National survey of limestone pavement and associated habitats in Ireland

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National survey of limestone pavement and associated habitats in Ireland

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Contents

Executive Summary

A National Survey of Limestone Pavement and associated habitats was undertaken during the period 2009-2011 following a pilot survey undertaken in 2008. The objectives were to identify and map the area and extent of limestone pavement and its associated habitats within the country, using both field surveys and assessments of aerial photos. In addition, non-designated areas of limestone pavement and associated habitats were identified and characterised. Recommendations for potential NHAs and proposals for the amendment or rationalisation of SAC boundaries were also made. Furthermore, a national baseline monitoring survey was undertaken to assess the conservation status of this habitat.

The National Limestone Pavement habitat distribution map was produced based on a revision of the map generated as part of the limestone pavement habitat (8240) Conservation Status Assessment report commissioned by NPWS in 2007. The revised map indicates that the overall extent of this habitat is 32,187ha, rather than 36,000ha as reported in 2007. The final map contains new polygons of limestone pavement, which account for 1,595ha. The addition of these new areas to the original 2007 map and the elimination of areas wrongly classified as limestone pavement in 2007 resulted in the modification of the habitat range map produced in 2007.

The project developed methodologies to assess the conservation status of EU Annex I Habitat Limestone Pavement (8240) and associated habitats in Ireland. One hundred and thirty five 100m x 100m monitoring plots within 26 monitoring sites were surveyed. These plots were sampled across the range of limestone pavement and mapped according to EU Annex I and Fossitt (2000) habitats. In addition, 15 areas of limestone pavement and associated habitat outside the NATURA 2000 network (potential NHAs or extensions of SACs) were surveyed, four of which overlapped with monitoring sites. A total of 358 relevés were recorded within both monitoring sites and potential NHA sites. Four broad habitat types were recorded; limestone pavement (exposed), limestone pavement (wooded), heath and grassland.

The utilisation of hierarchical Cluster Analysis and Indicator Species Analysis (ISA) on the relevé data revealed three main groups: limestone pavement (exposed), limestone pavement (wooded), and grassland/heath group. These were sub-divided into five exposed limestone pavement vegetation types, two wooded limestone pavement vegetation types, 10 grassland vegetation types and four heath vegetation types, giving a total of 21 vegetation types for limestone pavement and associated habitats. Non-multidimensional scaling analysis results concurred with these groupings.

Targets were set to assess the conservation status of the EU Annex I Habitat Limestone pavement (8240) and associated habitats (i.e. *Festuco-Brometalia grassland* (6210/6211), Alpine and Boreal heaths

(4060) and European dry heaths (4030)). An overall favourable assessment was given to the EU Annex I Habitat 4030, 4060 and 8240 (wooded). Unfavourable - Inadequate assessments were given to 8240 (exposed) and 6210/6211. At a national level, limestone pavement (including associated habitats) was given an Unfavourable - Inadequate assessment. Quarrying, removal of pavement, land reclamation, problematic native species and non-native invasive species were identified as the most threatening activity affecting limestone pavement and associated habitats.

A ranking system was developed for sites surveyed outside the NATURA 2000 network (potential NHAs). Conservation scores were based on criteria such as species diversity, the presence of Annex I habitats and size of the site. Threat scores were also developed based on damaging activities such as encroachment, quarrying, reclamation and the presence of invasive species. These conservation and threat scores for each potential NHA surveyed can be used for management purposes or as a means of ranking sites to aid the selection of sites for designation. It also allows for the identification of sites with a high conservation value which may be threatened.

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Introduction

Limestone pavement in Ireland

Limestone pavements are areas of calcareous rock that were exposed by the scouring action of ice sheets as they moved across the landscape during the last glaciation (Williams 1966). The habitat is found mainly in the west of Ireland with counties Clare, Galway and Mayo containing the largest extent. Smaller areas are found in Sligo, Leitrim, Donegal, Offaly, Kerry, Cavan, Limerick, Longford, Tipperary, Roscommon and Westmeath. Limestone pavement is also found in Fermanagh in Northern Ireland (Pender (Ed.), 2008). Ireland has the largest area of limestone pavement in the EU, over 32,187ha compared to less than 3,000ha in the UK. The most extensive limestone pavement occurs in the Burren/East Galway area (Williams 1966).

Definition of Limestone pavement

Limestone pavements are both geologically and biologically important resources. The structure of limestone pavement consists typically of blocks of rock, known as clints, separated by fissures, or grikes. There is considerable variation with some areas consisting of massive blocks of smooth, relatively un-weathered pavement with well-developed grikes to areas where the grikes are very narrow and shallow. Finely fractured pavements or shattered pavements, where grikes are almost absent, also occur. The rock surface is almost devoid of overlying soils (considerably less than 50% cover) except sometimes for patches of shallow skeletal soils, although more extensive areas of deeper soil occasionally occur (Anon. 2007). This morphology results in a variety of microclimates, and together with the varied pedology allows for the establishment of a complex vegetation mosaic of different communities. The vegetation in grikes is unusual, as it is composed of woodland and shade species along with plants of rocky habitats (Ward & Evans 1976, Osborne *et al.* 2003). The deeper grikes provide sheltered, moist conditions and are favoured by a range of plants more commonly associated with woodlands (Pender (Ed.) 2008).

Many definitions exist for limestone pavement. However, there does not appear to be any standardised definition. The Wildlife and Countryside Act (HMSO 1981) in the UK defines limestone pavement as "an area of limestone which lies wholly or partly exposed on the surface of the ground and has been fissured by natural erosion". The UKBAP Limestone Pavement Steering Group have classified limestone pavement in Britain into two subtypes; "Wooded" limestone pavements where a canopy of scrub and trees have covered the pavement, and "Open" pavements where there is no

canopy. Stephen Ward (pers. com.) defines the following two categories of limestone pavement; "Classic Limestone Pavement" where the exposed rock is equal to or greater than 75%, and "Limestone Pavement Mosaic", where the patterns of clints and grikes can be discerned but is overlain by vegetation comprising 25% or more of the area. Willis (2011) compiles a list of limestone pavement definitions and notes that they all target the geodiversity of the landform and therefore do not refer to their unique and rich biodiversity. Two different pavement types have been described as part of this survey based on their morphology:

- Blocky: this type is characterised by a well-defined structure of clints and grikes, which can vary greatly in depth and width (Plate 1).
- Shattered: areas of loose rubble, which do not generally have a well-defined structure of clints and grikes or grikes are narrow and shallow (Plate 2).

Plate 1 Blocky limestone pavement.

Plate 2 Shattered limestone pavement.

Habitats and species associated with limestone pavement in Ireland

The majority of research on limestone pavement habitats in Ireland has centered on the Burren region, the largest expanse of limestone pavement in Ireland. Numerous studies have documented the unusual nature of upland and montane species growing at sea level in this region, as well as woodland or shade species occurring in exposed areas (Webb 1962, Ivimey-Cook & Proctor 1966, Osborne *et al.* 2003, Parr *et al.* 2009). The mosaic of calcareous grassland, heath and limestone pavement supports arctic-montane plants such as Mountain Avens (*Dryas octopetala*) and Spring Gentian (*Gentiana verna*) and Mediterranean-Atlantic species such as the Maidenhair Fern (*Adiantum capillus-veneris*) (Plate 3) and the Dense Flowered Orchid (*Neotinea maculata*). These species do not usually occur in the same location. Calcicole and calcifuge species are also found growing side by side. Parr *et al.* (2009), in reference to the Burren, states that being such a heterogeneous landscape, with a paucity of clear-cut ecological boundaries, means that many of the communities merge and interdigitate, particularly the grassland and heath communities. Limestone pavement can also occur in a mosaic with scrub/woodland, with extensive areas dominated by Hazel (*Corylus avellana*) and Hawthorn (*Crataegus monogyna*). Blackthorn (*Prunus spinosa*) can also be abundant.

Plate 3 Maidenhair Fern (*Adiantum capillus-veneris*) growing in a grike.

Limestone pavement and associated habitat classification

Limestone pavement is currently described under two categories in the Irish context; the Annex I habitats of the EU Habitats Directive (92/43/EEC) and those described by Fossitt (2000). Several EU Habitats Directive Annex I habitats associated with limestone pavement have been identified in Ireland and are listed below (Table 1). The EU Habitats Directive Interpretation Manual (Anon. 2007) description of Limestone pavement is given in Box 1 below.

Table 1 EU Habitats Directive Annex I habitats associated with Limestone pavement.

EU Habitats Directive Code	EU Habitats Directive Habitat
4030	European dry heaths
4060	Alpine and Boreal heaths
5130	*Juniperus communis* formations on heaths or calcareous grasslands
6210/6211	Semi-natural dry grasslands and scrub facies on calcareous substrates (*Festuco-Brometalia*) (Priority for important orchid sites (6211))
8240	Limestone pavements*
91J0	*Taxus baccata* woods*

* - priority habitats

Box 1: EU Habitats Directive Interpretation Manual (Anon. 2007) description of Limestone pavements (8240)

Regular blocks of limestone known as "clints" with loose flags separated by a network of vertical fissures known as "grykes" or "shattered pavements", containing more loose limestone rubble. The rock surface is almost devoid of overlying soils (considerably less than 50% cover) except for some patches of shallow skeletal or loessic soils, although more extensive areas of deeper soil occasionally occur; sometimes there is encroachment of peat. This morphology offers a variety of microclimates allowing the establishment of complex vegetation consisting of a mosaic of different communities. The fissures provide a cold humid microclimate where shade-tolerant vascular plants such as *Geranium robertianum* and *Ceterach officinale* occur, as well as formations of herbaceous species typical of calcareous woodland; the small pockets of soil are occupied by communities of *Mesobromion* (e.g. *Seslerio-Mesobromenion*); heath and scrub also occur (e.g. *Corylo-Fraxinetum*). Apart from areas of species rich scrub (generally *Prunetalia spinosae*), the ecosystem is maintained by grazing in some regions; this, combined with severe winds, means that isolated shrubs can only survive in prostrate growth form (e.g. *Dryas octopetala*); at the margins of ungrazed sites *Geranium sanguineum* occurs.

This EU Habitats Directive manual includes two corresponding categories in the UK for the Limestone pavement Habitat (8240); "W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland" and "W9 *Fraxinus excelsior-Sorbus aucuparia-Mercurialis perennis* woodland". There are no corresponding vegetation categories for Ireland. According to the EU Habitats Directive Interpretation Manual (Anon. 2007) the definition of limestone pavement includes not only exposed rock, but areas of associated heath, scrub and grassland. Therefore, these areas also come under the definition of Limestone pavement Habitat (8240) in Ireland. Fossitt (2000) defines six habitats, which are relevant; these are listed in Table 2.

Table 2 Fossitt (2000) habitats associated with Limestone pavement.

Fossitt Code	Fossitt Habitat
ER2	Exposed calcareous rock
GS1	Dry calcareous and neutral grassland
HH2	Dry calcareous heath
WS1	Scrub
WN2	Oak-ash-hazel woodland
WN3	Yew woodland

In accordance with the EU Habitats Directive interpretation manual, Fossitt (2000) also states that Exposed calcareous rock (ER2) can be associated with areas of grassland, heath and scrub. Other vegetation classifications of limestone pavement and associated habitats in Ireland, mainly focusing on the Burren, have been developed by Ivimey-Cook & Proctor, (1966), White & Doyle (1982), McGough (1984), Jeffrey (2003) and more recently Parr *et al.* (2009). Parr *et al.* (2009) also delivers a background to phytosociological studies of grasslands and heaths in Ireland. Other studies focusing on the classification of semi-natural grasslands, some of which are associated with limestone pavement are currently under way (O'Neill *et al.* 2010). In the UK, Willis (2011) developed a classification system, based solely on limestone pavement (exposed and wooded) and therefore did not include the associated habitats of grassland and heath.

The JNCC National Vegetation Classification (NVC) states that limestone pavement is difficult to accommodate within the frame of the classification because it is essentially a complex of various vegetation types. It is frequently described as 'not fitting the NVC' (Rodwell *et al.* 2000). Rodwell (2000) states that there is nothing encountered on the various forms of limestone pavement that cannot be described in terms of fragments or complexes of a variety of vegetation types already represented in *British Plant Communities*. What is distinctive about the vegetation of limestone pavements is the intricate fashion in which these elements are disposed over a diversity of physiographic features like clints, grikes and solution hollows and transitions to the surrounding context of cliff, scree, grassland, woodland, mire or heath. A list of vegetation types associated with limestone pavement according to the NVC is given in Appendix 1. It does not give a classification of limestone pavement vegetation in its own right.

The current study takes a holistic approach to the classification of limestone pavement and its associated habitats, i.e. classifying not only exposed and wooded limestone pavements, but also the associated habitats; European dry heaths, Alpine and Boreal heaths and Semi-natural dry grasslands and scrub facies on calcareous substrates.

Conservation of Limestone pavement

The Assessment, Monitoring and Reporting under Article 17 of the Habitats Directive report (Evans & Arvela 2011) provides the basic guidelines to report the conservation status of habitats listed in Annex I of the Habitats Directive. In addition, the Joint Nature Conservation Council (JNCC) has establishment Common Standards Monitoring Guidelines for a selection of habitats based on the UK 'NVC' vegetation types. Both sources have been the main reference for the establishment of previous conservation status assessment methodologies for Annex I EU habitats in Ireland such as raised bog

habitats (Fernández *et al.* 2006), grassland habitats (Dwyer *et al*. 2007, Martin *et al*. 2007), dune systems (Ryle *et al.* 2009) and salt marshes (McCorry 2007).

EU Habitats Directive (92/43/EEC) specifies that habitats protected by the Directive must be maintained in 'Favourable Conservation Status' within their range in the member states. The conservation status of a natural habitat will be taken as favourable when:

- its natural range and the area it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable.

To assess a habitat's conservation status, four parameters are taken into consideration; range, area, structure and functions, and future prospects. Favourable reference values are set for range and area. These reference values have to be at least equal to the value when the EU Habitats Directive came into force. Favourable Reference Range (FRR) is the geographic range within which all significant ecological variations of a habitat are included for a given biogeographical region and which is sufficiently large to allow the long-term survival of that habitat (Evans & Arvela 2011). The favourable reference value for the area covered by the habitat is the minimum area needed to ensure the long-term viability of the habitat and should include areas for the restoration and development of the habitat (Evans & Arvela 2011). The assessment of structure and function including typical or indicator species are assessed as well as pressures being listed to determine future prospects. The conservation status assessment is based on a 'traffic light' system, which factors in all of the four parameters and it is based on the worst scenario, i.e. when any of the previous attributes is deemed unfavourable the overall habitat conservation status is also unfavourable.

The last conservation status assessment results for Limestone pavement (NPWS 2008) are given in Table 3. According to this assessment, the areas, structure and functions, as well as the future prospects, of limestone pavement and its associated habitats in Ireland were assessed as Unfavourable - Inadequate. This assessment for area was due to a loss of approximately 0.2% of the habitat per annum as a result of limestone pavement removal, quarrying, development and agricultural improvement. The result for structure and functions, and future prospects, was due to pressures such as scrub encroachment, inappropriate grazing regimes and quarrying.

Table 3 Previous Conservation Status Assessment results for Limestone pavement (8240).

Range	Favourable
Area	Unfavourable - Inadequate
Structure and Function	Unfavourable - Inadequate
Future Prospects	Unfavourable - Inadequate
Overall Conservation Status	Unfavourable - Inadequate

Scope of the report

This report details the findings of the *National Survey of Limestone Pavement and Associated Habitats in Ireland,* carried out by *Ecologic Environmental & Ecological Consultants Ltd* and commissioned by the National Parks and Wildlife Service (NPWS). The results gathered have been used in conjunction with results gathered from the Pilot Survey of Limestone Pavement (PSLP) carried out in 2008/9 (Murphy & Fernández, 2009).

Summary of the pilot survey

The objective of the pilot survey was to develop methodologies to assess the conservation status of EU Annex I Habitat Limestone pavement (8240) and associated habitats in Ireland. Thirty six 100m x 100m plots within six monitoring sites were surveyed during July and August 2008. These survey plots were sampled across the natural range of limestone pavement and mapped according to EU Annex I and Fossitt (2000) Habitats. Ninety relevés were recorded within four main habitat types; 40 limestone pavement relevés, 25 heath relevés, 18 grassland relevés and six scrub relevés.

The vegetation data analysis methods employed proved useful in separating the four main habitats surveyed; heath, pavement, grassland and scrub. The utilisation of hierarchical Cluster Analysis on the relevé data revealed four main habitat groups, with two of these groups (limestone pavement and grassland) further dividing into two sub-habitat groups (vegetation types). It was hoped that the addition of more relevé data during the National Survey would help refine the description of habitats and vegetation communities further.

Targets were set to assess the conservation status of the EU Annex I Habitat Limestone pavement (8240) and associated habitats (i.e. exposed limestone pavement (8240), *Festuco-Brometalia* grassland (6210/6211) and European dry heaths (4030)). Quarrying and removal of pavement were identified as the most threatening activity affecting exposed limestone pavement (8240). An overall favourable assessment was given to the EU Annex I Habitat 4030. Unfavourable assessment results for habitat 6210/6211 were the main reason for an overall unfavourable assessment for habitat 8240 when the assessments of the associated habitats were combined. Assessment criteria used in the pilot survey were based on existing methodologies and were subject to revision during the National Survey.

A National Limestone Pavement habitat distribution map was produced based on a revision of the map generated as part of the Limestone pavement habitat (8240) Conservation Status Assessment report commissioned by NPWS in 2007. The revised map indicated that the overall extent was 31,000ha, rather than 36,000ha as was reported in 2007. The final map contains 403 new limestone pavement areas, which accounted for 952ha. The addition of these new areas to the original 2007 map and the elimination of areas wrongly classified as limestone pavement in 2007 resulted in the modification of the habitat range map produced in 2007. This map was further refined, during the National Survey.

Project tasks

The main objective of the current study was to undertake a national survey and monitoring programme to assess the conservation status of limestone pavement and associated habitats in Ireland. The identification of areas that may possibly be suitable for NHA designation and the rationalisation of SAC boundaries, where required, was also undertaken.

The project consisted of two major components:

Element I: Survey of non-designated areas for potential designation.

Using a combination of GIS, field surveys and other data, areas of limestone pavement and associated habitats were identified, which were considered suitable for designation. Special attention was given to scrub/woodland covered pavement and also to the Burren and adjacent areas where a rationalisation of SAC boundaries may be required.

Element II: National baseline monitoring survey

A national baseline monitoring survey was undertaken, to assess the conservation status of limestone pavement. The methodology used was based on that developed in the pilot project by Murphy & Fernández (2009). These methods were reviewed and revised where appropriate.

Methods

Pre-survey

Pre-survey work involved the following tasks:

- Collation of all existing information, including the pilot survey of limestone pavement (Murphy & Fernández 2009), and a literature review of limestone pavement in the survey areas, with particular emphasis on NPWS reports, publications and additional material held in NPWS.
- Liaising with NPWS staff, BurrenLIFE Project staff, and other experts such as Dr Stephen Ward, to discuss survey areas and proposed methodologies.

Survey design including organising the fieldwork schedule and the compilation of site packs.

Setting up of a TurboVeg database (Hennekens & Schaminee 2001) to collect plot, relevé and potential NHA survey data. This simplified methods used in the pilot survey. Previously four different field cards were used, the data from which had to be manually transferred to excel and then to Access and PC-Ord (McCune & Grace 2002) for further analysis. Using TurboVeg, data was captured in two separate databases. The first was designed (in collaboration with the National Biodiversity Data Centre staff) to record relevé data; the second was designed to record species and environmental data for monitoring plots and potential NHA sites. The type of information recorded is described in the methods section. See Appendix 2 for an example of site cards used in the field.

Preparation and testing of ruggedised GeoExplorer handheld GPS minicomputer (Trimble GeoXT). Custom data dictionaries were produced using TerraSync software, to record certain types of information in the field (e.g., time, date, habitat boundary, relevé type, GPS position of invasive species and rare species).

Site selection

This section describes site selection for both Element I and II of the project. Figure 1 gives an overview of the sites surveyed for both Elements. The red dots represent Element I sites, substantial areas of limestone pavement and associated habitats that currently have no protection under designation. The blue dots represent Element II sites, all of which have some form of designation (SAC or NHA) and which were surveyed for monitoring purposes. The green dots represent sites with no designation that were chosen for both Elements, i.e. they were surveyed as potential NHAs and as monitoring sites. See below for a description of how the sites were selected.

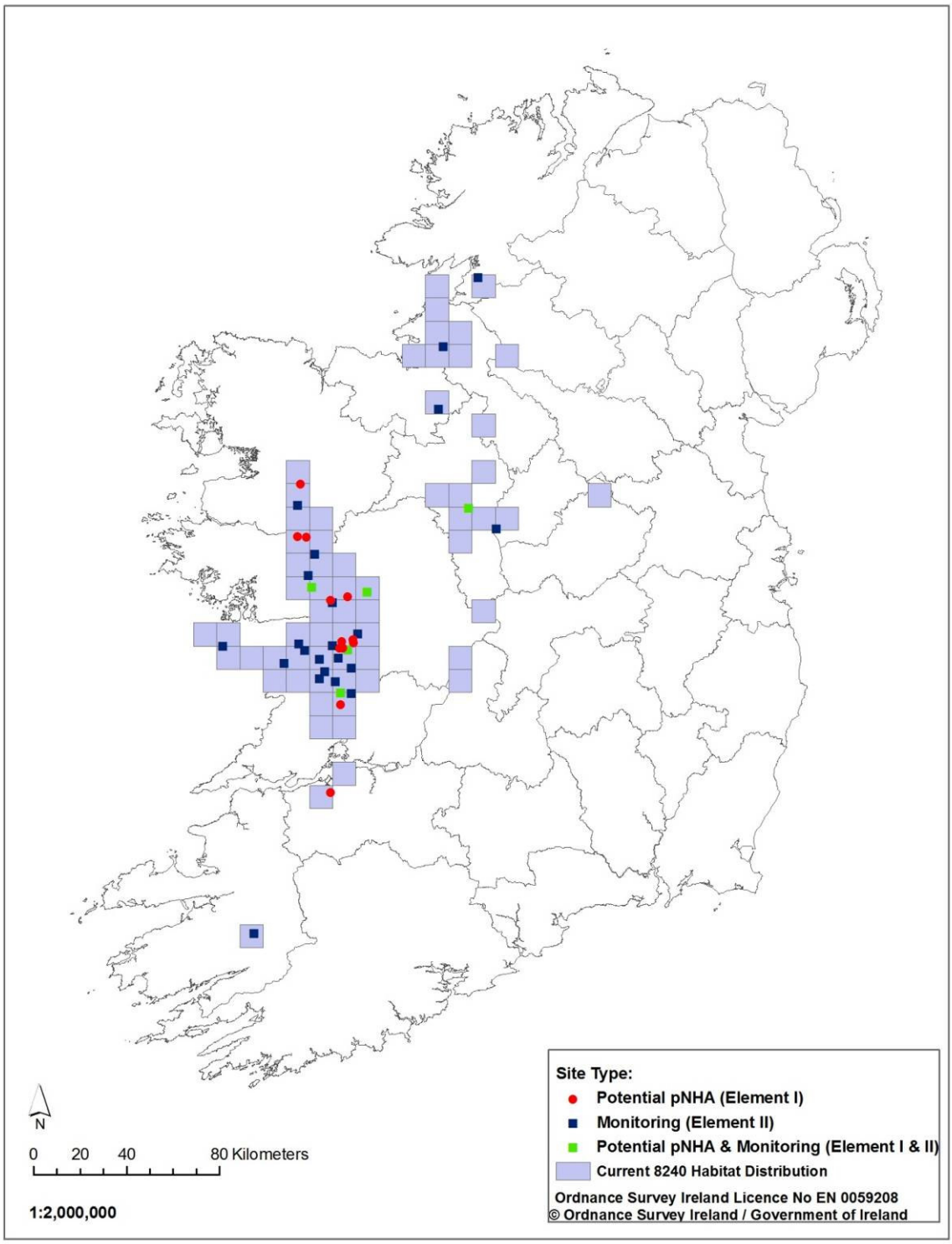

Figure 1 Location of Pilot Survey of Limestone Pavement (PSLP) and National Survey of Limestone Pavement (NSLP) sites (Element I and II).

Sites for each Element were given two different numbering systems. Element I potential NHA sites were numbered from 31-55. Element II sites were numbered from 01 to 30. Sites which were surveyed for both Elements were given two different site numbers; an Element I site number and an Element II

site number. This was deemed necessary to avoid confusion and to ensure that sites that were surveyed for both Elements could be analysed separately.

An extensive desk based survey was undertaken to select potential NHA and monitoring sites. Sites were chosen based on a number of criteria, some of which were adapted from the ASI Manual (Lockhart *et. al.* 1993);

- Size
- Diversity (habitat variation; based on identification of potential habitats from the 2005 aerial photograph)
- Species rarity (based on the occurrence of rare species records, e.g. *Gymnocarpium robertianum*, *Viola hirta*)
- Habitat rarity
- Proximity to nearby designated sites
- Distance from the sea in the case of coastal sites
- Distance from water features (e.g. turloughs, lakes)
- Altitude
- Exposure
- Rock unit and soils diversity, based on the Geological Survey of Ireland (GSI) and (Fealy *et al*. 2006).
- Homogeneous management units – the aim was to select plots within homogeneous management units, which are generally defined by stone walls.

The monitoring and potential NHA sites varied in extent and distinct boundaries separating the units from adjacent areas were not always clear. However, the general aim was to select sites based on the presence of some physical boundaries (e.g. stone walls, improved fields, flushes, woodland, dense scrub etc.).

A number of people were contacted prior to the commencement of fieldwork such as NPWS regional staff, NPWS research staff, the National Biodiversity Data Centre and Biodiversity and Heritage officers, via email asking for information on the sites that were selected, as well as information on any additional sites that were known in the area.

Prior to a monitoring site visit, several 100m x 100m (1ha) plots were selected within the site. These plots were used as the main means of capturing data at a very detailed scale and were nested within a much larger survey area or 'monitoring site'. A 100m floating grid based on the Irish national grid was

overlaid upon the survey area in order to select target plots. This 'floating' grid was a modification from the 'fixed' grid that was used in the pilot survey and was developed as a result of limitations with the latter. This grid was produced by splitting a larger scale (i.e. 10km) grid. Considering that this was a limestone pavement and associated habitats survey, one of the main selection criteria was that at least 25% bare rock was to be present in the plots. Both Annex I Habitat and Fossitt (2000) classification systems define Limestone pavement habitat as containing at least 50% bare rock.

As discussed in Murphy & Fernández (2009), the 100m x 100m (1ha) plot size was considered the most appropriate, for the following reasons:

- The plots could be compared throughout the range of the habitat
- It was considered a manageable plot size.
- This method would cover higher variability than if surveying only a few large, homogeneous areas.
- The 100m x 100m plot could be easily used as a monitoring unit, whereas anything much larger would be impractical.

The 100m x 100m (1ha) plots were not selected randomly. One of the aims of the monitoring survey was to cover a wide range of habitats within the selected sites, considering factors such as altitude, orientation, exposure, management units, and the presence of habitat diversity. A purely randomised approach could well have omitted some areas of interest.

Originally, eight plots were considered an adequate number to survey at each monitoring site. However, it was found that the number of plots selected within the monitoring site was dependent on the area and variation in habitats present. The number of plots selected, therefore, was based on the variation found within the monitoring site. More plots than were required were selected during the pre-survey phase. This was considered necessary for the following reasons; upon arrival in the field, some plots were inaccessible due to rough or steep terrain. In addition, certain plots which, from the 2005 aerial photographs, were thought to contain limestone pavement, actually consisted of only grassland or heath. These plots were not surveyed as they did not fall under the proposed selection criteria of containing at least 25% limestone pavement. In addition, some sites were too small to select eight plots. In these instances, a suitable number of plots were chosen, which insured that the diversity of habitats present was represented and that time was not wasted in 'over surveying' the site.

Field survey methods

Site surveys and general data recorded

Many aspects of the field survey methods were common to both potential NHA (Element I) and monitoring (Element II) surveys. Unless otherwise stated, methods described are for both aspects of the project. Those which are specific to either of the project elements are described separately.

Prior to a site visit, a plan was devised on how best to survey the site. A start position was decided on and a rough estimation of how long the site would take to survey was calculated. In the case of the potential NHA survey, the entire site was walked, to aid site familiarisation and to record a comprehensive vascular plant list, which included the major bryophyte and lichen species. Similarly, at the monitoring sites, each 100m x 100m plot was walked to determine the habitats present and to record a species list for the plot. One species list was recorded for each potential NHA site, whereas one species list was recorded for each plot within each monitoring site. This could result in up to eight species lists being recorded for each monitoring site. This was a time-consuming but important part of the monitoring survey methodologies; it meant that the plots could be analysed or re-surveyed independent from one another, within and between sites, across the range of the monitoring survey. The potential NHA site / monitoring plot species lists were recorded using TurboVegCE software on a GeoExplorer handheld GPS minicomputer (Trimble GeoXT).

Species nomenclature follows the 'Ireland2008' checklist as follows;

- Vascular plants, native and alien, list for Ireland; National Botanic Gardens, Glasnevin 2008: This database was constructed from several sources, mainly Scannell & Synnott (1987) and Praeger (1901). Other sources include the on-line Botanical Society of the British Isles database. Common spelling errors are also included as synonyms.
- Bryophytes, native and alien, list for Ireland; National Botanic Gardens, Glasnevin 2008: This list was derived from Holyoak (2003). The red data categories have been taken from Holyoak (2006).
- Checklist of Lichens of Great Britain and Ireland London: British Lichen Society (Coppins 2002). (There is no separate Irish Checklist available).

For potential NHA (Element I) surveys, detailed site notes were recorded throughout the site; each habitat type encountered was described, features of interest, impacts and activities (Ssymank 2011), fauna and notable species were also recorded. Detailed notes were recorded in a waterproof notebook. The location of each note was fixed on the habitat map using a GeoExplorer handheld GPS minicomputer (Trimble GeoXT), (see section on data capture for more details). Potential NHA site notes are recorded in numerical order e.g. N1, N2 etc. and under the following headings:

Habitat: These notes refer to a Fossitt (2000) habitat recorded in the field. The habitat was described, dominant species were listed and an overview photograph of the habitat in question was taken and recorded with the note.

Impact/Activity: These notes are recorded for areas of damage within or adjacent to the site. Notes for grazing (appropriate/inappropriate), scrub encroachment, bracken cover and invasive species were also recorded under this heading. Any other management issues also fell under this category.

Boundary: These notes were recorded in reference to a boundary feature or structure.

General: Notes which were not covered by the other categories mentioned above were recorded here. Topics covered include fauna, topography, notable species and features of interest.

For both Elements I and II the following general plot and site data were recorded using TurboVegCE or TerraSync software using a GeoExplorer handheld GPS minicomputer (Trimble GeoXT):

Habitat boundary points: Habitat boundary points were taken for each plot or potential NHA site using both Fossitt (2000) and the EU Habitats Directive Annex I habitats classifications. A further revision of these habitats was undertaken, post-survey, based on relevés and site notes recorded during the field survey. The minimum mapping size for monitoring plots was approximately 4m x 4m. The minimum mapping size for potential NHA sites was approximately 20m x 20m. Generally, areas smaller than these were not mapped. However, sometimes they were recorded as points.

Topographical features: The topographical position (e.g., upper slope, mid slope, lower slope) of the monitoring plot or potential NHA site was also noted.

Site Management: Rangers were contacted to ascertain management of monitoring sites. Landowners were also consulted, where possible. All relevant management practices were recorded and their intensity and impact was assessed.

Encroachment: The presence of bracken, hazel and other woody species considered to be a threat to limestone pavement or its associated habitats was noted in each monitoring plot or potential NHA. The habitat in which it was problematic was also noted. Intensity was recorded on a three point scale, where possible; light, moderate or heavy.

Grazing level: Grazing was recorded on a three point scale where possible; light, moderate or heavy.

Fauna: The presence of domestic animals (e.g. cattle, sheep, horses) and other relatively common fauna (e.g. goats, hare, deer) were noted.

Impacts/Activity: Threats and damaging activities such as rock removal, rock displacement, land reclamation, dumping, grike filling, trampling and scrub removal were recorded. Intensity and impact (positive or negative) of these activities was recorded on a three point scale where possible; low, moderate or high.

Invasive species: The presence of invasive species such as *Cotoneaster* spp., *Clematis vitalba* and *Centranthus ruber* (Red Valerian), and the habitat in which it was found, was noted in each monitoring

plot or potential NHA site. Intensity was recorded on a three point scale where possible; light, moderate or heavy.

Geological features: Grike depth and pavement type were recorded, as these features may affect the floristic diversity of limestone pavement. These variables were recorded in all limestone pavement relevés.

Additional features: Other features, which were considered important include: Site exposure, whether grikes were vegetated and what % of this vegetation was emergent. The latter two features were only recorded in limestone pavement relevés.

All monitoring plot and potential NHA site data were recorded in the field using TurboVegCE or TerraSync software and were transferred to a Microsoft Access database (National Limestone Pavement database). See Appendix 2 for an example of data sheets for recording in the field.

Recording of relevés

For the monitoring survey (Element II), one relevé was recorded for each limestone pavement or associated habitat represented in each plot. For each potential NHA site (Element I), at least one relevé was recorded for each limestone pavement or associated habitat present in the site. Consequently, many more relevés were recorded at a monitoring site, compared to the number recorded at a potential NHA site.

The size of the relevé was dependent on habitat type:

- 1m x 1m relevés for grassland and heath habitats.
- 5m x 5m square relevés for limestone pavement, scrub and woodland habitats.

Due to the heterogeneous (mosaic) nature of habitats associated with limestone pavement, 1m x 1m relevés were recorded in grassland and heath habitats. This size was chosen to avoid recording a relevé in a mosaic of two different habitats, which could easily occur if using a 2m x 2m relevé. This smaller relevé size has been used in other studies to accommodate the scale and shape of target vegetation (Perrin *et al.* 2009).

Cover in vertical projection for all vascular and bryophyte species was recorded using the Domin scale. Other parameters such as bare soil, litter and bare rock were recorded as percentage cover. The percentage cover of functional groups was also recorded in each relevé as follows: bryophytes, grasses, sedges, broadleaf herbs, low woody and shrubs. The major components of the lichen ground flora were also recorded. For each relevé a 12-figure grid reference (i.e. 6 Easting and 6 Northing) was obtained using a DGPS unit (one for the 1m x 1m relevé, two for the 5m x 5m relevé). Topography, altitude, slope and aspect were also recorded. Soil depth in centimetres was measured *in situ* with a

metal skewer in the grassland and heath relevés, taking an average measurement from four readings in each relevé.

All relevé data were recorded in the field using TurboVegCE or TerraSync software on a GeoExplorer handheld GPS minicomputer (Trimble GeoXT) and were transferred to a Microsoft Access database (National Limestone Pavement database). See Appendix 2 for an example of data sheets for recording in the field.

Photographs

At least one photographic record was taken for each potential NHA site note. A photographic record of each monitoring plot (overview) and relevé (detail and overview) was also taken. The grid reference of each photograph was fixed with GPS, and the aspect taken with a compass. A list and description of images collected during the potential NHA and monitoring surveys were added to the project's image catalogue, which was based on the NPWS delivery guidelines template. This spreadsheet file includes information such as file name, subject, date, camera used, copyright, various keywords, etc. All images were taken using a Canon DIGITAL IXUS 500, Panasonic LUMIX DMC-TZ5 or Panasonic LUMIX DMC-TZ6 and are in JPEG (.jpg) format.

Data capture

A GeoExplorer handheld GPS minicomputer (Trimble GeoXT) was used in the field to record the location of relevés, habitat boundaries, photographs, rare plants, invasive plants and other points of interest. The GPS positions of these features were logged and stored on Terrasync software (Trimble). Additional comments were also stored as text fields in the device. Post-processing of data was carried out to improve accuracy based on the Active GPS Network from Ordnance Survey Ireland to obtain sub-metre accuracy of data. Relevé data, site and plot species and environmental data were also captured on a Trimble GeoXT using TurboVegCE software.

Quality control

Quality control was essential in generating data that is accurate, clear and correctly formatted. The following measures were taken to ensure data quality was assured:

- Periodic inspection of data during the data collection phase to identify errors and omissions.
- The use of software such as TurboVeg ensuring the accurate recording of species names.
- Backing up and re-checking sub-sets of data on a regular basis.

Habitat mapping

National Limestone pavement distribution map

A National Limestone Pavement habitat distribution map was produced, based on a revision of the original map, which was completed as part of the Conservation Status Assessment report commissioned by NPWS in 2007. The updated map was produced in polygon shapefile format in ArcGIS 9.3 using the Irish National Grid (ING) as the co-ordinate reference system. The review was undertaken using the OSi 2005 aerial ortho-photography as a background. Mapping was done at a 1:5,000 scale. A more up-to-date version (e.g. 2010 ortho-photographs) was not available when this task was undertaken.

Updating the map consisted of the following steps:

- A review of all polygons mapped as part of the original map in order to rule out any misclassified areas in the original map.
- Re-shaping of all original polygons to attain a higher level of accuracy.
- Identification of new habitat areas specified by additional sources (e.g. Dwyer (2000) (see Appendix 3 for further detail). The use of the OSi 2005 Aerial ortho-photography was essential to carry out this process.
- Exclusion of areas not corresponding to limestone pavement such as open water and improved agriculture land, within mapped polygons. This process was carried out based on visual validation at a 1:5,000 mapping scale.
- Production of a comprehensive attribute table. The map not only contains areas of exposed limestone pavement but also areas of associated habitats such as grassland, scrub, heath and woodland. The 2007 map poorly reported the reason for the selection of pavement areas; therefore particular emphasis was given to assure that these sources were well documented.

The following data sources, which were used for the production of the original 2007 Limestone pavement habitat map, have been revised in order to improve the accuracy of the final Limestone pavement map. These sources are described in Appendix 3.

- Corine 2000 Land cover – EPA (2000)
- National Soils and Parent Material Map – Teagasc (2006)
- Bedrock Data – Geological Survey of Ireland (2006)
- Karst Heritage sites – Geological Survey of Ireland (2001)
- Designated sites records and digital maps – NPWS
- Landsat Thematic mapper satellite imagery
- 2005 Aerial ortho-photography – Ordnance Survey of Ireland (2005)
- Burren habitat mapping – Parr *et al.* (2006)
- Habitat map of County Roscommon – Heritage Council (2011)

When digitising, special attention was given to areas covered with scrub, particularly where scrub occurred close to areas of mapped exposed limestone pavement, as these areas of scrub are more likely to have limestone pavement underneath. Each polygon was given a level of certainty of habitat occurrence; those areas containing large open areas of pavement which are obvious on the ortho-photographs or which were surveyed were given a "certainty" value. Those areas with low possibility of occurrence of the habitat and which will require a site visit were given a "low" certainty value. Remaining polygons were given either a "medium" or "high" certainty, depending on the subjective decision of whether the habitat was likely to occur. The GIS attribute table contains additional information such as other potential habitats which may be found within each polygon (e.g. open pavement (LP), scrub, woodland, heath or grassland), the occurrence of threatening activities such as removal or quarrying and whether the mapped area is included within a SAC, NHA or pNHA.

National Limestone pavement maps

The national 10km grid habitat distribution map was produced by intersecting the overall national Limestone pavement habitat map with the 10km grid. It shows 10km squares where the habitat is present. The Irish National Grid was used as the co-ordinate reference system. See Figure 4 under Habitat Mapping in the results section.

The habitat range is defined as the smallest polygon size containing all grid squares where the habitat was recorded. The current range map in Irish Grid for Limestone Pavement (8240) was generated using 'Species and Habitat types Range Tool'version RangeTool.tbx which is the 'ESRI ArcGIS 10 Toolbox containing the Range tool for version 10.0, version 30/08/2012, downloaded from (http://bd.eionet.europa.eu/activities/Reporting_Tool/Reporting_Tool_Software).

Mapping of habitats within potential NHA sites

The mapping of sites for potential designation involved the following steps:

Pre-survey habitat mapping: a habitat map for each site was drawn up prior to the field survey in ArcGIS 9.3 using 2005 OSi ortho-photographs as a background. Each polygon was given a potential habitat type (i.e. open limestone pavement, grassland, heath, scrub and/or woodland,) based on visual identification.

Habitat recording in the field: habitat boundaries were recorded in the field using DGPS/GIS handset (Trimble GeoXT) minicomputers. A digital copy of the pre-survey habitat map was used on the Trimble GeoXT devices with the 2005 OSi ortho-photographs as a background, to aid habitat mapping. The minimum mapping unit was approximately 20m x 20m. Areas of habitat smaller than this were mapped as a mosaic.

Post-survey habitat mapping: post-processing of data was carried out to improve accuracy based on the Active GPS Network from Ordnance Survey Ireland to obtain sub-metre accuracy of data. Habitats assigned during the pre-survey phase were revised post-survey based on field data and vegetation classification of relevé data. Each polygon was given a Fossitt (2000) and EU Annex I habitat classification (when applicable); those habitats not corresponding to an EU habitat type were listed as NSC (No significant correspondence). The overall boundary of the site was also assessed to determine whether or not it would be an appropriate boundary for a potential NHA. Pre-survey and post-survey mapping was done at a 1:2,500 scale. The Irish National Grid (ING) was used as the co-ordinate reference system.

Mapping of habitats within monitoring sites

The mapping of sites within monitoring sites involved the following steps:

Pre-survey habitat mapping: prior to the site visit a series of 100m x 100m (1ha) plots were drawn in each monitoring site (see site selection section for further details). Monitoring plots were drawn in ArcGIS 9.3 using 2005 OSi ortho-photographs as a background.

Habitat recording in the field: habitat boundaries were recorded in the field using DGPS/GIS handset (Trimble GeoXT) minicomputers. A digital copy of the monitoring plots was used on the Trimble GeoXT devices with the 2005 OSi ortho-photographs as a background to aid habitat mapping. The minimum mapping unit was approximately 4m x 4m. Areas were mapped as mosaics where intricate patterns of habitats occur and no apparent dominant habitat was apparent. In these instances, all habitats which occurred in the mosaic were listed.

Post-survey habitat mapping: post-processing of data was carried out to improve accuracy based on the Active GPS Network from Ordnance Survey Ireland to obtain sub-metre accuracy of data. Habitats assigned during the pre-survey phase were revised post-survey based on field data and vegetation classification of relevé data. Each polygon was given a Fossitt (2000) and EU Annex I habitat classification (when applicable); those habitats not corresponding to an EU habitat type were listed as NSC (No significant correspondence). Pre-survey and post-survey mapping was done at a 1:750 scale. The Irish National Grid (ING) was used as the co-ordinate reference system. Details of GIS files produced are given in Appendix 4.

Quality control

Quality control was essential in generating accurate, consistent and high quality mapping. The following measures were taken:

- Periodic inspection of subsets of data during data collection and transfer to GIS systems.

- Field survey rechecks to ensure consistency in vegetation classification.
- Systematic review of datasets, particularly once all habitats datasets were entered into GIS systems to check for topological errors and to ensure thematic and positional accuracy as well as dataset completeness.

Vegetation data analysis

Data preparation

In order to produce a classification of Limestone pavement and associated habitats, data collected from the Limestone pavement pilot survey (Murphy & Fernández 2009), from the current survey, as well as data collected in a survey of grassland and heath habitats in the Burren (Parr *et al.* 2009), were analysed. A total of 358 relevés and 277 species were recorded in the pilot and National Limestone pavement survey. Two hundred grassland and heath relevés were added from Parr *et al.* (2009). This gave a total of 558 relevés. Parr *et al*. (2009) divided these relevés prior to analysis into two groups (grassland and heath) based on a rule used by Fossitt (2000) to differentiate grassland from heath (>25% cover of dwarf shrubs). This was not repeated in the current set of analyses; all relevés were grouped together so that groupings could be derived from the analyses techniques used.

Outlier analysis was conducted in PCORD (MjM Software, Oregon) as outliers can profoundly influence multivariate analysis (McCune & Grace 2002). Using three standard deviations from the grand mean as a cut-off no relevés were removed. Species occurring in fewer than three relevés were excluded from the analysis because species with only a few occurrences provide little reliability in assigning them to groups (McCune & Grace 2002). This yielded a matrix of 558 relevés and 226 species. Outlier analysis was again conducted on the groups resulting from the first round of Cluster Analysis. Several relevés (mosaic habitats) were removed at this stage. Taxa recorded to genus level were included in the analysis but only if there were no other taxa from the same genus that were identified to species level. Each "species" is considered different, so overlaps would confuse the similarity measure basis of the analyses. Species cover was recorded in the Domin scale in the field. These scores were converted to midrange percentage values (Currall 1987), which are detailed in Table 4 below.

Table 4 Domin score and equivalent mid-range values (Currall 1987).

Domin score	Range (%)	Mid-range value (%)
10	95-100	97.5
9	75-94	84.5
8	50-74	62
7	33-49	41
6	25-32	28.5
5	10-24	17
4	5-9	7
3	1-4	2.5
2	<1	0.5
1	<1	0.5
+	<1	0.5

Analysis techniques

A number of techniques were employed to analyse the data. All analyses were carried out using PCORD 6.

NON-METRIC MULTIDIMENSIONAL SCALING (NMS)

Non-metric Multidimensional Scaling is the most generally effective ordination method for ecological community data (McCune & Grace 2002). Ordination techniques are used to simplify a complex multivariate data set into a small number of dimensions that explain most of the variation. The major objective is to achieve an effective data reduction, expressing many-dimensional relationships in a small number of dimensions. Objects close in the ordination space are generally more similar than objects distant in the ordination space. It is a useful tool for comparing relevés and to show relationships between relevés and environmental data.

NMS is an ordination method that is well suited to data that are non-normal or are on arbitrary, discontinuous, or otherwise questionable scales. One of its main advantages is that it avoids the assumption of linear relationships among variables (McCune & Grace 2002). It is an iterative search for a ranking and placement of n entities on k dimensions (axes) that minimizes the stress of the k-dimensional configuration. The calculations are based on an n x n distance matrix calculated from the n x p-dimensional main matrix, where n is the number of rows and p is the number of columns in the main matrix. "Stress" is a measure of departure from monotonicity in the relationship between the dissimilarity (distance) in the original p-dimensional space and distance in the reduced k-dimensional ordination space (McCune & Grace 2002).

The Sørenson (Bray-Curtis) distance measure was used in this analysis. To test the robustness of the data a Monte Carlo (randomisation) test of 100 runs was employed. Each run consists of a separate randomisation or permutation of the data. A large number of runs is generally desirable but is dependent upon computer power, data set size, and the desired precision of the resulting p-value. Note that the p-value for a randomization test can be no smaller than 1/N where N is the total number of runs (McCune & Grace 2002).

It was decided to run the NMS on each of the three main groups derived from Cluster Analysis, rather than on the whole dataset as the differences between groups would have been too great to show significant variation amongst groups. Hence, a preliminary 'slow and thorough' autopilot run was conducted on each of the three main datasets; limestone pavement (exposed), limestone pavement (wooded) and grassland/heath. Parr *et al.* (2009) data was not included in these analyses as environmental variables were not compatible between the Parr *et al.* (2009) data set and the NSLP data set.

Pearson correlation was used to provide a way of comparing positions of the sample units on the ordination axes with environmental variables. If a variable has any linear relationship with an ordination axis, it is expressed in the correlation coefficient. These correlations should primarily be used for descriptive purposes (McCune & Grace 2002).

HIERARCHICAL, AGGLOMERATIVE CLUSTER ANALYSIS

Agglomerative Cluster Analysis is a useful tool if groups are sought from multivariate ecological data (McCune & Grace 2002). This was the primary method used to identify habitat types and to sort the data into group. Two rounds of Cluster Analysis were completed, the first to separate the data into broad groups, the second to divide the data into a number of vegetation types.

Firstly, from a data matrix of relevés and species, a distance matrix was calculated using Sørensen (Bray-Curtis) as a distance measure. Sørensen (Bray-Curtis) was used as a distance measure as it has repeatedly been shown to be one of the most effective measures of sample or species similarity (McCune & Grace 2002). Flexible Beta (-0.25) was used as a linkage method. This is an omnibus method that spans the range between nearest flexible neighbour (complete linkage) and farthest neighbour clustering, depending at what value the beta parameter is set. B = 1 gives a nearest neighbour clustering, with lots of chaining, and B = -1 gives farthest neighbour, with very little chaining where most relevés join pair-wise before forming larger clusters. The results of the Cluster Analysis are displayed as a dendrogram.

INDICATOR SPECIES ANALYSIS (ISA)

This method combines information on the concentration of species abundance in a particular group and the faithfulness of occurrence of a species in a particular group (McCune & Grace 2002). Indicator values are tested for statistical significance using a randomisation (Monte Carlo) technique. This is a test of significance of observed maximum indicator value (IV) for each species, based on 1000 randomisations. The means and standard deviations of the IV from the randomisations are given along with p-values for the hypothesis of no difference between groups. The p-value is based on the proportion of randomised trials with indicator value equal to or exceeding the observed indicator value (McCune & Grace 2002). An infrequent species has no possibility of being a statistically significant indicator species because is quite likely that all its occurrences will fall into one group.

There are two main criteria for a species to be an indicator:

1. Significant Monte Carlo p-value
2. An indicator value (IV) of at least 25 (when 2 groups are being analysed) so that at least half the samples in the group have the species present. (i.e. 1/no.of groups) x 0.5

Indicator species can also be used as a stopping point in Cluster Analysis (Dufrene & Legendre 1997). This works on the premise that if groups are too finely divided or if groups are too large that the Indicator Values will be low. Dufrene and Legendre (1997) found that the indicator values peak at some intermediate level of clustering and the position of the peak will vary with species. Taken collectively, the method can be used to decide on an appropriate level of clustering for species data. When there are more than two groups, the IVs for a species in a particular group depends on the set of sample units belonging to the other groups. Species with only one or two occurrences never yield an IV stronger than expected by chance, i.e. it won't have a significant p-value. If groups are too finely divided then indicator values will be low. If the groups are too large, then their internal heterogeneity will reduce the indicator values (McCune & Grace 2002). ISA was run on the output of hierarchical Cluster Analysis. The number of species, with significant indicator values ($p \leq 0.05$), and the sum of significant indicator values at each stage of grouping was compared. The average p-value across all species at each stage of clustering was also compared in order to choose the optimum number of groups in the data.

Assessment of EU Annex I habitat conservation status

Overview

One of the main objectives of the project was to develop methodologies to assess the conservation status of Limestone pavement and associated habitats in Ireland. The setting of a national baseline monitoring programme (Element II of the project) was identified as an essential step in this process.

For this purpose, methodologies established in the pilot project (Murphy & Fernández 2009), were revised and new methods were developed when required, in discussion with NPWS.

The assessment of the conservation status of the habitat at national level involves two main steps:

1. The conservation status of limestone pavement and associated habitats within individual sites surveyed as part of the national monitoring programme.
2. The conservation status of limestone pavement and associated habitats at a national level based on the results of individual site assessments as well as additional data.

Conservation status assessment at site level

The conservation status assessment of Annex I Habitats at the monitoring sites was based on the assessment of each of the following attributes:

- Area
- Structure & Functions (S&F) (i.e. quality) - including conservation status of its typical species.
- Future Prospects (FP) - based on current impacts or pressure and future impacts or threats, as well as positive actions (e.g. restoration works, positive management measures) (Ellmauer 2010).

Table 5 gives a summary of the parameters and conditions required to assess the conservation status of habitats at site level.

Table 5 Summary matrix of the parameters and conditions required to assess the conservation status of habitats at site level. See Evans & Arvela (2011) for complete assessment matrix for the national level.

	Favourable	Unfavourable - Inadequate	Unfavourable - Bad
Area	Stable	>0% <1% decline/year	> 1% decline/year
Structure & Functions	Structure & functions (including typical species) in good condition and no significant deteriorations / pressures.	Any other combination 1 – 25% decline/failure (e.g. 1-25% of monitoring stops fail)	> 25% of the area is unfavourable as regards its specific structures and functions (including typical species)
Future Prospects	Good - The habitats prospects for its future are excellent / good, no significant impact from threats expected; long-term viability assured.	Poor - Any other combination	Bad - The habitats prospects are bad, severe impact from threats expected; long-term viability not assured.
Overall	All green	Combination of green and amber	One or more red

AREA

A quantitative assessment of the variation in Annex I habitat extent within the reporting period was not carried out as this was a baseline survey. However, the following rules should be followed when assessing variation in area in the future: a decline in habitat area within a site, greater than 0% and smaller than 1% per year, should be assessed as Unfavourable - Inadequate; a decline greater than 1% per year should be assessed as Unfavourable - Bad. Area should also be given a trend assessment based on the variation in its value in the reporting period. Thus, trend is assessed as Stable, Increasing or Decreasing.

STRUCTURE AND FUNCTIONS

Article 1(e) of the Habitats Directive specifies that for the conservation status of a habitat to be favourable, "the specific Structure and Functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future". The assessment of the habitats structure and functions is based on the selection of a series of measurable attributes (e.g. positive and negative indicators) that should describe the condition of the habitat. Each attribute has a specific target, or a range of targets, against which the sample point can be scored to pass or fail. A more detail description of the attributes selected for each specific habitat is given in Appendix 5.

Previous assessments carried out in Ireland, such as Martin *et al.* (2007), McCorry (2007) and Ryle *et al.* (2009), were based on the establishment of a series of monitoring stops in the field, where attributes were assessed. Monitoring stops covered any expected variation within the habitat. Seriously disturbed areas or areas suffering from encroachment were excluded. Where possible, monitoring stops were recorded in multiples of four (i.e. 4, 8, or 12), in order to simplify assessing whether more than 25% of monitoring stops had failed. This also allows scaling up to the national level for national assessments.

Four or multiple numbers of four monitoring stops could not be established at the plot level (100m x 100m) in this national survey due to the small extent of the habitats mapped within each plot (minimum mapping unit size approximately 16m^2 (4m x 4m)). However, multiple monitoring stops were established for a monitoring site where a series of plots were surveyed. All relevés recorded at monitoring sites for the pilot survey (Murphy & Fernández 2009) and the national survey, which were selected as representative of the overall condition of a habitat within a plot, were treated as monitoring stops here.

A new assessment based on a matrix was proposed where S&F are assessed at two different levels within a monitoring site. See Table 6 for an illustration of these methods.

Monitoring stop (relevé) level (row):

A fail of two or more separate attributes within a monitoring stop results in an overall fail for the monitoring stop. This is illustrated in Table 6 (cases I and II). Subsequently, at site level, if 1-25% of monitoring stops fail, the results give an Unfavourable - Inadequate (Amber) assessment and if more than 25% of monitoring stops fail, it results in an Unfavourable-Bad (Red) assessment. This is illustrated in Table 6, where three out of four (75%) of monitoring stops fail, giving an overall monitoring site assessment of Unfavourable-Bad (case III). This method has been slightly modified from that used in the pilot survey where two fails within a monitoring stop result in an overall Yellow (amber) Fail for the Monitoring stop and three fails are deemed to correspond to a Red Fail. This addition of degrees of failure (i.e. amber/red) was considered too complicated to apply at monitoring stop level, thus resulting in a more simplified version of the methodology.

Table 6 Hypothetical monitoring site structure and functions assessment matrix (see text for further detail).

	Monitoring stop level	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Attribute 5	Attribute 6	Attribute 7	Attribute 8	Monitoring stop level	Overall assessment
Monitoring site	Monitoring stop 1	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Unfavourable - Bad
	Monitoring stop 2	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Fail (case I)	
	Monitoring stop 3	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Fail (case I)	
	Monitoring stop 4	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail (case II)	
	Attribute level	Pass	Pass	Pass	Pass	Fail (case IV)	Fail (case V)	Pass	Pass	Fail (case III)	

Attribute level (column):

When more than 25% of the monitoring stops fail for an attribute, the attribute fails (cases IV and V in Table 6). This method has been modified from the pilot survey in which 25-50% failure of the attribute would lead to a Yellow Fail (Unfavourable - Inadequate), whereas if more than 50% of the monitoring stops fail for a similar attribute, the overall assessment for this attribute is a Red Fail (Unfavourable - Bad). This addition of degrees of failure (i.e. amber/red) was considered too complicated to apply at monitoring stop level and so a simplified version of the methodology was developed, whereby an attribute either passes or fails.

Expert judgement needs to be applied to determine the severity of the fail (amber or red) at site level, if the site passes at monitoring stop level but fails at attribute level. For example, if all monitoring stops pass at monitoring stop level, but fail consistently at attribute level (i.e. one attribute fails at all monitoring stops) then the failing of the attribute must be put in context and assessed as a whole with the condition of the rest of the attributes. In this way, the attribute level assessment will play a less important role in determining the structure and functions assessment at site level. However, it will be important in highlighting the 'problem areas' that need to be addressed if the conservation status of the site or habitat is to be improved.

The proposed method is considered to be a more thorough way to evaluate the condition of a habitat. Although this system may appear less critical than other survey methods, which were based on just one fail within an attribute to given an overall fail for the site, the addition of a second level of assessment provides an accumulative level of assessment at attribute level. Four or multiples of four monitoring stops are deemed the most appropriate number for a standardised assessment; however, when only a small number of monitoring stops (i.e. 1 to 3) are recorded, expert judgment was used.

The structure and functions of four EU Annex I habitats were assessed; Limestone pavement (exposed) and Limestone pavement (wooded) (8240), Semi-natural dry grasslands and scrubland facies on calcareous substrates (6210), Alpine and Boreal heaths (4060) and European dry heaths (4030). Two other EU Annex I Habitats known to be associated with Limestone pavement (8240), namely *Juniperus communis* formations on heaths or calcareous grasslands (5130) and *Taxus baccata* woods (91J0) were not assessed. Information on the conservation status of these habitats can be found in Cooper *et al.* (2012) and Cross & Lynn (2012) respectively.

LIMESTONE PAVEMENT (EXPOSED) (8240)

The structure and function conservation status assessment for exposed limestone pavement was based on the following attributes and targets (see Appendix 5 for further detail):

Vegetation composition:

- Presence of positive indicator species, at least seven of which should be present, in order for the monitoring stop (relevé) to pass.
- Cover of negative indicator species: collective cover of negative indicators should be less than 1%; cover of bracken should be less than 10%; cover of non-native species should be less than 1%.

Vegetation structure:

- Cover of scrub species, a list of which is given in Appendix 5, should be less than 25%; individual cover of *Prunus spinosa* and *Corylus avellana* should also be noted but not assessed separately.

Other data:

- Indicators of local distinctiveness, including notable species should be recorded but not assessed.

The above attributes and targets were selected based on the monitoring methodologies established for the habitat by JNCC (2008). Indicator species (positive and negative) were devised from data collected during this project, as well as from the NPWS (2007b) 8240 habitat conservation status assessment typical indicator species and EU Habitats Directive Interpretation Manual list of characteristic species for the habitat.

JNCC (2008) also proposed the assessment of the habitat structure based on grazing and browsing pressure which is estimated based on the percentage of emergent vegetation (more than 25% herbaceous vegetation cover should be made up of emergent and clint-top plants, flower heads and fern fronds). Thom *et al.* (2004) suggests that emergent vegetation must be present on at least 25% of the pavement area for the site to be in favourable condition. It must be noted that these criteria are based on optimum conditions of limestone pavement in the British context and are not necessarily suitable for Ireland. This attribute was considered during the early stages of establishing methodologies in the pilot survey. However, it was not deemed relevant in the Irish context as certain areas of pavement, which are exposed to harsh weather conditions for example, naturally have low emergent vegetation, and would fail an assessment as a result. Indeed, Thom *et al*. (2004) states that emergent vegetation may not be a good measure of grazing impact, as other factors such as altitude, exposure and pavement structure may play a more important role.

LIMESTONE PAVEMENT (WOODED) (8240)

This habitat type includes low woodland formations dominated by Hazel and/or Ash with typical blocky pavement under the canopy. Many of these areas have canopies less than 4m high and would therefore be described as scrub. However, for the purpose of the structure and functions assessment, all areas of scrub were classified as low woodland. The structure and function conservation status assessment for wooded limestone pavement was based on the following attributes and targets (see Appendix 5 for further detail):

Vegetation composition:

- Presence of positive indicator species, at least seven of which should be present in order for the monitoring stop (relevé) to pass.
- Collective cover of negative indicator species should be less than 10%.

Vegetation structure:

- Canopy cover: The total canopy cover should be greater than 30%.

- Bryophyte cover: The total bryophyte cover should be more than 50%.

Other targets:

- Grazing: No grazing pressure within relevé.
- Deadwood: Dead wood present within relevé.
- Non-native species: Absence of non-native shrub/tree regeneration present within relevé.
- Indicators of local distinctiveness, including notable species should be noted but are not assessed.

The above attributes and targets were selected based on the monitoring methodologies established for native woodland habitats by Perrin *et al.* (2008) and were adapted to wooded limestone pavement for this project. This was done in accordance with data recorded in the field and in consultation with NPWS staff.

SEMI-NATURAL DRY GRASSLANDS AND SCRUBLAND FACIES ON CALCAREOUS SUBSTRATES (*FESTUCO-BROMETALIA*) (IMPORTANT ORCHID SITES) (6210/6211)

The structure and function conservation status assessment for Semi-natural dry grasslands and scrubland facies on calcareous substrates was based on the following attributes and targets (see Appendix 5 for further detail):

Vegetation composition:

- Presence of at least two high quality indicator species.
- Presence of at least seven positive indicator species, (including high quality indicator species), in order for the monitoring stop (relevé) to pass.
- Collective cover of negative indicator species should be no more than 20% and individual cover should be less than 1%.
- Collective cover of non-native species should be less than 1%.

Vegetation structure:

- Forb component should be between 40 and 90%;
- Collective cover of scrub and bracken should be no more than 10%.
- Height of 30-70% of the sward should be 5-40cm.
- Litter cover should be ≤ 25%, (although this attribute was not assessed in the current survey).

Physical structure:

- Cover of disturbed ground no more than 10%.

Other data:

- Indicators of local distinctiveness, including notable species should be noted but are not part of the assessment.

The above attributes and targets were selected based on the monitoring methodologies established for the habitat by Dwyer *et al.* (2007), Martin *et al.* (2007) and O'Neill *et al.* (2010); NPWS (2007b) 6110 and 6120 habitat conservation status assessment typical indicator species and EU Habitats Directive Interpretation Manual list of characteristic species for the habitat. The monitoring methodologies established by JNCC (2004a) for lowland grasslands were also consulted.

No differentiation was made between habitats 6210 and 6211; the main reason for not distinguishing orchid-rich sites is the ephemeral nature of orchids, with large orchid populations present one year and absent the next. Additional species (including bryophytes) were added to the list of positive indicators based on data collected during this survey as well as constant species listed by Parr *et al.* (2009) and species listed by Dwyer *et al.* (2007). Attributes were only assessed at monitoring stop (relevé) level. Assessing attributes at local vicinity level was not considered appropriate for this survey.

ALPINE AND BOREAL HEATHS (4060)

The structure and function conservation status assessment for Alpine and Boreal heaths was based on the following attributes and targets (see Appendix 5 for further detail):

Vegetation composition:

- Presence of at least seven positive indicator species, in order for the monitoring stop (relevé) to pass.
- Collective cover of negative indicator species should be no more than 1%.
- Collective cover of non-native species should be no more than 1%.

Vegetation structure:

- Collective cover of trees and shrubs should be no more than 25%.

Physical structure:

- Cover of disturbed ground should be no more than 10%.

Other data:

- Indicators of local distinctiveness, including notable species should be noted but not assessed.

The above attributes and targets were selected based on the monitoring methodologies established for the habitat by Perrin *et al.* (2010). The assessment criteria were modified for the current survey as

some of the attributes assessed by Perrin *et al.* (2010) were not considered to be relevant or appropriate in the context in which they are found associated with limestone pavement. Species list were modified based on data collected during this survey as well as constant species listed by Parr *et al*. (2009). A number of additional attributes were included, such as positive indicator species, cover of trees and shrubs and cover of non-native species.

EUROPEAN DRY HEATHS (4030)

The structure and function conservation status assessment for European dry heaths was based on the following attributes and targets (see Appendix 5 for further details):

Vegetation composition:

- Presence of at least 7 positive indicator species, in order for the monitoring stop (relevé) to pass.
- Collective cover of negative indicator species should be no more than 1%.
- Collective cover of non-native species should be no more than 1%.

Vegetation structure:

- Collective cover of trees and shrubs should be less than 25%.

Physical structure:

- Cover of disturbed ground should be less than 10%.

Other data:

- Indicators of local distinctiveness, including notable species should be noted but not assessed.

The above attributes and targets were selected based on the monitoring methodologies established for the habitat by JNCC (2004b) and Perrin *et al*. (2010). Several criteria were modified for the current survey as some of the attributes assessed by Perrin *et al.* (2010) were not considered relevant or appropriate in the context in which the habitat is found associated with limestone pavement. NPWS (2007a) 4030 habitat conservation status assessment typical indicator species and EU Habitats Directive Interpretation Manual list of characteristic species for the habitat were consulted. Species lists were modified based on data collected during this survey as well as constant species listed by Parr *et al.* (2009). A number of additional attributes were included such as positive indicator species, cover of trees and shrubs and cover of non-native species. A selection of negative indicators were also provided based on JNCC (2004b), and revised for Ireland.

OVERALL LIMESTONE PAVEMENT AND ASSOCIATED HABITATS (8240) STRUCTURE AND FUNCTIONS

The Habitats Directive Interpretation Manual describes Limestone pavement (8240) as comprising of a mosaic of vegetation communities including associated habitats. Therefore, an overall limestone pavement structure and functions assessment was developed, which, gives a conservation status assessment for 8240 and associated habitats.

The assessment was based on a summary of the Annex I habitat structure and function assessment result within each monitoring site. The area of the habitat should also be taken into consideration when assessing the overall limestone pavement and associated habitat assessment. Expert judgement needs to be used when deciding on the outcome of the assessment. As a rule of thumb, when the overall extent of Annex I habitats failing within a site is between 1 and 25%, habitat 8240 is given an overall Unfavourable - Inadequate assessment, whereas when more than 25% of Annex I habitats fail, habitat 8240 is given an overall Unfavourable - Bad assessment. Structure and functions was also given a trend assessment based on the variation on its value in the reporting period. Thus trend was assessed as Stable, Improving or Declining.

FUTURE PROSPECTS

Future prospects for a habitat are deemed to be in unfavourable condition when pressures impacting on the habitat or threats expected to impact on the habitat compromise the habitats viability (Evans & Arvela 2011). An overall assessment should be based not only on negative but also on positive activities affecting the habitat. A full list of impacts and codes is given in Appendix 6; Terminology is based on standardised EU reference list (Ssymank 2011). A modified list of common impacts and codes for limestone pavement and associated habitats based on Fernández *et al.* (2012) is given in Appendix 7.

The future prospects of four EU Annex I habitats were assessed; Limestone pavement (exposed) and Limestone pavement (wooded) (8240), Semi-natural dry grasslands and scrubland facies on calcareous substrates (6210), Alpine and Boreal heaths (4060) and European dry heaths (4030). Two other EU Annex I Habitats known to be associated with Limestone pavement (8240), namely *Juniperus communis* formations on heaths or calcareous grasslands (5130) and *Taxus baccata* woods (91J0) were not assessed. Information on the conservation status of these habitats can be found in Cooper *et al.* (2012) and Cross & Lynn (2012) respectively.

Impacting activities were recorded in the field for each of the Annex Habitat found in each site. Impacting activities could take place inside the Annex I habitat or outside (adjacent to) the habitat.

Impacting activities outside plots but within the site were also taken into account. These activities were given the following attributes:

- Impact code: this is based on the system developed by Ssymank (2011).
- Intensity: the activity was ranked as having a low, medium or high intensity. High intensity suggests that an activity is very serious and concentrated and often involves doing a great deal of damage in a short time (e.g. pavement removal); low intensity suggests an activity is slight, while medium intensity suggests an activity between the two.
- Effect: the activity was noted as having a negative, positive or neutral effect on the Annex I habitat.

The intensity and effect of each impacting activity in each Annex habitat were taken into account and an assessment of Favourable, Unfavourable - Inadequate or Unfavourable - Bad was given to each habitat in each site. These categories were based on those given by Ellmauer (2010) which are defined as follows:

- Favourable when the habitat's prospects for its future must be good or even excellent. No significant impact from pressures should be expected and long-term (two monitoring periods, i.e. 12 years) viability is assured.
- Unfavourable - Bad when the habitat's prospects for its future are bad, with severe impact from pressures expected and long-term viability not assured.
- Unfavourable - Inadequate when an assessment gives results that are in between Favourable or Unfavourable - Bad.

OVERALL LIMESTONE PAVEMENT AND ASSOCIATED HABITATS (8240) FUTURE PROSPECTS

An overall assessment of future prospects for limestone pavement and associated habitats was carried out. The assessment was based on a summary of the Annex I habitat future prospects assessment result within each site. The area of the habitat was also taken into consideration when assessing the overall limestone pavement and associated habitat assessment. Expert judgement needs to be used when deciding on the outcome of the assessment; there may be instances where pressures or threats are not considered to be as threatening as the final assessment may indicate. Similar criteria to the one described above for structure and functions is then applied; when the overall extent of Annex I habitats failing within a site is between 1 and 25%, habitat 8240 is given an overall Unfavourable - Inadequate assessment, whereas when more than 25% of Annex I habitats fail, habitat 8240 is given an overall Unfavourable - Bad assessment. Future prospects was also given a trend assessment; Stable, Improving or Declining.

OVERALL ANNEX I HABITAT CONSERVATION STATUS ASSESSMENT

An overall habitat assessment at site level was based on the results of the assessments for area, structure and functions and future prospects. This is based on the worst case scenario, i.e., when any of the attributes are deemed unfavourable the overall habitat conservation status is also considered unfavourable (Table 5).

OVERALL SITE CONSERVATION STATUS ASSESSMENT

An overall site conservation status assessment was based on the results of the assessments for area, structure and functions and future prospects for each EU Annex I Habitat within the site. This overall site assessment is based on the worst case scenario, i.e., when any of the attributes are deemed unfavourable the overall habitat conservation status is also considered unfavourable (Table 5). The overall conservation status assessment was given a trend assessment; Stable, Improving or Declining.

Conservation status assessment at national level

The conservation status of a habitat is defined as the sum of the influences acting on the habitat that may affect its long-term viability. To assess the conservation status of Annex I habitat at national level, four parameters are objectively scored: a) Range, b) Area, c) Structure and Functions, and d) Future Prospects.

The method for the assessment of conservation status of an Annex I habitat at national level involves the application of a "traffic-light" system and brings together information on the four parameters for each habitat (Evans & Arvela 2011). Each parameter is assessed as being "Favourable FV" or good/green, "Unfavourable - Inadequate (UI)" or poor/amber, "Unfavourable - Bad (UB)" or bad/red and "unknown" or grey. If any one of the four parameters is assessed as "red", the overall assessment is also "red" (i.e. Unfavourable - Bad). All parameters must be green to achieve an overall Favourable assessment. Any other combination would result in an Unfavourable - Inadequate overall assessment. A trend value should be given to each attribute conservation status assessment. Thus, Range, Area, S&F and FP should be given an Increasing/Improving, Stable or Decreasing/Declining assessment. Favourable reference values are set as targets against which future values can be judged. These reference values have to be at least equal to the value that existed when the EU Habitats Directive came into force, i.e. in 1994. For habitats, favourable reference values are set for range and area (Evans & Arvela 2011).

RANGE

Range is defined as the area over which a species or habitat is usually found. For the purposes of this exercise, range is taken to be the outer limits of the overall area in which a habitat is found at present. It can be considered as an envelope within which areas actually occupied occur, as in many cases not all the range will actually be occupied by the habitat (Evans & Arvela 2011). The calculation of the habitat current range should be based on the current habitat national distribution map. Range is then depicted as those 10km grid (Irish National Grid) squares intersecting the national habitat distribution map. The range is then mapped based on the range mapping rules set by the EU (Evans & Arvela 2011). Any change in range over time should be assessed. Current range value should be also compared to the Favourable Reference Range value. Favourable Reference Range is the geographic range within which all significant ecological variations of a habitat are included and which is sufficiently large to allow the long-term persistence of that habitat and must be at least the value given when the Directive came into force.

AREA

Area is defined as the area currently occupied by the habitat at national level (Evans & Arvela 2011). The refinement of the 2007 national habitat distribution map was one of the main objectives of this project. This map provides a more accurate value of the habitat area at national level than given in 2007 (see Mapping section for further details). The assessment of the conservation status of the area should be based on any change in habitat area over time. The current area value should be also compared to the Favourable Reference Area (FRA) value, which is defined as the minimum value required for the long-term survival of the habitat and must be at least the value given when the Directive came into force. An actual figure is not available for when the Directive came into force, but it can be assumed that it is smaller than the current area, due to limestone pavement quarrying, land reclamation and limestone pavement displacement.

STRUCTURE AND FUNCTIONS

The conservation status of the habitat structure and functions was assessed in order to provide a national habitat conservation status. This assessment was based on the results of the structure and functions conservation status assessment at site level within those sites includinedas part of the National Monitoring Survey. An assessment of this attribute trend in the reporting period was also provided based on the individual sites assessed as part of the monitoring site assessment as well as other sources such as the BurrenLIFE project (Anon. 2010) and the Burren Farming for Conservation Project (Anon. 2011, Anon. 2012).

FUTURE PROSPECTS

The future prospects of habitats are determined by examining the influence of current impacting activities and pressures (current reporting period) and by the use of expert judgement to assess their impacts and potential threats in the future (2 reporting periods in the future). Impacting activities could have a negative, positive or neutral effect on the habitat. The assessment of the habitat's future prospects at national level was based on the results of the future prospects assessment results at site level within those sites including as part of the National Monitoring Survey. Any information from additional sources (e.g. BurrenLIFE project) (Anon. 2010) was also taken into account. The data collected for the potential NHA survey was also used. This was particularly important as it gave an indication of the condition of limestone pavement and associated habitats outside the NATURA network. An assessment of this attribute trend in the reporting period was also provided based on the future prospects of individual sites as well as information gathered from the potential NHA survey and from additional sources such as the BurrenLIFE Project (Anon. 2010) and the Burren Farming for Conservation Project (Anon. 2011, Anon. 2012).

Ranking of potential NHA sites using conservation and threat scores

For the sites surveyed outside the NATURA 2000 network (potential NHAs), an evaluation or ranking system was developed. This process is useful, as it allows comparison between sites; it also gives an indication, albeit subjective, on the strength and weaknesses of individual sites in terms of factors such as habitat and species diversity. The techniques used were developed using previous studies such as Foss & Crushell (2008), Derwin *et al.* (2004), O'Neill *et al.* (2010) as well as Lockhart *et al.* (1993). Site information was collected for each potential NHA as described in the methods section.

Usher's (1989) approach to the conservation of sites involves the identification of attributes used to reflect the conservation interest of the site, along with criteria to express these attributes, in a form that allows evaluation. The result is that each site is given a conservation score, which can be used for management purposes or as a means of ranking sites to aid the selection process for potential designation. Table 7 presents the full list of criteria used to assess the conservation score for a site, which include the size of the site, species diversity, the presence of Annex I Habitats and geographical location. Sites were given a conservation score out of a maximum of 49 and were presented as percentage values, following methodologies by O'Neill *et al.* (2010).

Threat score criteria were also developed. These were based on damaging activities such as encroachment, quarrying, reclamation as well as other negative indicators such as the presence of invasive species. A full list of criteria is given in Table 8. Sites were given a threat score out of a

maximum of 20 and were presented as percentage values, following methodologies by O'Neill *et al*. (2010).

Table 7 Criteria used to calculate the conservation score for potential NHA sites.

Criterion	Score	Details			Max score
Fossitt habitats	*1*	*for each Limestone pavement and associated habitat (Fossitt 2000)*			*5*
Annex I habitats	*2*	*Annex I Limestone pavement and associated habitats*			*12*
Other semi-natural habitats	*0.5*	*Any other semi-natural habitat recorded during the survey, e.g. Fen/Bog*			*2*
Area		*Sites are divided into 8 groups on the basis of the percentile distribution. The range is greater in the larger site groups, and this is reflected by the steep increase in scores for larger sites.*			*12*
	0	0-0.5ha	4	20-40ha	
	1	0.5-5ha	6	40-80ha	
	2	5-10ha	9	80-160ha	
	3	10-20ha	12	over 160ha	
Species Diversity		*To remove the bias towards larger sites, the number of species present on each site was divided by the log10 (area+1). The resulting figures were then divided according to percentiles as shown.*			*4*
	0	<25 species	3	66-80 species	
	1	25-51 species	4	>80species	
	2	52-65 species			
Notable species		*Notable species include those listed in the Flora Protection Order 1999 (FPO) and the Red Data Book (RDB) (Curtis & McGough 1988) of vascular plants.*			*8*
	0	No notable species	2	One RDB species	
	4	One FPO species	4	Two RDB species	
	8	Two or more FPO species	6	Three or more RDB species	
Typicality		*Degree to which a site displays typical habitat features*			*2*
	0	Habitat not representative			
	1	Moderate example of habitat			
	2	Excellent example of habitat			
Expert opinion		*Overall surveyors opinion of site value and conservation potential, based on all habitats present.*			*2*
	0	Site has no value for conservation			
	1	Site has moderate value for conservation			
	2	Site has high value for conservation			
Geographical location		*Isolated sites and sites which represent the extremes of the range are scored higher than sites in the centre of the range*			*2*
	0	Proximal to a designated site or within centre of habitat range			
	1	Moderate proximity to a designated site / not at edge of habitat range			
	2	Isolated or at the extremes of the habitat range			
Maximum total score					***49***

Table 8 Criteria used to calculate the threat score for potential NHA sites.

Criteria	Score	Description	Max score
Scrub encroachment	0	No encroachment	3
	1	Low level of encroachment	
	2	Medium level of encroachment	
	3	High level of encroachment	
Succesional change	0	No succesional change	3
	1	Low level of succesional change	
	2	Medium level of succesional change	
	3	High level of succesional change	
Invasive non-native species	0	No invasives	3
	1	Low level of invasives	
	2	Medium level of invasives	
	3	High level of invasives	
Quarrying	0	No quarry nearby	4
	2	Quarry adjacent to site	
	4	Quarry within site	
Land reclamation	0	No land reclamation	4
	2	Small areas of reclamation	
	4	Large areas of reclamation	
Other Damaging Activities	0	No damaging activities	3
	1	One damaging activity	
	2	Two damaging activities	
	3	Three or more damaging activities	
Maximum total score			**20**

These assessments resulted in conservation and threat scores for each potential NHA surveyed. Following the methodologies employed by O'Neill *et al.* (2010), conservation scores and threat scores were not combined. O'Neill *et al.* (2010) states that combining these scores can lead to misinterpretation when comparing sites, for example comparing a high quality site with many threats and a medium quality site with no threats. This allows for the identification of sites with a high conservation value which may be threatened.

Results

General survey results

General site surveys

During the field survey for the *National Survey of Limestone Pavement* (NSLP) which ran from July 2009 to August 2011 and the *Pilot Survey of Limestone Pavement* (PSLP) which ran from July 2008 to May 2009 the following sites, listed in Table 9, were surveyed. Table 9 gives a list of all sites of Element I – potential NHA sites and Element II – monitoring sites that were surveyed during this time. Four sites were surveyed as both monitoring and potential NHA sites and are denoted with an asterix (Table 9). A map of the location of the sites is given in Figure 2. A map showing the year each site was surveyed is given in Figure 3.

POTENTIAL NHA SURVEY

A total of 25 potential NHA sites were chosen during the pre-survey phase, of which 17 were surveyed as potential NHAs. See Table 9 and Appendix 8 for further information. These sites were selected in counties Clare, Galway, Limerick, Mayo and Roscommon. Many sites were chosen which were adjacent to existing SACs. The reason for this was to ease the process of rationalisation of SAC boundaries in the future. None of the potential NHA sites were designated. A total of 64 relevés were recorded during the potential NHA survey and the overall extent of limestone pavement and associated habitats mapped was approximately 1570ha. Four main habitats types were surveyed and recorded according to Fossitt (2000) and EU Annex I Habitat classification; Limestone pavement, (exposed) (17 relevés), grassland (27 relevés), heath (7 relevés), and limestone pavement (wooded) (12 relevés). One wet grassland (GS4) relevé was also recorded. Table 10 below gives a summary of these results. See Appendix 9 for examples of potential NHA site boundary and habitat maps (EU Annex I and Fossitt) and Appendix 10 for detailed potential NHA site notes.

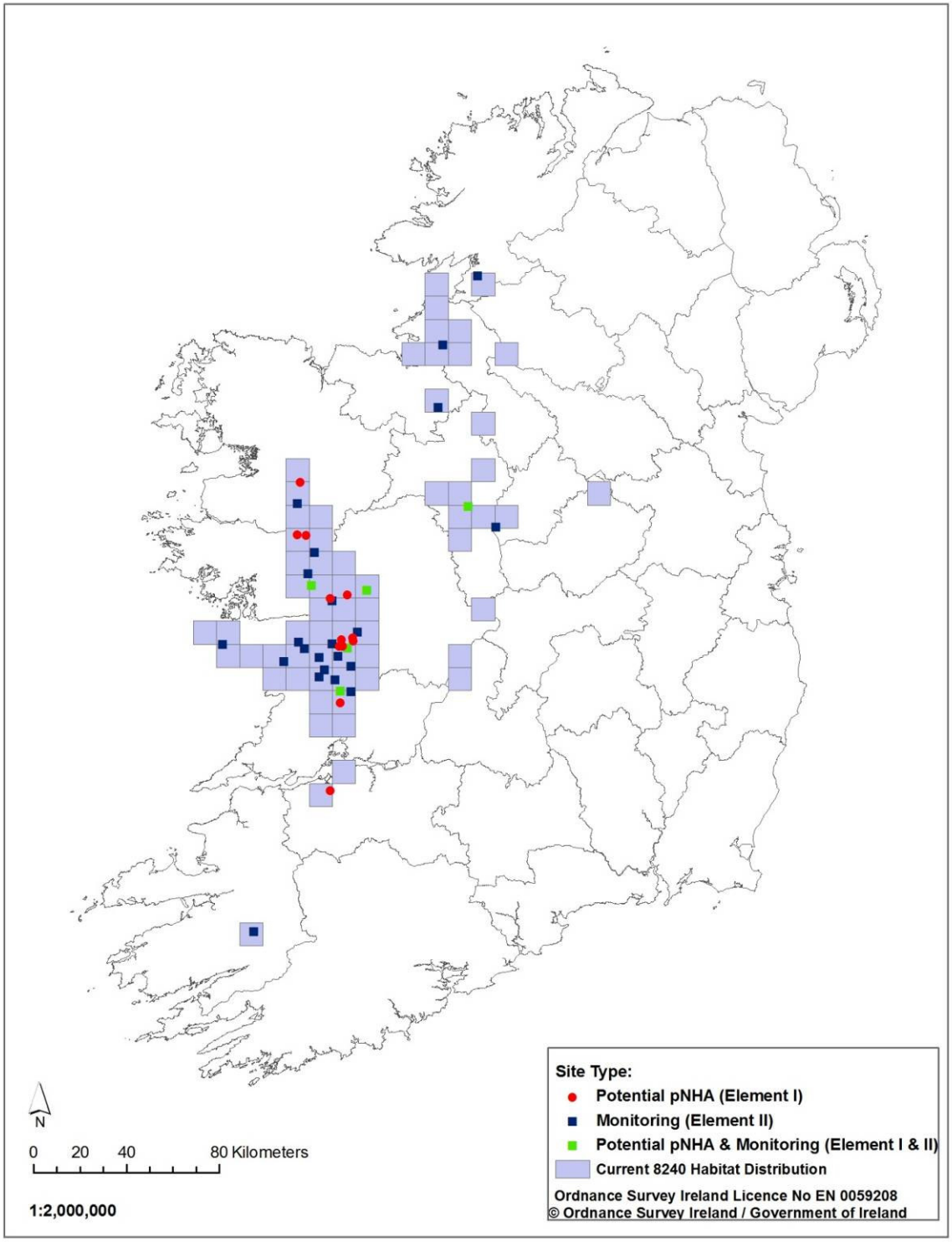

Figure 2 Location of Pilot Survey of Limestone Pavement (PSLP) and National Survey of Limestone Pavement (NSLP) sites (Element I and II).

Table 9 List of PSLP and NSLP sites (potential NHA and monitoring) surveyed.

Site Number	Site Name	Designation	County
1	Murrooghtoohy North	SAC (000020) - BlackHead-Poulsallagh Complex	Clare
2	Gortlecka	SAC (001926) - East Burren Complex	Clare
3	Corranellistrum	SAC (001271) - Gortnandarragh	Galway
4	Abbey East	SAC (001926) - East Burren Complex	Clare
5	Lough Mask	SAC (001774) - Lough Carra/Mask Complex	Mayo
6	Mullaghfarna	SAC (001656) - Bricklieve Mountains and Keishcorran	Sligo
7	Aillwee	SAC (000020) - BlackHead-Poulsallagh Complex	Clare
8	Rannagh West	SAC (001926) - East Burren Complex	Clare
9	Slievecarran	SAC (001926) - East Burren Complex	Clare
10	Ballyryan	SAC (000020) - BlackHead-Poulsallagh Complex	Clare
12	Cashel	SAC (000440) - Lough Ree	Longford
13	Ballynacarrick	SAC (000115) - Ballintra	Donegal
14	Sramore	NHA (002435) - Crockauns/Keelogyboy Bogs	Leitrim
15	Mucross	SAC (000365) - Killarney National Park	Kerry
16	Cuildooish	SAC (000606) - Lough Fingall Complex	Galway
17	Cloonselherny	SAC (001926) - East Burren Complex	Clare
18	Clooneen	SAC (000057) - Moyree River System	Clare
19/36*	Caherlough	Not designated	Clare
20/38*	Cloonnasee	Not designated	Galway
21	Sheshymore	SAC (000054) - Moneen Mountain	Clare
22	Formoyle East	SAC (000020) - BlackHead-Poulsallagh Complex	Clare
23/41*	Grange East	Not designated	Galway
24	Kilroghter	SAC (000297) - Lough Corrib	Galway
26	Cloghmoyne	SAC (000479) - Cloughmoyne	Galway
27	Inishmore	SAC (000213) - Inishmore Island	Galway
29/47*	Ballydotia	Not designated	Galway
31	Mullagh	Not designated	Limerick
32	Mountscribe	Not designated	Galway
33	Carrownamaddra	Not designated	Galway
34	Tooreen East	Not designated	Galway
35	Cartron	Not designated	Galway
37	Shanclogh	Not designated	Galway
39	Moymore	Not designated	Clare
40	Coolteige	Not designated	Roscommon
42	Menlough	Not designated	Galway
43	Cregboy	Not designated	Galway
44	Creevagh	Not designated	Mayo
45	Kildun More	Not designated	Mayo
46	Glasgort	Not designated	Mayo

* Sites surveyed as both monitoring and potential NHA sites

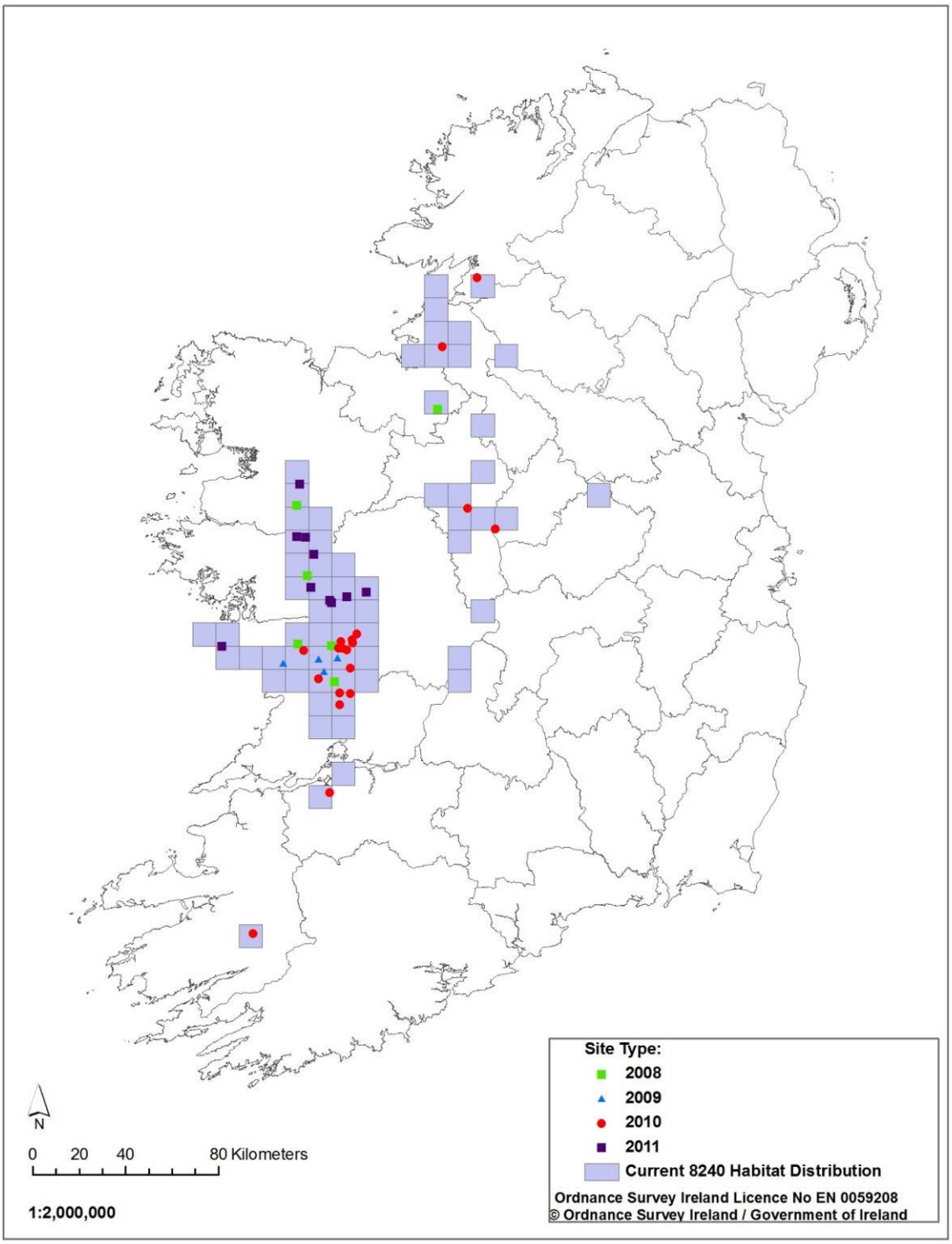

Figure 3 Location of PSLP and NSLP sites and year they were surveyed.

MONITORING SURVEY

For the monitoring survey, 20 sites were chosen for survey, bringing the total to 26 monitoring sites for limestone pavement and associated habitats in Ireland (six were surveyed during the pilot survey,

see Murphy & Fernández (2009) for further details). Sites were selected in counties Clare, Donegal, Galway, Kerry, Mayo, Roscommon and Sligo. See Table 9 above and Appendix 8 for further information. The majority of the monitoring sites had some form of designation (e.g. SAC, NHA); however, those sites that were surveyed as both monitoring and potential NHA sites (i.e. NSLP 19/36, 20/38, 23/41 and 29/47) had no form of legal protection. A total of 135 plots and 294 relevés were recorded during the survey. This gave an average of 5.2 plots and 11.3 relevés per monitoring site. Approximately 270 species were recorded in the relevés during the monitoring survey; approximately 360 species were recorded for both monitoring and potential NHA sites (relevés and site species lists). The altitudinal range of the surveyed areas spanned from 5m at NSLP01 (Murrooghtoohy North West-Burren) to 430m at NSLP14 (Sramore, Co. Leitrim). The overall extent of limestone pavement and associated habitats surveyed was 145 ha for the monitoring survey, although the sites were much larger than this. See Appendix 10 for an example of NSLP monitoring site and plot habitat maps (EU Annex I and Fossitt).

Four main habitats types were surveyed and recorded according to Fossitt (2000); Limestone pavement, (exposed) (133 relevés) grassland (72 relevés), heath (74 relevés), and limestone pavement (wooded) (13 relevés). One fen (PF1), one turlough (FL6) and five wet grassland (GS4) relevés were also recorded. An additional sub category of HH2, namely HH2Dryas, was developed to accommodate those relevés which were classified as Alpine and Boreal heaths (4060) and which did not appear to fit in to any other Fossitt category. Table 10 gives a summary of these results.

Table 10 Fossitt (2000) classification of relevés recorded for both monitoring and potential NHA sites.

Fossitt Habitat	Number of relevé monitoring survey	Number of relevé potential NHA Survey	Total relevé
ER2	133	17	150
FL6	1	0	1
GS1	67	27	94
GS4	5	1	6
HH2	55	7	62
HH2Dryas	19	0	19
PF1	1	0	1
WN2	10	12	22
WN3	1	0	1
WS1	2	0	2
Total			**358**

Eight main habitats were surveyed according to the EU Annex I Habitat classification; 166 Limestone pavement (8240) relevés, 92 *Festuco-Brometalia* (6210/11) relevés, 62 European dry heath (4030) relevés, 19 Alpine and boreal heath (4060) relevés, five *Molinia* meadows (6410) relevés, one Alkaline fen

(7230) relevé, one Turlough (3180) relevé and one *Taxus baccata* woodland relevé. The remaining 12 relevés had no significant correspondence with an EU Annex Habitat. Table 11 gives a summary of the results.

Table 11 EU Annex I Habitat classification.of relevés recorded for both monitoring and potential NHA sites.

EU Annex I Habitat Classification	Number of relevé monitoring survey	Number of relevé potential NHA survey	Total relevé
3180	1	0	1
4030	55	7	62
4060	19	0	19
6210	65	27	92
6410	3	1	4
7230	1	0	1
8240	137	29	166
91J0	1	0	1
No significant correspondance	12	0	12
Total	2	0	358

Habitat mapping

National Limestone pavement distribution map

An updated national limestone pavement and associated habitats (e.g. grassland, heath, scrub and woodland) map was produced in shape file format (Figure 4). The updated national map indicates that the national extent of limestone pavement and associated habitats is 32,187ha. This figure is smaller than the previously estimate in 2007 of 36,000ha. The reduction in the extent is the result of more accurate mapping, rather than actual loss of habitat. The updated map features a total of 490 new polygons (areas) not previously reported in the 2007 map. This included 10 potential 8240 habitat polygons, with an overall extent of 2.46ha from the Mapping of Habitats in County Roscommon Report (Heritage Council 2011). These polygons correspond with areas classified as having "Low" certainty of corresponding with 8240 habitat.

A total of 1,365 polygons were mapped and their extent varies from 0.05ha to 3,374ha. The updated map features 490 new polygons with a total extent of 1,595ha not previously reported in the 2007 map. 724 of the polygons are not designated. The average size of the non-designated polygons is 7.78ha. This is much smaller than the average size of designated polygons (41.43ha).

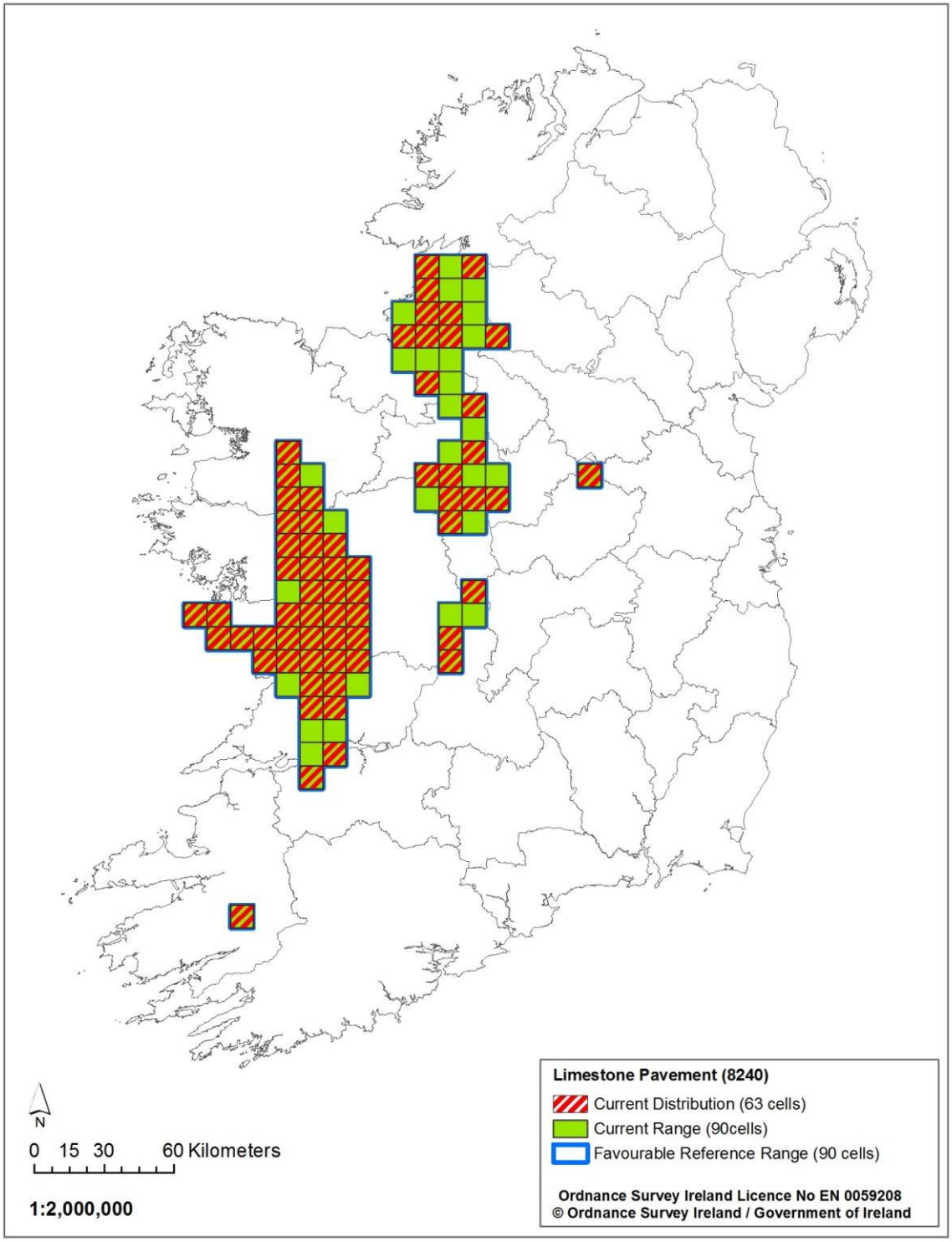

Figure 4 Current distribution and range of Limestone pavement in Ireland, from the revised National Limestone Pavement habitat distribution map.

Approximately 82.69% (26,557ha) of the national resource is located within an SAC or NHA and the remaining 17.31% (5,630ha) is not designated (this includes 57ha within pNHAs). County Clare has the highest extent of limestone pavement and associated habitats in the country (24,128ha), followed

by county Galway (6,761ha). The extent of the habitat designated within county Galway (64.46%) is considerable smaller than county Clare (88.68%). See Table 12 below for details, further details can be found in Appendix 11. A total of 34 SACs (26,530ha), one NHA (26ha) and 39 pNHAs (57ha) have been identified as containing limestone pavement and associated habitat (Table 12), giving a total area of 26,557ha. Some sites were designated as both SAC and pNHA.

Table 12 The distribution of Limestone pavement and associated habitats in Ireland.

County	Extent (ha)	Extent designated SACs and NHAs (ha)	% designated
Cavan	35	13	37.14
Clare	24,128	21,397	88.68
Donegal	69	38	55.07
Galway	6,761	4,358	64.46
Kerry	39	39	100
Leitrim	134	46	34.33
Limerick	27	0	0
Longford	3	2	66.67
Mayo	707	468	66.20
Offaly	40	38	95
Roscommon	64	2	3.13
Sligo	174	151	86.78
Tipperary	5	4	80
Westmeath	1	1	100
Total	32,187	26,557	82.69

Table 13 Sites containing Limestone pavement and associated habitats.

Designation	Other designation	Site Code	Site Name	SAC 8240 qualifying interest
	pNHA	000011	Lough Derg	
SAC	pNHA	000016	Ballycullinan Lake	No
SAC	pNHA	000019	Ballyogan Lough	No
SAC	pNHA	000020	Black Head-Poulsallagh Complex	Yes
SAC	pNHA	000032	Dromore Woods and Loughs	Yes
SAC	pNHA	000054	Moneen Mountain	Yes
SAC	pNHA	000057	Moyree River System	Yes
	pNHA	000071	Turloughnagullaun	
SAC	pNHA	000115	Ballintra	Yes
SAC	pNHA	000191	St. John's Point	Yes
SAC	pNHA	000212	Inishmaan Island	Yes
SAC	pNHA	000213	Inishmore Island	Yes
SAC		000216	River Shannon Callows	Yes
SAC	pNHA	000238	Caherglassaun Turlough	No
SAC	pNHA	000242	Castletaylor Complex	Yes
SAC	pNHA	000252	Coole-Garryland Complex	Yes
SAC	pNHA	000268	Galway Bay Complex	No
SAC	pNHA	000297	Lough Corrib	Yes
SAC	SPA	000322	Rahasane Turlough	
SAC	pNHA	000365	Killarney National Park	No
SAC	pNHA	000440	Lough Ree	Yes
SAC	pNHA	000479	Cloughmoyne	Yes
SAC	pNHA	000606	Lough Fingall Complex	Yes
SAC	pNHA	000612	Mullygollan Turlough	No
SAC	pNHA	000623	Ben Bulben,Gleniff and Glenade Complex	No
	pNHA	000681	Hill of Mael and The Rock of Curry	
SAC	pNHA	000894	Clorhane Wood	
SAC	pNHA	000979	Corratirrim	Yes
SAC	pNHA	000996	Ballyvaughan Turlough	No
SAC	pNHA	001271	Gortnandarragh Limestone Pavements	Yes
SAC	pNHA	001275	Inisheer Island	Yes
	pNHA	001288	Knockmaa Hill	
SAC	pNHA	001403	Arroo Mountain	No
	pNHA	001421	Sheemore Wood	
SAC	pNHA	001626	Annaghmore Lough	No
SAC	pNHA	001656	Bricklieve Mounttains and Keishcorran	No
	pNHA	001670	Knocknarea Mountain and Glen	
SAC	pNHA	001774	Lough Carra, Mask Complex	Yes
SAC	pNHA	001926	East Burren Complex	Yes
	pNHA	002068	Carricknahorna Lough and Lough Gorman	
SAC		002241	Lough Derg, North-East Shore	Yes
SAC		002244	Ardrahan Grassland	Yes
SAC		002294	Cahermore Turlough	No
NHA		002435	Crockauns, Keelogyboy Bogs	

According to Table 13, 22 of the SACs containing limestone pavement and associated habitats, have the habitat listed as a qualifying interest. The extent of the habitat within these 22 SACs is 25,932ha. Barrigone SAC (000432) is listed as having habitat 8240 as a qualifying interest; however, the site was considered to contain rocky outcrops rather than limestone pavement. Therefore, it was not listed in Table 13. There are 12 SACs within which limestone pavement is likely to be present but for which 8240 is not a qualifying interest. Therefore, despite the limestone pavement being within an SAC, it is not given full legal protection. The extent of the habitat within these 12 SACs is 598ha. Overall 97.65% (25,932ha) of the habitat within designated sites is given full protection as the habitat is a qualifying interest for the SAC. The remaining 2.35% (624ha) is not given full protection despite being within a SAC (598ha) where the habitat is not a qualifying interest, or NHA (26ha).

National Limestone pavement distribution, range and favourable reference range maps

The 10km distribution and range map for limestone pavement from 2007 were revised. The new map is slightly different than the one reported in 2007. A total of 63 10km grid cells (6,300km^2) are considered to intersect areas potentially containing habitat 8240, versus the 60 cells reported in 2007. Some cells (e.g. R25) are considered not to contain habitat 8240 whereas other cells (e.g. M18) are now thought to contain the habitat. These changes are due to an improvement of the 10km grid habitat distribution map, as a result of improved knowledge, rather than any actual change in extent (e.g. losses). The habitat range has also changed in distribution and its value differs to the one reported in 2007 which was 7,400km^2 (74 10km cells). The current range value is 9, 000km^2 (90 10km cells). The favourable reference range value is equal to the current range (9,000km^2) as there is no evidence of a decline in range since the Directive came into force. This new figure for range was calculated based on the IT Tool version 10.0 (30/08/2012) generated by European Topic Centre on Biological Diversity. Therefore the variation in both current and favourable range is due to the method used to calculate the range rather than any actual change in habitat range.

Mapping of habitats within potential NHA sites

Table 14 shows the total extent of each EU Annex I habitat mapped within potential NHA sites. The figures shows that approximately 39% of the areas mapped are habitats with no significant correspondence (NSC) with EU Annex I habitats. Calcareous grasslands (6210) are the most common habitats within the potential NHA surveyed, followed by wooded limestone pavement (10.62%) in a mosaic with other non EU habitats and (8240) exposed limestone pavement (6.67%).

Table 14 Mapped extent of Annex I habitat within potential NHA sites.

Annex Code	Area (ha)	%
No significant correspondence (NSC)	617.96	39.2
6210	163.79	10.39
8240(wooded)/NSC	159.94	10.14
8240(exposed)	103.55	6.57
8240(exposed)/NSC	91.9	5.83
6210/NSC	62.6	3.97
8240(exposed)/8240(wooded)/NSC	52.39	3.32
8240(exposed)/6210	38.16	2.42
8240(exposed)/6210/4030	35.46	2.25
8240(exposed)/8240(wooded)/4030	25.81	1.64
3180	25.66	1.63
4030	21.24	1.35
8240(wooded)	20.67	1.31
7130 and 7130/NSC	19.79	1.26
6210/4030/NSC	17.5	1.11
8240(exposed)/Unknown	17.26	1.09
8240(exposed)/6410/4030(5130)	15.01	0.95
Unknown	13.97	0.89
8240(exposed)/6210/NSC	11.43	0.72
8240(exposed)/4030/NSC	10.92	0.69
6410 and 6410/NSC	10.05	0.63
8240(exposed)/8240(wooded)	9.22	0.59
7210 and 7210/NSC	6.74	0.42
8240(exposed)/4030	6.06	0.38
6210(5130)/NSC	4.51	0.29
4030(5130)	3.25	0.21
8240(exposed)/6210/4030/NSC	3.07	0.19
8240(exposed)/8240(wooded)/4030/NSC	2.96	0.19
7130/4010	2.51	0.16
8240(exposed)/4030(5130)	2.02	0.13
4030/NSC	0.95	0.06
4010	0.23	0.01
Total	1576.57	

Mapping of habitats within monitoring sites

A shapefile format map showing all habitats recorded within the field survey monitoring plots from 2008 (PSLP) to 2011 was generated. Table 15 shows the total extent of each EU Annex I habitat mapped within monitoring sites. The figures shows that more than 46% of the areas mapped were exposed limestone pavement. The next largest representation of habitats recorded was calcareous grassland (9.88%), followed by habitats with no significant correspondence with any EU habitat (9.14%) and calcareous grassland and exposed limestone pavement mosaic (6.99%).

Table 15 Extent of Annex I habitat within monitoring sites.

Annex Code	Area (ha)	%
8240 (exposed)	67	46.21
6210	14.33	9.88
NSC	13.25	9.14
6210/8240 (exposed)	10.14	6.99
4030	9.46	6.52
8240 (exposed)/4030	5.95	4.1
8240 (exposed)/NSC	5.93	4.09
4060	4.44	3.06
8240 (wooded)	2.41	1.66
7230	1.94	1.34
8240 (exposed)/4060	1.94	1.34
8240 (exposed)(5130)	1.34	0.93
4030/NSC	1.28	0.88
6210/NSC	1.13	0.78
8240 (exposed)/6210 (5130)	1.1	0.76
4030 (5130)	0.89	0.62
6410	0.85	0.59
7130	0.73	0.5
8240 (exposed)/4030/NSC	0.31	0.22
8240 (exposed)/6210/NSC	0.29	0.2
3180	0.2	0.14
8240 (exposed)/4030 (5130)	0.11	0.08
6210/4030	0.11	0.07
8240 (exposed)/4030/6210	0.02	0.01
Total	**145**	

Vegetation data analysis

Cluster Analysis and Indicator Species Analysis

The initial Cluster Analysis of 558 relevés and 266 species revealed 3 main groups; Limestone pavement (exposed), limestone pavement (wooded) and a large grassland/heath group. This level of grouping was decided on after analysing the resulting dendrogram and based on expert judgement. Some manual relocation of relevés was conducted to improve ecological integrity and outliers were removed. This resulted in a limestone pavement (exposed) group containing 142 relevés, a limestone pavement (wooded) group containing 21 relevés and a grassland/heath group (including 198 relevés from Parr *et al.* 2009) containing 375 relevés. These three groups were further analysed using Cluster Analysis and subsequently Indicator Species Analysis. Hence, each of the three groups was divided

into a number of sub-groups or vegetation types. This resulted in a total of 21 vegetation types; five limestone pavement (exposed), two limestone pavement (wooded) and 14 grassland/heath vegetation types (grouped into five sub-groups).

The vegetation types were generally named after the best indicator species in the sub-group. However, however some variation from this rule was needed in cases where strong indicator species were not found. Indicator Species Analysis (ISA) was used as a means of choosing an optimum number of groups (vegetation types) from the Cluster Analysis results but it must be mentioned that it was only used as a guide and expert judgement was used in the final selection of vegetation types. Indicator Species Analysis showed peaks at the following grouping levels; Limestone pavement exposed: two or five groups, limestone pavement wooded: two groups, grassland heath: two or 14 groups. Table 16, 17 and 18 summarise the Cluster Analysis and Indicator Species Analysis results for each of the three main habitat groupings.

Table 16 Vegetation type and number of relevés determined by (ISA) for limestone pavement (exposed)

Group ID	Vegetation type	Number of relevés
1a	*Phyllitis scolopendrium - Hedera helix* pavement	21
1b	*Teucrium scorodonia - Sesleria caerulea* pavement	54
1c	*Prunus spinosa - Rubus fruticosus* pavement	28
1d	*Mycelis muralis - Fissidens dubius* pavement	17
1e	*Corylus avellana - Neckera crispa* pavement	22
	Total	142

Table 17 Vegetation type and number of relevés determined by (ISA) for limestone pavement (wooded)

Group ID	Vegetation type	Number of relevés
2a	*Corylus avellana - Ctenidium molluscum* low woodland	14
2b	*Fraxinus excelsior - Plagiomium undulatum* woodland	7
	Total	21

Table 18 Vegetation type and number of relevés determined by (ISA) for grassland and heath (including Parr *et al.* (2009) data

Group ID	Vegetation type	Number of relevés	Group Total
3	***Holcus lanatus-Trifolium repens Grassland Group***		50
3a	*Cynosurus cristatus - Leucanthemum vulgare* grassland	26	
3b	*Dactylis glomerata-Achillea millefolium* grassland	7	
3c	*Holcus lanatus - Anthoxanthum odoratum* grassland	4	
3d	*Arrhenatherum elatius – Rumex acetosa* grassland	13	
4	***Festuca ovina/rubra - Succisa pratensis Heath/Grassland Group***		105
4a	*Erica cinerea - Juniperus communis* heath	37	
4b	*Anthoxanthum odoratum - Succisa pratensis* grassland	36	
4c	*Festuca ovina/rubra - Plantago lanceolata* grassland	32	
5	***Dryas octopetala Heath Group***		40
5a	*Dryas octopetala - Empetrum nigrum* heath	40	
6	***Sesleria caerulea - Thymus polytrichus Grassland Group***		98
6a	*Sesleria caerulea - Dicranum scoparium* grassland	25	
6b	*Sesleria caerulea - Anthyllis vulneraria* grassland	19	
6c	*Sesleria caerulea- Thymus polytrichus* grassland	34	
6d	*Sesleria caerulea - Plantago maritima* grassland	20	
7	***Calluna Heath Group***		82
7a	*Calluna vulgaris-Potentilla erecta* heath	55	
7b	*Calluna vulgaris-Molinia caerulea* heath	27	
	Total		375

Non-metric Multidimensional Scaling

The Non-metric Multi-dimensional Scaling (NMS) ordination found a 2-dimensional solution for the exposed limestone pavement group and a 2-dimensional solution for the grassland/heath group. Stress on the solutions were 28.36 and 24.46 respectively. According to McCune & Grace (2002) these stress values are quite high. However, they are comparable to those found in similar studies (Martin *et al.* 2007, Perrin *et al.* 2008 and Cooper *et al.* 2012). For the exposed limestone pavement group Axis 1 (r^2=0.180) and Axis 2 (r^2=0.357) together cover 53.7% of the variance in the distance matrix. For the grassland/heath group Axis 1 (r^2=0.251) and Axis 2 (r^2=0.428) together cover 68% of the variance in the distance matrix. The wooded limestone group is not graphed below as it did not form any distinct groupings in ordination space, due to the similarity between samples in the group and also small sample size (N=21). The scatter plots for the exposed limestone pavement and grassland/heath groups are shown in Figures 5 and 6 respectively. The groups which were identified in Non-metric Multi-dimensional Scaling were in general agreement with the cluster results of the Indicator Species Analysis.

The 2-dimensional NMS ordination plot for exposed limestone pavement (Figure 5) illustrates relevés falling into groups according to vegetation types, which is in agreement with the Cluster Analysis solution. Each of the five main exposed limestone pavement vegetation types (as detailed in Table 16) is represented by a different colour on the scatter plot. Axis 1 primarily represents limestone pavement with deeper wider grikes (i.e. blocky pavement) with relevés from the *Phyllitis scolopendrium – Hedera helix* vegetation type positioned at the higher end of the axis and mostly relevés from the *Teucrium scorodonia – Sesleria caerulea* vegetation type positioned at the lower end of the axis. Axis 2 primarily represents vegetation cover, with relevés from the *Corylus avellana – Neckera crispa* vegetation type at the higher end of the axis and *the Mycelis muralis – Fissidens dubius* vegetation type at the lower end of the axis.

Pearson and Kendall correlation coefficients express the linear and rank relationships between the ordination scores and the individual variables used to construct the ordination (McCune & Grace 2002). Pearson and Kendall correlation found that NMS axes were significantly correlated with various environmental variables; these variables are shown in the ordination plot. Axis 1 was most significantly negatively correlated with grike cover and grike depth and was most significantly positively correlated with grass cover, herb cover, litter cover and shrub cover. This emphasises the fact that in the majority of cases, there is very little vegetation present on the clint surface of limestone pavement with wide and deep grikes (i.e. blocky pavement). Axis 2 was most significantly positively correlated with moss cover, shrub cover, litter cover, low woody cover, grass cover and species diversity and was most significantly negatively correlated with bare rock and grike depth. This may reflect the high bryophyte cover that is associated with encroachment of Hazel on limestone pavement, with often very high cover of the moss species *Neckera crispa* occurring underneath individual Hazel shrubs. It also suggests that these more vegetated limestone pavement community types are more likely to occur on limestone pavement with less well-defined clints and grikes, i.e., shattered limestone pavement.

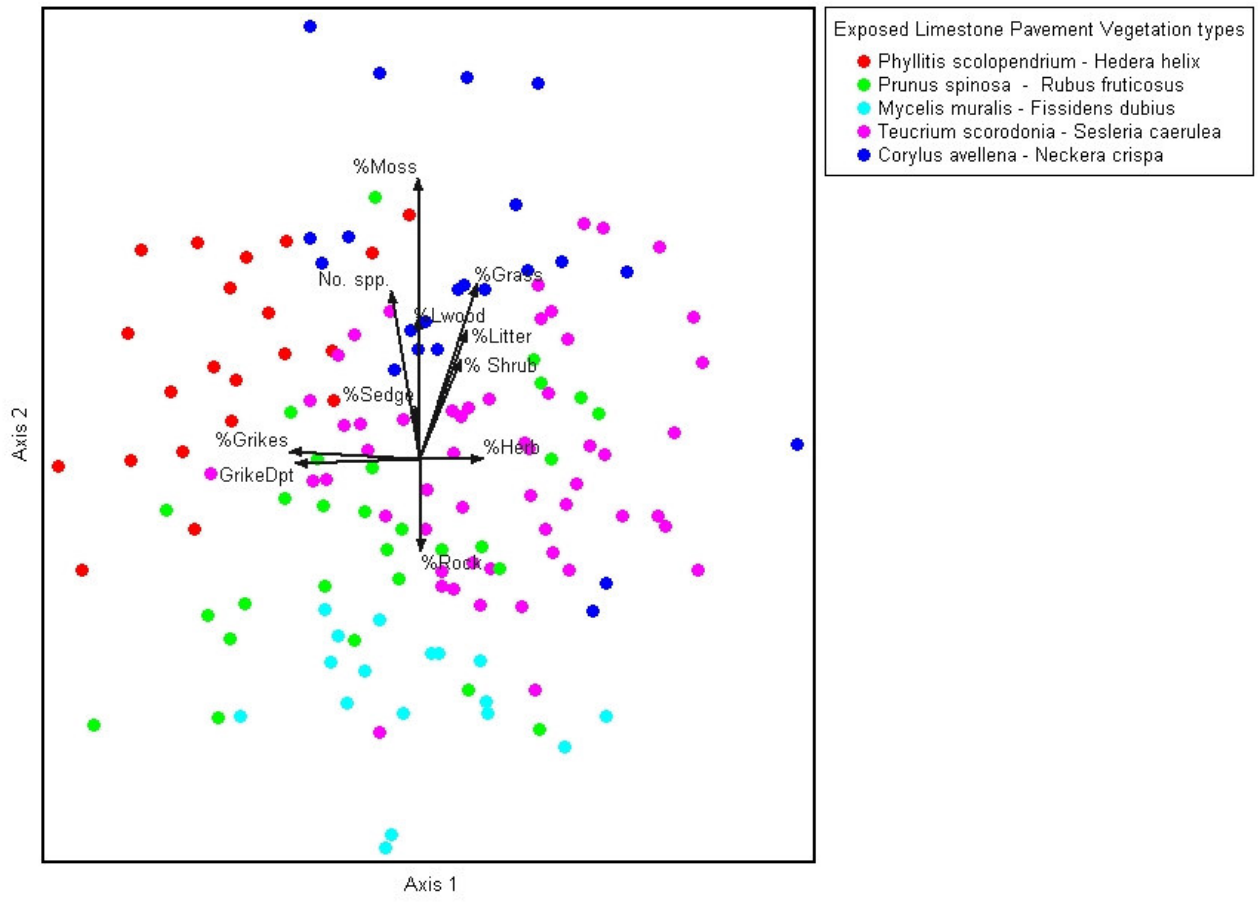

Figure 5: Non-metric Multidimensional Scaling ordination plot of 142 relevés. Direction of lines from origin shows Pearson correlation of environmental variables with axes. Length indicates strength of correlation. %Shrub = Shrub cover, No. spp. = Species diversity, %Lwood = Low woody cover, %Litter = Litter cover, %Moss = Bryophyte cover, %Grass = Grass Cover, % Sedge = Sedge Cover, %Shrub = Shrub cover, %Herb = Herb cover, %Rock = % Bare rock, %Grikes = Grike cover, GrikeDpt = Grike depth.

The 2-dimensional NMS ordination plot for the grassland/heath dataset (Figure 6) illustrates relevés falling into groups according to vegetation types and groups, which is in agreement with the Cluster Analysis solution. Each of the five main grassland/heath groups (as detailed in Table 18) is represented by a different colour on the scatter plot. Vegetation types within these groups are represented by different symbols. Axis 1 primarily represents a transition from grassland to heath communities with relevés from the *Cynosurus cristatus – Leucanthemum vulgare, Dactylis glomerata – Achillea millefolium* and *Holcus lanatus – Anthoxanthum odoratum* vegetation types at the lower end of the axis and mostly relevés from the *Dryas octopetala – Empetrum nigrum, Calluna vulgaris – Molinia caerulea,* and *Calluna vulgaris – Potentilla erecta* vegetation types positioned at the higher end of the axis. Axis 2 primarily represents soil depth with relevés from the *Cynosurus cristatus – Leucanthemum*

vulgare, Dactylis glomerata – Achillea millefolium, Holcus lanatus – Anthoxanthum odoratum, Calluna heath vegetation types at the higher end of the axis and the *Sesleria* grassland and *Dryas* heath relevés positioned at the lower end of the axis.

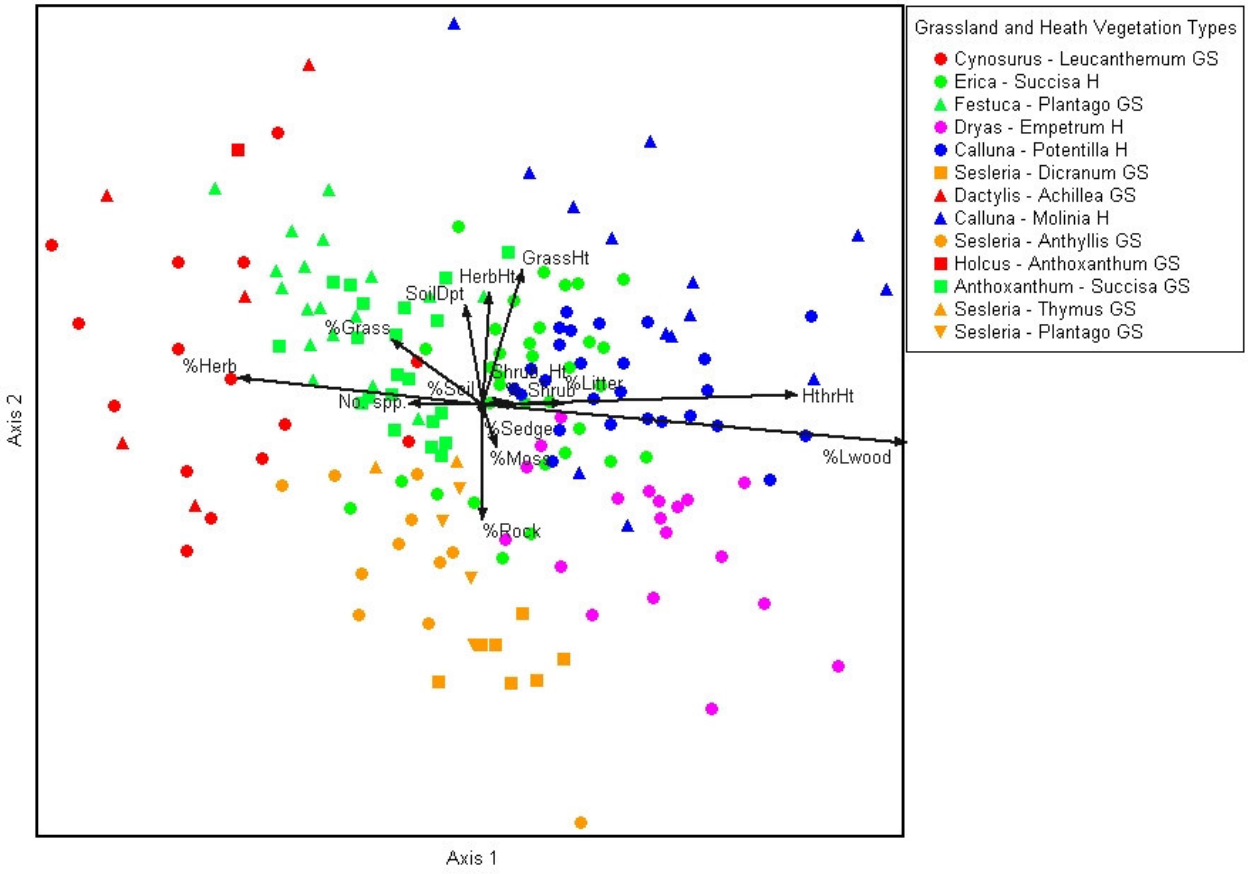

Figure 6: Non-metric Multi-dimensional Scaling ordination plot of 176 relevés. Direction of lines from origin shows Pearson correlation of environmental variables with axes. Length indicates strength of correlation. %Shrub = Shrub cover, ShrubHt = Shrub height, HthrHt = Heather height, No. spp. = Species Diversity, %Lwood = Low Woody cover, %Litter = Litter cover, %Moss = Bryophyte cover, %Grass = Grass cover, % Sedge = Sedge cover, %Shrub = Shrub cover, %Herb = Herb cover, %Rock = % Bare rock, % Soil = Bare ground cover and SoilDpt = Soil depth.

Pearson and Kendall correlation found that NMS axes were significantly correlated with various environmental variables; these variables are shown in the ordination plot. Axis 1 was most significantly positively correlated with grass height, herb height and soil depth and most significantly negatively correlated with cover of bare rock, low woody cover and bryophyte cover. This reflects the effect of varying soil depths on the vegetation, and shows that *Sesleria* grassland and *Dryas* heath communities are very much associated with areas of shallower soils than those associated with *Calluna*

heath and the more mesotrophic grasses dominated by species such as *Dactylis glomerata*, *Anthoxanthum odoratum, Holcus lanatus* and *Cynosurus cristatus*. Axis 2 was most significantly positively correlated with grass cover, herb cover and species diversity, and most significantly negatively correlated with cover of low woody species and heather height. This clearly emphasises the broad split between grassland and heath vegetation types.

Habitat classification

Below a classification is presented for the vegetation types that resulted from Cluster Analysis and Indicator Species Analysis (ISA). These habitats are listed and detailed in the order that they have been grouped by cluster and ISA. For each habitat group the significant indicator species is listed and a brief description of the habitat is given, as well as the topographical occurrence and geographical distribution where possible. These indicator species have been used to supplement the 'Conservation Status Assessment' indicator species lists for EU habitats in Ireland (Appendix 5). Confusion tables (Table 19 and 20) are used to compare the habitat groups resulting from Indicator Species Analysis with previously described classifications, such as EU Annex I Habitats, and Fossitt (2000) Habitats. Parr *et al*. (2009) relevés were not included in these confusion tables.

Table 19 Relevés assigned to habitat types using hierarchical clustering with *a priori* assignment of relevés to Annex I habitat types. Figures are number of relevés. Parr *et al.* (2009) relevés are not included. Figures in italics are row and column totals.

Vegetation type	**8240**	**6410**	**6210**	**4060**	**4030**	**Total**
Phyllitis scolopendrium - Hedera helix pavement	21					*21*
Teucrium scorodonia - Sesleria caerulea pavement	54					*54*
Prunus spinosa - Rubus fruticosus pavement	28					*28*
Mycelis muralis - Fissidens dubius pavement	17					*17*
Corylus avellana - Neckera crispa pavement	22					*22*
Corylus avellana - Ctenidium molluscum low woodland	14					*14*
Fraxinus excelsior - Plagiomium undulatum woodland	*7*					*7*
Cynosurus cristatus - Leucanthemum vulgare grassland			15			*15*
Dactylis glomerata - Achillea millefolia grassland			5			*5*
Holcus lanatus - Anthoxanthum odoratum grassland			1			*1*
Arrhenatherum elatius - Rumex acetosa grassland						
Erica cinerea - Juniperus communis heath			8		25	*33*
Anthoxanthum odoratum - Succisa pratensis grassland			21			*21*
Festuca ovina/rubra - Plantago lanceolata grassland			18			*18*
Dryas octopetala - Empetrum nigrum heath				19		*19*
Sesleria caerulea - Dicranum scoparium grassland			7			*7*
Sesleria caerulea - Anthyllis vulneraria grassland			11			*11*
Sesleria caerulea - Thymus polytrichus grassland			2			*2*
Sesleria caerulea - Plantago maritima grassland			4			*4*
Calluna vulgaris - Potentilla erecta heath					26	*26*
Calluna vulgaris - Molinia caerulea heath		4			10	*14*
Total	***163***	***4***	***92***	***19***	***61***	**339**

The vegetation types that resulted from the Cluster Analysis fall into four main EU Annex I Habitats; Limestone pavements (8240), *Festuco-Brometalia* (6210), Alpine and Boreal heaths (4060) and European dry heaths (4030), with the exception of four relevés which were classified as *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), (6410). Two of the vegetation types consisted of relevés from two different EU Annex I Habitats; the *Erica cinerea - Juniperus communis* heath vegetation type contained relevés from 6210 and 4030 and the *Calluna vulgaris-Molinia caerulea* heath vegetation type contained relevés from 6410 and 4030.

Table 20 Relevés assigned to habitat types using hierarchical clustering with *a priori* assignment of relevés to Fossitt (2000) habitat types. Figures are number of relevés. Figures in italics are row and column totals.

Vegetation type	ER2	GS1	GS4	HH2	HH2 Dryas	WN2	Total
Phyllitis scolopendrium - Hedera helix pavement	21						*21*
Teucrium scorodonia - Sesleria caerulea pavement	54						*54*
Prunus spinosa - Rubus fruticosus pavement	28						*28*
Mycelis muralis - Fissidens dubius pavement	17						*17*
Corylus avellana - Neckera crispa pavement	22						*22*
Corylus avellana - Ctenidium molluscum low woodland						14	*14*
Fraxinus excelsior - Plagiomium undulatum woodland						7	*7*
Cynosurus cristatus - Leucanthemum vulgare grassland		15					*15*
Dactylis glomerata - Achillea millefolia grassland		5					*5*
Holcus lanatus - Anthoxanthum odoratum grassland		1					*1*
Arrhenatherum elatius - Rumex acetosa grassland							
Erica cinerea - Juniperus communis heath		8		25			*33*
Anthoxanthum odoratum - Succisa pratensis grassland		21					*21*
Festuca ovina/rubra - Plantago lanceolata grassland		18					*18*
Dryas octopetala - Empetrum nigrum heath					19		*19*
Sesleria caerulea - Dicranum scoparium grassland		7					*7*
Sesleria caerulea - Anthyllis vulneraria grassland		11					*11*
Sesleria caerulea - Thymus polytrichus grassland		2					*2*
Sesleria caerulea - Plantago maritima grassland		4					*4*
Calluna vulgaris - Potentilla erecta heath				26			*26*
Calluna vulgaris - Molinia caerulea heath			4	10			*14*
Total	***142***	***92***	***4***	***61***	***19***	***21***	***339***

The vegetation types that resulted from the Cluster Analysis fall into four main Fossitt (2000) Habitats; Exposed calcareous rock (ER2), Dry calcareous and neutral grassland (GS1), Dry calcareous heath (HH2), and Oak-ash-hazel woodland (WN2), with the exception of four relevés which were classified as wet grassland (GS4). An additional sub category of HH2, namely HH2Dryas was developed to accommodate those relevés which were classified as Alpine and Boreal heaths (4060) and which did not appear to fit in to any other Fossitt category. Two of the vegetation types consisted of relevés from two different Fossitt habitats; the *Erica cinerea - Juniperus communis* heath vegetation type contained relevés from GS1 and HH2, the *Calluna vulgaris-Molinia caerulea* heath vegetation type contained relevés from GS4 and HH2.

A synoptic table for each habitat group or sub-group is presented below. Frequency and abundance data are given for the occurrence of each species in each habitat type. Frequency is indicated by Roman numerals, where I = 0.1 – 20.0%, II = 20.1 – 40.0%, III = 40.1 – 60.0%, IV = 60.1 – 80.0% and V = 80.1 – 100%. Species with highest frequencies in the group (constant species with frequency greater

than 60%) are listed first, and are in bold. Significant indicators species for each group are denoted by asterisks, with the indicator value score being indicated by the number of asterisks, such that: * = 0.1 – 20.0%, ** = 20.1 – 40.0%, *** = 40.1 – 60.0%, **** = 60.1 – 80.0% and ***** = 80.1 – 100%. Species with only one asterisk are poor indicators. These indicator values may be a result of small sample size and should not be considered reliable indicators. The remaining species in the list are those that have occurred in the habitat type but that don't have any significant affinities with the habitat type; they generally occur in the habitat at low frequencies. These companion species are divided into the following groups; woody, herbs, grasses/rushes/sedges, orchids, ferns and bryophytes/lichens, and are ordered by frequency within these groups.

Brief accounts of the vegetation types are given after each of the three main groups, i.e. Limestone pavement (exposed), limestone pavement (wooded) and Grassland/Heath. Examples of sites where these vegetation types can be found, as well as affinities with other classification systems such as Fossitt (2000), NVC (Rodwell *et al*. 2000) and EU Annex I Habitats are given. For the limestone pavement vegetation types, affinities are given for the group as a whole, not to individual vegetation types. It must be noted that comparisons with the NVC classification are tentative at best and were not formed based on analysis with vegetation comparison software; Limestone pavement is frequently described as 'not fitting the NVC' (Rodwell *et al.* 2000). Comparisons with other vegetation classification studies, such as Perrin *et al.* (2008), Parr *et al.* (2009), O'Neill *et al.* (2010) and Willis (2011) are also be given where appropriate. A summary of the grassland and heath classification by Parr *et al*. (2009), and the limestone pavement (wooded and exposed) classification by Willis (2011) are given in Appendix 1 for reference.

Group 1 Exposed Limestone pavement

Five vegetation types are present in the exposed limestone pavement group. Each of these vegetation types is described below. Constant species for this group are *Geranium robertianum, Sesleria caerulea, Asplenium ruta-muraria, Tortella tortuosa, Fissidens dubius,* and *Teucrium scorodonia.* This group is characterised by limetone pavement (exposed), in both shattered and blocky forms.

This group has affinities with the Annex I Habitat 8240 – Limestone pavements and the Hertiage Council (Fossitt 2000) ER2 – exposed calcareous rock classification. This group also has affinities with the NVC (Rodwell *et al.* 2000) classifications OV38, OV39 as well as OV40 (Table 21). This vegetation type also shows affinities with Group 1, 3, 6 and 7 of the Willis (2011) classification of limestone pavement in the UK (Appendix 1).

Table 21 Relevant vegetation community affinities for the Exposed Limestone Pavement Group.

Classification	Relevant Affinities
EU Annex I:	8240 – Limestone Pavements
Fossitt:	ER2 – Exposed calcareous rock
NVC:	OV38 – *Gymnocarpium robertianum-Arrhenatherum elatius* community
	OV39 – *Asplenium trichomanes – A.ruta-muraria* community
	OV40 – *Asplenium viride – Cystopteris fragilis* community

VEGETATION TYPE 1A *PHYLLITIS SCOLOPENDRIUM - HEDERA HELIX* PAVEMENT

Indicator species: *Geranium robertianum, Phyllitis scolopendrium, Hedera helix, Festuca ovina/rubra, Carex flacca, Geranium sanguineum, Thamnobryum alopecurum, Succisa pratensis.*

Description: Constant species in this group include *Geranium robertianum, Sesleria caerulea, Asplenium ruta-muraria, Tortella tortuosa, Fissidens dubius, Teucrium scorodonia, Phyllitis scolopendrium, Hedera helix and Festuca ovina/rubra.* This vegetation type was found in seven sites and contained a total of 21 relevés. All of these sites were situated in the Burren. All of the relevés in this group (except one) were made up of blocky limestone pavement. The average depth of the deepest grike was 88cm. These relevés also grouped together in ordination space (Figure 5). This vegetation type is characterised by limestone pavement with well-defined clints and grikes. Grikes are generally wide and deep with little vegetation growing on the clint surface. Where there isn't sufficient soil cover present, plants are restricted to the grikes. Typical species in these fissures include *Brachypodium sylvaticum, Thalictrum minus, Eupatorium cannabinum, Hypericum androsaemum,* and the bryophytes *Breutelia chrysocoma, Plagiomnium undulatum*, *Homalothecium sericeum* and *Conocephalum conicum*. This vegetation type contained, on average, a higher number of species per relevé than the other types (22 species). A full list of species for the vegetation type is given in Table 22 (synoptic). Affinities with the group as a whole are given in Table 21 above and a summary of these and other comparable vegetation types/groups is given in Appendix 1. Plate 4 shows an example of the vegetation type.

Plate 4 *Phyllitis scolopendrium - Hedera helix* vegetation type, at Shesymore, Co. Clare (NSLP21).

VEGETATION TYPE 1B *TEUCRIUM SCORODONIA - SESLERIA CAERULEA* PAVEMENT

Indicator species: *Sesleria caerulea, Teucrium scorodonia.*

Description: Constant species in this group include *Geranium robertianum, Sesleria caerulea, Asplenium ruta-muraria, Tortella tortuosa, Fissidens dubius, Teucrium scorodonia, Mycelis muralis, Corylus avellana, Neckera crispa* and *Thymus polytrichus.* This vegetation type was found in 23 sites and contained a total of 54 relevés. Therefore this vegetation type was ubiquitous throughout the NSLP sites. The average depth of the deepest grike recorded for this vegetation type was 57cm. The average number of species per relevé for this vegetation type was 18; just below the group average of 19. A full list of species for the habitat is given in Table 22 (synoptic). Affinities with the group as a whole are given in Table 21 above and a summary of these and other comparable vegetation types/groups is given in Appendix 1. According to the NMS results, the relevés in this community are found at the higher end of Axis 1 (Figure 5), suggesting a vegetation type that occurs on shattered rather than blocky limestone pavement. Plate 5 shows an example of the vegetation type.

Plate 5 *Teucrium scorodonia - Sesleria caerulea* vegetation type at Murrooghtoohy North, Co. Clare (NSLP01).

VEGETATION TYPE 1C *PRUNUS SPINOSA - RUBUS FRUTICOSUS* PAVEMENT

Indicator species: *Prunus spinosa, Rubus fruticosus, Lotus corniculatus, Euonymous europaeus.*

Description: Constant species for this vegetation type include *Geranium robertianum, Sesleria caerulea, Asplenium ruta-muraria, Tortella tortuosa, Fissidens dubius, Teucrium scorodonia, Prunus spinosa* and *Mycelis muralis.* This vegetation type contained a total of 28 relevés and was found in 13 sites. The majority of these sites were situated in 'mainland' county Galway, with only three of these sites situated in county Clare and the remaining site on Inishmore. The average depth of the deepest grike recorded for this vegetation type was 60cm. The average number of species per relevé for this vegetation type was 19, which was the same as the group average. A full list of species for the habitat is given in Table 22 (synoptic). Affinities with the group as a whole are given in Table 21 and a summary of these and other comparable vegetation types/groups is given in Appendix 1. Plate 6 shows an example of the vegetation type.

Plate 6 *Prunus spinosa – Rubus fruticosus* vegetation type at Shanclogh, Co. Galway (NSLP37).

VEGETATION TYPE 1D *MYCELIS MURALIS - FISSIDENS DUBIUS* PAVEMENT

Indicator species: *Fissidens dubius, Mycelis muralis.*

Description: Constant species in this vegetation type include *Geranium robertianum, Sesleria caerulea, Asplenium ruta-muraria, Tortella tortuosa, Fissidens dubius, Teucrium scorodonia, Mycelis muralis* and *Senecio jacobea.* This vegetation type contained a total of 17 relevés and was found in 13 sites. These sites were spread across counties Clare, Galway and Mayo. The majority of the relevés in this vegetation type were made up of blocky limestone pavement. However, the vegetation type also contains relevés recorded on shattered limestone pavement. This vegetation type is characterised by limestone pavement with well-defined clints and grikes. The average depth of the deepest grike was 74cm. Although this vegetation type also appears to be a 'blocky' limestone pavement type, the average number of species is much lower than that in group 1a, (13 compared to 22 species). This vegetation type may be a less species-rich type of group 1a. A full list of species for the vegetation type is given in Table 22 (synoptic). Affinities with the group as a whole are given in Table 21 and a summary of these and other comparable vegetation types/groups is given in Appendix 1. Plate 7 shows an example of the vegetation type. This community appears to be sparsely vegetated; this is backed up by the NMS analysis, which shows that this group of relevés cluster at the lower end of Axis 2 which is strongly correlated with bare rock cover (Figure 5).

Plate 7 *Mycelis muralis - Fissidens dubius* vegetation type at Abbey East, Co. Clare (NSLP04).

VEGETATION TYPE 1E *CORYLUS AVELLANA-NECKERA CRISPA* PAVEMENT

Indicator species: *Corylus avellana, Neckera crispa, Ctenidium molluscum, Tortella tortuosa, Pteridium aquilinum, Dicranum scoparium, Salix repens.*

Description: Constant species in this group include *Geranium robertianum, Sesleria caerulea, Asplenium ruta-muraria, Tortella tortuosa, Fissidens dubius, Teucrium scorodonia, Mycelis muralis, Hedera helix, Corylus avellana, Neckera crispa and Ctenidium molluscum.* This vegetation type was found in 13 sites and contained a total of 22 relevés. These sites were situated in counties Clare, Galway, Mayo, Longford, Donegal and Limerick. The vegetation type occurred on both shattered and blocky pavement and is characterised by limestone pavement with ill-defined clints and grikes, with vegetation growing on the clint surface. The depth of grikes (43cm) suggests that this vegetation type is more common on shattered pavement. It contained, on average 19 species per relevé, which is the same as the group average.

This pavement type may be a precursor to low woodland type 2a and suggests limestone pavement that is being encroached by scrub. A full list of species for the vegetation type is given in Table 22 (synoptic). Affinities with the group as a whole are given in Table 21 and a summary of these and other comparable vegetation types/groups is given in Appendix 1. Plate 8 shows an example of the vegetation type. This vegetation community is more vegetated than the other types in this group as

can be seen from the NMS scatterplot (Figure 5). The relevés from this vegetation type cluster at the higher end of Axis 2 which is strongly correlated with bryophyte, grass and low woody species cover.

Plate 8 *Corylus avellana - Neckera crispa* vegetation type at Aillwee, Co. Clare (NSLP07).

Table 22 Synoptic Table for the Exposed Limestone Pavement Habitat Group.

Exposed Limestone Pavement Group	***Phyllitis scolopendrium - Hedera helix* pavement**			***Teucrium scorodonia - Sesleria caerulea* pavement**			***Prunus spinosa - Rubus fruticosus* pavement**			***Mycelis muralis - Fissidens dubius* pavement**			***Corylus avellana - Neckera crispa* pavement**		
Constant Species															
Geranium robertianum	**V**	**30**	**	**V**	**19**		**V**	**17**		**V**	**14**		**V**	**20**	
Sesleria caerulea	**V**	**13**		**V**	**32**	**	**V**	**24**		**IV**	**3**		**IV**	**29**	
Asplenium ruta-muraria	**IV**	**17**		**V**	**23**		**V**	**19**		**V**	**21**		**V**	**21**	
Tortella tortuosa	**IV**	**18**		**IV**	**21**		**V**	**20**		**IV**	**13**		**V**	**28**	**
Fissidens dubius	**IV**	**16**		**IV**	**17**		**V**	**18**		**V**	**26**	**	**V**	**24**	
Teucrium scorodonia	**IV**	**10**		**V**	**40**	**	**V**	**14**		**V**	**19**		**IV**	**17**	
***Phyllitis scolopendrium - Hedera helix* vegetation type indicator species**															
Phyllitis scolopendrium	V	46	**	III	10		III	10		III	22		III	11	
Hedera helix	IV	42	**	II	9		III	13		II	2		IV	35	
Festuca ovina/rubra	IV	47	**	III	19		III	19		II	6		III	10	
Carex flacca	III	57	**	II	12		II	11		I	1		I	19	
Geranium sanguineum	III	56	**	I	13		II	13					I	17	
Succisa pratensis	III	45	**	II	16		II	16					I	23	
Thamnobryum alopecurum	II	58	**	I	6		I	18					I	18	
Hypericum androsaemum	II	85	*	I	7		I	7							
Brachypodium sylvaticum	II	63	*	I	7		II	25					I	5	
Breutelia chrysocoma	II	61	*	I	9		I	1		I	2		I	28	
Plantago lanceolata	II	58	*	I	4		I	29					I	9	
Linum catharticum	II	42	*	I	18		I	12		I	13		I	15	
Agrostis stolonifera	I	81	*										I	19	
Plagiomnium undulatum	II	61	*	I	5								I	35	
Homalothecium sericeum	I	70	*										I	17	

***Phyllitis scolopendrium - Hedera helix* vegetation type indicator species continued**	***Phyllitis scolopendrium - Hedera helix* pavement**			***Teucrium scorodonia - Sesleria caerulea* pavement**			***Prunus spinosa - Rubus fruticosus* pavement**			***Mycelis muralis - Fissidens dubius* pavement**			***Corylus avellana - Neckera crispa* pavement**		
Conocephalum conicum	I	75	*	I	8		I	16							
Koeleria macrantha	I	72	*	I	9		I	18							
Schoenus nigricans	I	98	*	I	2										
***Teucrium scorodonia - Sesleria caerulea* vegetation type indicator species - see constant species**															
***Prunus spinosa - Rubus fruticosus* vegetation type indicator species**															
Prunus spinosa	II	11		II	8		V	60	***	I	1		II	20	
Rubus fruticosus agg	I	2		II	9		III	55	**	II	7		II	27	
Lotus corniculatus	I	10		II	20		III	53	**	I	8		I	9	
Euonymus europaeus	I	16					I	84	*						
***Mycelis muralis - Fissidens dubius* vegetation type indicator species**															
Mycelis muralis	III	12		V	23		IV	13		V	31	**	IV	20	
***Corylus avellana-Neckera crispa* vegetation type indicator species**															
Corylus avellana	II	4		IV	5		I	1		I	2		V	88	*****
Ctenidium molluscum	V	32		III	10		II	5		II	2		V	51	***
Neckera crispa	IV	14		IV	21		II	6		III	3		IV	56	***

***Corylus avellana-Neckera crispa* vegetation type indicator species continued**	***Phyllitis scolopendrium - Hedera helix* pavement**		***Teucrium scorodonia - Sesleria caerulea* pavement**		***Prunus spinosa - Rubus fruticosus* pavement**		***Mycelis muralis - Fissidens dubius* pavement**		***Corylus avellana - Neckera crispa* pavement**		
Pteridium aquilinum	I	9	I	13	I	18	I	6	II	54	*
Dicranum scoparium	I	11			I	8			I	81	*
Salix repens									I	100	*
Other Woody Species											
Thymus polytrichus	IV	21	IV	37	III	21	I	3	II	19	
Rosa spinosissima	II	12	II	47	II	9	I	2	II	29	
Fraxinus excelsior	I	40	I	28	I	6			II	26	
Lonicera periclymenum	I	32	I	4	II	40	I	13	I	10	
Crataegus monogyna	I	17	I	37	I	24			I	22	
Sorbus aucuparia			I	32			I	20	I	47	
Sorbus aria			I	36			I	46	I	18	
Ilex aquifolium	I	39	I	46	I	6	I	10			
Juniperus communis	I	21	I	64	I	15					
Rubus saxatilis	I	80	I	16	I	4					
Dryas octopetala	I	15	I	85							
Helianthemum oelandicum			I	51	I	49					
Other Herbs											
Senecio jacobaea	II	11	III	23	III	21	IV	26	III	18	
Taraxacum officinalis agg	II	19	III	31	III	30	I	11	I	9	
Viola species	II	34	II	22	II	26	I	11	I	8	
Carlina vulgaris			II	39	I	20	I	8	II	32	
Potentilla erecta	II	35	I	50	I	2	I	4	I	9	
Hypochaeris radicata	I	14	II	39	I	16	I	9	I	21	
Campanula rotundifolia	I	36	I	21	I	14	I	11	I	17	
Solidago virgaurea	I	25	I	32	I	25	I	10	I	8	
Plantago maritima	I	30	I	32	I	38					
Euphrasia officinalis agg	I	32	I	8	I	40			I	20	

***Corylus avellana-Neckera crispa* vegetation type indicator species continued**		***Phyllitis scolopendrium - Hedera helix* pavement**		***Teucrium scorodonia - Sesleria caerulea* pavement**		***Prunus spinosa - Rubus fruticosus* pavement**		***Mycelis muralis - Fissidens dubius* pavement**		***Corylus avellana - Neckera crispa* pavement**	
Other Herbs											
Pilosella officinarum				I	34	I	32	I	13	I	21
Asperula cynanchica	I	33		I	34	I	33				
Eupatorium cannabinum	I	48		I	16	I	36				
Leontodon hispidus				I	21			I	45	I	34
Hypericum pulchrum	I	51		I	30	I	19				
Thalictrum minus	I	51		I	30	I	19				
Sonchus asper	I	51		I	10	I	39				
Valeriana officinalis	I	51								I	49
Rubia peregrina	I	57		I	22	I	21				
Arabis hirsuta				I	35			I	37	I	28
Hieracium anglicum	I	28		I	44					I	27
Leontodon autumnalis				I	34	I	66				
Sonchus oleraceus	I	40		I	30	I	30				
Antennaria dioica				I	19	I	36			I	46
Polygala vulgaris				I	34	I	66				
Oxalis acetosella				I	65			I	35		
Other Grasses/Rushes/Sedges											
Carex panicea	I	37		I	41	I	9			I	12
Molinia caerulea	I	62		I	29	I	2	I	4	I	3
Carex pulicaris	I	37		I	14	I	14			I	35
Dactylis glomerata	I	55		I	29	I	7			I	9
Briza media	I	30		I	29	I	11			I	29
Juncus articulatus	I	29		I	22	I	22			I	27
Arrhenatherum elatius	I	68								I	32
Anthoxanthum odoratum	I	16		I	6					I	77

***Corylus avellana-Neckera crispa* vegetation type indicator species continued**	***Phyllitis scolopendrium - Hedera helix* pavement**		***Teucrium scorodonia - Sesleria caerulea* pavement**		***Prunus spinosa - Rubus fruticosus* pavement**		***Mycelis muralis - Fissidens dubius* pavement**		***Corylus avellana - Neckera crispa* pavement**	
Orchids										
Epipactis atrorubens			I	33			I	26	I	41
Epipactis helleborine	I	30	I	12					I	58
Other Ferns										
Asplenium trichomanes	II	14	III	21	II	16	III	23	III	27
Ceterach officinarum	I	9	III	32	II	18	III	19	III	23
Polystichum setiferum	I	53	I	8	II	5	I	28	I	6
Dryopteris filix-mas	I	15	I	9	I	12	I	57	I	7
Adiantum capillus-veneris	I	32	I	29	I	40				
Cystopteris fragilis	I	29	I	34			I	36		
Polypodium interjectum	I	57			I	43				
Other Bryophytes/Lichens										
Scapania aspera	I	13	I	23	I	7	II	39	II	18
Didymodon rigidulus	I	28	I	18	I	14	I	12	I	27
Encalypta streptocarpa			I	12	I	39	I	39	I	10
Hypnum lacunosum	I	10	I	2	I	4	I	6	I	78
Bryum species	I	43	I	41	I	16				
Neckera complanata	I	49	I	28					I	23
Plagiochila asplenioides	I	70	I	16					I	13
Homalothecium lutescens			I	3	I	10			I	88
Scleropodium purum	I	37			I	28			I	35
Cladonia rangiformis			I	45					I	55
Hylocomium splendens	I	30	I	70						

Group 2 Wooded Limestone pavement

Two vegetation types are present in this wooded limestone pavement group. Each of these vegetation types is described below. Constant species for this group are *Hedera helix, Corylus avellana, Rubus fruticosus, Crataegus monogyna, Rhytidiadelphus triquetrus, Thamnobryum alopecurum, Brachypodium sylvaticum, Viola* spp., and *Thuidium tamariscinum.* This group is characterised by a canopy of a combination of *Corylus avellana* and *Fraxinus excelsior*. This woodland vegetation type lies over limestone pavement with a luxuriant cover of bryophytes (approximately 80%) and a field layer consisting of species such as *Geranium robertianum*, *Viola* species, *Oxalis acetosella, Sanicula europaea*, *Arum maculatum* and *Epipactis helleborine*.

This group has affinities with the Annex I Habitat 8240 – Limestone pavements and the Hertiage Council (Fossitt 2000) habitat type WN2 – Oak – ash – hazel woodland (Table 23). This vegetation type also shows affinities with Groups 4, and 8 of the Willis (2011) classification of Limestone pavement in the UK (see Appendix 1). It also has affinities with *Corylus avellana* / *Prunus spinosa* scrub – *Fraxinus* Woodland (Kelly & Kirby 1982) and *Fraxinus excelsior – Hedera helix* woodland group and in particular the *Corylus avellana – Oxalis acetosella* vegetation type (Type 2e) of Perrin *et al*. (2008). According to Perrin *et al*. (2008) this woodland type corresponds to species-rich hazel-ash stands of well-drained mineral soils, which include hazel scrub-woodland stands on limestone pavement or shallow, rocky soils, where the canopy is typically low (5-8m) and dominated by *Corylus avellana* with *Fraxinus excelsior* occurring as scattered emergents.

Table 23 Relevant vegetation community affinities for the Wooded Limestone Pavement Group.

Classification	**Relevant Affinities**
EU Annex I:	8240 – Limestone Pavements
Fossitt (2000):	ER2 – Exposed calcareous rock
NVC:	W9 – *Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland
Perrin *et al*. (2008)	FHe – *Corylus avellana-Oxalis acetosella* type

VEGETATION TYPE 2A *CORYLUS AVELLANA – CTENIDIUM MOLLUSCUM LOW WOODLAND*

Indicator species: *Corylus avellana, Ctenidium molluscum* and *Potentilla sterilis*

Description: Constant species in this group include *Hedera helix, Corylus avellana, Rubus fruticosus, Thuidium tamariscinum, Brachypodium sylvaticum, Viola* spp., *Rhytidiadelphus triquetrus, Thamnobryum*

alopecurum, Ctenidium molluscum and *Potentilla sterilis.* This vegetation type represents the typical Hazel scrub habitat which occurs over limestone pavement. The group was found in 11 sites in counties Clare, Galway, Mayo, Roscommon and Sligo and contained a total of 14 relevés. This vegetation type could be considered as low woodland as the average canopy height was approximately 3m. Hazel (*Corylus avellana*) and Blackthorn (*Prunus spinosa*) were the dominant woody species in this group. Other typical species encountered include *Geranium sanguineum*, *Lathyrus linifolius*, *Teucrium scorodonia*, *Sesleria caerulea*, *Asplenium ruta-muraria* and *Asplenium trichomanes*. This type appears to be an early successional vegetation type with species typical of open ground. On average, 24 species were recorded per relevé. A full list of species for the vegetation type is given in Table 24 (synoptic). Affinities with the group as a whole are given in Table 32. Plate 9 shows an example of the vegetation type.

Plate 9 *Corylus avellana – Ctenidium molluscum* vegetation type at Mullaghfarna, Co. Sligo (NSLP06).

VEGETATION TYPE 2B *FRAXINUS EXCELSIOR – PLAGIOMNIUM UNDULATUM WOODLAND*

Indicator species: *Fraxinus excelsior, Plagiomnium undulatum and Rhytidiadelphus triquetrus*.

Description: Constant species in this group include *Hedera helix, Corylus avellana, Rubus fruticosus, Thuidium tamariscinum, Brachypodium sylvaticum, Viola* spp., *Rhytidiadelphus triquetrus, Thamnobryum alopecurum, Plagiomnium undulatum* and *Fraxinus excelsior.* This vegetation type was found in 6 sites in counties Clare, Galway, Longford and Mayo and contained a total of 7 relevés. This group was defined by a higher canopy then group 2a, with the average canopy height being approximately 5m. This vegetation type occurs in areas of rocky or shallow soils. Ash (*Fraxinus excelsior*) was the dominant woody species in this vegetation type. This vegetation type did not contain any species that were not present in vegetation type 2a and contained, on average, 19 species per relevé. A full list of species for the vegetation type is given in Table 24 (synoptic). Affinities with the group as a whole are given in Table 23. Plate 10 shows an example of the vegetation type.

Plate 10 *Fraxinus excelsior - Plagiomnium undulatum* vegetation type at Creevagh, Co. Galway (NSLP44).

Table 24 Synoptic Table for the Wooded Limestone Pavement Group.

Wooded Limestone Pavement Group	***Corylus avellana - Ctenidium molluscum* low woodland**			***Fraxinus excelsior - Plagiomium undulatum* woodland**		
Constant Species						
Hedera helix	**V**	**67**		**V**	**33**	
Corylus avellana	**V**	**63**	****	**V**	**37**	
Rubus fruticosus	**V**	**57**		**V**	**43**	
Thuidium tamariscinum	**V**	**32**		**V**	**68**	
Brachypodium sylvaticum	**IV**	**92**		**IV**	**8**	
Viola species	**IV**	**42**		**IV**	**58**	
Thamnobryum alopecurum	**IV**	**35**		**V**	**65**	
Rhytidiadelphus triquetrus	**IV**	**15**		**V**	**85**	****
***Corylus avellana - Ctenidium molluscum* vegetation type indicator species**						
Ctenidium molluscum	IV	93	****	II	7	
Potentilla sterilis	III	100	***			
***Fraxinus excelsior - Plagiomium undulatum* vegetation type indicator species**						
Plagiomnium undulatum	III	15		V	85	*****
Fraxinus excelsior	II	27		V	73	****
Other Woody Species						
Crataegus monogyna	IV	51		III	49	
Lonicera periclymenum	III	28		IV	72	
Prunus spinosa	IV	91		I	9	
Euonymus europaeus	II	37		II	63	
Rosa spinosissima	II	100				
Other Herbs						
Geranium robertianum	IV	21		III	79	
Oxalis acetosella	II	55		III	45	
Sanicula europaea	II	74		II	26	
Arum maculatum	II	89		I	11	
Vicia sepium	I	83		I	17	
Geranium sanguineum	II	100				
Lathyrus linifolius	II	100				
Potentilla erecta	II	100				
Teucrium scorodonia	II	100				
Other Grasses/Sedges/Rushes						
Sesleria caerulea	III	93		I	7	
Carex flacca	II	100				
Dactylis glomerata	II	100				
Orchids						
Epipactis helleborine	II	71		I	29	

Wooded Limestone Pavement Group	***Corylus avellana - Ctenidium molluscum* low woodland**		***Fraxinus excelsior - Plagiomium undulatum* woodland**	
Ferns				
Phyllitis scolopendrium	III	45	III	55
Dryopteris filix-mas	II	50	II	50
Pteridium aquilinum	II	100		
Asplenium ruta-muraria	II	100		
Asplenium trichomanes	II	100		
Polystichum setiferum	II	100		
Other Bryophytes/Lichens				
Eurhynchium striatum	III	27	III	73
Neckera crispa	III	54	III	46
Hylocomium brevirostre	II	44	III	56
Scapania aspera	II	75	II	25
Plagiochila asplenioides	II	57	I	43
Scleropodium purum	II	76	I	24
Tortella tortuosa	II	91	II	9
Hylocomium splendens	II	23	I	77
Breutelia chrysocoma	II	100		
Fissidens species	II	89	I	11
Neckera complanata	II	91	I	9
Rhytidiadelphus squarrosus	I	83	I	17

Group 3 Holcus lanatus-Trifolium repens Grassland Group

Four vegetation types are present in this grassland group, which are described below. Constant species for this group are *Plantago lanceolata, Trifolium repens, Trifolium pratense, Cynosurus cristatus, Anthoxanthum odoratum,* and *Galium verum.* This group contained a total of 50 relevés. This group is characterised by deeper soils compared to the other grassland groups and represents grasslands that are more agriculturally productive than those seen in other grassland groups described below. This is supported by the NMS analysis results which show relevés from this group (red symbols, Figure 6) are found at the lower end of Axis 1, which represents a higher concentration of herbaceous species and at the higher end of Axis 2, which represents soil depth.

This group has affinities with the Annex I Habitat 6210 – Semi-natural dry grasslands and scrub facies on calcareous substrates (*Festuco-Brometalia*) (Priority for important orchid sites (6211)) and the Hertiage Council (Fossitt 2000) habitat type GS1 – Dry and neutral grassland. This vegetation type

also shows affinities with the *Dactylis glomerata – Holcus lanatus* association of more mesotrophic grasslands (Parr *et al.* 2009). It also has affinities with NVC (Rodwell *et al.* 1992) (MG5) *Cynosurus cristatus–Centaurea nigra* grassland community (Table 25). There are also similarities with McGough (1984) *Leucanthemum – Rhinanthus* meadows and O'Neill *et al.* (2010) *Festuca rubra – Plantago lanceolata* group.

Table 25 Relevant vegetation community affinities for the *Holcus lanatus - Trifolium repens* Grassland Group.

Classification	Relevant Affinities
EU Annex I:	6210/6211 – *Festuco-Brometalia*
Fossitt (2000):	GS1 – Dry and neutral grasslands
NVC:	MG5 – *Cynosurus cristatus–Centaurea nigra* grassland community

VEGETATION TYPE 3A *CYNOSURUS CRISTATUS - LEUCANTHEMUM VULGARE* GRASSLAND

Indicator species: *Trifolium repens, Cynosurus cristatus, Leucanthemum vulgare, Prunella vulgaris, Agrostis capillaris, Lolium perenne, Hypochaeris radicata, Leontodon autumnalis, Bellis perennis* and *Centaurea scabiosa.*

Description: Constant species for this vegetation type include *Plantago lanceolata, Trifolium repens, Trifolium pratense, Cynosurus cristatus, Anthoxanthum odoratum, Galium verum, Leucanthemum vulgare, Prunella vulgaris, Hypochaeris radicata, Festuca ovina/rubra, Euphrasia officinalis* agg., *Potentilla erecta, Succisa pratensis and Carex flacca.* This vegetation type was represented by 26 relevés (15 NSLP / 11 Parr *et al.* 2009) and was found in 11 NSLP sites in counties Clare, Galway and Mayo and five Parr *et al.* (2009) sites in the Burren. Other typical species encountered include *Dactylis glomerata, Centaurea nigra, Achillea millefolium, Lotus corniculatus, Potentilla erecta* and *Succisa pratensis.* A full list of species for the vegetation type is given in Table 26 (synoptic). Affinities with the group as a whole are given in Table 25. Plate 11 shows an example of the vegetation type.

Plate 11 *Cynosurus cristatus - Leucanthemum vulgare* vegetation type at Creevagh, Co. Galway (NSLP44).

VEGETATION TYPE 3B *DACTYLIS GLOMERATA-ACHILLEA MILLEFOLIUM* GRASSLAND

Indicator species: *Trifolium pratense, Dactylis glomerata, Rosa spinossissima, Centaurea nigra, Achillea millefolium, Cerastium fontanum* and the moss *Brachythecium rutabulum.*

Description: Constant species for this vegetation type include *Plantago lanceolata, Trifolium repens, Trifolium pratense, Cynosurus cristatus, Anthoxanthum odoratum, Galium verum, Agrostis capillaris, Dactylis glomerata, Rosa spinossissima, Centaurea nigra, Achillea millefolium* and *Cerastium fontanum.* This vegetation type was represented by seven relevés (five NSLP / two Parr *et al.* 2009) and was found in five NSLP sites in counties Clare and Galway and two Parr *et al.* (2009) sites in the Burren. A full list of species for the vegetation type is given in Table 26 (synoptic). Affinities with the group as a whole are given in Table 25. Plate 12 shows an example of the vegetation type.

Plate 12 *Dactylis glomerata - Achillea millefolium* vegetation type at Gortlecka, Co. Clare (NSLP02).

VEGETATION TYPE 3C HOLCUS LANATUS - ANTHOXANTHUM ODORATUM GRASSLAND

Indicator species: *Holcus lanatus, Plantago lanceolata, Anthoxanthum odoratum, Ranunculus acris, Ranunculus bulbosus, Rhinanthus minor, Vicia cracca* and *Eurhynchium* spp.

Description: Constant species for this vegetation type include *Plantago lanceolata, Trifolium repens, Trifolium pratense, Cynosurus cristatus, Anthoxanthum odoratum, Galium verum, Agrostis capillaris, Dactylis glomerata, Centaurea nigra, Cerastium fontanum, Holcus lanatus, Ranunculus bulbosus, Potentilla erecta, Pteridium aquilinum, Festuca ovina/rubra* and *Carex flacca.* The mosses *Rhytidiadelphus squarrosus, Scleropodium purum* and *Calliergonella cuspidata* were also constant species for this community type. This vegetation type was represented by 4 relevés (one NSLP / three Parr *et al.* 2009) and was found in one NSLP site (NSLP06) in county Mayo and three Parr *et al.* (2009) sites in the Burren. Other typical species encountered include *Dactylis glomerata, Centaurea nigra, Achillea millefolium, Lotus corniculatus, Potentilla erecta* and *Succisa pratensis.* A full list of species for the vegetation type is given in Table 26 (synoptic). Affinities with the group as a whole are given in Table 25. Plate 13 shows an example of the vegetation type.

Plate 13 *Holcus lanatus - Anthoxanthum odoratum* vegetation type at Mullaghfarna, Co. Sligo (NSLP06).

VEGETATION TYPE 3D ARRHENATHERUM ELATIUS – RUMEX ACETOSA GRASSLAND

Indicator species: *Arrhenatherum elatius, Rumex acetosa, Veronica chamaedrys, Vicia sepium, Poa pratensis, Conopodium majus, Geranium sanguineum, Odontites vernus, Stellaria graminae, Prunus spinosa* and the moss *Hylocomium splendens.*

Description: Constant species for this vegetation type include *Plantago lanceolata, Trifolium repens, Trifolium pratense, Cynosurus cristatus, Anthoxanthum odoratum, Galium verum, Dactylis glomerata, Achillea millefolium, Cerastium fontanum, Holcus lanatus, Lotus corniculatus, Potentilla erecta, Euphrasia officinalis* agg., *Lathyrus pratensis, Viola* spp., *Festuca ovina/rubra* and *Succisa pratensis.* The mosses *Rhytidiadelphus squarrosus, Scleropodium purum, Rhytidiadelphus triquetrus* and *Ctenidium molluscum* were also constant species for this community type. This was the only vegetation type that did not contain relevés from both projects (NSLP and Parr *et al.* 2009). This vegetation type was represented by 13 relevés (all Parr *et al.* 2009) and was only found in five Parr *et al.* (2009) sites in the Burren. Incidentally, Parr *et al.* (2009) classified a similar vegetation type characterised by *Rumex acetosa* and *Arrhenatherum elatius.* This vegetation type was as species-rich as type 3a. A full list of species for the vegetation type is given in Table 26 (synoptic). Affinities with the group as a whole are given in Table 25. There is no image for this vegetation type as all of the relevés were recorded by Parr *et al.* (2009).

Table 26 Synoptic Table for the *Holcus lanatus – Trifolium repens* Grassland Group.

***Holcus lanatus-Trifolium repens* Grassland Group**	***Cynosurus cristatus - Leucanthemum vulgare* Grassland**			***Dactylis glomerata-Achillea millefolium* Grassland**			***Holcus lanatus - Anthoxanthum odoratum* Grassland**			***Arrhenatherum elatius – Rumex acetosa* Grassland**	
Constant Species											
Plantago lanceolata	**V**	**9**		**V**	**8**		**V**	**25**	**	**V**	**7**
Trifolium repens	**V**	**23**	**	**V**	**16**		**IV**	**7**		**V**	**19**
Trifolium pratense	**V**	**14**		**V**	**18**	*	**IV**	**5**		**V**	**6**
Anthoxanthum odoratum	**V**	**9**		**IV**	**6**		**V**	**30**	**	**V**	**3**
Cynosurus cristatus	**V**	**32**	**	**V**	**11**		**IV**	**6**		**IV**	**8**
Galium verum	**IV**	**8**		**IV**	**6**		**IV**	**3**		**V**	**14**
***Cynosurus cristatus - Leucanthemum vulgare* Grassland vegetation type indicator species**											
Leucanthemum vulgare	IV	37	**	I	1					II	2
Prunella vulgaris	V	32	**	II	2					I	1
Lolium perenne	II	64	*				II	4		I	3
Agrostis capillaris	III	34	*	IV	11		V	11		II	9
Hypochaeris radicata	IV	26	*	II	2					II	4
Taraxacum officinalis agg	III	41	*	I	8						
Leontodon autumnalis	III	37	*	II	37						
Bellis perennis	II	43	*							I	4
Centaurea scabiosa	I	79	*								
***Dactylis glomerata-Achillea millefolium* Grassland vegetation type indicator species**											
Dactylis glomerata	III	3		V	55	***	V	7		V	9
Rosa spinosissima	II	3		IV	44	**				II	6
***Holcus lanatus-Trifolium repens* Grassland Group**	***Cynosurus cristatus - Leucanthemum vulgare* Grassland**			***Dactylis glomerata-Achillea millefolium* Grassland**			***Holcus lanatus - Anthoxanthum odoratum* Grassland**			***Arrhenatherum elatius – Rumex acetosa* Grassland**	
Achillea millefolium	IV	13		IV	30	**	II	1		V	15

Centaurea nigra	IV	7	IV	28	**	IV	19		III	5	
Brachythecium rutabulum	I	21	II	67	*						
Cerastium fontanum	III	12	V	17	*	IV	15		IV	20	
***Holcus lanatus - Anthoxanthum odoratum* Grassland vegetation type indicator species**											
Holcus lanatus	IV	7	III	9		IV	60	***	IV	12	
Ranunculus acris	II	6	II	2		III	71	**	II	4	
Eurhynchium species	I	2				II	74	*			
Ranunculus bulbosus	II	12	I	22		IV	23	*	I	5	
Rhinanthus minor	I	4	II	15		III	33	*			
Vicia cracca	I	4	II	50		III	31	*			
***Arrhenatherum elatius – Rumex acetosa* Grassland vegetation type indicator species**											
Arrhenatherum elatius	I	2	II	9					V	72	****
Rumex acetosa	I	2	I	27		III	21		V	49	***
Veronica chamaedrys	I	2	II	14		III	24		V	45	***
Vicia sepium			I	5					IV	92	***
Poa pratensis	II	11	II	53					IV	31	**
Conopodium majus	II	12	I	4		II	7		IV	35	**
Geranium sanguineum	I		III	4					V	18	*
Hylocomium splendens	II	2	I			II	12		V	19	*
Odontites vernus	I	24	I	15					II	40	*
Prunus spinosa	I	4							II	61	*
***Holcus lanatus-Trifolium repens* Grassland Group**	***Cynosurus cristatus - Leucanthemum vulgare* Grassland**		***Dactylis glomerata- Achillea millefolium* Grassland**			***Holcus lanatus - Anthoxanthum odoratum* Grassland**			***Arrhenatherum elatius – Rumex acetosa* Grassland**		
Stellaria graminea									II	67	*
Other Woody Species											
Thymus polytrichus	II	3							III	4	
Corylus avellana	I	3				II	3				

Rubus fruticosus agg	I	6					I	19
Calluna vulgaris	I	1						
Other Herbs								
Lotus corniculatus	V	14	V	9	III	1	IV	5
Euphrasia officinalis agg	IV	9	I	1	IV	10	IV	6
Potentilla erecta	IV	3	III	3	IV	6	IV	3
Succisa pratensis	IV	3			III	1	IV	3
Lathyrus pratensis	I	2	II	10	II	3	V	14
Viola species	I	2	II	2	III	4	IV	11
Ranunculus repens	II	33	III	4	II	12	I	42
Linum catharticum	III	7	I	2	II	3	I	2
Campanula rotundifolia	II	6			II	2	II	4
Daucus carota	II	28	III	17			I	1
Pilosella officinarum	II	9			II	4		
Hypericum maculatum	I	9	I	57	II	20		
Lathyrus linifolius	I	4	III	19				
Primula veris	I	16	I	43	II	15		
Anthyllis vulneraria	II	16	I	1				
Potentilla sterilis	I	13			II	27	I	8
Filipendula ulmaria	I	1					II	90
Senecio jacobaea	I	10	I	7			I	4
Leontodon hispidus	II	30	I	3				

***Holcus lanatus-Trifolium repens* Grassland Group**	***Cynosurus cristatus - Leucanthemum vulgare* Grassland**		***Dactylis glomerata-Achillea millefolium* Grassland**		***Holcus lanatus - Anthoxanthum odoratum* Grassland**		***Arrhenatherum elatius – Rumex acetosa* Grassland**	
Other Herbs								
Hypericum pulchrum	I	2	I	2			I	1
Medicago lupulina	I	46	I	50				
Plantago maritima	I	7	I	4				
Cirsium arvense	I	23			II	29		
Pimpinella saxifraga	I	24	I	56				

Cirsium palustre	I	34	I	63				
Alchemilla filicaulis	I	9					I	35
Primula vulgaris	I	3						
Filipendula vulgaris			I	6				
Sanguisorba minor			I	30				
Solidago virgaurea			I	6				
Centaurium erythraea	I	22						
Galium sterneri	I	3					I	6
Potentilla anserina	I	1					I	89
Veronica officinalis	I	11					I	22
Blackstonia perfoliata	I	24						
Polygala vulgaris	I	3						
Alchemilla xanthochlora	I	72						
Cerastium arvense							I	47
Asperula cynanchica	I							
Pedicularis sylvatica	I	4						
Teucrium scorodonia	I							
Crepis capillaris	I	58						
Geum rivale	I	62						
Leontodon saxatilis	I	5						

***Holcus lanatus-Trifolium repens* Grassland Group**	***Cynosurus cristatus - Leucanthemum vulgare* Grassland**		***Dactylis glomerata-Achillea millefolium* Grassland**		***Holcus lanatus - Anthoxanthum odoratum* Grassland**		***Arrhenatherum elatius – Rumex acetosa* Grassland**	
Other Grasses/Sedges/Rushes								
Festuca ovina/rubra	V	5	III	5	V	8	V	5
Carex flacca	V	7	III	4	IV	4	III	1
Luzula campestris	III	19	I	16	III	11	III	10
Other Grasses/Sedges/Rushes								
Briza media	III	7	II	2	II	2	II	1
Carex panicea	III	8	II	12	III	1		
Koeleria macrantha	III	8	I	3			III	5

Carex caryophyllea	III	11			II	2	II	2
Sesleria caerulea	II	1	I	1			III	1
Agrostis stolonifera	II	30	III	22				
Agrostis canina	I	5			II	6	I	2
Helictotrichon pubescens	II	4	III	25	III	13	IV	10
Molinia caerulea	I	2	II	1				
Carex pulicaris	I	4			II	2		
Danthonia decumbens	I	9						
Juncus articulatus	I	15						
Poa annua	I	95						
Trisetum flavescens	I	89						
Juncus conglomeratus	I	81						
Orchids								
Dactylorhiza fuschii	I	11	I	5	III	18	I	6
Dactylorhiza maculata	I	12	I	14	II	25		
Orchis mascula	I	12						
Gymnadenia conopsea	I	4						
Spiranthes spiralis	I	40						

***Holcus lanatus-Trifolium repens* Grassland Group**	***Cynosurus cristatus - Leucanthemum vulgare* Grassland**		***Dactylis glomerata- Achillea millefolium* Grassland**		***Holcus lanatus - Anthoxanthum odoratum* Grassland**		***Arrhenatherum elatius – Rumex acetosa* Grassland**	
Listera ovata	I	4						
Ferns								
Pteridium aquilinum	I		III	3	IV	67	III	4
Other Bryophytes/Lichens								
Rhytidiadelphus squarrosus	IV	27	III	13	II	1	V	16
Scleropodium purum	IV	6	III	7	II		IV	3
Calliergonella cuspidata	IV	17	III	15	III	15	II	1
Other Bryophytes/Lichens								
Rhytidiadelphus triquetrus	II	19	I	9	II	1	V	15
Ctenidium molluscum	III	3			II	1	IV	3

Plagiomnium undulatum	II	13	I	4	II	6	II	15
Thuidium tamariscinum	II	5					III	13
Tortella tortuosa	II	5			II	3	I	1
Hypnum cupressiforme	I	7					II	2
Breutelia chrysocoma	I						II	4
Hylocomium brevirostre	I						II	8
Dicranum scoparium	I	2					I	1
Climacium dendroides	I	58					I	19
Homalothecium lutescens	I	19					I	13
Fissidens species	I	9						
Neckera crispa	I	2						
Ditrichum gracile	I	3						
Cladonia portentosa							I	30
Bryum species	I	14						
Frullania tamarisci	I	2						
Homalothecium sericeum	I	6						

***Holcus lanatus-Trifolium repens* Grassland Group**	***Cynosurus cristatus - Leucanthemum vulgare* Grassland**		***Dactylis glomerata- Achillea millefolium* Grassland**	***Holcus lanatus - Anthoxanthum odoratum* Grassland**	***Arrhenatherum elatius – Rumex acetosa* Grassland**
Hypnum lacunosum	I	13			
Cladonia pocillum	I	7			

Group 4 Festuca ovina/rubra - Succisa pratensis Grassland Group

Three vegetation types are present in this grassland group, which are described below. This group is essentially a grassland group, although there does appear to be a transition, or different stage in succession in some of the relevés, from grassland to heath. This was not a well-defined group in Cluster Analysis. The NMS scatterplot (Figure 6) shows that this group lies in ordination space between the main grassland and heath groups, highlighting the transitional nature of the vegetation. Constant species for this group are *Sesleria caerulea, Briza media, Festuca ovina/rubra, Plantago lanceolata, Succisa pratensis, Anthoxanthum odoratum, Potentilla erecta, Lotus corniculatus, Carex flacca* and *Scleropodium purum.* This group contained a total of 105 relevés.

This group has affinities with the Annex I Habitats 6210 – Semi-natural dry grasslands and scrub facies on calcareous substrates (*Festuco-Brometalia*) (Priority for important orchid sites (6211)) and 4030 – European dry heaths and the Hertiage Council (Fossitt 2000) habitat type GS1 – Dry and neutral grassland and HH2 – Dry calcareous heaths. This vegetation type also shows affinities with the *Dactylis glomerata – Holcus lanatus* association of more mesotrophic grasslands as well as the *Sesleria caerulea – Breutelia chrysocoma* community (Parr *et al.* 2009). It also has affinities with the NVC (Rodwell *et al.* 1992) classification MG5 *Cynosurus cristatus – Centaurea nigra* grassland community, CG1 *Festuca ovina – Carlina vulgaris* grassland community and CG9 - *Sesleria albicans – Galium sterneri* grassland community (Table 27).

Table 27 Relevant vegetation community affinities for the *Festuca ovina/rubra - Succisa pratensis* Grassland Group.

Classification	Relevant Affinities
EU Annex I:	6210/6211 – *Festuco-Brometalia*
	5130 – *Juniperus communis* formations on heaths or calcareous grasslands
	4030 – European dry heaths
Fossitt (2000):	GS1 – Dry and neutral grasslands
	HH2 – Dry calcareous heaths
NVC:	MG5 – *Cynosurus cristatus–Centaurea nigra* grassland community
	CG1 – *Festuca ovina – Carlina vulgaris* grassland community
	CG9 – *Sesleria albicans – Galium sterneri* grassland community

VEGETATION TYPE 4A *ERICA CINEREA - JUNIPERUS COMMUNIS* GRASSLAND/HEATH

Indicator species: *Succisa pratensis, Erica cinerea* and *Juniperus communis.*

Description: Constant species for this vegetation type include *Thymus polytrichus, Calluna vulgaris, Hypericum pulchrum, Briza media, Sesleria caerulea, Festuca ovina/rubra, Plantago lanceolata, Succisa pratensis, Anthoxanthum odoratum, Potentilla erecta, Lotus corniculatus, Carex flacca* and *Scleropodium*

purum. This vegetation type was represented by 37 relevés (33 NSLP / four Parr *et al*. 2009) and was found in 21 NSLP sites in counties Clare, Donegal, Galway and Mayo and two Parr *et al*. (2009) sites in the Burren. This vegetation type is made up of a combination of grassland and heath relevés. Although *Erica cinerea* is an indicator of this community, it occurs at varying frequencies and in fact, some of the relevés are devoid of Ericoid species. Juniper occurs at moderate abundance in this vegetation type, although at low frequencies. This vegetation type is representative of Juniper grassland/heath that occurs throughout the country in limestone areas and in some cases may be considered as the EU Annex I Habitat (5130) *Juniperus communis* formations on heaths or calcareous grasslands. *Sesleria caerulea* is also a constant feature of this vegetation type. The relevés from this vegetation type are positioned on the middle to lower end of Axis 1 in the NMS scatterplot (Figure 6) which represents a continuum from grassland to heath, emphasising the somewhat transitional nature of the vegetation. This vegetation type would be considered heath by Fossitt (2000) classification as the average cover of low woody species for the vegetation type is 29%. However, there are many elements which suggest that this is in fact a grassland community. This reiterates the difficulty in classifying limestone pavement 'grasslands' as discussed in McGough (1984) and Parr *et al.* (2009). A full list of species for the vegetation type is given in Table 28 (synoptic). Affinities with the group as a whole are given in Table 27. Plate 14 shows an example of the vegetation type.

Plate 14 *Erica cinerea - Juniperus communis* vegetation type at Cloonselherny, Co. Galway (NSLP17).

VEGETATION TYPE 4B *ANTHOXANTHUM ODORATUM - SUCCISA PRATENSIS* GRASSLAND

Indicator species: No specific indicator species: see constant species.

Description: Constant species for this vegetation type include *Briza media, Sesleria caerulea, Cynosurus cristatus, Koeleria macrantha, Dactylis glomerata, Carex panicea, Carex caryophyllea, Rhytidiadelphus squarrosus, Prunella vulgaris, Galium verum, Trifolium pratense, Trifolium repens, Euphrasia officinalis* agg., *Centaurea nigra, Achillea millefolium, Festuca ovina/rubra, Plantago lanceolata, Succisa pratensis, Anthoxanthum odoratum, Potentilla erecta, Lotus corniculatus, Carex flacca* and *Scleropodium purum*. This vegetation type was represented by 36 relevés (21 NSLP / 15 Parr *et al.* 2009) and was found in 14 NSLP sites in counties Clare, Donegal, Galway and Mayo and 10 Parr *et al.* (2009) sites in the Burren, one of which was within an NSLP site (NSLP09). This vegetation type has similarities with some of the vegetation types in the *Holcus lanatus – Trifolium repens* grassland group. A full list of species for the vegetation type is given in Table 28 (synoptic). Affinities with the group as a whole are given in Table 27. Plate 15 shows an example of the vegetation type.

Plate 15 *Anthoxanthum odoratum - Succisa pratensis* vegetation type at Slievecarran, Co. Clare (NSLP09).

VEGETATION TYPE 4C *FESTUCA OVINA/RUBRA - PLANTAGO LANCEOLATA* GRASSLAND

Indicator species: No specific vegetation type indicator: see constant species.

Description: Constant species for this vegetation type include *Briza media, Sesleria caerulea, Cynosurus cristatus, Dactylis glomerata, Rhytidiadelphus squarrosus, Prunella vulgaris, Galium verum, Trifolium pratense, Trifolium repens, Euphrasia officinalis* agg., *Centaurea nigra, Achillea millefolium, Geranium sanguineum, Festuca ovina/rubra, Plantago lanceolata, Succisa pratensis, Anthoxanthum odoratum, Potentilla erecta, Lotus corniculatus, Carex flacca and Scleropodium purum.* This vegetation type was represented by 32 relevés (18 NSLP / 14 Parr *et al.* 2009) and was found in 11 NSLP sites in counties Clare and Galway and eight Parr *et al.* (2009) sites in the Burren, two of which were within NSLP sites (NSLP09/10). This vegetation type has similarities with some of the vegetation types in the *Holcus lanatus – Trifolium repens* grassland group. This is apparent from the NMS scatterplot; this vegetation type is situated at the higher end of Axis 1, which represents grassland rather than heath communities. A full list of species for the vegetation type is given in Table 28 (synoptic). Affinities with the group as a whole are given in Table 27. Plate 16 shows an example of the vegetation type.

Plate 16 *Festuca ovina/rubra – Plantago lanceolata* vegetation type at Slievecarran, Co. Clare (NSLP09).

Table 28 Synoptic Table for the *Festuca ovina/rubra - Succisa pratensis* Grassland Group.

***Festuca ovina/rubra – Succisa pratensis* Grassland Group**	***Erica cinerea - Juniperus communis* Grassland/Heath**			***Anthoxanthum odoratum - Succisa pratensis* Grassland**		***Festuca ovina/rubra - Plantago lanceolata* Grassland**	
Constant Species							
Festuca ovina/rubra	**V**	**8**		**V**	**11**	**V**	**22**
Plantago lanceolata	**IV**	**4**		**V**	**11**	**V**	**15**
Succisa pratensis	**V**	**17**	*	**V**	**15**	**IV**	**4**
Anthoxanthum odoratum	**IV**	**4**		**V**	**14**	**IV**	**5**
Potentilla erecta	**V**	**10**		**V**	**11**	**V**	**4**
Lotus corniculatus	**V**	**11**		**V**	**7**	**V**	**5**
Carex flacca	**IV**	**9**		**V**	**8**	**V**	**9**
Briza media	**IV**	**9**		**V**	**15**	**IV**	**5**
Sesleria caerulea	**V**	**5**		**IV**	**3**	**IV**	**3**
Scleropodium purum	**V**	**15**		**IV**	**5**	**IV**	**8**
***Erica cinerea - Juniperus communis* Grassland/Heath vegetation type indicator species**							
Erica cinerea	III	56	**	I	2	I	1
Juniperus communis	II	68	**	I	3		
***Anthoxanthum odoratum - Succisa pratensis* grassland vegetation type indicator species - no specific indicators**							
***Festuca ovina/rubra - Plantago lanceolata* Grassland vegetation type indicator species - see constant species**							
Other woody species							
Thymus polytrichus	IV	6		III	5	III	2
Calluna vulgaris	V	15		II	1	I	
Rosa spinosissima	II	4		II	7	II	4
Prunus spinosa	I	10		I	4	I	1
Dryas octopetala	I	1		I			
Corylus avellana	I	1		I	1		
Crataegus monogyna	I	9				I	2
Helianthemum oelandicum	I	25					
Salix repens				I	19		
Hedera helix						I	5
Lonicera periclymenum	I	14					
Other Herbs							
Galium verum	III	4		V	11	V	13
Trifolium pratense	III	5		V	7	V	12
Trifolium repens	II	1		V	5	V	7
Euphrasia officinalis agg	III	11		IV	12	IV	7
Achillea millefolium	III	4		IV	5	V	11

***Festuca ovina/rubra – Succisa pratensis* Grassland Group**		***Erica cinerea - Juniperus communis* Grassland/Heath**		***Anthoxanthum odoratum - Succisa pratensis* Grassland**		***Festuca ovina/rubra - Plantago lanceolata* Grassland**	
Other Herbs							
Centaurea nigra	II	3	IV	13	IV	9
Geranium sanguineum	III	3	III	10	IV	13
Prunella vulgaris	III	6	IV	14	III	13
Linum catharticum	III	7	III	6	III	9
Hypochaeris radicata	III	5	III	7	III	8
Viola species	III	4	III	4	III	4
Campanula rotundifolia	III	6	III	7	II	5
Rhinanthus minor	II	8	III	6	III	9
Leucanthemum vulgare	I	4	II	10	III	10
Hypericum pulchrum	IV	16	I	3	I	1
Pilosella officinarum	III	12	II	6	I	5
Plantago maritima	II	4	II	2	II	11
Polygala vulgaris	II	7	II	13	I	4
Daucus carota	I	2	I	9	III	11
Leontodon autumnalis	I		I	5	II	11
Anthyllis vulneraria	II	13	I	2	II	3
Cerastium fontanum	I	1	I	3	II	11
Solidago virgaurea	I	3	II	4	I	1
Lathyrus pratensis			II	5	II	10
Ranunculus bulbosus	I	5	II	11	I	4
Asperula cynanchica	I	1	I	4	I	1
Ranunculus repens	I	1	I	4	I	1
Antennaria dioica	II	5	I	1	I	23
Senecio jacobaea	I	4	I	4	II	11
Lathyrus linifolius	I	5	I	10	I	1
Conopodium majus	I	1	I	8	I	10
Primula vulgaris	I	1	I	11	I	4
Teucrium scorodonia	II	7	I	2		
Leontodon hispidus	I	3	I	17		
Sanguisorba minor	I	8	I	36	I	3
Filipendula vulgaris	I	8	I	19	I	64
Taraxacum officinalis agg	I	4	I	8	I	3
Centaurium erythraea	I	5	I	21	I	24
Gentianella campestris	I	59	I	20	I	11
Veronica chamaedrys			I	1	I	7
Bellis perennis	I	3	I	17	I	10
Ranunculus acris			I		I	12
Vicia cracca	I	2	I	1	I	1
Pedicularis sylvatica	I	25	I	3		
Primula veris	I	2	I	2	I	4
Carlina vulgaris	I	3	I	1	I	2
Galium sterneri	I	2	I	7		
Odontites vernus					I	10

***Festuca ovina/rubra – Succisa pratensis* Grassland Group**	***Erica cinerea - Juniperus communis* Grassland/Heath**		***Anthoxanthum odoratum - Succisa pratensis* Grassland**		***Festuca ovina/rubra - Plantago lanceolata* Grassland**	
Pimpinella saxifraga			I	4	I	2
Leontodon saxatilis					I	82
Alchemilla filicaulis			I	45		
Filipendula ulmaria			I	4		
Other Herbs						
Armeria maritima					I	20
Cirsium arvense			I	3	I	4
Gentiana verna	I	3			I	4
Hypericum maculatum			I	2	I	12
Potentilla anserina					I	2
Potentilla sterilis			I	46		
Rumex acetosa					I	1
Pedicularis palustris	I	49				
Blackstonia perfoliata					I	10
Cirsium palustre			I	2		
Parnassia palustris					I	33
Rubia peregrina	I	20				
Stellaria graminea					I	9
Veronica officinalis			I	8		
Crepis capillaris					I	9
Geum rivale			I	9		
Other Grasses/Sedges/Rushes						
Cynosurus cristatus	II	2	IV	9	IV	14
Koeleria macrantha	III	8	IV	11	III	8
Dactylis glomerata	I		IV	3	IV	14
Carex panicea	III	14	IV	13	II	3
Carex caryophyllea	III	17	IV	18	II	7
Carex pulicaris	III	13	III	14	I	1
Helictotrichon pubescens	II	2	III	6	II	8
Agrostis capillaris	II	4	II	9	III	6
Agrostis canina	II	14	II	10	I	2
Danthonia decumbens	III	18	II	6	I	1
Holcus lanatus	I		II	1	II	6
Agrostis stolonifera	II	12	I	10	I	7
Molinia caerulea	II	6	I	1	I	2
Luzula campestris	I	1	II	16	II	8
Lolium perenne	I	5	I	1	I	13
Arrhenatherum elatius			I		I	1
Brachypodium sylvaticum	I	5	I	6	I	6
Carex hostiana	I	6			I	21
Poa pratensis	I				I	1
Carex nigra	I	4	I	22		
Schoenus nigricans	I	89				
Juncus articulatus			I	2		

***Festuca ovina/rubra – Succisa pratensis* Grassland Group**	***Erica cinerea - Juniperus communis* Grassland/Heath**		***Anthoxanthum odoratum - Succisa pratensis* Grassland**		***Festuca ovina/rubra - Plantago lanceolata* Grassland**	
Poa annua			I	5		
Juncus conglomeratus			I	12		
Other Orchids						
Dactylorhiza fuschii	I	3	II	9	I	3
Listera ovata	I	9	I	15	I	3
Gymnadenia conopsea	I	7	I	4		
Dactylorhiza maculata			I	17		
Coleoglossum viride			I	34		
Other Orchids						
Spiranthes spiralis	I	28			I	32
Orchis mascula			I	3		
Platanthera bifolia	I	28				
Ferns						
Pteridium aquilinum	III	5	III	4	II	2
Asplenium ruta-muraria					I	32
Other Bryophytes/Lichens						
Rhytidiadelphus squarrosus	II	4	IV	8	IV	9
Ctenidium molluscum	III	6	III	4	III	5
Calliergonella cuspidata	II	3	IV	6	III	17
Hylocomium splendens	II	4	III	3	II	1
Rhytidiadelphus triquetrus	II	7	II	4	I	2
Plagiomnium undulatum	I	6	II	10	II	22
Thuidium tamariscinum	II	10	II	9	I	5
Dicranum scoparium	II	10	II	3	I	2
Breutelia chrysocoma	I	1	II	3	I	1
Tortella tortuosa	I	1	I	4	I	4
Hylocomium brevirostre	I	2	I	4	I	3
Hypnum cupressiforme			II	4	I	2
Fissidens species	I	5	I	3	I	2
Frullania tamarisci	I	2	I	2	I	3
Neckera crispa	I	1	I		I	2
Homalothecium lutescens			I	6	I	8
Hypnum lacunosum	I	55				
Brachythecium rutabulum			I	1	I	2
Cladonia rangiformis			I	6	I	1
Lophocolea bidentata	I	25	I	25		
Pleurozium schreberi	I	16	I	3		
Racomitrium lanuginosum	I	9	I	1		
Eurhynchium striatum			I	8		
Ditrichum gracile			I	1		

Group 5 *Dryas octopetala* Heath Group

VEGETATION TYPE 5A *DRYAS OCTOPETALA – EMPETRUM NIGRUM* HEATH

Indicator Species: *Dryas octopetala, Empetrum nigrum* and *Frullania tamarisci*

This group contains only one vegetation type which is characterised by the constant presence of *Dryas octopetala*. Other ubiquitous species include *Sesleria caerulea, Carex flacca, Thymus polytrichus, Calluna vulgaris, Hypericum pulchrum, Potentilla erecta, Viola species, Festuca ovina/rubra, Campanula rotundifolia, Succisa pratensis, Euphrasia officinalis* agg. and *Lotus corniculatus.* The mosses *Scleropodium purum, Breutelia chrysocoma, Hylocomium splendens* and *Ctenidium molluscum* are also constant. This vegetation type was only recorded in the Burren.

This vegetation type was represented by 40 relevés (19 NSLP / 21 Parr *et al.* 2009) and was found in only seven NSLP sites, all of which were situated in the Burren, county Clare and seven Parr *et al.* (2009) sites in the Burren. This indicates the restricted distribution of this vegetation type. It is clear from the NMS scatterplot (Figure 6) that this type of heath community occurs in shallower soils than the typical *Calluna* heath communities. Affinities include the Annex I Habitats 4060 – Alpine and Boreal heaths and the Hertiage Council (Fossitt 2000) habitat type HH2 – Dry calcareous heaths. This *Dryas octopetala* heath type has been classified as a variant of Fossitt (2000) HH2 named HH2Dryas. It is a vegetation community strongly associated with limestone pavement and shallow calcareous soils. This vegetation type also shows affinities with the *Dryas* heath association described by Parr *et al.* (2009). According to Parr *et al.* (2009), this group has affinities with NVC (Rodwell *et al.* 1992) (CG9) (*Sesleria caerulea – Galium sterneri* grassland) and CG13 (*Dryas octopetala – Carex flacca* heath) (Table 29). This vegetation type can also be compared to that described as *Dryas – Sesleria – Hypericum pulchrum* community by McGough (1984). A full list of species for the vegetation type is given in Table 30 (synoptic). Plate 17 shows an example of the vegetation type.

Table 29 Relevant vegetation community affinities for the *Dryas octopetala* Heath Group.

Classification	Relevant Affinities
EU Annex I:	4060 – Alpine and Boreal heaths
	4030 – European dry heaths
	6210/6211 – *Festuco-Brometalia*
Fossitt (2000):	HH2 – Dry calcareous heaths
NVC:	CG9 – *Cynosurus cristatus–Centaurea nigra* grassland community
	CG13 – *Dryas octopetala – Carex flacca* heath

Plate 17 *Dryas octopetala – Empetrum nigrum* vegetation type at Aillwee, Co. Clare (NSLP07).

Table 30 Synoptic Table for the *Dryas octopetala* Heath Habitat Group.

***Dryas octopetala* Heath Group**	***Dryas octopetala - Empetrum nigrum* Heath**		
Indicator Species			
Dryas octopetala	**V**	**72**	****
Empetrum nigrum	**II**	**94**	**
Frullania tamarisci	**III**	**33**	*
Constant Species			
Breutelia chrysocoma	IV	19	
Carex flacca	V	13	
Hypericum pulchrum	V	13	
Sesleria caerulea	V	10	
Scleropodium purum	V	10	
Thymus polytrichus	V	8	
Calluna vulgaris	IV	10	
Potentilla erecta	V	7	
Hylocomium splendens	IV	9	
Viola species	IV	9	
Campanula rotundifolia	IV	9	
Succisa pratensis	V	7	
Festuca ovina/rubra	V	5	
Euphrasia officinalis agg	IV	7	
Lotus corniculatus	IV	5	
Ctenidium molluscum	IV	6	

Other Woody Species		
Arctostaphylus ursa-urvi	I	47
Helianthemum oelandicum	I	50
Rosa spinosissima	II	2
Erica cinerea	I	8
Juniperus communis	I	6
Corylus avellana	I	2
Crataegus monogyna	I	7
Other Herbs		
Solidago virgaurea	III	12
Asperula cynanchica	II	12
Linum catharticum	III	6
Rhinanthus minor	III	7
Galium sterneri	II	18
Polygala vulgaris	III	7
Geranium sanguineum	III	5
Hypochaeris radicata	II	5
Antennaria dioica	II	7
Orobanche alba	I	37
Plantago lanceolata	II	2

***Dryas octopetala* Heath Group**		***Dryas octopetala - Empetrum nigrum* Heath**
Other Herbs		
Trifolium pratense	II	2
Primula vulgaris	I	7
Carlina vulgaris	I	11
Cirsium arvense	I	41
Parnassia palustris	I	27
Trifolium repens	II	1
Galium verum	I	1
Prunella vulgaris	I	2
Achillea millefolium	I	1
Plantago maritima	I	2
Lathyrus pratensis	I	4
Teucrium scorodonia	I	3
Leucanthemum vulgare	I	1
Pilosella officinarum	I	3
Cerastium fontanum	I	2
Lathyrus linifolius	I	5
Vicia cracca	I	1
Hieracium species	I	7
Primula veris	I	3
Ranunculus bulbosus	I	2
Senecio jacobaea	I	3

Anemone nemorosa	I	19
Anthyllis vulneraria	I	
Centaurea nigra	I	
Daucus carota	I	
Filipendula ulmaria	I	1
Gentiana verna	I	3
Gentianella campestris	I	9
Geranium robertianum	I	1
Sanguisorba minor	I	5
Taraxacum officinalis agg	I	1
Orchids		
Gymnadenia conopsea	II	14
Listera ovata	I	16
Dactylorhiza fuschii	I	5
Orchis mascula	I	11
Coeloglossum viride	I	15
Other Grasses/Sedges/Rushes		
Carex pulicaris	III	17
Carex panicea	III	11
Koeleria macrantha	III	5
***Dryas octopetala* Heath Group**	***Dryas octopetala - Empetrum nigrum* Heath**	
Carex nigra	I	58
Agrostis canina	II	8
Danthonia decumbens	II	6
Other Grasses/Sedges/Rushes		
Anthoxanthum odoratum	III	2
Carex caryophyllea	II	3
Briza media	II	3
Luzula campestris	I	6
Molinia caerulea	I	1
Agrostis capillaris	I	2
Helictotrichon pubescens	I	1
Agrostis stolonifera	I	4
Dactylis glomerata	I	
Cynosurus cristatus	I	
Ferns		
Pteridium aquilinum	I	
Other Bryophytes/Lichens		
Neckera crispa	III	15
Tortella tortuosa	III	15
Dicranum scoparium	III	12
Rhytidiadelphus triquetrus	III	11
Hypnum cupressiforme	II	11

Racomitrium lanuginosum	I	21
Pleurozium schreberi	I	59
Hylocomium brevirostre	III	7
Fissidens species	II	11
Rhytidiadelphus squarrosus	III	4
Hypnum lacunosum	I	26
Thuidium tamariscinum	II	4
Cladonia rangiformis	I	6
Ditrichum gracile	I	6
Homalothecium sericeum	I	12
Cladonia portentosa	I	20
Calliergonella cuspidata	I	1
Cladonia pocillum	I	9
Bryum species	I	9
Cladonia furcata	I	9
Plagiomnium undulatum	I	1

Group 6 Sesleria caerulea - Thymus polytrichus Grassland Group

Four vegetation types are present in this grassland group, which are described below. Constant species for this group are *Sesleria caerulea, Thymus polytrichus, Ctenidium molluscum, Briza media, Succisa pratensis, Lotus corniculatus, Scleropodium purum, Carex flacca, Festuca ovina/rubra* and *Potentilla erecta.* This group contained a total of 98 relevés with an average number of 39 species per relevé. This group is characterised by shallower soils than those in groups 3 and 4. It is clear when viewing the constant species for this group that there are similarities with groups 4 and 5 described previously, with the majority of the constant species being present in all three groups. These groups presumably represent stages in a continuum from limestone grassland to limestone heath. The relevés from this group are situated on the lower end of Axis 2 in the NMS scatterplot (Figure 6) showing that they occur in shallow soils; they appear to be closely associated with those relevés found in the *Dryas* heath group.

McGough (1984) states that soils in these *Sesleria* dominated communities range from being drift to being amore typical dark organic type. The soil is shallow, rarely exceeding 5cm in depth. Calcicole mosses are frequent but common calcifuge species such as *Hylocomium splendens* and *Rhytidiadelphus* spp. are also present. McGough (1984) also notes that these *Sesleria* grasslands appear to represent a stage in progressive leaching to a more species-poor limestone heath in which heath species are increasingly dominant.

This group has affinities with the Annex I Habitats 6210 – Semi-natural dry grasslands and scrub facies on calcareous substrates (*Festuco-Brometalia*) (Priority for important orchid sites (6211)), 4030 – European dry heaths and 4060 Alpine and Boreal heaths and the Heritage Council (Fossitt 2000) habitat type GS1 – Dry and neutral grassland and HH2 – Dry calcareous heaths. This vegetation type also shows affinities with the *Dryas* heath association as well as the *Sesleria caerulea – Breutelia chrysocoma* community described by Parr *et al.* (2009). It also has affinities with NVC (Rodwell *et al.* 1992) (CG9) *Sesleria caerulea – Galium sterneri* grassland community (Table 31).

Table 31 Relevant vegetation community affinities for the *Sesleria caerulea - Thymus polytrichus* Grassland Group.

Classification	Relevant Affinities
EU Annex I:	6210/6211 – *Festuco-Brometalia*
	4030 – European dry heaths
Fossitt (2000):	GS1 – Dry and neutral grasslands
	HH2 – Dry calcareous heaths
NVC:	CG9 – *Sesleria caerulea – Galium sterneri* community

VEGETATION TYPE 6A *SESLERIA CAERULEA - DICRANUM SCOPARIUM* GRASSLAND

Indicator species: *Sesleria caerulea, Dicranum scoparium, Breutelia chrysocoma* and *Hieracium* spp.

Description: Constant species for this vegetation type include *Polygala vulgaris, Solidago virgaurea, Hypnum cupressiforme, Calluna vulgaris, Campanula rotundifolia, Viola* spp., *Hylocomium splendens, Sesleria caerulea, Thymus polytrichus, Ctenidium molluscum, Briza media, Succisa pratensis, Lotus corniculatus, Scleropodium purum, Carex flacca, Festuca ovina/rubra* and *Potentilla erecta.* This vegetation type was represented by 25 relevés (seven NSLP / 18 Parr *et al.* (2009)) and was found in five NSLP sites, in counties Clare and Galway and six Parr *et al.* (2009) sites in the Burren. This vegetation type has a higher frequency of woody species such as *Calluna vulgaris*, compared with the others in the group. It has direct comparisons to the Parr *et al.* (2009) *Solidago virgaurea – Hypericum pulchrum* sub-group of the *Sesleria caerulea – Breutelia chrysocoma* group. A full list of species for the vegetation type is given in Table 32 (synoptic). Affinities with the group as a whole are given in Table 31. Plate 18 shows an example of the vegetation type.

Plate 18 *Sesleria caerulea - Dicranum scoparium* vegetation type at Grange East, Co. Galway (NSLP41).

VEGETATION TYPE 6B *SESLERIA CAERULEA - ANTHYLLIS VULNERARIA* GRASSLAND

Indicator species: *Anthyllis vulneraria, Leontodon hispidus, Linum catharticum, Polygala vulgaris, Gentianella amarella, Gymnadenia conopsea* and *Ctenidium molluscum.*

Description: Constant species for this vegetation type include *Plantago lanceolata, Galium verum, Trifolium pratense, Trifolium repens, Prunella vulgaris, Centaurea nigra, Anthoxanthum odoratum, Cynosurus cristatus, Carex caryophyllea, Carex panacea, Anthyllis vulneraria, Linum catharticum, Polygala vulgaris, Sesleria caerulea, Thymus polytrichus, Ctenidium molluscum, Briza media, Succisa pratensis, Lotus corniculatus, Scleropodium purum, Carex flacca, Festuca ovina/rubra and Potentilla erecta.* This vegetation type was represented by 19 relevés (11 NSLP / eight Parr *et al.* (2009)) and was found in five NSLP sites in counties Clare, Donegal and Galway and six Parr *et al.* (2009) sites in the Burren. This vegetation type has a higher frequency of typical grassland species compared with type 6a and has similarities with some of the vegetation types in group 3 (*Holcus lanatus – Trifolium repens*). It also has direct comparisons to the Parr *et al.* (2009) *Anthyllis vulneraria – Plantago maritima* sub-group of the *Sesleria caerulea – Breutelia chrysocoma* group. It is species-rich, with an average of 40 species per relevé, although as many as 45 species were found (1m x 1m). A full list of species for the vegetation type is given in Table 32 (synoptic). Affinities with the group as a whole are given in Table 31. Plate 19 shows an example of the vegetation type.

Plate 19 *Sesleria caerulea – Anthyllis vulneraria* vegetation type at Gortlecka, Co. Clare (NSLP02).

VEGETATION TYPE 6C *SESLERIA CAERULEA- THYMUS POLYTRICHUS* GRASSLAND

Indicator species: *Koeleria macrantha, Hypnum cupressiforme, Cladonia rangiformis, Hylocomium brevirostre, Ditrichum gracile, Homalothecium lutescens.*

Description: Constant species for this vegetation type include *Campanula rotundifolia*, *Plantago lanceolata*, *Viola* spp., *Galium verum*, *Geranium sanguineum*, *Trifolium pratense*, *Trifolium repens*, *Hypochoeris radicata*, *Euphrasia officinalis* agg., *Achillea millefolium*, *Anthoxanthum odoratum*, *Carex caryophyllea*, *Linum catharticum*, *Sesleria caerulea*, *Thymus polytrichus*, *Ctenidium molluscum*, *Briza media*, *Succisa pratensis*, *Lotus corniculatus*, *Scleropodium purum*, *Carex flacca*, *Festuca ovina/rubra* and *Potentilla erecta.* Other mosses include *Hylocomium splendens*, *Rhytidiadelphus squarrosus*, *Rhytidiadelphus triquetrus,* and *Thuidium tamariscinum*. This vegetation type was represented by 34 relevés, the majority of which were from Parr *et al.* (2009) and was found in two NSLP sites in counties Clare and Galway and 11 Parr *et al.* (2009) sites in the Burren. This vegetation type has a higher frequency of typical grassland species compared with type 6a and has similarities with some of the vegetation types in group 3 (*Holcus lanatus – Trifolium repens*). It also has direct comparisons to the Parr *et al.* (2009) *Sesleria caerulea – Thymus polytrichus* sub-group of the *Sesleria caerulea – Breutelia chrysocoma* group. A full list of species for the vegetation type is given in Table 31 (synoptic). Affinities with the group as a whole are given in Table 32. Plate 20 shows an example of the vegetation type.

Plate 20 *Sesleria caerulea – Thymus polytrichus* vegetation type at Clooneen, Co. Clare (NSLP18).

VEGETATION TYPE 6D *SESLERIA CAERULEA- PLANTAGO MARITIMA* GRASSLAND

Indicator species: *Plantago maritima, Neckera crispa, Asperula cynanchica, Solidago virgaurea, Carlina vulgaris, Cladonia pocillum.*

Description: Constant species for this vegetation type include *Breutelia chrysocoma, Hypnum cupressiforme, Campanula rotundifolia*, *Viola* spp., *Plantago lanceolata, Geranium sanguineum, Hypochoeris radicata, Anthoxanthum odoratum, Linum catharticum, Polygala vulgaris, Sesleria caerulea, Thymus polytrichus, Ctenidium molluscum, Briza media, Succisa pratensis, Lotus corniculatus, Scleropodium purum, Carex flacca, Festuca ovina/rubra* and *Potentilla erecta.* This vegetation type was represented by 20 relevés (four NSLP / 16 Parr *et al.* (2009)) and was found in three NSLP sites and 13 Parr *et al.* (2009) sites in the Burren. This vegetation type has direct comparisons to the Parr *et al.* (2009) *Anthyllis vulneraria – Plantago maritima* sub-group of the *Sesleria caerulea – Breutelia chrysocoma* group. A full list of species for the vegetation type is given in Table 32 (synoptic). Affinities with the group as a whole are given in Table 31. Plate 21 shows an example of the vegetation type.

Plate 21 *Sesleria caerulea – Plantago maritima* vegetation type at Inishmore, Co. Galway (NSLP27).

Table 32 Synoptic Table for the *Sesleria caerulea - Thymus polytrichus* Grassland Group.

***Sesleria caerulea - Thymus polytrichus* Grassland Group**	***Sesleria caerulea - Dicranum scoparium* Grassland**			***Sesleria caerulea - Anthyllis vulneraria* Grassland**			***Sesleria caerulea- Thymus polytrichus* Grassland**			***Sesleria caerulea - Plantago maritima* Grassland**		
Constant Species												
Sesleria caerulea	**V**	**34**	**	**V**	**8**		**V**	**9**		**V**	**15**	
Thymus polytrichus	**V**	**18**		**IV**	**10**		**V**	**25**		**V**	**9**	
Ctenidium molluscum	**V**	**14**		**V**	**19**	*	**V**	**15**		**V**	**10**	
Briza media	**V**	**9**		**V**	**24**		**IV**	**10**		**IV**	**6**	
Succisa pratensis	**V**	**9**		**V**	**8**		**V**	**9**		**V**	**5**	
Lotus corniculatus	**V**	**6**		**V**	**10**		**V**	**9**		**V**	**5**	
Scleropodium purum	**IV**	**7**		**IV**	**12**		**V**	**8**		**IV**	**6**	
Carex flacca	**V**	**13**		**IV**	**8**		**V**	**4**		**V**	**6**	
Festuca ovina/rubra	**V**	**8**		**V**	**3**		**V**	**6**		**V**	**4**	
Potentilla erecta	**V**	**6**		**V**	**8**		**V**	**7**		**V**	**5**	
***Sesleria caerulea - Dicranum scoparium* Grassland vegetation type indicator species**												
Dicranum scoparium	IV	41	**	II	7		III	5		III	5	
Breutelia chrysocoma	IV	24	*	III	7		V	20		IV	6	
Hieracium species	II	76	*				I	4		I	14	
***Sesleria caerulea - Anthyllis vulneraria Grassland* vegetation type indicator species**												
Anthyllis vulneraria	I	4		IV	34	**	II	12		II	13	
Leontodon hispidus	I	1		III	45	**						
Linum catharticum	III	9		IV	18	*	V	10		IV	12	
Polygala vulgaris	IV	12		IV	23	*	III	10		IV	10	
Gentianella amarella				I	100	*						
Gymnadenia conopsea	I	8		III	24	*	II	15		II	18	
***Sesleria caerulea- Thymus polytrichus Grassland* vegetation type indicator species**												
Hypnum cupressiforme	IV	11		II	7		V	33	**	IV	17	
Koeleria macrantha	II	3		III	17		V	19	*	III	3	
Cladonia rangiformis	II	14		II	9		IV	26	*	III	27	
Hylocomium brevirostre	I	10		I	18		III	27	*	II	7	
Ditrichum gracile	I	5		I	16		II	48	*	III	20	
Homalothecium lutescens				I	4		II	47	*	I	3	
***Sesleria caerulea - Plantago maritima Grassland* vegetation type indicator species**												
Plantago maritima	I	5		I	2		I			IV	41	**
Neckera crispa	III	17		II	4		II	7		IV	43	**
Asperula cynanchica	III	22		III	10		II	14		IV	31	**
Solidago virgaurea	IV	24		II	5		II	9		IV	28	*
Carlina vulgaris	II	26		II	14		I	8		III	35	*

***Sesleria caerulea - Plantago maritima Grassland* vegetation type indicator species**	***Sesleria caerulea - Dicranum scoparium* Grassland**		***Sesleria caerulea - Anthyllis vulneraria* Grassland**		***Sesleria caerulea- Thymus polytrichus* Grassland**		***Sesleria caerulea - Plantago maritima* Grassland**		
Cladonia pocillum					II	41	II	44	*
Other Woody Species									
Rosa spinosissima	III	5	II	8	I	1	III	7	
Calluna vulgaris	IV	9	I		I	1	II	1	
Dryas octopetala	II	17	I				I	2	
Corylus avellana	I	8	I	2	I	37	I	5	
Crataegus monogyna	I	2	I	6	I	26	I	41	
Rubus fruticosus			I	5	I	40	I	12	
Hedera helix			I	9	I	29	I	16	
Juniperus communis	I	13					I		
Prunus spinosa	I	9	I	1	I	5			
Helianthemum oelandicum							I	8	
Salix repens			I	77					
Rubus saxatilis	I	84							
Lonicera periclymenum					I	76			
Other Herbs									
Campanula rotundifolia	IV	11	III	10	V	14	V	12	
Plantago lanceolata	II	2	IV	4	V	5	IV	1	
Viola species	IV	10	III	5	IV	16	V	12	
Galium verum	II	2	V	16	V	15	II	1	
Geranium sanguineum	III	4	II	6	IV	5	V	12	
Trifolium pratense	I	1	IV	6	V	11	III	4	
Trifolium repens	I		IV	6	V	9	II	1	
Hypochaeris radicata	II	2	II	3	IV	18	IV	7	
Euphrasia officinalis agg	II	6	III	6	IV	7	II	3	
Hypericum pulchrum	III	12	III	11	III	6	III	12	
Pilosella officinarum	III	13	II	12	III	13	III	18	
Achillea millefolium	I		III	2	V	11	II	2	
Prunella vulgaris	I	1	IV	8	III	5	III	8	
Centaurea nigra	I	1	IV	9	II	1	II	2	
Teucrium scorodonia	III	36	II	8	II	10	III	16	
Leucanthemum vulgare	I	2	III	18	II	5	II	5	
Senecio jacobaea	II	16	I	5	II	15	II	20	
Rhinanthus minor	I	1	II	3	II	2	III	11	
Antennaria dioica	II	28	I	3	I	6	II	12	
Daucus carota	I	2	III	20	I	5	I	3	
Lathyrus pratensis			I	2	III	20	I	7	
Cerastium fontanum	I	1	II	4	II	6	I	3	
Galium sterneri	I	10	I	4	II	22	II	20	
Primula vulgaris	I	1	I	5	II	22	II	19	
Conopodium majus			II	8	I	13	I	1	
Ranunculus bulbosus	I	1	II	7	I	5	I	2	
Leontodon autumnalis			I	3	I	2	I	3	

***Sesleria caerulea - Plantago maritima Grassland* vegetation type indicator species**	***Sesleria caerulea - Dicranum scoparium* Grassland**		***Sesleria caerulea - Anthyllis vulneraria* Grassland**		***Sesleria caerulea- Thymus polytrichus* Grassland**		***Sesleria caerulea - Plantago maritima* Grassland**	
Bellis perennis			II	15	I	8		
Other Herbs								
Taraxacum officinalis agg			I	6	I	3	I	11
Veronica chamaedrys			I	2	II	4		
Ranunculus acris			I	3	I		I	1
Gentiana verna	I	63	I	6			I	17
Primula veris			I	3			I	9
Ranunculus repens			I	1	I	1	I	
Sanguisorba minor			I	4	I	1	I	11
Pimpinella saxifraga	I	9	I	4				
Blackstonia perfoliata	I	25	I	16	I	9		
Fragaria vesca					I	37	I	63
Vicia cracca					I	1	I	3
Odontites vernus					I	12		
Centaurium erythraea			I	10	I	11		
Crepis capillaris					I	18	I	15
Leontodon saxatilis	I	5			I	8		
Lathyrus linifolius	I	1					I	1
Veronica officinalis					I	59		
Cerastium arvense					I	53		
Geranium robertianum			I	40	I	2		
Stellaria graminea			I	15	I	9		
Vicia sepium					I	2		
Alchemilla filicaulis							I	11
Armeria maritima							I	80
Centaurea scabiosa			I	21				
Midicago lupulina			I	4				
Orobanche alba							I	37
Filipendula vulgaris	I	2						
Filipendula ulmaria					I	1		
Potentilla anserina					I	1		
Alchemilla xanthochlora					I	28		
Other Orchid Species								
Dactylorhiza fuschii	I	6	II	13	I	3	I	4
Orchis mascula	I	17	I	6	I	15	I	21
Listera ovata	I	4			II	25	I	5
Dactylorhiza maculata	I	8						
Platanthera bifolia							I	53
Coeloglossum viride					I	18		
Other Grasses/Sedges/Rushes								
Anthoxanthum odoratum	III	3	IV	7	V	5	IV	2
Carex caryophyllea	III	3	IV	20	IV	8	III	6
Carex panicea	II	3	IV	13	III	4	III	3
Helictotrichon pubescens	I	1	III	16	III	6	II	3

***Sesleria caerulea - Plantago maritima Grassland* vegetation type indicator species**	***Sesleria caerulea - Dicranum scoparium* Grassland**		***Sesleria caerulea - Anthyllis vulneraria* Grassland**		***Sesleria caerulea- Thymus polytrichus* Grassland**		***Sesleria caerulea - Plantago maritima* Grassland**	
Carex pulicaris	III	6	II	5	II	4	II	8
Cynosurus cristatus			IV	7	III	6	I	1
Danthonia decumbens	II	17	III	24	I	2	II	5
Dactylis glomerata			III	3	III	3	I	
Agrostis capillaris	I		II	4	II	2	I	1
Other Grasses/Sedges/Rushes								
Agrostis canina	I	1	II	8	I	1	II	4
Holcus lanatus			II	3	I	1	I	
Luzula campestris	I	2			II	6	I	2
Arrhenatherum elatius			I	3	II	14		
Poa pratensis			I	2	I	1	I	1
Agrostis stolonifera	I		I	1	I		I	2
Lolium perenne			I	2	I	8	I	1
Molinia caerulea	I	1	I	1			I	3
Brachypodium sylvaticum	I	49						
Carex nigra					I	5		
Juncus articulatus					I	2		
Trisetum flavescens					I	11		
Ferns								
Pteridium aquilinum	II	6	II	1	II	3	I	
Asplenium ruta-muraria					I	30		
Other Bryophytes/Lichens								
Tortella tortuosa	III	12	III	12	III	16	IV	15
Hylocomium splendens	IV	12	II	2	IV	15	II	2
Rhytidiadelphus squarrosus	II	2	II	2	IV	5	III	2
Rhytidiadelphus triquetrus	II	1	II	2	IV	5	III	4
Frullania tamarisci	II	6	II	9	III	16	II	20
Calliergonella cuspidata	I		IV	17	II	3	II	1
Thuidium tamariscinum	I		II	3	IV	6	I	2
Fissidens species	II	11	I	14	II	10	II	20
Racomitrium lanuginosum	I	1			II	19	I	30
Plagiomnium undulatum	I	1	I	1	II	10	I	1
Cladonia furcata					I	51	I	34
Syntrichia ruralis-ruralis	I	9	I	60	I	20	I	11
Bryum species					I	42	I	36
Homalothecium sericeum					I	41	I	39
Brachythecium rutabulum			I	9	I	1		
Scapania aspera			I	55			I	26
Cladonia portentosa	I	16			I	35		
Hypnum lacunosum			I	7				
Climacium dendroides					I	22		
Eurhynchium striatum	I	2			I	2		

Group 7 Calluna vulgaris Heath Group

Two vegetation types are present in this heath group, which are described below. Constant species for this group are *Calluna vulgaris, Potentilla erecta, Succisa pratensis, Lotus corniculatus, Carex flacca, Festuca ovina/rubra, Sesleria caerulea* and *Scleropodium purum.* This group contained a total of 82 relevés with an average number of 31 species per relevé. This group is characterised by deeper soils than those found in the *Dryas octopetala* heath group. This is supported by the NMS analysis (Figure 6), with relevés from this group positioned at the higher end of Axis 2. The group was characterised by the constant presence of *Calluna vulgaris* and the less frequent presence of calcicole species. This group represents more typical 'heath' communities that occur as associated limestone pavement habitats in areas where the leaching of soils has taken place.

This group has affinities with the Annex I Habitats 4030 – European dry heaths and 4060 Alpine and Boreal heaths and the Hertiage Council (Fossitt 2000) HH2 – Dry calcareous heaths and GS4 Wet grasslands. This vegetation type also shows affinities with the *Calluna* heath association as well as the *Dryas* heath community described by Parr *et al.* (2009). It also has affinities with NVC (Rodwell *et al.* 1992) H10, *Calluna vulgaris – Erica cinerea* heath and CG13 - *Dryas octopetala – Carex flacca* heath (Table 33).

Table 33 Relevant vegetation community affinities for the *Calluna vulgaris* Heath Group.

Classification	Relevant Affinities
EU Annex I:	4030 – European dry heaths
	4060 – Alpine and Boreal heaths
Fossitt (2000):	HH2 – Dry calcareous heaths
	GS4 – Wet grasslands
NVC:	H10 – *Calluna vulgaris – Erica cinerea* heath community
	CG13 – *Dryas octopetala – Carex flacca* heath

VEGETATION TYPE 7A *CALLUNA VULGARIS-POTENTILLA ERECTA* HEATH

Indicator species: *Calluna vulgaris, Potentilla erecta, Thuidium tamariscinum.*

Description: Constant species for this group are *Thymus polytrichus, Viola* spp., *Plantago lanceolata, Hypericum pulchrum, Anthoxanthum odoratum, Hylocomium splendens, Calluna vulgaris, Potentilla erecta, Succisa pratensis, Lotus corniculatus, Carex flacca, Festuca ovina/rubra, Sesleria caerulea* and *Scleropodium purum.* This vegetation type is typical of the Fossitt (2000) description of dry calcareous heath. It was represented by 55 relevés (26 NSLP / 29 Parr *et al.* (2009)) and was found in 13 NSLP sites and 12 Parr

et al. (2009) sites in the Burren. It characterises typical lowland heath. Other typical species encountered include *Geranium sanguineum*, *Campanula rotundifolia* and *Carex pulicaris.* This vegetation type has direct comparisons to the Parr *et al.* (2009) *Calluna heath: typical* sub-group of the *Calluna vulgaris* group. A full list of species for the vegetation type is given in Table 34 (synoptic). Affinities with the group as a whole are given in Table 33. Plate 22 shows an example of this vegetation type.

Plate 22 *Calluna vulgaris - Potentilla erecta* vegetation type at Murrooghtoohy North, Co. Galway (NSLP01).

VEGETATION TYPE 7B *CALLUNA VULGARIS-MOLINIA CAERULEA* HEATH

Indicator species: *Molinia caerulea, Lathyrus linifolius, Carex hostiana and Potentilla fruticosus.*

Description: Constant species for this group are *Geranium sanguineum, Carex pulicaris, Carex panicea, Ctenidium molluscum, Calluna vulgaris, Potentilla erecta, Succisa pratensis, Lotus corniculatus, Carex flacca, Festuca ovina/rubra, Sesleria caerulea and Scleropodium purum.* This vegetation type represents wetter conditions than those found in type 7a, with more water-logged soils. *Calluna vulgaris* is still present in this vegetation type but the percentage cover is generally lower than in type 7a and *Molinia caerulea* dominates. It was represented by 27 relevés (14 NSLP / 13 Parr *et al.* (2009)) and was found in nine NSLP sites and three Parr *et al.* (2009) sites in the Burren. Other typical species encountered include *Plantago maritima* and *Pedicularis sylvatica.* This vegetation type has direct comparisons to the Parr *et al.* (2009) *Calluna heath: calcareous Molinia* and *Calluna heath: calcareous Molinia – Erica cinerea* sub-

groups of the *Calluna vulgaris* group. A full list of species for the vegetation type is given in Table 34 (synoptic). Affinities with the group as a whole are given in Table 33. Plate 23 shows an example of this vegetation type.

Plate 23 *Calluna vulgaris - Molinia caerulea* vegetation type at Gortlecka, Co. Clare (NSLP02).

Table 34 Synoptic Table for the *Calluna vulgaris* Heath Group.

***Calluna vulgaris* Heath Group**	***Calluna vulgaris-Potentilla erecta* Heath**			***Calluna vulgaris-Molinia caerulea* Heath**	
Constant Species					
Calluna vulgaris	**V**	**42**	*******	**V**	**21**
Potentilla erecta	**V**	**14**	*****	**V**	**12**
Succisa pratensis	**V**	**11**		**V**	**9**
Lotus corniculatus	**V**	**9**		**V**	**3**
Carex flacca	**V**	**9**		**IV**	**6**
Festuca ovina/rubra	**V**	**7**		**V**	**4**
Sesleria caerulea	**V**	**7**		**IV**	**4**
Scleropodium purum	**V**	**10**		**IV**	**4**
***Calluna vulgaris-Potentilla erecta* Heath vegetation type Indicator Species**					
Thuidium tamariscinum	III	41	**	I	1

***Calluna vulgaris-Molinia caerulea Heath* vegetation type Indicator Species**					
Molinia caerulea	II	2	V	80	****
Lathyrus linifolius	II	27	III	26	*
Carex hostiana			II	73	*
Potentilla fruticosa			I	100	*
Other Woody Species					
Thymus polytrichus	IV	6	III	2	
Rosa spinosissima	II	4	III	5	
Erica cinerea	I	9	II	25	
Dryas octopetala	II	7	I		
Juniperus communis	I	4	I	7	
Corylus avellana	I	13	I	27	
Arctostaphylos uva-ursi	I	7	I	46	
Hedera helix	I	41			
Prunus spinosa	I	5			
Rubus fruticosus	I	19			
Salix repens			I	4	
Crataegus monogyna	I	6			
Helianthemum oelandicum			I	17	
Rubus saxatilis	I	16			
Empetrum nigrum	I	6			
Lonicera periclymenum	I	9			
Other Herbs					
Viola species	IV	10	III	7	
Plantago lanceolata	IV	3	III	3	
Geranium sanguineum	III	9	IV	9	
Campanula rotundifolia	III	8	III	5	
***Calluna vulgaris* Heath Group**	***Calluna vulgaris-Potentilla erecta Heath***		***Calluna vulgaris-Molinia caerulea Heath***		
Other Herbs					
Hypericum pulchrum	IV	13	III	8	
Galium verum	III	4	II	3	
Euphrasia officinalis agg	III	8	III	5	
Trifolium repens	III	3	II	2	
Trifolium pratense	III	3	II	5	
Prunella vulgaris	II	4	III	4	
Linum catharticum	III	8	II	3	
Achillea millefolium	II	4	II	1	
Hypochaeris radicata	II	6	II	5	
Plantago maritima	I		III	21	
Solidago virgaurea	II	3	II	4	
Polygala vulgaris	II	6	II	4	
Centaurea nigra	I	1	II	1	

Antennaria dioica	II	5	II	9
Lathyrus pratensis	II	22	I	2
Primula vulgaris	II	24	I	3
Vicia cracca	I	4	I	2
Teucrium scorodonia	II	18	I	
Asperula cynanchica	I	2	I	3
Taraxacum officinalis agg	I	4	I	10
Rhinanthus minor	I	1	I	1
Cerastium fontanum	I	2	I	3
Pilosella officinarum	I	3	I	1
Leucanthemum vulgare	I	3	I	1
Cirsium dissectum	I	63	I	37
Pedicularis sylvatica			I	68
Anthyllis vulneraria			I	2
Geranium robertianum	I	57		
Galium sterneri	I	7		
Leontodon autumnalis	I		I	1
Blackstonia perfoliata	I	6	I	11
Pedicularis palustris	I	17	I	34
Potentilla sterilis	I	2	I	4
Ranunculus repens	I		I	
Filipendula ulmaria	I	4		
Primula veris	I	3		
Anemone nemorosa	I	81		
Centaurium erythraea			I	7
Conopodium majus	I	1		
Daucus carota			I	
Filipendula vulgaris			I	2
Gentiana verna			I	4
***Calluna vulgaris* Heath Group**	***Calluna vulgaris-Potentilla erecta* Heath**		***Calluna vulgaris-Molinia caerulea* Heath**	
Orobanche alba	I	27		
Parnassia palustris			I	40
Potentilla anserina			I	6
Other Herbs				
Ranunculus bulbosus	I	1		
Rubia peregrina	I	80		
Sanguisorba minor			I	2
Veronica chamaedrys	I	1		
Vicia sepium	I	1		
Carlina vulgaris	I	1		
Leontodon hispidus	I			
Ranunculus acris	I			
Rumex acetosa	I			
Geum rivale	I	29		

Orchids				
Dactylorhiza fuschii	I	5	II	8
Dactylorhiza maculata	I	2	II	22
Listera ovata	I	14	I	4
Orchis mascula	I	4	I	12
Gymnadenia conopsea	I	4	I	2
Coeloglossum viride	I	33		
Platanthera bifolia	I	19		
Other Grasses/Sedges/Rushes				
Anthoxanthum odoratum	IV	6	III	3
Carex pulicaris	III	9	IV	17
Carex panicea	II	4	IV	10
Koeleria macrantha	III	5	II	3
Agrostis canina	II	21	III	17
Briza media	II	3	II	3
Carex caryophyllea	II	2	I	1
Danthonia decumbens	I	6	II	6
Helictotrichon pubescens	II	4	I	2
Agrostis capillaris	I	3	II	3
Dactylis glomerata	II	1	I	1
Cynosurus cristatus	I	3	I	
Agrostis stolonifera	I	8	I	3
Luzula campestris	I	4		
Holcus lanatus	I		I	
Carex nigra			I	11
Schoenus nigricans			I	11
Juncus articulatus			I	81
Poa pratensis	I	1		
Arrhenatherum elatius	I			
***Calluna vulgaris* Heath Group**	***Calluna vulgaris-Potentilla erecta* Heath**		***Calluna vulgaris-Molinia caerulea* Heath**	
Brachypodium sylvaticum	I	18		
Juncus conglomeratus	I	8		
Ferns				
Pteridium aquilinum	II	5	I	1
Asplenium ruta-muraria	I	37		
Other Bryophytes/Lichens				
Ctenidium molluscum	III	8	IV	7
Hylocomium splendens	IV	16	II	2
Rhytidiadelphus squarrosus	III	7	II	2
Breutelia chrysocoma	III	12	II	3
Rhytidiadelphus triquetrus	III	19	I	
Dicranum scoparium	III	10	I	3

Hylocomium brevirostre	II	12	I	1
Neckera crispa	I	3	II	6
Calliergonella cuspidata	I	1	II	2
Tortella tortuosa	II	6	I	5
Hypnum cupressiforme	II	6	I	
Frullania tamarisci	I	4	I	1
Plagiomnium undulatum	I	7	I	2
Fissidens species	I	4	I	10
Cladonia rangiformis	I	10		
Pleurozium schreberi	I	85	I	15
Racomitrium lanuginosum	I	20		
Lophocolea bidentata	I	17	I	34
Eurhynchium striatum			I	11
Homalothecium lutescens			I	1
Pleurozium schreberi	I	22		
Scapania aspera			I	19
Cladonia furcata	I	6		
Homalothecium sericeum	I	3		

Assessment of EU Annex I habitat conservation status

Conservation status assessment at site level

The following are the results of the National Limestone pavement and associated habitats monitoring survey. A total of 282 monitoring stops were recorded in 26 monitoring sites. This includes those recorded in the pilot survey (Murphy & Fernández 2009). The conservation status was assessed at 25 of these sites; the remaining site in Killarney National Park (NSLP15) will be assessed separately as part of the *Taxus baccata* woods (91J0) conservation status assessment (Cross & Lynn 2012).

AREA

This project involved the collection of baseline data for Limestone pavement in Ireland. Therefore, it was not possible to calculate the changes in habitat area over time. Any estimation based on ortho-photography would have been inaccurate, particularly at the level of mapping undertaken. Data on habitat extent generated as part of this survey should be taken as a baseline and used to measure future changes.

STRUCTURE AND FUNCTIONS

The results for structure and functions of the four EU Annex I habitats assessed (Limestone pavements (exposed) and Limestone pavements (wooded) (8240), Semi-natural dry grasslands and scrubland facies on calcareous substrates (6210), Alpine and Boreal heaths (4060) and European dry heaths (4030)) are given below. The results for the other two EU Annex I Habitats known to be associated with Limestone pavement (8240), namely *Juniperus communis* formations on heaths or calcareous grasslands (5130) and *Taxus baccata* woods (91J0) were not assessed. Information on the conservation status of these habitats can be found in Cooper *et al.* (2012) and Cross & Lynn (2012) respectively.

LIMESTONE PAVEMENT (EXPOSED) (8240)

Structure and Functions were assessed at a total of 133 monitoring stops (i.e. relevés) containing exposed limestone pavement within the 25 sites. A total of five criteria were assessed; positive indicator species, negative indicator species, bracken cover, scrub cover and non-native species cover (Appendix 5). This habitat failed at four sites (Table 35). An inadequate number of positive indicators, high cover of negative indicators, high cover of scrub and non-native species (*Cotoneaster* spp., *Clematis vitalba, Centranthus ruber*) were the reasons for these failed assessments; see Table 36 for a breakdown of percentage pass rates for each attribute assessed. Expert judgement was used in some cases; two sites (NSLP20 and NSLP27) failed at attribute level for the presence of negative indicators

but this was not deemed enough to justify a negative assessment for the site on the whole. See Appendix 12 for further details. As this was a baseline survey, the trend for the structure and functions assessment for Limestone pavement (exposed) (8240) is unknown.

Table 35 Structure and functions results for Limestone pavement and associated habitats at each monitoring site.

Site Code	8240 (exposed)	8240 (wooded)	6210	4060	4030	Overall Site Structure and Functions
NSLP01	Pass		Pass	Pass	Pass	Favourable
NSLP02	Pass	Pass	Pass		Pass	Favourable
NSLP03	Pass		Fail		Pass	Unfavourable - Inadequate
NSLP04	Pass		Pass	Pass	Pass	Favourable
NSLP05	Fail	Pass	Pass		Pass	Unfavourable - Inadequate
NSLP06	Pass	Pass	Fail			Unfavourable - Bad
NSLP07	Pass		Pass	Pass	Pass	Favourable
NSLP08	Pass		Pass	Pass	Pass	Favourable
NSLP09	Pass	Pass	Pass	Pass	Pass	Favourable
NSLP10	Pass		Fail	Pass	Pass	Unfavourable - Inadequate
NSLP12	Fail	Pass				Unfavourable - Inadequate
NSLP13	Pass		Pass		Pass	Favourable
NSLP14	Pass					Favourable
NSLP16	Pass	Pass	Fail		Pass	Unfavourable - Inadequate
NSLP17	Pass	Pass	Fail		Pass	Unfavourable - Inadequate
NSLP18	Pass		Fail		Pass	Unfavourable - Inadequate
NSLP19	Pass					Favourable
NSLP20	Pass		Fail		Pass	Unfavourable - Inadequate
NSLP21	Pass		Fail		Pass	Unfavourable - Inadequate
NSLP22	Pass		Pass	Pass	Pass	Favourable
NSLP23	Pass		Pass		Pass	Favourable
NSLP24	Fail		Pass			Unfavourable - Inadequate
NSLP26	Pass		Fail		Pass	Unfavourable - Inadequate
NSLP27	Pass		Pass		Pass	Favourable
NSLP29	Fail		Pass		Pass	Unfavourable - Inadequate

Table 36 Percentage pass rates for structure and functions attributes assessed for the Annex I Habitat 8240. (Total number of monitoring stops = 133).

Assessment Criteria	Pass	Fail	% Pass
Positive indicator species	127	6	95%
Negative indicator species	118	15	89%
Bracken cover	133	0	100%
Non-native species cover	131	2	98%
Scrub cover	131	2	98%

LIMESTONE PAVEMENT (WOODED) (8240)

Structure and Functions were assessed at a total of 9 monitoring stops (i.e. relevés) containing wooded limestone pavement within 7 sites. A total of seven criteria were assessed; positive indicator species, negative indicator species, canopy cover, bryophyte cover, grazing pressure, deadwood and non-native shrub/tree regeneration (Appendix 5). This habitat passed at all sites (Table 35). See Appendix 12. As this was a baseline survey, the trend for the structure and functions assessment for Limestone pavement (wooded), (8240) is unknown.

SEMI-NATURAL DRY GRASSLANDS AND SCRUBLAND FACIES ON CALCAREOUS SUBSTRATES (*FESTUCO-BROMETALIA*) (IMPORTANT ORCHID SITES) (6210/6211)

Structure and Functions were assessed at a total of 66 monitoring stops (i.e. relevés) containing Annex I habitat 6210/6211 within 22 monitoring sites. A total of nine criteria were assessed; high quality positive indicator species, positive indicator species, negative indicator species (individual and collective cover), forb:grass ratio, scrub /bracken cover, sward height, cover of disturbed ground and non-native species cover (Appendix 5).

Initially, litter cover was considered as an additional criterion to assess. Litter cover can be used as an indicator of grazing conditions, and although the percentage of litter cover (<25% required) was assessed, this attribute was not taken into account in the structure and functions assessment. The litter cover was very high in the majority of the monitoring stops and thus most of the stops would have failed this attribute. The majority of the NSLP sites are winterage sites, which were surveyed at the end of the growing season prior to the grazing period. According to JNCC (2004a) methodologies, litter cover is considered a secondary attribute and should be used to provide substantiating evidence for an assessment but should not be used as a primary indicator of conditions. Therefore it was considered justifiable to exclude this attribute from the assessment, although the importance of this target may need to be re-assessed in the future.

The *Festuco-Brometalia* habitat failed at nine of the monitoring sites (Table 35). All of these sites fail as a result of a low Forbs ratio, an inadequate number of positive indicators, high cover of negative indicators and scrub/bracken/heath encroachment; see Table 37 for a breakdown of percentage pass rates for each attribute assessed. Several sites (NSLP01, 02, 08, 23) failed at attribute level for the presence of negative indicators, forbs ratio and lack of positive indicator species, but this was not deemed enough to justify a negative assessment for the site on the whole, re-iterating the fact that expert judgement must be used in many cases. See Appendix 12 for details of the results. As this was a baseline survey, the trend for the structure and functions assessment for Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (important orchid sites) (6210/6211) is unknown.

Table 37 Percentage pass rates for structure and functions attributes assessed for the Annex I Habitat 6210. (Total number of monitoring stops = 66).

Assessment Criteria	Pass	Fail	% Pass
High quality positive indicator species	58	8	88%
Positive indicator species	61	5	92%
Negative indicator species - Individual cover	52	14	79%
Negative indicator species - Collective cover	60	6	91%
Non-native species cover	66	0	100%
Forb:Grasses/Sedges ratio	60	6	91%
Scrub/Bracken encroachment cover	61	5	92%
Sward height	66	0	100%
Cover of disturbed ground	66	0	100%

ALPINE AND BOREAL HEATHS (4060)

Structure and Functions were assessed at a total of 19 monitoring stops containing Annex I habitat 4060 within seven of the monitoring sites. A total of five criteria were assessed; positive indicator species, negative indicator species, tree and shrub cover, cover of disturbed ground and non-native species (Appendix 5). This habitat passed at all the sites (Table 35; Appendix 12). As this was a baseline survey, the trend for the structure and functions assessment for Alpine and Boreal heaths (4060) is unknown.

EUROPEAN DRY HEATHS (4030)

Structure and Functions were assessed at a total of 55 monitoring stops containing Annex I habitat 4030 within 20 of the monitoring sites. A total of five criteria were assessed; positive indicator species, negative indicator species, tree and shrub cover, cover of disturbed ground and non-native species cover (Appendix 5). This habitat passed at all the sites (Table 35). Although positive indicators and negative indicator attributes failed at some of the monitoring stops, this was not deemed enough to justify a negative assessment on the whole (Appendix 12). As this was a baseline survey, the trend for the structure and functions assessment for European dry heaths (4030) is unknown.

OVERALL STRUCTURE AND FUNCTIONS FOR LIMESTONE PAVEMENT AND ASSOCIATED HABITATS (8240)

The results of an overall assessment of the structure and functions of the priority habitat 8240 taking into consideration the assessment given to its associated habitats are given in Table 35. Structure and functions were considered Favourable at 12 monitoring sites; Unfavourable - Inadequate at 12 monitoring sites and Unfavourable - Bad at one site. An Unfavourable assessment of the calcareous

grassland component was the reason for the Unfavourable - Inadequate/Unfavourable - Bad assessment results at NSLP 03, 06, 10, 16-18, 20, 21 and 26. An unfavourable assessment of the exposed limestone pavement component was the reason for the Unfavourable - Inadequate assessment results at NSLP 05, 12, 24 and 29. As this was a baseline survey, the trend for the structure and functions assessment for Limestone pavement and associated habitats (8240) is unknown.

FUTURE PROSPECTS

The results for future prospects for the four EU Annex I habitats assessed ((Limestone pavement (exposed) and Limestone pavement (wooded) (8240), Semi-natural dry grasslands and scrubland facies on calcareous substrates (6210), Alpine and Boreal heaths (4060) and European dry heaths (4030)) are given below. The results for the other two EU Annex I Habitats known to be associated with Limestone pavement (8240), namely *Juniperus communis* formations on heaths or calcareous grasslands (5130) and Taxus baccata woods (91J0) were not assessed. Information on the conservation status of these habitats can be found in Cooper *et al*. (2012) and Cross & Lynn (2012) respectively.

LIMESTONE PAVEMENT (EXPOSED) (8240)

Future prospects were assessed for exposed limestone pavement in 25 monitoring sites. Table 38 illustrates the results of the assessment; further details of the assessments are given in Appendix 13. Future prospects were considered Favourable at 10 of the 25 monitoring sites and Unfavourable - Inadequate at 15 of the 25 sites. Non-native species (*Cotoneaster* spp., *Clematis vitalba, Centranthus ruber*) were present at nine of the monitoring sites. Other factors which affected the Unfavourable - Inadequate assessments were scrub encroachment, limestone pavement displacement/removal and quarrying and land reclamation. As this was a baseline survey, the trend for the future prospects assessment for Limestone pavement (exposed), (8240) is unknown.

LIMESTONE PAVEMENT (WOODED) (8240)

Future prospects were assessed for wooded limestone pavement in seven of the 25 monitoring sites. Table 38 illustrates the results of the future prospects assessment for wooded limestone pavement; further details of the assessments are given in Appendix 13. Future prospects were considered Favourable at all of the monitoring sites for wooded limestone pavement. As this was a baseline survey, the trend for the future prospects assessment for Limestone Pavement (wooded), (8240) is unknown.

SEMI-NATURAL DRY GRASSLANDS AND SCRUBLAND FACIES ON CALCAREOUS SUBSTRATES (*FESTUCO-BROMETALIA*) (IMPORTANT ORCHID SITES) (6210/6211)

Future prospects were assessed for habitat 6210/6211 in 22 of the 25 monitoring sites. Table 38 illustrates the results of the assessment; further details of the assessments are given in Appendix 13. Future prospects were considered Favourable at 16 and Unfavourable - Inadequate at six of the 22 monitoring sites. The main reasons for Unfavourable - Inadequate assessment results were scrub encroachment and problematic native species such as bracken. Trampling and re seeding were also recorded. As this was a baseline survey, the trend for the future prospects assessment for Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (important orchid sites) (6210/6211) is unknown.

EUROPEAN DRY HEATHS (4030)

Future prospects were assessed for habitat 4030 in 20 of the 25 monitoring sites. Table 38 gives the results of the assessment; further details of the assessments are given in Appendix 13. Future prospects were considered Favourable at 16 and Unfavourable - Inadequate at 4 of the 20 sites containing the habitat 4030. The reasons for Unfavourable - Inadequate assessment results were the presence of non-native species (*Cotoneaster* spp.) and problematic native species (bracken). As this was a baseline survey, the trend for the future prospects assessment for European dry heaths (4030) is unknown.

ALPINE AND BOREAL HEATHS (4060)

Future prospects were assessed for habitat 4060 in seven of the 25 monitoring sites. Table 38 illustrates the results of the assessment; further details of the assessments are given in Appendix 13. Future prospects were considered Favourable at all of the seven monitoring sites containing the habitat 4060. As this was a baseline survey, the trend for the future prospects assessment for Alpine and Boreal heaths (4060) is unknown.

OVERALL FUTURE PROSPECTS FOR LIMESTONE PAVEMENT AND ASSOCIATED HABITATS (8240)

Table 38 gives the results of the overall future prospects assessment for limestone pavement and associated habitats; further details of the assessments are given in Appendix 12 and 14. Table 38 illustrates the future prospects were considered Favourable at 10 of the 25 monitoring sites and Unfavourable - Inadequate at 15 of the 25 sites. An Unfavourable assessment of at least one of the limestone pavement associated habitats has resulted in an overall assessment for future prospects of

EU Annex I Habitat 8240 as Unfavourable. As this was a baseline survey, the trend for the future prospects assessment for Limestone pavement and associated habitats (8240) is unknown.

Table 38 Future prospects assessment results for Annex I habitats and monitoring sites.

Site Code	8240 (exposed)	8240 (wooded)	6210	4060	4030	Overall Site Future Prospects
NSLP01	Pass		Pass	Pass	Pass	Favourable
NSLP02	Pass	Pass	Pass		Pass	Favourable
NSLP03	Fail		Fail		Fail	Unfavourable - Inadequate
NSLP04	Fail		Pass	Pass	Pass	Unfavourable - Inadequate
NSLP05	Fail	Pass	Fail		Pass	Unfavourable - Inadequate
NSLP06	Pass	Pass	Fail			Unfavourable - Inadequate
NSLP07	Pass		Pass	Pass	Pass	Favourable
NSLP08	Pass		Pass	Pass	Pass	Favourable
NSLP09	Pass	Pass	Pass	Pass	Pass	Favourable
NSLP10	Pass		Fail	Pass	Pass	Favourable
NSLP12	Pass	Pass				Favourable
NSLP13	Fail		Fail		Fail	Unfavourable - Inadequate
NSLP14	Fail					Unfavourable - Inadequate
NSLP16	Fail	Pass	Fail		Pass	Unfavourable - Inadequate
NSLP17	Fail	Pass	Pass		Fail	Unfavourable - Inadequate
NSLP18	Fail		Pass		Pass	Favourable
NSLP19	Fail					Unfavourable - Inadequate
NSLP20	Fail		Pass		Pass	Unfavourable - Inadequate
NSLP21	Pass		Pass		Pass	Favourable
NSLP22	Pass		Pass	Pass	Pass	Favourable
NSLP23	Fail		Pass		Pass	Unfavourable - Inadequate
NSLP24	Fail		Fail			Unfavourable - Inadequate
NSLP26	Fail		Fail		Pass	Unfavourable - Inadequate
NSLP27	Fail		Pass		Pass	Unfavourable - Inadequate
NSLP29	Fail		Pass		Fail	Unfavourable - Inadequate

OVERALL ANNEX I HABITAT CONSERVATION STATUS ASSESSMENT

LIMESTONE PAVEMENT (EXPOSED) (8240)

The overall conservation status for 8240 (exposed) was assessed at 25 monitoring sites. Taking into account the assessment results for both structure and functions and future prospects, the overall conservation status for exposed limestone pavement was assessed as Favourable (Table 39) at 10 of the 25 monitoring sites, Unfavourable - Inadequate at 14 sites and Unfavourable - Bad at one site. Limestone pavement displacement and quarrying, land reclamation, an inadequate number of positive indicators, high cover of negative indicators, scrub encroachment and non-native species (*Cotoneaster* spp., *Clematis vitalba, Centranthus ruber*) were the reasons for these failed assessments. As this was a baseline survey, the trend for the conservation status assessment for Limestone pavement (exposed), (8240) is unknown.

LIMESTONE PAVEMENT (WOODED) (8240)

The overall conservation status for 8240 (wooded) was assessed at seven monitoring sites. Taking into account the assessment results for both structure and functions and future prospects, the overall conservation status for wooded limestone pavement was assessed as Favourable (Table 39) at all of the seven sites at which it was found. As this was a baseline survey, the trend for the conservation status assessment for wooded Limestone pavement (8240) is unknown.

Table 39 Overall Conservation Status assessment results for Annex I habitats at each monitoring site.

Site Code	8240 (exposed) CSA	8240 (wooded) CSA	6210 CSA	4060 CSA	4030 CSA
NSLP01	Favourable		Favourable	Favourable	Favourable
NSLP02	Favourable	Favourable	Favourable		Favourable
NSLP03	Unfavourable - Inadequate		Unfavourable - Bad		Favourable
NSLP04	Unfavourable - Inadequate		Favourable	Favourable	Favourable
NSLP05	Unfavourable - Bad	Favourable	Favourable		Favourable
NSLP06	Favourable	Favourable	Unfavourable - Bad		
NSLP07	Favourable		Favourable	Favourable	Favourable
NSLP08	Favourable		Favourable	Favourable	Favourable
NSLP09	Favourable	Favourable	Favourable	Favourable	Favourable
NSLP10	Favourable		Unfavourable - Inadequate	Favourable	Favourable
NSLP12	Unfavourable - Inadequate	Favourable			
NSLP13	Unfavourable - Inadequate		Unfavourable - Inadequate		Unfavourable - Inadequate
NSLP14	Unfavourable - Inadequate				
NSLP16	Unfavourable - Inadequate	Favourable	Unfavourable - Inadequate		Favourable
NSLP17	Unfavourable - Inadequate	Favourable	Unfavourable - Bad		Unfavourable - Inadequate
NSLP18	Unfavourable - Inadequate		Unfavourable - Bad		Favourable
NSLP19	Unfavourable - Inadequate				
NSLP20	Unfavourable - Inadequate				Favourable
NSLP21	Favourable		Unfavourable - Bad		Favourable
NSLP22	Favourable		Favourable	Favourable	Favourable
NSLP23	Unfavourable - Inadequate		Favourable		Favourable
NSLP24	Unfavourable - Inadequate		Unfavourable - Inadequate		
NSLP26	Unfavourable - Inadequate		Unfavourable - Inadequate		Favourable
NSLP27	Unfavourable - Inadequate		Favourable		Favourable
NSLP29	Unfavourable - Inadequate		Favourable		Unfavourable - Inadequate

SEMI-NATURAL DRY GRASSLANDS AND SCRUBLAND FACIES ON CALCAREOUS SUBSTRATES (*FESTUCO-BROMETALIA*) (IMPORTANT ORCHID SITES) (6210/6211)

The overall conservation status for 6210 was assessed at 21 monitoring sites. The Conservation Status was found to be Favourable at 12 monitoring sites, Unfavourable - Inadequate at four sites and Unfavourable - Bad at five sites (Table 39). Scrub encroachment, problematic native species such as bracken, an inadequate number of positive indicators, high cover of negative indicators, as well as a low forbs ratio were the reasons for these failed assessments. Trampling and re seeding were also recorded. As this was a baseline survey, the trend for the conservation status assessment for Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (important orchid sites) (6210/6211) is unknown.

EUROPEAN DRY HEATHS (4030)

The overall conservation status for 4030 was assessed at 20 monitoring sites. The Conservation Status was found to be Favourable at 17 sites and Unfavourable - Inadequate at three sites (Table 39). The presence of non-native species (*Cotoneaster* spp.) and problematic native species (bracken) were the reason for these failed assessments. As this was a baseline survey, the trend for the conservation status assessment for European dry heaths (4030) is unknown.

ALPINE AND BOREAL HEATHS (4060)

The overall conservation status for 4060 was assessed at seven monitoring sites. Taking into account the assessment results for both structure and functions and future prospects, the overall conservation status for the habitat 4060 was assessed as Favourable (Table 39) at all of the seven sites at which it was found. As this was a baseline survey, the trend for the conservation status assessment for Alpine and Boreal heaths (4060) is unknown.

OVERALL SITE CONSERVATION STATUS ASSESSMENT

The conservation status of limestone pavement and associated habitats was assessed at 25 monitoring sites. Table 40 illustrates the results of the assessment; further details are given in Appendix 12 and 14. The conservation status of limestone pavement and associated habitats was assessed as Favourable at 6 of the 25 monitoring sites, Unfavourable - Inadequate at 18 of the sites and Unfavourable - Bad at one of the sites. The assessment of the overall habitat 8240 is based on the assessment results given in tables 35 and 38.

Table 40 Conservation Status assessment results for each monitoring site.

Site Code	Area	Structure and functions	Future Prospects	Overall Conservation Status Assessment
NSLP01	Unknown	Favourable	Favourable	Favourable
NSLP02	Unknown	Favourable	Favourable	Favourable
NSLP03	Unknown	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP04	Unknown	Favourable	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP05	Unknown	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP06	Unknown	Unfavourable - Bad	Unfavourable - Inadequate	Unfavourable - Bad
NSLP07	Unknown	Favourable	Favourable	Favourable
NSLP08	Unknown	Favourable	Favourable	Favourable
NSLP09	Unknown	Favourable	Favourable	Favourable
NSLP10	Unknown	Unfavourable - Inadequate	Favourable	Unfavourable - Inadequate
NSLP12	Unknown	Unfavourable - Inadequate	Favourable	Unfavourable - Inadequate
NSLP13	Unknown	Favourable	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP14	Unknown	Favourable	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP16	Unknown	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP17	Unknown	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP18	Unknown	Unfavourable - Inadequate	Favourable	Unfavourable - Inadequate
NSLP19	Unknown	Favourable	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP20	Unknown	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP21	Unknown	Unfavourable - Inadequate	Favourable	Unfavourable - Inadequate
NSLP22	Unknown	Favourable	Favourable	Favourable
NSLP23	Unknown	Favourable	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP24	Unknown	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP26	Unknown	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP27	Unknown	Favourable	Unfavourable - Inadequate	Unfavourable - Inadequate
NSLP29	Unknown	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate

Conservation status assessment at national level

The assessment of the conservation status of the Annex I habitat Limestone Pavement at site level was used to make an assessment of the habitat at a national level. The same three parameters used in the monitoring site assessments (i.e. area, structure and function and future prospects), were used as well as an additional range parameter. Data from other sources such as results of the potential NHA surveys, BurrenLIFE (Anon. 2010), Burren Farming for Conservation (Anon. 2011, Anon. 2012) and NPWS Site Inspection reports were also taken into consideration. The monitoring site results were extrapolated to give an overall assessment, which will be used in conjunction with the data from other sources, to update the last Article 17 assessment from 2007. The 2007 results for Range, Area, Structure

and Functions and Future Prospects are given in Table 41; the current results are discussed below and are summarised in Table 52.

Table 41 NPWS 2007 Conservation Status Assessment results for Limestone pavement (8240).

Range	Favourable
Area	Unfavourable - Inadequate
Structure and Function	Unfavourable - Inadequate
Future Prospects	Unfavourable - Inadequate
Overall Conservation Status	Unfavourable - Inadequate

RANGE

The current national range for Annex I Habitat 8240 is 9,000km2 (90 10 km cells), which differs significantly from the range reported in 2007 (NPWS 2007a). The revised range was calculated based on the IT Tool version 10.0 (30/08/2012) generated by the European Topic Centre on Biological Diversity. The variation in both current and favourable range is only due to the method used to calculate the range rather than any actual change in habitat range. The favourable reference range value is set as the current range (9,000km2). As it is sufficiently large enough to ensure the long term survival of the habitat and there is no evidence of a decline since the Directive came into force, its conservation status is assessed as Favourable. Range is also given a Stable trend.

The current range map is based on the 2005 OSi ortho-photographs. A revision of the range map based on a more recent dataset may show changes in range, taking into consideration habitat loss, particularly in areas outside the main habitat distribution (i.e. small pockets of pavement outside designated sites within counties Galway, Mayo and Clare, threatened by land reclamation).

AREA

The new National Limestone pavement and associated habitat map shows that the current habitat area is 32,187ha. This figure is smaller than the 2007 estimate, which was 36,000ha. This reduction is a result of more accurate mapping of the habitat, rather than actual habitat loss. The area was calculated based on the digitising of areas of potential habitat using the 2005 OSi ortho-photographs as a background; more up-to-date ortho-photographs were not available. A total of 63 10km grid cells (6,300km2) were considered to intersect areas that potentially contained habitat 8240, compared to the 60 grid cells reported in 2007. Some cells (e.g. R25), previously mapped as containing the habitat 8240 were considered not to contain the habitat and a number of new cells (e.g. M18) were discovered to contain the habitat. Approximately 82.69% (26,557ha) of the national resource is located within an

SAC or NHA. The remaining17.31% (5,630ha) has no designation. Of the designated portion, 25,932ha of the habitat is within SACs for which the habitat is a qualifying interest. Therefore 80.58% of the national resource is given full legal protection.

The revised area should be taken as a baseline figure for future assessment against which future assessments should be compared. The current area is smaller than the Favourable Reference Area (FRA), the size of which is unknown, although it would be larger than the current area, as loses in limestone pavement have occurred since the Directive came into force.

Visual identification of limestone pavement removal (i.e. land reclamation) incidences in the 2005 ortho-photographs (see Mapping section) has shown a high frequency of this type of activity across the country. Although the activities occurred prior to 2005, which is outside the reporting period, the national survey (2008 to 2011) also identified removal of limestone pavement at seven of the 16 sites (40%) surveyed as part of Element I of this project within the reporting period. Approximately 95ha of limestone pavement and associated habitats have been irreversibly damaged at these sites. Although an estimate of the habitat loss within the reporting period cannot be given, it is likely to have been <1% per year and thus the habitat Area is given an Unfavourable - Inadequate assessment. This attribute is given a decreasing trend as no measures have been put in place to halt further habitat losses, which are likely to continue into the future.

STRUCTURE AND FUNCTIONS

The results of an overall assessment of the structure and function of the priority habitat 8240 taking into consideration the assessment given to its associated habitats are summarised in Table 40**.** Of the 25 monitoring sites assessed, a total of 12 (48%) sites were assessed as Favourable, 12 (48%) of sites were assessed as Unfavourable - Inadequate and one (4%) was assessed as Unfavourable - Bad. The main reasons for this Unfavourable assessment are negative indicator species, as a result of land abandonment, which may also explain some of the failures for the presence of positive indicator species, and the presence of non-native species.

At a national level, significantly less than 25% of the habitat is Unfavourable with regard to its structure and functions. Following the rules outlined by Evans & Arvela (2011) (Table 5), the overall structure and functions assessment for the priority habitat is Unfavourable - Inadequate. The structure and functions of the habitat would need to be in good condition, with no significant deteriorations or pressures for it to be given Favourable status. Limestone pavements were assessed as Unfavourable - Inadequate in 2007. Since then, measures have been put in place to improve land management practices in the Burren, the largest expanse of limestone pavement in Ireland (Anon. 2010, Anon. 2011, Anon. 2012). Therefore, the trend for structure and functions was assessed as improving, as the condition of the habitat is likely to improve in the future.

FUTURE PROSPECTS

The results of an overall assessment of the future prospects of the priority habitat 8240 taking into consideration the assessment given to its associated habitats are summarised in Table 40**.** Of the 25 monitoring sites assessed, a total of 10 (40%) were assessed as Favourable and 15 (60%) were assessed as Unfavourable - Inadequate. None of the sites were assessed as Unfavourable - Bad. Limestone pavement quarrying, land reclamation, scrub encroachment, invasive non-native species and problematic native species were deemed the main pressures. At a national level, the overall future prospects assessment for the priority habitat is Unfavourable - Inadequate. Limestone pavements were assessed as Unfavourable - Inadequate in 2007. Due to recent initiatives in improved landuse management by the BurrenLIFE Project (Anon. 2010) and Burren Farming for Conservation Project (Anon. 2011, Anon. 2012) the status of current pressures and future threats such as inappropriate grazing regimes and scrub encroachment is likely to improve in these areas. However, no measures have been put in place to halt other pressures such as quarrying and land reclamation outside SACs. Therefore, on balance the trend for future prospects was assessed as Stable. Below is a summary of some of the more important impacting activities affecting limestone pavement and associated habitats in Ireland. Table 42 gives an overview of the main impacts associated with limestone pavement. The main impacts are discussed below.

Table 42 Impacts recorded at PSLP and NSLP monitoring and potential NHA sites.

Impact code	Impact Description	Intensity (L/M/H)	Effect (-/0/+)	Designated sites	Non-designated sites	Total
A04.01.02	Intensive sheep grazing	L	-	1	0	1
A04.02.01	Non intensive cattle grazing	L	+	1	0	1
A05.02	Stock feeding	L	-	2	0	2
A10.01	Removal of hedges and copses or scrub	M	+	1	0	1
B02	Forest and Plantation management & use	M	-	0	1	2
C01	Mining and quarrying	H	-	4	3	7
G05.01	Trampling, overuse	L	-	1	0	1
I01	Invasive non-native species	M	-	7	4	11
I02	Problematic native species	M	-	4	1	5
J02.01	Land reclamation	H	-	0	7	7
K02.01	Species composition change (succession)	M	-	4	4	8

THREATS

MINING AND QUARRYING (C01)

Quarrying was reported at seven sites during the field survey (2008-2011) - see Appendix 13 for further details of these sites. Plate 24 shows an example of quarrying that has taken place in a

designated site. In four instances these quarries were adjacent to designated sites. Quarrying was also reported from three non-designated sites. This data is only based on the 2005 ortho-photographs as more recent data was not available for this assessment reporting period (2007-2012). Nonetheless, quarrying is likely to have continued in many of these areas over the survey period, but may have ceased or declined recently due to the economic downturn.

Plate 24 Quarrying recorded on designated site in county Galway.

INVASIVE NON-NATIVE SPECIES (I01)

Table 43 lists sites (monitoring and potential NHA) where invasive non-native species were reported during the field survey (2008-2011). Invasive species appear to be more prevalent on exposed limestone pavement than on any of the associated habitats. The threat was recorded at seven designated sites and five non-designated site. Plate 25 shows *Centranthus ruber* invading limestone pavement at NSLP32. Plate 26 shows *Clematis vitalba* invading limestone pavement at NSLP19/36.

Table 43 PSLP and NSLP sites where invasive species were recorded.

Site Code	Species
NSLP03	*Cotoneaster* spp.
NSLP04	*Centranthus ruber*
NSLP05	*Cotoneaster* spp.
NSLP17	*Clematis vitalba* / *Centranthus ruber*
NSLP18	*Cotoneaster* spp.
NSLP19/36	*Clematis vitalba*
NSLP23/41	*Centranthus ruber*
NSLP24	*Cotoneaster* spp. / *Centranthus ruber*
NSLP26	*Cotoneaster* spp.
NSLP29/47	*Cotoneaster* spp.
NSLP32	*Centranthus ruber*
NSLP37	*Centranthus ruber*

Plate 25 *Centranthus ruber* invading limestone pavement at Mountscribe, Co. Galway (NSLP32).

Plate 26 *Clematis vitalba* invading limestone pavement at Caherlough, Co. Clare (NSLP19/36).

PROBLEMATIC NATIVE SPECIES (I02)

This impact was recorded at five sites, four of which were designated. The main species of concern were bracken, and bramble, which mostly affected grasslands and heath associated with limestone pavement, as well as exposed pavement. Diminution and abandonment of grazing practices has been identified as one of the main threats to the conservation of priority habitats in the Burren region by the BurrenLIFE Project along with scrub encroachment (Anon. 2010). Problematic native species such as bracken are a direct result of this abandonment.

RECLAMATION (J02.01)

Table 44 lists the areas containing limestone pavement and associated habitats where land reclamation was reported during the field survey (2008-2011). The damage was identified based on areas identified as reclaimed in the field (monitoring and potential NHA surveys) and mapped used the 2005 OSI ortho-photographs. However, the extent of the reclamation is only approximate. A more recent ortho-photograph dataset was not available when this assessment was undertaken. In the case of site NSLP41, part of the area given for land reclamation is due, in part, to quarrying. The activity was only recorded within non-designated sites. Plate 27 shows a large reclaimed area, which was visible as limestone pavment in the 2005 ortho-photographs.

Plate 27 A large area (approximately 22ha) of land reclamation at Mountscribe, Co. Galway (NSLP32).

Table 44 Areas of limestone pavement and associated habitat that have been reclaimed within non-designated NSLP sites.

Site Code	Area reclaimed (ha)	Habitats affected (EU code)	Approx. % of site
NSLP19/36	20	8240 (exposed/wooded)/6210	10
NSLP20/38	1.5	8240 (exposed/wooded)	1
NSLP23/41	4	(8240 (exposed)/4030)	2.6
NSLP32	22	8240 (exposed/wooded)/6210	53
NSLP37	19	8240 (exposed/wooded)/6210	27
NSLP43	10	8240 (exposed/wooded)	23
NSLP44	7	(8240 (exposed)/6210)	5.5

The negative effect of the single payment scheme under the Common Agricultural Policy (CAP) on limestone pavement habitats is highlighted by the last conservation status assessment (NPWS 2008). Under this scheme, land covered in rock does not qualify for single-farm payment and therefore this would have inadvertently encouraged clearance of limestone pavement (both exposed and wooded (scrub)) for agriculture, thus promoting the destruction of a priority habitat under the Habitats Directive. This situation has continued in the new reporting period (2007-2012) as confirmed by Bleasdale (pers. comm., 2012). The 2007 assessment also highlighted some cultural reasons; Limestone pavement in itself is perceived negatively: converting it from exposed rock to pasture is seen as good practice.

SCRUB ENCROACHMENT (K02.01)

This impact is listed as species composition change (succession), (K02.01). Table 45 lists the sites containing limestone pavement and associated habitats where scrub encroachment was reported during the field survey (2008-2011).

Table 45 NSLP sites affected by scrub encroachment.

Site Code	Habitats affected (EU code)
NSLP13	8240 (exposed)/6210/4030
NSLP16	8240 (exposed)/6210
NSLP24	8240 (exposed)/6210
NSLP26	8240 (exposed)/6210
NSLP29	8240 (exposed)
NSLP31	8240 (exposed)/6210
NSLP32	8240 (exposed)/6210
NSLP35	8240 (exposed)/6210

Scrub encroachment was recorded in eight sites; four designated and four non-designated. This impact mostly affects grassland and heath associated with limestone pavement, as well as exposed pavement. The main problematic species recorded were hazel and blackthorn. According to the NPWS (2008) conservation status assessment report, historical evidence indicates that scrub cover has waxed and waned over time over limestone pavement areas. However, a satisfactory balance between wooded areas and open areas should be established. The establishment of this balance poses a challenge from a conservation management perspective. The current amount of scrub is considered favourable. Therefore, any increase in scrub cover would be considered a negative impact.

The BurrenLIFE project highlights scrub encroachment, predominantly Hazel (*Corylus avellana*) and Blackthorn (*Prunus spinosa*), as a major concern for both farmers and conservationists alike in the Burren region. According to the report (Anon. 2010), scrub is spreading at an unprecedented rate, the situation having gone from one where scrub was very scarce 150 years ago to the current situation where 14% of the Burren is covered by relatively dense scrub and at least another 5-10% (conservative estimate) is scrub-affected.

It is stated in a Heritage Council report on landscape change in the Burren, Co. Clare (Heritage Council 2006) that encroachment of scrub is a major threat to the species-richness and floral diversity of the calcareous grasslands both through change of habitat from open land to scrub and by impeding movement of grazing livestock. This report also maintains that low grazing levels are also resulting in the increase of senescent *Calluna* in areas of limestone heath which shades out many species and may foster scrub encroachment. The report noted that in several areas under study *Prunus spinosa* was

encroaching on the more productive, winter-grazed grassland and that whilst *Prunus spinosa* can form dense thickets itself, it is probably more of a threat in enabling hazel to establish in areas where exposure to wind would normally limit its growth.

ABANDONMENT (A04.03)

Widespread diminution and abandonment of grazing practices, combined with localised intensification of grazing and supplementary feeding with silage, has been identified as one of the main threats to the conservation of priority habitats in the Burren region by the BurrenLIFE project but it also applies elsewhere. Undergrazed grasslands and heaths become rank and are invaded by scrub and bracken. Reduced grazing levels encourage the development of a layer of dead plant material that chokes out the less robust species and reduces species frequency and diversity over time. Localised intensification of grazing around ring-feeders results in overgrazing, dunging, which encourages the growth of nitrophilous species, and point-source water pollution (Anon. 2010). Abandonment was not recorded directly as an activity during the NSLP. However, scrub encroachment (K02.01) and problematic native species (I02) were considered to be a direct result of abandonment, which was recorded, if present, at both the monitoring and potential NHA sites (Table 45, Appendix 14).

SCRUB REMOVAL (A10.01)

This activity may be both beneficial and damaging. It can be done either by hand or by machine and while the former is invariably beneficial, the use of machinery is almost always destructive unless done with extreme care. Scrub removal was recorded at one of the monitoring sites (NSLP02). This activity has been undertaken at a number of sites as part of both BurrenLIFE (approx. 100ha scrub removed) and Burren Farming for Conservation (approx. 100ha scrub removed) Projects. See relevant sections below for project summaries.

OTHER SOURCES OF INFORMATION

PRESSURES RECORDED BASED ON NATIONAL MAP FINDINGS

The identification of limestone pavement areas (i.e. polygons) where quarrying and pavement removal took place prior to 2005, using the 2005 ortho-photographs, was undertaken as part of the generation of the national map. Pavement removal (J02.01), in the form of land reclamation for agricultural purposes and quarrying (C02.01) tend to affect larger areas (>1ha) and irreversibly destroys the habitat. It must be stated that a more up to date dataset (ortho-photographs) would have given a more realistic view of the current situation with regards limestone pavement removal and quarrying; several cases of pavement removal and quarrying not visible on the 2005 ortho-photographs were recorded in the field during the 2008 to 2011 survey.

A total of 176 polygons (13% of those mapped) were reported as being threatened by quarrying or pavement removal. These activities were recorded within or immediately adjacent to the polygon. These activities were more frequently recorded within non-designated sites as Table 46 shows. Table 47 provides a list of all designated sites with polygons threatened by either removal or quarrying. The threatened areas were either completely or partially within the site. County Galway, followed by counties Mayo and Clare, had the highest number of polygons threatened by pavement removal and/or quarrying (Table 48). County Galway has a total of 101 polygon threatened; Mayo 25 polygons and Clare 15 polygons. Three of the four polygons in county Limerick were threatened by these activities. It must be noted that all of these activities were noted to take place within or adjacent to polygons mapped using the 2005 ortho-photographs. One polygon may feature more than one case of removal within it. More than one polygon may be adjacent to the same threat (e.g. quarry). Therefore the results must be interpreted with caution, as one threat (e.g. quarry) may have been recorded several times.

Table 46 Summary of most threatening activities to limestone pavment.

Threat	polygons (designated)	polygons (non-designated)
Adjacent quarry	4	33
Dumping	0	1
Pavement removal	27	110
Pavement removal and road construction	0	1
Total	31	145

Table 47 Summary of most threatening activities within designated sites.

SAC Code	Site Name	Designation	County	Threat	Polygons
000016	Ballycullinan Lake	SAC/pNHA	Clare	Removal	3
000019	Ballyogan Lough	SAC/pNHA	Clare	Removal	1
000054/000268	Moneen Mountain & Galway Bay Complex	SAC/pNHA	Clare	Removal	1
000115	Ballintra	SAC/pNHA	Donegal	Adjacent quarry	1
000212	Inishmaan Island	SAC/pNHA	Galway	Removal	1
000252	Coole-Garryland Complex	SAC/pNHA	Galway	Removal	2
000268	Galway Bay Complex	SAC/pNHA	Clare/Galway	Removal	9
000297	Lough Corrib	SAC/pNHA	Galway	Adjacent quarry	2
000479	Cloughmoyne	SAC/pNHA	Mayo	Removal	3
001271	Gortnandarragh Limestone Pavements	SAC/pNHA	Galway	Removal	1
001774	Lough Carra, Mask Complex	SAC/pNHA	Mayo	Adjacent quarry	1
001926	East Burren Complex	SAC/pNHA	Clare	Removal	5
002244	Ardrahan Grassland	SAC	Galway	Removal	1
Total					31

Table 48 Summary of most threatening activities within non-designated sites.

County	Threat	Polygons
Clare	Adjacent quarry	4
Clare	Removal	11
Galway	Adjacent quarry	22
Galway	Removal	78
Galway	Removal and road construction	1
Limerick	Adjacent quarry	3
Mayo	Adjacent quarry	3
Mayo	Removal	21
Mayo	Dumping	1
Roscommon	Adjacent quarry	1
Total		**145**

NPWS SITE INSPECTION REPORT (SIR)

Activities observed within SACs are recorded on a regular basis by NPWS regional staff. They are reported on a three year cycle as part of a Site Inspection Reporting process. These activities may have a negative, neutral or positive impact on Annex I habitats. According to the latest reporting cycle, agricultural improvement, removal of limestone pavement, restructuring of agricultural land holdings and communication networks (paths, tracks, cycling tracks) were the most frequently reported pressures affecting limestone pavement habitat (8240) (Table 49). The majority of these activities are related to intensification of agricultural practices, which involved the destruction of limestone pavement. The SIR also reported positive activities within SAC 001926; these consisted of the removal of scrub as part of the BurrenLIFE project management actions. The listed activities are only likely to be related to exposed limestone pavement and not the associated habitats. Note that old activity codes are used here.

Table 49 Activities recorded for 8240 based on SIR data from the latest reporting cycle.

SAC Code	Activity Code	Activities	Influence	Area affected
000020	103	Agricultural improvement	Negative	0.2
000054	103	Agricultural improvement	Negative	0.01
000057	103	Agricultural improvement	Negative	0
000606	103	Agricultural improvement	Negative	0.4
001275	103	Agricultural improvement	Negative	0.75
000020	104	Removal of limestone pavement	Negative	0.1
000057	104	Removal of limestone pavement	Negative	0.37
000213	104	Removal of limestone pavement	Negative	0.01
000019	150	Restructuring agricultural land holding	Negative	0.06
000606	150	Restructuring agricultural land holding	Negative	5
001926	150	Restructuring agricultural land holding	Negative	2.5
000020	501	Paths, tracks, cycling tracks	Negative	0.03
000054	501	Paths, tracks, cycling tracks	Negative	0.18
000268	501	Paths, tracks, cycling tracks	Negative	0.01
001926	152	Removal of scrub	Positive	1.4

COILLTE LIFE WOODLAND RESTORATION PROJECT

This was an initiative, partly funded by the EU, which ran from 2006-2009 (Coillte 2010). This project targeted the restoration of approximately 550ha of priority woodland habitats which have been impacted by human activities. Woodland on limestone pavement comprised the majority of the area, with 393ha to be restored. NSLP sites which have been positively affected by this initiative are given in Table 50.

Table 50 NSLP sites that are part of the Coillte Woodland Restoration Project.

Site	SAC Code	Coillte Forest	SAC Name	County	Area (ha)
1	001774	Clonbur	Lough Carra/Mask	Galway / Mayo	292.9*
2	001926	Attyslany	East Burren Complex	Clare	67.1
7	000242	Castletaylor	Castletaylor	Galway	32.8
Total					**392.8**

*Not all limestone pavement habitat

THE BURRENLIFE PROJECT

The Burren LIFE Project was a cooperative project between the National Parks and Wildlife Service, Teagasc, the Burren Irish Farmers' Association and local farmers and was jointly funded by the

European Commission and the National Parks and Wildlife Service. The main objective of the project was to develop a new model for the sustainable agriculture management of the Habitats Directive Annex I habitats of the Burren region (see http://www.burrenlife.com/the_project.php for further detail). This was considered necessary to address the problem of changing farm practices, which are threatening the future status of priority and other Annex I habitats in the region. The project focused on the following priority habitats; limestone pavement, orchid-rich calcareous grasslands and a range of wetlands including turloughs, petrifying springs and *Cladium* fens. The BurrenLIFE Project ran from 2005 to 2010.

The Project highlighted that recent decades have seen a withdrawal, restructuring or reduction of farming activity in the Burren. This has led to the visible degradation of priority habitats through abandonment, undergrazing and the loss of important land management traditions. The project also highlighted the importance of traditional pastoral systems, in particular "winter grazing" regimes, as being integral to maintaining the unusual plants assemblages found in the region. Traditional management of the landscape by generations of farmers and their livestock ensured that large areas of limestone pavement remained free of scrub (Anon. 2010).

The project identified the reduction in agricultural activity as a threat to the future of priority habitats, especially orchid-rich grassland and limestone pavement mosaics. The project set out to address the problem of farm polarisation (simultaneous intensification on productive land and neglect or abandonment of traditional winterages) and loss of traditional management knowledge and skills. It worked with 20 Burren farmers to develop a series of practical farm management techniques that could benefit the environment, the habitats and the farmers of the Burren (Anon. 2010). The 20 farms covered more than 3,000ha of farm land, 2,485ha of which were designated as SAC. The practical measures implemented as part of the project aimed to encourage and support the grazing of winterages. These include facilitating livestock movement and herding around sites, increasing water availability and restoring internal stone walls.

BURREN FARMING FOR CONSERVATION PROGRAMME (BFCP)

The BFCP is jointly funded by the National Parks and Wildlife Service (Department of Arts, Heritage and the Gaeltacht) and the Department of Agriculture, Food and the Marine. The three year project started in April 2010 as a follow-on to the BurrenLIFE Project and is based on the findings of that project (see http://www.burrenlife.com/the_project.php for further detail). This BFCP aims to manage existing limestone pavement areas to improve their conservation status mostly within 3 large SACs: Black Head/Poulsallagh Complex SAC, Moneen Mountain SAC and East Burren Complex SAC, including the Burren National Park and Slieve Carron National Nature Reserve. According to the latest figures (B. Dunford, pers.comm)), the BFCP is being implemented on 160 farms covering

approximately 14,600ha or 46% of the total area of the SACS. Within the 3 SACs there are approximately17,500ha of limestone pavement so that approximately 8,151ha of limestone pavement is subject to positive management. This represents about 25% of the total national resource of limestone pavement. Farm plans have been produced and are being implemented for all 160 farms. The plans include measures such as the production of species-rich grassland and site enhancement works such as scrub removal and wall repairs. Table 51 gives a list of monitoring sites which are part of farms participating in the BFCP. The future prospects for limestone pavement and associated habitats within these monitoring sites are already showing an improvement and are likely to improve further in the future.

Table 51 List of NSLP monitoring sites with farms participating in BFCP.

Site Code	Site Name	County	Area (ha)	Comment	% monitoring site within BFCP
NSLP01	Murrooghtoohy North	Clare	395	Multiple farms	75
NSLP02	Gortlecka polygon 1	Clare	107	Multiple farms	90
NSLP02	Gortlecka polygon 2	Clare	187	Multiple farms	90
NSLP04	Abbey East	Clare	242	Single farm	25
NSLP07	Aillwee	Clare	1,373	Multiple farms	>90
NSLP08	Rannagh West	Clare	435	Multiple farms	80
NSLP09	Slievecarran	Clare	948	Multiple farms	50-60
NSLP17	Cloonselherny	Clare	433	Multiple farms	30
NSLP21	Sheshy more	Clare	45	Two farms	45
NSLP22	Formoyle East	Clare	184	Multiple farms	35

OVERALL CONSERVATION STATUS ASSESSMENT FOR LIMESTONE PAVEMENT AND ASSOCIATED HABITATS

In summary, the range for Annex I Habitat 8240 is similar to that reported in 2007; any discrepancies are due to improved knowledge, rather than any actual change in extent. Therefore, its conservation status is assessed as Favourable and the trend is Stable. A new area was estimated since 2007; this new area (32,187ha) is smaller than the previous estimate as a result of improved mapping. The visual identification of limestone pavement removal (i.e. land reclamation) on the 2005 ortho-photographs (see Mapping section) has shown a high frequency of this activity across the country. Although an estimate of the habitat loss within the reporting period cannot be given, it is likely to have been <1% per year and thus the habitat Area is given an Unfavourable - Inadequate assessment; the trend is also Decreasing.

The results of an overall assessment of the structure and function of the priority habitat 8240 (taking into consideration the assessment given to its associated habitats), is Unfavourable - Inadequate. The main reasons for this assessment were lack of positive indicator species, the presence of negative indicator species and the presence of non-native species. Although several monitoring sites failed in terms of structure and functions, it must be stressed that significantly less than 25% of the habitat is Unfavourable (see rules set out by Evans & Arvela 2011 in Table 5). In addition, measures undertaken within the Burren, to halt further damage to the habitat (Anon. 2012) are having a positive impact on the habitats and therefore the trend was given as 'improving'.

The result of the overall assessment of the future prospects of the priority habitat 8240 is Unfavourable - Inadequate. Limestone pavement quarrying, land reclamation, scrub encroachment, invasive non-native species, problematic native species and lack of grazing were deemed the main pressures. However, the recent initiatives in the Burren (the largest expanse of limestone pavement in Ireland) by the BurrenLIFE Project (Anon. 2010) and the Burren Farming for Conservation Project (Anon. 2011, Anon. 2012) to improve landuse management are reversing inappropriate grazing regimes and locally reducing the area of scrub and attempting to control encroachment. The overall assessment has therefore been evaluated as Unfavourable - Inadequate (Improving). Outside the Burren, however, land abandonment and other damaging activities, such as quarrying and land reclamation, continue to be a threat and no measures have been put in place to halt these pressures.

The current conservation status of Limestone pavement (8240) is given below (Table 52). This assessment was made based on all available information discussed above. These data have been used to provide a National Assessment for Limestone Pavement (8240) in Ireland. The information was used to produce a report on the main results of the surveillance under Article 17 for Annex I habitat types (Annex D).

Table 52 Current Conservation Status and trend value for Limestone Pavement and Associated Habitats (8240).

Parameter	Future trend	Status
Range	Stable	Favourable
Area	Decreasing	Unfavourable - Inadequate
Structure and Function	Improving	Unfavourable - Inadequate
Future Prospects	Improving	Unfavourable - Inadequate
Overall Conservation Status	Stable	Unfavourable - Inadequate

Ranking of potential NHA sites using conservation and threat scores

Conservation and threat scores were calculated as described in the methods section. Table 53 and Table 54 give conservation and threat scores for each of the potential NHA surveyed as part of the National Survey of Limestone pavement. Each site was ranked relative to the other sites for both conservation and threat scores.

Table 53 Conservation scores for each of the potential NHA sites surveyed for the NSLP

Site Code	Site Name	County	Cnservation Score (%)	Rank	Total score	Limestone pavement (Fossitt)	Annex I Habitat	Other semi-natural habitats	Area	Species-richness	Notable species	Typicality	Expert opinion	Location
Max score					*49*	*5*	*12*	*2*	*12*	*4*	*8*	*2*	*2*	*2*
NSLP31	Mullagh	Limerick	70	3	32	4	6	3	9	3	2	1	2	2
NSLP32	Mountscribe	Galway	41	13	19	3	4	0	6	3	0	2	1	0
NSLP33	Carrownamaddra	Galway	50	10	23	5	6	0	6	3	0	1	1	1
NSLP34	Tooreen East	Galway	46	11	21	4	6	0	6	3	0	1	1	0
NSLP35	Cartron	Galway	39	14	18	3	4	0	6	3	0	1	1	0
NSLP19/36	Caherlough	Clare	59	7	27	5	4	0	12	3	0	2	1	0
NSLP37	Shanclogh	Galway	60	6	28	4	8	0.5	6	4	2	1	2	0
NSLP20/38	Cloonnasee	Galway	59	7	27	4	6	0	9	3	0	2	2	1
NSLP39	Moymore	Clare	54	9	25	5	6	0	9	3	0	1	1	0
NSLP40	Coolteige	Roscommon	-	-	-	-	-	-	-	-	0	1	1	2
NSLP23/41	Grange East	Galway	62	5	29	5	6	0.5	9	3	0	2	2	1
NSLP42	Menlough	Galway	39	14	18	3	4	0	4	4	0	1	1	1
NSLP43	Cregboy	Galway	43	12	20	4	4	0	6	3	0	1	1	1
NSLP44	Creevagh	Galway	55	8	26	4	4	0.5	9	3	0	2	1	2
NSLP45	Kildun More	Mayo	65	4	30	5	8	1	9	3	0	1	1	2
NSLP46	Glasgort	Mayo	73	1	34	5	10	2.5	9	3	0	1	1	2
NSLP29/47	Ballydotia	Galway	72	2	33	5	10	1	9	3	0	2	2	1

The potential NHA site with the highest conservation score was Glasgort, Co. Mayo (NSLP46), followed closely by Ballydotia in Co. Galway (NSLP47) and Mullagh in Co. Limerick (NSLP31). These sites were scored highly due to the presence of Annex I Habitats and notable species. These sites also scored highly for size; with the top three sites all being over 110ha in area. The sites that were ranked lowest were Cartron (NSLP35), Menlough (NSLP42) and Mountscribe (NSLP32), all of which were in Co. Galway. These sites had a low conservation score mainly due to their small size and low number of Annex I habitats present. Coolteige in Co. Roscommon (NSLP40) was not ranked as data was not recorded for the site, due to problems with site access.

Table 54 Threat scores for each of the potential NHA sites surveyed for the NSLP

Site Code	Site Name	County	Threat score (%)	Rank	Bracken encroachment	Scrub encroachment	Non-native invasives	Quarrying	Land reclamation	Other damaging activities	Total
Max score					*3*	*3*	*3*	*4*	*4*	*3*	*20*
NSLP31	Mullagh	Limerick	10	4	0	2	0	0	0	0	2
NSLP32	Mountscribe	Galway	15	3	0	2	1	0	0	0	3
NSLP33	Carrownamaddra	Galway	0	5	0	0	0	0	0	0	0
NSLP34	Tooreen East	Galway	0	5	0	0	0	0	0	0	0
NSLP35	Cartron	Galway	10	4	0	2	0	0	0	0	2
NSLP19/36	Caherlough	Clare	15	4	0	0	0	0	4	0	4
NSLP37	Shanclogh	Galway	30	2	0	0	2	0	4	0	6
NSLP20/38	Cloonnasee	Galway	15	4	0	0	0	0	4	0	4
NSLP39	Moymore	Clare	0	5	0	0	0	0	0	0	0
NSLP40	Coolteige	Roscommon	-	-	-	-	-	-	-	-	-
NSLP23/41	Grange East	Galway	15	4	0	0	0	0	4	0	4
NSLP42	Menlough	Galway	0	5	0	0	0	0	0	0	0
NSLP43	Cregboy	Galway	15	4	0	0	0	0	4	0	4
NSLP44	Creevagh	Galway	15	4	0	0	0	0	4	0	4
NSLP45	Kildun More	Mayo	0	5	0	0	0	0	0	0	0
NSLP46	Glasgort	Mayo	0	5	0	0	0	0	0	0	0
NSLP29/47	Ballydotia	Galway	35	1	0	2	2	2	0	1	7

Table 54 shows that the most threatened potential NHA site was Ballydotia in Co. Galway (NSLP47) followed by Shanclogh, Co. Galway (NSLP37). Ballydotia (NSLP47) was also ranked as the site with the second highest conservation value. The site is currently threatened by scrub encroachment, invasive non-native species and quarrying activities. Shanclogh (NSLP37) was ranked highly due to the presence of non-native invasive species and land reclamation. Several sites had no significant threats such as Carrownamaddra and Tooreen East in Co. Galway, Moymore in Co. Clare and Kildun More and Glasgort in Co. Mayo.

Discussion

Habitat mapping

The updated Limestone pavement and associated habitats map depicts the distribution and extent of habitat 8240 at national level. Mapping was undertaken at a 1:5000 scale, therefore small habitat areas and areas completely covered by scrub may have been omitted. However, in some instances, areas as small as 500m² were mapped. Special attention was given to areas covered by scrub, where pavement was visible, or to areas adjacent to pavement that were covered in scrub, where occurrence of the habitat was identified with a high degree of certainty. Improved accuracy in mapping resulted in changes in the distribution and a reduction in area from 36,000ha to 32,187ha. The revised map features a total of 490 new polygons (areas) not previously reported in the original 2007 map.

A total of 34 SACs, one NHA and 39 pNHAs have been identified as containing limestone pavement and associated habitats. Only 22 SACs are listed as having habitat 8240 as a qualifying interest. County Clare has the highest extent of limestone pavement and associated habitats in the country (24,128ha), followed by county Galway (6,761ha). Approximately 82.69% (26,557ha) of the habitat national resource is located within a SAC or NHA, 25,932ha of which lies within SACs for which the habitat is a qualifying interest. The remaining 17.31% (5,630ha) are not designated.

The mapping of the national habitat resource has allowed the identification of habitat areas threatened by pavement removal (i.e. land reclamation) and quarrying by visually identifying these areas on the 2005 OSi ortho-photographs. These activities have been more frequently recorded within non-designated sites. County Galway followed by Mayo and Clare, are the counties with the highest number of polygons threatened by pavement removal and/or quarrying. Although these activities occurred prior to 2005 (more recent ortho-photographs were not available during the assessment period), the actual pressure from these activities is likely to have continued in the 2007-2012 period.

Recommendations

Further field surveying may be required, in some instances, to confirm or rule out the occurrence of limestone pavement and associated habitats, particularly for those polygons assigned a low certainty value. Ground surveys should be conducted to confirm the presence or absence of the habitat in these low certainty areas, before the inclusion of the habitat as a qualifying interest is considered.

An overall assessment of the main pressures on the habitat such as pavement removal (land reclamation) and quarrying have been given within the report. This was based on the visual identification of these activities on the 20005 OSi ortho-photographs. A more recent data set should be

used, when available, to assess changes in habitat extent and distribution or to estimate the extent and distribution of major impacts such as those mentioned above.

Vegetation analysis and Habitat classification

The data analysis methods proved useful in separating the main habitats surveyed; Limestone pavement, heath, grassland and woodland. Analysis methods also distinguished sub-habitat groups (vegetation communities) for limestone pavement, heath, grassland and woodland. The vegetation types which resulted from the suite of analyses used, show similarities to other comparable studies, such as those described by Perrin *et al.* (2008), Parr *et al.* (2009) and O'Neill *et al*. (2010).

The classification of exposed limestone pavement was successful in terms of the production of meaningful vegetation types. Preliminary investigation in the pilot survey (Murphy & Fernández 2009) suggested that vegetation types may be devised according to pavement structure (shattered or blocky). In the current study, five vegetation types resulted from the cluster and Indicator Species Analysis techniques used: of these, type 1a and 1d were more typical of blocky pavement, and one type (1e) was more characteristically found on shattered limestone pavement. The remaining two vegetation types appeared to consist of a mix of both shattered and blocky pavement types. This intimates the complex nature of the habitat and the continued difficulty in classifying the habitat on the whole. This is reflected in Rodwell *et al.* (2000) which states that the vegetation of limestone pavements is frequently described as 'not fitting the NVC'. The classification of wooded limestone pavement proved successful in separating scrub or low woodland covered limestone pavement from typical wooded pavement. It also produced meaningful indicator species for the vegetation types that resulted from the analysis.

The inclusion of relevé data from Parr *et al.* (2009) allowed for a more comprehensive analysis of the grassland and heath habitats being studied. The NSLP classification broadly mirrors the Parr *et al.* (2009) classification; similarities were seen with a number of the vegetation types in both sets of analyses. However, different techniques in data preparation and data analysis, namely the splitting of relevés into grassland and heath groups prior to analysis by Parr *et al*. (2009) and the use of TWINSPAN rather than Cluster Analysis and Indicator Species Analysis, meant that the grouping of relevés was different between Parr *et al.* (2009) and the current study.

Parr *et al.* (2009) states that because of the intimate mixture of usually quite widely separated species assemblages, such as Arctic-alpine and Mediterranean species, the community types found in the Burren do not fit neatly into any existing classification. This vegetation classification during the NSLP project may help to elucidate the complex nature of limestone pavement and associated habitats. It may also be useful in terms of conservation; by tailoring management strategies to the different

vegetation types, it may help in the preservation of the unique habitats that are found along the continuum from limestone grassland to limestone heath.

It is well documented, that limestone pavement commonly occurs in a mosaic with other habitats (Parr *et al.* 2009, Jeffrey 2003, Fossitt 2000, McGough 1984, Ivimey-Cook & Proctor 1966). Fossitt (2000) defines a mosaic as a complex pattern or patchwork of habitats or species occurring in intimate associations. Fossitt (2000) does not attempt to classify these mosaics but rather states that the identification and differentiation of habitats is often difficult in practice. Habitats frequently merge or grade from one to another, or form complex mosaics, with the result that a continuum of variation often exists within and between different habitat types. Inevitably, several relevés were recorded during the present study that were considered to be a mosaic of two or more habitat types. These relevés were not included in the vegetation analysis and were, in fact, removed as outliers, in the initial stages of the analysis process.

The vegetation classification outlined in this report has contributed to a greater understanding of Limestone pavement and its associated habitats. It also highlights the need for a revision of the current classification of vegetation in Ireland (Fossitt 2000). As a final note, it must be stated that vegetation classification should be used as a guide only. As stated by Perrin *et al.* (2009) the system of vegetation classification is inherently artificial and its aim is to simplify a highly complex dataset; it is not seeking to identify real divisions in nature. Vegetation types are simply approximations – artificial labels for the purpose of convenience – and therefore no classification system is perfect (Smith *et al*. 2011).

Conservation status assessment

Conservation status assessments have been carried out for the following Annex I EU habitats: Limestone pavement (exposed) (8240); Limestone pavement (wooded) (8240); Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (important orchid sites) (6210/6211), European dry heaths (4030) and Alpine and Boreal heaths (4060). Overall, the results provided should be taken as an indication of current status, which can be used as a baseline for further monitoring of these habitats.

A new method for assessing the structure and functions of Annex I EU habitats was devised during this project. This method is based on the analysis of a matrix where structure and functions are assessed at monitoring stop level and attribute level. The proposed method is considered to be a fairer representation of the condition of a habitat. The addition of a second level of assessment provides an accumulative level of assessment at attribute level (i.e. if the same attributes fail at several monitoring stops within a site it is taken into consideration in the assessment).

Change in habitat area was not assessed as part of this survey. The use of ortho-photography for evaluating changes in habitat extent was not deemed appropriate. The size of the monitoring plots (1ha) and minimum mapping unit size (4m x 4m) made it impossible to ascertain area changes at this level of fine scale mapping. However, data on habitat extent gathered as part of this survey will be useful as baseline data for future assessments.

The conservation status of Limestone pavement and associated habitats (8240) was determined, based on each of the individual associated habitat conservation status assessment results. More than half of the monitoring sites failed the structure and functions assessments. This was mainly due to the failing of 8240 (exposed) and 6210. Limestone pavement (exposed) failed at four monitoring sites. The principal reasons were an inadequate number of positive indicators, high cover of negative indicators, scrub encroachment and non-native species (*Cotoneaster* spp., *Clematis vitalba, Centranthus ruber*). The Annex I Habitat 6210 failed at over half of the sites, largely due to scrub encroachment, problematic native species such as bracken, an inadequate number of positive indicators, high cover of negative indicators and a low forbs ratio. The majority of sites for habitats 8240, 4030 and 4060 passed the structure and functions assessments

More than half of the monitoring sites failed the future prospects assessments. This was mainly due to the failing of 8240 (exposed) and, to a lesser degree, 6210. Limestone pavement (exposed) failed at fifteen of the 25 monitoring sites, 6210 failed at six sites and 4030 failed at three sites. The main reasons for these failures were scrub encroachment, limestone pavement displacement and quarrying and land reclamation. Other reasons for failed future prospects assessments include the presence of non-native species (*Cotoneaster* spp.) and problematic native species (bracken).

At a national level, limestone pavement quarrying, land reclamation, scrub encroachment, invasive non-native species, problematic native species and lack of grazing were considered the main issues and resulted in an assessment of Unfavourable - Inadequate for Limestone pavement (8240). However, although the habitat overall has been assessed as Unfavourable – Inadequate, it is given an 'improving' trend because of the measures being implement to improve current landuse practices in the Burren, the largest expanse of limestone pavement in Ireland. Further measures are needed to combat the issue of limestone pavement removal and land reclamation, particularly in areas without legal protection.

Recommendations

Currently only limestone pavement lying within protected areas receive any form of safeguard in Ireland, leaving substantial areas outside such areas unprotected, despite this being a priority habitat under the European Habitats Directive. In the UK, the Wildlife and Countryside Act 1981 was passed to provide strengthened legal protection for threatened wildlife and environmental features.

Limestone Pavement Orders (LPOs) are made under this Act, which bans the removal of pavement (Goldie 1993). A similar piece of legislation is needed in Ireland, particularly for the protection of limestone pavement outside the NATURA 2000 network. Goldie (1993) states that, as a result of the LPOs, there is evidence that a number of limestone pavement contractors in the UK have shifted their attention to extraction of limestone pavement in Ireland for export to the UK market.

A report on trading of water-worn limestone between the UK and the Republic of Ireland (Pendry & Allen (Eds.) 1999) states that all extraction or damage to pavement within SACs is illegal. However, planning permission is not required for operation below 2.5ha in size outside of SAC's. This report indicates the increase in demand for Irish water-worn limestone since UK Legal protection has been put into place preventing the extraction from the UK. The study has identified both legal and illegal extraction in the Republic of Ireland. The report recommends increasing the enforcement of the legal protection of limestone pavement by relevant authorities in both the UK and the Republic of Ireland to protect remaining resources. The use of the Environmental Liability Directive for preventing damage (removal of pavement) in non-designated areas has been proposed by the UK-Ireland Limestone Pavment Biodiveristy Group (S. Ward pers. comm.). In addition, the Single Farm Payment Scheme under the Common Agricultural Policy is encouraging the removal of pavement. This should be addressed so that it does not continue into the future.

Ranking of potential NHA sites using conservation and threat scores

A ranking system was developed for sites surveyed outside the NATURA 2000 network (potential NHAs). Conservation scores were based on criteria such as species diversity, the presence of Annex I habitats and area. Threat scores were also developed, based on damaging activities such as encroachment, quarrying, reclamation and the presence of invasive species. The conservation scores appeared to be generally high. These high scores, along with the moderate threat scores for each potential NHA, highlighted the fact that there are many undesignated sites which are of conservation value that are threatened. These sites will continue to be threatened by activities such as quarrying and land reclamation, if they are not given full legal protection.

Monitoring protocol for 8240 Limestone pavements

This monitoring protocol should be used as a quick reference guide for assessing the conservation status of *8240 Limestone pavements* and associated habitats. It does not replace the detailed methods outlined in the main project report.

Field Survey Methods

Field surveys should focus on the monitoring sites surveyed (see Table 9 in results section of main report) as part of the PSLP and NSLP surveys. If time does not permit the surveying of all sites listed, then a number of sites should be selected across the range of the habitat. Field ecologists should work in pairs. Prior to the site visit a plan must be devised on how best to survey the site. A start position should be decided on and a rough estimation of how long the site would take to survey should be calculated (based on site map). Landowners and rangers must be contacted (when possible) before entering the site.

Monitoring plot survey

Each monitoring plot (100m x 100m) should be walked, to aid plot familiarisation and to record a comprehensive plant list, which should include the major bryophyte and lichen species. The monitoring plot species lists should be recorded using TurboVegCE software on a GeoExplorer handheld GPS minicomputer (Trimble GeoXT). Additional information which should be recorded for each plot is listed in the methods section of the main report. This information should be recorded using a combination of TurboVegCE software and Terrasync software on a Trimble GeoXT. A photographic record of each plot (overview) should be taken. Photographs of damaging activities such as quarrying, non-native invasive species or land reclamation should also be captured. The grid reference of each photograph should be fixed with GPS, and the aspect of each taken with a compass.

Recording of relevés (monitoring stops)

At least one relevé should be recorded in each limestone pavement or associated habitat found in the plot. The size of the relevé is dependent on habitat type (1m x 1m relevés for grassland and heath habitats, 5m x 5m relevés for limestone pavement, scrub and woodland habitats). Cover in vertical projection for all vascular and bryophyte species should be recorded using the Domin scale. Other parameters such as bare soil, litter and bare rock should be recorded as percentage cover. The percentage cover of functional groups should also be recorded in each relevé as follows: bryophytes, grasses, sedges, broadleaf herbs, low woody and shrubs. The major components of the lichen ground

flora should also be recorded. All information should be recorded using TurboVegCE software on a Trimble GeoXT.

For each relevé a 12-figure grid reference (i.e. 6 Easting and 6 Northing) should be obtained using a DGPS unit (one for the 1m x 1m relevé, two for the 5m x 5m relevé), altitude, slope and aspect should also be recorded. Soil depth (cm) should be measured *in situ* with a metal skewer, taking an average measurement from four readings in each relevé. Photographical records of the relevé should be taken; detail and overview for grassland and heath and overview for limestone pavement and scrub. The grid reference of each photograph should be fixed with GPS and the aspect of each taken with a compass.

Habitat Mapping

Data for the habitat map within each plot should be captured in the field, using the Irish National Grid (ING) as the co-ordinate reference system. Habitats should be mapped at two different vegetation classification levels: Fossitt (2000), which should be done in the field, and EU Habitats Directive Habitat classification, which should be carried out post survey. Post survey mapping is undertaken at a 1:750 spatial resolution for monitoring sites. Mapping procedures are described in more detail in the mapping section of the main report.

Conservation Status Assessment

Area

The conservation assessment for Annex I habitats is based on three main aspects; area, structure and functions and future prospects. A quantitative assessment of the variation in Annex I habitat extent within the reporting period should be carried out by comparing it to the baseline survey. When assessing changes in area the rules stated in Evans & Arvela (2011) should be followed; a decline in habitat area within a site, greater than 0% and smaller than 1% per year, should be assessed as Unfavourable - Inadequate; a decline greater than 1% per year should be assessed as Unfavourable - Bad. Area should also be given a trend assessment based on changes in extent in the reporting period. Large changes in habitat extent should be evident during field survey, if damaging activities such as land reclamation or quarrying have occurred. These changes will also be apparent if different sets (from different years) of OSI aerial photographs are compared. Local NPWS rangers may also be aware of landuse changes or damaging activities in their area.

Structure and Functions

Data for the assessment of structure and function should be gathered through the recording of relevés which is described in detail in the methods section of the report. Data recorded during the PSLP and NSLP should be used for comparative purposes for the next round of assessments. Digital photographs recorded during the PSLP and NSLP surveys will also be available for reference to allow comparisons during the next round of monitoring. As there are different criteria for the assessment of each of the five Annex I Habitats associated with limestone pavement, the relevant assessment criteria should be used (details can be found in Appendix 5). Once all of the relevant criteria for a monitoring stop have been assessed, the stop can be given an overall assessment of Pass or Fail. The assessment of each of the individual Annex I Habitats at a site will lead to an overall assessment of limestone pavement and associated habitats at each monitoring site. A site will be considered Favourable if Structure & functions (including typical species) are in good condition and no significant deteriorations / pressures are apparent. It will be considered Unfavourable - Bad if >25% of the area is unfavourable as regards its specific structures and functions (including typical species) and it will be considered Unfavourable - Inadequate if there is 1 – 25% decline/failure (e.g. 1-25% of monitoring stops fail).

Future Prospects

Data for the future prospects assessment should be gathered not only from the monitoring site relevés, but also the monitoring plot data and data collected from other relevant sources, such as local NPWS Rangers, and projects such as the Burren Farming for Conservation Programme. The future prospects assessment should be viewed as the overall outlook for the site. The assessment should be made by combining habitat knowledge with site-based experience of negative impacts and positive influences on the site. Data recorded during the PSLP and NSLP should be used for comparative purposes for the next round of assessments. Digital photographs recorded during the PSLP and NSLP surveys will also be available for reference. The list of impacts and impact codes which should be used can be found in Appendix 6 and is based on Ssymank (2011). Each impact should be listed as being positive, negative or neutral in nature and the intensity should be recorded as high, moderate or low. A certain degree of expert judgement will need to be used to gauge the severity of the impact on the site. The overall status of Future Prospects should be determined as Favourable if the habitat's prospects for its future are excellent / good and no significant impact from threats are expected; Unfavourable-Inadequate if the habitat's prospects for its future are poor and Unfavourable - Bad if the habitat's prospects are bad and severe impact from threats are expected. The scale of the damage (estimate in hectares) should also be recorded. This can then be compared to previous assessments and a trend given as follows; declining, stable or improving.

Reporting

Future conservation assessment should be reported using the standard Annex D format as presented in the most up-to-date EU Habitats Directive Conservation Assessment Guidelines.

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Appendix 1: Relevant vegetation classifications associated with limestone pavement

NVC list of vegetation types associated with limestone pavement (Rodwell *et al.* 2000)*

Deeper grikes

essentially a field layer of W9 *Fraxinus-Sorbus-Mercurialis* woodland

Shallower grikes and bigger clint crevices

OV38 *Gymnocarpietum robertianum* fern vegetation

Smaller crevices in grikes and clint surfaces

OV39 *Asplenietum trichomano-rutae-murariae* fern vegetation

OV40 *Asplenio-Cystopteridetum fragilis* fern vegetation

Shallower soil-filled grikes

CG9 *Sesleria-Galium* grassland

MG5 *Centaureo-Cynosuretum* grassland

Shallower peat-filled grikes

M10 *Pinguiculo-Caricetum dioicae* small-sedge fen

M26 *Molinia-Crepis* fen-meadow

M27 *Filipendula-Angelica* tall-herb fen

Solution-hollows on clint surfaces

M10 *Pinguiculo-Caricetum* small-sedge fen

algae/cyanobacterial assemblages

Seasonally-desiccated soils on clint surfaces

Saxifrago-Poetum compressae community

Airo-Sedetum anglici stonecrop community

Pavement surrounds

Rubo-Origanetum woodland fringe community and transitions to various grassland, woodland, mire and heath communities

* W9 *Fraxinus excelsior-Sorbus aucuparia-Mercurialis perennis* woodland, although not listed by Rodwell *et al.* (2000) is also associated with wooded limestone pavement.

Parr *et al.* (2009) Burren grassland and heath vegetation types

Group	Description
Group1	***Dryas octopetala* community**
1a	*Antennaria dioica –Asperula cynanchica*
1b	*Teucrium scorodonia*
1c	*Galium verum – Lathyrus pratensis*
Group2	**Calluna vulgaris community**
2d	*Calluna* Heath: Typical
2ea	*Calluna* Heath: Calcareous *Molinia*
2eb	*Calluna* Heath: *Molinia-Erica cinerea*
Group3	***Sesleria albicans –Breutelia chrysocoma***
3f	*Achillea millefolium – Helichtotrichon pubescens*
3g	*Anthyllis vulneraria – Plantago maritima*
3h	*Solidago virgaurea- Hypericum pulchrum*
Group4	***Dactylis glomerata-Holcus lanatus***
4i	*Arrhenatherum elatius – Rumex acetosa*
4j	*Sesleria caerulea- Thymus polytrichus*
4k	*Centaurea nigra – Plantago maritima*

Willis (2011) UK limestone pavement types

Group	Description
1	A higher altitude, open limestone pavement group with mid-range grike depth 0.5-1m and low species-richness
3	An open, coastal limestone pavement group with little moss growth and un-vegetated clints
4	A mossy, densely vegetated woodland limestone pavement group
6	A higher altitude, level, species-rich, thickly bedded open limestone pavement group
7	A higher altitude limestone pavement group with shallow, wide grikes, typically heavily grazed
8	A lower altitude, sloping woodland limestone pavement group with Oak and Silver birch predominant

Cooper *et al.* (2012) Juniper vegetation groups

Group	Vegetation group	Description
1	*Carex flacca – Succisa pratensis*	Wet grassland, heath or bog
2	*Teucrium scorodonia – Geranium sanguineum*	Exposed calcareous rock *aka* limestone pavement
3	*Lotus corniculatus - Trifolium pratensis*	Dry calcareous heath and grassland
4	*Calluna vulgaris – Erica cinerea*	Dry siliceous heath and raised bog
5	*Galium verum – Pilosella offcinarum*	Dry calcareous or neutral grassland including coastal dune grassland

O'Neill *et al.* (2010) Grassland vegetation groups and types

Group	Vegetation Groups and Types
1	***Festuca rubra – Plantago lanceolata* group**
1a	*Carex flacca – Thymus polytrichus* vegetation type
1b	*Carex flacca – Briza media* vegetation type
1c	*Trifolium pratense – Rhinanthus minor* vegetation type
1d	*Trifolium pratense – Cynsosurus cristatus* vegetation type
1e	*Agrostis stolonifera – Festuca rubra* vegetation type
1f	*Dactylis glomerata – Holcus lanatus* vegetation type
1g	*Arrhenatherum elatius – Festuca rubra* vegetation type
1h	*Festuca rubra – Lotus corniculatus* vegetation type
1i	*Plantago coronopus – Armeria maritima* vegetation type
1j	*Elytrigia repens – Holcus lanatus* vegetation type
2	***Anthoxanthum odoratum – Rhytidiadelphus squarrosus* group**
2a	*Nardus stricta – Hylocomium splendens* vegetation type
2b	*Anthoxanthum odoratum – Potentilla erecta* vegetation type
2c	*Festuca ovina – Galium saxatile* vegetation type
2d	*Agrostis capillaris – Plantago lanceolata* vegetation type
2e	*Anthoxanthum odoratum – Succisa pratensis* vegetation type
2f	*Rhytidiadelphus squarrosus – Juncus* spp. vegetation type
2g	*Juncus acutiflorus/articulatus – Holcus lanatus* vegetation type
2h	*Agrostis canina/vinealis – Juncus* spp. vegetation type
3	***Agrostis stolonifera – Juncus effusus* group**
3a	*Juncus effusus – Holcus lanatus* vegetation type
3b	*Carex disticha – Filipendula ulmaria* vegetation type
3c	*Calliergonella cuspidata – Juncus* spp. vegetation type
3d	*Molinia caerulea – Calliergonella cuspidata* vegetation type
3e	*Filipendula ulmaria – Ranunculus repens* vegetation type
3f	*Agrostis stolonifera – Potentilla anserina* vegetation type
3g	*Agrostis stolonifera – Holcus lanatus* vegetation type
3h	*Alopecurus pratensis – Ranunculus repens* vegetation type
3i	*Agrostis stolonifera – Equisetum fluviatile* vegetation type
4	***Molinia caerulea – Cirsium dissectum* group**
4a	*Molinia caerulea – Potentilla erecta* vegetation type
4b	*Molinia caerulea – Cirsium dissectum* vegetation type
5	***Lolium perenne – Trifolium repens* group**
5a	*Lolium perenne – Trifolium repens* vegetation type
5b	*Cynosurus cristatus – Trifolium repens* vegetation type
5c	*Festuca rubra –Trifolium repens* vegetation type
5d	*Holcus lanatus – Agrostis stolonifera* vegetation type
5e	*Agrostis capillaris – Trifolium repens* vegetation type

Appendix 2: Site cards

Below are the following site cards:

1. Plot/Site data card
2. Plot/Site species list data card
3. Limestone pavement/ scrub/woodland relevé data card
4. Grassland/heath relevé data card

Site ID		**Plot ID (for monitoring sites)**		**Date (year/month/day)**	
Recorder					

County		**Fauna**		**Bracken Present (L-M-H)**	
Altitude (m)		Rabbits		Pavement	
Slope		Hares		Grassland	
Flat		Foxes		Heath	
Slight		Frogs		Scrub	
Moderate		Ant hills		Mosaic	
Steep		Other (describe)		**Hazel Present (L-M-H)**	
Aspect (NSEW)		**Site Management**		Pavement	
Easting		Cattle		Grassland	
Northing		Goats		Heath	
Exposure		Horses		Scrub	
Exposed		Sheep		Mosaic	
Partially exposed		Other (describe)		**Invasive Present (L-M-H)**	
Sheltered		Summer grazing: May-Sept		**Species:**	
Topography		Winter grazing: Oct-Apr		Pavement	
Summit		Supplementary feeding		Grassland	
Slope		Scrub removal		Heath	
Depression		**Grazing level**		Scrub	
Ridges		None		Mosaic	
Flat		Light		**Relevé Description**	**No:**
Other (describe)		Moderate			
Dominant pavement		Heavy			
Blocky		**Damaging operations**			
Sharp		Quarrying			
Shattered		Rock removal			
Other (describe)		Land reclamation			
Other pavement		Dumping		**General Plot/NHA Notes**	
Blocky		Grike filling			
Sharp		Trampling			
Shattered		Other			
Other (describe)		**Mosses identified (y/n)**			
		Lichens identified (y/n)			

Site ID:	Grasses/Sedges/Rushes	Herbs	Herbs	Orchids	Mosses	Low Woody
Plot ID (monitoring):	Melica uniflora	Galium sterneri	Potentilla erecta	Anacamptis pyramidalis	Ctenidium molluscum	Hedera helix
Recorder:	Molinia caerulea	Galium verum	Potentilla sterilis	Coeloglossum viride	Dicranum scoparium	Helianthemum oelandicum
Date:	Phleum pratense	Gentiana verna	Primula veris	Dactylorhiza fuchsii	Didymodon rigidulus	Ilex aquifolium
Notes	Poa annua	Gentianella amarella	Primula vulgaris	Dactylorhiza maculata	Ditrichum gracile	Lonicera periclymenum
	Poa pratensis	Gentianella campestris	Prunella vulgaris	Epipactis atrorubens	Encalypta streptocarpa	Rosa canina
	Schoenus nigricans	Geranium robertianum	Ranunculus acris	Epipactis helleborine	Eurhynchium striatum	Rosa spinosissima
	Sesleria caerulea	Geranium sanguineum	Ranunculus bulbosus	Gymnadenia conopsea	Fissidens adianthoides	Rubus fruticosus agg.
	Trichophorum caespitosum	Geum urbanum	Ranunculus ficaria	Listera ovata	Fissidens dubius	Rubus saxatilis
	Herbs	Hieracium anglicum	Ranunculus repens	Neotinia intacta	Fissidens taxifolius var. tax	Thymus polytrichus
	Achillea millefolium	Hyacinthoides n-s	Rhinanthus minor	Orchis mascula	Grimmia pulvinata	**Woody**
Grasses/Sedges/Rushes	Agrimonia eupatoria	Hypericum androsaemum	Rubia peregrina	Platanthera bifolia	Homalothecium lutescens	Cornus sanguinea
Agrostis canina	Alchemilla filicaulis	Hypericum maculatum	Rumex acetosa	Spiranthes spiralis	Homalothecium sericeum	Corylus avellana
Agrostis capillaris	Alchemilla xanthochlora	Hypericum perforatum	Rumex crispus	**Ferns**	Hylocomium brevirostre	Crataegus monogyna
Agrostis stolonifera	Anemone nemorosa	Hypericum pulchrum	Rumex obtusifolius	Adiantum capillus-veneris	Hylocomium splendens	Euonymus europaeus
Anthoxanthum odoratum	Antennaria dioica	Hypochaeris radicata	Sanguisorba minor	Asplenium adiantum-nigrum	Hypnum cupressiforme	Frangula alnus
Arrhenatherum elatius	Anthyllis vulneraria	Knautia arvensis	Sanicula europaea	Asplenium marinum	Hypnum lacunosum	Fraxinus excelcior
Brachypodium sylvaticum	Arabis hirsuta	Lathyrus linifolius	Saxifraga hypnoides	Asplenium ruta-muraria	Isothecium myosuroides	Juniperus communis
Briza media	Arum maculatum	Lathyrus pratensis	Saxifraga tridactylites	Asplenium viride	Mnium hornum	Pinus sylvestris
Bromus hordaceus	Asperula cynanchica	Leontodon autumnalis	Sedum acre	Asplenium trichomanes	Neckera complanata	Prunus spinosa
Carex binervis	Bellis perennis	Leontodon hispidus	Senecio jacobaea	Botrychium lunaria	Neckera crispa	Potentilla fruticosa
Carex caryophyllea	Blackstonia perfoliata	Leucanthemum vulgare	Sisymbrium officinale	Ceterach officinarum	Plagiomnium undulatum	Rhamnus catharticus
Carex flacca	Campanula rotundifolia	Linum catharticum	Solidago virgaurea	Cystopteris fragilis	Pleurozium schreberi	Salix aurita
Carex hostiana	Carlina vulgaris	Lotus corniculatus	Sonchus arvensis	Dryopteris filix-mas	Racomitrium lanuginosum	Salix caprea
Carex nigra	Centaurea nigra	Medicago lupulina	Sonchus asper	Phyllitis scolopendrium	Rhizomnium punctatum	Salix cinerea
Carex panicea	Centaurea scabiosa	Melampyrum pratense	Sonchus oleraceus	Polypodium interjectum	Rhytidiadelphus squarrosus	Salix repens
Carex pulicaris	Centaurium erythraea	Mentha aquatica	Stellaria graminea	Polypodium vulgare	Rhytidiadelphus triquetrus	Sorbus aria
Carex spicata	Centranthus ruber	Mentha arvensis	Stellaria holostea	Polystichum aculeatum	Scleropodium purum	Sorbus aucuparia
Cynosurus cristatus	Cerastium fontanum	Minuartia verna	Stellaria media	Polystichum setiferum	Syntrichia ruralis	Taxus baccata
Dactylis glomerata	Circaea lutetiana	Mycelis muralis	Succisa pratensis	Pteridium aquilinum	Thamnobryum alopecurum	Ulex europaeus
Danthonia decumbens	Cirsium arvense	Odontites vernus	Taraxacum officinale	**Liverworts**	Thuidium delicatulum	Vaccinium myrtillus
Deschampsia flexuosa	Cirsium dissectum	Orobanche alba	Teucrium scorodonia	Conocephalum conicum	Thuidium tamariscinum	Viburnum opulus
Festuca arundinacea	Cirsium palustre	Origanum vulgare	Thalictrum minus	Frullania tamarisci	Tortella tortuosa	**Other spp.**
Festuca ovina / rubra	Circium vulgare	Oxalis acetosella	Trifolium pratense	Lophocolea bidentata	**Lichens**	
Helictotrichon pubescens	Clematis vitalba	Parnassia palustris	Trifolium repens	Plagiochila asplenioides	Cladonia ciliata	
Holcus lanatus	Conopodium majus	Pedicularis palustris	Valeriana officinalis	Plagiochila porelloides	Cladonia rangiformis	
Juncus articulatus	Daucus carota	Pedicularis sylvatica	Veronica chamaedrys	Scapania aspera	Cladonia spp.	
Juncus conglomeratus	Eupatorium cannabinum	Persicaria maculosa	Veronica officianalis	**Mosses**	**Low Woody**	
Juncus effusus	Euphrasia sp.	Pilosella officinarum	Veronica serpyllifolia	Brachythecium rutabulum	Arctostaphylos uva-ursi	
Juncus squarrosus	Filipendula ulmaria	Pimpinella saxifraga	Vicia cracca	Breutelia chrysocoma	Calluna vulgaris	
Koeleria macrantha	Filipendula vulgaris	Plantago lanceolata	Vicia sepium	Bryum sp.	Cotoneaster spp.	
Lolium perenne	Fragaria vesca	Plantago maritima	Viola sp.	Calliergonella cuspidata	Dryas octopetala	
Luzula campestris	Galium odoratum	Polygala vulgaris	Viola canina	Campyliadelphus chrysophyllus	Empetrum nigrum	
Luzula sylvatica	Galium saxatile	Potentilla anserina	Viola riviniana	Climacium dendroides	Erica cinerea	

Site ID	Grasses/Sedges/Rushes	Herbs	Herbs	Herbs	Mosses	Orchids
Plot ID	Agrostis canina	Anthyllis vulneraria	Leontodon autumnalis	Solidago virgaurea	Fissidens taxifolius	Dactylorhiza fuchsii
Relevé ID	Agrostis capillaris	Arabis hirsuta	Leontodon hispidus	Sonchus arvensis	Grimmia pulvinata	Dactylorhiza maculata
Recorder	Agrostis stolonifera	Arum maculatum	Leucanthemum vulgare	Sonchus asper	Homalothecium lutescens	Epipactis atrorubens
Date	Anthoxanthum odoratum	Asperula cynanchica	Linum catharticum	Sonchus oleraceus	Homalothecium sericeum	Epipactis helleborine
Aspect	Arrhenatherum elatius	Blackstonia perfoliata	Lotus corniculatus	Stellaria graminea	Hylocomium brevirostre	Gymnadenia conopsea
Slope	Brachypodium sylvaticum	Campanula rotundifolia	Medicago lupulina	Stellaria holostea	Hylocomium splendens	Listera ovata
Flat	Briza media	Carlina vulgaris	Melampyrum pratense	Stellaria media	Hypnum cupressiforme	Orchis mascula
Slight	Bromus hordaceus	Centaurea nigra	Mentha aquatica	Succisa pratensis	Hypnum lacunosum	Platanthera bifolia
Moderate	Carex binervis	Centaurea scabiosa	Mentha arvensis	Taraxacum officinale agg.	Isothecium myosuroides	**Low Woody**
Steep	Carex caryophyllea	Centaurium erythraea	Minuartia verna	Teucrium scorodonia	Mnium hornum	Arctostaphylos uva-ursi
Grikes type (majority)	Carex flacca	Centranthus ruber	Mycelis muralis	Thalictrum minus	Neckera complanata	Calluna vulgaris
Narrow + shallow (<10<30cm)	Carex hostiana	Cerastium fontanum	Odontites vernus	Trifolium pratense	Neckera crispa	Cotoneaster spp.
Narrow + deep	Carex nigra	Circaea lutetiana	Orobanche alba	Trifolium repens	Plagiomnium undulatum	Dryas octopetala
Wide + shallow grikes	Carex panicea	Cirsium arvense	Origanum vulgare	Valeriana officinalis	Pleurozium schreberi	Empetrum nigrum
Wide + deep	Carex pulicaris	Cirsium dissectum	Oxalis acetosella	Veronica chamaedrys	Racomitrium lanuginosum	Erica cinerea
Deepest grikes (cm)	Carex spicata	Cirsium palustre	Parnassia palustris	Veronica officianalis	Rhizomnium punctatum	Hedera helix
	Cynosurus cristatus	Circium vulgare	Pedicularis palustris	Veronica serpyllifolia	Rhytidiadelphus squarrosus	Helianthemum oelandicum
Dom Pavement Type	Dactylis glomerata	Clematis vitalba	Pedicularis sylvatica	Vicia cracca	Rhytidiadelphus triquetrus	Ilex aquifolium
Blocky	Danthonia decumbens	Conopodium majus	Persicaria maculosa	Vicia sepium	Scleropodium purum	Lonicera periclymenum
Sharp	Deschampsia flexuosa	Daucus carota	Pilosella officinarum	Viola canina	Syntrichia ruralis	Rosa canina
Shattered	Festuca arundinacea	Eupatorium cannabinum	Pimpinella saxifraga	Viola riviniana	Thamnobryum alopecurum	Rosa spinosissima
Other	Festuca ovina / rubra	Euphrasia officinalis agg.	Plantago lanceolata	**Liverworts**	Thuidium delicatulum	Rubus fruticosus agg.
% Cover	Helictotrichon pubescens	Filipendula ulmaria	Plantago maritima	Conocephalum conicum	Thuidium tamariscinum	Rubus saxatilis
Bare rock	Holcus lanatus	Filipendula vulgaris	Polygala vulgaris	Frullania tamarisci	Tortella tortuosa	Thymus polytrichus
Bare Earth	Juncus acutiflorus	Fragaria vesca	Potentilla anserina	Lophocolea bidentata	**Ferns**	**Woody**
Grike	Juncus articulatus	Galium odoratum	Potentilla erecta	Plagiochila asplenioides	Adiantum capillus-veneris	Cornus sanguinea
% veg in grikes	Koeleria macrantha	Galium saxatile	Potentilla sterilis	Plagiochila porelloides	Asplenium adiantum-nigrum	Corylus avellana
% emergent veg	Lolium perenne	Galium sterneri	Primula veris	Scapania aspera	Asplenium marinum	Crataegus monogyna
Litter	Luzula campestris	Galium verum	Primula vulgaris	**Lichens**	Asplenium ruta-muraria	Euonymus europaeus
Deadwood	Luzula sylvatica	Gentiana verna	Prunella vulgaris	Cladonia ciliata	Asplenium viride	Frangula alnus
Field Layer	Melica uniflora	Gentianella amarella	Ranunculus acris	Cladonia rangiformis	Asplenium trichomanes	Fraxinus excelcior
Grass	Molinia caerulea	Gentianella campestris	Ranunculus bulbosus	**Mosses**	Botrychium lunaria	Juniperus communis
Sedge	Poa annua	Geranium robertianum	Ranunculus ficaria	Brachythecium rutabulum	Ceterach officinarum	Pinus sylvestris
Broad Leaves	Poa pratensis	Geranium sanguineum	Ranunculus repens	Breutelia chrysocoma	Cystopteris fragilis	Prunus spinosa
Bryophytes	Schoenus nigricans	Geum urbanum	Rhinanthus minor	Calliergonella cuspidata	Dryopteris filix-mas	Potentilla fruticosa
Low Woody	Sesleria caerulea	Hieracium anglicum	Rubia peregrina	Campyliadelphus chrysophyllus	Phyllitis scolopendrium	Rhamnus catharticus

Shrub	Trichophorum caespitosum	Hyacinthoides non-scripta	Rumex acetosa	Climacium dendroides	Polypodium interjectum	Salix cinerea
Median Shrub Height (cm)	**Herbs**	Hypericum androsaemum	Rumex crispus	Ctenidium molluscum	Polypodium vulgare	Salix repens
Mosses identified (y/n)	Achillea millefolium	Hypericum maculatum	Sanguisorba minor	Dicranum scoparium	Polystichum aculeatum	Sorbus aria
Lichens identified (y/n)	Agrimonia eupatoria	Hypericum perforatum	Sanicula europaea	Didymodon rigidulus	Polystichum setiferum	Sorbus aucuparia
	Alchemilla filicaulis	Hypericum pulchrum	Saxifraga hypnoides	Ditrichum gracile	Pteridium aquilinum	Taxus baccata
Regeneration (% and spp.)	Alchemilla xanthochlora	Hypochaeris radicata	Saxifraga tridactylites	Encalypta streptocarpa	**Orchids**	Ulex europaeus
	Anemone nemorosa	Lathyrus linifolius	Sedum acre	Eurhynchium striatum	Anacamptis pyramidalis	Vaccinium myrtillus
	Antennaria dioica	Lathyrus pratensis	Senecio jacobaea	Fissidens dubius	Coeloglossum viride	Viburnum opulus

Site ID	Grasses/Sedges/Rushes	Herbs	Herbs	Herbs	Mosses	Orchids
Plot ID	Cynosurus cristatus	Cerastium fontanum	Minuartia verna	Succisa pratensis	Hylocomium brevirostre	Epipactis helleborine
Relevé ID	Dactylis glomerata	Circaea lutetiana	Mycelis muralis	Taraxacum officinale agg.	Hylocomium splendens	Gymnadenia conopsea
Recorder	Danthonia decumbens	Cirsium arvense	Odontites vernus	Teucrium scorodonia	Hypnum cupressiforme	Listera ovata
Date	Deschampsia flexuosa	Cirsium dissectum	Orobanche alba	Thalictrum minus	Hypnum lacunosum	Neotinia intacta
Aspect	Festuca arundinacea	Cirsium palustre	Origanum vulgare	Trifolium pratense	Isothecium myosuroides	Orchis mascula
Slope	Festuca ovina / rubra	Circium vulgare	Oxalis acetosella	Trifolium repens	Mnium hornum	Platanthera bifolia
Flat	Helictotrichon pubescens	Clematis vitalba	Parnassia palustris	Valeriana officinalis	Neckera complanata	Spiranthes spiralis
Slight	Holcus lanatus	Conopodium majus	Pedicularis palustris	Veronica chamaedrys	Neckera crispa	Low Woody
Moderate	Juncus articulatus	Daucus carota	Pedicularis sylvatica	Veronica officianalis	Plagiomnium undulatum	Arctostaphylos uva-ursi
Steep	Juncus conglomeratus	Eupatorium cannabinum	Persicaria maculosa	Veronica serpyllifolia	Pleurozium schreberi	Calluna vulgaris
% Cover	Juncus effusus	Euphrasia officinalis agg.	Pilosella officinarum	Vicia cracca	Racomitrium lanuginosum	Cotoneaster spp.
Bare rock	Juncus squarrosus	Filipendula ulmaria	Pimpinella saxifraga	Vicia sepium	Rhizomnium punctatum	Dryas octopetala
Bare Earth	Koeleria macrantha	Filipendula vulgaris	Plantago lanceolata	Viola canina	Rhytidiadelphus squarrosus	Empetrum nigrum
Litter	Lolium perenne	Fragaria vesca	Plantago maritima	Viola riviniana	Rhytidiadelphus triquetrus	Erica cinerea
Grass	Luzula campestris	Galium odoratum	Polygala vulgaris	**Liverworts**	Scleropodium purum	Hedera helix
Sedge	Luzula sylvatica	Galium saxatile	Polygonum aviculare	Conocephalum conicum	Syntrichia ruralis	Helianthemum oelandicum
Broad Leaves	Melica uniflora	Galium sterneri	Potentilla anserina	Frullania tamarisci	Thamnobryum alopecurum	Ilex aquifolium
Bryophytes	Molinia caerulea	Galium verum	Potentilla erecta	Lophocolea bidentata	Thuidium delicatulum	Lonicera periclymenum
Low Woody	Phleum pratense	Gentiana verna	Potentilla sterilis	Plagiochila asplenioides	Thuidium tamariscinum	Rosa canina
Shrub	Poa annua	Gentianella amarella	Primula veris	Plagiochila porelloides	Tortella tortuosa	Rosa spinosissima
	Poa pratensis	Gentianella campestris	Primula vulgaris	Scapania aspera	**Ferns**	Rubus fruticosus agg.
Median grass hgt (cm)	Schoenus nigricans	Geranium robertianum	Prunella vulgaris	**Lichens**	Adiantum capillus-veneris	Rubus saxatilis
Median herb hgt (cm)	Sesleria caerulea	Geranium sanguineum	Ranunculus acris	Cladonia ciliata	Asplenium adiantum-nigrum	Thymus polytrichus
Max Heather hgt (cm)	Trichophorum caespitosum	Geum urbanum	Ranunculus bulbosus	Cladonia rangiformis	Asplenium marinum	**Woody**
	Herbs	Hieracium anglicum	Ranunculus ficaria	Cladonia spp.	Asplenium ruta-muraria	Cornus sanguinea
Moss identified (y/n)	Achillea millefolium	Hyacinthoides non-scripta	Ranunculus repens	**Mosses**	Asplenium viride	Corylus avellana
Lichen identified (y/n)	Agrimonia eupatoria	Hypericum androsaemum	Rhinanthus minor	Brachythecium rutabulum	Asplenium trichomanes	Crataegus monogyna
	Alchemilla filicaulis	Hypericum maculatum	Rubia peregrina	Breutelia chrysocoma	Botrychium lunaria	Euonymus europaeus
Soil Depth (cm)	Alchemilla xanthochlora	Hypericum perforatum	Rumex acetosa	Bryum sp.	Ceterach officinarum	Frangula alnus
	Anemone nemorosa	Hypericum pulchrum	Rumex crispus	Calliergonella cuspidata	Cystopteris fragilis	Fraxinus excelcior
Grasses/Sedges/Rushes	Antennaria dioica	Hypochaeris radicata	Rumex obtusifolius	Campyliadelphus chrysophyllus	Dryopteris filix-mas	Juniperus communis
Agrostis canina	Anthyllis vulneraria	Knautia arvensis	Sanguisorba minor	Climacium dendroides	Phyllitis scolopendrium	Pinus sylvestris
Agrostis capillaris	Arabis hirsuta	Lathyrus linifolius	Sanicula europaea	Ctenidium molluscum	Polypodium interjectum	Prunus spinosa
Agrostis stolonifera	Arum maculatum	Lathyrus pratensis	Saxifraga hypnoides	Dicranum scoparium	Polypodium vulgare	Potentilla fruticosa
Anthoxanthum odoratum	Asperula cynanchica	Leontodon autumnalis	Saxifraga tridactylites	Didymodon rigidulus	Polystichum aculeatum	Rhamnus catharticus
Arrhenatherum elatius	Bellis perennis	Leontodon hispidus	Sedum acre	Ditrichum gracile	Polystichum setiferum	Salix cinerea
Brachypodium sylvaticum	Blackstonia perfoliata	Leucanthemum vulgare	Senecio jacobaea	Encalypta streptocarpa	Pteridium aquilinum	Salix repens
Briza media	Campanula rotundifolia	Linum catharticum	Solidago virgaurea	Eurhynchium striatum	**Orchids**	Sorbus aria
Bromus hordaceus	Carlina vulgaris	Lotus corniculatus	Sonchus arvensis	Fissidens adianthoides	Anacamptis pyramidalis	Sorbus aucuparia
Carex caryophyllea	Centaurea nigra	Medicago lupulina	Sonchus asper	Fissidens dubius	Coeloglossum viride	Taxus baccata
Carex flacca	Centaurea scabiosa	Melampyrum pratense	Sonchus oleraceus	Fissidens taxifolius	Dactylorhiza fuchsii	Ulex europaeus
Carex panicea	Centaurium erythraea	Mentha aquatica	Stellaria graminea	Homalothecium lutescens	Dactylorhiza maculata	Vaccinium myrtillus
Carex pulicaris	Centranthus ruber	Mentha arvensis	Stellaria media	Homalothecium sericeum	Epipactis atrorubens	Viburnum opulus

Appendix 3: Sources of information for the National Limestone Pavement habitat distribution map

Corine 2000 Land Cover Map

The Corine National Land Cover Map was produced by the Environmental Protection Agency (EPA) in 2000. Only bare rock was used to select pavement areas. The minimum mapping unit for Corine 2000 was 25ha and therefore smaller rock outcrop areas were not recorded.

National Soils and Parent Material Map

The National Soils and Parent Material map was produced by Teagasc under the Irish Forest Soils Project in 2006. The map included two datasets: soils and sub-soils. The sub-soils have a class of calcareous rock and this was used to select areas of potential limestone pavement. However, the calcareous rocks sub-soils class appears to include limestone pavement and thin soils over limestone bedrock. Thus the class is not a definitive guide to limestone pavements.

Bedrock Data - Geological Survey of Ireland

The Bedrock Data (i.e. solid geology) map was produced by the Geological Survey of Ireland in 2006. This dataset was assessed to select areas of pure carboniferous limestone as these were thought to comprise most of the limestone pavements. Much of the Irish midlands are underlain by these rocks and whilst the class is not very useful in finding limestone pavements, it does provide a check against any areas of bare rock mapped from 2005 ortho-photography.

Karst Heritage sites - Geological Survey of Ireland

The Karst Heritage of the Republic of Ireland was produced by theGeological Survey of Ireland in 2001. This dataset contains Karst features listed in the karst database. These were used to map limestone pavement but they were not found to be of much use. All sites mapped were inspected using the 2005 ortho-photographs. Most of the features in the karst database are sinks, resurgences, cave entrances, dolins or turloughs.

Designated sites records and digital maps - NPWS

The main NPWS sources consulted to obtain information on limestone pavement records were:

- The Habitats Assignment Project - The main aim of this desk based project was to identify and report habitats listed in the Annex I of the Habitats Directive (92/43/EEC) from a series of sources. These sources included potential NHA site files, MPSU Plans, NATURA 2000 Forms, NPWS surveys, Aerial photographs, NGO proposals, etc.

- NPWS designated sites boundaries – NHA, potential NHA and SAC sites maps for those sites listed in the Habitats Assignment Project as containing limestone pavement were looked at in order to ascertain the location of limestone pavement.

Landsat Thematic mapper satellite imagery

Landsat Thematic mapper satellite imagery was employed to map the distribution of limestone pavement during the production of the 2007 map. Cloud-free Landsat TM imagery is available for Ireland from 2000/2001. A supervised classification was performed on the imagery based upon visual interpretation of training areas from both imagery and ortho-photographs. Two classes of limestone pavement were recognized in the Burren area: bare limestone and sparsely vegetated limestone. There was no accuracy assessment of the classification as it was used purely to guide the subsequent visual interpretation of the ortho-photography.

2005 Aerial ortho - photography - Ordnance Survey of Ireland

2005 ortho-photography have been an essential source of information to identify new areas of limestone pavement and confirm the occurrence of areas reported by other sources. The digitisation of limestone pavement areas would not have been possible without these dataset.

Burren habitat mapping

The Burren Habitat mapping project produced a broad habitat map of the Burren using satellite imagery. The final map contains polygons of bare and vegetated limestone pavement for the Burren identified by Parr *et al.* (2006) from Landsat satellite imagery.

Mapping of Habitats in County Roscommon

This source provided a digital map of habitats in County Roscommon including limestone pavement (8240). Only ten of the limestone pavement areas, with an overall extent of 2.46ha, were added to the overall habitat map. These areas were described as having low certainty of corresponding with habitat 8240 and field work is recommended to confirm whether they do actually correspond with habitat 8240 or not.

Appendix 4: GIS files submitted

The following is a list of GIS (.shp) files generated and submitted as part of the project.

Raw spatial data recorded on the field:

The following are the original spatial data files recorded on the field after post-processing in the office to obtain sub-meter accuracy:

- NSLP12_habitat_dots: This file provides dot records for all habitats recorded on the field based on Fossitt (2000) vegetation classification. Attribute table includes the following fields: [Site_Code]; [County]; [Type]: habitat or habitats when mosaic type; [Comment]: additional info specific for that dot record (e.g. note number, presence of bracken); [DATE]: date data recorded.
- NLSP12_boundary_dots: This file provides dot records for boundaries recorded on the field. Attribute table includes the following fields: [Site_Code]; [County]; [Type]: boundary type (e.g. habitat, relevé or other boundary); [RELEVÉ_COR]: location of relevé corner (e.g. N, S, E, W); [HAB_BNDY]: whether the boundary corresponds with a G(grassland), H(heath), P(pavement), S(scrub), W(woodland) or M(mosaic); [Comment]: additional info specific for that dot record (e.g. relevé number, mosaic type); [DATE]: date data recorded.
- NSLP12_additional_data_dots: This file provides dot records for any additional data considered relevant to the survey site. Attribute table includes the following fields: [Site_Code]; [County]; [Comment]: additional info specific for that dot record (e.g. impacting activities, fauna, grazing level).
- NSLP12_invasive_sp_dots: This file provides dot records for invasive species data. Attribute table includes the following fields: [Site_Code]; [County]; [NAME]: species Latin name; [COMMENT]: additional info (e.g. note number, area covered).
- NSLP12_notable_sp_dots: This file provides dot records for notable species. Attribute table includes the following fields: [Site_Code]; [County]; [NAME]: species Latin name; [COMMENT]: additional info (e.g. number of individuals or area covered).
- NSLP12_photographs_dots: This file provides dot records for photographical data. Attribute table includes the following fields: [Site_Code]; [County]; [TYPE]: photo type (i.e. Relevé overview, relevé detail, Plot SE corner, Other); [PHOTO_ID]; [Aspect]: photographical aspect; [OTHER]: relevé number or feature; [DATE]: date data recorded; [TIME]: time data recorded; [Easting]: easting value; [Northing]: northing value.
- NSLP12_relevé_data_dots: This file provides dot records for relevés recorded. Attribute table includes the following fields: [Site_Code]; [County]; [Foss_field]: Fossitt (2000) habitat code as firstly determined on the field; [Foss_ana]: Fossitt (2000) habitat code as based on vegetation analysis; [Annex_Code]: Habitats Directive Annex I habitat code (NSC (Not significant correspondence); [RELEVÉ_ID]; [OTHER]: additional info specific for that dot record; [DATE]: date data recorded; [ALTITUDE]: altitude (m); [EASTING]: easting value; [NORTHING]: northing value.

Digitised spatial data:

The following are the spatial data files digitised in the office based on raw spatial data recorded on the field and 2005 OSi Ortho-photographs.

NSLP12_site_centroid_dots: This file provides dot data illustrating the location of all sites surveyed. Attribute table includes the following fields: [Site_Code]; [County]; [Element]: element type (i.e. Element I (potential NHA sites) and Element II (Monitoring sites); [Year_surv]: year survey was undertaken; [EASTING]: easting value; [NORTHING]: northing value.

- NSLP12_potential NHA_habitats_map: This file provides polygon data illustrating habitats depicted based on Fossitt (2000) and Habitats Directive Annex I habitats vegetation classification within element I sites (potential NHA). Attribute table includes the following fields: [Site_Code]: element I site code; [County]; [SURVEY_MET]: survey method; [SURVEY_DAT]: survey date; [FOSSIT_COD]: Fossitt (2000) habitat code; [FIELD_NOTE]: note number; [ANNEX_CODE]: Habitats Directive Annex I habitat code (NSC (Not significant correspondence); [COMMENT]: additional info specific to that polygon; [AREA]: polygon area in m^2.
- NSLP12_Mon_Plots_habitats_map: This file provides polygon data illustrating habitats depicted based on Fossitt (2000) and Habitats Directive Annex I habitats vegetation classification within element II sites (monitoring sites). Attribute table includes the following fields: [Site_Code]: element II site code; [County]; [SURVEY_MET]: survey method; [SURVEY_DAT]: survey date; [FOSSITT_COD]: Fossitt (2000) habitat code; [ANNEX_CODE]: Habitats Directive Annex I habitat code (NSC (Not significant correspondence); [DESYGNTYPE]: this field describes whether the monitoring plots are within a designated sites (site code and designation type provided) or not; [COMMENT]: additional info specific to that polygon; [PLOT_ID]; [AREA]: polygon area in m^2.
- NSLP12_8240_distribution_map: This file provides polygon data illustrating the distribution of the potential national resource of limestone pavement and associated habitats based on the interpretation of the 2005 OSI Ortho-photographs and additional sources listed in the attribute table. Attribute table includes the following fields: [CSA_07]: this logical field describes whether the polygon was reported by the Conservation Status Assessment, Habitats and Species Conservation Status Assessment Project, National Parks & Wildlife Service (2007) or not; [CORINE]: this logical field describes whether the polygon was reported by Corine National Land Cover data, Environmental Protection Agency (2000) or not; [COMM]: this logical field describes whether the polygon reported as Limestone Pavement / Grassland (XIII) as part of the Commonage Framework Plan Surveys, Department of Agriculture & Food and the & NPWS (2007) or not; [KARST]: this logical field describes whether the polygon intersects any Karst features record by the Karst Heritage of the Republic of Ireland, Geological Survey of Ireland (2001) or not; [PARR06]: this logical field describes whether the area mapped intersects any limestone pavement area (vegetated or bare) mapped by The Burren Habitat Mapping project, Parr *et al*. (2006) or not; [PARTMAT]: this field describes the dominant underlying parent material type according to The National Soils and Parent Material Map, Teagasc. (2006); [IFC_SOIL]: this field describes the dominant soil type according to The National Soils and Parent Material Map, Teagasc (2006); [Add_Sourc]: additional sources used to detect the specific

potential habitats polygon (e.g. 2005 OSI ortho-photo); [POTENLP]: this field 3describes the potential habitat/s dominating the area mapped; only based on a visual identification on the 2005 Ortho-photographs (e.g. classed as LP/Grassland,LP/Grassland/Heath, LP/Grassland/Heath/Scrub, LP/Grassland/Scrub/Woodland/Heath, LP/Grassland/Heath/Molinia Peat, etc.); [THREAT]: this field lists threatening activities to each individual polygon (e.g. threat by removal, threat by adjacent Quarry); [DESIG]: this field describes the location of the area mapped in relation to a designated site (e.g. within SAC, NHA or outside (i.e. No)); [Site_Code]; [AREA]: polygon area in m^2; [AREA_DESIG]: area of polygon within a designated site; [PERC_DESIG]: percentage of polygon designated; [CERTAINTY]: level of certainty of occurrence of limestone pavement and associated habitats within the polygon (i.e. certain, high, medium, low); [County].

- NSLP12_relevé_polyg_map: This file provides polygon data illustrating a 5m square containing scrub, woodland or pavement relevé data. Attribute table includes the following fields: [Site_Code]; [County]; [RELVE_ID]; [PLOT_ID].
- NSLP12_survey_units_map: This file provides polygon data illustrating the location and extent of sites. Attribute table includes the following fields: [Site_Code]; [County]; [Name]; [Area]: polygon area in m^2.
- NSLP12_Mon_plots_map: This file provides polygon data illustrating the location and extent of monitoring plots. Attribute table includes the following fields: [Site_Code]; [County]; [PLOT_ID]; [No_relevés]: this field lists the number of relevés per plot; [Discovery]: this field lists the discovery maps where the plots fall into; [Townland]; [EASTING]: easting value; [NORTHING]: northing value and [ALTITUDE]: altitude value in meters.
- NSLP12_8240_dist_10kmgrid_map: This file illustrates on a 10km Irish National Grid the distribution of habitat limestone pavement and associated habitats (EU code 8240) based on the intersection with the NSLP12_8240_distribution_map.shp file. Attribute table includes the following fields: [HD_Habitat]: Habitats Directive habitat code; [Data_Sourc]: data source; [Data_Date]: data period; [TEN_KM_SQ2]: square (grid) number.
- NSLP12_8240_range_10kmgrid_map: This file illustrates on a 10km Irish National Grid the current national range of limestone pavement and associated habitats (EU code 8240) based on NSLP12_8240_dist_10kmgrid_map.shp file. Attribute table includes the following fields: [HD_Habitat]: Habitats Directive habitat code; [Data_Sourc]: data source and whether the square has been added to create range polygon; [TEN_KM_SQ2]: square (grid) number.
- NSLP12_8240_favrefrange_10kmgrid_map: This file illustrates on a 10km Irish National Grid the national favourable reference range of limestone pavement and associated habitats (EU code 8240) based on NSLP12_8240_range_10kmgrid_map.shp file. Attribute table includes the following fields: [HD_Habitat]: Habitats Directive habitat code; [Data_Sourc]: data source and whether the square has been added to create range polygon; [TEN_KM_SQ2]: square (grid) number.

Appendix 5: Structure and Functions assessment criteria for Annex I Habitats

Below are structure and functions assessment criteria for the following Annex I EU Habitats:

- Limestone pavement (exposed) (8240)
- Limestone pavement (wooded) (8240)
- Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco - Brometalia*) (important orchid sites) (6210/6211)
- Alpine and Boreal heaths (4060)
- European dry heaths (4030)

Limestone pavement (exposed) (8240)

Positive indicator species

Herbs, grasses and woody

Arabis hirsuta
Asperula cynanchica
Dryas octopetala
Eupatorium cannabinum
Geranium sanguineum
Geranium robertianum
Hedera helix
Helianthemum oelandicum
Juniperus communis
Mycelis muralis
Plantago maritima
Rhamnus cathartica
Rosa spinosissima
Rubia peregrina
Rubus saxatilis
Saxifraga hypnoides
Sesleria caerulea
Taxus baccata
Teucrium scorodonia
Thalictrum minus
Thymus polytrichus
Viola spp.

Ferns

Adiantum capillus-veneris
Asplenium trichomanes
Asplenium ruta-muraria
Ceterach officinarum
Cystopteris fragilis
Dryopteris filix-mas
Phyllitis scolopendrium
Polystichum aculeatum
Polystichum setiferum

Bryophytes

Breutelia chrysocoma
Conocephalum conicum
Ctenidium molluscum
Fissidens spp.
Neckera crispa
Tortella tortuosa

Orchids

Epipactis atrorubens
Orchis mascula

Pass ≥7 of listed species present

Negative indicator species

Arrhenatherum elatius
Cirsium arvense
Cirsium vulgare
Lolium perenne
Rubus fruticosus
Urtica dioica

Pass = Collective cover ≤1%

Bracken cover

Pass = Collective cover ≤10%

Non-native species cover

Acer pseudoplatanus
Cotoneaster spp.
Clematis vitalba
Centranthus ruber

Pass = Collective cover ≤1%

Vegetation structure

Scrub cover

Corylus avellana, Crataegus monogyna, Euonymus europaeus, Fraxinus excelsior, Ilex aquifolium, Prunus spinosa, Rhamnus cathartica, Rubus saxatilis, Rubus fruticosus agg., *Rosa micrantha, Rosa spinosissima, Salix* spp., *Sorbus aria, Sorbus aucuparia, Viburnum opulus*

Pass = Collective cover ≤ 25%

Corylus avellana and *Prunus spinosa* cover to be reported individually

Other data

Indicators of local distinctiveness/Notable species

Notable species*: Potentilla fruticosus*

Red Data species (e.g. *Calamagrostis epigejos, Frangula alnus, Gymnocarpium robertianum, Viola hirta)*

Limestone pavement (wooded) (8240)

Positive indicator species

Woody

Corylus avellana
Crataegus monogyna
Euonymus europaeus
Fraxinus excelsior
Hedera helix
Ilex aquifolium
Lonicera periclymenum
Prunus spinosa
Rosa spp.
Rubus fruticosus
Sorbus aucuparia

Herbs & grasses

Anemone nemorosa
Arum maculatum
Brachypodium sylvaticum
Carex sylvatica
Circaea lutetiana
Fragaria vesca
Geranium robertianum
Geum urbanum
Hypericum pulchrum
Melica uniflora
Oxalis acetosella
Potentilla sterilis
Primula vulgaris
Ranunculus ficaria
Sanicula europaea
Sesleria caerulea
Veronica chamaedrys
Viola spp.

Negative indicators

Acer pseudoplatanus
Clematis vitalba
Conifer spp. (excluding *Pinus sylvestris*)
Cotoneaster spp.
Fagus sylvatica

Pass = Collective cover ≤10%

Orchids

Epipactis helleborine
Listera ovata
Platanthera spp.

Ferns

Asplenium trichomanes
Dryopteris filix-mas
Polystichum setiferum
Phyllitis scolopendrium

Bryophytes

Atrichum undulatum
Ctenidium molluscum
Eurhynchium spp.
Fissidens spp.
Hylocomium brevirostre
Isothecium spp.
Kindbergia praelonga
Neckera spp.
Plagiochila spp.
Plagiomnium undulatum
Rhytidiadelphus triquetrus
Scapania aspera
Thamnobryum alopecurum
Thuidium tamariscinum
Tortella tortuosa

Pass ≥7 of listed species present

Vegetation structure

Total canopy cover (Relevé)

Pass>30%

Total bryophyte layer (Relevé)

Pass≥50%

Grazing Pressure

Pass = no evidence of grazing pressure

Dead wood

Pass = present

Non-native shrub/tree regeneration

Pass = no regeneration

Other data

Indicators of local distinctiveness/ Notable species

Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco - Brometalia*) (important orchid sites) (6210/6211)

High Quality positive indicator species

Herbs & Grasses

Antennaria dioica
Anthyllis vulneraria
Briza media
Campanula rotundifolia
Carex caryophyllea
Carlina vulgaris
Centaurea scabiosa
Galium verum
Gentianella amarella
Gentianella campestris
Knautia arvensis
Koeleria micrantha
Lotus corniculatus
Origanum vulgare
Primula veris
Sanguisorba minor

Orchids

Anacamptis pyramidalis
Dactylorhiza fuchsia
Dactylorhiza maculata
Gymnadenia conopsea
Listera ovata
Neotinea maculata
Ophyrs apifera
Orchis mascula
Orchis morio
Platanthera bifoliata
Platanthera chlorantha
Spiranthes spiralis

Pass ≥2HQ indicator species

Negative indicator species

Arrhenatherum elatius
Cirsium arvense
Cirsium vulgare
Dactylis glomerata
Holcus lanatus
Lolium perenne
Rumex crispus
Rumex obtusifolius
Senecio jacobaea
Trifolium repens

Positive indicator species

Herbs & Grasses

Asperula cynanchica
Blackstonia perfoliata
Bromus erectus
Carex flacca
Conopodium majus
Daucus carota
Euphrasia spp.
Filipendula vulgaris
Geranium sanguineum
Helictotrichon pubescens
Leontodon hispidus
Leontodon saxatilis
Linum catharticum
Pilosella officinarum
Pimpinella saxifrage
Ranunculus bulbosus
Sesleria caerulea
Solidago virgaurea
Succisa pratensis
Trisetum flavescens

Bryophytes

Breutelia chrysocoma
Calliergonella cuspidate
Dicranum scoparium
Homalothecium lutescens
Plagiomnium undulatum
Rhytidiadelphus squarrosus
Scleropodium purum

Pass ≥7 of positive indicator species

Vegetation structure

Forb: Grass/Sedge Ratio

Pass = Broadleaf herb component 40-90%

Scrub/Bracken encroachment cover

Pass= Cover of woody species (*Corylus avellana, Rubus fruticosus, Prunus spinosa, Crataegus monogyna, Ulex europaeus*) plus *Pteridium* ≤ 10% cover.

Sward height

Pass = 30-70% of the sward 5-40cm high

Litter cover

Pass = ≤ 25% cover

Urtica dioica

Pass = Individual cover ≤ 10%; Collective cover ≤ 20%.

Non-native species cover

Centranthus ruber

Cotoneaster spp.

Pass = Collective cover ≤ 1%

Physical structure

Cover of disturbed ground

Pass ≤ 10% cover

Other data

Indicators of local distinctiveness/Notable species

Notable species*:* (e.g. *Gentiana verna*)

Red data species : (e.g. *Vicia orobus*)

Alpine and Boreal heaths (4060)

Positive indicator species

Woody

Arctostaphylos uva-ursi
Calluna vulgaris
Dryas octopetala
Empetrum nigrum
Erica cinerea
Helianthemum oelandicum
Juniperus communis
Thymus polytrichus

Herbs

Campanula rotundifolia
Hypericum pulchrum
Linum catharticum
Lotus corniculatus
Polygala vulgaris
Potentilla erecta
Solidago virgaurea
Succisa pratensis
Viola spp.

Grasses

Carex flacca
Carex caryophyllea
Carex pulicaris
Festuca spp.
Molinia caerulea
Sesleria caerulea

Bryophytes

Breutelia chrysocoma
Ctenidium molluscum
Dicranum scoparium
Hylocomium splendens
Scleropodium purum

Lichens

Cladonia rangiformis

Pass ≥ 7 positive indicator species

Negative indicator species (Relevé)

Cirsium arvense
Cirsium vulgare
Dactylis glomerata
Holcus lanatus
Ranunculus repens
Rumex spp. *(except R. acetosa)*
Senecio jacobea
Urtica dioica
Pass = Collective cover ≤10%

Trees and shrubs (excluding *Juniperus communis*)

Corylus avellana
Crataegus monogyna
Prunus spinosa
Rubus fruticosus
Ulex europaeus
Pass ≤25% collective cover

Cover of disturbed ground (rocks/stones not included)

Pass < 10% cover

Non-native species

Centranthus ruber
Cotoneaster spp.
Pass ≤ 1% collective cover

Other Data

Indicators of local distinctiveness/Notable species

European dry heaths (4030)

Positive indicator species

Woody

Arctostaphylos uva-ursi
Calluna vulgaris
Dryas octopetala
Empetrum nigrum
Erica cinerea
Juniperus communis
Thymus polytrichus

Herbs

Campanula rotundifolia
Galium saxatile
Galium verum
Hypericum pulchrum
Lotus corniculatus
Potentilla erecta
Succisa pratensis

Grasses

Carex flacca
Carex pulicaris
Festuca spp.
Molinia caerulea
Sesleria caerulea

Bryophytes

Scleropodium purum
Breutelia chrysocoma
Dicranum scoparium

Pass ≥ 7 positive indicator species

Negative indicator species

Cirsium arvense
Cirsium vulgare
Dactylis glomerata
Holcus lanatus
Ranunculus repens
Rumex spp. *(except R. acetosa)*
Senecio jacobea
Urtica dioica

Pass = Collective cover ≤10%

Non-native species cover

Centranthus ruber
Cotoneaster spp.

Pass ≤ 1% collective cover

Trees and shrubs (excluding *Juniperus communis*)

Corylus avellana
Crataegus monogyna
Prunus spinosa
Rubus fruticosus
Ulex europaeus

Pass ≤25% collective cover

Cover of disturbed ground (rocks/stones not included)

Pass < 10% cover

Other Data

Indicators of local distinctiveness/Notable species

Appendix 6: Future prospects impacts and codes

The following list is based on the standardised EU reference list (Ssymank 2011).

Impact Code	Impact Description
A	**Agriculture**
A01	Cultivation
A02	modification of cultivation practices
A02.01	agricultural intensification
A02.02	crop change
A02.03	grassland removal for arable land
A03	mowing / cutting of grassland
A03.01	intensive mowing or intensification
A03.02	non intensive mowing
A03.02	abandonment / lack of mowing
A04	grazing
A04.01	intensive grazing
A04.01.01	intensive cattle grazing
A04.01.02	intensive sheep grazing
A04.01.03	intensive horse grazing
A04.01.04	intensive goat grazing
A04.01.05	intensive mixed animal grazing
A04.02	non intensive grazing
A04.02.01	non intensive cattle grazing
A04.02.02	non intensive sheep grazing
A04.02.03	non intensive horse grazing
A04.02.04	non intensive goat grazing
A04.02.05	non intensive mixed animal grazing
A04.03	abandonment of pastoral systems, lack of grazing
A05	livestock farming and animal breeding (without grazing)
A05.01	Animal breeding,
A05.02	stock feeding
A05.03	Lack of animal breeding
A06	annual and perennial non-timber crops
A06.01	annual crops for food production
A06.01.01	intensive annual crops for food production/ intensification
A06.01.02	non- intensive annual crops for food production
A06.02	perennial non-timber crops
A06.02.01	intensive perennial non-timber crops/intensification
A06.02.02	non-intensive perennial non-timber crops
A06.03	biofuel-production
A06.04	abandonment of crop production
A07	use of biocides, hormones and chemicals
A08	Fertilisation
A09	Irrigation
A10	Restructuring agricultural land holding
A10.01	removal of hedges and copses or scrub

A10.02	removal of stone walls and embankments
Impact Code	**Impact Description**
A11	Agriculture activities not referred to above
B	**Sylviculture, forestry**
B01	forest planting on open ground
B01.01	forest planting on open ground (native trees)
B01.02	artificial planting on open ground (non-native trees)
B02	Forest and Plantation management & use
B02.01	forest replanting
B02.01.01	forest replanting (native trees)
B02.01.02	forest replanting (non-native trees)
B02.02	forestry clearance
B02.02	removal of forest undergrowth
B02.04	removal of dead and dying trees
B02.05	non- intensive timber production (leaving dead wood/ old trees untouched)
B02.06	thinning of tree layer
B03	forest exploitation without replanting or natural regrowth
B04	use of biocides, hormones and chemicals (forestry)
B05	use of fertilizers (forestry)
B06	grazing in forests/ woodland
B07	Forestry activities not referred to above
C	**Mining, extraction of materials and energy production**
C01	Mining and quarrying
C01.01	Sand and gravel extraction
C01.01.01	sand and gravel quarries
C01.01.02	removal of beach materials
C01.02	Loam and clay pits
C01.03	Peat extraction
C01.03.01	hand cutting of peat
C01.03.02	mechanical removal of peat
C01.04	Mines
C01.04.01	open cast mining
C01.04.01	underground mining
C01.05	Salt works
C01.05.01	abandonment of saltpans (salinas)
C01.05.02	conversion of saltpans
C01.06	Geotechnical survey
C01.07	Mining and extraction activities not referred to above
C02	Exploration and extraction of oil or gas
C02.01	exploration drilling
C02.02	production drilling
C02.03	jack-up drilling rig
C02.04	semi-submersible rig
C02.05	drill ship
C03	Renewable abiotic energy use
C03.01	geothermal power production
C03.02	solar energy production
C03.03	wind energy production

C03.04	tidal energy production
Impact Code	**Impact Description**
D	**Transportation and service corridors**
D01	Roads, paths and railroads
D01.01	paths, tracks, cycling tracks
D01.02	roads, motorways
D01.03	car parks and parking areas
D01.04	railway lines, TGV
D01.05	bridge, viaduct
D01.06	tunnel
D02	Utility and service lines
D02.01	electricity and phone lines
D02.01.01	suspended electricity and phone lines
D02.01.02	underground electricity and phone lines
D02.02	pipe lines
D02.03	communication masts and antennas
D02.09	other forms of energy transport
D03	shipping lanes, ports, marine constructions
D03.01	port areas
D03.01.01	slipways
D03.01.02	piers
D03.01.03	fishing harbours
D03.01.04	industrial ports
D03.02	Shipping
D03.03	marine constructions
D04	airports, flightpaths
D04.01	airport
D04.02	aerodrome, heliport
D04.03	flight paths
D05	Improved access to site
D06	Other forms of transportation and communication
E	**Urbanisation, residential and commercial development**
E01	Urbanised areas, human habitation
E01.01	continuous urbanisation
E01.02	discontinuous urbanisation
E01.03	dispersed habitation
E01.04	other patterns of habitation
E02	Industrial or commercial areas
E02.01	factory
E02.02	industrial stockage
E02.03	other industrial / commercial area
E03	Discharges
E03.01	disposal of household waste
E03.02	disposal of industrial waste
E03.03	disposal of inert materials
E03.04	Other discharges
E03.04.01	costal sand suppletion/ beach nourishment
E04	Structures, buildings in the landscape

E04.01	Agricultural structures, buildings in the landscape
Impact Code	**Impact Description**
E04.02	Military constructions and buildings in the landscape
E05	Storage of materials
E06	Other urbanisation, industrial and similar activities
E06.01	demolishment of buildings & human structures
E06.02	reconstruction, renovation of buildings
F	**Biological resource use other than agriculture & forestry**
F01	Marine and Freshwater Aquaculture
F01.01	intensive fish farming, intensification
F01.02	suspension culture
F01.03	bottom culture
F02	Fishing and harvesting aquatic resources
F02.01	Professional passive fishing
F02.01.01	potting
F02.01.02	netting
F02.01.03	demersal longlining
F02.01.04	pelagic longlining
F02.02	Professional active fishing
F02.02.01	benthic or demersal trawling
F02.02.02	pelagic trawling
F02.02.03	demersal seining
F02.02.04	purse seining
F02.02.05	benthic dredging
F02.03	Leisure fishing
F02.03.01	bait digging
F03	Hunting and collection of wild animals (terrestrial)
F03.01	Hunting
F03.01.01	damage caused by game (excess population density)
F03.02	Taking and removal of animals (terrestrial)
F03.02.01	collection of animals (insects, reptiles, amphibians.....)
F03.02.02	taking from nest (e.g. falcons)
F03.02.03	trapping, poisoning, poaching
F03.02.04	predator control
F03.02.05	accidental capture
F03.02.09	other forms of taking animals
F04	Taking / Removal of terrestrial plants, general
F04.01	pillaging of floristic stations
F04.02	collection (fungi, lichen, berries etc.)
F04.02.01	hand raking
F04.02.02	hand collection
F05	Hunting, fishing or collecting activities not referred to above
F05.01	game/ bird breeding station
G	**Human intrusions and disturbances**
G01	Outdoor sports and leisure activities, recreational activities
G01.01	nautical sports
G01.01.01	motorized nautical sports
G01.01.02	non-motorized nautical sports

G01.02	walking, horse-riding and non-motorised vehicles
Impact Code	**Impact Description**
G01.03	motorised vehicles
G01.03.01	regular motorized driving
G01.03.02	off-road motorized driving
G01.04	mountaineering, rock climbing, speleology
G01.04.01	mountaineering & rock climbing
G01.04.02	speleology
G01.05	gliding, delta plane, paragliding, ballooning
G01.06	skiing, off-piste
G01.07	other outdoor sports and leisure activities
G02	Sport and leisure structures
G02.01	golf course
G02.02	skiing complex
G02.03	stadium
G02.04	circuit, track
G02.05	hippodrome
G02.06	attraction park
G02.06	sports pitch
G02.07	camping and caravans
G02.08	wildlife watching
G02.09	other sport / leisure complexes
G03	Interpretative centres
G04	Military use and civil unrest
G04.01	Military manoeuvres
G04.02	abandonment of military use
G05	Other human intrusions and disturbances
G05.01	Trampling, overuse
G05.02	Vandalism
G05.03	intensive maintenance of public parks
G05.04	tree surgery, felling for public safety, removal of roadside trees
G05.05	missing or wrongly directed conservation measures
G05.06	closures of caves or galleries
G05.07	fences, fencing
G05.08	overflying with aircrafts (agricultural)
H	**Pollution**
H01	Pollution to surface waters (limnic & terrestrial)
H01.01	pollution to surface waters by industrial plants
H01.02	pollution to surface waters by storm overflows
H01.03	other point source pollution to surface water
H01.04	diffuse pollution to surface waters via storm overflows or urban run-off
H01.05	diffuse pollution to surface waters due to agricultural and forestry activities
H01.06	diffuse pollution to surface waters due to transport and infrastructure without connection to canalization/sweepers
H01.07	diffuse pollution to surface waters due to abandoned industrial sites
H01.08	diffuse pollution to surface waters due to household sewage and waste waters
H01.09	diffuse pollution to surface waters due to other sources not listed
H02	Pollution to groundwater (point sources and diffuse sources)

Impact Code	Impact Description
H02.01	groundwater pollution by leakages from contaminated sites
H02.02	groundwater pollution by leakages from waste disposal sites
H02.03	groundwater pollution associated with oil industry infrastructure
H02.04	groundwater pollution by mine water discharges
H02.05	groundwater pollution by discharge to ground such as disposal of contaminated water to soakaways
H02.06	diffuse groundwater pollution due to agricultural and forestry activities
H02.07	diffuse groundwater pollution due to non-sewered population
H02.08	diffuse groundwater pollution due to urban land use
H03	Marine water pollution
H03.01	oil spills in the sea
H04	Air pollution, air-borne pollutants
H04.01	Acid rain
H04.02	Nitrogen-input
H04.03	other air pollution
H05	Soil pollution and solid waste (excluding discharges)
H05.01	garbage and solid waste
H06	excess energy
H06.01	Noise nuisance, noise pollution
H06.01.01	point source or irregular noise pollution
H06.01.02	diffuse or permanent noise pollution
H06.02	Light pollution
H06.03	Thermal heating of water bodies
H07	Other forms of pollution
I	**Invasive, other problematic species and genes**
I01	invasive non-native species
I02	problematic native species
I03	introduced genetic material, GMO
I03.01	genetic pollution (animals)
I03.02	genetic pollution (plants)
J	**Natural System modifications**
J01	fire and fire suppression
J01.01	burning down
J01.02	suppression of natural fires
J01.03	lack of fires
J02	human induced changes in hydraulic conditions
J02.01	Landfill, land reclamation and drying out, general
J02.01.01	polderisation
J02.01.02	reclamation of land from sea, estuary or marsh
J02.01.03	infilling of ditches, dykes, ponds, pools, marshes or pits
J02.01.04	recultivation of mining areas
J02.02	Removal of sediments (mud...)
J02.02.01	dredging/ removal of limnic sediments
J02.02.02	estuarine and coastal dredging
J02.03	Canalisation & water deviation
J02.03.01	large scale water deviation
J02.03.02	canalisation

J02.04	Flooding modifications
Impact Code	**Impact Description**
J02.04.01	flooding
J02.04.02	lack of flooding
J02.05	Modification of hydrographic functioning, general
J02.05.01	modification of marine currents
J02.05.02	modifying structures of inland water courses
J02.05.03	modification of standing water bodies
J02.05.04	reservoirs
J02.05.05	small hydropower projects, weirs
J02.06	Water abstractions from surface waters
J02.06.01	surface water abstractions for agriculture
J02.06.02	surface water abstractions for public water supply
J02.06.03	surface water abstractions by manufacturing industry
J02.06.04	surface water abstractions for the production of electricity (cooling)
J02.06.05	surface water abstractions by fish farms
J02.06.06	surface water abstractions by hydro-energy
J02.06.07	surface water abstractions by quarries/ open cast (coal) sites
J02.06.08	surface water abstractions for navigation
J02.06.09	surface water abstractions for water transfer
J02.06.10	other major surface water abstractions
J02.07	Water abstractions from groundwater
J02.07.01	groundwater abstractions for agriculture
J02.07.02	groundwater abstractions for public water supply
J02.07.03	groundwater abstractions by industry
J02.07.04	groundwater abstractions by quarries/open cast (coal)sites
J02.07.05	other major groundwater abstractions from groundwater for agriculture
J02.08	Raising the groundwater table /artificial recharge of groundwater
J02.08.01	discharges to groundwater for artificial recharge purposes
J02.08.02	returns of groundwater to GWB from which it was abstracted
J02.08.03	mine water rebound
J02.08.04	other major groundwater recharge
J02.09.	Saltwater intrusion of groundwater
J02.09.01	saltwater intrusion
J02.09.02	other intrusion
J02.10	management of aquatic and bank vegetation for drainage purposes
J02.11	Dumping, depositing of dredged deposits
J02.11	Dykes, embankments, artificial beaches, general
J02.11.01	sea defense or coast protection works, tidal barrages
J02.11.02	dykes and flooding defense in inland water systems
J02.12	Abandonment of management of water bodies
J02.13	Other human induced changes in hydraulic conditions
J03	Other ecosystem modifications
J03.01	reduction or loss of specific habitat features
J03.01.01	reduction of prey availability (including carcasses)
J03.02	anthropogenic reduction of habitat connectivity
J03.02.01	reduction in migration/ migration barriers
J03.02.02	reduction in dispersal

J03.02.03	reduction in genetic exchange
Impact Code	**Impact Description**
J03.03	reduction, lack or prevention of erosion
J03.04	applied (industrial) destructive research
K	**Natural biotic and abiotic processes (without catastrophes)**
K01	abiotic (slow) natural processes
K01.01	Erosion
K01.02	Silting up
K01.03	Drying out
K01.04	Submersion
K01.05	Soil salinization
K02	Biocenotic evolution, succession
K02.01	species composition change (succession)
K02.02	accumulation of organic material
K02.03	eutrophication (natural)
K02.04	acidification (natural)
K03	Interspecific faunal relations
K03.01	competition (fauna)
K03.02	parasitism (fauna)
K03.03	introduction of disease
K03.04	predation
K03.05	antagonism arising from introduction of species
K03.06	antagonism with domestic animals
K03.07	other forms of interspecific faunal competition
K04	Interspecific floral relations
K04.01	competition (flora)
K04.02	parasitism (flora)
K04.03	introduction of disease
K04.04	lack of pollinating agents
K04.05	damage by herbivores (including game species)
K05	reduced fecundity/ genetic depression
K05.01	reduced fecundity/ genetic depression in animals (inbreeding)
K05.02	reduced fecundity/ genetic depression in plants (incl. endogamy)
K06	other forms or mixed forms of interspecific floral competition
L	**Geological events, natural catastrophes**
L01	volcanic activity
L02	tidal wave, tsunamis
L03	earthquake
L04	avalanche
L05	collapse of terrain, landslide
L06	underground collapses
L07	storm, cyclone
L08	inundation (natural processes)
L09	fire (natural)
L10	other natural catastrophes
M	**Climate change**
M01	Changes in abiotic conditions
M01.01	rise of temperature & extremes

M01.02	droughts and less precipitations
Impact Code	**Impact Description**
M01.03	flooding and rising precipitations
M02	Changes in biotic conditions
M02.01	habitat shifting and alteration
M02.02	desynchronisation of processes
M02.03	decline or extinction of species
M02.04	migration of species (natural newcomers)
X	**No threats or pressures**
XO	**Threats and pressures from outside the Member State**
XE	**Threats and pressures from outside the EU territory**

Appendix 7: Future prospects impacts and codes for limestone pavement and associated habitats

Below is a modified list of common impacts and codes for limestone pavement and associated habitats based on Fernández *et al*. (2012) and O'Neill et al. (in prep.); The terminology is based on the standardised EU reference list (Ssymank 2011).

Impact Code	Impact	Description
A02.01	agricultural intensification	Agricultural improvement/intensification.
A04.01.01	intensive cattle grazing	High stock numbers and /or agricultural improvement can impact on limestone pavement and associated habitats.
A04.01.02	intensive sheep grazing	As above.
A04.01.03	intensive horse grazing	As above.
A04.01.05	intensive mixed animal grazing	As above. This applies when grazers have equal intensity, effect and % scores when found grazing together within the habitat
A04.02.01	non intensive cattle grazing	Low stock numbers and little to no agricultural improvement may also impact on limestone pavement and associated habitats. Their impact may be positive or neutral in some cases. Includes associated trampling impacts.
A04.02.02	non intensive sheep grazing	As above.
A04.02.03	non intensive horse grazing	As above.
A04.02.04	non intensive goat grazing	As above.
A04.02.05	non intensive mixed animal grazing	As above. This applies when grazers have equal intensity, effect and % scores when found grazing together within the habitat
A04.03	Abandonment/lack of mowing	This impact takes place when a habitat is abandoned or due to lack of adequate grazing leading to unfavourable structure and functions (such as tall, rank, tussocky swards with high litter content). Intensity should generally be either medium or low. Intensity in this case is usually high when the habitat has been truly abandoned.
A05.02	Stock feeding	Inappropriate supplementary feeding can cause localized pollution and habitat damage.
A08	Fertilisation	
A10.01	Removal of hedges and copses or scrub	Scrub removal, if carried out in the wrong place or in the wrong way can also be damaging to this habitat.

Impact Code	Impact	Description
B01	forest planting on open ground	This activity corresponds with plantations impacting on the habitat that appear to have been planted within current monitoring period.
B02	Forest and Plantation management & use	This activity corresponds with mature plantations impacting on the habitat.
C01	Mining and quarrying	This includes both removal of rock for sale as rockery stone and quarrying activities, both of which cause direct destruction of the habitat.
D01.01	paths, tracks, cycling tracks	Construction of paths, tracks or cycling tracks can cause localised damage to limestone pavement.
D01.02	roads, motorways	Construction of roads or motorways can cause localised damage to limestone pavement.
D01.03	car parks and parking areas	Construction of car parks and parking areas can cause localised damage to limestone pavement
D02.01.01	suspended electricity and phone lines	Construction of suspended electricity and phone lines can cause localised damage to limestone pavement
E01.03	dispersed habitation	Development on limestone pavement can result in its direct removal. Digging and removal of limestone pavement for drainage of adjacent developments can also occur.
E04.01	Agricultural structures, buildings in the landscape	Development on limestone pavement can result in its direct removal.
G01.02	walking, horse-riding and non-motorised vehicles	Recreational activities can cause localized damage due to impacts such as trampling and rock disturbance.
G01.03.02	off-road motorized driving	Quad bikes, 4x4 vehicles or scrambler bikes can cause disturbance to the habitat
G05.04	Vandalism	Vandalism on limestone pavement mainly comprises localized damage through displacement of rocks.
H05.01	garbage and solid waste	Dumping of domestic rubbish or industrial waste, especially in grikes can cause damage to the habitat.
I01	invasive non-native species	Invasive non-native species such as *Cotoneaster* spp., *Clematis vitalba* and *Centranthus ruber*.
I02	problematic native species	Bracken encroachment (& other problematic native species).
J01.01	Burning down	
J02.01	Infilling and reclamation	Land reclamation, usually for agricultural purposes, generally consists of the direct removal or displacement of limestone pavement, often followed by spreading of topsoil.
J02.07.01	groundwater abstractions for agriculture	This activity corresponds with digging drainage ditches.
K02.01	species composition change (succession)	Scrub or heath encroachment

Appendix 8: Site details

Site Number	Site Name	Designation	County	Discovery Map	Area (ha)	Altitudinal Range (m)	Plots	Relevés
1	Murrooghtoohy North	SAC (000020) - BlackHead-Poulsallagh Complex	Clare	CL51	395.19	5-210	8	18
2	Gortlecka	SAC (001926) - East Burren Complex	Clare	CL51,GY52	293.27	30-70	8	21
3	Corranellistrum	SAC (001271) - Gortnandarragh	Galway	GY45	122.53	20-30	8	19
4	Abbey East	SAC (001926) - East Burren Complex	Clare	CL51	242.25	90-210	8	18
5	Lough Mask	SAC (001774) - Lough Carra/Mask Complex	Mayo	MO 38	19.25	10-30	3	11
6	Mullaghfarna	SAC (001656) - Bricklieve Mountains and Keishcorran	Sligo	SL 25	8.56	220	1	3
7	Aillwee	SAC (000020) - BlackHead-Poulsallagh Complex	Clare	CL51	1373.39	50-290	8	15
8	Rannagh West	SAC (001926) - East Burren Complex	Clare	CL51	435.26	160-190	8	17
9	Slievecarran	SAC (001926) - East Burren Complex	Clare	CL51,GY52	948.15	130-210	8	18
10	Ballyryan	SAC (000020) - BlackHead-Poulsallagh Complex	Clare	CL51	186.49	10-20	8	20
12	Cashel	SAC (000440) - Lough Ree	Longford	RN40	28.15	60	2	3
13	Ballynacarrick	SAC (000115) - Ballintra	Donegal	DL11	60.91	80-90	3	7
14	Sramore	NHA (002435) - Crockauns/Keelogyboy Bogs	Leitrim	SL25	28.69	400-430	2	2
15	Mucross	SAC (000365) - Killarney National Park	Kerry	KY 78	39.19	30	2	2
16	Cuildooish	SAC (000606) - Lough Fingall Complex	Galway	GY52	359.75	20	6	13
17	Cloonselherny	SAC (001926) - East Burren Complex	Clare	GY52	432.65	20	6	12
18	Clooneen	SAC (000057) - Moyree River System	Clare	GY52	154.25	20-40	6	11
19/36*	Caherlough	Not designated	Clare	CL57,CL58	227.51	20	4	8
20/38*	Cloonnasee	Not designated	Galway	GY52	153.43	10-20	4	11
21	Sheshymore	SAC (000054) - Moneen Mountain	Clare	CL51	44.69	100-110	4	6
22	Formoyle East	SAC (000020) - BlackHead-Poulsallagh Complex	Clare	CL51	183.72	240-290	3	7
23/41*	Grange East	Not designated	Galway	GY46	154.28	50-60	5	15
24	Kilroghter	SAC (000297) - Lough Corrib	Mayo	GY45	99.46	25-55	4	6
26	Cloghmoyne	SAC (000479) - Cloughmoyne	Galway	GY45	55.96	30-55	4	12
27	Inishmore	SAC (000213) - Inishmore Island	Galway	GY51	902.74	30-90	8	20
29/47*	Ballydotia	Not designated	Galway	GY45	116.08	20	4	10
31	Mullagh	Not designated	Limerick	LK64	156.96	20	na	2
32	Mountscribe	Not designated	Galway	GY52	41.00	10	na	3
33	Carrownamaddra	Not designated	Galway	GY52	67.23	10	na	6

Site Number	Site Name	Designation	County	Discovery Map	Area (ha)	Altitudinal Range (m)	Plots	Relevés
34	Tooreen East	Not designated	Galway	GY52	53.16	20	na	4
35	Cartron	Not designated	Galway	GY52	66.84	10	na	5
37	Shanclogh	Not designated	Galway	GY52	62.28	10	na	6
39	Moymore	Not designated	Clare	CL57,CL58	90.26	20	na	5
40	Coolteige	Not designated	Roscommon	RN40	3.11	80	na	1
42	Menlough	Not designated	Galway	GY45	20.40	25	na	3
43	Cregboy	Not designated	Galway	GY46	42.94	35	na	3
44	Creevagh	Not designated	Galway	MO38	127.78	35-45	na	6
45	Kildun More	Not designated	Mayo	MO38	88.63	25-30	na	3
46	Glasgort	Not designated	Mayo	MO38	109.62	40	na	6

Appendix 9: Site boundary and habitat maps for potential NHA site

Potential pNHA NSLP41 (Grange East)
Site Boundary

Legend

Potential pNHA boundary

N

0 0.15 0.3 0.6 Km

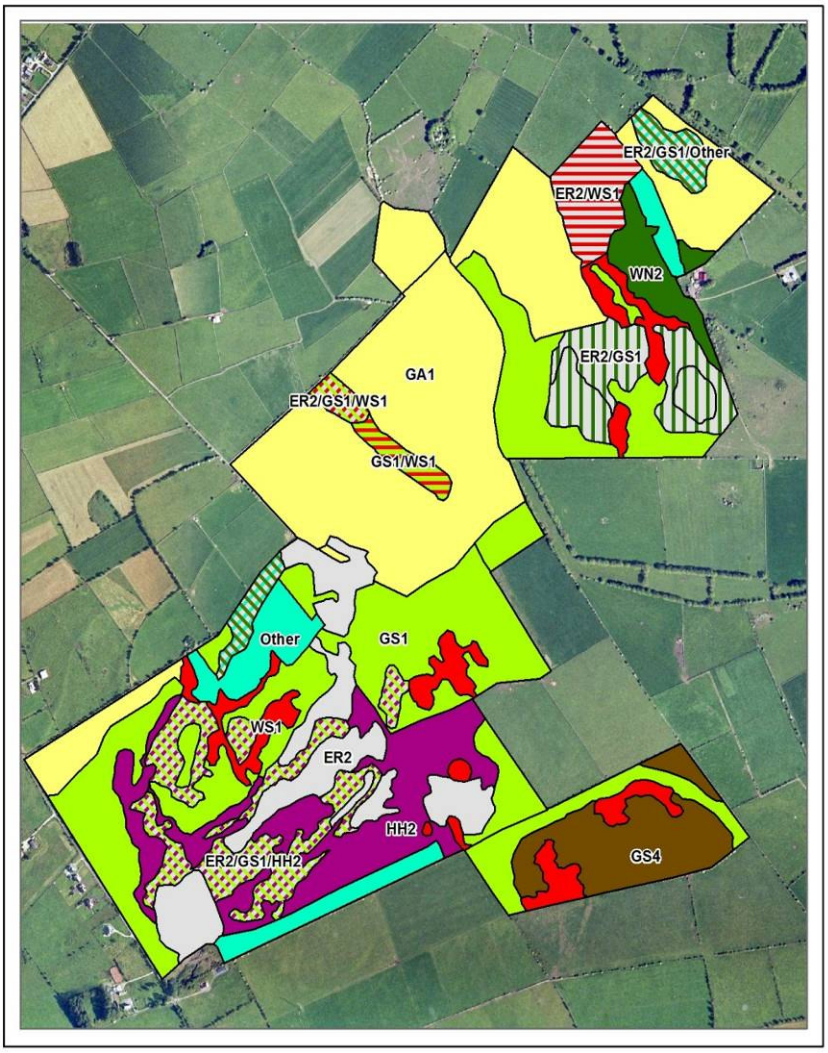
1:11,000

Potential pNHA NSLP41 (Grange East)
Habitat Map (Fossitt 2000)

Legend

Fossitt habitat type

- ER2
- ER2/GS1
- ER2/GS1/HH2
- ER2/GS1/WS1
- ER2/GS1/Other
- ER2/WS1
- GA1
- GS1
- GS1/WS1
- GS4
- HH2
- WN2
- WS1
- Other



N

0 0.15 0.3 0.6 Km

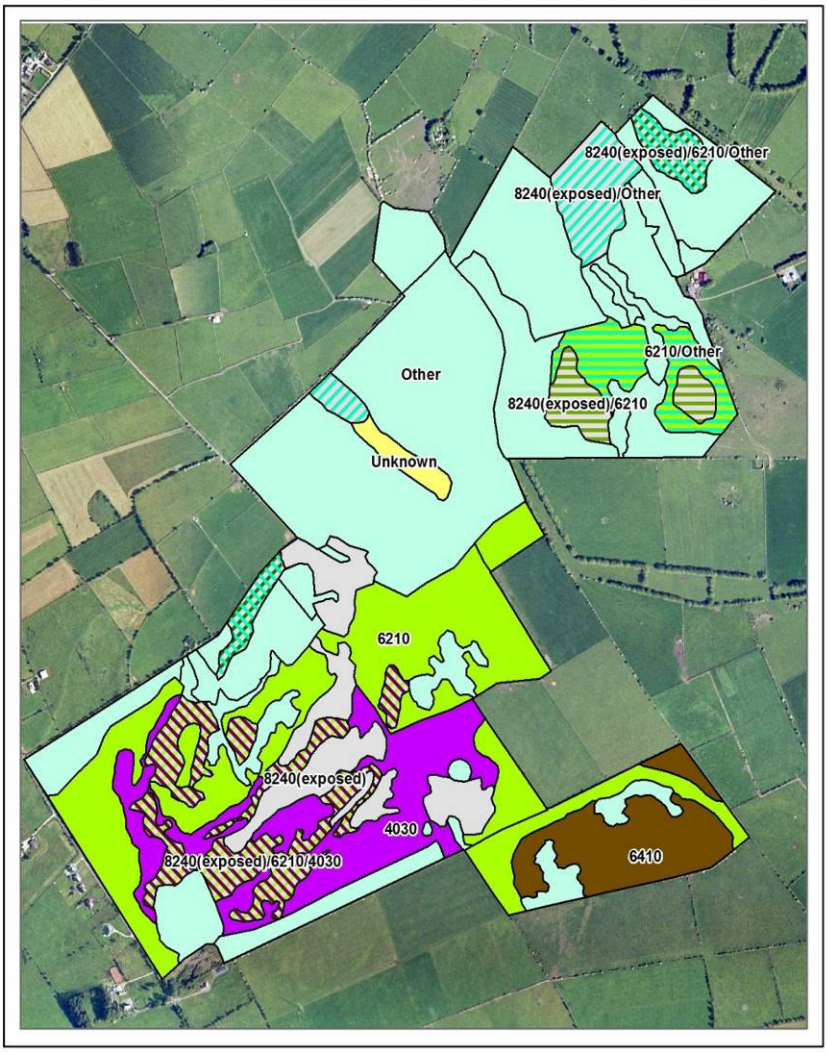
1:11,000

Potential pNHA NSLP41 (Grange East)
Habitat Map (Annex I Habitats Directive)

Legend

Annex I Habitats Directive habitat type

- 4030
- 6210
- 6210/Other
- 6410
- 8240(exposed)
- 8240(exposed)/6210
- 8240(exposed)/6210/4030
- 8240(exposed)/6210/Other
- 8240(exposed)/Other
- Other
- Unknown



N

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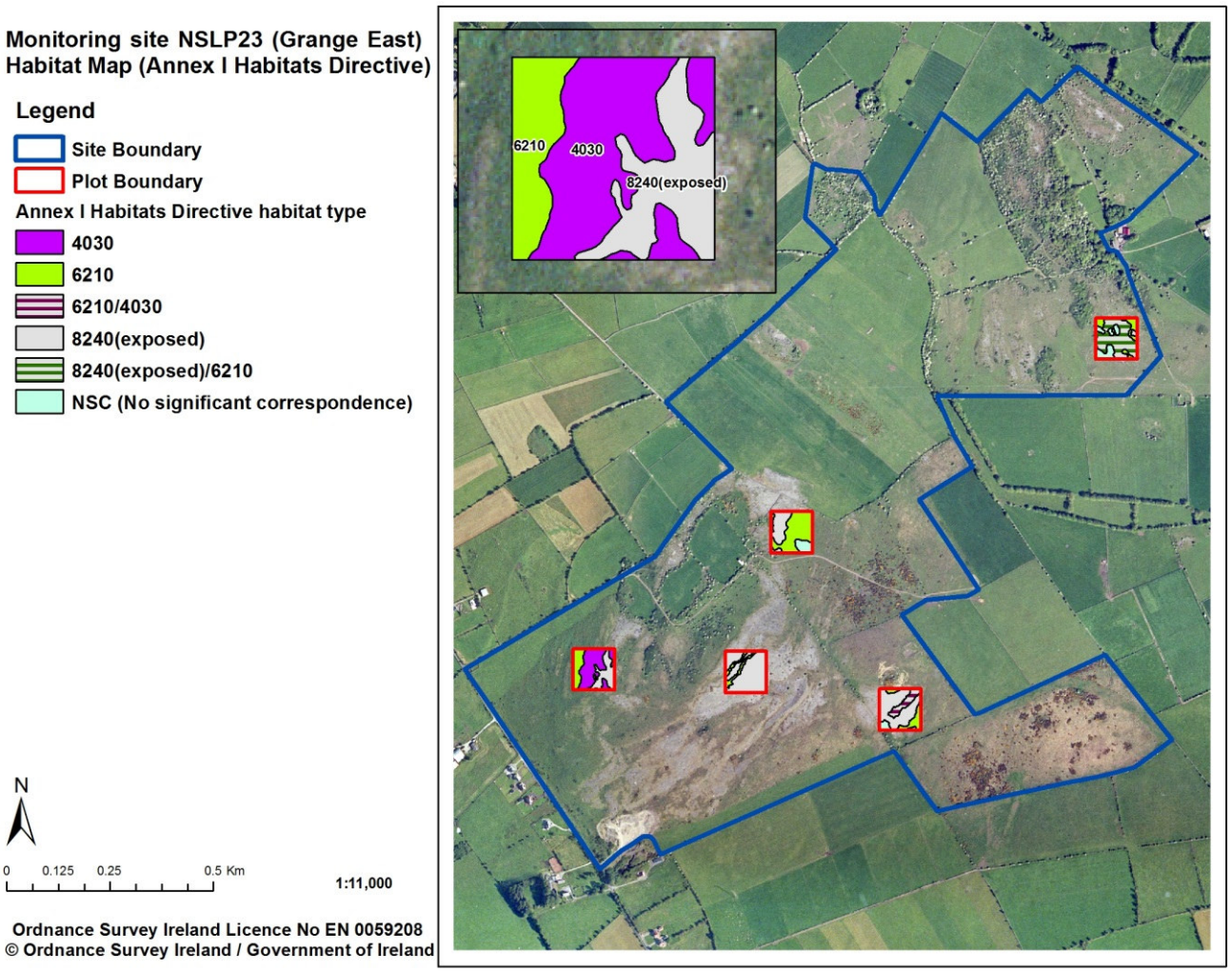
Appendix 10: Habitat maps for monitoring site NSLP23/41



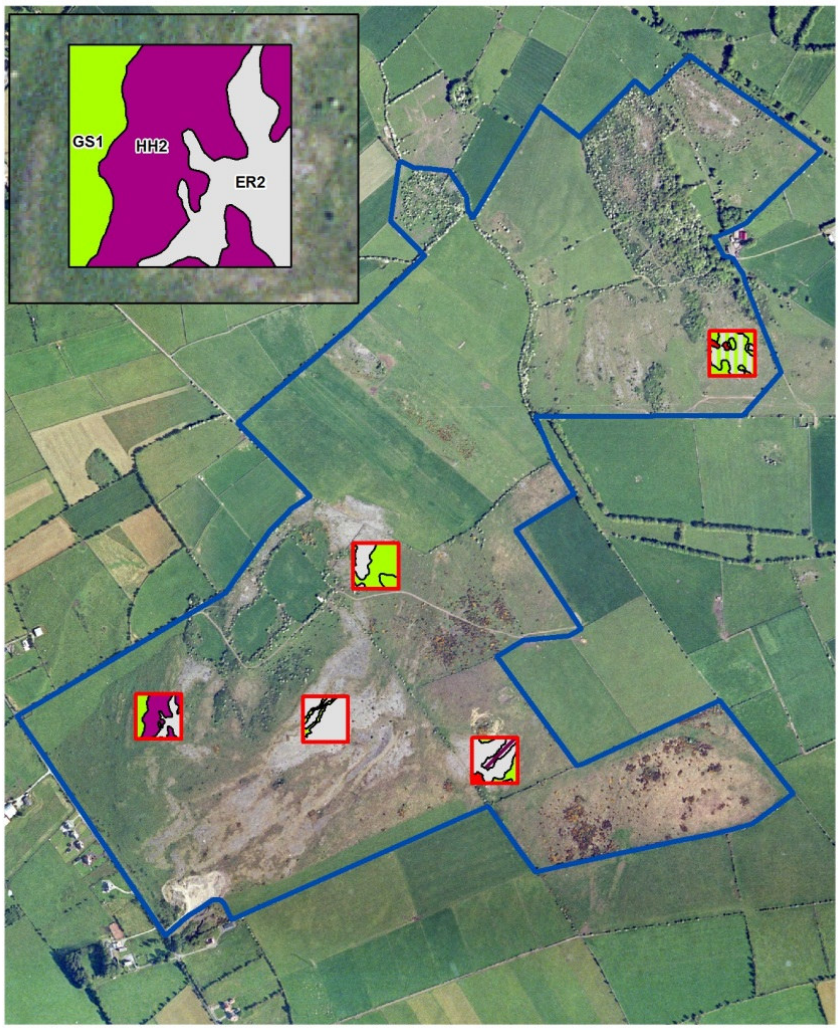
Monitoring site NSLP23 (Grange East)
Habitat Map (Fossitt 2000)

Legend

- Site Boundary
- Plot Boundary

Fossitt habitat type

- GS1/HH2
- ER2
- GS1/ER2
- GS1
- HH2
- WS1



N

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1:11,000

Appendix 11: Additional mapping data

Below is an extension of Table 12 in the Mapping results section.

County	Extent (ha)	Extent designated SACs and NHAs (ha)	% designated	No. of polygons	Average size polygon (ha)	No. polygons designated	Average size polygon (ha)	No. polygons not designated	Average size polygon (ha)
Cavan	35	13	37.14	2	17.63	1	12.94	1	22.31
Clare	24,128	21,397	88.68	508	47.5	358	64.06	150	7.96
Donegal	69	38	55.07	14	4.93	9	6.12	5	2.80
Galway	6,761	4,358	64.46	609	11.1	177	26.58	432	4.76
Kerry	39	39	100	1	39.19	1	39.19	0	0
Leitrim	134	46	34.33	37	3.62	26	1.93	11	7.62
Limerick	27	0	0	4	6.8	0	0	4	6.8
Longford	3	2	66.67	5	0.63	3	0.7	2	0.53
Mayo	707	468	66.20	125	5.66	39	12.47	86	2.57
Offaly	40	38	95	1	39.65	1	39.65	0	0
Roscommon	64	2	3.13	35	1.82	2	1.03	33	1.87
Sligo	174	151	86.78	21	8.3	21	8.30	0	0
Tipperary	5	4	80	1	4.51	1	4.51	0	0
Westmeath	1	1	100	2	0.43	2	0.43	2	0
Total	32,187	26,557	82.69	1,365	23.58	641	41.43	724	7.78

Appendix 12: Structure and functions assessment results at site level

Structure and Functions results for Limestone pavement (exposed)

Relevé	Total positive indicators (>7)	Total positive indicator species	Negative indicators	Bracken cover	Non-native species (Collective)	Scrub cover	Prunus spinosa (%)	Corylus avellana (%)	Overall Structure and functions	Site S&F	Expert judgement Site S&F
NSLP01P1R1	13	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP01P2R2	11	Pass	Pass	Pass	Pass	Pass	7	0	Pass		
NSLP01P3R1	10	Pass	Fail	Pass	Pass	Pass	2.5	0	Pass		
NSLP01P4R1	9	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP01P5R2	15	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP01P6R1	12	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP01P7R1	11	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP01P8R2	15	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP02P1R1	11	Pass	Pass	Pass	Pass	Pass	0	7	Pass	Pass	Pass
NSLP02P1R3	13	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP02P2R2	9	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP02P3R2	7	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP02P4R2	12	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP02P5R2	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP02P6R2	11	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP02P7R1	15	Pass	Pass	Pass	Pass	Pass	2.5	0.5	Pass		
NSLP02P8R3	15	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP03P1R3	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP03P2R2	14	Pass	Pass	Pass	Pass	Pass	17	0	Pass		
NSLP03P3R2	14	Pass	Pass	Pass	Pass	Pass	7	17	Pass		
NSLP03P4R2	8	Pass	Pass	Pass	Pass	Pass	0	2.5	Pass		
NSLP03P5R2	10	Pass	Pass	Pass	Pass	Pass	7	0	Pass		
NSLP03P6R2	8	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP03P7R2	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP03P8R1	10	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP04P1R2	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP04P2R1	13	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP04P3R1	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP04P4R2	11	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP04P5R2	13	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP04P6R3	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP04P7R2	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP04P8R2	11	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		

Relevé	Total positive indicators (>7)	Total positive indicator species	Negative indicators	Bracken cover	Non-native species (Collective)	Scrub cover	Prunus spinosa (%)	Corylus avellana (%)	Overall Structure and functions	Site S&F	Expert judgement Site S&F
NSLP05P1R2	6	Fail	Pass	Pass	Fail	Pass	0	0	Fail	Fail	Fail
NSLP05P2R1	6	Fail	Fail	Pass	Pass	Fail	17	0	Fail		
NSLP05P2R2	8	Pass	Fail	Pass	Pass	Pass	0	0	Pass		
NSLP05P2R4	8	Pass	Pass	Pass	Fail	Pass	0.5	0	Pass		
NSLP05P3R2	7	Pass	Pass	Pass	Pass	Pass	0	2.5	Pass		
NSLP05P3R3	10	Pass	Pass	Pass	Pass	Fail	0	17	Pass		
		Fail	Fail		Fail	Fail					
NSLP06P1R2	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP07P1R1	13	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP07P2R2	9	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP07P3R2	12	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP07P4R1	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP07P5R1	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP07P6R1	12	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP07P7R1	14	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP07P8R1	11	Pass	Pass	Pass	Pass	Pass	0.5	0.5	Pass		
NSLP08P2R1	9	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP08P3R2	15	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP08P5R3	11	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP08P6R2	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP08P8R2	11	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP09P1R2	13	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass	Pass	Pass
NSLP09P2R2	12	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP09P5R2	15	Pass	Pass	Pass	Pass	Pass	7	2.5	Pass		
NSLP09P6R2	7	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP09P7R2	9	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP09P7R3	15	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP09P8R2	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP10P1R2	10	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass	Pass	Pass
NSLP10P1R3	13	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP10P2R2	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP10P3R1	15	Pass	Fail	Pass	Pass	Pass	0	0	Pass		
NSLP10P4R3	10	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP10P5R2	12	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP10P5R3	7	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP10P6R1	4	Fail	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP10P7R3	15	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP10P8R1	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass		

Relevé	Total positive indicators (>7)	Total positive indicator species	Negative indicators	Bracken cover	Non-native species (Collective)	Scrub cover	Prunus spinosa (%)	Corylus avellana (%)	Overall Structure and functions	Site S&F	Expert judgement Site S&F
NSLP12P1R1	8	Pass	Fail	Pass	Pass	Pass	0	7	Pass	Fail	Fail
NSLP12P2R1	9	Pass	Fail	Pass	Pass	Pass	0	2.5	Pass		
			Fail								
NSLP13P1R1	7	Pass	Pass	Pass	Pass	Pass	0	7	Pass	Pass	Pass
NSLP13P3R1	8	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP14P1R1	12	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP14P2R1	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP16P1R2	14	Pass	Fail	Pass	Pass	Pass	2.5	0	Pass	Pass	Pass
NSLP16P2R2	13	Pass	Pass	Pass	Pass	Pass	7	0	Pass		
NSLP16P3R1	11	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP16P4R2	14	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP16P5R2	11	Pass	Pass	Pass	Pass	Pass	2.5	7	Pass		
NSLP16P6R3	10	Pass	Pass	Pass	Pass	Pass	0.5	2.5	Pass		
NSLP17P1R2	11	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass	Pass	Pass
NSLP17P2R3	14	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP17P3R2	10	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP17P4R2	8	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP17P5R2	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP17P6R1	5	Fail	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP18P1R2	11	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass	Pass	Pass
NSLP18P2R2	16	Pass	Fail	Pass	Pass	Pass	0	0	Pass		
NSLP18P3R2	9	Pass	Pass	Pass	Pass	Pass	0.5	17	Pass		
NSLP18P4R1	14	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP18P5R2	10	Pass	Pass	Pass	Pass	Pass	7	0.5	Pass		
NSLP18P6R1	12	Pass	Pass	Pass	Pass	Pass	7	7	Pass		
NSLP19P1R1	9	Pass	Pass	Pass	Pass	Pass	2.5	7	Pass	Pass	Pass
NSLP19P2R1	12	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP19P3R1	12	Pass	Pass	Pass	Pass	Pass	2.5	2.5	Pass		
NSLP19P4R1	14	Pass	Pass	Pass	Pass	Pass	0	7	Pass		
NSLP20P1R1	12	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP20P2R1	10	Pass	Fail	Pass	Pass	Pass	0	0	Pass		
NSLP20P3R3	8	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP20P4R1	13	Pass	Pass	Pass	Pass	Pass	2.5	0.5	Pass		
			Fail								
NSLP21P1R1	12	Pass	Pass	Pass	Pass	Pass	2.5	0.5	Pass	Pass	Pass
NSLP21P2R1	8	Pass	Pass	Pass	Pass	Pass	0	0.5	Pass		
NSLP21P3R1	17	Pass	Pass	Pass	Pass	Pass	0	2.5	Pass		
NSLP21P4R2	13	Pass	Pass	Pass	Pass	Pass	0	2.5	Pass		

Relevé	Total positive indicators (>7)	Total positive indicator species	Negative indicators	Bracken cover	Non-native species (Collective)	Scrub cover	Prunus spinosa (%)	Corylus avellana (%)	Overall Structure and functions	Site S&F	Expert judgement Site S&F
NSLP22P1R1	13	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP22P2R1	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP22P3R3	14	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP23P1R2	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Pass	Pass
NSLP23P2R2	6	Fail	Pass	Pass	Pass	Pass	7	0	Pass		
NSLP23P3R1	12	Pass	Pass	Pass	Pass	Pass	7	0	Pass		
NSLP23P4R2	7	Pass	Pass	Pass	Pass	Pass	7	0	Pass		
NSLP23P5R1	9	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP24P1R1	8	Pass	Pass	Pass	Pass	Pass	0	0	Pass	Fail	Fail
NSLP24P2R1	8	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP24P3R1	8	Pass	Fail	Pass	Pass	Pass	2.5	0	Pass		
NSLP24P4R1	12	Pass	Fail	Pass	Pass	Pass	2.5	0	Pass		
			Fail								
NSLP26P1R1	14	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass	Fail	Pass
NSLP26P2R2	5	Fail	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP26P3R3	9	Pass	Pass	Pass	Pass	Pass	2.5	7	Pass		
NSLP26P4R2	7	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
		Fail									
NSLP27P1R2	15	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass	Fail	Pass
NSLP27P2R2	12	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP27P3R1	9	Pass	Fail	Pass	Pass	Pass	17	0	Pass		
NSLP27P4R2	14	Pass	Fail	Pass	Pass	Pass	2.5	0	Pass		
NSLP27P5R2	13	Pass	Pass	Pass	Pass	Pass	0.5	0	Pass		
NSLP27P6R2	13	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
NSLP27P7R2	11	Pass	Pass	Pass	Pass	Pass	2.5	0	Pass		
			Fail								
NSLP29P1R3	8	Pass	Fail	Pass	Pass	Pass	2.5	0.5	Pass	Fail	Fail
NSLP29P2R2	11	Pass	Fail	Pass	Pass	Pass	2.5	0	Pass		
NSLP29P3R2	9	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
NSLP29P4R2	10	Pass	Pass	Pass	Pass	Pass	0	0	Pass		
			Fail								

Structure and Functions results for Limestone pavement (wooded)

Relevé	Total positive indicators (>7)	Total positive indicator species	Non-native trees & shrub species	Total canopy cover	Total bryophyte layer	Grazing pressure	Dead wood	Non-native shrub/tree regeneration	Overall Structure and functions	Site S&F
NSLP02P1R2	18	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	Pass
NSLP02P7R4	10	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	
NSLP05P2R3	12	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	Pass
NSLP06P1R3	21	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	Pass
NSLP09P7R4	24	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	Pass
NSLP09P8R3	22	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	
NSLP12P1R2	20	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	Pass
NSLP16P4R1	18	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	Pass
NSLP17P2R2	19	Pass	Pass	Pass	Pass	unknown	Pass	Pass	Pass	Pass

Structure and Functions results for Semi-natural dry grasslands and scrubland facies on calcareous substrates (6210)

Relevé	Total HQ positive indicator species (>2)	Total HQ positive indicator species	Total positive indicator species (>7)	Total positive indicator species	Negative indicator species (individual)	Negative indicator species (Collective)	Non-native species cover	Forb:Grasses/Sedges	Scrub/Bracken encroachment cover	Sward height	Litter cover	Cover of disturbed ground	Overall Structure and functions	Site S&F	Expert judgement Site S&F
NSLP01P2R1	3	Pass	7	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP01P3R3	2	Pass	7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP01P4R3	2	Pass	6	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP01P6R2	3	Pass	11	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
		Pass		Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass			
NSLP02P2R1	2	Pass	7	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP02P4R1	5	Pass	10	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP02P7R3	4	Pass	8	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
NSLP02P8R2	3	Pass	6	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
		Pass		Fail	Fail	Pass	Pass	Pass	Pass	Pass	Fail	Pass			
NSLP03P1R1	1	Fail	7	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Fail	Pass	Fail	Fail	Fail
NSLP03P5R1	1	Fail	7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
NSLP03P8R2	1	Fail	8	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
		Fail		Pass	Pass	Pass	Pass	Fail	Fail	Pass	Fail	Pass			
NSLP04P2R3	4	Pass	10	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
NSLP04P4R1	3	Pass	9	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
NSLP04P6R1	3	Pass	7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
		Pass		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass			
NSLP05P3R1	0	Fail	6	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Fail	Fail	Pass
		Fail		Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass			

Relevé	Total HQ positive indicator species (>2)	Total HQ positive indicator species	Total positive indicator species (>7)	Total positive indicator species	Negative indicator species (individual)	Negative indicator species (Collective)	Non-native species cover	Forb:Grasses/Sedges	Scrub/Bracken encroachment cover	Sward height	Litter cover	Cover of disturbed ground	Overall Structure and functions	Site S&F	Expert judgement Site S&F
NSLP06P1R1	1	Fail	5	Fail	Fail	Fail	Pass	Fail	Fail	Pass	Fail	Pass	Fail	Fail	Fail
		Fail		Fail	Fail	Fail	Pass	Fail	Fail		Fail	Pass			
NSLP07P1R2	4	Pass	11	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
		Pass		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass			
NSLP08P4R1	2	Pass	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass
NSLP08P5R2	2	Pass	10	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
NSLP08P6R1	5	Pass	13	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
		Pass		Pass	Fail	Pass	Pass	Pass	Pass	Pass	Fail	Pass			

NSLP09P1R1	3	Pass	13	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
NSLP09P3R1	3	Pass	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP09P4R1	5	Pass	16	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP09P5R1	4	Pass	15	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
		Pass		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass			
NSLP10P3R2	2	Pass	9	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Fail	Fail	Fail
NSLP10P4R2	4	Pass	11	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP10P6R2	3	Pass	8	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP10P7R2	1	Fail	10	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
		Fail		Pass	Fail	Fail	Pass	Pass	Pass	Pass	Fail	Pass			
NSLP13P1R2	6	Pass	15	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP13P2R1	4	Pass	8	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP13P2R2	4	Pass	11	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP13P3R2	3	Pass	7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
		Pass		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass			

Relevé	**Total HQ positive indicator species (>2)**	**Total HQ positive indicator species**	**Total positive indicator species (>7)**	**Total positive indicator species**	**Negative indicator species (individual)**	**Negative indicator species (Collective)**	**Non-native species cover**	**Forb:Grasses/Sedges**	**Scrub/Bracken encroachment cover**	**Sward height**	**Litter cover**	**Cover of disturbed ground**	**Overall Structure and functions**	**Site S&F**	**Expert judgement Site S&F**
NSLP16P2R1	5	Pass	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail
NSLP16P5R1	3	Pass	14	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP16P6R1	4	Pass	12	Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass	Fail		
NSLP16P6R2	5	Pass	13	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass		
		Pass		Pass	Fail	Fail	Pass	Fail	Pass	Pass	Fail	Pass			
NSLP17P3R1	3	Pass	7	Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass	Fail	Fail	Fail
NSLP17P4R1	4	Pass	13	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
		Pass		Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass			
NSLP18P1R1	4	Pass	16	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail
NSLP18P3R1	2	Pass	4	Fail	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Fail		
NSLP18P6R2	5	Pass	12	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass		
		Pass		Fail	Fail	Pass	Pass	Fail	Fail	Pass	Pass	Pass			
NSLP20P1R2	7	Pass	18	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Fail	Fail
NSLP20P2R2	3	Pass	10	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass		
NSLP20P3R1	8	Pass	20	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP20P3R2	4	Pass	12	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
		Pass		Pass	Fail	Pass	Pass	Pass	Fail	Pass	Pass	Pass			
NSLP21P3R2	0	Fail	7	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail
		Fail		Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass			
NSLP22P3R1	1	Fail	7	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass
		Fail		Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass			
NSLP23P1R1	5	Pass	13	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP23P2R1	2	Pass	7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		

Relevé	Total HQ positive indicator species (>2)	Total HQ positive indicator species	Total positive indicator species (>7)	Total positive indicator species	Negative indicator species (individual)	Negative indicator species (Collective)	Non-native species cover	Forb:Grasses/Sedges	Scrub/Bracken encroachment cover	Sward height	Litter cover	Cover of disturbed ground	Overall Structure and functions	Site S&F	Expert judgement Site S&F
NSLP23P3R2	6	Pass	15	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass		
NSLP23P5R2	6	Pass	13	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
		Pass		Pass	Fail	Pass	Pass	Fail	Pass	Pass	Pass	Pass			
NSLP24P1R2	8	Pass	18	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP24P3R2	6	Pass	14	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
		Pass		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass			
NSLP26P1R2	5	Pass	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail
NSLP26P1R3	6	Pass	15	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP26P2R1	5	Pass	9	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail		
NSLP26P3R1	4	Pass	11	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP26P4R1	6	Pass	16	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP26P4R3	6	Pass	15	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
		Pass		Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass			
NSLP27P1R3	6	Pass	15	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP27P2R1	2	Pass	9	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP27P3R3	5	Pass	15	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP27P4R1	5	Pass	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP27P7R1	7	Pass	17	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
NSLP27P8R2	6	Pass	11	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass		
		Pass		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass			
Relevé	**Total HQ positive indicator species (>2)**	**Total HQ positive indicator species**	**Total positive indicator species (>7)**	**Total positive indicator species**	**Negative indicator species (individual)**	**Negative indicator species (Collective)**	**Non-native species cover**	**Forb:Grasses/Sedges**	**Scrub/Bracken encroachment cover**	**Sward height**	Litter cover	**Cover of disturbed ground**	**Overall Structure and functions**	**Site S&F**	**Expert judgement Site S&F**
NSLP29P1R1	6	Pass	10	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
		Pass		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass			

Structure and Functions results for Alpine and Boreal heaths (4060)

Relevé	Total positive indicators (>7)	Total positive indicators	Negative indicators	Non Native species cover	Trees and shrubs	Cover of disturbed ground	Overall Structure and functions	Site Structure and Functions
NSLP01P4R2	13	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP01P7R2	15	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP01P8R1	15	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP04P1R1	17	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP04P2R2	15	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP04P3R2	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP04P5R1	15	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP04P6R2	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP07P2R1	11	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP07P3R1	14	Pass	Fail	Pass	Pass	Pass	Pass	
NSLP07P4R2	11	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP07P5R2	15	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP07P6R2	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP08P8R1	15	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP09P8R1	15	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP10P2R1	17	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP10P4R1	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP22P2R2	18	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP22P3R2	12	Pass	Pass	Pass	Pass	Pass	Pass	

Structure and Functions results for European dry heaths (4030)

Relevé	Total positive indicators (>7)	Total positive indicators	Negative indicators	Non Native species cover	Trees and shrubs	Cover of disturbed ground	Overall Structure and functions	Site Structure and Functions
NSLP01P3R2	9	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP01P5R1	12	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP01P6R3	11	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP02P3R1	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP02P5R1	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP02P6R1	16	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP02P6R3	7	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP02P7R2	12	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP02P8R1	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP03P1R2	10	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP03P2R1	7	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP03P4R1	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP03P5R3	9	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP03P6R1	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP03P7R1	16	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP03P8R3	11	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP04P7R1	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP04P8R1	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP05P1R1	13	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP07P3R3	10	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP08P1R1	13	Pass	Fail	Pass	Pass	Pass	Pass	Pass
NSLP08P2R2	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP08P3R1	11	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP08P4R3	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP08P5R1	12	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP08P7R1	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP09P6R1	14	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP09P6R3	10	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP10P1R1	10	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP10P5R1	9	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP10P7R1	11	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP10P8R2	12	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP13P1R3	11	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP16P1R1	13	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP17P1R1	14	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP17P2R1	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP17P5R1	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP18P5R1	16	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP20P4R2	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP21P4R1	12	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP22P1R2	17	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP23P2R3	15	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP23P4R1	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP26P3R2	16	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP26P3R4	17	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP27P1R1	14	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP27P2R3	13	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP27P3R2	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP27P5R1	12	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP27P6R1	12	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP27P7R3	15	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP27P8R1	12	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP29P2R1	10	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NSLP29P3R1	14	Pass	Pass	Pass	Pass	Pass	Pass	
NSLP29P4R1	6	Fail	Pass	Pass	Pass	Pass	Pass	

Appendix 13: Future prospects assessment results at site level

Site Code	Impact Code	Impact Description	Intensity	Effect	Overall Future Prospects
NSLP01	X	X	X	X	Favourable
NSLP02	A05.02	Stock feeding	L	-	Favourable
NSLP02	A04.02.01	non intensive cattle grazing	L	+	
NSLP02	A10.01	Removal of hedges and copses or scrub	L	+	
NSLP03	I01	Invasive non-native species	M	-	Unfavourable - Inadequate
NSLP04	I01	Invasive non-native species	H	-	Unfavourable - Inadequate
NSLP05	I01	Invasive non-native species	H	-	Unfavourable - Inadequate
NSLP06	A04.01.02	intensive sheep grazing	M	-	Unfavourable - Inadequate
NSLP06	I02	Problematic native species	H	-	
NSLP07	X	X	X	X	Favourable
NSLP08	X	X	X	X	Favourable
NSLP09	X	X	X	X	Favourable
NSLP10	G05.01	Trampling, overuse	L	-	Favourable
NSLP12	X	X	X	X	Favourable
NSLP13	K02.01	Species composition change (succession)	H	-	Unfavourable - Inadequate
NSLP14	A04.01.02	intensive sheep grazing	H	-	Unfavourable - Inadequate
NSLP16	C01	Mining and quarrying	M	-	Unfavourable - Inadequate
NSLP16	K02.01	Species composition change (succession)	M	-	
NSLP17	I02	problematic native species	H	-	Unfavourable - Inadequate
NSLP17	I01	Invasive non-native species	L	-	
NSLP18	A05.02	Stock feeding	L	-	Favourable
NSLP18	I01	Invasive non-native species	L	-	
NSLP19	J02.01	Land reclamation	H	-	Unfavourable - Inadequate
NSLP19	I01	Invasive non-native species	H	-	
NSLP20	CO1	Mining and quarrying	H	-	Unfavourable - Inadequate
NSLP20	J02.01	Land reclamation	H	-	
NSLP21	X	X	X	X	Favourable
NSLP22	X	X	X	X	Favourable
NSLP23	J02.01	Land reclamation	M	-	
NSLP23	I01	Invasive non-native species	L	-	Unfavourable - Inadequate
NSLP24	K02.01	Species composition change (succession)	M	-	Unfavourable - Inadequate
NSLP24	I02	Problematic native species	M	-	
NSLP24	I01	Invasive non-native species	L	-	
NSLP26	I02	Problematic native species	M	-	Unfavourable - Inadequate
NSLP26	K02.01	Species composition change (succession)	M	-	
NSLP26		Reseeding grassland	M		
NSLP26	I01	Invasive non-native species	L	-	
NSLP26	CO1	Mining and quarrying	H		
NSLP27	C01	Mining and quarrying	H	-	Unfavourable - Inadequate
NSLP29	I01	Invasive non-native species	M	-	Unfavourable - Inadequate
NSLP29	K02.01	Species composition change (succession)	M	-	

Appendix 14: Future prospects assessment results at National level

Site Code	EU Habitat	Impact Code	Impact Description	Intensity (L/M/H)	Effect (-/0/+)
NSLP02	4030	A04.02.01	non intensive cattle grazing	L	+
NSLP02	6210	A04.02.01	non intensive cattle grazing	L	+
NSLP02	8240	A04.02.01	non intensive cattle grazing	L	+
NSLP02	6210	A05.02	Stock feeding	L	-
NSLP02	8240	A10.01	Removal of hedges and copses or scrub	L	+
NSLP03	4030	C01	Mining and quarrying	H	-
NSLP03	6210	C01	Mining and quarrying	H	-
NSLP03	8240	C01	Mining and quarrying	H	-
NSLP03	8240	I01	Invasive non-native species	M	-
NSLP04	8240	I01	Invasive non-native species	H	-
NSLP05	8240	I01	Invasive non-native species	H	-
NSLP06	6210	A04.01.02	intensive sheep grazing	M	-
NSLP06	6210	I02	Problematic native species (bracken)	H	-
NSLP10	6210	G05.01	Trampling, overuse	L	-
NSLP13	4030	K02.01	Species composition change (succession)	H	-
NSLP13	6210	K02.01	Species composition change (succession)	H	-
NSLP13	8240	K02.01	Species composition change (succession)	M	-
NSLP14	8240	A04.01.02	intensive sheep grazing	H	-
NSLP16	8240	C01	Mining and quarrying	M	-
NSLP16	8240/4030/6210	C01	Mining and quarrying	H	-
NSLP16	8240	K02.01	Species composition change (succession)	M	-
NSLP16	6210	K02.01	Species composition change (succession)	M	-
NSLP17	8240	I01	Invasive non-native species	L	-
NSLP17	4030	I02	problematic native species (bracken)	H	-
NSLP18	6210	A05.02	Stock feeding	L	-
NSLP18	8240	I01	Invasive non-native species	L	-
NSLP19	8240	I01	Invasive non-native species	H	-
NSLP19/36	8240/6210	J02.01	Land reclamation	H	-
NSLP20	8240	CO1	Mining and quarrying	H	-
NSLP20/38	8240	J02.01	Land reclamation	H	-
NSLP23	8240	CO1	Mining and quarrying	H	-
NSLP23	8240	CO1	Mining and quarrying	M	-
NSLP23	8240	I01	Invasive non-native species	L	-
NSLP23/41	8240/4030	J02.01	Land reclamation	H	-
NSLP24	6210	K02.01	Species composition change (succession)	H	-
NSLP24	8240	K02.01	Species composition change (succession)	M	-
NSLP24	8240	I01	Invasive non-native species	L	-
NSLP24	6210	I02	Problematic native species	H	-
NSLP24	8240	I02	Problematic native species	M	-
NSLP26	6210	K02.01	Species composition change (succession)	M	-
NSLP26	8240	K02.01	Species composition change (succession)	M	-

Site Code	EU Habitat	Impact Code	Impact Description	Intensity (L/M/H)	Effect (-/0/+)
NSLP26	8240	C01	Mining and quarrying	H	
NSLP26	8240	I01	Invasive non-native species	L	-
NSLP26	6210	I02	Problematic native species (bracken)	H	-
NSLP26	8240	I02	Problematic native species (bracken)	M	-
NSLP27	8240	C01	Mining and quarrying	H	-
NSLP29/47	8240	K02.01	Species composition change (succession)	M	-
NSLP29/47	8240	B02	Forest and Plantation management & use	H	-
NSLP29/47	8240	C01	Mining and quarrying	H	-
NSLP29/47	8240	I01	Invasive non-native species	M	-
NSLP29/47	4030	I01	Invasive non-native species	L	-
NSLP31	8240/6210	K02.01	Species composition change (succession)	M	-
NSLP32	8240/6210	K02.01	Species composition change (succession)	M	-
NSLP32	8240	I01	Invasive non-native species	L	-
NSLP32	8240/6210	J02.01	Land reclamation	H	-
NSLP33	8240/6210/4030	I02	Problematic native species (bracken)	M	-
NSLP35	8240/6210	K02.01	Species composition change (succession)	M	-
NSLP37	8240	I01	Invasive non-native species	M	-
NSLP37	8240/6210	J02.01	Land reclamation	H	-
NSLP43	8240	J02.01	Land reclamation	H	-
NSLP44	8240/6210	J02.01	Land reclamation	H	-