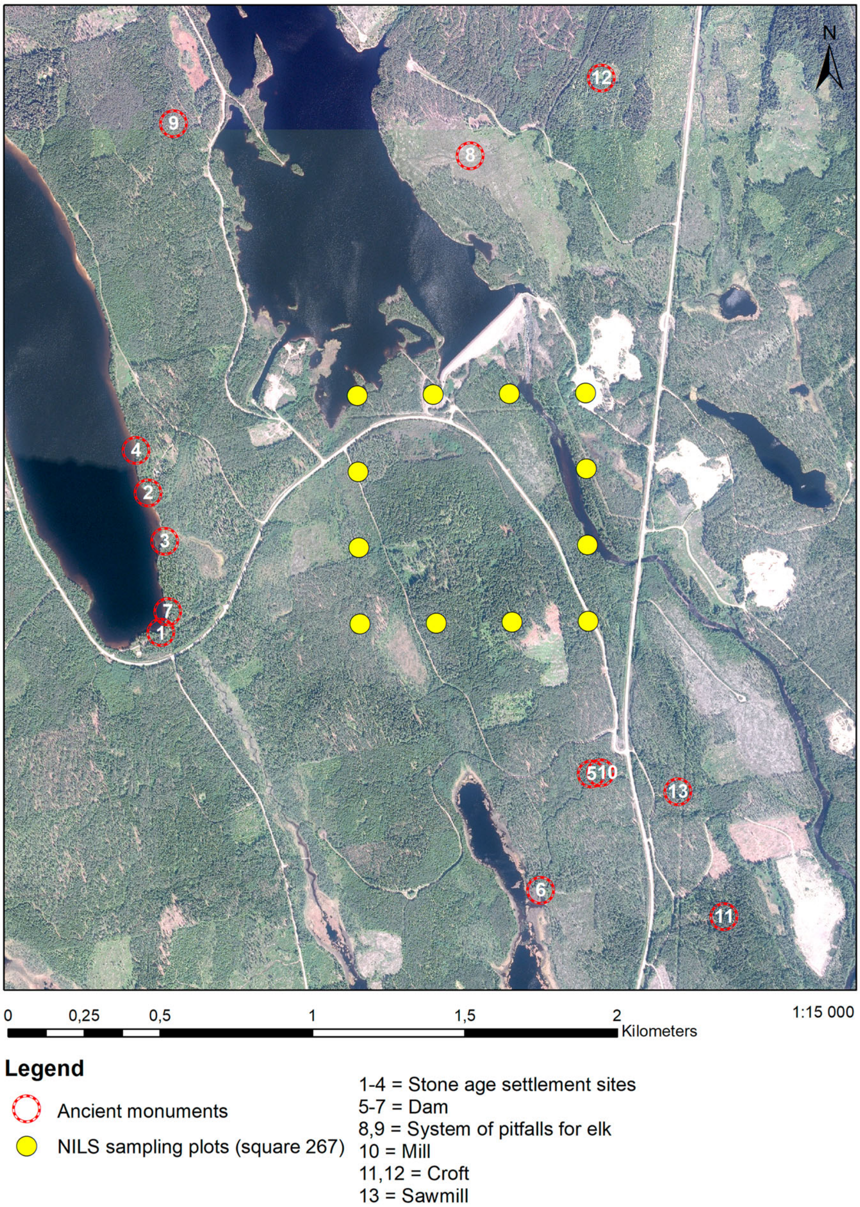

Figure 2. NILS square 267 and ancient monuments. Source: GSD-Orthofoto, 0.5m colour © Lantmäteriet (2015) (Map: Jan Haas).

once. For each plant species we summarised the occurrences in each of the 0.28 m radius plots per sampling unit.

Other alternative databases were explored, such as surveys of woodland key habitats (Timonen *et al.* 2010) and the Swedish Species Observation System (Artportalen), but they were ruled out as unsuitable. The first did not contain detailed information on indicator species of human land use, and while the second yielded data for the number of species within the five squares (154 vascular plants, 274 lichen, 42 mosses and 89 mushrooms), nearly all findings are unvalidated and no records are considered relevant for this study.

Fornsök, being the national and official register, was by contrast the only option for obtaining data on ancient monuments. It is operated and controlled by the Swedish National Heritage Board (RAÄ), and contains all *known* and *registered* ancient monuments. But there are also numerous unknown and unregistered ancient monuments, especially in Sweden's vast forests. Fornsök has been compiled over a long time, the first national 'survey' of ancient monuments being carried out in the seventeenth century by parish vicars reporting ancient monuments in their respective areas to the government. The first systematic, national survey by the RAÄ started in 1937 in connection with the Search on Land Survey for basic mapping of Sweden and went on in two stages until the 1990s, although the whole of Sweden was never covered. In particular much of the northern forests and mountains have not been surveyed, and where they have been, only less systematically. The survey for ancient monuments did not follow a grid system, and the field staff worked mainly by searching environments that were topographically likely to harbour ancient monuments and by checking indications such as information from local inhabitants and older antiquarian documentation. Information from historical maps (Lantmäteriet, Historiska kartor) have also been used systematically during the later phases, including for the areas investigated in this paper.

Since the national survey for ancient monuments was closed by the RAÄ, there have been other surveys contributing information on more delimited areas to the Register of Ancient Monuments, such as surveys in connection with development plans. For ten years from the mid-1990s, the survey *Skog & Historia* (Forest & History) was carried out by the Forest Commission (Skogens Pärlor 2020). Today (2020) there are more than 700,000 locations registered in Fornsök, of which several contain more than one monument.

About 10,000 of the registered sites are in northern Värmland, which was surveyed by the RAÄ in the late 1960s, again mainly in 1989–1990 (partly by one of the authors of this study), and to some extent by the *Skog & Historia* survey after 1990. The area considered in this paper thus has one of the highest (maybe even the highest) degree of systematic survey for ancient monuments in forested areas in Sweden (and on an international level) as the surveyors had more time allocated for surveying the forest than in regions further north. Yet still there are large areas that have not been surveyed properly, and many unknown and unregistered sites can be expected in northern Värmland. Another problem is that only a few of the very many charcoal stacks that are very common in the investigation area because there were several iron mills in the seventeenth to late nineteenth and early twentieth centuries (Furuskog 1924) have been registered in Fornsök. Late settlement remains such as crofts, charcoal burners' huts and wood cutter cottages are also severely under-surveyed.

The Fornsök ancient monument dataset was obtained as vector geodata in the form of points, lines and polygons, depending on the monument's spatial nature. From the NILS dataset, two sheets of tabular data were acquired. The first contained the inventoried taxa for each sampling plot. The second contained the exact location in SWEREF99 TM coordinate pairs for each of the 58 sample plots. The tables were joined on a common sample plot identifier and imported to a new point layer in ESRI ArcGIS 10.8. The new layer contains over 1,500 individual point records, each point representing one taxon recorded at a specific point in time. The ancient monuments have been used to identify the human impact in question, through a light version of the verbal method (e.g. Gräslund Berg *et al.* 2013), translating ancient monuments into activities.

Results

Vegetation and ancient monuments

Five NILS squares were selected for investigation. In total, the NILS database lists 52 different taxa in total, distributed over the 0.28 m radius plots in the five sampling units (Table 1), among those sixteen bryophyte and three lichen taxa. The NILS taxa may also include closely related species pairs or species groups that are difficult to identify in the field. Of the nine species that occurred in all sample units, eight are characteristic species of the most common coniferous forest types in the boreal zone: the *Picea abies-Vaccinium myrtillus* type or the *Pinus sylvestris-Cladonia* spp. type (Påhlsson 1998), and one species is characteristic of mires.

As there were hardly any ancient monuments within the NILS squares investigated here, sites located in proximity to the NILS squares were brought into the analysis when the human activity indicated by the character of the sites could be presumed to have had an impact on the NILS squares. The ancient monuments are of a character often found in forested environments and near water, such as pitfalls for elk, bloomery iron production sites, water driven industrial sites, Stone Age settlement sites and deserted settlements, such as farmsteads and crofts, and shielings. The earliest sites, i.e. the Stone Age settlement sites, might well be 7,000–8,000 years old, whereas the youngest sites might date to the nineteenth and even the twentieth centuries A.D. It is clear that activities such as dwelling, hunting, gathering, fishing, iron production, charcoal burning for iron production, industrial work, forest grazing and cereal cultivation took place in the vicinity of our NILS squares, and several of these activities, especially forest grazing and tree consuming charcoal burning, can be expected to have had impact on vegetation over fairly large areas, and most likely touching the NILS square.

NILS square 267 (inventory from 2018)

The NILS inventory lists 27 taxa for this square (Figure 2). Most frequent plants are spruce and pine forests species such as *Vaccinium vitis-idaea*, *V. myrtillus*, *Hylocomium splendens*, *Melampyrum* spp., *Trientalis europaea, Calluna vulgaris*, *Cladonia* spp. and *Dicranum majus*. There are no indicators of human land use, such as light-demanding or grazing-tolerant grassland herbs. There are several ancient monuments in the area surrounding square 267, especially in relation to the lakes and rivers. The dam north of the square was previously a river, and it is unknown if any ancient monuments were flooded when constructing the dam. The registered sites are settlement sites of Stone Age character by the lake shores, pitfalls and systems of pitfalls for elk, crofts, dams and a mill. The Stone Age settlement sites were presumably used by hunter-gatherers during the Mesolithic. The crofts, dams and the mill are probably of a relatively young date with use until the last century. Pitfalls for elk have a wide dating; in northern Värmland the oldest have been dated to the Neolithic, and the youngest to the seventeenth century

Table 1. Frequency (%) of plant species in 0.28 m radius subplots in four NILS sampling units (SU): SU288, SU267, SU 268, SU288, SU304 and SU305 contained 36 subplots.

Species	SU267	SU268	SU288	SU304	SU305	Mean
Vaccinium vitis-idaea	66.7	61.1	83.3	55.6	72.2	67.8
Vaccinium myrtillus	66.7	61.1	80.6	66.7	61.1	67.2
Pleurozium schreberi (B)	72.2	50.0	47.2	52.8	80.6	60.6
Hylocomium splendens (B)	55.6	47.2	27.8	50.0	8.3	37.8
Deschampsia flexuosa	16.7	58.3	36.1	25.0	25.0	32.2
Polytrichum commune (B)	0.0	52.8	25.0	13.9	22.2	22.8
Calluna vulgaris	16.7	0.0	2.8	13.9	63.9	19.4
Cladonia spp. section *Cladina* (L)	13.9	8.3	2.8	8.3	47.2	16.1
Carex globularis	0.0	8.3	19.4	2.8	38.9	13.9
Sphagnum spp. small red species (B)	0.0	0.0	27.8	2.8	36.1	13.3
Melampyrum pratense/arvense	16.7	13.9	22.2	2.8	5.6	12.2
Maianthemum bifolium	8.3	27.8	2.8	13.9	0.0	10.6
Vaccinium oxycoccus/microcarpum	0.0	2.8	19.4	13.9	16.7	10.6
Ptilium crista-castrensis (B)	11.1	5.6	13.9	8.3	8.3	9.4
Empetrum nigrum s.l.	0.0	0.0	11.1	2.8	33.3	9.4
Trientalis europaea	8.3	19.4	5.6	11.1	0.0	8.9
Eriophorum vaginatum	0.0	2.8	13.9	13.9	13.9	8.9
Rubus chamaemorus	5.6	5.6	16.7	8.3	5.6	8.3
Andromeda polifolia	0.0	0.0	2.8	13.9	8.3	5.0
Linnea borealis	16.7	0.0	0.0	5.6	0.0	4.4
Vaccinium uliginosum	0.0	0.0	2.8	0.0	19.4	4.4
Equisetum sylvaticum	0.0	11.1	2.8	8.3	0.0	4.4
Luzula pilosa	11.1	5.6	0.0	2.8	2.8	4.4
Molinia caerulea	0.0	0.0	5.6	13.9	0.0	3.9
Dicranum majus (B)	2.8	8.3	8.3	0.0	0.0	3.9
Polytrichum strictum (B)	2.8	0.0	0.0	0.0	13.9	3.3
Calamagrostis canascens/purpurea	0.0	2.8	5.6	8.3	0.0	3.3
Polytrichum juniperinum (B)	0.0	0.0	0.0	5.6	8.3	2.8
Drosera spp.	0.0	0.0	2.8	11.1	0.0	2.8
Sphagnum papillosum (B)	0.0	0.0	8.3	5.6	0.0	2.8
Solidago virgaurea	2.8	0.0	0.0	8.3	0.0	2.2
Sphagnum magellanicum (B)	0.0	0.0	2.8	0.0	8.3	2.2
Sphagnum fuscum (B)	0.0	0.0	2.8	0.0	8.3	2.2
Carex pauciflora	0.0	0.0	2.8	2.8	5.6	2.2
Menyanthes trifoliata	2.8	0.0	0.0	8.3	0.0	2.2
Potentilla erecta	0.0	0.0	0.0	8.3	0.0	1.7
Cetraria spp. (L)	0.0	0.0	0.0	0.0	8.3	1.7
Calamagrostis arundinacea	5.6	2.8	0.0	0.0	0.0	1.7
Eriophorum angustifolium	0.0	0.0	0.0	8.3	0.0	1.7
Rhytidiadelphus squarrosus (B)	5.6	0.0	0.0	0.0	0.0	1.1
Oxalis acetosella	5.6	0.0	0.0	0.0	0.0	1.1
Phegopteris connectilis	0.0	0.0	0.0	5.6	0.0	1.1
Polytrichum piliferum (B)	5.6	0.0	0.0	0.0	0.0	1.1
Comarum palustre	5.6	0.0	0.0	0.0	0.0	1.1
Juncus filiformis	5.6	0.0	0.0	0.0	0.0	1.1
Gymnocarpium dryopteris	0.0	0.0	0.0	2.8	0.0	0.6
Sphagnum riparium (B)	0.0	0.0	2.8	0.0	0.0	0.6
Viola palustris	0.0	0.0	0.0	2.8	0.0	0.6
Plagiochila asplenioides (B)	2.8	0.0	0.0	0.0	0.0	0.6
Equisetum fluviatile	0.0	0.0	0.0	2.8	0.0	0.6
Sphagnum capillifolium (B)	2.8	0.0	0.0	0.0	0.0	0.6
Peltigera spp. (L)	2.8	0.0	0.0	0.0	0.0	0.6

Note: Species sorted according to mean frequency. Abbreviations: (L) = lichen; (B) = bryophyte.

A.D. (Svensson 1998, 75). The ancient monuments indicate that activities such as dwelling, hunting, gathering, fishing and industrial work, and also transportation in relation to the mill, took place in the vicinity of the square. Especially, the late dwelling sites (the crofts) would have included various activities such as wood collection and forest grazing, covering larger forest areas, most likely touching the square. None of these activities is visible in the recorded vegetation.

NILS square 268 (inventory from 2014)

This square contains 20 taxa (Figure 3). It shares most of the typical forest species with the other NILS subunits. There are no indicators of human land use, and there are no ancient monuments registered in or adjacent to the square. Some distance from the square there is a bloomery iron production site, a shieling, a still-used site that was a shieling and croft. The hill east of the square is called *Östersäterberget* meaning 'the east shieling mountain', indicating that the forest here was used for grazing. The ancient monuments indicate that activities such as iron production, charcoal burning for iron production and forest grazing took place in the vicinity of, most likely even touching the square. At least forest grazing was carried out fairly recently, probably as late as the nineteenth or twentieth centuries. None of these activities is visible in the recorded vegetation.

NILS square 288 (inventory from 2016)

For square 288, NILS lists 30 taxa (Figure 4). Most species in this square are typical and common representatives of different types of spruce and pine forests and mires. Additionally, the square shares with squares 304 and 305 some frequent species from mires and bogs such as *Vaccinium oxycoccus/microcarpum*, *Empetrum nigrum* s.l., *Eriophorum vaginatum*, *Andromeda polifolia*, *Sphagnum papillosum*, *Sphagnum magellanicum*, and *Carex pauciflora*. There are no indicator species of human land use present in this square. A deserted farmstead of probably fairly young origin and deserted quite recently, traces of haymaking on mires, a pit for extracting bog ore, a few crofts, three mills, a sawmill, and a few small, and probably fairly young, shielings have been registered in the vicinity of the square. It should also be noted that the square is situated in an area strongly influenced by Forest Finns, famous for their practice of large-scale swidden cultivation in spruce forest, and later by an iron mill industry. There are remains of charcoal stacks, producing charcoal for the iron mill, but these are not documented individually in Fornsök. The ancient monuments indicate that activities such as dwelling, charcoal burning, industrial work, forest grazing, haymaking, probably swidden cultivation and cereal cultivation took place in the vicinity of, likely touching the square. Most of these activities were carried out into the last century. None of these activities is visible in the recorded vegetation.

NILS square 304 (inventory from 2017)

The NILS inventory lists 36 taxa for this square (Figure 5). Besides typical spruce and pine forest species, some species of bogs and mires are present, e.g. *Vaccinium oxycoccus*, *Rubus chamaemorus*, *Drosera rotundifolia*. Within, or adjacent to the square, pitfalls for elk, bloomery iron production sites with a number of connected charcoal pits, a shieling and three croft sites have been registered. A bloomery iron production site close by has been excavated and dated to *ca*. 850–1,200 A.D., and it is likely that the bloomery iron production sites and charcoal pits connected to the NILS square 304 is of a

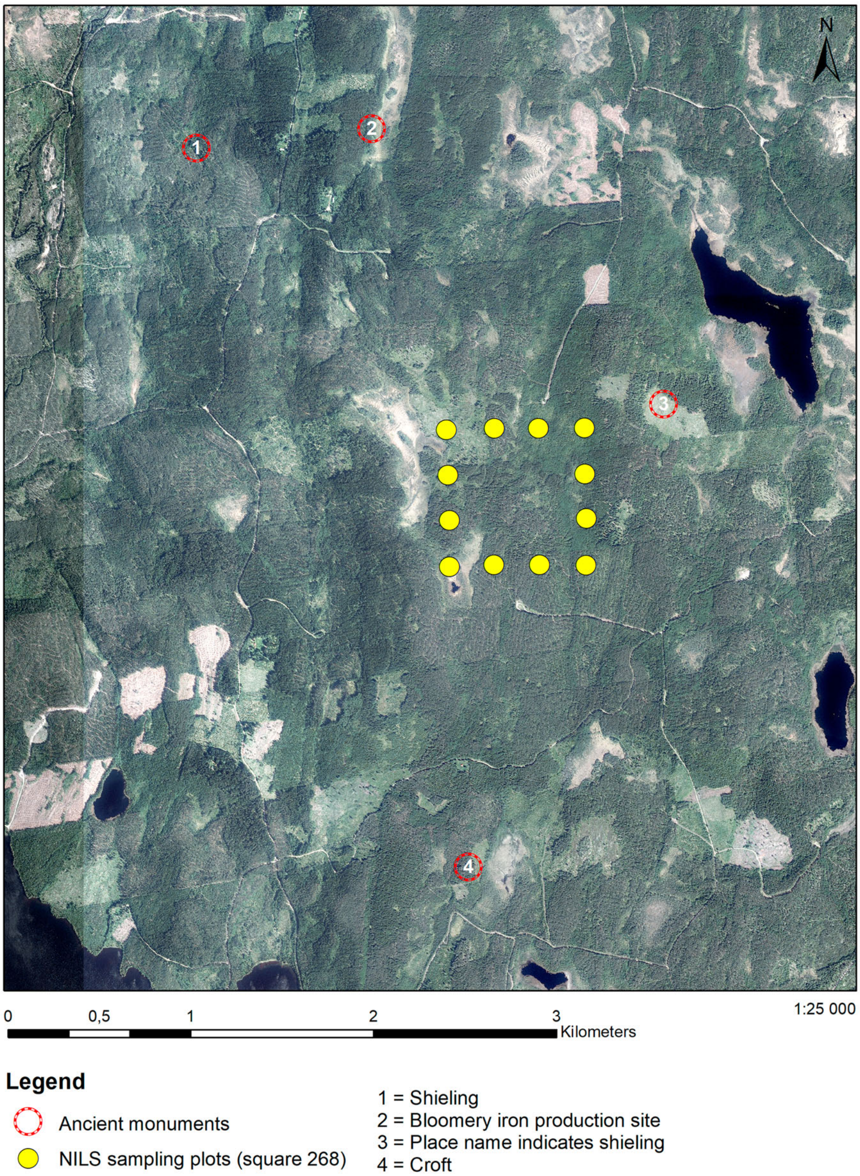

Figure 3. NILS square 268 and ancient monuments. Source: GSD-Orthofoto, 0.5m colour © Lantmäteriet (2015) (Map: Jan Haas).

similar date. The pitfalls for elk may have a similar dating as it is quite a common dating for single or clustered pitfalls, not being part of a system of pitfalls (Svensson 1998).The shieling is small, and probably connected to the Forest Finns in the area, indicating a date in the eighteenth and nineteenth centuries. The crofts are presumably of the same date. The ancient monuments indicate that activities such as dwelling, iron production, charcoal burning for iron production, forest grazing and cereal cultivation took place in the vicinity of and even in the square. None of these activities are visible in the recorded vegetation.

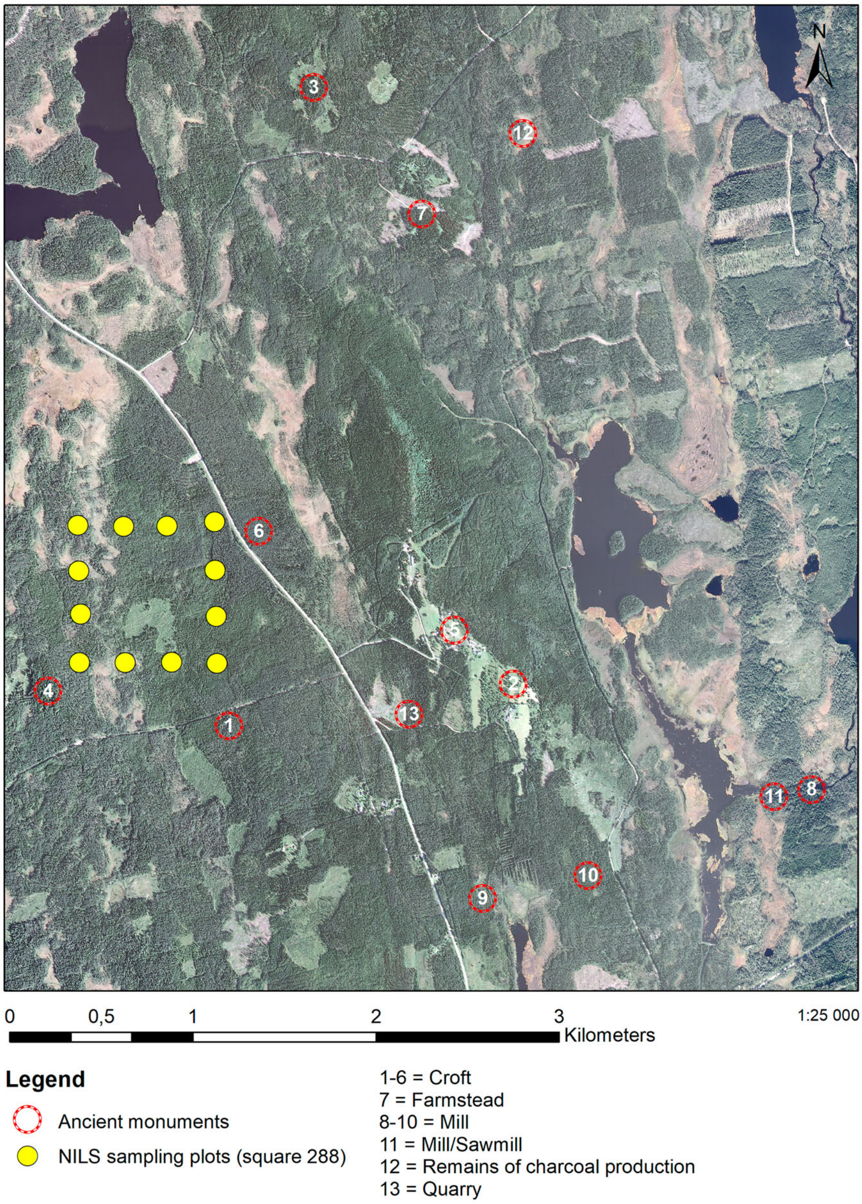

Figure 4. NILS square 288 and ancient monuments. Source: GSD-Orthofoto, 0.5m colour © Lantmäteriet (2015) (Map: Jan Haas).

NILS square 305 (inventory from 2015)

The square is situated on the border between Värmland and Dalarna (Figure 6). Square 305 harbours 25 taxa of plants. It is also mainly characterised by forest and bog species. Here, species such as *Calluna vulgaris* and *Cladonia* spp. section *Cladina* show their highest frequencies; additionally *Carex globularis*, a species of the transition zone between coniferous forests and mires has high frequency. There are no indicators of

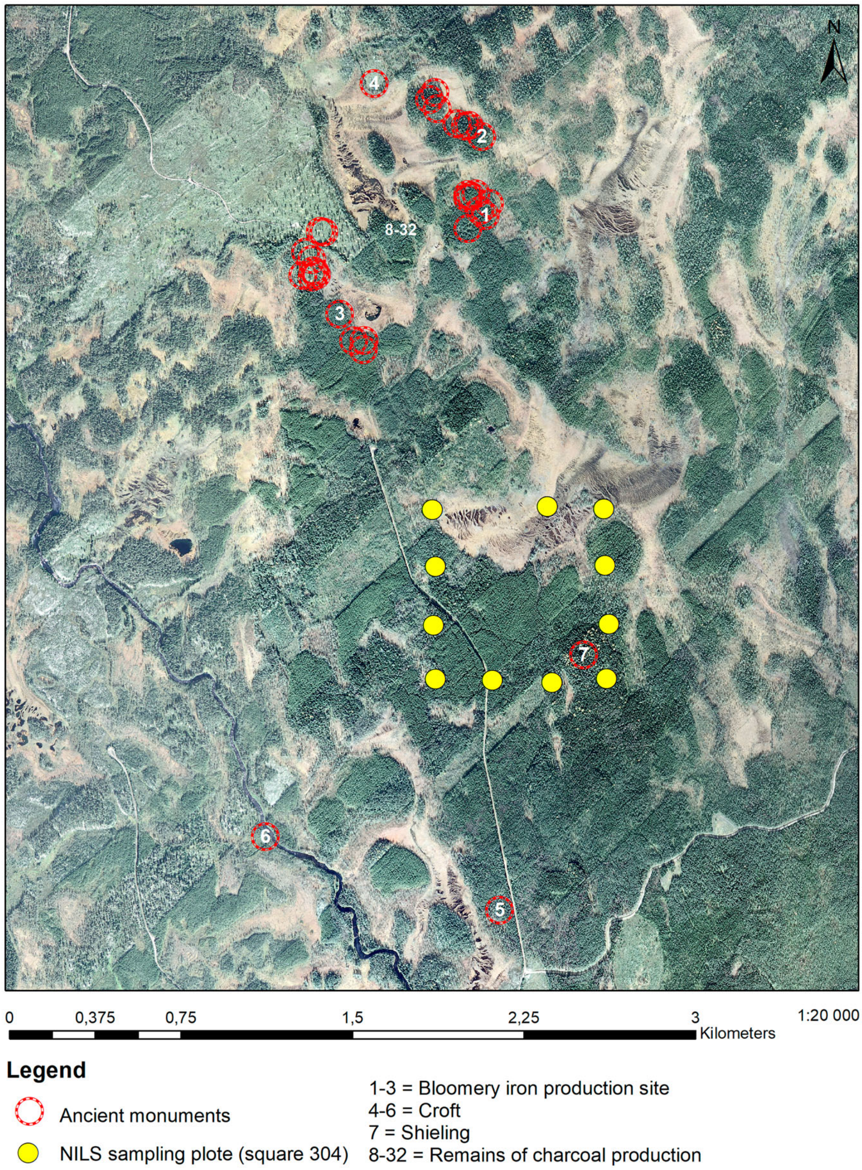

Figure 5. NILS square 304 and ancient monuments. Source: GSD-Orthofoto, 0.5m colour © Lantmäteriet (2015) (Map: Jan Haas).

human land use. Within the square there is a lake, which has been dammed to a higher water level. There does not appear to have been any survey for ancient monuments preceding the damming, which is otherwise customary and required. There are very few ancient monuments registered in and adjacent to the square; a charcoal pit, a possible pitfall system for elks, two pitfalls for elk and a shieling of probably young origin. However, it is highly likely that there were also Stone Age settlements for Mesolithic hunter gatherers. By the neighbouring lake in Dalarna, which has been surveyed,

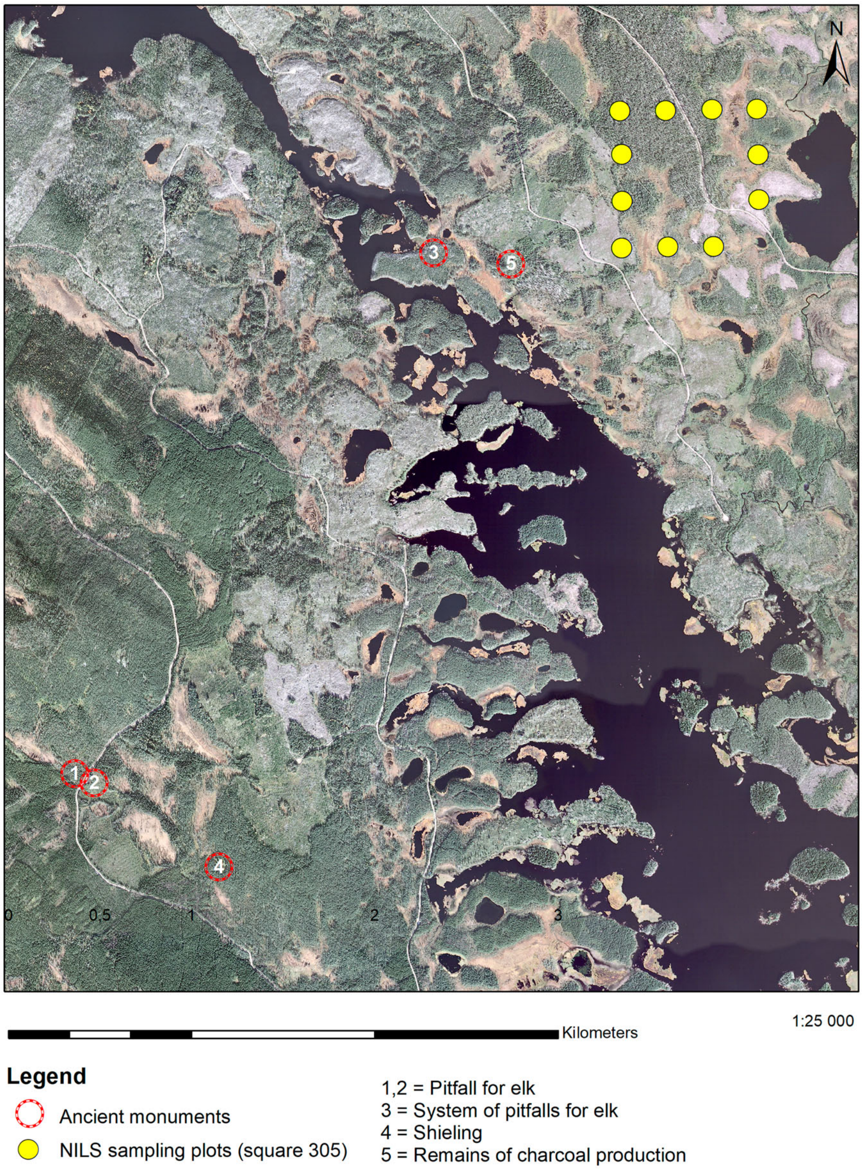

Figure 6. NILS square 305 and ancient monuments. Source: GSD-Orthofoto, 0.5m colour © Lantmäteriet (2015) (Map: Jan Haas).

several Stone Age settlement sites have been documented. The ancient monuments indicate that activities such as charcoal burning for iron production, hunting, forest grazing and probably dwelling, hunting, gathering and fishing took place in the vicinity of the square. From the character of the ancient monuments (Svensson 1998) it appears likely that forest grazing was performed until the nineteenth or even early twentieth century, whereas the other activities were carried out in prehistoric or medieval times. None of these activities is visible in the recorded vegetation.

Discussion

According to our results, there are no clear connections between the ancient monuments and the vegetation in the investigated NILS squares. The historical land use does not appear to have left any effect on the vegetation, and there are no vegetation responses to the detected human activities. We should emphasise that the situation would probably have been very different if the investigated NILS squares had been located in agrarian contexts; our experience probably only applies to forested areas. It is also possible that NILS squares in other forested parts of Sweden would have yielded another result concerning vegetation, something we have not checked due to less systematically gathered information on heritage sites in other boreal forests, and the geographically limited study area. But as northern Värmland is relatively well surveyed, and the NILS squares are random, we have no reason to believe that a similar desk-based investigation such as ours in another forest would give a radically different result.

We assume four major explanations for the lack of correlation: time, scale, knowledge gaps (including data and survey methods) and disciplinary perspective.

Concerning time

Cultural plant relics at deserted sites, as mentioned above, appear to have a disappearance rate of about 1% annually (Eriksson and Glav Lundin 2020), although research from France shows that there were still traces of 2,000-year-old agriculture in the soil and vegetation (Dupouey *et al.* 2002; Plue *et al.* 2008). For some very old ancient monuments, however, such as settlement sites from the Stone Age, the timespan between the human impact and present vegetation is simply too long. The Stone Age settlements registered in the investigation area appear to be mostly Mesolithic, before cereal cultivation and cattle breeding was introduced, and even if hunters and gatherers did manage their environment to improve hunting and gathering, they had only minor impact on the environment. To close the time gap, to document not only the effect of direct human impact but also the different successive ecological niches (Eriksson and Arnell 2017; Eriksson *et al.* 2021), other sources and methods, such as historical maps and pollen analysis would have to be used.

Unfortunately, historical maps (Lantmäteriet, Historiska kartor) give little information on forested areas. Sweden has an exceptional collection of historical maps from the seventeenth century onwards, but the older maps are confined to settlement and infield areas, and forests and forest resources were with few exceptions only mapped in the nineteenth century and yield little information. Attempts have been made to track historical land use by how the value of different forest patches was graded, although such results need to be followed up by field surveys to detect the resources and land use behind the different grades (Emanuelsson *et al.* 2003, 81–3). So far vegetation historical methods such as pollen analyses have provided the best long-term studies of vegetation responses to human impact, for agrarian as well as industrial and other activities (Berg 2004; Emanuelsson 2001; Emanuelsson *et al.* 2003; Karlsson *et al.* 2015, 2016; Lagerås 2007, 119; Segerström *et al.* 1994). Pollen analyses are however expensive, have limited spatial scope and are carried out and published in relation to specific projects and sites or areas. But if added to other databases, e.g. Fornsök, they could be found and used in other studies.

A large time gap is probably, however, not a sufficient explanation. In the vicinity of most squares there are remains of fairly recent activities, and these are still not reflected in the vegetation documented by NILS. Some of them, such as forest grazing in relation to shielings, farmsteads and crofts covered large areas, and some of the squares in this investigation should presumably have been grazed not too long ago. The lack of impact from these activities is harder to explain by time.

Concerning scale

The lack of relationship between (non-intensive) former land use and current vegetation may also be an effect of a mismatch between the scales of observation utilised in the different databases. The NILS squares and the ancient monument plotted data are spatially limited. They spatially overlap in only one of the investigated sites, although historic activities potentially affected all the squares. Studies on landscape legacies have mostly found an effect of historical land use at a local scale, i.e. relationships between e.g. diversity of a plot to the plot-specific management history (e.g. Austrheim *et al.* 1999; Cousins and Eriksson 2002; Dupouey *et al.* 2002). Connecting to previous research, it appears that interrelations and long-term vegetation responses to human impact can be expressed on a landscape level, for instance as more mosaic forests (Segerström *et al.* 1994). Another example is the transition from forests with a higher degree of deciduous trees to more coniferous trees due to charcoal production (Lagerås 2007, 119). Such large-scale transitions would not be captured in the plot-scale inventories of the NILS squares.

Concerning knowledge gaps

It could be the case that the lack of indications of human activities on the vegetation could contribute to the interpretation of human behaviour. For instance, it has been presumed that charcoal burning for iron production, in charcoal pits and charcoal stacks, included clear-cutting of large areas. But maybe that was not the case, and maybe wood for charcoal burning was collected from branches and selected trees over large areas or with other techniques with minimum impact on the forest as a whole. The lack of tar production sites could be an argument for such an interpretation, as a clear-cutting would have left a lot of stubs suitable for producing tar. The lack of grazing indicators in the NILS squares close by farmsteads, crofts and shielings where livestock presumably were grazing, could show that forest grazing was more restricted or piecemeal than assumed, and that the NILS squares happened to be barred from grazing.

Concerning disciplinary perspectives

A final but important reason behind our negative result lies in the type and the way in which data are recorded both in NILS and Fornsök. In NILS, it is a question of recording individual plants, in Fornsok individual sites; neither database record assemblages, groups, networks, landscapes, time depths or contexts. Nor is the data collection carried out with interdisciplinary ambitions, but for use in the respective management sectors and academic disciplines. This means that neither sector takes responsibility for the integrated biocultural heritage. Interestingly enough, there were ambitions in the

1990s and early twenty-first century to increase integration between nature conservation and heritage management, e.g. a couple of advisory projects carried out as initiatives from the Swedish Board of Agriculture, and to some extent also the previously mentioned project *Forest & History* carried out by the Swedish Forest Agency in cooperation with the National Heritage Board (Nilsson *et al.* 2008, 21–2). But these projects were not followed up.

Conclusion

The low budget method that was investigated was not successful for studying biocultural heritage and the entanglement of nature and heritage in the forest as no vegetation responses to documented human impact were recorded. In our opinion, the negative outcome of the investigation can be explained mainly by methodological problems of handling time and scale in data collection, as surveys of ancient monuments and vegetation follow the different logics of their respective sector. We are therefore calling for integrated survey methods and large-scale databases enabling interdisciplinary landscape interpretations, both for research and for sustainable management of our environment.

Considering the present knowledge of the value of integrating information on both natural and cultural impact on our landscape, it is about time to develop integrated survey methods and large-scale databases enabling interdisciplinary landscape interpretations, both for research and for sustainable management of our environment. The optimal would of course be integrated landscape surveys, combining different competences in the field and documenting different expressions in a landscape context, not only individual sites or landscape features and aspects, and using methods for closing the time gap. Unfortunately, Swedish agencies today are unwilling to undertake large scale surveys with national coverage. Presently, we are left with the option of using existing data. A more realistic way to move forward would therefore be to develop a digital infrastructure functioning as an umbrella for different databases harbouring information on various aspects of the biocultural heritage and landscapes. The existence and access to such a comprehensive database would enable sampling strategies with respect to present data, e.g. looking for particular indicator species, or vice versa, searching for signs of past land-use when indicator species are discovered during in-situ data collection. Such a digital infrastructure would not solve the problems we have encountered in this paper, but it would highlight the gaps in a systematic way and maybe opening up for new interdisciplinary methods.

Acknowledgements

This paper is part of the project *Innovasjon for grønn omstilling i skogen – InGO* (Eng. Innovation for green transition in the Forest – InGO), funded by *Interreg Sweden-Norway, European Regional Development Fund*, ID 20201307. We would like to thank Ove Eriksson and two anonymous reviewers for fruitful comments on an earlier draft of this paper.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributors

Eva Svensson is a historical archaeologist and professor in Environmental Sciences at Risk- and Environmental Studies, Karlstad University, Sweden. Svensson is an expert in socio-ecological and interdisciplinary approaches to forested landscapes in a long-term perspective, and on the role of heritage and history in realising Agenda 2030.

Jan Haas is associate professor at Geomatics, Karlstad University, Sweden and holds a PhD in geoinformatics. He is specialised in multispectral/radar remote sensing, photogrammetry, data classification, GIS and geodata.

Rolf Lutz Eckstein is a vegetation- and landscape ecologist and professor of biology at Karlstad University. He is interested in the role of local and landscape factors for biodiversity and conservation.

ORCID

Eva Svensson http://orcid.org/0000-0003-0571-2624
Jan Haas http://orcid.org/0000-0002-6140-2922
Rolf Lutz Eckstein http://orcid.org/0000-0002-6953-3855

References

Andersson, S., Sköld, J. and Åhman, E. 2007. Kulturväxter på övergivna torp. In *Torpens arkeologi*, ed. S. Welinder, Riksantikvarieämbetet, 79–98.

Artdatabanken. 2021. https://www.artportalen.se/, accessed 3 February 2021.

Austrheim, G., Gunilla, E., Olsson, A. and Grøntvedt, E. 1999. Land-use impact on plant communities in semi-natural sub-alpine grasslands of Budalen, central Norway. *Biological Conservation* 87 (3), 369–79.

Axelsson Linkowski, W. 2010. *Utmarksbete, främst skogsbete, och dess effekter på biologisk mångfald*. CBM:s skriftserie 40. Naptek, Centrum för biologisk mångfald, Uppsala.

Axelsson Linkowski, W. 2017. Managing Mountains, Past and Present Conditions for Traditional Summer Farming and Sami Reindeer Husbandry in Northern Scandinavia, Diss. Uppsala: Sveriges lantbruksuniversitet, Acta Universitatis Agriculturae Sueciae, 1652-6880, 2017:80, ISBN 978-91-7760-050-3.

Berg, A. 2004. Bergsbruk och skog under 1000 år – en pollenanalytisk studie av sjön Kalven i Norbergs bergslag. Undergraduate Essay, Swedish University of Agricultural Sciences.

Bladh, G. 1995. *Finnskogens landskap och människor under fyra sekler: en studie av samhälle och natur i förändring*. Högskolan i Karlstad.

Cousins, S.A.O. and Eriksson, O. 2002. The influence of management history and habitat on plant species richness in a rural hemiboreal landscape, Sweden. *Landscape Ecology* 17, 517–29.

Dupouey, J.L., Dambrine, E., Laffite, J.D. and Moares, C. 2002. Irreversible impact of past land use on forest soils and biodiversity. *Ecology* 83, 2978–84.

Emanuelsson, M. 2001. Settlement and Land-Use History in the Central Swedish Forest Region: The Use of Pollen Analysis in Interdisciplinary Studies, Doctoral dissertation, Swedish University of Agricultural Sciences.

Emanuelsson, M. 2003. *Skogens biologiska kulturarv: Att tillvarata föränderliga värden*, Riksantikvarieämbetet.

Emanuelsson, M., Johansson, A., Nilsson, S., Pettersson, S. and Svensson, E. 2003. *Settlement, shieling and landscape: the local history of a forest hamlet*, Almqvist & Wiksell International.

Ericsson, T.S., Berglund, H. and Östlund, L. 2005. History and forest biodiversity of woodland key habitats in south boreal Sweden. *Biological Conservation* 122, 289–303.

Ericsson, S., Östlund, L. and Axelsson, A.-L. 2000. A forest of grazing and logging: deforestation and reforestation history of a boreal landscape in central Sweden. *New Forests* 19, 227–40.

Eriksson, O. 2018. What is biological cultural heritage and why should we care about it? An example from Swedish rural landscapes and forests. *Nature Conservation* 28, 1–32.
Eriksson, O. and Arnell, M. 2017. Niche construction, entanglement and landscape domestication in Scandinavian infield systems. *Landscape Research* 42 (1), 78–88.
Eriksson, O. and Glav Lundin, L. 2020. 'Gooseberry is the only thing left' – a study of declining biological cultural heritage at abandoned crofts in the province of Södermanland, Sweden. *International Journal of Heritage Studies* 26 (11), 1061–76.
Eriksson, O., Arnell, M. and Lindholm, K.-J. 2021. Historical ecology of Scandinavian infield systems. *Sustainability* 13, 817. doi:10.3390/su13020817.
Fornsök. 2020. https://app.raa.se/open/fornsok/, accessed 11 June 2020.
Furuskog, J. 1924. *De värmländska järnbruken: kulturgeografiska studier över den värmländska järnhanteringen under dess olika utvecklingsskeden*, Bronellska bokhandeln.
Gräslund Berg, E., Durieu Du Pradel, C., Fiebranz, R., Jacobsson, B., Hassan Jansson, K., Lennersand, M., Lindberg, E., Lindström, D., Lindström, J., Ling, S., Mispelaere, J., Oja, L., Pihl, C., Rydén, G., Ågren, M. and Östman, A.-C. 2013. Praktiker som gör skillnad: Om den verb-inriktade metoden. *Historisk Tidskrift (Sweden)* 133 (3), 335–54.
Grundén, N. 1997. Untra – landskapsekologisk historia vid nedre Dalälven 1700–1996. Undergraduate Essay, Swedish University of Agricultural Sciences.
Josefsson, T., Olsson, J. and Östlund, L. 2010. Linking forest history and conservation efforts: long-term impact of low-intensity timber harvest on forest structure and wood-inhabiting fungi in northern Sweden. *Biological Conservation* 143, 1803–11.
Karlsson, J., Rydberg, J., Segerström, U., Nordström, E.-M., Thöle, P., Biester, H. and Bindler, R. 2016. Tracing a bog-iron bloomery furnace in an adjacent lake-sediment record in Ängersjö, central Sweden, using pollen and geochemical signals. *Vegetation History and Archaeobotany* 25 (6), 569–81.
Karlsson, J., Segerström, U., Berg, A., Mattielli, N. and Bindler, R. 2015. Tracing modern environmental conditions to their roots in early mining, metallurgy, and settlement in Gladhammar, southeast Sweden: vegetation and pollution history outside the traditional Bergslagen mining region. *The Holocene* 25 (6), 944–55.
Lagerås, P. 2007. *The ecology of expansion and abandonment: medieval and post-medieval agriculture and settlement in a landscape perspective*, Riksantikvarieämbetet.
Länsstyrelsen i Värmland. 2014a. Kartläggning av biologiskt kulturarv i fäbodmiljöer. Värmlands län 2012. Länsstyrelsen i Värmland 2014:12.
Länsstyrelsen i Värmland. 2014b. Kartläggning av biologiskt kulturarv i fäbodmiljöer. Värmlands län 2012. Länsstyrelsen i Värmland 2014:39.
Lantmäteriet, Historiska kartor. 2021. https://historiskakartor.lantmateriet.se/historiskakartor/search.html accessed 30 January 2021.
Liljewall, B. ed. 1996. *Tjära, barkbröd och vildhonung: Utmarkens människor och mångsidiga resurser*, Nordiska museet.
Lind, H. and Svensson, E. 2001. Pinoberget. En socialhistorisk studie utifrån sentida bebyggelselämningar och obesuttna människor. In *Projekt uppdragsarkeologi. Sentida bebyggelse i antikvarisk och arkeologisk verksamhet*. Riksantikvarieämbetet rapport 2, 47–88.
Lindholm, K.-J. and Ekblom, A. 2019. A framework for exploring and managing biocultural heritage. *Anthropocene* 25, 100195.
Lötberg, L. 2003. Vilka botaniska naturvärden finns vid torplämningar i norra Uppland? Skogsstyrelsen. Rapport 2003, 7.
Milberg, P., Bergman, K.-O., Jonason, D., Karlsson, J. and Westerberg, L. 2019. Land-use history influence the vegetation in coniferous production forests in southern Sweden. *Forest Ecology and Management* 440, 23–30.
Nilsson, B., Skoglund, P. and Svensson, E. 2008. *Mötesplatser – på väg mot en samlad natur- och kulturmiljövård*. ArchaeologyLund 3, Lund University.
Påhlsson, L. 1998. Vegetationstyper i Norden. TemaNord 1998:510. Nordisk Ministerråd.

Panfalk, H. and Österberg, A.-S. 2015. De forna torpgläntornas landskap – en fallstudie av torplämningar i sydsvensk skogsbygd. Undergraduate Essay, School of Education and Environment, Kristianstad University.
Pedersen, S., Gangås, K.E., Chetri, M. and Andreasson, H.P. 2020. Economic gain vs. ecological pain – environmental sustainability in economies based on renewable biological resources. *Sustainability* 12 (9), 3557.
Plue, J., Hermy, M., Verheyen, K., Thuillier, P., Saguez, R. and Decocq, G. 2008. Persistent changes in forest vegetation and seed bank 1,600 years after human occupation. *Landscape Ecology* 23, 673–88.
Segerström, U., Bradshaw, R., Hörnberg, G. and Bohlin, E. 1994. Disturbance history of a swamp forest refuge in northern Sweden. *Biological Conservation* 68, 189–96.
Sjödin, M. 2019. *Fältinstruktion för Nationell Inventering av Landskapet i Sverige, NILS 2019*, Swedish University of Agricultural Sciences.
Sjörs, H. 1999. The background: geology, climate and zonation. In *Swedish plant geography*, eds. H. Rydin, P. Snoeijs and M. Diekmann, Acta Phytogeographica Suecica 84, Uppsala, 5–14.
Skogens Pärlor. 2020. https://www.skogsstyrelsen.se/sjalvservice/karttjanster/skogens-parlor/skogens-parlor-material/, accessed 30 August 2020.
Skogsstyrelsen. 2020. 'Hänsynsuppföljning kulturmiljöer', at https://www.skogsstyrelsen.se/statistik/statistik-efter-amne/hansynsuppfoljning-kulturmiljoer/, accessed 13 December 2020.
Ståhl, G., Allard, A., Esseen, P.-A., Glimskär, A., Ringvall, A., Svensson, J., Sundquist, S., Christensen, P., Gallegos Torell, Å, Höström, M., Lagerqvist, K., Marklund, L., Nilsson, B. and Inghe, O. 2011. National Inventory of Landscapes in Sweden (NILS) – scope, design, and experiences from establishing a multiscale biodiversity monitoring system. *Environmental Monitoring and Assessment* 173, 579–95.
Svensson, E. 1998. *Människor i utmark*, Almqvist & Wiksell International.
Svensson, E. 2006. Cultural heritage of the forest and cultural heritage in the forest. In *Forestry and our Cultural Heritage. Proceedings of the seminar 13–15 June 2005, Sunne, Sweden*, ed. MCPFE Warsaw, MCPFE, 106–10.
Svensson, E. 2008. *The medieval household: daily life in castles and farmsteads. Scandinavian examples in their European context*, Brepols.
Svensson, E. 2014. Heritage at risk. The devastating effects of mechanised forestry on local heritage. In *Via Spatiosa. Festschrift to Ragnar Andersson on his 67th birthday*, eds. S. Moniruzzaman, F. Nilsson and E. Svensson, Karlstad University Studies 2014:60, 81–91.
Timonen, J., Siitonen, J., Gustafsson, L., Kotiaho, J.S., Stokland, J.N., Sverdrup-Thygeson, A. and Mönkkönen, M. 2010. Woodland key habitats in Northern Europe: concepts, inventory and protection. *Scandinavian Journal of Forest Research* 25 (4), 309–24.
Tunón, H. and Bele, B. 2019. *Fäboden: naturen, kulturen och kulturlandskapet*. CBM:s skriftserie 109. Centrum för biologisk mångfald, Uppsala.
Turner, M. and Gardner, R.H. 2015. *Landscape ecology in theory and practice*, Springer.