Irish Semi-natural Grasslands Survey

Annual Report No. 4:

Western Seaboard Counties (Clare, Galway, Kerry, Limerick, Mayo)

& County Tipperary

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Cover photo: Calcareous grassland at Pollkeen, Co. Galway (Site 2280). Photo taken by Fiona Devaney.

Executive Summary

Between 2011 and 2012, 337 sites and 1288 relevés in Clare, Galway, Kerry, Limerick, Mayo and Tipperary were surveyed as part of the Irish Semi-natural Grasslands Survey (ISGS). 61.7% of these sites were associated with an NPWS conservation site (SAC, NHA, pNHA or SPA). Wet grassland was the most frequent semi-natural grassland habitat, recorded at 71.2% of sites and covering 49.4% of the total area of grassland surveyed. Freshwater marsh was the least frequent grassland habitat and represented less than 1% of the grassland area surveyed across these counties. The EU Habitats Directive Annex I grassland habitat with the highest frequency of occurrence was Orchid-rich/calcareous grassland (Festuco-Brometalia) ([*]6210), recorded at 60 sites, followed by *Molinia* meadows (6410), recorded at 33 sites, Species-rich *Nardus* grassland (*6230), recorded at 21 sites, and Lowland hay meadows (6510), recorded at 13 sites. Eight sites with Hydrophilous tall herb fringe communities (6430) were recorded in the western counties in 2011-2012. In terms of area, [*]6210 covered by far the greatest area, 222.5 ha, due to the large areas of this Annex I habitat recorded in Clare and Galway. This was followed by 6410 (110.6 ha), *6230 (46.8 ha) and 6510 (35.3 ha).

The median area of the semi-natural grassland sites in Clare, Galway, Kerry, Limerick, Mayo and Tipperary was 9.9 ha and the county medians ranged from 5.9 ha in Galway to 21.6 ha in Limerick, with individual sites ranging in size from 0.3 ha to 103.0 ha. Conservation scores, based on factors such as habitat diversity and quality, species richness, site size and presence of plant species of conservation interest within a site, were calculated for all 337 sites. Of the 25 sites that scored highly (a score of 40% or over) in the conservation evaluation, 21 were associated with an NPWS conservation site. Threat scores were based on factors such as damaging activities, agricultural improvement, negative adjacent habitats and presence of negative species within a site. Of the 16 sites that received high threat evaluations (a score of over 50%), five were associated with an NPWS conservation site.

The main category of habitat adjacent to surveyed sites was woodland, including hedges and treelines, scrub, and semi-natural woodland, adjacent to 78.3% of sites (with scrub adjacent to 60% of sites, and treelines and hedgerows adjacent to 45% of sites). Built land and coastal constructions were the next most frequent category, adjacent to 76% of sites.

Primary areas of Annex I grassland have been identified which represent the best examples of Annex I grassland habitat surveyed during the ISGS; these provide a focus for semi-natural grassland conservation and monitoring in Ireland. Of the 337 western sites surveyed between 2011 and 2012, 54 primary areas of Annex I grassland habitat were identified.

The main negative impacts recorded for Annex I grassland habitats surveyed in the six western counties in 2011 and 2012 were species composition change (succession) and problematic native species (e.g. bracken). Only 33 of the 135 areas of Annex I grassland surveyed received an overall assessment of *Favourable* (i.e., having favourable conservation assessments for area, structure and functions and future prospects), emphasising their vulnerability and the urgency with which they need

to be studied and monitored. However, in most cases the implementation of appropriate management would improve the condition of the Annex I habitat, and assessment scores of *Favourable* could be attainable in the medium term.

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1: INTRODUCTION

1.1 General background

Grassland habitats are reported to cover approximately 60% (Byrne 1996, CSO 2012) of the land area of Ireland, but the overwhelming majority of this is improved agricultural grassland, with semi-natural grassland habitats contributing only a small percentage of the total. The term 'semi-natural', when applied to grassland, implies that it has been altered by human agricultural or pastoral activity, generally grazing or mowing, but without the input of fertilisers (Calaciura and Spinelli 2008) or reseeding with high-yielding species such as *Lolium perenne* and *Trifolium repens*. The current dominance of grassland habitats in Ireland is the result of millennia of human activity altering the predominantly wooded landscape that existed 5,000 years ago (Hall and Pilcher 1995). The low-intensity agricultural practices that once allowed the development of species-rich semi-natural grassland have now all but ceased, threatening the existence of this habitat type within Ireland. Any semi-natural grasslands that remain are threatened either by the abandonment of all management, which for most grassland areas results in reversion to scrub and ultimately woodland, or by the intensification of management, resulting in the replacement of a diverse array of species with a small number of high-yielding ones.

During the last 50 years, agriculture in Ireland has changed completely with increases in mechanisation, the implementation of arterial drainage schemes and the application of fertilisers. Ireland's entry into the European Economic Community (EEC) in 1973 resulted in financial incentives to improve agricultural productivity (Feehan 2003), and as a result the nature of Ireland's grasslands has been radically altered. From 1990 to 2000, arable land (including land used for silage production) and permanent crops increased in area by 35%, followed closely by artificial surfaces, which increased by 31%. These changes were largely at the expense of pasture and mixed farmland (EPA 2006). The majority of the remaining areas of semi-natural grassland within Ireland owe their continued existence to either a continuation of traditional extensive farming practices by some landowners, conservation measures or edaphic and topographical conditions that make them unsuitable for fertiliser application, reseeding or drainage.

1.2 Vegetation studies of Irish grasslands

Since Braun-Blanquet and Tüxen (1952) made the initial attempts at classifying the grasslands of Ireland, the number of vegetation studies of this habitat has been disproportionately small considering the large area of Ireland that grasslands occupy. One reason for this is that the overwhelming majority of Irish grassland vegetation is low-diversity agricultural grassland. The most notable research on Irish grasslands was conducted by O'Sullivan (1965, 1968, 1976, 1982), who collected field data from a broad range of grassland habitats. In addition to this research contributing to the most comprehensive classification of Irish grasslands to date (O'Sullivan 1982), the data from the

thousands of individual relevés collected provide researchers with a well-documented and archived dataset (Bourke *et al.* 2007).

The majority of the other grassland vegetation studies carried out in Ireland have been more specific in their aims. Research has either focused on a particular region of Ireland, such as the Burren (Ivimey-Cook and Proctor 1966, O'Donovan 1987, Keane and Sheehy-Skeffington 1995, Parr *et al.* 2009; Long 2011), Leinster (Byrne 1996), Galway (Sullivan *et al.* 2010), Sligo (O'Donovan 2007) or Fermanagh (Eakin 1995), or on a particular grassland vegetation type, such as callows grassland (Heery 1991, Tolkamp 2001, Maher 2013), esker grasslands (Bleasdale 1998, Tubridy 2006), grassland associated with limestone pavement (Wilson and Fernández 2013), hay meadows (Martin 1991) or Calaminarian grasslands (Holyoak 2008). However, some of the most recent studies have been broader in their remit. O'Donovan and Byrne (2004) carried out research in Sligo and Westmeath with the aim of developing a method for mapping semi-natural grassland across Ireland, and Dwyer *et al.* (2007) carried out a countrywide study of priority Annex I grassland habitats within Special Areas of Conservation (SACs). More recently in 2007, the semi-natural grasslands in both Roscommon and Offaly were surveyed (Martin *et al.* 2007), serving as a pilot study for the current project. In 2008, the current project commenced with a comprehensive survey of the semi-natural grasslands of Cork and Waterford (Martin *et al.* 2008). It continued in 2009 with a detailed survey of grasslands in Cavan, Leitrim, Longford and Monaghan (O'Neill *et al.* 2009), and in 2010 with a survey of Donegal, Dublin, Kildare and Sligo grasslands (O'Neill *et al.* 2010). The study culminated in 2011-2012 with this reported study of six counties; Clare, Galway, Kerry, Limerick, Mayo and Tipperary, plus a study of eight Leinster counties; Carlow, Kilkenny, Laois, Louth, Meath, Westmeath, Wexford and Wicklow (Martin *et al.* 2013).

1.3 Classification of Irish grasslands

Braun-Blanquet and Tüxen (1952) were the first to systematically classify Irish grasslands based on the Zurich-Montpellier phytosociological approach, but it was not until 1982 that the first comprehensive classification was published (O'Sullivan 1982). Using the same phytosociological approach, O'Sullivan divided all non-coastal Irish grassland into three classes: the Molinio-Arrhenatheretea, the Calluno-Ulicetea (Nardetea) and the Festuco-Brometea. The Molinio-Arrhenatheretea, which includes lowland meadows and pastures on neutral soils, was the most frequent group, based on over 2,500 relevés and estimated to cover 65% of the land area of Ireland. The Molinio-Arrhenatheretea is divided into the Arrhenatheretalia and Molinietalia orders. The Arrhenatheretalia generally includes drier meadows and pastures, including improved agricultural fields dominated by *Lolium perenne* and *Trifolium repens*. The Molinietalia represents wet meadows and pasture communities on clay, loam and humus-rich gley soils that are generally not fertilised. The Calluno-Ulicetea (Nardetea) includes acid grassland communities and was estimated to cover 4.4% of the land area of Ireland. The Festuco-Brometea, represented in Ireland by the sole order Brometalia erecti, includes dry limestone grasslands on base-rich soils, and was estimated to be the least frequent of the three major classes of grassland, covering only 0.3% of the Irish land area.

White and Doyle (1982) in their catalogue of Irish vegetation types drew heavily on the work of O'Sullivan (1982), reapplying his classification of Irish grasslands and adding some rarer associations, such as the Violetea calaminariae class, which includes the grassland vegetation of areas rich in heavy metals, and the Carici rupestris-Kobresietea bellardii class of arctic-alpine grass heaths, of which one association, the Breutelio-Seslerietum, has been described in Ireland from Ben Bulben in Co. Sligo.

Fossitt (2000) is the most widely utilised grassland classification in Ireland. Unlike O'Sullivan (1982), which is a vegetation classification, Fossitt (2000) is a habitat classification which utilises soils, geology and landscape features, in addition to plant communities, to define each habitat. Fossitt (2000) presents a simplified and standardised way to classify habitats in Ireland; however, it is based on the results of previous phytosociological studies rather than being based objectively on empirical data. The five Fossitt habitat categories directly relevant to this survey of semi-natural grassland are as follows:

- **Fossitt Code GS1 - Dry calcareous and neutral grassland.** This encompasses all unimproved and semi-improved dry grasslands on both calcareous and neutral soil. It is associated with free-draining mineral soils and low-intensity agriculture.
- **Fossitt Code GS2 - Dry meadows and grassy verges.** This habitat is found on free-draining mineral soils. The management is different from that in GS1 in that the grassland has little or no grazing but instead is managed primarily by mowing.
- **Fossitt Code GS3 - Dry-humid acid grassland.** This grassland is found on free-draining acid soils that are not waterlogged. It is found mainly on mineral-rich or peaty podzols in uplands, but is also found on siliceous sandy soils in the lowlands.
- **Fossitt Code GS4 - Wet grassland.** This habitat type is found on poorly drained mineral and organic soils and includes grassland that is seasonally or periodically flooded. It encompasses a range of wet grassland types, from wet rushy pasture to callows.
- **Fossitt Code GM1 - Freshwater marsh.** This habitat is found on waterlogged mineral and shallow peat soils near lake and river edges and other wetland habitats, where the watertable is close to the surface for most of the year. It is characteristically rich in broadleaf herbs, and grasses and sedges should not exceed 50% of the ground cover.

The grasslands section of the National Vegetation Classification (NVC) used to classify British plant communities (Rodwell 1991, 1992, 1995, 2000) does not utilise Irish data, but it does provide an indication of the range of plant communities likely to exist in Ireland. It also provides this in a system that does not follow the subjective methods inherent in the central European phytosociological approach of Braun-Blanquet and Tüxen (1952). Perrin *et al.* (2008a, b) produced an NVC-style classification of Irish woodland vegetation employing a range of more objective techniques. These techniques have also been applied in the analysis of the Irish semi-natural grasslands data. Previous ISGS reports (Martin *et al.* 2007, 2008; O'Neill *et al.* 2009, 2010) have outlined interim classifications

produced as the survey progressed. As data are now available from all 26 counties, the final vegetation classification of semi-natural grasslands in the Republic of Ireland has been produced and is detailed in a separate national synthesis ISGS report (O'Neill *et al.* 2013). With a total of 19 individual grassland vegetation types distributed among four groups, this new vegetation classification proposed by O'Neill *et al.* (2013) highlights the limitations of Fossitt (2000), which only classifies semi-natural grassland into four groups and marsh into one group that is rigidly defined by the proportions of forbs (broadleaf herbs) and graminoids (grasses, sedges and rushes) present; it should prove a useful tool for describing the complexity of Irish semi-natural grasslands.

1.4 Conservation of Irish grasslands

Semi-natural grasslands act as an important refuge for many invertebrate, bird and mammal species, and also provide a suitable habitat for many rare and protected plant species. Despite their importance, however, semi-natural grasslands are an extremely vulnerable habitat in Ireland. Areas of semi-natural grassland that are accessible to machinery are particularly susceptible to agricultural improvement. Keane and Sheehy-Skeffington (1995) showed that the addition of fertiliser to semi-natural grasslands resulted in a change of sward composition and a loss of plant species diversity. The vulnerability of semi-natural grasslands to agricultural improvement, afforestation and scrub encroachment was demonstrated by Byrne (1996), who found that 38% of the sites documented by O'Sullivan during the 1970s no longer supported semi-natural grassland communities by 1994. Similar trends have also been demonstrated in England and Wales, where a review of available data showed that only between one and two percent of remaining lowland grasslands comprise semi-natural communities (Blackstock *et al.*1999). Stevens *et al.* (2010) recently completed a comprehensive study of lowland grasslands in Wales which recognised lowland grassland as a priority for detailed survey and assessment because of the rapid losses and damage that had been taking place to the habitat over a number of decades.

Grasslands of conservation interest are protected in Ireland through conservation designations that vary in the level of protection they provide to the species and habitats found within them. For example, the Flora (Protection) Order 1999 affords protection to the 89 individual plant species listed in the Order, and the protection extends to their habitats. The Wildlife Act, 1976 and the subsequent Wildlife (Amendment) Act, 2000 are the two main articles of legislation that provide protection to wild flora, fauna and semi-natural habitats, including grasslands. Additional statutory protection is available under the recent Environmental Impact Assessment Agriculture Regulations (Statutory Instrument 456 of 2011), which offer protection to semi-natural grasslands in the event of their intended conversion for intensive agriculture, requiring screening to take place if the area to be affected exceeds a certain size. Semi-natural grassland habitats are also afforded legal protection by the Environmental Liability Directive, which prevents and remedies environmental damage to natural habitats and protected species.

Grasslands located within National Parks and Nature Reserves can have the highest level of protection, as they are State-owned and managed for conservation. Special Areas of Conservation (SACs) and Special Protection Areas for birds (SPAs) designated as a result of EU directives provide the next highest level of protection, while Natural Heritage Areas (NHAs) designated under domestic legislature provide the third tier of protection. As not all NHAs have been designated, proposed NHA (pNHA) is used to distinguish non-designated sites. Throughout this report when referring collectively to SACs, NHAs/pNHAs and SPAs, the term 'NPWS conservation sites' is often used. As there has been no comprehensive survey of semi-natural grassland for almost 30 years, the application of conservation designations to protect areas of semi-natural grassland has taken place in the absence of an accurate record of the extent of each habitat on the ground.

The EU Habitats Directive has contributed to the conservation of semi-natural grassland in Ireland by listing and defining 31 types of Annex I grassland habitat of conservation importance in Europe (Anon. 2007). Under this directive, Ireland has a responsibility to designate SACs to protect any of these habitats that occur within the State and to maintain them at a favourable conservation status. SACs are the most important wildlife conservation areas in the country and are strictly protected under the EU Habitats Directive. Any plans, projects or activities which are proposed and may significantly impact on an SAC must undergo special scrutiny in the form of an Appropriate Assessment. Also, certain activities which occur within an SAC that might be damaging (Notifiable Actions) can only be carried out with the permission of the Minister for Arts, Heritage and the Gaeltacht. Six Annex I grassland habitats of conservation importance have been recorded within Ireland by the National Parks and Wildlife Service (NPWS):

- Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) ([*]6210).[1]
- Species-rich *Nardus* grasslands on siliceous substrates in mountain areas (and sub-mountain areas, in Continental Europe) (*6230).
- *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) (6410).
- Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels (6430).
- Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (6510).
- Calaminarian grasslands of the Violetalia calaminariae (6130).

Only two grassland habitats in Ireland, the orchid-rich variant of 6210 (*6210) and *6230, are accorded priority status (i.e. habitats in danger of disappearance and whose natural range falls within the territory of the European Union). Priority Annex I habitats are conventionally listed with the habitat

[1] Festuco-Brometalia is an old synonym for the order Brometalia-erecti. It is *not* synonymous with the class Festuco-Brometea as indicated in Fossitt (2000)

code preceded by an asterisk '*'. Throughout this report, [*]6210 is used to denote both 6210 and the priority orchid-rich variant together.

Three distinct communities can be considered for the 6430 habitat in Ireland. The first is a lowland community of watercourses, particularly of unmanaged edges of slow-moving rivers and lake margins. The second occurs in the uplands on ungrazed or lightly grazed cliff ledges, typically occurring as small individual patches less than one metre across. The third variant is another lowland community that possibly occurs as a nitrophilous tall-herb community of woodland edges, referred to as a 'saum' community. However, this community has been little studied in Ireland (see Wilmanns and Brun-Hool 1982) and further investigation and discussion is required to determine if Ireland supports any examples worthy of Annex I status. The first two community types were assessed for the recent National Conservation Assessments (NPWS 2013); however, only the first lowland community was surveyed during the ISGS, and then only if it occurred in association with grassland.

As semi-natural grasslands in Ireland almost always exist within farming systems, agri-environment schemes such as the Rural Environmental Protection Scheme (REPS), the Agri-Environment Options Scheme (AEOS) and the NPWS Farm Plan Scheme are expected to contribute to the conservation of semi-natural grassland. Regional conservation projects are also impacting positively on the status of semi-natural grasslands. Wilson and Fernández (2013) report on initiatives in improved land use management by the BurrenLIFE Project and Burren Farming for Conservation Project (Anon. 2013) that aim to reduce current pressures and future threats, such as inappropriate grazing regimes and scrub encroachment within the Burren area.

1.5 Assessment and monitoring of Irish grasslands

The monitoring and assessment of the Annex I grassland habitats located within the State started with 33 orchid-rich calcareous grassland sites (*6210) and nine species-rich *Nardus* grasslands (*6230) being surveyed during 2006 (Dwyer *et al.* 2007). The methodology employed for the monitoring and assessment adapted those published by the EU (Anon. 2006), the Joint Nature Conservancy Council (JNCC) in Britain (JNCC 2004) and the methodology already utilised for dune systems in Ireland (Ryle *et al.* 2009). Following on from Dwyer *et al.* (2007), Annex I grassland monitoring was an integral part of the Irish Semi-natural Grasslands Survey, with the monitoring results published in Martin *et al.* (2007, 2008) and O'Neill *et al.* (2009, 2010). Additional studies of Annex I grassland habitats within Ireland include studies of the Shannon Callows (Heery 1991, Heery and Keane 1999) and Calaminarian grasslands (Holyoak 2008), the latter study having a particular emphasis on bryophytes. The National Parks and Wildlife Service published *The Status of EU Protected Habitats and Species in Ireland* (NPWS 2013) and this lists the overall conservation status of each of the Annex I grassland habitats as *Bad*.

1.6 Scope of this report

This document reports on a survey of semi-natural grassland and marsh communities in counties Clare and Mayo, conducted in summer 2011, and counties Galway, Kerry, Limerick and Tipperary carried out in summer 2012, which represent the fourth and fifth years (the final two years) of the *Irish Semi-natural Grasslands Survey* (ISGS). It follows on from the surveys of Donegal, Dublin, Kildare and Sligo grasslands in 2010 (O'Neill *et al.* 2010), Cavan, Leitrim, Longford and Monaghan grasslands in 2009 (O'Neill *et al*. 2009) and Cork and Waterford grasslands in 2008 (Martin *et al.* 2008). A pilot survey was also carried out in 2007 to examine Offaly and Roscommon grasslands (Martin *et al.* 2007). The remit of the project in the final two years was to survey 400 sites across the remaining 14 counties, recording relevés in each of the semi-natural grassland types which occur, and to map all habitat types found at each site using GIS. A further aim was to conduct a conservation assessment of any Annex I grassland habitats found. In addition, a scheme to assess the conservation value of each site as a whole was used to highlight important sites. The five western seaboard counties of Clare, Galway, Kerry, Limerick and Mayo, together with Tipperary, are reported on here; the remaining eight Leinster counties – Carlow, Kilkenny, Laois, Louth, Meath, Westmeath, Wexford and Wicklow – are covered by a separate report (Martin *et al.* 2013). Data from the survey were to be combined across all 26 counties to evaluate existing classification systems and to create an objective classification that described the diversity of vegetation types found. As noted above, this final vegetation classification encompassing all semi-natural grassland sites surveyed between 2007 and 2012 during the ISGS are detailed in a separate document (O'Neill *et al.* 2013). This report will primarily focus on results from the 2011-2012 field season as carried out in Tipperary and the five western seaboard counties listed above.

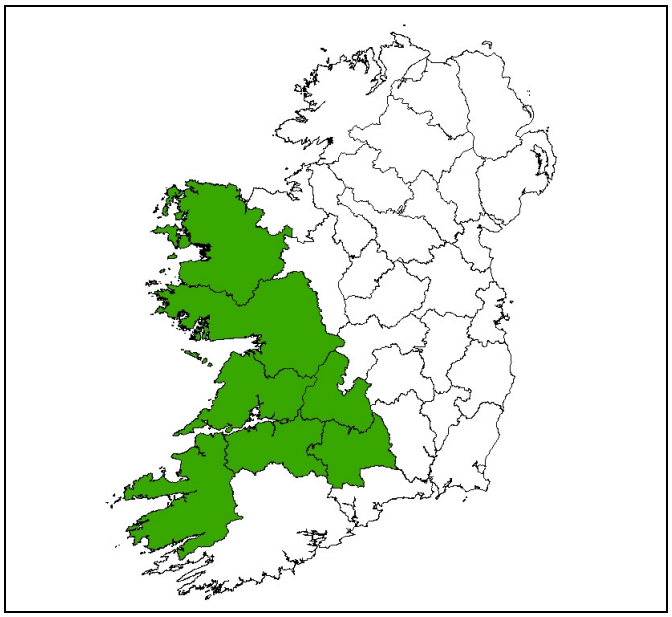
1.7 Study area

The six counties within the survey area are located in the west of Ireland and south-midlands (Fig. 1.1), with the biggest counties, Galway (6,150 km^2) and Mayo (5,588 km^2), being the most northerly of the six, and Kerry, the next largest (4,748 km^2), the most southerly. The remaining counties in order of decreasing area are Tipperary (4,305 km^2), Clare (3,242 km^2) and Limerick (2,687 km^2) (OSI 2013a). Geographically, Mayo hosts the most northerly point of the six counties surveyed, at the Stags of Broad Haven, uninhabited off-shore islands, while Kerry's Blasket Islands form the most westerly location in the country.

Agriculturally, the counties are distributed across four regions: the Central Statistics Office lists Galway and Mayo within the West region, Limerick, Clare and North Tipperary within the Mid-West region, South Tipperary within the South-East region and Kerry within the South-West region (CSO 2007). The most westerly seaboard areas, within which Mayo, Galway, Clare and Kerry are located, are agriculturally less well developed than the more easterly counties of Limerick and Tipperary. This is evidenced by the much smaller farm sizes in the West region: less than 25 ha, compared to over 40 ha in the South-East region. Farms in the Mid-West and South-West regions range between 33 ha

and 40 ha, with those in Clare, Limerick and Kerry between 33 ha and 35 ha, and North Tipperary close to 40 ha on average (CSO 2012). The four regions also differ in terms of the main farm types recorded there, with the West region having a high proportion of sheep farms, compared to the specialist tillage farms that proportionally dominate in the South-East, and dairy farms in the Mid-West and South-West regions (CSO 2012).

Figure 1.1 Map of Ireland showing the survey area of counties Clare, Galway, Kerry, Limerick, Mayo and Tipperary (Ordnance Survey Ireland Licence No EN 0059208 © Ordnance Survey Ireland / Government of Ireland).



Mayo and Galway are in the province of Connacht, while Clare, Limerick, Kerry and Tipperary are in the province of Munster. Of these six counties, only Tipperary is landlocked, the five others having varying lengths of coastline along the Atlantic Ocean. The Mayo coastline is not only the longest of the six counties surveyed (1,168 km), but also the longest in Ireland. The Mayo coastline is followed in size by the coastlines of Galway (689 km), Kerry (684 km), Clare (366 km) and lastly Limerick (95 km) (Anon. 1996). The coastal habitats of Mayo and Galway include machair (*21A0), a priority habitat in Ireland under EU law. Six coastal SACs listing machair as a qualifying interest have been designated in Mayo and another six in Galway; a further five SACs in Mayo and four in Galway list machair as being present. Machair is a special form of coastal grassland habitat which was surveyed as part of the coastal monitoring project (Ryle *et al.* 2009) and sand dunes monitoring project (Delaney *et al.* 2013). However, under Fossitt (2000) machair is listed as CD6, a sand dune habitat, and is therefore not within the remit of this survey.

Overall, regional differences in climate are small and, as is to be expected, with all six counties for this report being adjacent to each other, there are no significant differences between them climatically. The northwest is wetter than the other counties surveyed, with average annual rainfall (30-year average between 1981 and 2010) ranging from 1,245 mm at the weather station in Belmullet, Co.

Mayo to 948 mm at the weather station in Gurteen College, Co. Tipperary (Met Éireann 2013). In terms of temperatures, the northwest's climate is seen to be cooler in summer than the other counties surveyed, with a July mean temperature of 14.9°C in Mayo, compared to 16.4°C in Clare and 15.6°C in Tipperary. However, the winters in the northwest are milder, with a January mean of 6.3°C in Mayo, compared to 6.0°C in Clare and 5.4°C in Tipperary.

In terms of relief, Ireland can be described as being saucer-shaped due to its relatively low, flat midlands being surrounded by a ring of coastal mountains. The mountains found in Mayo and Galway, such as Croagh Patrick and the Twelve Bens, formed during the Caledonian fold movement and tend to run in a northeast to southwest direction (Freeman 1950). Kerry contains four of the five highest peaks in Ireland, Carrauntoohil (1,038 m), Beenkeragh (1,010 m) and Caher (1,001 m) which are in the MacGillycuddy Reeks, and Mount Brandon (951 m) in the Brandon Mountains (OSI 2013b). Mountains found in Kerry and the other counties within the Munster province formed during the Armorican fold movement and run in an east-west direction, forming a ridge and valley landscape (Freeman 1950). Limestone-floored lowland is found between these two different mountain formations. Bedrock digital maps from the Geological Survey of Ireland (GSI 2013) show that the limestone bedrock extends from the midlands to reach the Atlantic Ocean along the Shannon Estuary and at Galway Bay, Clew Bay and Killala Bay. The area where this limestone bedrock is most evident is in the Burren, which covers a region of north Clare and south Galway. The Burren is one of Europe's finest examples of a glaciated karst landscape (Dunford 2002) where, due to glacial activity, the limestone pavement has had soil stripped away leaving either bare limestone rock, or limestone rock thinly covered by soil. Farming practices within the Burren such as winter grazing contribute to the maintenance of the area as grassland by the prevention of scrub recolonisation.

A review of the principal soil and sub-soil types, using the digital soil maps of Fealy *et al.* (2006), shows that eskers and moraines extend westwards from Dublin to Galway and northwards from Galway to Mayo. The north of Mayo, particularly the western region, has a high proportion of blanket peats and some cutaway peat. Moving south along the coast, acidic rock becomes more frequent as a parent material, particularly in southwest Mayo and western Galway. East of this coastal band of acidic rock is a band of calcareous rock, which runs from Castlebar in Mayo in a southerly direction as far as Rathkeale in Limerick. As with Mayo and Galway, the western coastal areas of Clare and Kerry, as well as the western part of Limerick, comprise a mixture of acidic rock and blanket peats. An extensive band of cutover peat runs from east Mayo, through east Galway and down through east Tipperary.

Over 50% of all the fresh water in the Republic is found within the six counties of this report. Lough Corrib (176 km^2) in Co. Galway is the largest lake in the Republic of Ireland. This is followed by Lough Derg (118 km^2) which sits on the county borders of Tipperary, Galway and Clare. Approximately 5% of the total area of both Mayo and Galway comprises fresh water, while Limerick has the smallest area of fresh water (8.9 km^2) of the counties in the study area – less than 0.5% of its

total area (OSI 2013a, 2013b). The lake habitats of the six counties include turloughs (*3180), a priority habitat in Ireland under EU law. Six SACs listing turloughs as a qualifying interest have been designated in Clare; three of these extend into Galway, which has a further 17 SACs where turloughs are listed as a qualifying interest. Mayo has nine SACs which list turloughs as a qualifying interest. Turloughs are also present in Kerry, Tipperary and Limerick, but are not listed as qualifying interests within SACs. Turloughs are ephemeral lakes, occurring in limestone areas, which support a wide range of plant communities, including wet grassland. All areas within the normal high flood limit are considered part of the turlough habitat; however, grassland vegetation communities within this high flood limit were not within the remit of this survey. For information on the vegetation of turloughs refer to Sharkey (2012), and Kimberley and Waldren (in prep). Important river systems are also located within the study area with the River Shannon influencing five of the six counties, defining borders between Tipperary, Clare and Galway, and the estuary defining the Limerick, north Kerry and south Clare coastline. Central Mayo is dominated by the River Moy.

2: METHODS

2.1 Site selection

The target for this project in 2011-2012 was to visit and record at least one relevé in 400 sites across 14 counties: Carlow, Clare, Galway, Kerry, Kilkenny, Laois, Limerick, Louth, Mayo, Meath, Tipperary, Westmeath, Wexford and Wicklow. Clare, Mayo, Meath and Westmeath were surveyed in 2011, and the remaining ten counties were surveyed in 2012. This report gives the findings for the six Connacht and Munster counties surveyed between 2011 and 2012: Clare, Galway, Kerry, Limerick, Mayo and Tipperary. The findings for the eight Leinster counties are given in a separate report (Martin *et al.* 2013). The target number of sites for the six Connacht and Munster counties was 326. The number of sites selected in each county was calculated based on a combination of the size of the county and the amount of agricultural intensification within each county (Lafferty *et al.* 1999). A further downward adjustment of potential survey area was made by excluding all upland SACs from this survey to prevent overlap with the National Survey of Upland Habitats (Perrin *et al.* 2011, 2012, 2013; Roche *et al.* 2009, 2011a, 2011b, 2012a, 2012b). Based on these criteria, the six Connacht and Munster (western) counties were expected to contain relatively large amounts of semi-natural grassland and most were assigned a high target number of sites. Clare, Galway and Mayo had targets exceeding 50 (57, 92 and 111 respectively), while Kerry, Limerick and Tipperary had lower targets of 31, 14 and 21 sites per county.

Sites were primarily selected by interpretation of aerial orthographical photographs (2005 Ordnance Survey of Ireland series) and six-inch maps. Every effort was made to select an even geographic spread of sites. However, the method used in the earlier years of this project (2008-2009) of selecting 3-5 sites per 10 km grid square was found to be unworkable due to the uneven distribution of potential grassland sites, due mainly to the occurrence of extensive areas of bog, upland heath, urban housing and improved agricultural land within the survey area. Therefore, there were many occurrences of 10 km squares that contained no potential grassland sites for survey. Despite the unevenness of grassland habitat distribution, however, the number of sites to be surveyed in each county was maintained as per the calculations made above. As in previous years, additional sites were selected to allow for those that would not be surveyed due to problems such as a lack of semi-natural grassland habitats or denial of access by landowners.

In addition to this stratified sampling of the survey area, the criteria listed below were considered during site prioritisation to ensure that a broad range of semi-natural grassland sites was included in the survey:

- National Parks & Wildlife Service (NPWS) conservation sites[2], particularly those having an Annex I grassland habitat listed as a qualifying interest within the site.
- Large areas of semi-natural grassland for which few or no data are currently available.

[2] Note that, throughout this report, the term 'NPWS conservation sites' is used to refer collectively to NHAs, proposed NHAs (pNHAs), SACs and SPAs

- Sites which occur on different soil and sub-soil types, as indicated by the digital soils map of Fealy *et al.* (2006).
- Sites that represent the geographical variation that exists in the study area, such as altitudinal range, with the exclusion noted above of upland SACs.
- Sites identified by the National Survey of Upland Habitats (Perrin *et al.* 2011; Roche *et al.* 2009) as containing the Annex I grassland habitat Species-rich *Nardus* grassland (*6230), for which more data were desirable.
- Sites associated with important landscape features (e.g., eskers).
- Sites adjacent to river systems and lakes, ensuring a representative sample of wet grasslands and marshes.
- Sites highlighted by previous publications, such as Dwyer *et al.* (2007), which had highlighted semi-natural grassland of conservation value.
- Sites containing rare plant records, such as *Alchemilla alpina* and *Carum verticillatum*, from the NPWS rare plant records database.
- Information from the Botanical Survey of the British Isles (BSBI) county recorders.
- Information from NPWS regional staff.

Each of the criteria listed above was used in conjunction with the 2005 set of aerial orthographical photographs, which were used either to identify or to confirm all sites.

A subjective approach to site selection was adopted for this survey, primarily due to the practical constraints on the project and the need to acquire a critical mass of data for several habitat types. For example, for rarer grassland habitats, such as marsh, it was desirable to include a minimum number of sites within the survey to ensure that a reasonable level of information about this habitat type was obtained. It was also desirable to survey NPWS conservation sites, such as SACs, that contained semi-natural grassland so that comparisons could be made with sites outside this network. Given that a limited number of sites could be surveyed within the financial and time limits of the project, a purely randomised approach could well have omitted some or all of these sites. A similar case can be made for most of the criteria listed above. Furthermore, difficulties with obtaining access permission and accurately identifying semi-natural grassland habitats from aerial photographs and GIS datasets made a randomisation approach to site selection unworkable.

For the location and summary data of all sites see Appendices 1 and 2.

2.2 General site survey

For all sites selected for field survey, a site pack was compiled. Each site pack included a cover sheet that detailed general site information for the field surveyors (e.g., townlands, geology, soil types, grid reference), a six-inch map, an aerial photograph of the site at a scale appropriate for mapping, and copies of any previous survey notes. Fully charged-up electronic handheld Personal Digitial Assistants (PDAs) loaded with TurbovegCE version 1.5 for recording site and relevé data were

carried by each team of two. Paper data sheets (Appendix 3) were also carried for recording general site data, Annex I grassland habitat assessment data and Annex I grassland habitat impacts, as well as for recording site and relevé species in the event of PDA battery failure. Copies of the Annex I grassland habitat assessment criteria (Appendix 5) and impact criteria (Appendix 7) were also carried by individual surveyors.

For each selected site, a decision was made upon arrival in the field on the validity of surveying it, based on the presence of semi-natural grassland habitats and the area they covered: sites with semi-natural grassland covering less than the minimum site size of 0.5 ha were rejected (with some exceptions; see below). Similarly, sites deemed to be comprised primarily of improved grassland or non-grassland habitat (e.g., heath, scrub) were rejected. Permission was sought from the owner or owners of a site before entering and whenever possible the management of the site was discussed with the landowner. Sites for which access was denied were rejected. In some cases landowners were contacted by telephone before leaving for a site by using the Land Direct on-line service (www.landdirect.ie) provided by the Land Registry Office. For a small fee the name and address of the registered landowner for a particular site could be obtained. Eircom's on-line telephone directory (www.eircomphonebook.ie) was then utilised to find telephone numbers.

Sites at which recent habitat loss had reduced the area of suitable habitat to less than 0.5 ha were rejected. An exception was made for sites found to contain only a small area of a nationally rare Annex I grassland habitat (e.g., Hydrophilous tall herb fringe communities (6430)). Areas of non-grassland habitat (such as woodland) more than 400 m^2 in area and linear habitats (such as rivers) more than 4 m wide were excluded from the site. Species-poor *Molinia*-dominated vegetation on deeper (more than 0.5 m deep), often degraded peats were deemed to be peatland, or degraded wet heath if in the uplands, and excluded from the site. Areas of improved grassland (GA under Fossitt (2000)) that had recently been ploughed, re-seeded with *Lolium perenne* and *Trifolium repens*, drained and/or fertilised were also excluded. Areas with significant cover of *Sphagnum* species were also not surveyed, generally being categorised as fen, flush or bog, unless these areas represented the fen-meadow variant of the EU Annex I habitat *Molinia* meadows (6410).

The EU Annex I habitat 6430 Hydrophilous tall-herb fringe communities was within the remit of the survey, although swamp habitats in general were not. For the 2011 and 2012 field seasons, at the discretion of the surveyors, areas of tall herb swamp, even though they may not have corresponded to the Annex I habitat, could be included within a site where they existed with other semi-natural grassland habitats.

Some intermediate, semi-improved grassland types were retained within sites, especially if it was considered that such areas were of potential conservation importance if negative practices such as overgrazing or fertiliser application were to be removed. When semi-improved grassland habitats were recorded, an 'i' was inserted into the Fossitt category of the habitat type deemed to have been

present prior to improvement. Thus, for example, GSi4 denotes semi-improved wet grassland of potential conservation value.

The following details were recorded for each site surveyed. Unless otherwise indicated, these details were recorded on the general site data sheet:

Internal habitats: All habitats that were observed within the boundaries of a site were noted. The internal grassland habitats recorded within each site were categorised as Annex I grassland habitats (Anon. 2007), non-Annex I semi-natural grassland habitats (Fossitt 2000) or semi-improved grassland. Non-grassland habitats, as defined by Fossitt (2000), that were below the minimum mapping area (<400 m^2) or mapping width (<4 m) were also listed and retained within the site.

Following Dwyer *et al.* (2007), no differentiation was made in the field between the Annex I habitat Semi-natural dry grassland and scrubland facies on calcareous substrates (6210) and the priority Annex I habitat Semi-natural dry grassland and scrubland facies on calcareous substrates – important orchid sites (*6210). The main reason for Dwyer *et al*. (2007) not distinguishing orchid-rich sites is the ephemeral nature of orchids, with large orchid populations present one year and absent the next. Therefore all areas referred to as [*]6210 in this report may potentially include areas of the priority habitat.

Adjacent habitats: Adjacent habitats, including boundary habitats such as hedgerows or walls, observed during the field survey, were recorded for each site using the categories defined by Fossitt (2000). Areas of non-grassland habitat greater than the minimum mapping area, which were mapped out of the site, were also listed as adjacent habitats.

Site geography: Any geographical feature associated with the site, such as a hill, valley, drumlin or lake, was recorded. In addition, seasonal flooding, if observed or thought to occur on the site, was noted. Topography (e.g., upper slope, lower slope) was not recorded at site level in 2011-2012, unlike years 2007-2009 of the project, as this was found to be too broad a level to provide useful information. Topography of relevés, however, was recorded (see section 2.3 below).

Site management: Semi-natural grasslands are habitats that require some human management, in most cases grazing or mowing. Land managers were consulted, wherever possible, to ascertain current management practices. Variables recorded include frequency and timing of grazing/mowing, type of livestock, fertiliser application and burning.

Fauna: In addition to domestic animals such as cattle, sheep and horses using grassland for pasture, there are also several relatively common wild animals that utilise semi-natural grassland habitats; some may contribute to the overall maintenance of the habitat, for example, by grazing (e.g., deer), while others simply use the habitats for foraging (e.g., badger). The presence of such species was recorded. Anthills were also recorded within the fauna section, as there is evidence that they can indicate the presence of old semi-natural grassland (Breen and O'Brien 1995). Observations of Annex II species of animals (EU Habitats Directive), such as marsh fritillary, or Annex I species of birds (EU Birds Directive), such as chough, were also recorded.

Damaging operations: Three damaging operations were listed on the general site data sheet: drainage, dumping and recent afforestation in the vicinity. The occurrence of dumping at a site can be associated with illegal activities, whereas drainage and afforestation represent changes in management practice which are typically detrimental to semi-natural grassland habitats. Burning is included under site management. Camp fires were recorded separately as a damaging operation under 'Other'. Grazing levels (overgrazing, undergrazing and appropriate grazing) and encroachment (scrub, heath and bracken) were not recorded at a site level in 2011-2012, unlike years 2007-2009 of the project, as these data were found to be recorded at too coarse a resolution to be entirely useful; all three grazing levels were frequently recorded at sites, and a small amount of encroachment was accorded the same weighting on a small site as a large site, despite being proportionately more damaging in the smaller site. Scrub, heath and bracken were still recorded as adjacent habitats where they were large enough to be mapped out or as internal habitats if they were smaller than the minimum mapping area. Grazing and encroachment were, however, recorded separately if they impacted on Annex I grassland habitats (see section 2.4).

Archaeological features: Any archaeological feature (e.g., lazy beds, ringforts) present on a site was recorded.

Habitat mapping: A habitat map of the site was drawn in the field using the colour aerial photograph in the site pack as a base map. A handheld GPS (Garmin GPS 76 with MapSource) was used in the field to accurately map site boundaries, areas of Annex I grassland habitats (Anon. 2007), non-Annex I semi-natural grasslands (Fossitt 2000) and semi-improved grassland habitats, particularly where these were not visible on the photograph. The minimum mapping unit for habitats was 400 m^2, with a minimum habitat width of 4 m. An accurate habitat map of each site was produced using these data within ArcGIS 9.3.

Site area: The surveyed site area in hectares was derived from the ArcGIS habitat maps as accurately as is possible in the absence of a Digital Terrain Model (DTM). In the absence of a DTM, areas of habitat on steep slopes are likely to be underestimated due to the fact that only a vertical projection has been used to calculate area.

Site summary: In addition to the specific site data gathered and recorded on the general site data field sheet, a general description of each site was also written. A specific format was adhered to when writing descriptions of the sites. Included within these descriptions were:

- A summary of the location and geography of the site
- A description of the habitats and vegetation types present at the site
- A summary of management at the site and any damaging activities
- Rare, protected or notable species recorded at the site
- Archaeological features recorded on site
- Any relevant information given by the landowner / locals.

General site survey results are in section 3.1.

Summary information on the grassland habitats recorded at each site is in Appendix 4.

Site species list: For the semi-natural grassland habitats present at each site, a comprehensive list of vascular plant species and the major components of the bryophyte flora found were input into a Turboveg database (TurbovegCE 1.5) on the PDA; these data were subsequently downloaded to a Microsoft® Access relational database. The site bryophyte list was supplemented, particularly in the case of smaller and less obvious taxa, by the intensive sampling conducted within each relevé; macro-lichens were also recorded from relevés and added to the site list. Identification of bryophytes and lichens in the laboratory was conducted as required and problematic species were referred to an expert. Species names used throughout the survey for vascular plants, bryophytes and macro-lichens are according to the current Irish National Biodiversity Data Centre (NBDC) species checklist; at the time of writing, this is Ireland2008v2.

As noted above, the site species list was input into the Turboveg database. The remainder of the site data, with the exception of the habitat maps, were input into the Access database. When there was ownership information available for a site, this was also added to the Access database. Digital photographs were taken at all of the surveyed sites, and all of these images were submitted on DVD with the ArcGIS project.

2.3 Relevé survey

A minimum of one 2 m x 2 m relevé was recorded from within each semi-natural grassland habitat area mapped in each site. Multiple relevés were recorded where there was significant variation in the sward composition within a habitat type, for example, in transitional areas, or where Annex I grassland habitat assessments were conducted. For each relevé, a 10-figure grid reference was obtained using a GPS unit, and topography, altitude (from the OSi Discovery Series of maps or GPS unit), slope and aspect were recorded.

Cover in vertical projection for each vascular and bryophyte species was recorded on the Domin scale (Kent and Coker 1992), as were other general parameters: bare soil, bare rock, leaf litter, surface water, total field layer and total bryophyte cover. The Domin scale is superior to the Braun-Blanquet scale as the greater number of recording subdivisions permits more variation in vegetation composition to be detected in subsequent analysis. It also provides for a more sensitive means of monitoring changes in sward composition over time.

For each relevé, additional data were also recorded to define the structure of the grassland within the 2 m x 2 m plot. These were:

- Overall cover of forbs (broadleaf herbs, omitting ferns and horsetails), measured on the Domin scale;
- Ratio of % forb cover to % graminoid (grass / sedge / rush) cover;
- An estimate of the median graminoid height (omitting flowering heads of grasses unless significant in area, and omitting small clumps of taller species);
- An estimate of the median forb height;
- A digital photograph of the relevé.

Five soil sub-samples were taken from each relevé (one from the centre and one from each corner) with an aluminium corer to a depth of 10 cm, and combined for analysis. Soil pH of field-fresh material was recorded using a glass electrode and a 1:1 soil / water paste. Soil samples were air-dried and retained for subsequent laboratory analyses of total organic carbon and total phosphorus. During 2012, soil samples were collected from most relevés but only a sub-set of samples, mainly from Annex I relevés, was analysed as above: the majority were not analysed but instead dried and sent to a storage facility in the Agriculture and Food Science Centre in University College Dublin. A soil profile was examined to a minimum depth of 20 cm, and the soil type was defined according to a simplified version of the Great Soil Groups of Gardiner and Radford (1980) with the aid of the soil identification key in Trudgill (1989). The simplified categories are as follows:

- Well-drained mineral: includes brown earths, grey/brown podzolics and brown podzolics
- Gleys: includes gleys and peaty gleys
- Podzols
- Basin peats
- Lowland blanket bog peats
- Upland peats
- Other: includes rendzinas, regosols, lithosols, skeletal soils, alluvial soils and some coastal soils such as shallow peat over sand.

All of the above relevé data, with the exception of the digital photographs, were added directly to the Turboveg database (one database was used to hold both site and relevé data) and subsequently downloaded to the Access database. All digital images were submitted on DVD with the ArcMap project.

2.4 Assessment of Annex I grassland

The conservation status of all mapped areas of Annex I grassland habitat within the six western counties surveyed in 2011-2012 was assessed. The methodology used was similar to that used by the NPWS for their survey of dune systems (Ryle *et al*. 2009) and grassland (Dwyer *et al.* 2007), with subsequent adjustments to criteria made over the course of the ISGS in previous years (Martin *et al.* 2007, 2008; O'Neill *et al*. 2009, 2010). *JNCC Common Standards Monitoring Guidelines* (JNCC 2004) were used as a guide to help evaluate the conservation status of the habitats in conjunction with the *Interpretation manual of European Union habitats* (Anon. 2007) and explanatory notes and guidelines for Article 17 assessment given by Evans and Arvela (2011). All relevés recorded during the entire course of the ISGS (2007 to 2012) were re-checked for correspondence to Annex I habitats, and all Annex I relevés identified were assessed using a unified set of assessment criteria that were finalised for the National Conservation Assessments (NCAs) of Annex I grassland habitats. These NCAs were completed in 2013 as part of Ireland's reporting commitments under Article 17 of the EU Habitats Directive (NPWS 2013). The assessment criteria used are described below for each of the Annex I grassland habitats recorded during the ISGS in 2011-2012.

For each habitat assessment, three parameters were scored: area, structure and functions, and future prospects. For a habitat at a site to receive an overall assessment of *Favourable*, the habitat had to be assessed as *Favourable* within each of the three assessment parameters (Table 2.1). Any deviation from stability, as indicated by a negative change in area, structure and functions (determined by defined criteria assessed at monitoring stops; see Appendices 5 and 6) or future prospects (determined by defined criteria assessed at the Annex I habitat level; see Appendices 7 and 8), implies a negative impact, and the assessment is affected accordingly.

Table 2.1 Summary matrix of the parameters and conditions required to assess the conservation status of habitats (modified from Ryle *et al*. (2009)).

	Favourable	Unfavourable -Inadequate	Unfavourable - Bad
Area	Stable	>0% - <1% decline/year	≥1% decline/year
Structure & Functions	Stable	1 – 25% monitoring stops decline/failure	>25% monitoring stops decline/failure
Future Prospects	Good (≥0)	Poor (<0 to -3)	Bad (<-3)
Overall	All green	Combination of green and / or amber	One or more red

Results of Annex I grassland assessments are in section 3.2 as follows:
Area assessment: p. 43; Structure and functions: p. 43 and Appendix 6; Future prospects: p. 44 and Appendix 8; Overall condition assessment: Appendix 9

Area assessment

Loss of extent was assessed by comparing the area of the Annex I grassland habitat mapped during the 2011-2012 surveys with the estimated extent of the habitat apparent in 2000 following interpretation of aerial photographs from 2000. This comparison was made using ArcMap. While small changes in area were difficult to detect, this was nonetheless regarded as the best approach for the baseline assessment in the absence of an established monitoring scheme. On a technical note, the 2005 aerial photographs have been utilised when producing base maps, with the 2011-2012 boundaries superimposed over them. There was therefore an unavoidable bias towards the 2005 extent, with small habitat changes (such as scrub encroachment of less than 400 m^2) that occurred between 2005 and 2011 or 2012 not being mapped. However, changes in extent greater than 400 m^2 were mapped and these changes were reflected in the overall final percentage area change (see results in section 3.2 below).

Structure and functions assessment

The information required for the structure and functions assessment was recorded at monitoring stops, as described in Ryle *et al.* (2009). Areas of Annex I grassland habitat measuring less than 400 m^2 were usually not assessed, unless the habitat was particularly rare and deficient in data either nationally or regionally, such as the Annex I habitat Hydrophilous tall herb fringe communities (6430). In cases where the area was only slightly larger than 400 m^2, only one or two monitoring stops were recorded to avoid stops being positioned adjacent to each other. Where the habitat area was large enough, a minimum of four monitoring stops were recorded, with an increasing number of stops

recorded with increasing area. Table 2.2 shows the scale used to determine the number of monitoring stops to record; this table was proposed in O'Neill *et al.* (2009) to ensure adequate coverage of the Annex I grassland habitat. At each monitoring stop a full relevé was also recorded, with the exception of soil data, which were generally only recorded from the first stop in each Annex I grassland habitat. Each series of monitoring stops was positioned to encompass the variation that existed within the habitat, but did not usually include seriously disturbed areas or areas with very high levels of encroachment. Structure and functions were assessed at each monitoring stop using a number of factors, namely: forb to graminoid ratio, high quality species, positive indicator species, negative indicator species, scrub and bracken encroachment, sward height, litter cover, extent of bare ground, and grazing and disturbance levels. Threshold values for each of these criteria differ for each of the Annex I grassland habitats assessed (Appendix 5). For the Annex I habitat to receive a *Favourable* assessment for structure and functions, a pass was generally required for all criteria within all monitoring stops; however, high quality sites which narrowly failed on only one or two criteria were re-examined and, using expert judgement, a decision was made on whether a *Favourable* assessment for structure and functions was warranted. Components of structure and functions that were found to vary seasonally, such as sward height, litter, bare ground or disturbance levels, were all considered in the context of the date that the area was surveyed.

Table 2.2 Monitoring stop scale for Annex I grassland habitats

Area (ha)	Number of monitoring stops
<0.04	0
0.04 - 0.25	2
>0.25 – 4	4
>4 – 8	6
>8 – 16	8
>16 – 32	10
>32 – 64	12
>64	14+

For each of the Annex I grassland habitats found within Ireland, the general approaches taken by Dwyer *et al.* (2007) and JNCC (2004) were adopted when compiling the structure and functions criteria. The *Interpretation Manual of European Union Habitats* (Anon. 2007) and White and Doyle (1982) were also consulted to produce working lists of positive indicator species for each Annex I grassland habitat. As the ISGS progressed from 2007 to 2012, the structure and functions criteria were revised based on the data collected in the field. Only native Irish plant species were considered for inclusion as positive indicator species. No woody species, such as *Calluna vulgaris* or *Dryas octopetala*, were considered as positive indicator species for the Annex I grassland habitats, as woody species are often indicative of a lack of management or of communities where succession is occurring. To assist surveyors in identifying each of the Annex I habitats, key species or habitat management were sometimes highlighted. For example, Lowland hay meadows (6510) will almost always be managed as a traditional hay meadow, at least in the recent past, and *Molinia* meadows (6410) will usually contain some *Molinia caerulea.* High quality indicator species that are indicative either of a particular Annex I habitat or of habitat quality were also chosen to assist in the identification

and assessment of Annex I grassland habitats. For the Annex I habitats [*]6210, 6410 and 6510, all orchid species were considered to indicate good habitat quality and were included as high quality indicator species.

The final structure and functions criteria for each Annex I habitat (Appendix 5) were applied *post hoc* to all assessment relevés recorded between 2007 and 2012. A summary of the process applied to produce the list of positive indicator species for each of the Annex I habitats is given below.

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

The list of positive indicator species (Table 2.3) includes the 10 species listed in Anon. (2007) that are native to Ireland; the orchid species listed in Anon. (2007) are not specifically listed in Table 2.3 as the presence of any orchid species within the Annex I habitat is a positive indicator. In addition, all the indicator species listed for [*]6210 by Dwyer *et al.* (2007) were considered for inclusion within the final list of positive indicator species.

Table 2.3 Positive indicator species used to assess the structure and functions of the Annex I habitat [*]6210. The three sources for the indicator species are listed; high quality indicators are denoted by an asterisk. Note that all orchid species recorded within this habitat are considered to be high quality indicator species. *Leontodon saxatilis* is only included as a positive indicator species when *Leontodon hispidus* is not present in the habitat.

Anon. (2007)	**Dwyer *et al.* (2007)**		**ISGS data (2007-12)**
*Anthyllis vulneraria**	*Antennaria dioica**	*Helictotrichon pubescens*	*Ctenidium molluscum*
Arabis hirsuta	*Asperula cynanchica**	*Homalothecium lutescens*	*Thymus polytrichus*
Brachypodium pinnatum	*Blackstonia perfoliata**	*Knautia arvensis**	
Bromopsis erecta	*Briza media**	*Koeleria macrantha**	
*Carex caryophyllea**	*Campanula rotundifolia**	*Linum catharticum**	
*Carlina vulgaris**	*Carex flacca*	*Lotus corniculatus*	
*Centaurea scabiosa**	*Daucus carota*	*Origanum vulgare*	
Leontodon hispidus/saxatilis	*Filipendula vulgaris**	*Pilosella officinarum*	
*Primula veris**	*Galium verum*	*Ranunculus bulbosus*	
*Sanguisorba minor**	*Gentiana verna**	*Sesleria albicans*	
	*Gentianella campestris/amarella**	*Trisetum flavescens*	
	*Geranium sanguineum**		

*species that are considered as high quality indicators

After comparing the list of positive indicator species proposed by Dwyer *et al.* (2007) with the ISGS (2007-2012) dataset, it was decided to remove *Conopodium majus* from the indicator species list due to its occurrence in calcareous, neutral and acidic habitats. *Thymus polytrichus* and *Ctenidium molluscum* were added to the list, as both are calcicole species that are frequently recorded in the [*]6210 habitat. Frequent forb species that are associated with agriculturally improved grassland, such as *Trifolium repens,* or slightly more mesotrophic grasslands, such as *Trifolium pratense* or *Plantago lanceolata,* were not considered for inclusion within the list of positive indicator species. With the exception of *Briza media,* none of the graminoid species that were frequently recorded within the [*]6210 dataset, such as *Anthoxanthum odoratum* and *Festuca rubra*, were considered to be

particularly indicative either of the [*]6210 habitat or of good structure and functions within this Annex I habitat. Finally, species that frequently occur within the [*]6210 habitat but are more characteristic of damper conditions, such as *Succisa pratensis*, or acidic conditions, such as *Potentilla erecta*, were also not included within the list of positive indicator species for this Annex I habitat.

The character species listed for the Festuco-Brometea class and Mesobromion alliance (White and Doyle 1982) were considered for addition to the list of positive indicator species but it was decided that the species listed in Table 2.3 already included the most suitable candidates listed in White and Doyle (1982).

If the [*]6210 grassland has a population of any orchid species other than the relatively common *Dactylorhiza fuchsii* and *Dactylorhiza maculata* it should be considered for the orchid-rich priority habitat *6210. The following uncommon orchid species have been recorded in this Annex I habitat during the ISGS, *Anacamptis pyramidalis, Coeloglossum viride, Dactylorhiza fuchsii v. okellyi, Epipactis palustris, Gymnadenia conopsea, Ophrys apifera, Orchis mascula, Orchis morio, Listera ovata, Neotinea maculata, Platanthera bifolia* and *Platanthera chlorantha.*

- Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe) (*6230)

The list of positive indicator species (Table 2.4) includes the nine species listed in Anon. (2007) that are native to Ireland and that are associated with the *6230 Annex I habitat in Ireland. The native Irish species *Carex pallescens, Carex panicea, Hypericum maculatum, Pedicularis sylvatica, Platanthera bifolia,* and *Polygala vulgaris*, which are also listed for the *6230 habitat in Anon. (2007), are either not strongly associated with the *6230 habitat in Ireland, or in the case of *Carex panicea* and *Pedicularis sylvatica,* are often associated with damper habitats or wetter flushes.

The most frequent plant species recorded in *6230 relevés during the National Survey of Upland Habitats (NSUH) (2009-2011), plus species from this dataset that are considered to be characteristic of the Annex I habitat, were also added to the list of positive indicator species (see Table 2.4). Mineral flushing is usually required to create a habitat that supports a more species-rich *6230 community that conforms to the Annex I habitat as described in the *Interpretation manual of EU habitats* (Anon. 2007). Both a calcareous (calcareous flushing) and a non-calcareous sub-community of *6230 have been identified in Ireland and indicative species for both of these communities were identified from the NSUH (2009-2012) dataset. Any frequent species that were associated with agriculturally improved grassland, such as *Trifolium repens,* were not considered for inclusion within the list of positive indicator species. It was decided to use the NSUH dataset to define the *6230 Annex I habitat, as much of the ISGS data were collected on the periphery of the range of the *6230 habitat.

Table 2.4 Positive indicator species used to assess the structure and functions of the Annex I habitat *6230. The two sources for the indicator species are listed; high quality indicators are denoted by the relevant superscript. *Luzula campestris* is only included as a positive indicator species when *Luzula multiflora* is not present in the community.

Anon. (2007)	**NSUH data (2009-12)**	
Antennaria dioica†	*Alchemilla glabra*†	*Linum catharticum*†
Festuca ovina	*Agrostis capillaris*	*Lotus corniculatus*†
Galium saxatile	*Anthoxanthum odoratum*	*Luzula multiflora/campestris*
Lathyrus linifolius††	*Breutelia chrysocoma*††	*Lysmachia nemorum*†
Nardus stricta	*Campanula rotundifolia*†	*Polygala serpyllifolia*
Pseudorchis albida††	*Carex binervis*	*Primula vulgaris*†
Potentilla erecta	*Carex caryophyllea*††	*Prunella vulgaris*†
Veronica officinalis	*Carex pilulifera*††	*Rhytidiadelphus loreus*
Viola canina††	*Conopodium majus*†	*Rhytidiadelphus squarrosus*
	Ctenidium molluscum†	*Thymus polytrichus*†
	Danthonia decumbens††	*Viola riviniana*††
	Hylocomium splendens	

†species that are considered as high quality indicators for the calcareous sub-community
††species that are considered as high quality indicators for the non-calcareous sub-community

The character species listed for the Nardetea class and the Nardo-Galion saxatilis alliance (White and Doyle 1982) were considered for addition to the list of positive indicator species and it was decided that the species listed in Table 2.4 already included the most suitable candidates listed in White and Doyle (1982).

- *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) (6410)

For this habitat, the positive indicator species used in the assessment (Table 2.5) include the 12 species listed in Anon. (2007) that are native to Ireland for which fen meadows are one of their main habitats. *Colchicum autumnale* and *Inula salicina* are both listed for the Annex I habitat 6410 in Anon. (2007), however neither was added to the list of positive indicator species for Ireland as both species are extremely rare within the State and have been observed at all of their current sites, none of which corresponds to the Annex I habitat 6410. *Sanguisorba officinalis* is also listed for the Annex I habitat in Anon. (2007), but during the ISGS survey it was found to have a greater affinity with 6510 than 6410 and was therefore not included in the list of positive indicator species for 6410. *Carex pallescens*, although native in Ireland, has very little affinity with the 6410 habitat in Ireland.

In addition, 14 of the most frequent forb, sedge and rush species recorded in 6410 relevés during the ISGS (2007-2012) were included in the list of positive indicator species (see Table 2.5). Any frequent forb species that were associated with agriculturally improved grassland, such as *Trifolium repens,* or slightly more mesotrophic grasslands, such as *Ranunculus acris*, or drier grasslands, such as *Plantago lanceolata*, were not considered for the list of positive indicator species. With the exception of *Molinia caerulea*, none of the individual graminoid species recorded frequently within the *Molinia* meadows dataset, such as *Anthoxanthum odoratum* and *Holcus lanatus*, was considered to be particularly indicative either of *Molinia* meadows or of good structure and functions within this Annex I habitat. Two rare forb species – *Carum verticillatum* and *Lathyrus palustris* – listed in Curtis and

McGough (1988) were added to the list of high quality indicator species for the habitat. These two species were rarely recorded in the 6410 Annex I habitat but are indicative of good structure and functions. It should be noted that these species are indicative of an Annex I habitat with high conservation value but they are not particularly characteristic of *Molinia* meadows.

Table 2.5 Positive indicator species used to assess the structure and functions of the Annex I habitat 6410. The three sources for the indicator species are listed; high quality indicators are denoted by an asterisk. Note that all orchid species recorded within this habitat are considered to be high quality indicator species.

Anon. (2007)	ISGS data (2007-12)	Curtis and McGough (1988)
*Cirsium dissectum**	*Achillea ptarmica*	*Carum verticillatum**
*Crepis paludosa**	*Carex echinata*	*Lathyrus palustris**
*Galium uliginosum**	*Carex flacca*	
*Juncus conglomeratus**	*Carex nigra*	
Lotus pedunculatus	*Carex panicea*	
Luzula multiflora	*Carex pulicaris**	
Molinia caerulea	*Carex viridula*	
*Ophioglossum vulgatum**	*Equisetum palustre*	
Potentilla anglica	*Filipendula ulmaria*	
Potentilla erecta	*Galium palustre*	
Viola palustris	*Juncus acutiflorus/articulatus*	
*Viola persicifolia**	*Mentha aquatica*	
	Ranunculus flammula	
	Succisa pratensis	

*species that are considered as high quality indicators

The character species listed for the alliances Junco conglomerati – Molinion and Juncion acutiflori (White and Doyle 1982) were considered for addition to the list of positive indicator species but it was decided that the species listed in Table 2.5 already included the most suitable candidates listed in White and Doyle (1982).

- Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels (6430)

Only the plant communities within this Annex I habitat that form tall herb edge communities along water courses, particularly unmanaged edges of slow-moving rivers and the margins of lakes, were recorded as part of this survey, and the typical species presented in Table 2.6 reflect this. The hydrophilous tall herb fringe community of montane to alpine levels has been surveyed and defined as part of the NSUH (Perrin *et al.* 2011, 2012). In the lowlands this Annex I habitat also occurs as a nitrophilous tall herb community of woodland borders, sometimes referred to as a saum community. This saum community would fall within the Glechoma hederaceae order which is listed under this habitat in the *Interpretation manual of EU habitats* (Anon. 2007). No data were collected from this saum community as part of the ISGS.

As the Annex I habitat 6430 is a tall herb community, only forbs were used as positive indicator species. For this habitat, the diagnostic species from Convolvuletalia sepium and diagnostic and differential species from Filipendulion listed in White and Doyle (1982) were included. *Phalaris*

arundinacea, a graminoid, was omitted from the list of indicators. The uncommon Irish species *Crepis paludosa*, which is listed for this habitat in Anon. (2007), was also included as a positive indicator species for this habitat, as was *Filipendula ulmaria*, which is listed in Anon (2007) and was also the most frequent forb species recorded in 6430 relevés during the ISGS (2007-2012). *Trollius europaeus* is listed in Anon. (2007) in the context of tall herb communities of montane to alpine levels; as *T. europaeus* sites in Ireland are often on the flooded margins of lakes it was retained in the list of indicator species presented in Table 2.6. *Epilobium hirsutum* and *Lythrum salicaria* are listed under Anon. (2007), but could also have been listed under White and Doyle (1982) in addition to being frequent forb species recorded in 6430 relevés. Sixteen common or indicative forb species recorded in 6430 relevés, or in a few cases tall herb communities that had an affinity with the Annex I habitat, during the ISGS were also included in the list of positive indicator species (see Table 2.6).

Table 2.6 Positive indicator species used to assess the structure and functions of the Annex I habitat 6430. The three sources for the indicator species are listed.

Anon. (2007)	**ISGS data (2007-12)**		**White and Doyle (1982)**
Crepis paludosa	*Alisma lanceolatum*	*Iris pseudacorus*	*Calystegia sepium*
Epilobium hirsutum	*Alisma plantago-aquatica*	*Lysimachia vulgaris*	*Epilobium parviflorum*
Filipendula ulmaria	*Angelica sylvestris*	*Mentha aquatica*	*Eupatorium cannabinum*
Lythrum salicaria	*Cicuta virosa*	*Myosotis scorpioides*	*Hypericum tetrapterum*
Trollius europaeus	*Epilobium palustre*	*Persicaria amphibia*	*Solanum dulcamara*
	Equisetum fluviatile	*Rumex hydrolapathum*	*Stachys palustris*
	Equisetum palustre	*Sium latifolium*	*Symphytum officinale*
	Galium palustre	*Valeriana officinalis*	

- Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*) (6510)

For this habitat, the positive indicator species used in the assessment (Table 2.7) include the nine species listed in Anon. (2007) that are native to Ireland and for which meadows are one of their main habitats. Added to this were four additional species from the list of positive indicator species for the NVC lowland meadow community MG4 *Alopecurus pratensis-Sanguisorba officinalis* (Rodwell 1992), a community that has a very high affinity with the Annex I habitat 6510 (JNCC 2004). Only native species that had been recorded from a Lowland hay meadow during the ISGS survey (2007-2012) were considered; of these species, those that are more indicative of another Annex I habitat, such as *Galium verum*, which is more indicative of [*]6210, were discounted.

In addition, 10 of the most frequent forb species recorded in Annex I Lowland hay meadow relevés during the ISGS survey were included in the list of positive indicator species (see Table 2.7). Any frequent forb species that were associated with agriculturally improved grassland, such as *Trifolium repens* and *Cerastium fontanum*, were not considered for inclusion within the list of positive indicator species. None of the individual graminoid species recorded frequently within the Lowland hay meadows dataset, such as *Festuca rubra, Anthoxanthum odoratum* and *Holcus lanatus*, were considered to be particularly indicative either of Lowland hay meadows or of good structure and functions within this Annex I habitat. However, two rare meadow grass species that are listed in Curtis and McGough (1988) – *Hordeum secalinum* and *Bromus racemosus* – were added to the list of

high quality indicator species for the habitat. Both of these species were rarely recorded in Lowland hay meadow (*Hordeum secalinum* from four relevés and *Bromus racemosus* from two relevés), but they are indicative of a Lowland hay meadow with enhanced conservation value.

Table 2.7 Positive indicator species used to assess the structure and functions of the Annex I habitat 6510. The four sources for the indicator species are listed; high quality indicators are denoted by an asterisk. Note that all orchid species recorded within this habitat are considered to be high quality indicator species.

Anon. (2007)	JNCC (2004)	ISGS data (2007-12)	Curtis and McGough (1988)
Alopecurus pratensis	*Centaurea nigra*	*Crepis capillaris*	*Bromus racemosus**
Daucus carota	*Filipendula ulmaria*	*Heracleum sphondylium*	*Hordeum secalinum**
*Knautia arvensis**	*Lotus corniculatus**	*Hypochaeris radicata*	
Leontodon hispidus	*Rhinanthus minor**	*Lathyrus pratensis*	
*Leucanthemum vulgare**		*Leontodon autumnalis*	
*Pimpinella major**		*Plantago lanceolata*	
*Sanguisorba officinalis**		*Prunella vulgaris*	
*Tragopogon pratensis**		*Ranunculus acris*	
Trisetum flavescens		*Trifolium pratense*	
		Vicia cracca	

*species that are considered as high quality indicators

The character and diagnostic species listed for Arrhenatherion elatioris (White and Doyle 1982) were considered for addition to the list of positive indicator species but it was decided that the species listed in Table 2.7 already included the most suitable candidates listed in White and Doyle (1982). Grass species such as *Arrhenatherum elatius* and *Dactylis glomerata* were not considered as suitable candidates as they are both negative indicators for lowland meadows when their cover is high (JNCC 2004).

Future prospects assessment

The future prospects assessment relates to the likely development and maintenance of the Annex I grassland habitat in favourable condition for the foreseeable future. In order to assess this likelihood, pressures, threats and activities (including management) were recorded for each area of Annex I grassland habitat surveyed using the EU-devised list of impact codes (Ssymank, 2010; Appendix 7). Following Ssymank (2010) and recommendations made in Ellmauer (2010), the intensity of each impact at each site was assessed and given a score ranging from 0.5 to 1.5 (Table 2.8), corresponding to the EU criteria of low, medium and high impact/importance. Negative pressures were assigned a negative value, positive management/impacts were assigned a positive value and a score of zero indicated a neutral impact, balanced in terms of its positive and negative effects. The percentage of the Annex I habitat affected by the impact was also recorded, along with its source, i.e., whether it originated inside or outside the Annex I habitat. The percentage of the Annex I habitat affected was scored from 0.5 to 3 to correspond with the ranges <1% to 100% (Table 2.8). The source criterion was not scored (unlike in O'Neill *et al.* 2010) as this was not deemed to be a key issue when assessing the severity of the impact. As the data collected here are baseline data, trends of impact intensity could not be determined. When assessments are repeated in future years, it will

be possible to record whether a particular impact is increasing, decreasing or stable in trend by comparing with assessment data from previous years.

By multiplying together the scores of intensity, area and source and then combining the result with the negative, positive or neutral effect of each (i.e., by multiplying the score by -1, +1 or 0 respectively), a final score for each impact was produced. (Thus a neutral impact would always receive a score of 0 by this scheme.) For an Annex I habitat that was subject to multiple impacts on a site, the final scores were summed to gain an overall future prospect score for the habitat. Areas of Annex I grassland habitat that scored ≥0 were determined to have *Favourable* future prospects, while those scoring between <0 and -3 were *Unfavourable – Inadequate* and <-3 *Unfavourable – Bad*, as shown in Table 2.1. Furthering this quantitative analysis of future prospects, each site containing an Annex I grassland habitat was examined by a surveyor who took part in the field assessment to determine whether these scores were a true reflection of the future prospects of the habitat.

Table 2.8 Scoring system used to calculate future prospects scores for Annex I grassland habitats assessed in the six western counties surveyed in 2011-2012

Impact	Value	Score
% Area of Annex I habitat impacted	<1%	0.5
	1-25%	1
	26-50%	1.5
	51-75%	2
	76-99%	2.5
	100%	3
Intensity of impact	High	1.5
	Medium	1
	Low	0.5

All results for the assessment of Annex I grassland habitats (under the parameters area, structure and functions, future prospects) are in section 3.2. All assessment data were input into the Access database.

Structure and functions results for individual monitoring stops are in Appendix 6
Future prospects results for each assessed area of Annex I grassland are in Appendix 8
Condition assessment results for each assessed area of Annex I grassland are in Appendix 9

Primary areas of Annex I habitat

It was proposed in Martin *et al.* (2008) that a list of premium quality sites containing Annex I grassland habitats above a minimum size and of adequate structure and functions (according to field assessments) should be produced. Hereafter referred to as ***primary areas*** of Annex I grassland, these represent the best examples of Annex I grassland habitat recorded during the ISGS and are judged to be of primary importance due to a combination of the area they cover and their structure and functions. They should provide a focus for monitoring and conservation efforts in the future. A

list of primary areas of Annex I grassland habitat surveyed in Clare, Galway, Limerick, Kerry, Mayo and Tipperary in 2011-2012 was compiled. Criteria for primary areas of Annex I grassland habitat include: an extent of at least 1 ha; structure and functions should generally be *Favourable*; however, assessed areas with stops which failed but were considered to be near misses (e.g., only one positive indicator species off a pass, or within 10% of the required forb:graminoid ratio) were sometimes included if the condition of the habitat was otherwise good. Future prospects and past changes in extent were not taken into account when compiling this list of sites.

2.5 Ranking of sites using conservation and threat evaluations

Conservation of habitats is often best achieved on a site-by-site basis, with specific management plans based on the individual characteristics of a given habitat at a particular site (e.g., management, history, rarity). However, it is also useful to be able to evaluate sites in the context of others, and to make general comparisons regarding status. A broad range of sites was surveyed in the ISGS, with varying degrees of naturalness. As part of the survey methodology, data were collected which allowed the general condition of the site to be evaluated, with regard in particular to its conservation value and the presence of threats to the grassland. Factors which contribute to the conservation value of a site include its size, habitat diversity and quality, species richness and the presence of plant species of conservation interest, and factors such as these have been used when evaluating sites for conservation in the UK (Usher, 1989). By assigning a conservation score to each site, the sites can be compared and those which are of particularly high conservation value can be identified. This allows management efforts to focus on sites which are most valuable from a conservation point of view, and also provides a basis for monitoring individual sites into the future. Human activities such as agriculture, recreation and development can pose threats to semi-natural grassland habitats, as can the abandonment of traditionally managed land.

Conservation status was scored on the basis of seven criteria (Table 2.9). Semi-natural grassland habitats were scored on the basis of mapped surveyed areas in the site. Primary and secondary Annex I grassland habitats were identified as outlined above in section 2.4. Adjacent and internal semi-natural habitats evaluate the site in terms of its landscape context; because internal semi-natural grassland and marsh habitats were already scored under the semi-natural grassland habitats criterion, these were only scored here if they were recorded as present but not mapped (i.e., below the minimum mapping area). A modified figure for species density was derived, to remove the bias towards larger sites, by dividing the number of non-woody species present by the $\log_{10}(\text{area}+1)$, with area measured in hectares. Notable species include those listed on the Flora (Protection) Order 1999 (FPO) and in the vascular plant species Red Data Book of Curtis and McGough (1988), excluding those with an IUCN category of 'nt' (not threatened); species that occur in both lists were only scored once, as an FPO species. For the purposes of the conservation score calculation, high quality indicator species included <u>all</u> indicator species – both high quality and non-high quality – listed for the four main Annex I grassland habitats ([*]6210, *6230, 6410 and 6510), as well as an additional four marsh species (*Caltha palustris, Hydrocotyle vulgaris, Lychnis flos-cuculi* and *Potentilla palustris*) and one dry grassland taxon (*Euphrasia* spp.) listed as indicators of species-rich grassland in QUB (2008).

The final score for each site is given as a percentage of the total possible score of 47.5. The results for the 25 highest scoring sites surveyed in the six western counties in 2011-2012 are given in section 3.3, and the full list of conservation scores for the 2011-2012 western sites is given in Appendix 10.

Table 2.9 Criteria used in the calculation of the conservation score for each site.

Criterion	Scoring		Max. score
Semi-natural grassland habitats	1 for each semi-natural grassland habitat 0.5 for each semi-improved grassland habitat where the corresponding semi-natural grassland habitat is not present		5
Annex I grassland habitats	Annex I grassland habitats are divided into primary and secondary areas on the basis of quality (see section 2.4 & 3.2)		12
	2 One secondary Annex I grassland habitat	4 One primary Annex I grassland habitat	
	4 Two or more secondary Annex I grassland habitats	8 Two or more primary Annex I grassland habitats	
Adjacent and internal semi-natural habitats	0.5 for each of the following habitat groups recorded during the survey:		2.5
	F (Freshwater)	GS/GM (Semi-natural grassland, marsh)	
	H/P (Heath [excl. bracken], bog, fen)	WN/WS/WL (Woodland, scrub)	
	ER/EU/C/L/M (Exposed rock, coastal [excl. coastal constructions], littoral/marine habitats)		
Area	Sites are divided into eight 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 the 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 ≥ 160 ha	
Species density	Modified species density = number of non-woody species divided by $\log_{10}$ (area +1) of the site. The resulting figures were then divided according to percentiles as shown.		4
	0 < 25 spp./ha	2 57 – 71.9 spp./ha	
	1 25 – 56.9 spp./ha	3 72 – 96.9 spp./ha	
		4 ≥ 97 spp./ha	
Notable species	Notable species include those listed on the Flora (Protection) Order 1999 (FPO) and the Red Data Book (RDB) (Curtis and 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	
High quality indicator species	High quality indicator species were identified as described in section 2.5. Sites were scored on the number of high quality (HQ) indicator species recorded as shown.		4
	0 1-10 HQ species	2 16-20 HQ species	
	1 11-15 HQ species	3 21-25 HQ species	
		4 >25 HQ species	
Maximum total score			**47.5**

The assessment of threats to each site was based on the criteria detailed in Table 2.10. Damaging activities consisted mainly of drainage, dumping, quarries and recent afforestation in the vicinity of grassland sites. Agricultural improvement primarily included fertiliser application, liming, topping and supplementary feeding. The negative adjacent habitats of improved grassland and cultivated land follow the definitions of Fossitt (2000). The presence of certain negative species indicating habitat disturbance or sward improvement were used as a further measure of the extent to which sites were under threat. Fourteen species were used for this assessment: *Brassica napus, Brassica rapa, Capsella bursa-pastoris, Chenopodium album, Cirsium arvense, Lolium perenne, Matricaria discoidea, Plantago major, Poa annua, Polygonum aviculare, Rumex crispus, Senecio jacobaea, Stellaria media* and *Trifolium repens*. The final score for each site is given as a percentage of the total possible score of 13. The results for the 16 highest scoring sites surveyed in the six western counties in 2011-2012 are given in section 3.3, and the full list of threat scores for the 2011-2012 western sites is given in Appendix 11.

Table 2.10 Criteria used in the calculation of the threat score for each site.

Criterion	Scoring						Max. score
Negative adjacent habitats	0	No negative adjacent habitats					2
	1	Improved grassland (GA) or cultivated land (BC) adjacent					
	2	Improved grassland (GA) and cultivated land (BC) adjacent					
Damaging activities*	0	No damaging activities	1	One damaging activity			3
	2	Two damaging activities	3	Three or more damaging activities			
Agricultural Improvement*	0	No improvements	1	One improvement type			3
	2	Two improvement types	3	Three or more improvement types			
Negative species**	1	1-3 species	2	4-6 species	3	7-9 species	5
	4	10-12 species	5	13-14 species			
Maximum total score							**13**

* See section 2.5 for description of criteria.
** See section 2.5 for list of species scored.

Conservation and threat scores were entered separately into the Access database and were *not* combined to produce one overall score. Combining 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. Therefore threats were scored separately from conservation value so that sites with a high conservation score which are threatened could be identified. The scores are written as percentages of the total possible score. This allows a simple comparison to be made between sites, even if data were not available in all of the categories shown in Tables 2.9 and 2.10.

Conservation and threat score results are summarised in section 3.3
Full details in Appendices 10 and 11.

2.6 Vegetation data analysis

Analysis to produce a working classification of grassland and marsh for Ireland is presented in a separate report, O'Neill *et al*. (2013), which combines relevés from all 26 counties surveyed during the entire course of the ISGS, from 2007 to 2012.

3: RESULTS

3.1 General site survey

During the Irish Survey of Semi-natural Grasslands (ISGS) from April 2011 to September 2012, 4596.0 ha of grassland and marsh were surveyed: 1067.4 ha in Clare, 836.0 ha in Galway, 576.2 ha in Kerry, 398.0 ha in Limerick, 1454.3 ha in Mayo and 264.0 ha in Tipperary. An additional 10.8 ha of fen habitat (PF1 and PF2 in Fossitt (2000)) corresponding to Annex I habitat *Molinia* meadows (6410), and swamp vegetation (FS and FS2 in Fossitt (2000)) were also surveyed and included within site areas. This section of the results summarises the distribution of grassland and marsh habitats (GS and GM under Fossitt (2000)). The location of each site is shown in Appendix 1. In total, 337 sites were surveyed: 63 (18.7%) in Clare, 91 (27.0%) in Galway, 32 (9.5%) in Kerry, 15 (4.5%) in Limerick, 115 in Mayo (34.1%), and 21 in Tipperary (6.2%). The median site area across the six counties was 9.9 ha (the mean site area of 13.7 ha is skewed by a small number of exceptionally large sites), with sites ranging in size from 0.3 ha to 103.0 ha. The median site areas for the six counties showed some variability, with Galway sites having the smallest median size (5.9 ha) and Limerick by far the highest (21.6 ha).

An additional 58 sites were visited but rejected from the survey. This is equal to 14.7% of the 395 sites which were visited. The reasons for rejecting sites fell into five broad categories: strong evidence of improvement for agricultural or amenity use; difficulty in obtaining permission to access a site; dominance of non-grassland habitats; development; and forestry. Some sites were rejected for more than one reason. Table 3.1 indicates the number of sites which were rejected within each of the different categories.

Table 3.1 The number of sites that were rejected and the reasons for rejection. Fifty-eight sites were rejected but there are 74 reasons for rejection as many sites were rejected for more than one reason.

Reason for rejection	Number of sites
Agricultural improvement	35
Access difficulty	22
Non-grassland habitat	13
Development	2
Forestry	2
Number of sites rejected	*58*

The most frequently cited reasons for rejecting sites were agricultural improvement and access difficulty. Agricultural improvement was often recorded as the reason for rejecting a site when improved grassland for agricultural or amenity use was common on a site. Difficulty in obtaining access to a site was generally due to the refusal of permission by the owner, or difficulty in making contact with the owner. In a few instances access was prevented due to the location of the site on an island. For reasons of personal safety, land was not entered if certain livestock (e.g. a bull) were present, and a landowner would sometimes refuse permission due to potentially dangerous livestock.

The non-grassland habitats encountered most frequently included heath, swamp, fen and sand dune systems.

Grassland habitats

A detailed habitat map has been produced for each site showing the Fossitt (2000) and Annex I grassland habitats, the position of all relevés and the location of any associated pNHAs, NHAs and SACs. Table 3.2 shows the area in hectares covered by the different grassland habitats surveyed in 2011-2012 (defined according to Fossitt (2000)), together with the percentage by area and percentage by frequency of the habitats within each of the six counties.

Table 3.2 Summary habitat statistics of sites surveyed in Clare, Galway, Kerry, Limerick, Mayo and Tipperary in 2011-2012. Percentage frequency only includes sites where there was a mapped area of the Fossitt habitat.

		GS1	GS2	GS3	GS4	GM1	GA1	*Overall*
Clare	Area (ha)*	301.7	50.9	3.3	502.3	4.4	204.9	*1067.4*
	% survey area	28.3	4.8	0.3	47.1	0.4	19.2	
	% freq	57.1	22.2	1.6	63.5	4.8	58.7	
	No. of sites	36	14	1	40	3	37	*63*
Galway	Area (ha)*	305.5	21.5	39.1	396.6	2.5	70.6	*836.0*
	% survey area	36.5	2.6	4.7	47.4	0.3	8.5	
	% freq	68.1	13.2	12.1	57.1	1.1	44.0	
	No. of sites	62	12	11	52	1	40	*91*
Kerry	Area (ha)*	89.7	4.6	121.5	297.4	0.3	62.7	*576.2*
	% survey area	15.6	0.8	21.1	51.6	0.1	10.9	
	% freq	34.4	6.3	31.3	81.3	3.1	62.5	
	No. of sites	11	2	10	26	1	20	*32*
Limerick	Area (ha)*	17.8	26.2	103.0	198.5	1.1	51.5	*398.0*
	% survey area	4.5	6.6	25.9	49.9	0.3	12.9	
	% freq	26.7	20.0	6.7	80.0	6.7	80.0	
	No. of sites	4	3	1	12	1	12	*15*
Mayo	Area (ha)*	248.6	90.7	135.0	734.4	2.2	243.5	*1454.3*
	% survey area	17.1	6.2	9.3	50.5	0.1	16.7	
	% freq	55.7	22.6	33.9	82.6	3.5	57.4	
	No. of sites	64	26	39	95	4	66	*115*
Tipperary	Area (ha)*	20.4	9.4	62.8	141.7	0.2	29.5	*264.0*
	% survey area	7.7	3.5	23.8	53.7	0.1	11.2	
	% freq	42.9	14.3	23.8	71.4	4.8	33.3	
	No. of sites	9	3	5	15	1	7	*21*
Overall	*Area (ha)**	*983.7*	*203.2*	*464.7*	*2271.0*	*10.7*	*662.7*	*4596.0*
	% survey area	*21.4*	*4.4*	*10.1*	*49.4*	*0.2*	*14.4*	
	% freq	*55.2*	*17.8*	*19.9*	*71.2*	*3.3*	*54.0*	
	No. of sites	*186*	*60*	*67*	*240*	*11*	*182*	*337*

* Components may not sum to totals because of rounding

GS4 (wet grassland) was the most extensive of the semi-natural grassland habitats recorded in the survey, accounting for 49.4% of all grassland surveyed across the six counties. This was followed in order of decreasing extent by GS1 (dry calcareous and neutral grassland) at 21.4%, GS3 (dry-humid acid grassland) at 10.1%, GS2 (dry meadows and grassy verges) at 4.4% and GM1 (marsh) at less than 1%.

The percentage area of GS4 surveyed within each of the six counties was consistent at approximately 50% of the survey area. For GM1 the area was also similar across all counties at <1%. For the other three semi-natural grassland habitats the percentage of the surveyed areas varied across the counties depending on factors such as the predominant soil types, geography and management regimes. The surveyed area of GS1 was highest in Galway and Clare, both in terms of the percentage of the area surveyed and frequency within sites. This is due to the extensive areas of calcareous rock within these counties. GS3 was proportionately higher in counties with extensive areas of acidic rock in combination with upland areas, such as Kerry and Tipperary. Limerick also had a high proportion of GS3 as a percentage of the area surveyed, but this was due to just one large site of 103 ha in the Galtee Mountains. The frequency and area of GS2 within a county is often dependent on management; Limerick had proportionately the largest area of GS2, while Mayo had the highest frequency per site. Kerry had the lowest proportion of GS2 area and the lowest frequency per site for this habitat.

Areas of GA1 (improved agricultural grassland) which had a sufficient quantity of semi-natural grassland species to be of interest to the survey were included within the GSi (semi-improved grassland) category used throughout this survey but mapped within sites as GA1. Of the area of grassland surveyed in each county, the proportion of semi-improved grassland (GA1) was relatively consistent across the six counties, with Clare having the highest proportion, at 19.2% of the surveyed area, and Galway the lowest at 8.5%.

For details of grassland habitats for individual sites, see Appendix 4

NPWS conservation sites

A total of 208 sites were found to overlap with a NPWS conservation site. For Table 3.3 all surveyed areas of GS, GM, FS2 (plus FS) and Annex I grassland (including some small areas of fen) that intersected with a NPWS conservation site were investigated. Any grassland site with an overlap of less than the minimum mapping area (400 m^2) was removed from the analysis. All overlaps above the minimum mapping area were reported. The 208 ISGS sites that overlap with a NPWS conservation site represent 61.7% of the sites surveyed across the six counties. It should be noted that many of the 208 sites overlap with more than one type of NPWS conservation site.

Table 3.3 shows that 170 sites (50.4% of sites surveyed) overlap with an SAC, representing 34.4% of the area of surveyed grassland in the six counties. As would be expected, the figures are lower for SPAs, at 66 sites and 17.2% of the surveyed area, as these are designated for bird species rather than habitats. Of the six counties, Kerry had the greatest proportion of surveyed grassland within SACs, SPAs and NHA/pNHAs, at 65.4%, 33.0% and 56.0% respectively. Mayo had the lowest proportion of surveyed grassland within SACs at 25.8%, and Tipperary had the lowest proportion of surveyed grassland within SPAs and NHA/pNHAs, at 4.7% and 17.2% respectively.

Table 3.3 Occurrence of NPWS conservation sites (pNHA/NHA, SAC and SPA) within the survey. Areas presented below are based on the *total* surveyed area (GS, GM, FS and PF) within each county.

		NHA/pNHA	SAC	SPA
Clare	No. of sites	39	36	7
	% of sites	61.9	57.1	11.1
	Area (ha)	360.5	298.7	163.7
	% survey area	33.6	27.8	15.2
Galway	No. of sites	39	42	19
	% of sites	42.9	46.2	20.9
	Area (ha)	292.8	329.1	263.9
	% survey area	35.0	39.3	31.5
Kerry	No. of sites	16	21	14
	% of sites	50.0	65.6	43.8
	Area (ha)	323.5	377.6	190.4
	% survey area	56.0	65.4	33.0
Limerick	No. of sites	4	6	4
	% of sites	26.7	40.0	26.7
	Area (ha)	110.4	130.0	64.6
	% survey area	27.7	32.7	16.2
Mayo	No. of sites	52	58	19
	% of sites	45.2	50.4	16.5
	Area (ha)	380.2	376.3	95.7
	% survey area	26.1	25.8	6.6
Tipperary	No. of sites	7	7	3
	% of sites	33.3	33.3	14.3
	Area (ha)	45.5	74.7	12.4
	% survey area	17.2	28.3	4.7
Overall	*No. of sites*	157	170	66
	% of sites	46.6	50.4	19.6
	*Area (ha)**	1512.8	1586.4	790.7
	% survey area	32.8	34.4	17.2

* Components may not sum to totals because of rounding

The occurrence of semi-natural grassland habitats within SACs, SPAs and NHA/pNHAs followed slightly different patterns from the distribution of the habitats across the six counties. GS4 and GS1, the two most common grassland habitats within the survey area, had the largest areas within SACs, SPAs and NHA/pNHAs. However, a larger area of GS3 was recorded in both SACs and NHA/pNHAs than semi-improved grassland (mapped as GA1), even though GA1 had a larger total area surveyed across the six counties. GA1 was more common than GS3 in SPAs, which are designated for bird species rather than habitats. It should be noted that GS1 and GS3 were more common within SACs, 44.8% and 60.3% respectively, than GS4, at 30.5%, relative to the total area surveyed for each of the habitats across the six counties. This pattern is repeated within NHA/pNHAs. GM1, although an uncommon habitat within the surveyed area, was almost always found within a NPWS conservation site and 74.8% of the total area of this habitat surveyed within the six counties was found within SACs.

Among the six counties, the areas of the different grassland habitats within NPWS conservation sites (Table 3.4) tended to follow similar trends to those discussed above for Table 3.2, with Clare having a

large area of GS1 within SACs and NHA/pNHAs and Kerry having a large area of GS3 within SACs and NHAs/pNHAs. Limerick had a very low percentage of GS4 within SACs and NHA/pNHAs, 5.9% and <1% respectively, relative to the total area of GS4 surveyed within the county. This anomaly can partly be explained by the small number of NPWS conservation sites surveyed within Limerick and the dominance of dry grassland habitats surveyed within sites such as Barrigone (SAC 000432) and the Galtee Mountains (SAC 000646).

Table 3.4 Area in hectares of different grassland habitats surveyed within NPWS conservation sites.

County	Designation	GS1	GS2	GS3	GS4	GM1	GA1
Clare	NHA/pNHA	154.1	16.0	0.0	127.2	2.1	54.2
	SAC	159.0	17.1	0.0	85.6	2.1	34.8
	SPA	2.7	0.0	2.5	135.3	0.0	23.2
Galway	NHA/pNHA	46.0	2.6	15.6	207.4	2.5	17.6
	SAC	96.9	2.6	14.7	194.0	2.5	17.3
	SPA	23.1	0.0	2.6	219.0	2.5	16.7
Kerry	NHA/pNHA	32.5	3.8	98.1	162.9	0.3	24.9
	SAC	62.6	3.8	98.6	184.1	0.3	27.4
	SPA	83.7	3.8	16.2	70.5	0.3	15.9
Limerick	NHA/pNHA	8.7	4.1	96.7	0.9	0.0	0.03
	SAC	8.8	5.5	96.4	11.7	1.1	6.4
	SPA	0.0	2.4	0.0	59.0	0.0	3.2
Mayo	NHA/pNHA	128.6	45.8	44.3	116.2	2.0	42.4
	SAC	109.7	14.8	35.5	186.8	2.0	26.4
	SPA	21.0	2.2	29.5	28.8	1.2	12.1
Tipperary	NHA/pNHA	4.0	0.0	34.3	6.9	0.2	0.0
	SAC	3.8	0.3	35.2	30.9	0.0	4.4
	SPA	7.6	0.0	0.2	4.5	0.1	0.0
*Total**	*NHA/pNHA*	*374.0*	*72.4*	*289.0*	*621.4*	*7.2*	*139.2*
	SAC	*440.8*	*44.3*	*280.4*	*693.2*	*8.0*	*116.7*
	SPA	*138.2*	*8.4*	*50.9*	*517.1*	*4.2*	*71.1*

* Components may not sum to totals because of rounding

Annex I grassland habitats

The area of land covered by Annex I grassland habitats in counties Clare, Galway, Kerry, Limerick, Mayo and Tipperary is shown in Table 3.5, together with the number of areas of each recorded. In total, 421.1 ha of Annex I grassland habitat were recorded from 134 areas during the survey, which equates to 9.1% of the total area surveyed. The greatest amount of this occurred in Clare, where 157.4 ha were mapped as Annex I grassland habitat, representing 14.6% of the total area of grassland surveyed in that county. In Galway, 95.7 ha of the total area surveyed were mapped as an Annex I grassland habitat (11.4% of the grassland surveyed in the county), while Limerick proportionately had the highest amount of Annex I grassland across the six counties at 16.8% (66.9 ha of the grassland surveyed in the county). For counties Kerry, Mayo and Tipperary, less than 10% of the surveyed area was Annex I grassland, at 6.3%, 3.8% and 3.2% respectively.

Table 3.5 Area in hectares (number of areas) of Annex I grassland habitats recorded in Clare, Galway, Kerry, Limerick, Mayo and Tipperary.

County	Festuco-Brometalia [*]6210	*Nardus* grassland *6230	*Molinia* meadows 6410	Hydrophilous tall herb communities 6430	Lowland hay meadows 6510	Total area (no. of areas) ††	No. of sites†
Clare	107.9 (18)	0.0 (0)	37.5 (10)	1.6 (2)	10.3 (4)	157.4 (34)	32
Galway	78.9 (25)	3.2 (4)	11.0 (7)	2.5 (1)	0.0 (0)	95.7 (37)	34
Kerry	0.0 (0)	28.3 (4)	8.1 (1)	0.3 (1)	0.0 (0)	36.6 (6)	6
Limerick	16.9 (3)	0.0 (0)	40.5 (3)	1.1 (1)	8.4 (2)	66.9 (9)	6
Mayo	17.5 (10)	14.1 (10)	11.0 (9)	0.2 (1)	13.2 (6)	55.9 (36)	33
Tipperary	1.4 (4)	1.3 (3)	2.4 (3)	0.1 (1)	3.3 (1)	8.5 (12)	10
Total ††	222.5 (60)	46.8 (21)	110.6 (33)	5.9 (7)	35.3 (13)	421.1 (134)	121

† Two or more Annex I grassland habitats found in 13 sites
†† Components may not sum to totals due to rounding

The Annex I grassland habitat with the greatest cover was Festuco-Brometalia ([*]6210), with 222.5 ha in total. This habitat was also recorded across the most sites, at 17.8% (60 sites) of the 337 sites surveyed across the six counties. This is largely due to the many areas of [*]6210 habitat in Clare and Galway, where 84.0% of the area of this Annex I habitat was recorded and assessed. This is followed by *Molinia* meadows (6410) with a total cover of 110.6 ha; 70.5% of this Annex I grassland was recorded across two counties, Limerick and Clare. The other Annex I grassland habitats covered less area and were found at fewer sites: 46.8 ha of *Nardus* grassland (*6230) were recorded, with the habitat not found in either Clare or Limerick, and 35.3 ha of Lowland hay meadow (6510) were recorded, with the survey not finding the habitat in either Galway or Kerry. Although Hydrophilous tall herb fringe communities (6430) were recorded in all six counties, only a few small areas were found, with a total of only 5.9 ha mapped.

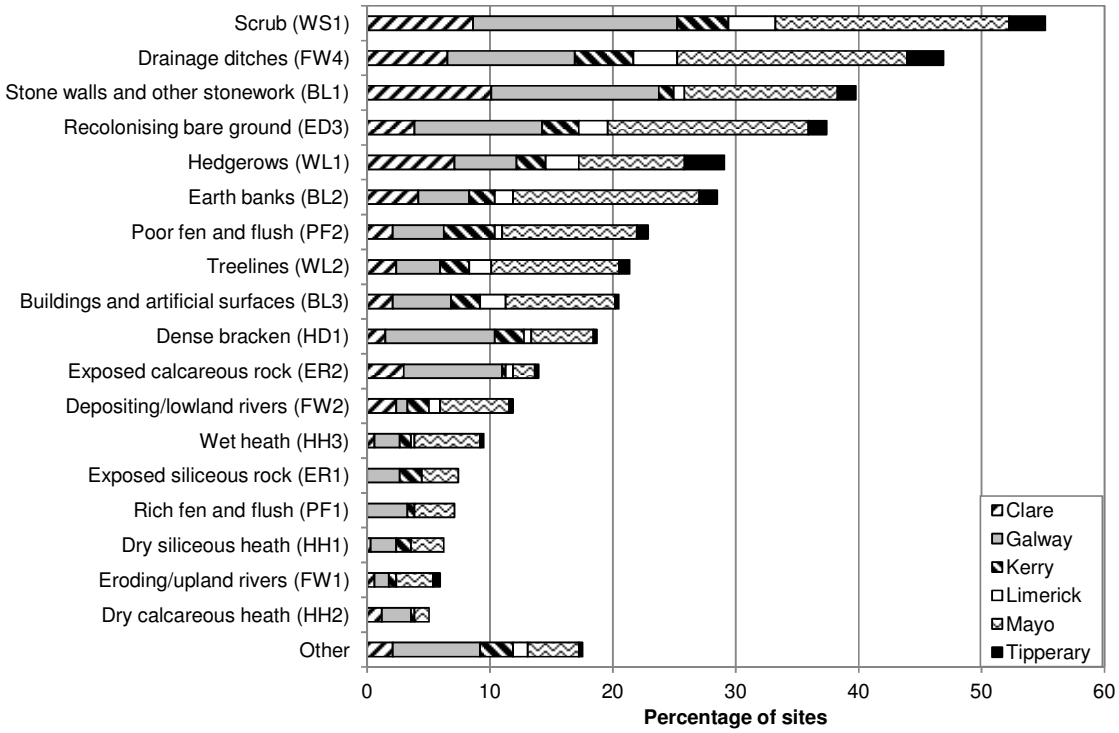
A total of 134 areas of Annex I grassland habitat were recorded across the six counties in 2011-2012. These 134 areas of Annex I grassland habitat occurred at 121 surveyed sites, or 35.9% of all sites surveyed. Of these, 34 were in Galway (37.4% of Galway sites), 33 sites were in Mayo (28.7% of sites in Mayo), 32 were in Clare (50.8% of sites in Clare), 10 in Tipperary (47.6% of sites in Tipperary), and six each in Limerick (40% of sites in Limerick) and Kerry (18.8% of sites in Kerry).

Internal habitats

Non-grassland internal habitats recorded during the 2011 and 2012 surveys of Clare, Galway, Kerry, Limerick, Mayo and Tipperary are shown in Fig. 3.1. Scrub was present at 55.2% of sites and was the most frequently occurring non-grassland internal habitat at sites across Galway, Limerick and Mayo. Overall, drainage ditches were the next most frequent internal habitat, occurring at 46.9% of sites, followed by stone walls and other stonework (39.8% of sites), recolonising bare ground (37.4% of sites) and hedgerows (29.1% of sites). Drainage ditches were the most frequently occurring non-grassland internal habitat across sites in Kerry, while stone walls and other stonework, and hedgerows were the most frequently occurring non-grassland internal habitats across sites in Clare and Tipperary respectively. The “Other” category includes habitats which occurred at less than 5% of

sites in the survey, including swamp (reed and tall herb), spoil and bare ground, improved agricultural grassland, exposed sand, gravel or till, and siliceous scree and loose rock.

Figure 3.1 Frequency of non-grassland Fossitt (2000) habitats within all surveyed sites, differentiated by county.

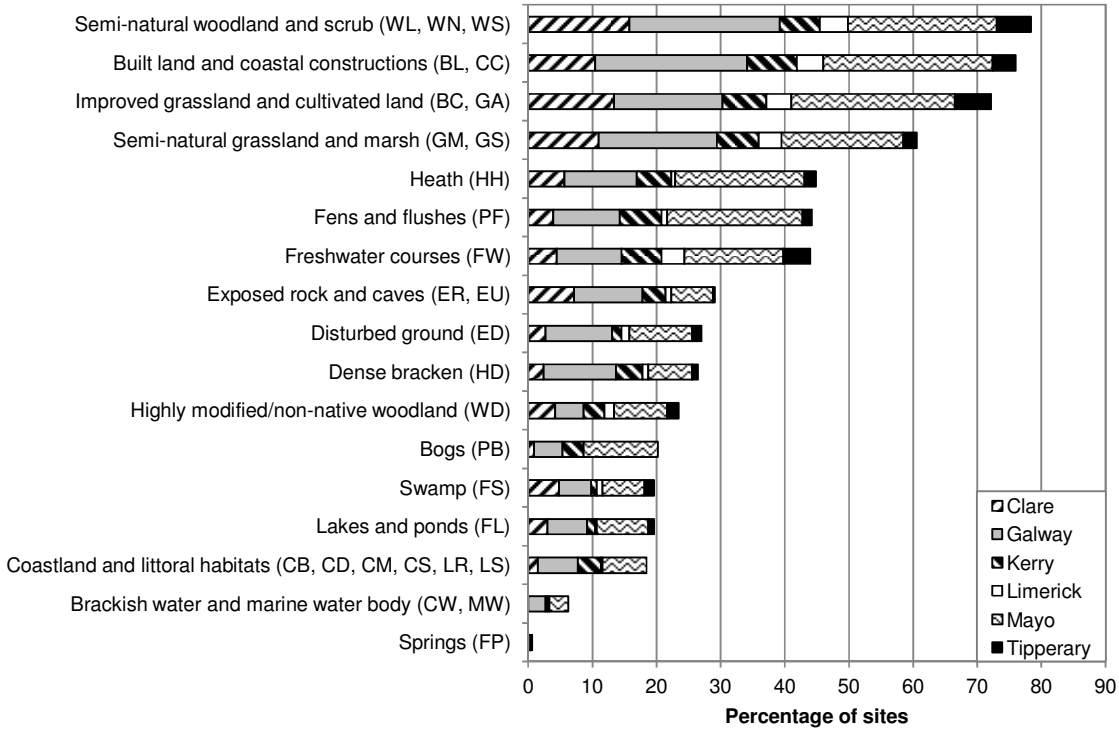


Adjacent habitats

Frequency of habitats which occurred adjacent to sites is shown in Fig. 3.2. Semi-natural woodland and scrub together formed the main land use adjacent to sites in the survey, and were recorded from 78.3% of sites. This category includes linear features and scrub, but excludes highly modified woodland. Most of this figure can be attributed to scrub, adjacent to 60% of sites, with the highest proportion in Galway (71% of sites in the county); and hedgerows and treelines, adjacent to 45% of sites, with the highest proportion of these recorded in Limerick (87% of sites in the county). Built land and coastal constructions was the next most frequent category, being recorded adjacent to 76% of sites. The bulk of this figure can be attributed to built land, ranging from 55.6% of sites in Clare to 93.3% of sites in Limerick. Coastal constructions were rare (adjacent to 0.6% of sites, recorded in Kerry and Mayo only). Other habitats frequently recorded adjacent to sites included: improved grassland and cultivated land, adjacent to 72.1% of sites, with sites in Tipperary having the highest proportion (90.5% of sites in the county); semi-natural grassland and marsh, adjacent to 60.5% of sites, with the highest proportion in Limerick (80% of sites in the county) and contrasting greatly with Tipperary, in which only 33.3% of sites were recorded adjacent to either semi-natural grassland or marsh; and heath, adjacent to 44.8% of sites, with the highest proportion in Mayo (59.1% of sites in the county). Fens and flushes (adjacent to 44.2% of sites) and freshwater courses (adjacent to 43.9%

of sites) were also frequently recorded as adjacent habitats. Multiple adjacent habitats were recorded at all sites, with a median of seven habitats occurring at sites across the six counties.

Figure 3.2 Frequency of habitats occurring adjacent to surveyed sites, differentiated by county.



Management

The majority of sites within the six western counties surveyed during 2011-2012 were just grazed (70.6% of sites) while only 4.5% were just mown (Fig. 3.3). A total of 22.6% of sites were managed through a combination of both grazing and mowing, while only 2.4% of the sites had no evidence of mowing or grazing recorded. There were a higher proportion of "Grazed only" sites within Galway (83.5%) and Kerry (81.3%) than within Mayo (68.7%), Tipperary (66.7%), Clare (57.1%) or Limerick (46.7%). Limerick had the highest proportion of "Mown only" sites (6.7% of the sites within the county), while Tipperary had none. The mixed regime of grazing and mowing on site was highest in Limerick (46.7% of sites in the county), followed by Clare (33.3% of sites in the county). Kerry and Limerick were the only counties that had grazing, mowing or a combination of the two at all sites surveyed. The other four counties had some sites which had no grazing or mowing recorded at all, with Clare and Tipperary having the highest proportions (4.8% of sites for both).

More than one grazing type was frequently encountered on a site. Cattle were the most frequently occurring grazing animal recorded, and were recorded on 68.2% of sites (Fig. 3.4). Sheep and horses were encountered at 33.5% and 29.4% of sites respectively. The only other domestic grazers recorded were donkeys, and in two instances, alpacas. Wild and feral grazers were also recorded, and these included deer, goats, rabbits and hares. Most common of these were hares, recorded at 23.1% of sites.

Figure 3.3 Frequency of different management regimes at sites, differentiated by county.

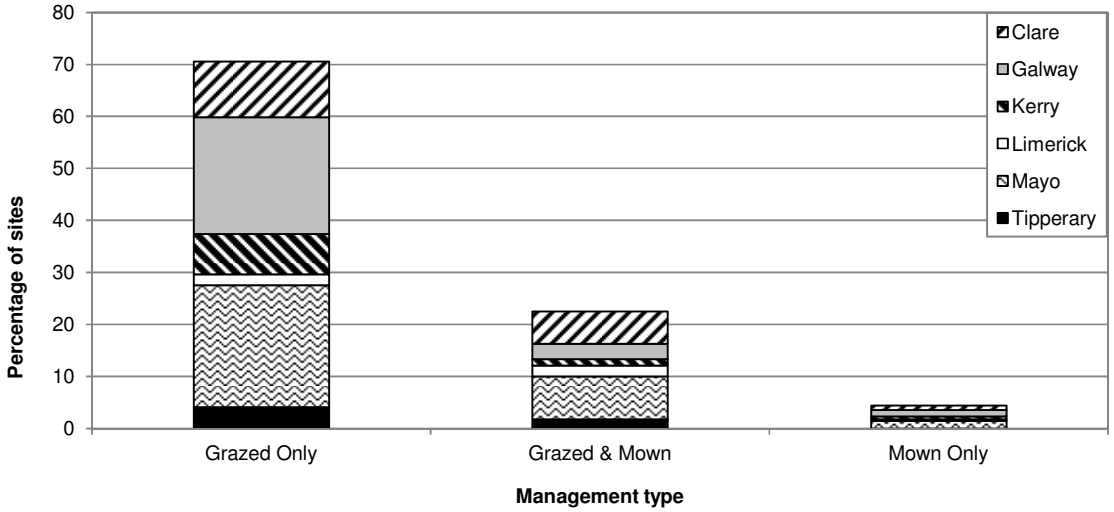
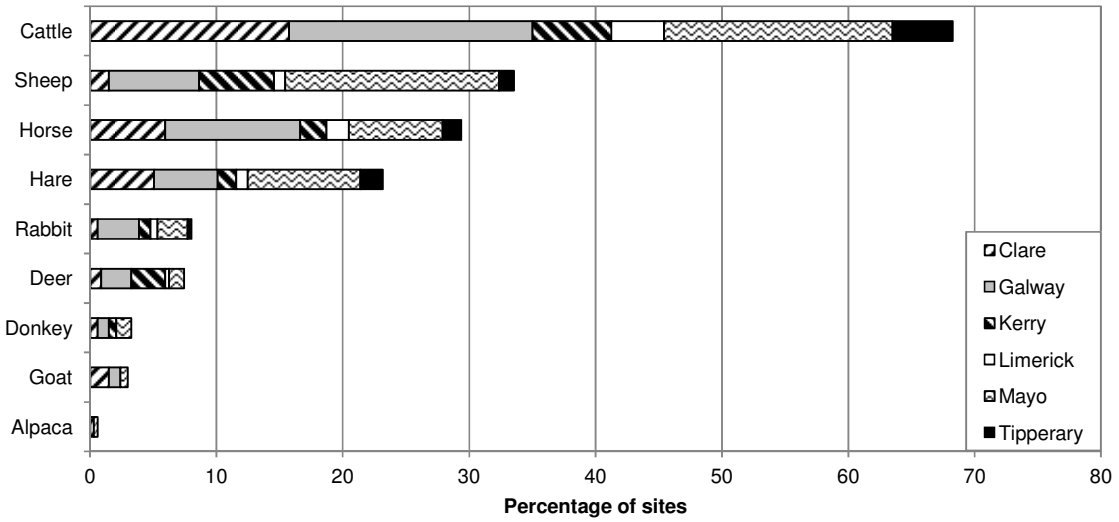


Figure 3.4 Frequency of grazing animals at sites, differentiated by county.



The most frequently recorded damaging activity was drainage (34.1% of sites), followed by adjacent afforestation (16.3% of sites), other (9.2%) and dumping (8.0% of sites; Fig. 3.5). A total of 49.6% of sites had no damaging activities recorded at all, with the highest proportion occurring in Tipperary (71.4% of sites in this county had no damaging activities recorded). Herbicide spraying, disturbance and abandonment, each occurring at 1.5% of sites, were also recorded but are not presented. Damaging activities that occurred at less than 1% of sites included crop planting, localised enrichment from stored silage bales, campfires, land clearance/reclamation, man-made developments and quarrying. These were grouped under "Other" damaging activities.

Figure 3.5 Frequency of occurrence of different types of damaging activity at sites, differentiated by county.

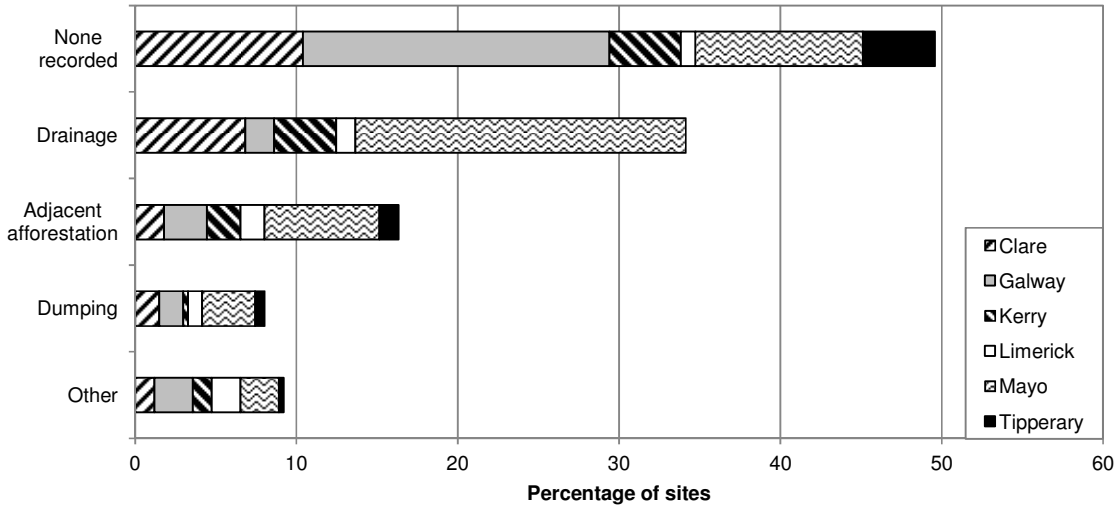
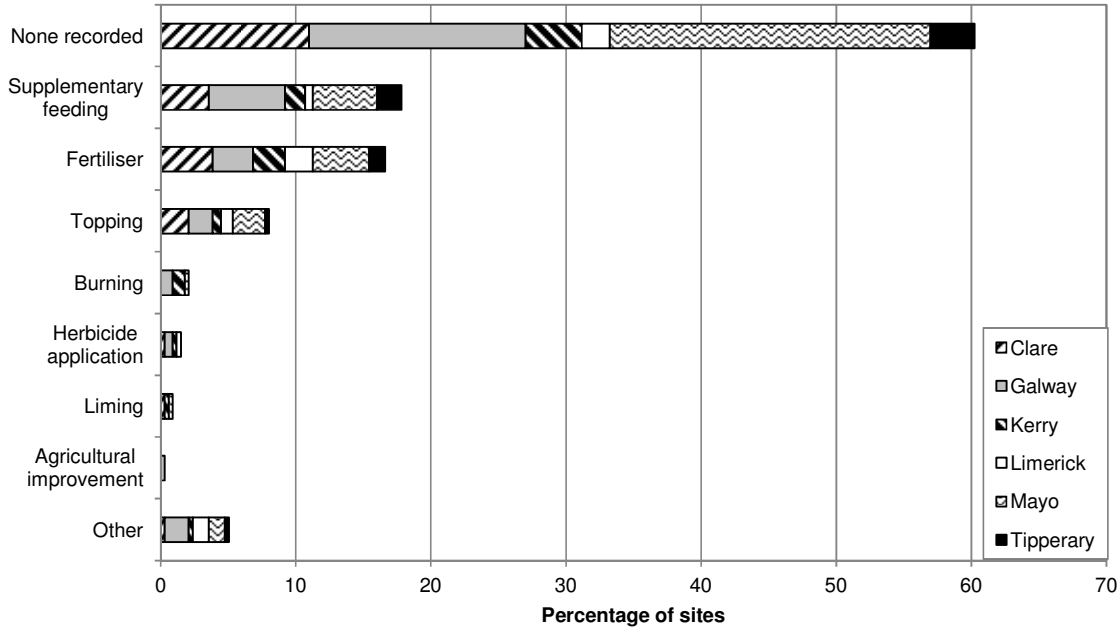


Fig. 3.6 indicates the frequency of agricultural activities in Clare, Galway, Kerry, Limerick, Mayo and Tipperary. The most frequent method of improvement observed was the provision of supplementary feeding (17.8% of sites), which was relatively more frequent within Tipperary (28.6% of Tipperary sites) compared to the other counties, with Limerick recorded as having the lowest provision of supplementary feeding (13.3% of Limerick sites). Fertiliser application (recorded in 16.6% of all sites) and topping (8.0% of all sites) were the next most frequent agricultural activities recorded. Both of these activities were highest within Limerick (46.7% and 20.0% of Limerick sites respectively). Fertiliser application was least frequent in Galway (11.0% of Galway sites), while topping was least frequent in Tipperary (4.8% of Tipperary sites). All counties had some sites in which no agricultural activities were recorded (60.2% of all sites), with Mayo having the highest proportion (69.6%). Other activities such as scrub clearance, hedgerow removal, shooting (species unspecified), educational uses, burning, liming, herbicide application and agricultural improvements were recorded in much fewer semi-natural grassland sites (5% or less of all sites).

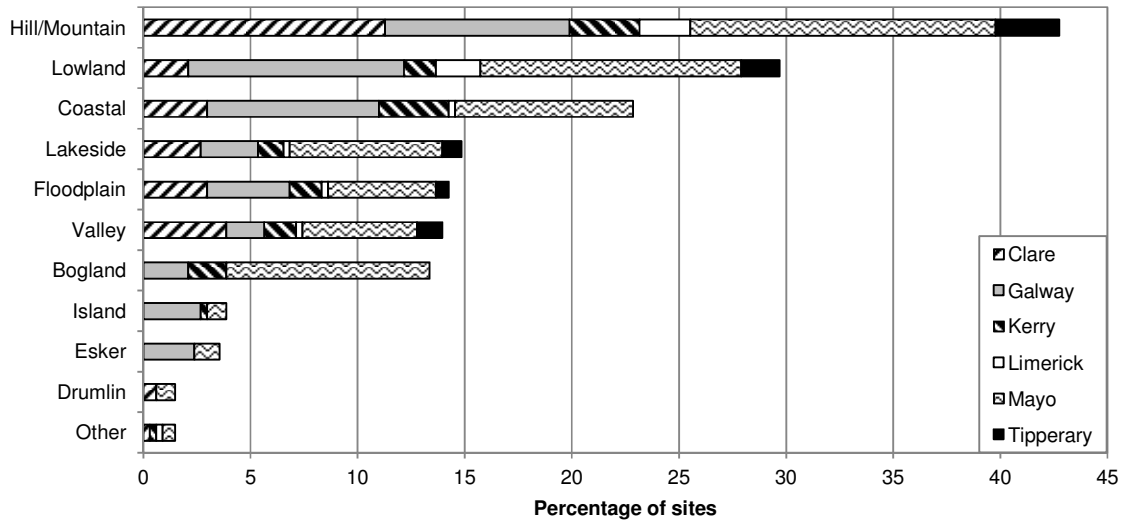
Figure 3.6 Frequency of agricultural activities recorded, differentiated by county.



Landscape features

Fig. 3.7 indicates the landscape features associated with sites included in the survey. The landscape feature most frequently recorded in association with sites was Hill/Mountain, occurring in 42.7% of sites. Clare and Limerick were the counties with the highest proportion of sites on hills or mountains (60.3% and 53.3% of sites in each county respectively), while Galway and Kerry had similarly low incidences of sites on hills (31.9% and 34.4% of sites in each county respectively). Lowland plain was the next most frequently recorded and was noted at 29.7% of all sites surveyed, highest within Limerick (46.7% of sites in the county) followed by Galway (37.4% of Galway sites). Coastal landscape features were the most frequent in Kerry and Galway, recorded in association with 34.4% and 29.7% of sites in each county respectively. Limerick had the lowest incidence of coastal landscape features (6.7% of Limerick sites), while landlocked Tipperary had no records. Lakesides were the next most frequent landscape feature recorded, occurring in 14.8% of sites. Mayo had the highest proportion of sites on lakesides (20.9%). The only other features of significance were floodplains, valleys and bogland, which were present in 14.2%, 13.9% and 13.4% of sites respectively. Floodplains and valleys had the highest incidence in Clare (15.9% and 20.6% of Clare sites respectively), while bogland had the highest proportion sites in Mayo (27.8%). No sites in Clare, Limerick or Tipperary were associated with bogland. Eskers were recorded at 12 sites in Galway and Mayo, with over half of these sites associated with an Annex I habitat. Drumlins were only recorded at five sites: two in Clare and three in Mayo. Island sites were not recorded in Limerick, Tipperary or Clare. Limestone crags, peninsulas, estuaries and turloughs were landscape features classified under “Other”.

Figure 3.7 Frequency of different geographical features associated with sites, differentiated by county.



3.2 Assessment of Annex I grassland

A total of 121 of the sites surveyed across the six counties of Clare, Mayo, Galway, Kerry, Limerick and Tipperary in 2011-2012 contained an area of Annex I grassland habitat greater than the minimum mapping area of 400 m^2. An assessment stop that was recorded in an area that was below the minimum mapping unit was included for 6430 (site 2341), however, due to the presence of an additional unsurveyed area of the habitat at the same site. The total number of assessed areas of 6430 is therefore 8 and the total number of assessed areas is 135 in 122 sites. Of these, the majority were in counties Galway (35 sites), Mayo (33 sites), and Clare (32 sites; Table 3.6). Just over half (54.1%) of the Annex I grassland areas are within SACs, with 73 of the 135 Annex I areas overlapping with an SAC. The data presented below summarise the extent, structure and functions, and future prospects for the 135 areas of Annex I grassland habitat recorded within the 122 sites.

Table 3.6 The sites surveyed in Clare, Mayo, Galway, Kerry, Limerick and Tipperary containing areas assessed as Annex I grassland habitat. 13 sites are listed more than once as they contain more than one Annex I habitat.

Site no.	Annex I habitat	County	SAC†	Site no.	Annex I habitat	County	SAC†
1603	6410	Clare	000994	1874	6510	Mayo	001482
1608	[*]6210	Clare		1877	*6230	Mayo	
1609	6410	Clare		2205	*6230	Galway	002031
1610	6410	Clare		2212	[*]6210	Galway	002074
1612	[*]6210	Clare	000020	2230	[*]6210	Galway	000212
1614	[*]6210	Clare	000020	2237	*6230	Galway	002031
1614	6510	Clare		2239	*6230	Galway	
1615	[*]6210	Clare	000020	2240	*6230	Galway	
1616	[*]6210	Clare	001926	2241	[*]6210	Galway	002111
1617	[*]6210	Clare	000020	2249	[*]6210	Galway	000297
1622	[*]6210	Clare	000054	2253	[*]6210	Galway	
1623	[*]6210	Clare	000054	2259	[*]6210	Galway	

Site no.	Annex I habitat	County	SAC†	Site no.	Annex I habitat	County	SAC†
1624	[*]6210	Clare	000054	2260	[*]6210	Galway	
1625	[*]6210	Clare	000054	2261	6410	Galway	
1627	6430	Clare	000032	2263	6410	Galway	000297
1628	6430	Clare	000057	2267	[*]6210	Galway	
1634	6410	Clare		2269	[*]6210	Galway	000268
1646	6410	Clare		2270	[*]6210	Galway	000268
1649	[*]6210	Clare	001926	2271	[*]6210	Galway	001926
1653	[*]6210	Clare	001926	2273	[*]6210	Galway	
1654	[*]6210	Clare	001926	2282	[*]6210	Galway	
1655	6410	Clare		2299	[*]6210	Galway	
1663	6410	Clare		2301	[*]6210	Galway	
1666	6410	Clare		2303	[*]6210	Galway	
1668	[*]6210	Clare	000054	2307	[*]6210	Galway	000606
1670	6410	Clare		2307	6410	Galway	000606
1671	[*]6210	Clare	000020	2310	[*]6210	Galway	002244
1672	[*]6210	Clare	000054	2317	[*]6210	Galway	
1675	[*]6210	Clare	001926	2320	[*]6210	Galway	002347
1676	[*]6210	Clare	001926	2326	[*]6210	Galway	
1696	6510	Clare	001926	2329	[*]6210	Galway	
1697	6410	Clare		2329	6410	Galway	
1697	6510	Clare		2337	[*]6210	Galway	
1699	6510	Clare		2340	6410	Galway	000216
1703	6410	Mayo		2340	6430	Galway	000216
1707	6410	Mayo		2341	6430	Galway	000216
1718	6410	Mayo		2342	6410	Galway	000216
1719	*6230	Mayo		2344	6410	Galway	000216
1729	*6230	Mayo		2345	[*]6210	Galway	002241
1730	6430	Mayo	002298	2380	[*]6210	Galway	001275
1731	6510	Mayo	002298	2401	*6230	Kerry	000375
1733	6510	Mayo	002298	2402	*6230	Kerry	000375
1735	6510	Mayo	002298	2403	6410	Kerry	000365
1744	6410	Mayo	001899	2406	6430	Kerry	000365
1749	*6230	Mayo	000534	2415	*6230	Kerry	000365
1752	*6230	Mayo	001501	2434	*6230	Kerry	000375
1769	*6230	Mayo	000500	2701	[*]6210	Limerick	000432
1804	6410	Mayo		2701	6510	Limerick	000432
1807	6410	Mayo		2703	[*]6210	Limerick	000439
1810	*6230	Mayo		2704	[*]6210	Limerick	002165
1819	[*]6210	Mayo		2704	6510	Limerick	002165
1819	6410	Mayo		2708	6410	Limerick	002165
1820	6510	Mayo		2708	6430	Limerick	002165
1827	[*]6210	Mayo		2719	6410	Limerick	
1827	6410	Mayo		2722	6410	Limerick	
1831	*6230	Mayo		2901	*6230	Tipperary	000646
1836	*6230	Mayo		2902	*6230	Tipperary	
1839	[*]6210	Mayo	001774	2903	[*]6210	Tipperary	
1846	6410	Mayo		2908	*6230	Tipperary	002125

Site no.	Annex I habitat	County	SAC†	Site no.	Annex I habitat	County	SAC†
1851	[*]6210	Mayo	001774	2908	6510	Tipperary	
1853	[*]6210	Mayo		2912	[*]6210	Tipperary	
1854	[*]6210	Mayo	001774	2914	6430	Tipperary	
1859	*6230	Mayo		2918	[*]6210	Tipperary	
1864	[*]6210	Mayo	001536	2918	6410	Tipperary	
1864	6510	Mayo		2922	[*]6210	Tipperary	
1865	[*]6210	Mayo	000479	2924	6410	Tipperary	002165
1867	[*]6210	Mayo		2925	6410	Tipperary	
1869	[*]6210	Mayo	001774				

† SAC code only shown if Annex I grassland habitat occurs within the SAC

Area assessment

Of the 135 areas of Annex I grassland habitat assessed across the six counties, two had increased in extent, four had decreased in extent and the remaining 129 were unchanged (Table 3.7), based on an area comparison between aerial photographs of 2000 and the areas mapped during 2011-2012. All Annex I grassland areas were scored as *Favourable* for area assessment except sites 1853, 2303 and 2704, which were assessed as *Unfavourable – Bad*, and site 2301, where the area of [*]6210 was assessed as *Unfavourable – Inadequate*.

Table 3.7 Annual percentage change in area between the years 2000 and 2011 / 2012 of Annex I grassland habitat areas surveyed in Clare, Mayo, Galway, Kerry, Limerick and Tipperary. Only those sites where a change in area was recorded are presented.

Site no.	Annex I habitat	Area in 2000 (ha)	Area in 2011/2012 (ha)	% change per yr
1654	[*]6210	7.4	8.0	0.7
1853	[*]6210	3.6	3.2	-1.1
2301	[*]6210	1.4	1.3	-0.6
2303	[*]6210	9.2	7.7	-1.3
2337	[*]6210	0.6	0.6	1.0
2704	6510	6.9	6.0	-1.2

Structure and functions assessment

Across the 11 individual criteria assessed, the highest percentage of passes at individual monitoring stops was achieved by Festuco-Brometalia ([*]6210) with a pass rate of 66%, and the lowest was 6410 with a pass rate of 13% (Table 3.8). Forb component was the criterion with the lowest pass rate in *Molinia* meadows (6410), while species richness had the lowest pass rate in *Nardus* grassland (*6230), followed closely by forb component. In Festuco-Brometalia ([*]6210) the criterion with the lowest pass rate was forb component, and positive indicator species had the lowest pass rate in Lowland hay meadows (6510). The criterion with the lowest pass rate in Hydrophilous tall herb fringe communities (6430) was sward height (50%). With expert judgement applied, this criterion for this habitat increased to a pass rate of 62.5%. There is an argument for lowering the threshold height (50 cm) for this criterion; however, no monitoring stops for Hydrophilous tall herb fringe communities (6430) failed this criterion in Martin *et al.* (2013) for Leinster counties, and therefore the threshold

value remains at 50 cm. The pass rate for the monitoring stops was lower across each of the Annex I habitats than for the individual criteria because a failure in any one of the criteria resulted in a failure for the monitoring stop overall.

As stated in section 2.4, for an Annex I habitat to receive a *Favourable* assessment for structure and functions, a pass was generally required for all criteria within all monitoring stops; however, high quality sites which narrowly failed on only one or two criteria were re-examined and, using expert judgement, a decision was made on whether a *Favourable* assessment for structure and functions was warranted. This approach resulted in the number of individual stops that passed for structure and functions across the five Annex I grassland habitats increasing from 232 to 295. The effect of this re-assessment was most noticeable for 6410, where the overall pass rate for monitoring stops increased from 13% to 30%.

Table 3.8 Percentage pass rate for individual criteria used to assess structure and functions for each Annex I grassland habitat surveyed in 2011-2012. Note: A monitoring stop fails if even only one criterion fails. N/A = criterion not assessed for that Annex I habitat.

	% of monitoring stops that passed on each criterion				
Assessment Criteria	**Festuco-Brometalia ([*]6210)**	***Nardus* grassland (*6230)**	***Molinia* meadows (6410)**	**Hydrophilous tall herb communities (6430)**	**Lowland hay meadows (6510)**
Positive indicator species (HQ[†])	98	91	84	N/A	92
Positive indicator species (HQ + Non-HQ)	96	100	89	100	82
Non-native species	100	99	100	100	100
Negative indicator species	91	87	96	88	87
Encroachment	92	96	99	100	98
Sward height	91	94	97	50	93
Litter cover	98	90	58	N/A	88
Bare ground cover	99	100	99	88	100
Grazing & disturbance	99	100	96	80	100
Forb component	88	76	42	88	90
Species richness	N/A	75	N/A	N/A	N/A
Pass rate for monitoring stops before expert judgement applied	66	42	13	38	57
Pass rate for monitoring stops after expert judgement applied	76	61	30	50	65

[†] HQ = High Quality positive indicator species (see section 2.4).

For results of individual structure and functions criteria within monitoring stops, see Appendix 6

Future prospects assessment

Assessment of the future prospects parameter for each of the Annex I grassland areas identified was carried out according to the scoring system outlined in Tables 2.1 and 2.8, with a score of 0 or greater assessed as *Favourable*, less than 0 to -3 as *Unfavourable – Inadequate* and less than -3 as *Unfavourable – Bad*. In total, 90 out of 135 (66.7%) Annex I grassland habitat areas assessed across the six counties were scored as *Favourable* (i.e. with the effects of positive and negative impacts

balanced in favour of the positive) (Appendix 8). The Annex I habitat with the best overall future prospects was 6430, with seven of eight areas (87.5%) assessed as having *Favourable* future prospects. The next most favourably rated was 6510, with 84.6% (11 out of 13 areas) of its assessed areas receiving a *Favourable* score. *6230 had 76.2% (16 of 21 areas) of assessed areas receive a *Favourable* score, while 63.6% (21 of 33 areas) of 6410 and 58.3% (35 of 60 areas) of [*]6210 received a *Favourable* score. There is some disparity between habitats' pass rates for structure and functions and for future prospects. Future prospects may appear more favourable because negative impacts such as agricultural improvement were under-recorded; this occurred because no baseline data were available for comparison, and such impacts would have had to have been observed on the day of survey to be recorded. Furthermore, an absence of monitoring data for structure and functions means that, by default, monitoring stops are being compared to the highest standards; subsequent monitoring may show that some Annex I grasslands, due to geographic location or other factors, may already have favourable structure and functions within the context of their local ecosystem.

In terms of the impacts recorded, 21 negative impacts were recorded on Annex I grassland habitats, with 13 positive and 17 neutral impacts also noted (Table 3.9). The most frequent negative impact recorded was species composition change (succession), which occurred at 81 areas. Problematic native species (e.g. bracken) was also a frequent negative impact, recorded in 47 areas. None of the other negative impacts were recorded in more than 10 areas. It should be noted that four of the top five negative impacts relate to current insufficient management or agricultural abandonment. Species composition change is symptomatic of either insufficient management (e.g., undergrazing) or abandonment. It is therefore often recorded in the absence of abandonment and in the presence of non-intensive grazing. Grazing in such cases is usually considered to have either a neutral or positive effect as, if it were removed, the situation would be even worse.

The top five positive impacts were all related to the management of grassland through either grazing or mowing. Collectively, grazing was identified as the most frequent positive impact, noted at 96 areas of Annex I grassland habitat, with cattle the most frequent grazing animal, recorded at 49 areas. Mowing was a positive feature for 20 areas and all but two of the areas of Lowland hay meadow (6510) were mown. Note that grazing was identified in some sites as a positive effect and at others as a negative impact, as well as occurring with a neutral effect (neither positive nor negative) in 15 areas. For example, grazing was generally recorded as having a negative impact in areas where it was insufficient to prevent a rank sward from developing, or where negative impacts due to trampling or enrichment outweighed any other positive effect that grazing might achieve; but cattle grazing was recorded as having a positive effect where it successfully controlled sward rankness and more than cancelled out any of the negative effects of grazing. An assessment of neutral was made when the positive and negative impacts cancelled each other out when an assessment was made across the total area of Annex I habitat within a site. This was a highly context-sensitive assessment, requiring a weighing up of all of the individual impacts seen at a site.

For future prospects results of assessed Annex I grassland habitat areas, see Appendix 8

Table 3.9 Impacts recorded for each of the Annex I grassland habitats assessed in the six western counties showing the number of areas each impact occurred at for each Annex I habitat.

(a) Negative impacts

		Annex I grassland habitat					
Impact code	**Description**	**[*]6210**	***6230**	**6410**	**6430**	**6510**	**Total**
K02.01	Species composition change (succession)	48	15	10	3	5	81
I02	Problematic native species (e.g. bracken)	39	4	-	-	4	47
I01	Invasive non-native species	3	5	1	-	-	9
A03.03	Abandonment/ lack of mowing	-	-	6	-	2	8
A04.03	Abandonment of pastoral systems, lack of grazing	1	-	6	-	-	7
G01.02	Walking, horse-riding and non-motorised vehicles	-	4	-	-	1	5
B01.02	Artificial planting on open ground (non-native trees)	1	-	2	-	-	3
A04.01.03	Intensive horse grazing	1	-	1	-	-	2
K02.02	Accumulation of organic material	-	-	2	-	-	2
A02.01	Agricultural intensification	1	-	-	-	-	1
A04.01.01	Intensive cattle grazing	1	-	-	-	-	1
A04.01.05	Intensive mixed animal grazing	1	-	-	-	-	1
A04.02.01	Non intensive cattle grazing	-	-	1	-	-	1
A04.02.03	Non intensive horse grazing	-	-	-	1	-	1
A05.02	Stock feeding	1	-	-	-	-	1
A11	Agriculture activities not referred to above	1	-	-	-	-	1
B02	Forest and Plantation management & use	1	-	-	-	-	1
D01.01	Paths, tracks, cycling tracks	-	1	-	-	-	1
D01.02	Roads, motorways	1	-	-	-	-	1
G02.08	Camping and caravans	1	-	-	-	-	1
H05.01	Garbage and solid waste	1	-	-	-	-	1

(b) Positive impacts

		Annex I grassland habitat					
Impact code	**Description**	**[*]6210**	***6230**	**6410**	**6430**	**6510**	**Total**
A04.02.01	Non intensive cattle grazing	29	3	14	2	1	49
A03.02	Non intensive mowing	1	-	7	-	10	18
A04.02.02	Non intensive sheep grazing	4	10	1	-	-	15
A04.02.05	Non intensive mixed animal grazing	10	1	3	-	-	14
A04.02.03	Non intensive horse grazing	6	1	3	1	1	12
A04.02	Non intensive grazing	1	3	-	-	-	4
A10.01	Removal of hedges and copses or scrub	3	-	1	-	-	4
J02.04.01	Flooding	-	-	1	2	1	4
A03	Mowing / cutting of grassland	-	-	1	-	1	2
A04.02.04	Non intensive goat grazing	2	-	-	-	-	2
A07	Use of biocides, hormones and chemicals	2	-	-	-	-	2
J02.07.01	Water extraction (drainage ditches)	-	-	1	-	-	1
K01.04	Competition	1	-	-	-	-	1

(c) Neutral impacts

Impact code	Description	Annex I grassland habitat					
		[*]6210	*6230	6410	6430	6510	Total
A04.02.01	Non intensive cattle grazing	7	-	4	-	-	11
G01.02	Walking, horse-riding and non-motorised vehicles	-	3	1	1	1	6
B02	Forest and Plantation management & use	-	1	4	-	-	5
D01.01	Paths, tracks, cycling tracks	2	1	-	1	-	4
A04.02.02	Non intensive sheep grazing	1	2	-	-	-	3
K02.01	Species composition change (succession)	2	-	1	-	-	3
A04.03	Abandonment of pastoral systems, lack of grazing	1	1	-	-	-	2
C01	Mining and quarrying	2	-	-	-	-	2
J02.07.01	groundwater abstractions for agriculture	-	-	2	-	-	2
A04.02.05	Non intensive mixed animal grazing	-	1	-	-	-	1
A08	Fertilisation	1	-	-	-	-	1
B01	Forest planting on open ground	-	-	1	-	-	1
C01.01.01	Sand and gravel quarries	1	-	-	-	-	1
G01.03.02	Off-road motorized driving	1	-	-	-	-	1
H04.03	Other air pollution	-	-	-	-	1	1
I02	Problematic native species	1	-	-	-	-	1
K01	Abiotic (slow) natural processes	1	-	-	-	-	1

Overall condition assessment

The condition assessment scores for the 135 areas of Annex I grassland habitat assessed across the six counties were derived as outlined in section 2.4. Examining each of the assessment parameters separately (area, structure and functions, and future prospects), the highest number of *Favourable* assessments were within area assessment, with 131 of the 135 areas assessed as *Favourable* (Table 3.7; see also Appendix 9), and the lowest were within structure and functions, with 47 of the 135 areas assessed as *Favourable*, even after all monitoring stops had been re-examined for near misses.

In terms of the overall condition assessment (i.e., combining all three assessment parameters with reference to the matrix presented in Table 2.1) for each of the 135 areas of Annex I grassland habitat, 33 areas received an overall assessment of *Favourable.*

For overall condition assessments of assessed Annex I grassland habitat areas, see Appendix 9

Primary areas of Annex I grassland habitat

During 2011 and 2012, 135 areas of Annex I grassland habitat greater than the minimum mapping area located at 122 sites (13 sites contained more than one Annex I grassland habitat) were surveyed across the six counties. Many of these areas of Annex I grassland habitat are either small (less than 1 ha) or have unfavourable structure and functions. Following the proposal in Martin *et al.* (2008) that a list of premium quality sites containing Annex I grassland habitats above a minimum size and of

adequate structure and functions be produced, Table 3.10 shows the list of such sites compiled from the Annex I grassland habitats assessed during 2011 and 2012 across the six counties. The 54 areas of Annex I grassland listed are hereafter referred to as ***primary areas*** of Annex I grassland and represent the best examples of Annex I grassland habitat recorded across the six counties. They are judged to be of primary importance due to a combination of the area they cover (at least 1 ha) and their structure and functions, and should provide a focus for monitoring and conservation efforts in the future. Seventeen of the 47 areas that received a *Favourable* structure and functions assessment were included in the list of primary areas, the majority of these 47 areas being too small. Eighteen of the 54 primary areas were recorded in Clare, 15 in Galway, and 11 in Mayo, with the remaining 10 located across Kerry, Limerick and Tipperary.

Thirty-seven of the areas of primary Annex I habitat were located within NPWS conservation sites; for 24 of these, between 90% and 100% of the Annex I habitat was located within an SAC or pNHA.

Table 3.10 List of the 54 primary areas of Annex I grassland habitat surveyed within the six western counties. The sites are ordered by Annex I habitat type and then site number within each type. The % within NPWS site refers to the % of the Annex I habitat located in an SAC or, if the habitat does not coincide with an SAC, the area located within an NHA or pNHA. % Pass for structure and functions is after expert judgement applied.

Site No.	County	Annex habitat	Area (ha)	Structure and functions	% in NPWS site	NPWS site no.
1608	Clare	[*]6210	5.4	67% Pass = Unfavourable-Bad	0	-
1612	Clare	[*]6210	2.0	100% Pass = Favourable	88	SAC 000020
1614	Clare	[*]6210	1.9	25% Pass = Unfavourable-Bad	0	-
1615	Clare	[*]6210	5.0	100% Pass = Favourable	100	SAC 000020
1616	Clare	[*]6210	3.0	80% Pass = Unfavourable-Inadequate	100	SAC 001926
1617	Clare	[*]6210	6.4	100% Pass = Favourable	84	SAC 000020
1622	Clare	[*]6210	1.8	75% Pass = Unfavourable-Inadequate	92	SAC 000054
1623	Clare	[*]6210	7.8	67% Pass = Unfavourable-Bad	100	SAC 000054
1649	Clare	[*]6210	2.2	100% Pass = Favourable	100	SAC 001926
1654	Clare	[*]6210	8.0	86% Pass = Unfavourable-Inadequate	100	SAC 001926
1671	Clare	[*]6210	18.2	89% Pass = Unfavourable-Inadequate	9	SAC 000020
1672	Clare	[*]6210	1.7	100% Pass = Favourable	100	SAC 000054
1676	Clare	[*]6210	14.1	75% Pass = Unfavourable-Inadequate	100	SAC 001926
1839	Mayo	[*]6210	1.7	75% Pass = Unfavourable-Inadequate	100	SAC 001774
1853	Mayo	[*]6210	3.2	75% Pass = Unfavourable-Inadequate	0	-
1864	Mayo	[*]6210	3.7	67% Pass = Unfavourable-Bad	99	SAC 001536
1865	Mayo	[*]6210	5.7	50% Pass = Unfavourable-Bad	100	SAC 000479
2259	Galway	[*]6210	1.2	75% Pass = Unfavourable-Inadequate	0	-
2260	Galway	[*]6210	1.8	60% Pass = Unfavourable-Bad	0	-
2267	Galway	[*]6210	10.4	50% Pass = Unfavourable-Bad	0	-
2271	Galway	[*]6210	1.3	100% Pass = Favourable	6	SAC 001926
2273	Galway	[*]6210	5.0	100% Pass = Favourable	0	-
2282	Galway	[*]6210	16.3	100% Pass = Favourable	0	-
2301	Galway	[*]6210	1.3	75% Pass = Unfavourable-Inadequate	0	-
2303	Galway	[*]6210	7.7	71% Pass = Unfavourable-Bad	0	-
2307	Galway	[*]6210	2.6	75% Pass = Unfavourable-Inadequate	99	SAC 000606

Site No.	County	Annex habitat	Area (ha)	Structure and functions	% in NPWS site	NPWS site no.
2310	Galway	[*]6210	20.7	100% Pass = Favourable	100	SAC 002244
2329	Galway	[*]6210	3.4	100% Pass = Favourable	11	NHA 000254
2345	Galway	[*]6210	2.0	75% Pass = Unfavourable-Inadequate	100	SAC 002241
2701	Limerick	[*]6210	7.5	67% Pass = Unfavourable-Bad	78	SAC 000432
2704	Limerick	[*]6210	8.5	67% Pass = Unfavourable-Bad	22	SAC 002165
1749	Mayo	*6230	1.2	50% Pass = Unfavourable-Bad	100	SAC 000534
2205	Galway	*6230	2.2	100% Pass = Favourable	9	SAC 002031
2401	Kerry	*6230	13.1	50% Pass = Unfavourable-Bad	100	SAC 000375
2415	Kerry	*6230	1.7	100% Pass = Favourable	100	SAC 000365
2434	Kerry	*6230	12.8	75% Pass = Unfavourable-Inadequate	100	SAC 000375
1603	Clare	6410	6.1	50% Pass = Unfavourable-Bad	93	SAC 000994
1634	Clare	6410	7.6	50% Pass = Unfavourable-Bad	0	-
1655	Clare	6410	2.7	25% Pass = Unfavourable-Bad	0	-
1666	Clare	6410	1.3	75% Pass = Unfavourable-Inadequate	33	pNHA 000011
1718	Mayo	6410	1.9	75% Pass = Unfavourable-Inadequate	0	-
1744	Mayo	6410	4.1	33% Pass = Unfavourable-Bad	61	SAC 001899
1827	Mayo	6410	2.2	50% Pass = Unfavourable-Bad	0	-
2261	Galway	6410	1.7	75% Pass = Unfavourable-Inadequate	0	-
2307	Galway	6410	1.1	100% Pass = Favourable	100	SAC 000606
2708	Limerick	6410	5.5	50% Pass = Unfavourable-Bad	99	SAC 002165
2708	Limerick	6430	1.1	100% Pass = Favourable	100	SAC 002165
1696	Clare	6510	6.7	60% Pass = Unfavourable-Bad	100	SAC 001926
1733	Mayo	6510	3.4	50% Pass = Unfavourable-Bad	3	SAC 002298
1735	Mayo	6510	5.8	100% Pass = Favourable	100	SAC 002298
1864	Mayo	6510	1.3	75% Pass = Unfavourable-Inadequate	0	-
2701	Limerick	6510	2.4	75% Pass = Unfavourable-Inadequate	66	SAC 000432
2704	Limerick	6510	6.0	100% Pass = Favourable	44	SAC 002165
2908	Tipperary	6510	3.3	100% Pass = Favourable	0	-

3.3 Ranking of sites using conservation and threat evaluations

Conservation and threat scores were calculated as described in section 2.5. The full list of conservation and threat scores for the six counties is given in Appendices 10 and 11.

Conservation scores

The 25 sites of highest conservation value are presented in Table 3.11. All of these sites had a conservation score of 40% or more. Clare has the highest number of top-ranked sites (seven), followed by Mayo and Kerry with five each. Limerick and Galway have three top-ranked sites each, with two located in Tipperary. The top-ranked site of all 337 sites surveyed within the six western counties in 2011-2012 is in Limerick – Aughinish (2704). This obtained a high score because it contains two primary areas of Annex I habitat; it also scored well in terms of landscape context (i.e., adjacent and internal habitats), species density and quality of the species present, obtaining maximum scores both for notable species and for high quality indicator species. All but four of the 25 sites occur at least partly within an NPWS conservation site. All 25 of the top sites contain at least

one Annex I grassland habitat, with five sites – Aughinish, Limerick (2704), Barrigone, Limerick (2701), Lacka (World's End), Limerick (2708), Knocknageeha, Mayo (1864) and Cartron, Galway (2307) – each containing two areas of primary Annex I grassland habitat. Six of the top 25 sites are over 40 ha in size, while 14 received the highest score for species density and 21 achieved the maximum for high quality indicator species.

Threat scores

The 16 most threatened sites are presented in Table 3.12, representing all sites that scored over 50% in the threat evaluation. Mayo and Limerick each have four of these sites, three are located in Clare, Galway and Kerry have two each, and one is in Tipperary. Two of these sites, Cloonakillina, Mayo (1744) and Pollaghanumera, Clare (1609) also appear on the list of the sites of greatest conservation value, highlighting the vulnerable nature of these important grassland sites. Five of these sites occur at least partly within NPWS conservation sites.

Table 3.11 The 25 highest ranked grassland sites according to their conservation score surveyed in the six western counties in 2011-2012. Rankings shared by two or more sites are indicated by "=".

Site No.	Site Name	County	NHA/pNHA	SAC	% score	Rank
2704	Aughinish	Limerick	000435	002165	70.5	1
2701	Barrigone	Limerick	000432	000432	57.9	2
2329	Killure More	Galway	000254	-	50.5	3
1864	Knocknageeha	Mayo	001536	001536	48.4	=4
2401	Ballinloghig	Kerry	000375	000375	48.4	=4
2908	Reafadda	Tipperary	-	002125	46.3	6
1827	Cogaula	Mayo	-	-	45.3	=7
2310	Ardrahan Grasslands	Galway	-	002244	45.3	=7
1697	Cream Point	Clare	-	-	44.2	=9
2403	Bunrower	Kerry	000365	000365	44.2	=9
1617	Murrooghkilly	Clare	000020	000020	43.2	=11
1671	Derreen West	Clare	000020	000020	43.2	=11
2307	Cartron	Galway	000606	000606	43.2	=11
2708	Lacka (World's End)	Limerick	-	002165	43.2	=11
1614	Crumlin (Clare)	Clare	000020	000020	42.1	=15
1616	Keelhilla	Clare	001926	001926	42.1	=15
1744	Cloonakillina	Mayo	001899	001899	42.1	=15
2415	Derrynafeana	Kerry	000365	000365	42.1	=15
1622	Cahergrillaun	Clare	000054	000054	41.1	=19
1703	Termoncarragh	Mayo	001501	001501	41.1	=19
2406	Dromyrourk	Kerry	000365	000365	41.1	=19
1609	Pollaghanumera	Clare	-	-	40.0	=22
1869	Partry House Estate	Mayo	001774	001774	40.0	=22
2434	Coumduff	Kerry	000375	000375	40.0	=22
2918	Graffin	Tipperary	-	-	40.0	=22

Table 3.12 The 16 highest ranked grassland sites according to their threat score surveyed in the six western counties in 2011-2012. Rankings shared by two or more sites are indicated by "=".

Site No.	Site Name	County	NHA/pNHA	SAC	% score	Rank
1846	Derrintogher	Mayo	-	-	61.5	=1
2706	Court	Limerick	-	-	61.5	=1
2710	Ballynort	Limerick	-	-	61.5	=1
1604	Magherabaun	Clare	-	-	53.8	=4
1605	Caheraghacullin	Clare	-	-	53.8	=4
1609	Pollaghanumera	Clare	-	-	53.8	=4
1744	Cloonakillina	Mayo	001899	001899	53.8	=4
1818	Barcull	Mayo	-	-	53.8	=4
1833	Roonah	Mayo	001529	001529	53.8	=4
2253	Ballydotia	Galway	-	-	53.8	=4
2255	Addragool	Galway	-	000297	53.8	=4
2446	Kineigh	Kerry	000335	000335	53.8	=4
2448	Gortalee	Kerry	000365	000365	53.8	=4
2721	Carrigparson	Limerick	-	-	53.8	=4
2725	Carrigkerry	Limerick	-	-	53.8	=4
2917	Cloncannon	Tipperary	-	-	53.8	=4

4: DISCUSSION

4.1 Summary data and the ranking of all surveyed sites

In this discussion the data collected in counties Clare, Galway, Kerry, Limerick, Mayo and Tipperary during ISGS 2011-2012 will be compared with the data collected in counties Carlow, Kilkenny, Laois, Louth, Meath, Westmeath, Wexford and Wicklow in 2011-2012 and the other 12 counties surveyed from 2007 to 2010. The discussion will focus on the six western counties surveyed in 2011 and 2012, with the remaining western seaboard counties – Donegal, Sligo and Cork, surveyed between 2007 and 2010, included where relevant. A detailed discussion of all counties surveyed during the lifespan of the ISGS can be found in O'Neill *et al.* (2013).

Table 4.1 Summary of sites surveyed by the ISGS 2007-2012. The counties are ordered by median site area.

County	Year	Hectares surveyed	No. of sites	Median site area (ha)	No. of relevés	Sites in SAC	Sites in NHA/pNHA	Annex I grassland sites
Leitrim	2009	3925.2	77	40.6	390	18	29	30
Sligo	2010	1527.4	52	24.8	312	20	26	31
Longford	2009	1290.7	49	23.1	187	12	14	5
Limerick	2012	398.0	15	21.6	86	6	4	6
Roscommon	2007	1381.1	51	20.0	178	10	19	19
Cavan	2009	1841.7	66	17.6	273	17	18	17
Laois	2012	138.5	8	16.2	29	3	3	1
Monaghan	2009	893.6	47	14.0	189	1	12	5
Kildare	2010	823.3	22	13.6	107	1	5	7
Kerry	2012	577.3	32	13.5	136	21	16	6
Clare	2011	1074.2	63	13.5	248	36	39	32
Dublin	2010	749.6	26	12.7	97	6	12	6
Offaly	2007	1365.0	41	12.1	139	10	21	15
Westmeath	2011	215.2	18	11.5	84	6	9	7
Carlow	2012	47.1	5	9.8	20	1	1	1
Mayo	2011	1456.2	115	9.7	465	58	52	33
Donegal	2010	1438.1	103	8.8	382	40	41	32
Tipperary	2012	264.0	21	7.7	71	7	7	10
Cork	2008	1859.5	192	7.2	589	40	42	14
Waterford	2008	706.0	58	7.1	176	15	17	4
Kilkenny	2012	110.7	8	6.9	27	5	4	4
Meath	2011	142.3	14	6.5	37	7	8	5
Galway	2012	837.0	91	5.9	282	42	39	34
Wexford	2012	61.0	7	4.0	15	3	3	0
Louth	2012	41.4	5	4.0	12	3	3	0
Wicklow	2012	24.0	6	3.4	13	1	1	0
Total		*23188.1*	*1192*	*11.6*	*4544*	*389*	*445*	*324*

Table 4.1 gives a summary of the 26 counties surveyed over the six years of the ISGS 2007-2012. Cork and Waterford, previously recorded as the counties with the lowest median site areas, have now been replaced by Galway and five of the Leinster counties surveyed in 2011-2012. The county with the lowest median site area is Wicklow (3.4 ha), while Leitrim still has the highest median site area of 40.6 ha. The range of site areas for the western counties presented in this report was extremely wide, ranging from 0.28 ha for one site in Tipperary, Templetney Quarry (site 2907) to 103.02 ha for Barna (2702) in Limerick. Limerick sites overall tended to be larger than the other five western counties surveyed in 2011-2012, with a median of 21.6 ha. Both Kerry and Clare had a median site area of 13.5 ha, while Galway had the lowest median area (5.9 ha). In fact, the median site areas for counties Mayo, Tipperary and Galway were all below the overall national median site area of 11.6 ha.

When examined individually, the median site area for Donegal of 8.8 ha is quite close to the overall median site area for the western counties surveyed in 2011-2012, as is the median site area for Cork of 7.2 ha, which was surveyed in 2008. Sligo had quite a large median site area of 24.8 ha, but this is in line with that of Limerick. The overall median site area for the western counties is higher than the overall median site area for the Leinster counties, Carlow, Kilkenny, Laois, Louth, Meath, Westmeath, Wexford and Wicklow, of 7.0 ha, also surveyed in 2011-2012 (Martin *et al.* 2013).

A small median site area tends to indicate fragmentation of semi-natural grasslands, as was the case for sites surveyed in Cork and Donegal. A high percentage of the semi-natural grasslands in these counties were found to be present in a landscape of improved grassland or adjacent to flush and heath. As mentioned above, Mayo, Tipperary and Galway all have median site areas below the national median site area. 90.5% of sites in Tipperary were adjacent to improved agricultural grassland and cultivated land. Based on maps of agriculture in Ireland (Lafferty *et al.* 1999) and data from both the Census of Agriculture 2010 (CSO 2012) and National Farm Survey 2011 (Hennessy *et al.* 2011), Tipperary has been shown to have the highest productivity of the western counties, measured by economic farm returns per unit of labour, farm size and family farm income per farm (FFI), and is more or less on par in terms of productivity with the other counties with lower median site areas in Table 4.1. The low median site area for Tipperary is a reflection of the level of agricultural activity on-going in the county.

In contrast to Tipperary, Mayo and Galway have the lowest productivity of the western counties, and yet their low median site areas would suggest fragmentation of semi-natural grassland habitats in these counties. Agricultural improvement and intensification seems to have increased in Mayo and Galway in recent years with many sites experiencing either damaging operations (70% of Mayo sites, the majority of which is due to drainage) or agricultural activity, not including grazing or mowing, that indicates intensification (41% of Galway sites and 30% of Mayo sites). In fact, 75% of sites in Mayo and 63% of sites in Galway were adjacent to improved agricultural grassland and cultivated land. A high number of sites in Mayo were also adjacent to heath (59%) and flush (62%), while 88% of Galway sites were adjacent to built land, demonstrating that the fragmentation of semi-natural

grassland habitats in these counties is not only due to agricultural intensification and improvement, but also due to the development of man-made structures and the predominance of habitats other than semi-natural grassland (e.g. wet heath) within the landscape.

Although the median site areas of Clare, Kerry and Limerick are greater than the other western counties surveyed in 2011-2012 and are above the national median site area of 11.6 ha, the semi-natural grassland within these counties still suffers from fragmentation, with agricultural intensification playing a large role in this.

Fragmentation of habitats is indicated partly by size, but also by the frequency with which semi-natural grassland and marsh were recorded as adjacent habitats. Only 33% of Tipperary sites were recorded as having further unsurveyed semi-natural grassland adjacent to them, further reiterating the level of intensive agricultural activity occurring within this county. This is similar to the situation in Cork and Donegal, where only 42% and 43% of sites respectively were recorded adjacent to further semi-natural grassland. The other five western counties surveyed in 2011 and 2012 had over 50% of their sites adjacent to further unsurveyed semi-natural grassland, ranging from Mayo with 56% of sites to Limerick with 80% of sites adjacent to semi-natural grassland. From examination of the occurrence of semi-natural grassland and marsh as adjacent habitats, these five counties, particularly Galway, Kerry and Limerick, appear to be less fragmented than Tipperary. Limerick sites tended, on the whole, to be the largest of the six western counties surveyed in 2011 and 2012, and were most likely to be adjacent to further unsurveyed areas of semi-natural grassland. They therefore appear to be the least fragmented. This is very similar to what was observed for Sligo in 2010. The median site area in Galway was the lowest of the six counties, but 68% of sites were found adjacent to semi-natural grassland. Galway had the highest number of Annex I areas within any county and subsequently more time was spent surveying and assessing these areas resulting in a high proportion of small sites with high quality grassland. The results here highlight the importance of not confusing median site area with quality, and also of the importance of looking at adjacent habitats as well as median site area to examine the level of fragmentation of habitats within any given county.

The west of Ireland tends to have a wetter climate than the east of the country. It is therefore not surprising that approximately half of all the surveyed area of the six western counties, as well as Sligo, Donegal and Cork, comprised wet grassland. Interestingly, dry-humid acid grassland follows wet grassland in terms of percentage of area surveyed for the more south-westerly counties – Limerick, Tipperary, Kerry and Cork; while dry calcareous and neutral grassland has the second largest area surveyed in the more north-westerly counties – Clare, Galway, Mayo, Sligo and Donegal. The difference can be attributed to the predominant soil types of the counties, with the presence of calcareous bedrock, outcropping rock and shallow calcareous soils in many of the northwest sites, which proved a suitable substrate for calcareous grassland. Bedrock digital maps from the Geological Survey of Ireland (GSI 2013) show that limestone bedrock extends from the midlands to reach the Atlantic Ocean along the Shannon Estuary and at Galway Bay, Clew Bay and Killala Bay. The area

where this limestone bedrock is most evident is in the Burren, which is found between Clare and Galway. As a result, both the number of records for, and area in hectares of, dry calcareous and neutral grassland and the Annex I habitat Festuco-Brometalia ([*]6210) were highest in Clare and Galway. The southwest counties tended to have a smaller proportion of calcareous bedrock, with more sites located over acidic soils in combination with upland areas. It is expected that the proportion of dry-humid acid grassland and its associated Annex I habitat *Nardus* grassland (*6230) is probably higher in the six western counties surveyed in 2011 and 2012 than the ISGS data suggest, due to a change in surveying methodology from 2010 onwards. All upland SACs were excluded from the ISGS survey to prevent overlap with the National Survey of Upland Habitats (NSUH). The NSUH has surveyed upland regions in four of the six western counties surveyed by the ISGS in 2011 and 2012: Mayo, Kerry, Limerick and Tipperary (Perrin *et al.* 2011, 2012, 2013; Roche *et al.* 2009, 2011a, 2011b, 2012a, 2012b). The Annex I grassland habitats Festuco-Brometalia ([*]6210), *Molinia* meadows (6410) and *Nardus* grassland (*6230) have all been recorded during those surveys, as have the four semi-natural grassland habitats and freshwater marsh.

Limerick (6.6%), Mayo (6.2%) and Cork (6.9%) had the highest proportion of hay meadows for the western counties (expressed as a percentage of surveyed semi-natural grassland within the county), but these proportions are quite low when compared to some of the Leinster counties. The frequency and area of dry meadows within the counties is often dependent on management. Over half of all sites surveyed in Limerick were managed by either mowing alone, or in combination with grazing, while just under 30% of Mayo sites recorded mowing. Hay meadows, particularly Annex I Lowland hay meadows (6510), have seen a substantial decline in recent decades. Data from Austin O'Sullivan's research from 1962-1982 showed that Lowland hay meadows (6510) were much more prevalent in the west of Ireland, with 10 sites recorded in Galway, six in Tipperary, three in Clare, two in Kerry and one in Limerick (Bourke *et al.* 2007). No Lowland hay meadows (6510) were recorded in Galway or Kerry as part of the ISGS in 2011-2012, and only one area was recorded in Tipperary. Martin (1991) highlighted the threat to hay meadows in the west of Ireland, with surveying focused around the area west of Lough Corrib in Galway.

Conservation scores were calculated as outlined in section 2.5 (Table 2.9). Table 4.2 shows the top 21 ISGS sites recorded across the country. All of the sites in Table 4.2 have a conservation score of over 50% and scored highly on all of the parameters tested. Ten of the 26 counties surveyed from 2007 to 2012 have sites in this table. Leitrim has the highest number of sites in the top rankings, with seven sites. Of the six western counties surveyed in 2011-2012, two counties had sites in this table. Galway had one, Killure More (2329), while Limerick had two, Barrigone (2701) and Aughinish (2704). Aughinish was the top-ranked site overall, and had two types of primary Annex I grassland habitat. The Lowland hay meadows (6510) were assessed as *Favourable* for this site, while 67% of its Festuco-Brometalia ([*]6210) assessment stops passed. Donegal and Sligo, other western seaboard counties, also had sites within this table, giving a total of eight sites from western counties having a conservation score of over 50%. It is surprising that Clare had no sites listed within the top 21 sites in

the country, as this county is well known for the presence of high quality grassland. Reasons for this absence include the fact that the ISGS did not go into the East Burren Complex (SAC 001926), as this area was covered under the Limestone Pavement Survey (Wilson and Fernández 2013), nor were grassland habitats associated with turloughs surveyed as all areas within the normal high flood limit are considered part of the turlough habitat and therefore grassland vegetation communities within this high flood limit were not within the remit of this survey. Clare sites also tended to have a lower diversity of habitats which therefore lowers the conservation scores.

Within the six western counties surveyed in 2011 and 2012, all but four of the 25 sites of highest conservation value occur at least partly within an NPWS conservation site. The four sites that are not within a designated area are Pollaghanumera (1609) and Cream Point (1697) in Clare, Cogaula, Mayo (1827) and Graffin, Tipperary (2918). All four sites are greater than 10 ha in area, have at least one Annex I grassland habitat and have both high species diversity and species quality. For these reasons, designation of these sites should be considered.

Table 4.2 Top 21 sites ranked by conservation score, surveyed during ISGS 2007-2012.
For Conservation score criteria see Table 2.9.

Site No.	Site Name	County	Area (ha)	SAC	NHA/pNHA	Annex I grassland habitat	Conservn Score (%)
2704	Aughinish	Limerick	31.8	002165	000435	[*]6210, 6510	70.5
109	Moystown Demesne and Bullock Island	Offaly	235.2	000216	000216, 002104	6410, 6510	65.3
818	Lugnafaughery	Leitrim	95.7	000623	002435	[*]6210, 6410	65.3
811	Larganavaddoge	Leitrim	76.3	000623	000623	[*]6210	62.1
1300	Glenasmole Valley	Dublin	45.0	001209	001209	[*]6210, 6410, 6510	58.9
850	Letterfine	Leitrim	121.1	-	-	[*]6210, 6510	57.9
2701	Barrigone	Limerick	20.1	000432	000432	[*]6210, 6510	57.9
825	Ballynaboll	Leitrim	178.8	-	-	[*]6210	56.8
1248	Rossnowlagh Lower	Donegal	45.2	000138	000138	6410, 6510	56.8
808	Keeloges	Leitrim	115.8	001403	001403	[*]6210	55.8
1067	Manragh Upper	Cavan	87.9	-	-	[*]6210	54.7
2012	Creaghduff	Westmeath	20.4	000440	000440	[*]6210, 6410, 6430	54.7
712	Coolberrin	Monaghan	95.9	-	-	6410, 6430	53.7
1250	St. John's Point	Donegal	70.1	000191	000191	[*]6210, 6410	52.6
1502	Edenbaum	Sligo	40.6	-	002435	[*]6210	52.6
1541	Cloonmacduff	Sligo	74.8	001898	001898	[*]6210, 6410	52.6
807	Aghadunvane	Leitrim	130.9	001403	001403	[*]6210	51.6
813	Aghalateeve	Leitrim	69.8	000623, 001919	000623, 001919	-	51.6
1004	Moneen	Cavan	208.0	002032	-	6410	50.5
1249	Drumhome	Donegal	13.6	000138	000138	*6230, 6410	50.5
2329	Killure More	Galway	22.0	-	000254	[*]6210, 6410	50.5

Threat scores were also calculated for western counties surveyed in 2011 and 2012. These scores are of maximum benefit when viewed in conjunction with conservation scores, particularly for sites that have a high conservation score. Two of the sites with high conservation scores received high threat scores also – Cloonakillina, Mayo (1744) and Pollaghanumera, Clare (1609), highlighting the vulnerability of these important grassland sites. Most of the threats scored are associated with activities relating to agricultural improvements. Buffer zones around areas of special conservation value might help to mitigate unwanted effects from agriculture such as weedy species encroachment and damaging activities such as drainage and fertiliser application.

Mayo and Limerick had four sites each within the 16 most threatened sites, while Tipperary only had one. Five of the sixteen sites occur within an NPWS conservation site. This highlights the fact that designation does not necessarily decrease the threats to a site. In some instances poor management or, indeed, a complete lack of management, can be due to uncertainty among landowners regarding notifiable actions.

4.2 Condition assessment of Annex I grassland

The number of sites in the western counties surveyed in 2011 and 2012 recorded as having Annex I grassland was higher than in previous years, with the presence of Annex I grassland noted at 122 sites. A total of 135 areas of Annex I grassland were assessed in terms of their change in extent since 2000, structure and functions, and future prospects. The number of sites containing Annex I grassland in the west of Ireland (six counties surveyed during 2011 and 2012, and Cork, Donegal and Sligo) was significantly higher (totalling 199 sites) than the number of Leinster sites with Annex I grassland habitat (totalling 51 sites). These figures are most likely a reflection of the higher levels of agricultural activity and productivity in Leinster counties compared to the western seaboard counties. The conservation value of a number of sites in the west of Ireland was enhanced by also having non-grassland Annex I habitats present. For example, some areas of [*]6210 grassland were closely associated with the Annex I habitats Juniper scrub (5130), calcareous heath (4030) or limestone pavement (*8240). In the western counties surveyed in 2011 and 2012, 33 Annex I grassland areas (24.4% of areas assessed) received an overall assessment of *Favourable*.

Area assessment

Change in area (extent) was noted in the methodology in section 2 as being slightly biased towards the area boundaries visible on the 2005 aerial photographs. This fact is being mentioned specifically in this report as the series of aerial photographs used as base mapping for the digitisation of sites in 2011 and 2012, including Annex I grassland areas, is six to seven years old and is therefore likely to be less representative of the 2011 and 2012 site boundary than in previous years of this survey due to the greater time elapsed since the photographs were taken. While GPS points were used to map grassland habitat boundaries that were not visible on the photograph (such as a transition from [*]6210 calcareous grassland to non-Annex I quality calcareous grassland), existing features on the aerial photograph, such as hedgerows or patches of scrub, were used where present on the ground in 2011

and 2012. Slight differences in features such as thickness of hedges or extent of scrub encroachment may not have been seen on the ground to be significantly different from the photograph, and may therefore not have been mapped in the field. Many such changes are likely to have been smaller than the minimum mapping area; there may, however, have been some area changes that were above the minimum mapping area but not identified when mapping in the field. This may potentially have impacted slightly on the results for Area assessment, most of the Annex I areas having been recorded as having undergone no decrease in area. Four sites recorded a measurable loss of area, which can be attributed to quarrying, construction work (houses and roads) and disposal of industrial waste. Two sites underwent a slight increase due to recolonisation of bare ground in old quarry sites. The accurate assessment of area change will be much improved when a new series of aerial photographs becomes available, and also when the surveys switch from baseline to monitoring.

Structure and functions assessment

The National Conservation Assessments (NCAs) of Annex I grassland habitats were completed in 2013 (NPWS 2013) as part of Ireland's reporting commitments under Article 17 of the EU Habitats Directive. The structure and functions criteria previously used during the ISGS were reviewed and amendments were made as part of the NCA process. Additionally, new criteria were added for the *Nardus* grassland (*6230) structure and functions assessment to ensure that only species-rich examples of this vegetation type were assessed and that the calcareous sub-community of this Annex I habitat was recognised. Also, some negative indicators for *Molinia* meadows (6410) were removed as they characterise the fen-meadow variant of this habitat, rather than suggesting negative structure and functions. All relevés recorded during the entire course of the ISGS (2007-2012) were re-checked for correspondence to Annex I habitats, and all Annex I relevés identified were assessed using these new criteria (refer to Appendix 5 for a summary of the structure and functions criteria and threshold levels).

For the majority of criteria for each of the five Annex I grassland habitats assessed, there was a pass rate of 80% or greater. The structure and functions criteria with the lowest pass rates included forb component (42%) and litter cover (58%) for *Molinia* meadows (6410), and sward height (50%) for Hydrophilous tall herb fringe communities (6430). Litter cover and sward height along with scrub encroachment, bare ground, and grazing and disturbance depend to a large extent on the degree to which the habitat is managed. Inadequate grazing or mowing regimes may result in a build-up of litter and the development of a rank, tussocky sward, which in turn lowers the biodiversity of the habitat, resulting in a low forb component. This appears to be the case for *Molinia* meadows (6410), with two of the most common impacts recorded for this habitat being abandonment/lack of mowing and abandonment/lack of grazing.

The pass rate for the monitoring stops was lower across each of the Annex I habitats than for the individual criteria because a failure in any one criterion resulted in a failure for the monitoring stop overall. After expert judgement was applied *Molinia* meadows (6410) had the lowest pass rate (30%),

while the other four Annex habitats had 50% or greater of their stops passing. Festuco-Brometalia ([*]6210) had the highest pass rate (76%). In order for an area to acquire a *Favourable* status, all monitoring stops within the area must have passed the structure and functions criteria, apart from a few exceptions reviewed on a case-by-case basis. Clare and Limerick, which between them had the largest areas of *Molinia* meadow (6410), had no areas assessed as having *Favourable* structure and functions for this habitat. The importance of appropriate management is of vital importance to the structure and functions of Annex I grassland habitats. With the correct management, the pass rate for all Annex I grassland habitats could be higher. To that end, agri-environment schemes or initiatives, such as the Burren Farming for Conservation Programme (Anon. 2013) and NPWS farm plan scheme, aim to encourage farmers back to appropriate active management practices to help alleviate some of the problems caused by current management or lack thereof. Agricultural policies need to be more proactive in promoting participation in such schemes, particularly in counties which have greater areas of intensive agricultural activity, such as that of Tipperary and Limerick, where participation in such schemes tends to be lower (EPA 2006).

Future prospects assessment

The assessment of this parameter utilised the list of impacts given by Ssymank (2010). This attempts to list all the potential negative, positive and neutral practices that impact on Annex I habitats. In 2010, the first year in which this list of impact criteria was used, it was found that some negative criteria, such as scrub, bracken or heath encroachment, were not explicitly listed among the impacts and could no longer be scored individually, or could potentially be scored in a number of ways, such as “Problematic native species” or by inference from another category; for example, encroachment could be scored through the negative impact “Abandonment / lack of mowing”, if the field was formerly mown, or “Abandonment of pastoral systems, lack of grazing” if formerly grazed. Following a review of the impact criteria after the field season in 2010, the recording of encroachment by scrub or heath by using the code “Species composition change (succession)” and use of “Problematic native species” being reserved for the recording of bracken encroachment was utilised for the 2011 and 2012 field seasons.

Four of the top five negative impacts recorded relate to a lack of management and agricultural abandonment, with species composition change (succession) listed as the top ranking negative impact recorded for the Annex I grassland habitats. These impacts highlight the vulnerability of both non-Annex and Annex I grassland habitats to abandonment or lack of adequate management. Without the correct grazing or mowing regime in place, grassland habitats often succeed to scrub and woodland habitats, dense bracken can encroach and biodiversity can be lost as a result of the tall, rank, tussocky growth of a few dominant species. It is not surprising that the most commonly recorded positive impacts for the Annex I habitats comprise non-intensive grazing and mowing.

The list of impacts recorded for the western counties in 2011 and 2012 highlights the fact that many of the Annex I *Molinia* meadows (6410) are managed by grazing rather than by mowing. While positive

effects may be obtained in the short term with appropriate grazing, the long-term effects may be less beneficial than mowing. Mowing removes litter and keeps nutrient input low, as well as giving a uniform sward structure, whereas grazing can increase nutrient inputs and, if carried out to excess, has additional undesirable effects of trampling and poaching, particularly in wet meadows. Some of the best examples of both *Molinia* meadows (6410) and Lowland hay meadows (6510) surveyed during the ISGS have been those that have been maintained by mowing rather than by grazing. These include meadows at Glenasmole, Dublin (1300), Rossnowlagh Lower, Donegal (1248), Kilcolman, Cork (618), Moystown Demesne and Bullock Island, Offaly (109) and Clonmacnoise, Offaly (107), and from the western counties surveyed in 2011 and 2012, Cloongee, Mayo (1735), Aughinish, Limerick (2704), Lacka (World's End), Limerick (2708) and Reafadda, Tipperary (2908).

Non-intensive grazing, particularly cattle for Festuco-Brometalia ([*]6210) and sheep for *Nardus* grassland (*6230), were recorded as positive impacts, with intensive grazing recorded as a negative impact. The level of grazing activity, type of grazer and stocking density are therefore important considerations for management of these Annex I habitats. For Hydrophilous tall herb fringe communities (6430) non-intensive horse grazing was recorded as both a positive and negative impact.

Primary areas of Annex I grassland habitat

Martin *et al*. (2008) proposed the compilation of a list of Annex I grassland areas that were of exceptionally good quality in terms of their structure and functions and overall area. Such a list would act as a focus for grassland conservation efforts in the future. Fifty-four areas have been added to the list of primary areas of Annex I grassland habitat following the 2011-2012 survey of the six western counties.

Of the western counties surveyed in 2011 and 2012, Clare has the highest number of sites included in the primary areas list, with a total of 18 sites from the county listed as being of sufficient area and having good structure and functions. Fifteen sites are located in Galway, eleven in Mayo, six in Limerick, three in Kerry and one in Tipperary. Of the primary areas, eight of the Galway sites, one of the Tipperary sites, and four each of the Clare and Mayo sites are not within an NPWS conservation site (17 in total). Further sites for Galway (two sites), Clare and Mayo (one for each county) have less than 10% of their area within an NPWS conservation site. These sites may be prime candidates for including within a designated area through the extension of an existing conservation site boundary. Sites that fall completely outside an NPWS conservation site boundary should be examined with a view to designating them for the grassland habitats they support.

Festuco-Brometalia ([*]6210) is the most frequent of the primary Annex I grassland areas and it also has the largest area. Conversely Hydrophilous tall herb fringe communities (6430) has the smallest occurrence and area, with only one site in Limerick, Lacka (World's End) (2708), fitting the criteria for primary areas of Hydrophilous tall herb fringe communities (6430). It is expected that this Annex I

habitat is probably more common than the ISGS data suggest however, as it is more commonly associated with areas of swamp which was outside the remit of this survey of semi-natural grassland. Any future monitoring of Annex I grassland habitats should focus on these primary areas. These areas are of good quality, covering at least 1 ha of land with the majority having at least 50% of the stops passing the structure and functions assessment at each site. They represent the best examples of Annex I grassland habitat recorded across the six western counties.

4.3 Vegetation classification

The vegetation classification of all semi-natural and semi-improved grassland habitats using the ISGS full dataset (2007-2012) is outlined in a separate National Synthesis Report (O'Neill *et al.* 2013).

4.4 Concluding remarks

This survey of 337 semi-natural grassland sites in Clare, Galway, Kerry, Limerick, Mayo and Tipperary, representing years four and five and the third phase of the Irish Semi-natural Grasslands Survey, has further defined the methodologies used to study the range of different semi-natural grassland habitats within a region, to identify and assess Annex I grassland habitats, and to accurately map and store survey data within datasets using a combination of GIS, a Turboveg database and an Access database.

The data showed that semi-natural grassland sites in the six western counties tended overall to be somewhat larger than those found in Leinster counties, however there was a wide range of median site areas among the six counties themselves, with Galway sites having significantly smaller sites than the others, and Limerick sites the largest. Most of the sites surveyed in 2011 and 2012 that were ranked as having a high conservation value were found in Clare and the highest ranking site in the country was found in Limerick. A total of 54 primary areas of Annex I grassland habitat were found between the six counties; Clare again had the highest number of primary areas. The majority of sites with primary areas of Annex I grassland habitat or those with a high conservation score were associated with an NPWS conservation site.

There were some interesting contrasts between the six western counties surveyed in 2011 and 2012 and the other western seaboard counties. Limerick and Sligo grasslands were found to be more extensive and less fragmented than those in Tipperary and Cork, while sites in Mayo and Donegal tended to be fragmented due to the predominance of habitats other than semi-natural grassland (e.g. wet heath) within the landscape, as much as due to agricultural improvement. Galway, Clare and Donegal contained a significant proportion of both dry neutral and calcareous grassland and the associated Annex I habitat Festuco-Brometalia ([*]6210). In fact these three counties contain the largest areas of Festuco-Brometalia ([*]6210) surveyed in the country.

Results from this report underline both the threat to and the decline of semi-natural grassland in these six western counties. Semi-natural grassland, for the most part, has become a fragmented and marginal part of the Irish landscape, with both the problems of abandonment and increased agricultural activity playing a large role in this. Comparing the occurrence of Annex I habitats found during the ISGS, particularly Lowland hay meadows (6510), with their occurrence recorded by Austin O'Sullivan in the 1960s to 1980s (Bourke *et al.* 2007) highlights the poor conservation status of semi-natural grasslands in Ireland today. Byrne (1996) found that 38% of the sites documented by O'Sullivan during the 1970s no longer supported semi-natural grassland communities by 1994, and the ISGS dataset provides further evidence for this declining trend. The decline of meadows in the west of Ireland and the proportion of Annex I grassland habitats failing structure and functions assessments due to inadequate management highlights the importance of retaining and encouraging traditional management practices such as late mowing and winterage as carried out in parts of the Burren. Agri-environment schemes, such as the Burren Farming for Conservation Programme (Anon. 2013) and NPWS farm plan scheme, are already starting to have a positive effect in the areas where they have been implemented. However, these positive initiatives are yet to be implemented across a significant proportion of the country.

A detailed habitat map has been produced for each site, showing the Fossitt (2000) and Annex I grassland habitats, the position of all relevés and the location of any associated NPWS conservation sites (NHAs/pNHAs and SACs). These habitat maps are available as a digitised GIS layer which can be overlaid onto the aerial photographs and viewed or printed at any scale.

This report on the ISGS data collected within Connacht and Munster in 2011 and 2012, together with the report on the data collected in counties Carlow, Kilkenny, Laois, Louth, Meath, Westmeath, Wexford and Wicklow (Martin *et al.* 2013) over the same time period represent the final phase of this project. In addition to these final two regional reports a national report (O'Neill *et al*. 2013) has also been written that summaries the data collected across the whole country and presents a classification of semi-natural grassland in Ireland.

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