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SCIENCE

Predicted distribution of High Nature Value farmland in the Republic of Ireland

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ABSTRACT

High Nature Value (HNV) farmland is typically characterised by low-intensity farming associated with high biodiversity and species of conservation concern. Mapping the occurrence and distribution of such farmland are useful for appropriate targeting of conservation measures and supporting associated rural communities. We mapped the likely distribution of HNV farmland in the Republic of Ireland using a linear regression model incorporating established European indicators, adapted for Ireland and weightings based on expert opinion. The indicators used were semi-natural habitat cover, stocking density, hedgerow density, river and stream density and soil diversity, with highest weightings placed on the first two indicators (40% and 30%, respectively). The map provides information on the likely occurrence and distribution of HNV farmland in each electoral division as a reference point for future monitoring of the distribution of HNV farmland in the Republic of Ireland in order to assist with planning and policy development for the rural environment.

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Semi-natural habitat; stocking density; electoral division; GIS; HNV

1. Introduction

The widespread decline in global biodiversity, including farmland biodiversity (Oppermann, Beaufoy, & Jones, 2012; Robinson & Sutherland, 2002; Tscharntke, Klein, Kruess, Steffan-Dewenter, & Thies, 2005), represents a major global conservation challenge (Butchart et al., 2010). Conservation of natural resources (including biodiversity) and halting the degradation of ecosystem services are key environmental objectives of the European Union (EU) and are priorities in Ireland's National Rural Development Plan for 2014–2020 (DAFM, 2014).

High Nature Value (HNV) farmland, characterised by a combination of low-intensity land use, presence of semi-natural vegetation and/or landscape mosaics (Figure 1) is important for biodiversity (Andersen et al., 2003; Beaufoy, 2008), but also represents an important resource that is critical to the development of ecosystem services like agro-tourism to support future sustainability of HNV farmland. Knowing the potential distribution of HNV farmland at the spatial scale of administrative units is essential to assist the targeting of agri-environment schemes under many Rural Development Programs.

Identification of HNV farmland relies on the availability of national scale data sets at a fine enough resolution to be ecologically meaningful. At a European scale, direct identification of HNV farmland is difficult and thus a number of studies (Andersen et al., 2003; Morellia, Jerzakb, & Tryjanowski, 2014; Strohbach, Kohler, Dauber, & Klimek, 2015) rely on a variety of surrogate indicators of species and habitat diversity. This has been carried out for several countries, or regions within countries, in Europe (Almeida & Pinto-correia, 2013; Klimek, Lohss, & Gabriel, 2014; Lazzerini et al., 2015; Lomba et al., 2014; Pointereau et al., 2007; Samoy, Lambotte, Biala, Terres, & Paracchini, 2007). Defining a minimum set of indicators is essential to this process and depends primarily on the scale and availability of data at a pan-European level. The aim of this research is to map the likelihood of occurrence of HNV farmland in Ireland using existing national scale data.

2. Materials and methods

2.1. Indicators for HNV farmland identification

Through the use of existing literature and expert knowledge (from the project team, steering group and stakeholder engagement), five variables (Table 1) were utilised to identify potential HNV farmland at tetrad scale (2 km×2 km grid). Values were calculated for each tetrad for all five indicators and scaled between 0 and 1.

Several ecological studies identify key indicators of HNV farmland. Paracchini et al. (2008) and Sullivan, Finn, Gormally, and Skeffington (2013) emphasise the significance of the extent of semi-natural habitats; Overmars et al. (2014) found that high livestock stocking density is negatively associated with HNV farmland; Boyle, Hayes, Gormally, Sullivan, & Moran (2015) concluded that small-scale features such as

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Figure 1. Field photograph showing a typical Irish HNV farmland landscape. The photograph was captured on 17 June 2014 at Connemara, Co. Galway.

field boundaries are important indicators of HNV; Sullivan et al. (2011) established that high river and stream density is associated with higher levels of semi-natural habitat cover in Ireland and; there is an association between high levels of soil type diversity and higher levels of habitat diversity (Giller, Beare, Lavelle, Izac, & Swift, 1997; Sullivan et al., 2011).

Table 1 describes the indicators used in this study, the data and their source. It also shows the weighting given to each indicator because they were not all considered as equally important as drivers of HNV farmland. The relative importance of each of the indicators is based on research in Boyle et al. (2015) and expert knowledge.

The CORINE 2012 land cover data (CLC2012, 2005) at level 3 classification scale, describing land use and land cover were classified into five classes (1–5) reflecting their suitability for representing farmed semi-natural habitats and scaled between 0 and 1. Land Parcel Identification System (LPIS; DAFRD, 1998) data describing average stocking density was used to calculate the average livestock stocking density for the year 2009. Based on the fact that small-scale features such as field boundaries are important HNV indicators, the national 1 m^2 pixel hedgerow cover map was utilised to calculate the per cent hedgerow cover for each tetrad. Similarly, we calculated the length of river and stream as a line feature for each tetrad from the Ordnance Survey of Ireland's (OSI) river-stream map data set. Finally, soil data at soil association level was used to calculate soil diversity using the Shannon diversity index (Shannon, 1948).

Table 1. List of HNV farmland indicators with percentage weight for model input and data source.

Source	Data	HNV indicators	Weight (%)
EPA GeoPortal	CORINE land cover 2012	CLC-level 3 classification for semi-natural land cover	40
Department of Agriculture, Food and Rural Development, Ireland	LPIS Land parcel identification vectors	Average stocking density	30
Teagasc, Ireland	Hedgerow cover	Per cent hedgerow cover	10
Ordnance Survey Ireland	OSI river-stream map	Length of river and stream	10
Teagasc, Ireland	Soil association map	Soil diversity	10

2.2. Geographic Information System (GIS) modelling

Prior to the modelling exercise, all input indicator layers were converted to the same projection (TM65 Irish Grid) and datum (D-TM65). Attribute tables were harmonised with similar precision and null values were removed. Finally, each tetrad was assigned the mean value of the input feature, except for the length of river and stream layer, for which the total sum of the line feature was assigned to the tetrad. To maintain all the input layers in one format and range, all the input values were rescaled between 0 and 1. All processing was undertaken using various GIS tools.

The weighted sum model (WSM) provides the ability to assign distinct weights to the input layers and combines multiple inputs to create an integrated

output at the desired scale (Mendas and Delali, 2012). This was used for final compilation of indicator layers. Using this model, an additive overlay analysis was carried out. The input layers maintained the attribute resolution of the values entered in the model. The weighted sum assumes that more favourable factors result in higher values in the final output, and, consequently, classifies these locations as being more likely to contain higher levels of HNV farmland.

The modelled output was masked with the 1 km^2 pixel farmland data of Ireland to display farmed areas only. The resulting electoral division (ED) map was then created by assigning the mean value of the tetrads falling in each ED. For publication, the map is degraded to ED scale in order to nest within the Nomenclature of Territorial Units for Statistics (NUTS) regions used at a pan-European scale with NUTS1, NUTS2, NUTS3 and GEOGID code attached to each ED. A similar article with HNV farmland distribution at tetrad scale with more detailed information about the methodology and data used is forthcoming.

3. Results

The map has 2962 EDs with values between 0 and 5, representing the likelihood of occurrence of HNV farmland in each ED. A total of 447 EDs had values below zero, represented by the grey colour in the map. A dark green colour (indicating a score of 5) shows EDs with a very high likelihood of HNV farmland, a blue colour (indicating a score of 0) shows EDs with a very low likelihood of HNV farmland, with a grey colour indicating urban areas. Reflecting its reliance on surrogate indicators, note that non-HNV farms may still occur in areas with high likelihood of HNV farmland, and HNV farms may occur in areas with lower likelihood of HNV farmland (Main Map).

4. Conclusions

The accuracy of detection of HNV farmland depends largely on the availability of suitable input indicator data. Here, we identify a set of indicators with distinctive weights to produce an HNV farmland map for the Republic of Ireland. This is an indicator-based likelihood map and must be interpreted within the limitations of the data used. While such maps are very useful for targeting priority areas for monitoring and policy support, they are also crucial in communicating spatial variation in the distribution of HNV farmland to both expert and lay audiences. To our knowledge, this is the first Irish national scale map based on objective agri-environmental criteria to identify the distribution of HNV farmland, and provides a reference point for the future monitoring of the distribution of HNV farmland in Ireland. It can also be used as an important resource to assist in planning and policy development for the rural environment.

A similar methodology and set of indicators may be suitable for preparing HNV farmland maps for other EU countries, with farm-type and country-specific weights, which also allows for possible future improvements. The spatial scale of the map is restricted by the coarse data availability at national scale data, although a set of further fine-scale indicators could be used to produce more relevant higher resolution maps. This map proved critical to the IDEAL-HNV project for geo-statistical analysis of policy developments, and an earlier version was also used to plan farm-scale field campaigns. A detailed associated article with further information about map accuracy and use is under consideration and planned to be published in another journal.

Software

GIS database creation and map generation were implemented using ESRI ArcGIS 10 software (Spatial analyst and 3D analyst tool extensions) and Microsoft Excel 2010 for other numerical calculations.

Data

A list of data and source is available in Table 1.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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