ECOLOGY OF SCOTS PINE (*PINUS SYLVESTRIS* L.) IN IRELAND: PRELIMINARY RESULTS

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ABSTRACT

The ecology of *Pinus sylvestris* in Ireland has not been adequately described. Research to determine its native status in Ireland has produced ambiguous results. *P. sylvestris* is being widely planted in semi-natural habitats. However, neither the ecological value of these plantations nor the optimum environmental conditions for *P. sylvestris* planting in Ireland have been determined. This study aims to provide reliable, consolidated information on the autecology and biodiversity value of *P. sylvestris* in Ireland. Data on vegetation, soil characteristics, stand structure and regeneration have been recorded at ten sites throughout the country to date. *P. sylvestris* occupies a wide variety of habitats in Ireland. Preliminary data analysis has shown that there is a low level of species constancy within *P. sylvestris* communities and therefore the communities are variable. Three distinct vegetation types are apparent and soil pH and altitude are important factors in determining their floristic composition.

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INTRODUCTION

Research to determine the native status of *P. sylvestris* in Ireland has produced ambiguous results. Palaeoecological evidence indicates that it flourished after the last glaciation but then declined to extinction *circa* 400 AD (Bradshaw & Browne, 1987; McAulay & Watts, 1961). However, recent research questions the methods by which this extinction was determined (Froyd, 2005). Additionally, the literary evidence suggests that *P. sylvestris* survived at least until later medieval times (Nelson & Walsh, 1993). This provokes the question: could isolated relict populations have survived? The native status of the species is therefore disputed. *P. sylvestris* has persisted in the Caledonian forests of Scotland, which are now recognized as an Annex 1 Habitat under the EU Habitats Directive. *P. sylvestris* was reintroduced to Ireland from Scotland *circa* 1700 AD (Mitchell & Ryan, 1997) and was widely planted.

The ecology of *P. sylvestris* in Ireland has not been adequately described. Due to its disputed native status, the species has been excluded from the Irish National Survey of Native Woodland (Perrin *et al.,* 2006a) and White & Doyle's (1982) catalogue of the vegetation of Ireland. Conversely, it has been included in the Native Woodland Scheme, which is administered by the Forest Service and provides payments for landowners to plant native trees of local provenance (Anon, 2001), so the species is being widely planted in semi-natural habitats in Ireland. However, neither the ecological value of these plantations nor the optimum environmental conditions for *P. sylvestris* planting in Ireland have been determined. Definitive information on the ecology and possible native status of the species is therefore urgently required.

The primary aims of this PhD project are:

1. To describe the autecology of *P. sylvestris* and the biodiversity of *P. sylvestris* communities in Ireland, by examining putative native and established naturalised and planted stands.

2. To review existing palaeoecological data and augment them with new data, in order to test the hypothesis that native *P. sylvestris* still exists in Ireland.

Table 1. Summary information on *P. sylvestris* woodland sites surveyed in 2006.

Site number	*Site name*	*County*	*Location (Irish national grid reference)*	*Altitude (metres)*
1	Dale Wood	Kerry	V 88181 80714	125
2	Clonfinane Bog	Tipperary	M 98815 03715	64
3	Rockforest	Clare	R 34755 95013	20
4	Priest's Leap	Cork	V 98853 59132	230
5	Glengarriff	Cork	V 90894 56831	10
6	All Saints Bog	Offaly	N 01203 11216	45
7	Glenfarne Demesne	Leitrim	H 02059 39747	60
8	The Scalp	Dublin	O 21719 20093	150
9	Coronation Plantation	Wicklow	O 09708 12792	340
10	Derrycrag	Galway	R 73616 99077	80

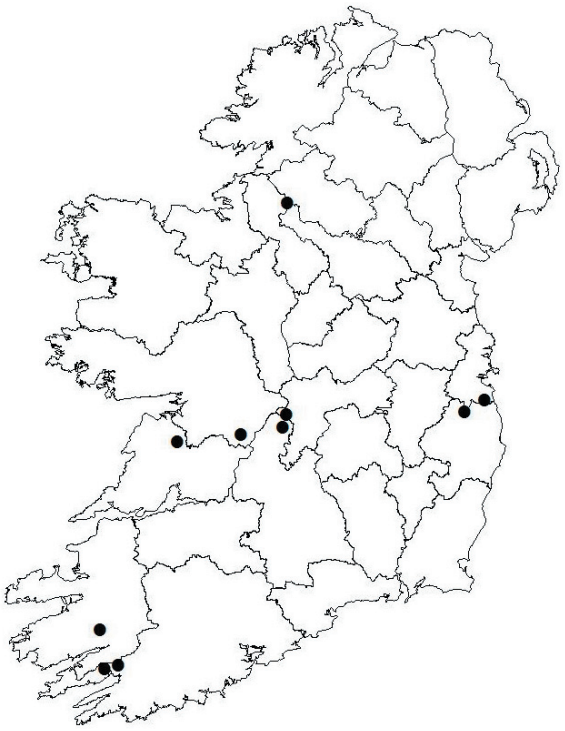

Fig. 1. The distribution of *P. sylvestris* woodland sites surveyed in 2006.

Contemporary ecological data from one year of fieldwork are presented here, and consequently the sample size is small. As survey work is ongoing, the results must be regarded as preliminary and are subject to change when a more comprehensive dataset has been collated.

METHODOLOGY

SITE SELECTION METHODOLOGY

Criteria were drawn up for the selection of suitable *P. sylvestris* woodland sites. These criteria stipulated mature woodland composed of either pure *P. sylvestris* or *P. sylvestris* intimately mixed with native tree species. *P. sylvestris* had to be dominant or co-dominant in the canopy. There had to be a well-developed natural ground flora which was reasonably free of invasive non-native species. Planted, naturalised and apparently naturally occurring *P. sylvestris* woodlands were included.

A number of expert contacts were consulted to obtain background information on potential survey sites. Using this information, the findings of a desk study and some preliminary visits, survey sites in Ireland were selected according to the criteria outlined above. The sites that were surveyed in 2006 are listed in Table 1 and their distribution is shown in Figure 1.

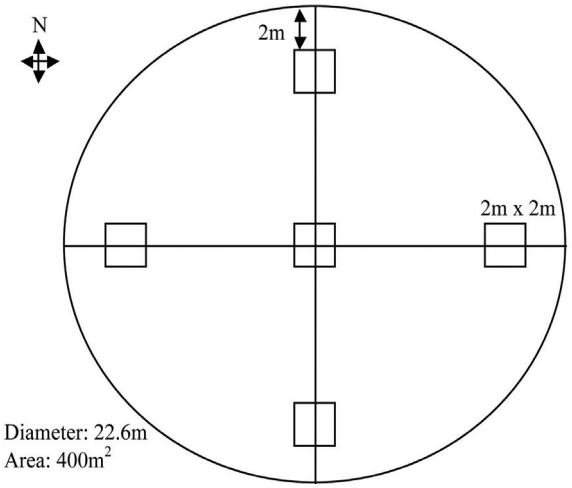

Fig. 2. Layout of five 2x2 m^2 quadrats within 400m^2 plot.

FIELD METHODOLOGY

Ten sites were surveyed over the period from May to September 2006. A circular 400m^2 plot was laid down in an area where the vegetation was judged to be representative of the site in general. The circular shape was chosen to facilitate pollen analysis. Within this plot, five 2x2m^2 quadrats were laid down as shown in Figure 2. In each of these quadrats, floristic data were recorded on the Domin scale for woody species, herbs and pteridophytes. Within the 400m^2 plot, any additional higher plant species were recorded, yielding presence/absence floristic data at the 400m^2 scale.

A soil corer was used to take a bulked soil sample from the corners and centre of each 2x2m^2 quadrat. The slope of the 400m^2 plot was recorded using a Sunnto clinometer. A grid reference was recorded at the centre of the 400m^2 plot using a Magellan SporTrak GPS unit. This grid reference was then used to estimate altitude from the contours of the relevant Ordnance Survey of Ireland Discovery Series Map.

LABORATORY METHODOLOGY

Plant specimens were identified using a hand lens when necessary, following Fitter *et al.* (1996), Hubbard (1984), Mitchell (1974) and Webb *et al.* (1996). For pH measurement, two replicates were prepared for each soil sample. A 10g sample of field moist soil was weighed into a small beaker and 20ml of distilled water was added. For some very dry samples, it was necessary to add 30ml of distilled water. The mixture was stirred thoroughly with a glass rod, until it reached a slurry-like consistency. The suspension was left to settle for 15 minutes. A portable WTW pH 330 meter and combination electrode were used. The electrode was immersed in the supernatant and left to stabilise for 30 seconds before pH was recorded.

DATA ANALYSIS

Data analysis was carried out using presence/absence data for higher plant species from ten 400m^2 plots, with associated environmental data on slope, altitude and soil pH.

Microsoft Excel was used to calculate the species richness (number of species present per 400m^2 plot) of each site, the frequency of each species and to analyse the soil pH data. In order to calculate valid mean values, the logarithmic soil pH values were converted to linear hydrogen ion concentrations. Mean hydrogen ion concentrations were calculated for each site and reconverted to pH.

Scatterplots of the environmental variables were produced and Spearman's rank correlation coefficients were calculated using Data Desk.

Vegetation community analysis was carried out using a cluster analysis approach which incorporates current best practice in statistical techniques and has been applied successfully to woodland vegetation in

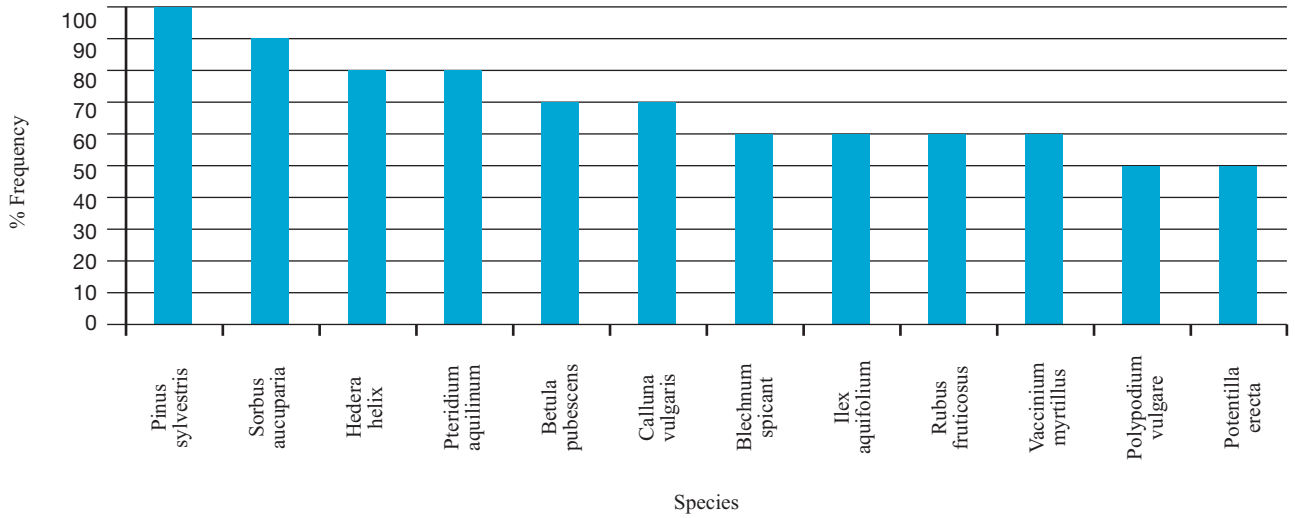

Fig. 3. The most frequently recorded higher plant species in *P. sylvestris* communities.

Ireland (McCune & Grace, 2002; Perrin *et al.,* 2006b). Analysis was conducted using PC-ORD 4 (MjM Software). Cluster Analysis was used to cluster plots of similar floristic composition, producing a cluster dendrogram. Sørensen's (Bray-Curtis) distance measure was used with Flexible Beta clustering, with parameter β set at 0.25, as recommended by McCune & Grace (2002). Indicator Species Analysis (ISA) was used as a stopping rule to objectively determine the most informative number of clusters. The criteria used to identify this point were the highest number of significant ($p \leq 0.05$) indicator species and the lowest average p-value for indicator species. Validation was carried out using non-metric multidimensional scaling (NMS) in slow and thorough autopilot mode (McCune & Grace, 2002) with Sørensen (Bray-Curtis) selected as the distance measure.

RESULTS

The preliminary results have shown that *P. sylvestris* occupies a wide variety of substrates in Ireland, including raised bog, limestone pavement, granite scree slopes and upland blanket bog.

A total of 118 vascular plant species were recorded. As shown in Figure 3, the 12 most frequently recorded species were *P. sylvestris, Sorbus aucuparia, Hedera helix, Pteridium aquilinum, Betula pubescens, Calluna vulgaris, Blechnum spicant, Ilex aquifolium, Rubus fruticosus* agg., *Vaccinium myrtillus, Polypodium vulgare* and *Potentilla erecta.* The study sites were selected for the presence of *P. sylvestris,* so its top ranking was unsurprising. No other species occurred in every site. Given that a total of 118 species was recorded, it is apparent from the steep drop-off in Figure 3 that there was a low level of constancy of species within *P. sylvestris* woodland communities.

MULTIVARIATE ANALYSIS

ISA has shown that three clusters was the most informative level of clustering in Cluster Analysis, as this level yielded the highest number of significant ($p \leq 0.05$) Indicator Species and a low average p-value. Mean species richness values and soil pH ranges for each cluster are presented in Table 2. A highly significant positive correlation was observed between mean soil pH and species richness (r_s=0.806).

NMS found a two-dimensional solution. Dimensions 1 and 2 represented 46.7% and 31.6% of the variance in the dataset respectively, 78.3% in total. Stress on this solution was 11.2%, which indicates a good solution according to Clarke's rules of thumb (McCune & Grace, 2002). An NMS ordination of the 10 plots, categorized by cluster number and overlaid with a biplot of environmental variables, is presented in Figure 4. It is apparent from Figure 4 that there was some structure in the data. The strong positive correlation between mean soil pH and species richness is also evident.

Cluster 1 contained 6 sites: Dale Wood, Priest's Leap, Glengarriff, Glenfarne, Coronation Plantation and Derrycrag, all of which were plantations. These sites encompassed a wide range of environmental conditions (Tables 1-2, Figure 4). The mean species richness was relatively low (Table 2) and there were no significant indicator species for this cluster.

Cluster 2 contained two raised bogs sites: All Saints' Bog and Clonfinane Bog, both of which were naturalised, non-relict *P. sylvestris* stands (Heery, 1993; O'Connell & Doyle, 1990). These sites were both flat, had acid soils and occurred at relatively low altitude (Tables 1-2, Figure 4). The mean species richness of these sites was relatively low (Table 2). The significant indicator species for this cluster were *Andromeda polifolia, Dryopteris carthusiana, Empetrum nigrum, Eriophorum vaginatum* and *Vaccinium oxycoccus* (p=0.042).

Table 2. Summary information on species richness and soil pH of Clusters 1 to 3.

Cluster number	*Number of sites*	*Mean species richness ± standard error*	*Soil pH range*
1	6	21 ± 3.69	3.28 – 3.81
2	2	18 ± 1.00	3.26 – 3.43
3	2	40.5 ± 12.50	3.73 – 5.00

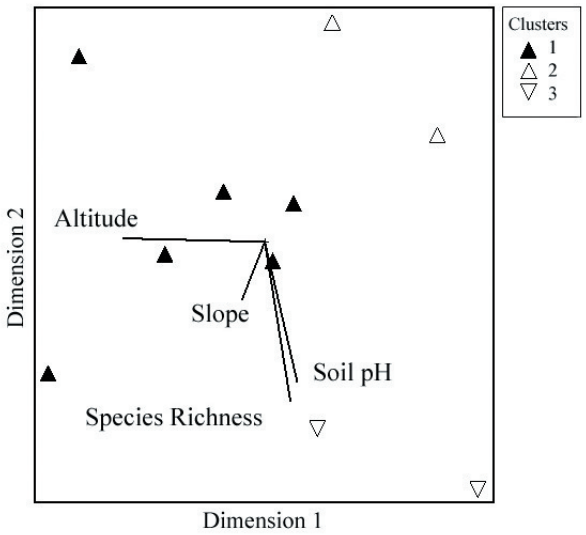

Fig. 4. NMS Ordination of 10 sites, showing the three clusters and environmental variables.

Cluster 3 contained two rocky sites: The Scalp and Rockforest. The Scalp was a naturalised, non-relict stand and Rockforest was of unknown origin. These sites had mid to high soil pH and relatively high mean species richness (Table 2). The significant indicator species for this cluster were *Corylus avellana, Geranium robertianum, Hypochoeris radicata* and *Teucrium scorodonia* (p=0.049).

DISCUSSION

P. sylvestris occupies a wide variety of substrates in Ireland and is therefore a non-specialist in terms of its ecological requirements. The diversity of substrates is reflected in the diversity of *P. sylvestris* vegetation communities. The vascular plant species richness of these communities has been shown to increase with increasing soil pH. A low level of species constancy within *P. sylvestris* communities results in a variable species composition.

Despite the small sample size, three separate vegetation types are apparent. Cluster 1 is poorly defined, but Clusters 2 and 3 are well defined in terms of their significant indicator species and the environmental conditions in which they occur. Cluster 2 represents the *P. sylvestris* community associated with raised bog and is relatively species-poor. Cluster 3 represents the *P. sylvestris* community associated with rocky sites and is relatively species-rich. From both the objective, statistical viewpoint and the subjective viewpoint of the ecologist in the field, Clusters 2 and 3 seem to represent distinct vegetation types and make good ecological sense. However, it must be noted that these vegetation types may change as additional sites are added to the dataset. Once the dataset is complete, this information will be used to integrate Irish *P. sylvestris* woodland communities into existing classification systems, placing them in the wider context of the flora of both Ireland and Britain.

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