AGFORWARD
Agroforestry for Europe

Research and Development Protocol for Wood Pasture and Parkland in the UK

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1 Context

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has four objectives:

1. to understand the context and extent of agroforestry in Europe,
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report contributes to the second objective. It contributes to the initial research and development protocol, Milestone 4 (2.3), for the participative research and development network focused on agroforestry of high nature and cultural value.

2 Background

Wood pasture and parklands are traditional land uses in the UK which tend to have their origins in medieval hunting forests, wooded commons, or treed pastures. Some of these sites were incorporated or established as parks, particularly in the 19th century, and in general they are home to a range of native species (Maddock 2011). Key features of wood pastures and parklands are the presence of open-grown ancient or veteran trees (often pollarded), grazing livestock, and an understorey of grassland or heathland.

The ground vegetation can be considered to be the key differentiator between woodland and wood pasture, in that woodlands tend to be dominated by shade tolerant species, whereas wood pastures and parklands tend to be dominated by communities of plants that prefer unshaded conditions (Rackham 2006). Indeed it has been demonstrated that wood pastures can be home to two distinct types of grassland: that which exists beneath the trees, and that which exists between the trees (Marañon 1986).

Trees within wood pastures also differ to those within woodlands as they have generally been subject to much less competition. This means that left unmanaged, they are likely to have the form of an open-grown tree: squat compared to woodland grown trees, with wide spreading limbs (Hein and Spiecker 2008). In the case of wood pastures in particular, the trees have generally been managed intensively, at least for part of their lives, usually by pollarding or shredding for firewood or fodder (Rackham 2006). This form of management can extend the lives of trees by keeping their respiration requirements within their photosynthetic means (Thomas 2000). This poses a problem to modern managers who are faced with the dilemma of whether to re-institute a cutting cycle which may have ended decades earlier and may lead to the loss of many trees (Dagley & Burman 1996) or to leave the trees to gradually disintegrate under continued growth (Dagley 2006).

Veteran and ancient pollarded trees typically have characteristics of large girth, cavities and hollowed stems and branches, water pools, decay pockets, standing deadwood in various states of decay, epiphytes, fruiting bodies from fungal decay organisms (Read 2000). As such these trees constitute a unique ecosystem home to many specialised organisms, the continuity of which can only be assured with re-institution of a pollarding cycle (Read 2000).

Whilst re-instituting tree management can be an important objective to ensure tree continuity, re-instituting grazing (or mowing) can be equally important to ensure the continuity of the pasture. With such an intimate source of tree seed, wood pastures and parklands can be at threat from ‘infill’ the gradual slide towards secondary woodland (Rackham 2006). Of course some natural regeneration is to be encouraged if an ‘age-class crisis’ is to be avoided, but finding the balance between preventing infill whilst ensuring sufficient natural regeneration is a problem that concerns contemporary managers of wood pasture and parkland systems.

2.1 Invisible fencing and GPS tracking

In the UK many wood pastures are commons (for example Epping Forest) where rights to access, grazing, and (historically) firewood collection have been enshrined in law (UK Government 2006). Fencing can therefore be a contentious issue, whilst also requiring considerable expense in terms on installation and maintenance. In recent years, technological advancements have allowed the creation of ‘invisible fencing’ systems which do not rely on physical barriers (Anderson 2007). These systems work by emitting cues to deter an animal from crossing a pre-defined boundary. Such cues are typically audible or electrical, and in the most sophisticated systems are combined into a ramped ‘package’ of cues allowing the animal to ‘choose’ its own level irritation before altering its behaviour (Anderson 2007).

The boundaries of these systems are typically defined by wires which generate an FM or AM radio signal which is received by an electrical device located on the animal (typically on a collar). These wires can be located above or belowground, and can be incorporated into roads mitigating the need for traditional cattle grids. More sophisticated systems can dispense with the wire entirely by making use of GPS units located on the animal; an exclusion zone can then be defined based on pre-defined virtual polygon. These systems come with the benefit that the grazing zone can be shifted day by day, allowing rotational grazing, although this may only be of real value in very large grazing systems like the US rangelands (Anderson 2007). In wood pastures where cattle may be under trees, Global Positioning Systems (GPS) may not be practical, as the accuracy of the satellite signal is likely to be compromised. GPS however can also be employed as a means of tracking cattle, and recapturing animals that manage to breach the invisible fencing perimeter. Data collected by these systems could provide useful insights for managers of wood pasture and parkland systems, but can be difficult to access and interpret without technical expertise.

3 Objectives

This project has three objectives:

- Develop a web-based platform to allow farmers to interrogate GPS data from cattle collars.
- Perform a simple cost benefit analysis of the invisible fencing system
- Develop and apply a management tool for assessing the impact of grazing.

4 System description

The trials are based at two main sites: Epping Forest and the Knepp Castle Estate (Table 1).

Table 1. Description of the sites, with soil, tree, understorey, and livestock characteristics

Site characteristics		
	Epping Forest	Knepp Castle Estate
Area: Co-ordinates:	450 ha (120 ha with invisible fencing) 51°39'28.8"N 0°02'27.4"E (51.658002, 0.040944)	1400 ha (in four distinct blocks) 50°59'00.1"N 0°21'16.8"W (50.983376, -0.354666)

Soil characteristics		
Soil type (WRB classification) Soil depth Soil texture (sand%, silt%, clay%)	Eutric luvic planosol 100 cm* Fine loam	Eutric luvic planosol 100 cm Fine loam

Tree characteristics		
Tree species	Mixed, but predominantly hornbeam (*Carpinus betulus*), beech (*Fagus sylvatica*), and oak (*Quercus robur* and *petraea*) pollards in wood pasture and parklands	Mixed broadleaves
Tree density	30-60 trees ha^{-1} (Hornbeam) 30-50 trees ha^{-1} (Beech)	Variable. Seedlings emerging.
Tree protection	None	None

Understorey characteristics		
Species	Predominantly grass, wild forbs, and brambles	Predominantly grass, wild forbs, and brambles
Coverage	Complete, but shade dependent	Complete

Livestock characteristics		
Species	Red polls and Longhorn cattle	Longhorn cattle
Stocking density	Variable	Variable

* UK value for the Wickham soils series (NSRI 2015b; NSRI 2015a)

4.1 Epping Forest

Epping (originally Waltham) Forest was a royal hunting ground in the tradition of medieval forests, situated around North East London (Rackham 2006). Wooded forests like Epping operated like wood-pasture commons in England, and were party to a number of rights: the right of the king to keep and hunt deer, the right of landowners (who might own the land, but not the hunting rights), and the rights of commoners, which included to lop the trees for firewood, and to graze livestock. It is these common rights which led to the formation of the distinctive wood pasture: a low density of pollarded trees within a matrix of grassland: a typical wood pasture (Rackham 2006).

Increasing urbanisation, and a shift towards coal rather than wood as a means of heating in the 19th century led to a decline in the practice of pollarding and commons grazing. Encroachment onto the forest was prevented in 1878, by the Epping Forest Act, which set Epping apart from other forested areas in the UK by providing the forest as an 'an open space for the recreation and enjoyment of the public' (Woodhouse et al. 2004). Today Epping covers over 2450 ha, and parts of it enjoy status as Sites of Special Scientific Interest (SSSI) and Special Areas of Conservation (SAC). Today pollarding and grazing are used as conservation tools to ensure the survival of the distinctive wood pasture habitats

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4.2 Knepp Castle Estate

Knepp Castle Estate is an estate in Sussex which can trace its history back to William the Conqueror (Anon, n.d.) who granted the land as a gift following the Battle of Hastings in 1066. During the war years (1939-1945) much of the land was turned over to agriculture, and remained so until 2001 when a series of re-wilding projects were initiated. In 2015, the estate has been turned over to grazing by fallow and roe deer, Exmoor ponies, Tamworth pigs, and longhorn cattle. The animals are allowed to graze freely, whilst the vegetation has been allowed to succeed. The estate continues to be supported by government subsides, for farming under the Single Farm Payment (SFP), and environmental stewardship with the Higher Level Stewardship (HLS) scheme (Natural England 2010), whilst also generating income from meat sales, forestry, field sports, venue hire, camping, property rental, and tourism.

5 Objective 1: GPS data platform

At present the managers of both Epping Forest and Knepp Castle Estate have tens of thousands of records of cattle movements spanning up to 18 months. The data have been used at Epping by the GPS collar supplier to produce 'heat maps' describing where the animals tend to concentrate, whilst no such insights have been made from the data at Knepp Castle Estate.

At both sites managers plan to extend their use of GPS collars, hence establishing a system which would quickly allow them to interrogate the data now, and in the future is of value. Some key information that could be presented includes:

- Displaying movements of individual/some/all animals on a given time period as either a heat map, or a trace.
- Summary statistics about the activity of individual animals over a given time period.
- Behaviour of animals in interaction with the invisible fencing system (at Epping).
- Linking of GPS data with other available datasets: e.g. weather, plant communities, or PIFs (at Knepp).

This portal will be produced using the R (R Development Core Team 2013) package 'shiny' (RStudio Inc. 2014), which is a framework for developing locally or remotely hosted web interfaces. These interfaces are relatively simple to implement and will allow subsets of the data to be examined interactively using methods such as sliders, tick boxes, and radio buttons. An example of a shiny app with spatial data can be seen here (Figure 1).

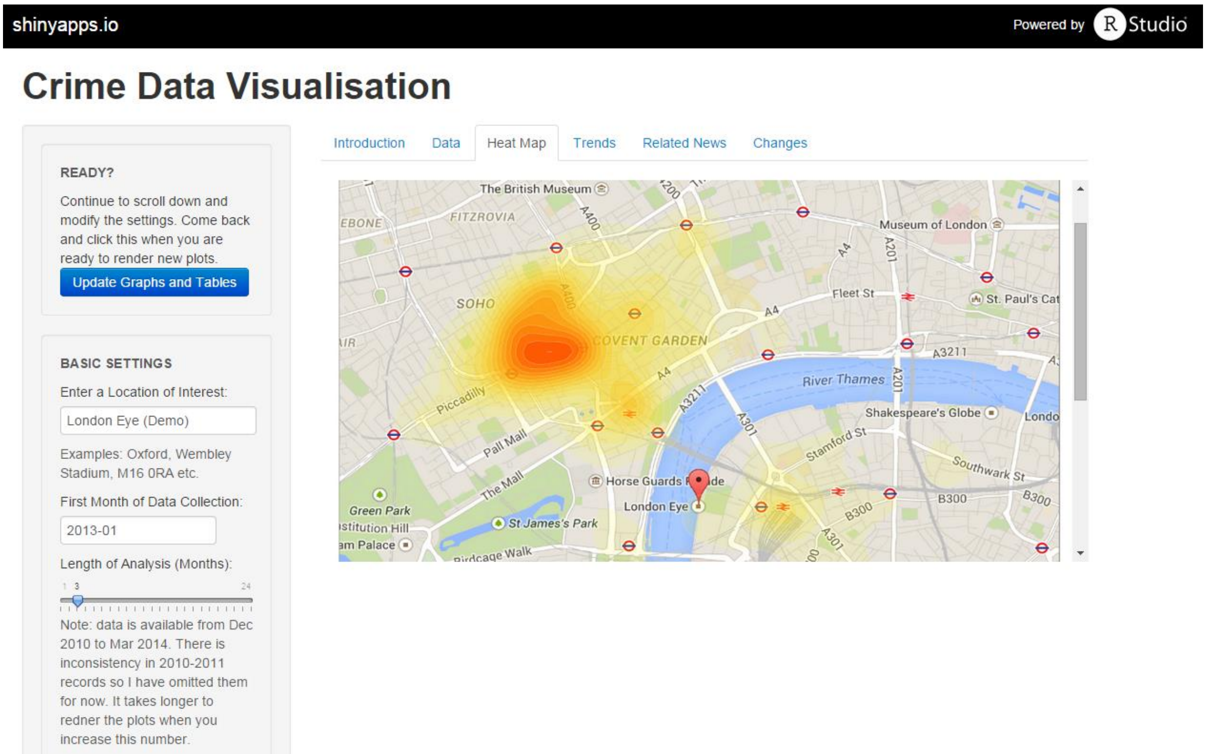

Figure 1. Screen capture from an example shiny application, available here

Producing the application in ‘shiny’ allows maps utilising publically available data to be quickly created using the ‘ggmap’ package (Kahle & Wickham 2013). The web-interface will provide a user-friendly alternative to a traditional GIS, which usually requires a significant investment of time in training, and capital in software license fees. In addition, producing the application from scratch will allow additional data from any site across Europe to quickly be added to the platform enabling new insights to be made with little additional work.

6 Objective 2: Cost effectiveness of invisible fencing

Invisible fencing systems are expensive, and at present are operated by a very small niche of operators in the UK whose aims in using the system are heavily influenced by conservation goals. At the present cost of the system, it is unlikely that it could be more widely adopted across the UK. The technology that underlies the system is relatively simple however, and it is likely that the cost will fall in the future.

This part of the project aims to look at the invisible fencing system from an economic point of view, taking the experiences from Epping Forest (and possibly also Essex County Council who run a similar system) to inform a cost-benefit analysis.

Some of the factors that could be included are avoided fencing costs, labour requirement, and the capital investment required to implement the system. This analysis should then be able to inform judgements about the cost effectiveness of the system in comparison to the traditional alternative, and how much the cost of the system would need to fall before the system might be more a more attractive prospect to farmers. This should also be weighed with an assessment of the effectiveness of the system, and the risk of cattle breaching the enclosures.

7 Objective 3: Grazing impact management tool

The final part of the project is concerned with the problem of assessing the correct level of grazing to ensure continuity of wood pasture and parkland systems. Grazing impact assessment protocols have already been produced for heathland with respect of insects and reptiles (Offer et al. 2003), upland native woodland (Thompson et al. 2004), and beech wood pasture at Burnham Beeches, a sister-site to Epping Forest (Read 2010).

The aim of this part of the project would be to review the existing Grazing Impact Assessments (GIAs), and to attempt to produce and apply a similar assessment which is more specific to wood pasture and parkland systems and the two local field sites. GPS measurements for 2014 may be useful in identifying areas which were grazed more intensively in 2014, and may therefore allow assessments to be made in areas that have historically received more grazing.

Some of the measures that might be included are presented in
Table 2 (S. Perry, personal communication). Of particular interest to managers at Knepp Estate, and an issue highlighted at the initial stakeholder meeting (Upson & Burgess 2014) is the impact that the formation of scrub has on seedling recruitment, hence measuring the relationship between scrub formation and tree seedling recruitment should be a key indicator.

It is hoped that this third objective will form the basis of an MSc research project, and a student with expertise in forest ecology has been engaged for the project.

Table 2. Possible indicators that might be included in a grazing impact assessment

Potential indicators of overgrazing
Sward height, diversity, and structure
Positive indicator species
Negative indicator species, e.g. thistles, bracken, ragwort
Quantity and distribution of scrub
Presence of bare ground
Recruitment of new trees
Presence and quantity of deadwood
Damage to tree bark

8 Acknowledgements

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