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Front cover, small photographs from top row:

A deep water fly trap anemone *Phelliactis* sp., Yvonne Leahy; **Common Newt** *Lissotriton vulgaris,* Brian Nelson; **Limestone pavement**, Bricklieve Mountains, Co. Sligo, Andy Bleasdale; **Garden Tiger** *Arctia caja,* Brian Nelson; **Violet Crystalwort** *Riccia huebeneriana*, Robert Thompson; **Coastal heath**, Howth Head, Co. Dublin, Maurice Eakin; **Meadow Saffron** *Colchicum autumnale*, Lorcan Scott

Bottom photograph: **Meadow with Great Burnet** *Sanguisorba officinalis,* Jim Martin

Floodplain and Callows Grasslands in Ireland

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Executive Summary

The first phase of the project utilised known datasets, such the Irish Semi-natural Grasslands Survey (ISGS), to identify 1,308 km² of potential floodplain grassland habitat including 114 ha of the three target Annex I habitats *Molinia* meadows (6410), Hydrophilous tall-herb (6430), and Lowland hay meadows (6510) across the EPA's 583 Water Framework Directive (WFD) subcatchments.

Access to Ordnance Survey Ireland's PRIME2 shapefiles was pivotal in providing accurately digitised field boundaries that ecological and management data could be added to during the project.

Twenty-seven callows and floodplain grassland sites were surveyed during the 2021 field season. A total of 1,026 fields covering 2,469.3 ha were surveyed and each field was represented by a polygon within a modified version of the PRIME2 shapefile (SCAL20_Field_sites). The largest site was the Suck River Callows NHA at 778.3 ha. The average size of the 27 floodplain sites was 91.5 ha and the average site covered 38 fields.

The 27 floodplain grassland sites were ranked using criteria (*e.g*. target Annex I habitat, hay meadows, area, rare floodplain species) developed during the project. The three National Heritage Areas (NHAs) were the three largest sites within the survey, and the Suck River Callows NHA was ranked in first position, with the River Little Brosna Callows NHA ranked third, and the Rinn River NHA ranked fifth. The four lowest-scoring floodplain grassland sites were all within the River Boyne catchment in the east of the country.

Across all 27 sites, the most common habitat surveyed was semi-natural wet grassland (Fossitt code GS4), which represented 62% of the survey area. Overall, semi-natural grassland and marsh habitats covered 70% of the total survey area. The management practices within all polygons where a grassland or associated habitat was present were recorded. Extensive cattle pasture was the most common management practice recorded across 43% of the survey area.

At least one of the three target Annex I habitats, or a potential target Annex I habitat (*i.e*. a grassland with close affinities to one of the target Annex I habitats), was recorded within 25 of the 27 floodplain grassland sites. A total area of 90.6 ha of the three target Annex I habitats was recorded during the survey, of which 51% was potential Annex I habitat. The most abundant of the Annex I habitats was 6410 with 20.3 ha recorded, and the most abundant potential Annex I habitat was 6510 with 27.8 ha recorded. New areas of the three target Annex I habitats were identified during the field study and these areas (41.6 ha) should be incorporated into the next round of Article 17 reporting.

In a departure from the ISGS, the *Structure and functions* parameter for the three target Annex I habitats was often assessed using a field-based rather than a plot-based approach (see Section 3.1.5 for details). A plot-based approach was only used for five of the 11 6410 assessments, three of the 11 6510 assessments, and none of the 15 6430 assessments. The field-based approach had the advantages of being quicker to record than a plot-based assessment and allowed every field to contribute to the assessment. During the current survey, the field-based assessment of the pressures impacting on the target Annex I habitats provided detailed information on the specific impacts within individual polygons. With these field-based data it was possible to propose conservation measures to try to reduce impacts on a field-by-field basis.

This study highlighted 16 floodplain grassland sites where at least one of the three target Annex I habitats has an unfavourable status. In all of these situations, specific conservation measures are required to improve the conservation status of these Annex I grassland habitats. In some cases these conservation measures are highlighted in the site reports, such as the 11 6510 sites where CA09: Manage the use of natural fertilisers and chemicals in agricultural production, is recommended as a measure to reduce the negative impacts of slurry spreading,

or the six 6410 sites where CA05: Adapt mowing, grazing and other equivalent agricultural activities, is recommended to tackle the negative impact of abandonment. A review was undertaken of the 23 floodplain grassland sites where target Annex I habitats were recorded (the two sites where only potential target Annex I habitats were recorded were not included within this review) and three areas of 6410 and two areas of 6510 were prioritised for the implementation of conservation measures.

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We are grateful to everyone who contributed to the planning and completion of this project.

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We would like to thank Maria Long for her assistance with the project, from the planning of the field surveys to providing comments on the final outputs. We would also like to thank her for her efforts trawling through the NPWS archives to source relevant paper-based surveys from the 1980s and 1990s.

This project utilised many different data resources that were kindly provided by different agencies, in particular the Office of Public Works (OPW), Ordnance Survey Ireland (OSI), and the National Biodiversity Data Centre (NBDC). Thank you to Gareth John and the GIS team in NPWS for providing the areas of the OSI's PRIME2 shapefile that are within a river floodplain, also thank you to Jochen Roller for providing the data on rare plant species that are located within floodplains.

Finally, we would like to thank the farmers and landowners for granting permission to survey their land and for the background information they provided.

1 Introduction

This project encompassed the review, collation, and digitisation of existing data for callows and floodplain grassland sites across Ireland, along with field surveys and a review of effective management practices. The final report and outputs from this project will be used by the National Parks and Wildlife Service (NPWS), and hopefully others, to guide and underpin future management and conservation decisions relating to callows and floodplain grasslands in Ireland.

Floodplains are the land adjacent to rivers which are covered by water only during floods; floodplains act as the interface between the catchment and the river (European Environment Agency, 2020). Larger Irish rivers, such as the Shannon, Lee, Suir, Nore, Barrow, Slaney, Munster Blackwater and Boyne, have extensive floodplains (Schindler *et al.*, 2016). In Ireland, the word callow is often used interchangeably with floodplain - it originates from the Irish word 'caladh', which can mean harbour or also river meadow (M. Long, pers. comm.). The word callow is most typically used in the context of the River Shannon system.

Within callows and floodplain grasslands the project focused on semi-natural grassland habitats as defined by Fossitt (2000), the associated habitats of marsh, fen meadow and tall-herb vegetation and the corresponding floodplain grassland Annex I habitats of *Molinia* meadows (6410), Lowland hay meadows (6510), and Hydrophilous tall-herb (6430) (NPWS, 2019).

Callows and floodplains are home to some of the most extensive areas of species-rich grassland in Ireland, including valuable areas of traditionally managed meadows. Previous research, such as the classification of meadow communities along the River Shannon (Heery, 1991) and the ISGS (O'Neill *et al.,* 2013) have highlighted the diverse range of grassland communities within callows areas. The range of ecosystem services, including flood protection, that callows and floodplain grasslands provide are also an important focus of research efforts (Schindler *et al.,* 2016; European Environment Agency, 2020). However, these important grasslands are under threat, and of particular concern are EU Annex I grassland habitats (European Commission, 2013) such as Lowland hay meadows, a habitat associated with callows and floodplain grasslands. With pressures and threats such as abandonment, agricultural intensification, drainage, and climate change all having an impact on callows and floodplain grasslands, the challenge is identifying where these impacts are taking place, their scale, and introducing measures to counteract them.

Data are required to inform the strategy that will be required to tackle the range of issues facing callows and floodplain grasslands. Among the questions that need to be answered are:

- Where are the grasslands of high conservation value located?

- How important are the non-annex floodplain grasslands?

- What are the issues affecting all semi-natural floodplain grasslands and how can these be addressed?

- What are the farming practices in these areas, and where is traditional low-intensity meadow management still taking place?

This project has gone some way towards addressing these questions and providing information and data on floodplain and callows grasslands in Ireland.

1.1 Project background and report structure

This project was organised into two distinct stages. Stage A involved the collection and collation of pre-existing habitat and management data on floodplain grasslands. These data were mostly stored as paper maps, or other paper-based resources such as reports. The digitisation of these data was primarily a GIS task. Section 2 of the report, entitled 'Data collation and site selection' covers this stage of the project. Stage B of the project involved the development of a field methodology to survey a subsample of the callows and floodplain grasslands highlighted during Stage A, and the presentation of the results of these surveys through summary charts, tables and site reports. This information is presented in Section 3 entitled 'Field survey and site assessments'.

Section 4 of the report 'Appropriate management for floodplain grasslands' combines the information from a review of this subject, undertaken during Stage A, with examples of floodplain grassland management collected during the field survey. The final section of the report, Section 5 'Discussion and recommendations', discusses the overall results from the project and looks forward with recommendations to help address current issues that are impacting the habitats and wildlife within callows and floodplain grasslands.

2 Section A: Data collation and site selection

The data collection involved a significant effort in sourcing and reviewing paper-based surveys from the 1980s and 1990s and a review of relevant NPWS files. In addition, ecologists in Ireland and further afield were contacted to locate relevant data and reports. The collation of the habitat and management data on floodplain grasslands from these paper-based surveys was primarily a GIS task. The first stage of this task was to review the available data resources and to make a decision on whether they could contribute to the GIS mapping. All floodplain grassland resources that were reviewed, even if they were not eventually used during the mapping, are listed in Appendix 1.

The GIS mapping task was divided into two parts: (i) to digitise historical data resources, and (ii) to devise a methodology for the creation and then ranking of a national floodplain grasslands dataset. Within the GIS shapefiles produced during the project polygons were used to map habitat and management data, and point files were used to map the location of vegetation plots recorded within floodplain grassland, or the associated target habitats of marsh, fen meadow and tall-herb vegetation. In addition, if habitat data corresponded to one of the target floodplain grassland Annex I habitats of *Molinia* meadows (6410), Lowland hay meadows (6510), or Hydrophilous tall-herb (6430), this was also recorded and mapped.

2.1 Digitisation of historical data resources

The first phase of the digitisation of historical data resources was to map a pilot study area in the vicinity of Bullock Island (ISGS site 109), using four non-digital (*i.e.* paper maps and associated reports) data resources: Nairn *et al.* (1988), Heery (1993), Heery (1994) and Heery & Keane (1999). One plot from the Irish National Vegetation Database (NVD) was located within the area being digitised and the data were utilised to add Irish Vegetation Classification (IVC) (Perrin *et al.,* 2018) and Annex I habitat labels to the historical data resource. The second phase of the digitisation covered a larger area and aimed to produce a map of the Shannon Callows between Portumna and Athlone, using the historical data resources of Nairn *et al.* (1988) and Heery (1993) to complement the digitised mapping of the callows that had previously been carried out for the ISGS (O'Neill *et al.,* 2013) and subsequent monitoring of Annex I grassland habitats (Martin *et al.*, 2018). The two historical sources Nairn *et al.* (1988) and Heery (1993) were chosen for mapping the larger area between Portumna and Athlone as during the digitisation of the Bullock Island area they were the resources assessed to hold the most valuable habitat and management data.

2.1.1 GIS Mapping

When investigating a widespread landscape feature, such as floodplain grasslands within Ireland, it is often useful to divide the total area into smaller compartments or sites. General rules were applied during this project for delimiting floodplain grassland sites. These were, where possible, that a site should be based on a previous study site (*e.g*. Nairn *et al.* (1988) or the ISGS), that sites should generally not cross county boundaries or major rivers, and that sites must not overlap each other. For the field survey and site assessment phase of the project (see Section 3 'Field survey and site assessments') sites were often split up into smaller areas of 50-75 ha area that could be surveyed by a two person field team within a day.

All digitisation of resources was undertaken in ArcMap at the 1:5000 scale or finer. A minimum mapping unit of approximately 10 m x 10 m was applied. The resources digitised for the pilot study, in the vicinity of Bullock Island, had originally been mapped on a paper copy of the six-inch map, so a digital version of the six-inch map was used as a base map to aid digitisation. For the second phase of the digitisation, mapping the larger area between Portumna and Athlone, the PRIME2 (OSI, 2018) shapefile was available and the vegetation polygons within the PRIME2 shapefile provided the base map for the digitisation of these specific resources. It should be noted that during all stages of this project the PRIME2 polygons were only altered

when it was obvious – either from field notes, mapping presented in reports, aerial photographs, or a combination of these – that there were multiple management units (*e.g*. individual fields with different grassland habitats) within a single PRIME2 polygon. When it was considered that there were different management units within the one polygon, the PRIME2 polygon was cut to reflect these differences. Adjacent polygons that contained the same habitat were not merged, in order to retain the mapping of the individual field boundaries from PRIME2.

The second phase of the digitisation aimed to produce a map of the Shannon Callows between Portumna and Athlone, using the data resources of Nairn *et al.* (1988) and Heery (1993). Within these two datasets the priority was to map areas or specific fields that had not been mapped by the ISGS and were subject to at least low probability flooding (mapped by the OPW River Flood Extents - Present Day - Low Probability (0.1%)). To accurately and efficiently map a large area of floodplain grassland using the available project resources, a hierarchical approach to digitisation was adopted. The first level in the hierarchy was the ISGS dataset (O'Neill *et al.,* 2013), which mapped areas of semi-natural grassland between 2007 and 2012; updated mapping conducted between 2015 and 2017 during an NPWS grassland monitoring survey (GMS) was also included within this dataset (Martin *et al.,* 2018). The second level in the hierarchy was to produce a digitised map of areas of floodplain grassland that had not been mapped by the ISGS, using the information provided by Heery (1993). The third level was to produce a digitised map of areas of floodplain grassland using the information provided by Nairn *et al.* (1988) to map areas that had not been mapped by either the ISGS or Heery (1993).

While mapping the information from Nairn *et al.* (1988) it was noticed that, although the data resource sometimes did not provide information on new areas of floodplain grassland habitats, it did often contain additional management data. This resulted in polygons that were mapped using Heery (1993) having additional management data added from Nairn *et al.* (1988) into the 'Notes' field of the shapefile. Overall, the hierarchical approach ensured that, within the Shannon Callows area between Portumna and Athlone, all floodplain grassland polygons that have been surveyed by the ISGS (2007 to 2012), GMS (2015-2017), Heery (1993), or Nairn *et al.* (1988) were mapped using the most recent data source. It should be noted that, as the ISGS mapping did not use the PRIME2 base map, there are some minor overlaps between the ISGS and the digitisation undertaken using PRIME2.

The resulting GIS shapefile SCAL20_VegetationPoly_SACclip, was based on the PRIME2 vegetation polygons that intersected the River Shannon Callows SAC (site code 000216), with 750 polygons mapped based on the information in the Heery (1993) and Nairn *et al.* (1988) resources. This shapefile was created with the attribute table design outlined in Table 1, with five additional PRIME2 fields also retained to allow the original PRIME2 polygons to be identified and to display the 'Form' (*i.e*. habitat type) and 'Function' (*i.e*. land use) data from PRIME2 (see Section 2.2 below).

Table 1 GIS attribute table for the habitat and management data shapefile based on the historical data resources.

Field	Description
SITE_ID	Unique number based on the ISGS site if there is one and then sequentially from 4000 onwards
SITE_NAME	Unique name based on the ISGS site if there is one. If not, a locally used name for the site, a site name used by a previous study, or the townland name will be used.
COUNTY	Irish county the floodplain grassland is located within
CATCHMENT	EPA river catchment (e.g. Lower Shannon)
SAC_CODE	For the designated sites the floodplain grassland is located within
SPA_CODE	For the designated sites the floodplain grassland is located within
NHA_CODE	For the designated sites the floodplain grassland is located within
pNHA_CODE	For the designated sites the floodplain grassland is located within
OWNERSHIP	For example, private, state body or local authority. This is based on Land Registry data and utilises the codes listed in Table 2. The area that the ownership type covers is also indicated as in some case there are multiple types of ownership for a polygon
HCH_ID	Habitat codes (e.g. GS4) listed in Fossitt (2000). It is expected that some polygons will contain mosaics of different habitats. If a resource did not record grassland habitat data for the polygon 'grassland not recorded' will be entered in the field
IVC_ID	Irish vegetation community codes listed in https://www.biodiversityireland.ie/projects/national-vegetation-database/irish-vegetation-classification/. For most resources it is not possible to deduce the IVC community and in these cases 'Unknown' is entered in the field. If a resource did not record grassland habitat data for the polygon 'grassland not recorded' will be entered in the field
HDH_ID	EU Annex I habitat codes if applicable. 'None' is entered when there is no Annex I habitat. If a resource did not record grassland habitat data for the polygon 'grassland not recorded' will be entered in the field
HDH_CERT	Values range from 1 to 3 and indicate degree of certainty that the polygon represents the Annex I habitat listed, with 3 being high certainty and 1 being low. Zero was used when no grassland habitat data were recorded
ORIG_HAB	When mapping resources that did not utilise Fossitt (2000) or Annex I to classify habitats, BEC have added the resource's original habitat label, such as 'dry alluvial grassland'
ORIG_SHP	Holds name of original shapefile from which polygon was copied, or if the current project created the shapefile it will be labelled with BEC (2020). For BEC (2020) polygons the information source will be divided into 'Data source - description', 'Data source - paper map', or 'Data source - description and paper map'
DATA_SRCE	Reference for the data source (e.g. Heery and Keane 1999)
SRVY_DATE	Year the data were collected
IMPACT_1, IMPACT_2…	Impact and activities code (e.g. A08, A10). Version 2.3 of the 2017 EU list of pressures/threats will form the basis for the data recorded. When more than one impact has been recorded for a polygon, the impacts are listed and comma-separated

Table 1 (continued)

Field	Description
I_EFFECT_1, I_EFFECT_2…	The effect of the impact or management will be scored as neutral or negative
EUCM_1, EUCM_2…	EU list of conservation measures code (e.g. CA03). Version 2.3 of the 2017 EU list of conservation measures will form the basis for the data recorded
C_EFFECT_1, C_EFFECT_2…	The effect of the conservation measure will be scored as positive, neutral, negative
IECM_1, IECM_2…	A draft version of the Irish Conservation Measures (IECM) code (e.g. 177-37-136). A draft copy of the IECM hierarchy was provided by NPWS to trial during the project
MANAGMNT	Based on the management data provided by the original resource and using standardised management categories (see Table 3). If a resource did not record management data for the polygon, 'NR' (not recorded) will be entered in the field.
NOTES	Additional information on decision to include the polygon, or information on the polygon provided by the original resource

Within the attribute file based on Table 1 the 'Ownership' field was populated based on Land Registry data provided by NPWS and the codes listed in Table 2. The ownership information was incorporated into the main shapefile based on the Land Registry folio number. This resulted in three ownership outcomes for the 750 polygons within the SCAL20_VegetationPoly_SACclip shapefile. These were, a single owner (*e.g*. Electricity Supply Board (ESB) (3.5 ha)), multiple ownership (*e.g.* ESB (2.12 ha)/PVT (1.68 ha)), or unknown ownership. The areas of ownership are always shown, as in some instances the floodplain grassland polygons extended beyond the Land Registry data shapefile provided by NPWS. For the 24 polygons where the ownership was unknown this was either due to no overlapping polygon within the Land Registry data (*e.g*. No GEOMETRY_V106.shp overlap), or the overlapping polygon had no folio number with which to identify the owner (*e.g.* No Folio no. in GEOMETRY_V106.shp).

Table 2 Land registry ownership codes.

Ownership codes
PVT – Private ownership
BNM – Bord na Móna
CLT – Coillte Teoranta
CMU – community groups, including charitable organisations that are non-ecological in their operations
ECO – ecological NGOs, An Taisce, Irish Wildbird Conservancy (BirdWatch Ireland), etc.
ESB – Electricity Supply Board and its equivalents
GOV – government departments, Irish Land Commission, OPW, Waterways Ireland, etc.
HSE – health boards, psychiatric institutions, poor law union boards, guardians of the poor, etc.
LAU – local authorities, urban district councils, burgesses and aldermen, etc.
LTD – companies that are limited, unlimited, PLCs, DACs, TEO, etc.
SST – semi-state; for this project it does not include Bord na Móna, ESB or Coillte

Within the attribute file based on Table 1 the 'Management' field was populated using the codes and descriptions listed in Table 3. These codes were developed in consultation with the NPWS

grassland ecologist to capture the main management practices observed within floodplain grasslands.

Table 3 Standardised management categories recorded within the floodplain grasslands.

Code	Description
P1	Pasture - cattle
P2	Pasture - horses
P3	Pasture - sheep
P4	Pasture - cattle and horses
P5	Pasture - cattle and sheep
P6	Pasture - cattle, horses and sheep
P7	Pasture - stock unknown
P8	Alternating pasture and mowing
A1	Abandoned pasture
A2	Abandoned mowing
A3	Abandoned - original management unknown
H1	Mown with aftergrazing
H2	Mown with no aftergrazing
H3	Mown - aftergrazing unknown (i.e. it is unknown if aftergrazing is occurring)

2.1.1.1 Notes on the digitisation of specific resources

Nairn *et al.* (1988): This resource included data on land use and plant communities; however, for many sites the information on plant communities was limited. The information provided by Nairn *et al.* (1988) was mapped for areas that appeared to be floodplain grassland or the associated target habitats of marsh, fen meadow or tall-herb vegetation, either due to information within the resource, aerial photographs, or a combination of both. For the digitisation of the pilot study site in the vicinity of Bullock Island, mapping of the plant communities in Nairn *et al.* (1988) was viewed in the context of the ISGS data. When the mapped outline of the two coincided, the ISGS polygon outlines were used to add clarity and avoid multiple thin slivers. When adding habitat labels to the Nairn *et al.* (1988) dataset, the description of the plant community in Nairn *et al.* (1988) was taken into account, together with any NVD plots (most often ISGS plots) that were located within the polygon. When the plant community described in Nairn *et al.* (1988) matched the NVD plot, the habitat or IVC name assigned to the NVD plot were utilised. If the plant community differed then it was always still possible to add a Fossitt code, but the IVC community was almost always added as unknown. Habitats described by Nairn *et al.* (1988), such as tall grass washland with *Glyceria maxima*, tall sedges, and reed swamp, that do not correspond to the target habitats and would be classified under Fossitt as FS1 (reed and large sedge swamp) were not mapped; however, tall grass washland with *Phalaris arundinacea* was mapped, as this is often more closely related to GS4 (semi-natural wet grassland).

National Areas of Scientific Interest (ASI) survey of the Shannon Callows (Heery, 1993): This resource included data on land use and plant communities. The ASI mapping utilised target notes that in some cases referred to very specific areas and in others referred to broader areas. In the situation where target notes were non-specific, for example ‘most of the subsite consists of lowland wet (callow) grassland typical of the Shannon Callows’ with no annotation or unclear annotation on the map, it was not possible to accurately digitise the information. For the digitisation of the pilot study site in the vicinity of Bullock Island, the mapped target notes were viewed in the context of the ISGS data. When the mapped outline of the two coincided, the ISGS polygon outlines were used to add clarity and avoid multiple thin slivers. When adding

habitat labels to the ASI survey dataset, the description of the plant community in the notes was taken into account, together with any NVD plots (most often ISGS plots) that were located within the polygon. When the information provided by Heery (1993) indicated that an area was floodplain grassland but did not provide any detailed management data, the management information provided by Nairn *et al.* (1988) was added to the polygon if it was available. When the management data from Nairn *et al.* (1988) were used in this way, it is recorded in the 'Notes' field of the shapefile.

When applying the hierarchical approach used during phase two of the digitisation process, situations did arise where Heery (1993) indicated that an area was reed and large sedge swamp, but Nairn *et al.* (1988) mapped the same areas as a target habitat such as marsh or wet grassland. Where at least one data source indicated that an area matched one of the target habitats, it was digitised. It is unclear if the differences between data sources were due to genuine change between 1987 and 1993, or differences in the vegetation classification or nomenclature used by the two projects.

Heery (1994): This resource focused on management data, labelling areas as pasture or hay meadow, with some limited information on plant communities. Information was also provided on the future management of areas, but these data were not mapped during phase one of the mapping process. During phase one, the maps were viewed in the context of the ISGS data. When the mapped outline of the two coincided, the ISGS polygon outlines were used to add clarity and avoid multiple thin slivers. As information on plant communities was limited, 'grassland not recorded' was mapped for most habitat information, with a Fossitt habitat only added in the instances when some information on plant communities had been recorded.

Heery & Keane (1999): This resource included data on land use and plant communities and is the earliest dataset to map Annex I habitats. The Heery & Keane (1999) mapping utilised target notes that in some cases referred to very specific areas and in others referred to broader areas. For the digitisation of the pilot study site in the vicinity of Bullock Island, the mapped target notes were viewed in the context of the ISGS data. When the mapped outline of the two coincided, the ISGS polygon outlines were used to add clarity and avoid multiple thin slivers. When there was no coincidence between maps, new polygons were created to follow the Heery & Keane (1999) mapping and the description in the notes. When adding habitat labels, the description of the plant community in the notes was taken into account, together with any NVD plots (most often ISGS plots) that were located within the polygon. New Annex I polygons were mapped for the pilot study area around Bullock Island to investigate the data available within the resource and in particular assess its usefulness for adding additional habitat information to the mapping. Due to the time and resources it took to re-map the Heery & Keane (1999) data in the vicinity of Bullock Island it was decided that for the national mapping of floodplain grassland it would be a better use of resources to utilise the previous mapping of this dataset that had been carried out for the 2013 Article 17 reporting.

For the digitisation of the pilot study site in the vicinity of Bullock Island, there were five additional datasets (Heery, 1991; Borggreve & de Groot, 1996; Bron & de Heer, 1996; Maher, 2013; Owens, 2016) that have recorded relevant information in the area, such as grassland plot data, but could not be digitised, often due to a lack of detailed location data. These five datasets are summarised in Appendix 1. It should be noted that there were two outstanding ASI datasets, the Suck River Callows and Dovegrove Callows, that were not digitised and added to the SCAL20_VegetationPoly_SACclip GIS shapefile during this first phase of the project due to a lack of time and resources. 2.1.2 Conclusions on the digitisation of historical data resources

The digitisation of historical data resources focused on the GIS mapping of the data from two reports, Heery (1993) and Nairn *et al.* (1988) to produce a complete map of the Shannon Callows area between Portumna and Athlone. The base map for the digitisation process was the PRIME2 shapefile, a recently available OSI resource. These digitised historical data, together with other available GIS layers, were used to compile a national floodplain grasslands dataset. This was utilised in the subsequent phases of the project to undertake a national

assessment of the callows and floodplain grassland resource within the country and choose sites for a field survey.

2.2 Methodology for the creation and ranking of a national floodplain grassland database

2.2.1 The use of the PRIME2 dataset to map potential floodplain grassland habitat in Ireland

In order to create a base map for the production of a national floodplain grassland map, a range of available GIS resources were reviewed. Of the reviewed resources the OPW's publicly available datasets that map the probability of river flood extent (high 10% probability, medium 1% and low 0.1%) were deemed the most useful. These three flood extent shapefiles were merged, and the resultant shapefile was clipped with the Ordnance Survey's PRIME2 shapefile (OSI, 2018). This work was carried out internally in NPWS, and the resultant shapefile named VEGETATION_POLY_CLIPPED_by_FluvCurr_001_010_100.shp was used as the basemap for the project. The vegetation polygons within the PRIME2 shapefile include two pertinent feature classes for ecologists, these are 'Form' and 'Function' (Table 4).

Table 4 The form and functions values for the vegetation polygons within PRIME2. In addition to those listed Function 632 = 'Not applicable'.

Form values	Function		
45 : Bog	20 : Field Allotment	497 : Unmanaged Woodland	595 : Grassland Rough Pasture
95 : Woodland Coniferous	65 : Burial Ground	534 : Field Rough Pasture	596 : Gallops
110 : Woodland Deciduous	83 : Cemetery	539 : Athletic Track	597 : Golf Driving Range
166 : Grassland	93 : Cillin	542 : Bowling Green	598 : Green Space
177 : Heath	123 : Field Cropland	560 : Pitch GAA	599 : Parkland
226 : Marsh	178 : Firebreak	561 : Pitch Hockey	602 : Pitch Cricket
238 : Woodland Mixed	213 : Graveyard	562 : Pitch Rugby	603 : Race Track
261 : Nursery	268 : Managed Woodland	563 : Pitch Soccer	604 : Showground
274 : Orchard	277 : Median	568 : Rail Verge	605 : Sports Ground
334 : Salt Marsh	319 : Grassland Pasture	572 : Road Verge	610 : Sports Ground Multiple Use
340 : Scrub	331 : Field Pasture	573 : Roundabout	615 : Golf Course
447 : Woodland General	340 : Polo Ground	585 : Tennis Court	616 : Golf Links
	496 : Unknown	586 : Traffic Island	617 : Pitch and Putt

To produce a national floodplain grassland dataset the habitat forms that were not grassland, marsh or other target habitats needed to be removed from the shapefile. From a preliminary assessment of the vegetation polygons within the PRIME2 dataset it appeared that the three main 'Form' categories that represented woodland (*i.e.* 95=coniferous woodland, 110=deciduous woodland, and 238=mixed woodland) consistently represented woodland or scrub habitat and could be removed from the national floodplain grassland dataset. To test this, 15 polygons from each of the three categories were chosen from throughout the dataset (polygons were ordered by object id and a polygon with an area greater than the minimum mapping unit of 100 m^2 was chosen approximately every 100 polygons), viewed using recent remote imagery, and the Fossitt (2000) habitats present within the polygons were identified. Of the 45 polygons viewed, 43 were 100% woodland or scrub and the other two polygons were either 70% woodland and 30% improved agricultural/semi-natural grassland, or 20% woodland and 80% amenity grassland. As grassland habitats were extremely uncommon within polygons classed in the three woodland categories and the small amount of grassland viewed was mostly of a lower conservation value (*i.e.* improved agricultural and amenity grassland), it was decided to remove these 11,704 woodland polygons from the national floodplain grassland

dataset. Of the remaining 122,636 polygons, 121,071 were grassland, 210 were marsh, and the five other categories, such as bog, only represented 1.1% of the dataset. From the preliminary assessment of the PRIME2 dataset, other habitats, such as bog, appeared to occasionally have areas of floodplain grassland or the associated target habitats of marsh, fen meadow or tall-herb vegetation within them, so no other habitats were removed at this stage in the process. The total area of potential floodplain grassland mapped by this dataset was 994 km^2 (representing 1.4% of the Republic of Ireland (ROI) area), of which 5.4% (54 km^2) has been previously surveyed by the ISGS. This updated version of the PRIME2 dataset was renamed PRIME_GRASS_POLY_CLIPPED_by_FluvCurr_National_v1.1.shp and is displayed below in Figure 1.

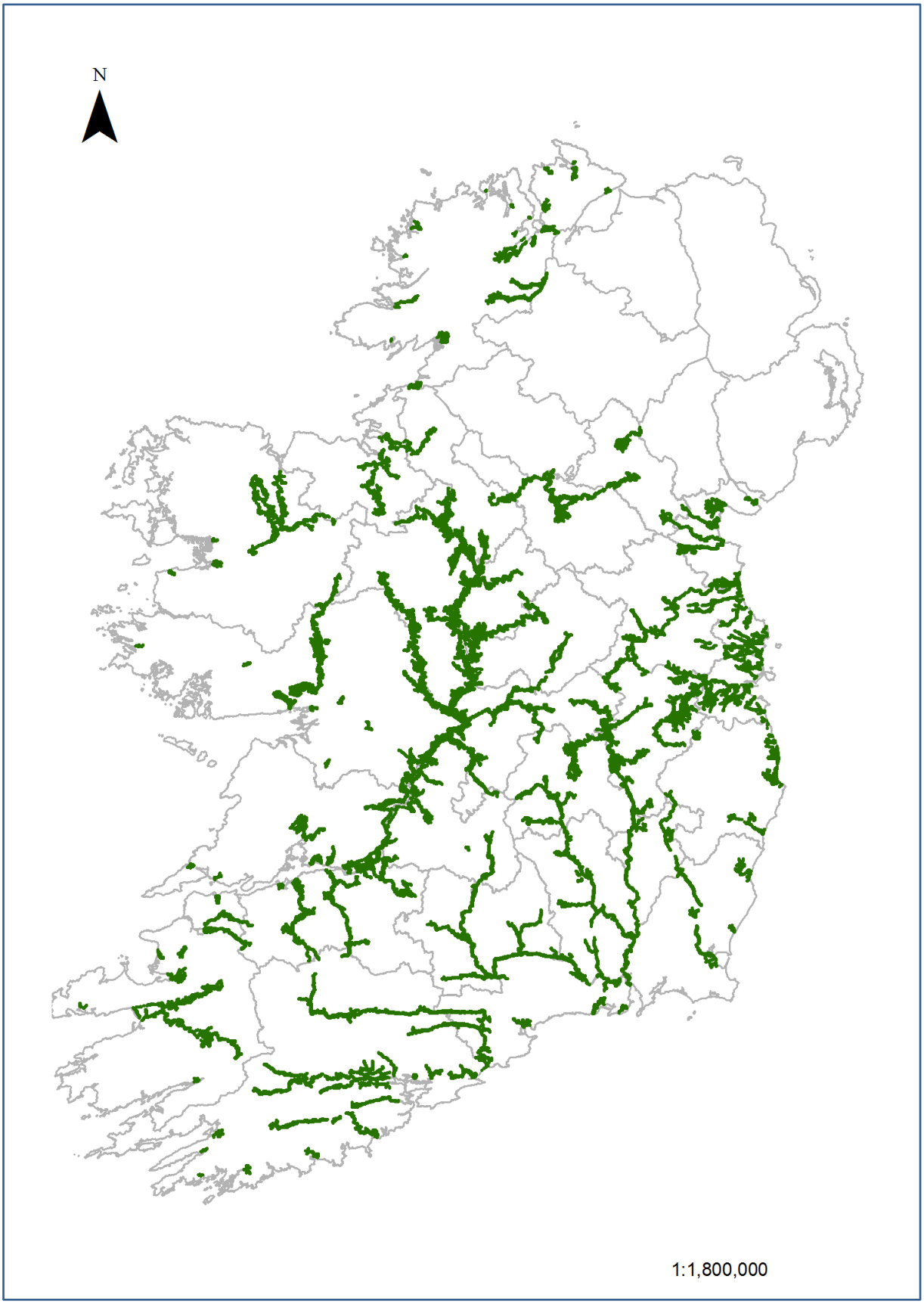

Figure 1 The areas shown in green are the potential floodplain grassland habitats in Ireland mapped by the PRIME2 dataset intersected with a merged version of the OPW's three datasets that map high (10%), medium (1%) and low (0.1%) probability of present day river flood extents (ROI only shown).

It should be noted that the OPW's three datasets that map high (10%), medium (1%) and low (0.1%) probability of present day river flood extents (public_ex_f_c_001_ITM.shp) do not cover all the fluvial flooding events that occur in Ireland (OPW, 2012a). The OPW identified 300 Areas for Further Assessment (AFAs) through a scoping phase called the 'Preliminary Flood Risk Assessment' (PFRA) (OPW, 2012b). The Catchment-based Flood Risk Assessment and Management (CFRAM) Programme then mapped those areas in each county where the flood risk was determined to be potentially significant (OPW, 2012b). In designating areas that required further assessment, the OPW considered the impacts that flooding can have on property, businesses, critical infrastructure, the environment and cultural heritage. As stated in the OPW's floodinfo.ie website, six CFRAM study areas, covering 29 of the WFD river basins, were assigned. A GIS intersection between the EPA's WFD river basins shapefile and the public_ex_f_c_001_ITM.shp shows that these 29 river basins cover almost the entire country, with the main gaps occurring in northwest Mayo, western Connemara, west Clare and west Kerry. These gaps can be seen in the map presented in Figure 1, together with other gaps such as, the mountainous areas of Wicklow where floodplain grassland would be expected to be less common due to the steep terrain and high elevation, and the Cavan-Meath border region where there is no immediately obvious explanation for the lack of floodplain grasslands.

Although the OPW's three River Flood Extents datasets (public_ex_f_c_001_ITM.shp) do not cover all known areas of flooding within the country, they still represent a very important resource that can be utilised to assist in the mapping of floodplain grasslands. As discussed below, other datasets that have also recorded flooding within grasslands (*e.g*. ISGS 2007-12) were also used to compile the national dataset. In addition, field surveys of a subsample of selected sites (see Section 3), will allow the coverage and accuracy of OPW River Flood Extents datasets such as the public_ex_f_c_001_ITM shapefile for use in projects such as this to be assessed further.

As Figure 1 shows, the areas of potential floodplain grassland have a linear pattern that follows the major river systems. Some of the areas of floodplain, such as the two in west Galway, are small and easily delineated for further study, but many of the areas are extensive and will need to be divided to facilitate further study. Having considered different administrative boundaries, such as county and townland boundaries, that could be used to compartmentalise the large floodplain grassland dataset, it was decided to utilise the EPA's WFD subcatchments. The reasons for using this dataset were, that it was freely available, it covered the whole country, there was an environmental basis (*i.e*. hydrological) to how the subcatchments were delineated, there are existing conservation initiatives associated with some of the subcatchments, and as a water-dependent habitat, a significant proportion of the floodplain grasslands will require listing on the register of protected areas under the WFD. For River Basin Management Planning (2015-21) the EPA divided the country up using 583 WFD subcatchments; the majority of these are between 100 and 200 km^2, an area which was chosen as an appropriate scale for community groups to work together to improve water quality (EPA, 2018). To promote community engagement, the subcatchments were also split each side of a main river channel. Of the 583 subcatchments, 69% (402 subcatchments) intersect with an area of potential floodplain grassland within the PRIME2 potential grassland polygons that were clipped with the OPW River Flood Extents shapefile and when additional datasets (*e.g*. ISGS 2007-12) are queried this rose to 86% (504 subcatchments).

2.2.2 The use of the National Vegetation Database to provide data on potential floodplain grassland habitat in Ireland

The National Vegetation Database (NVD) was established in 2007 by the National Biodiversity Data Centre, in conjunction with the NPWS (Weekes & Fitzpatrick, 2010). The NVD contains approximately 30,000 relevés and it is listed in the Global Index of Vegetation-Plot Databases and is part of the European Vegetation Archive. The NVD was searched for plots that were labelled as grassland, marsh or tall-herb vegetation under either Fossitt or the IVC, this search located 10,713 plots. The 10,713 plots were then reviewed to see which had accurate location data that would allow them to contribute to a national map, 9,154 plots had at least a four figure

grid reference that was located within ROI and these plots were saved as the NVD grassland plot database. The data resources listed in Appendix 1 were reviewed to assess if any that were not already within the NVD could contribute additional plot data. Only one dataset provided accurate location data and was not already within the NVD, this dataset was 22 plots from Tubridy (1988) and these were added so that the total number of plots within the database was now 9,176.

The NVD grassland plot dataset was then investigated to see if it could contribute data on floodplain grasslands. A 4 m buffer (buffer with an 8 m diameter) was added around all plots within the newly created NVD_grassland_plots shapefile to ensure that any plots adjacent to a floodplain were included. The buffer was restricted to 4 m because if it was larger than this, plots would be >4 m from the edge of the known flooding extent, representing the width of a country road or a ditch, and the potential for a change in flooding regime. The buffered plots were intersected, using the 'select by location' tool in ArcGIS, with the OPW River Flood Extents shapefile (public_ex_f_c_001_ITM.shp). This resulted in 874 potential floodplain grassland plots. Of the 874 potential floodplain grassland plots, 469 were collected during the ISGS and were already associated with mapped areas of semi-natural grassland including Annex I habitats. The remaining 405 plots that had previously been classified as a grassland community or associated target habitat under the IVC were then investigated to see if they had an affinity to any of the target floodplain grassland Annex I habitats of *Molinia* meadows (6410), Lowland hay meadows (6510), or Hydrophilous tall-herb (6430). Using the guidance provided on the website https://www.biodiversityireland.ie/projects/national-vegetation-database/irish-vegetation-classification/explore/ , a plot was classified as potential Annex I grassland habitat as follows:

- *Molinia* meadows (6410) if the IVC community was *Molinia caerulea – Succisa pratensis* (GL1C), or *Molinia caerulea – Potentilla erecta – Agrostis stolonifera* (GL1D);
- Lowland hay meadows (6510) if the IVC community was *Festuca rubra – Rhinanthus minor* (GL3E); and
- Hydrophilous tall-herb (6430) if they were IVC community *Agrostis stolonifera – Ranunculus repens* (GL2A) or *Filipendula ulmaria – Phragmites australis* (FW3F).

This resulted in 68 previously undocumented (*i.e*. not previously documented by the ISGS) potential 6430 plots, 47 potential 6410 plots, and three potential 6510 plots within areas of floodplain grassland.

2.2.3 Scoring system for floodplain grasslands within each subcatchment

A scoring system was developed to allow the floodplain grasslands within the 583 WFD subcatchments to be ranked. This ranking aimed to assist in the national assessment of floodplain grasslands and was used to help choose sites for a field survey. The scoring system allowed each subcatchment to score a maximum of 10 points (Table 5). There was a maximum score of three points for Annex I grassland habitats (a score of one for the confirmed presence of each of the target Annex I habitats 6410, 6430, and 6510), a maximum score of one for the presence of traditional hay meadow management, whether Annex I or non-Annex, a maximum score of five for the area of floodplain grassland, with a score of one for an area of Annex I habitat >5 ha and a score of one for each of the four categories of >5 ha, >50 ha, >250 ha and >500 ha. The final category was a maximum score of one for the presence of a rare floodplain grassland species. The scoring system is summarised in Table 5. In the case of both the confirmed presence of a category and the high potential of its presence, such as for the presence of an Annex I habitat within a subcatchment, the highest score was taken rather than both (*e.g*. a subcatchment could score one for confirmed *Molinia* meadows (6410) or 0.5 for potential 6410, but not 1.5 for the presence of both). When devising the area categories of >5 ha, >50 ha, >250 ha and >500 ha, these final four categories were chosen as they exhibited sensible scaling between categories (*i.e*. 10x, 5x, 2x). Also, the top scoring category was

significantly above the mean area of 224 ha of floodplain grassland per subcatchment. As the category size increased, the number of subcatchments within it decreased, with a simple linear relationship (Figure 2) resulting in just under half (43%) of the subcatchments scoring within the top two categories of >250 ha and >500 ha. The 79 subcatchments with no potential floodplain grasslands and the 27 with >0 ha to 5 ha were given no score based on area.

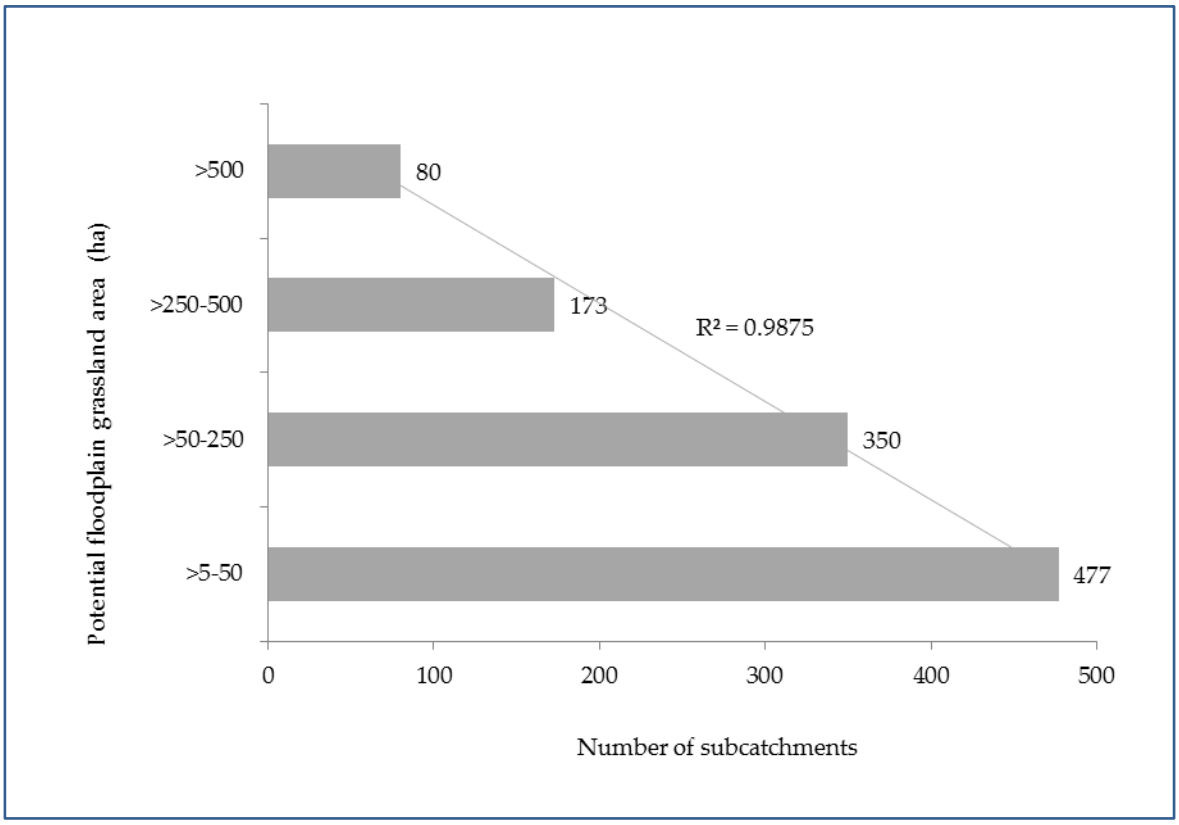

Figure 2 The four size classes of floodplain grassland utilised to rank the floodplain and callows grasslands. The cumulative number within each category ranged from 477 subcatchments in the >5 to 50 ha category to 80 subcatchments in the >500 ha category. There is a simple linear decrease in the number of subcatchments within each class, $R^2=1$ is linear.

The list of rare and uncommon plant species associated with floodplain grassland habitats was chosen based on the expert knowledge of the project team and then cross-checked with the information in the BSBI atlas (Preston *et al.,* 2002). The ten species chosen were *Bromus racemosus, Carum verticillatum, Colchicum autumnale, Hordeum secalinum, Juncus compressus, Lathyrus palustris, Mentha pulegium, Oenanthe fistulosa, Sanguisorba officinalis,* and *Spiranthes romanzoffiana.*

Table 5 The scoring system for assessing floodplain grasslands. A subcatchment cannot score twice for the same item (*i.e*. a subcatchment cannot score 1.5 for the presence of both a confirmed and high potential occurrence of a particular target Annex I habitat, or the confirmed presence and high potential of hay meadows).

Category	Subcategory	Max score
Annex I habitats within floodplain	Confirmed: score 1 for the confirmed presence of each target Annex I habitat, 6410, 6430, 6510	3
Annex I habitats within floodplain	High potential: score 0.5 if there is a high potential that a target Annex I habitat, 6410, 6430, 6510 is present	1.5
Hay meadow within floodplain	Confirmed: score 1 for the presence of traditional hay meadow management whether Annex I or non-Annex	1
Hay meadow within floodplain	High potential: score 0.5 if there is a high potential for traditional hay meadow management, whether Annex I or non-Annex, is present	0.5
Area: Score once for each category so that the maximum area score is 5	Target Annex I habitat >5 ha=1; potential floodplain grassland >5 ha=1; potential floodplain grassland >50 ha=1; potential floodplain grassland >250 ha=1; potential floodplain grassland >500 ha=1	5
Rare floodplain grassland species	A maximum score of for the presence of one or more of the following species: *Bromus racemosus, Carum verticillatum, Colchicum autumnale, Hordeum secalinum, Juncus compressus, Lathyrus palustris, Mentha pulegium, Oenanthe fistulosa, Sanguisorba officinalis, Spiranthes romanzoffiana*	1
TOTAL SCORE		10

The scores for the 583 subcatchments (Excel file SCAL20_WFD Subcatchments scores is listed within the resource catalogue and available for download from the NPWS website) were used to rank them nationally. The current scoring system is relatively simple, and complexity and further information could be included in the future by scoring areas of potential floodplain grassland that overlap with a Natura 2000 site, or with SACs where one or more of the target grassland Annex I habitats (6410, 6430, 6510) are listed as a qualifying interest.

2.2.4 The GIS methodology used to calculate ranking scores for the floodplain grassland within each subcatchment

As discussed above, OPW's three River Flood Extents datasets that map high (10%), medium (1%) and low (0.1%) probability of present day river flood extents (public_ex_f_c_001_ITM.shp) do not cover all the fluvial flooding events that occur in Ireland (OPW, 2012a). Therefore, the analysis also utilised polygons from:

- ISGS15_Habitats: this NPWS shapefile recorded the Fossitt and Annex I habitat polygons mapped during the ISGS 2007-12 and updated during the grassland monitoring survey 2015-18. Polygons were included which were outside public_ex_f_c_001_ITM.shp but within sites where either seasonal flooding or a floodplain was recorded by O'Neill *et al.* (2013).
- The OPW dataset national_hma.shp: this OPW shapefile (OPW, 2020) recorded the Fossitt and Annex I habitat polygons mapped as part of the flood relief scheme environmental spatial data collected by the OPW from 2013-18. Polygons were included that recorded a target habitat. As the dataset was collected in relation to OPW flood relief works associated with rivers, it was considered likely that almost all of its polygons would be within the river floodplain and polygons were included here if they recorded a target habitat.

- Other relevant information: such as information on individual sites provided by NPWS: this was utilised on an *ad hoc* basis. Where additional information, from NPWS or other sources, was used, it was recorded within the notes of the ranking score for the relevant subcatchments (see Excel file SCAL20_WFD Subcatchments scores within the resource catalogue).

Each component of the floodplain grassland score for each WFD subcatchment was calculated using the following methodology.

Confirmed Annex I habitats score: The following NPWS shapefiles were intersected, using the 'select by location' tool in ArcGIS, with the merged version of the OPW's River Flood Extents dataset (public_ex_f_c_001_ITM.shp):

- ISGS15_Habitats.shp
- ISGS15_AR1719_6410_NCADist_points.shp
- ISGS15_AR1719_6410_NCADist_polygon.shp
- NSUH17_AR1719_6430_NCADist_point.shp
- ISGS15_AR1719_6510_NCADist_polygon.shp (there is no equivalent point shapefile for this habitat)
- NSUH17_AR1719_6430_NCADist_polygon.shp

For the Article 17 National Conservation Assessment (NCA) shapefiles there are certainty scores associated with each of the Annex I grassland polygons, for this project all three certainty scores of one, two and three were used to indicate the confirmed presence of the Annex I habitat. Target Annex I polygons within ISGS15_Habitats.shp which were outside public_ex_f_c_001_ITM.shp but within ISGS sites where either seasonal flooding or a floodplain was recorded were included within the analysis. Also, all the polygons from the OPW dataset national_hma.shp where a confirmed Annex I habitat was recorded were utilised. All datasets were intersected with the EPA's WFD_Subcatchments.shp and the presence of the target Annex I habitats within each subcatchment was scored. There are four subcatchments where the presence of the target Annex I habitats is only recorded by a point. As the area is unknown, no Annex I area was recorded for these subcatchments.

High potential Annex I habitats score: The following shapefiles were intersected with the WFD_Subcatchments.shp and the presence of potential target Annex I habitats within each subcatchment was scored:

- NVD_grassland_plots.shp (a subset of plots that were classified as IVC communities that have a high affinity with target Annex I habitats),
- SCAL20_VegetationPoly_SACclip.shp (polygons listed as having an Annex I habitat present based on the descriptions from Nairn *et al.* (1988) and Heery (1993))
- OPW_national_hma.shp (a subset of polygons listed as having potential Annex I habitats)

Confirmed hay meadow score: Of the available datasets only Nairn *et al.* (1988) and Heery (1993) recorded non-Annex hay meadows. For datasets such as the NPWS shapefiles ISGS15_AR1719_6510_NCADist_polygon.shp and ISGS15_Habitats_ITM.shp the presence of 6510 within each subcatchment was scored as confirmed hay meadows. This assumption was based on the knowledge of the project team that compiled these datasets and only classified an area as the Annex I habitat 6510 when it was thought to be managed as hay meadow. For the field survey (see Section 3) hay meadow management was recorded for both Annex I and non-Annex grasslands.

High potential hay meadow score: The OPW shapefile national_hma.shp was intersected with the WFD_Subcatchments.shp and the presence of 6510 was scored as a high potential for hay meadows being present. This was based on the assumption that where the 6510

habitat is confirmed by the OPW dataset there is a high potential, but no confirmation, that the area is managed as hay meadow. Also where the SCAL20_VegetationPoly_SACclip.shp had digitised areas of hay meadow recorded in 1987 and 1993 (Nairn *et al.,* 1988; Heery, 1993) these areas were considered to still have a high potential to include hay meadow and were intersected with the WFD_Subcatchments.shp.

Area data: A GIS stacking technique was used to create a floodplain grassland shapefile that included all the available GIS data, but removed any overlaps, allowing accurate area data to be calculated for each EPA subcatchment. The baseline dataset used in the stack was PRIME_GRASS_POLY_CLIPPED_by_FluvCurr_National_v1.1.shp. Datasets based on more accurate grassland datasets were then stacked on top of this in the following order:

1. the OPW's national_hma.shp
2. AR1719_6430_6410_6510_NCADist_polygon.shp (this shapefile combines three NPWS shapefiles, ISGS15_AR1719_6410_NCADist_polygon, ISGS15_AR1719_6510_NCADist_polygon, and NSUH17_AR1719_6430_NCADist_polygon, and only polygons that intersected with the OPW's public_ex_f_c_001_ITM.shp were utilised)
3. ISGS15_Habitats_ITM.shp (only polygons that intersected with the OPW's public_ex_f_c_001_ITM.shp, or that were within sites where either seasonal flooding or a floodplain had been recorded by the ISGS were utilised).

The output dataset, called ISGS_ART17_OPW_PRIME.shp, was cleaned using the GEO_WIZARD tool. To calculate the area of floodplain grassland, this cleaned shapefile was intersected with the EPA's subcatchments shapefile and the area of intersection was calculated.

Rare floodplain grassland species: A list of rare and uncommon plant species associated with floodplain grassland habitats was chosen. The ten species are *Bromus racemosus, Carum verticillatum, Colchicum autumnale, Hordeum secalinum, Juncus compressus, Lathyrus palustris, Mentha pulegium, Oenanthe fistulosa, Sanguisorba officinalis,* and *Spiranthes romanzoffiana*. Only records within the last 50 years (recorded in 1970 or later) were analysed, with the assumption that records that had not been confirmed within the last 50 years were unlikely to still be extant. Rare plant records that intersected with the PRIME2 and OPW dataset national_hma.shp were provided by NPWS. In addition, the ISGS dataset was searched and records for seven of the ten species were located across 28 ISGS sites. Twenty-seven of the sites were classed as floodplain grasslands based on either an intersection with the public_ex_f_c_001_ITM shapefile, or because either seasonal flooding or a floodplain was recorded during the ISGS. The 874 potential floodplain grassland plots produced by the intersection between the NVD_grassland_plots and the public_ex_f_c_001_ITM.shp were also checked for the presence of the ten rare and uncommon floodplain grassland species. In total there were 106 subcatchments where at least one of the rare floodplain grassland species were recorded.

2.2.5 The ranking of the subcatchment floodplain grassland sites

Overall, the analysed GIS datasets covered an area of 1,308 km² of potential floodplain grassland habitat. The scores were calculated for the 583 subcatchments and 487 (84%) had a score above zero, 65 (11%) scored five or above, and five subcatchments attained the maximum score of 10. The average score per subcatchment was 2.5. The location of the subcatchments with low (score of 0 to 1), lower-middle (2 to 4.5), upper-middle (5 to 7), and high scores (7.5 to 10) are shown in Figure 3. As Figure 3 shows, the subcatchments with upper-middle and high scores are not evenly distributed around the country, but focused on the River Shannon Callows in particular, and to a lesser extent around the rivers Moy, Corrib and Boyne. This concentration of high-scoring areas is further illustrated by the fact that 20 (31%) of the 65 subcatchments that scored five or higher are associated with the River Shannon.

As the River Shannon is the largest river system in Ireland it would be expected that it contains a large area of floodplain grassland. However, it is also undoubtedly the most intensively studied area of floodplain grassland, and it is difficult to assess the contribution of surveying bias to the relatively higher scores for the Shannon subcatchments. It should also be acknowledged that the OPW's River Flood Extent maps are biased towards areas where the impact of flooding on critical infrastructure, property and businesses is the greatest (OPW, 2012a) and some low scoring subcatchments may be impacted by significantly higher levels of flooding than the current mapping indicates. These known biases within the floodplain grassland datasets cast some doubt on the floodplain grassland scores for subcatchments where less ecological data had been collected or that are outside of the OPW's flood maps. To counteract these problems, when selecting sites for further study during Stage B of the project, subcatchments covering a range of geographical areas and scores were chosen.

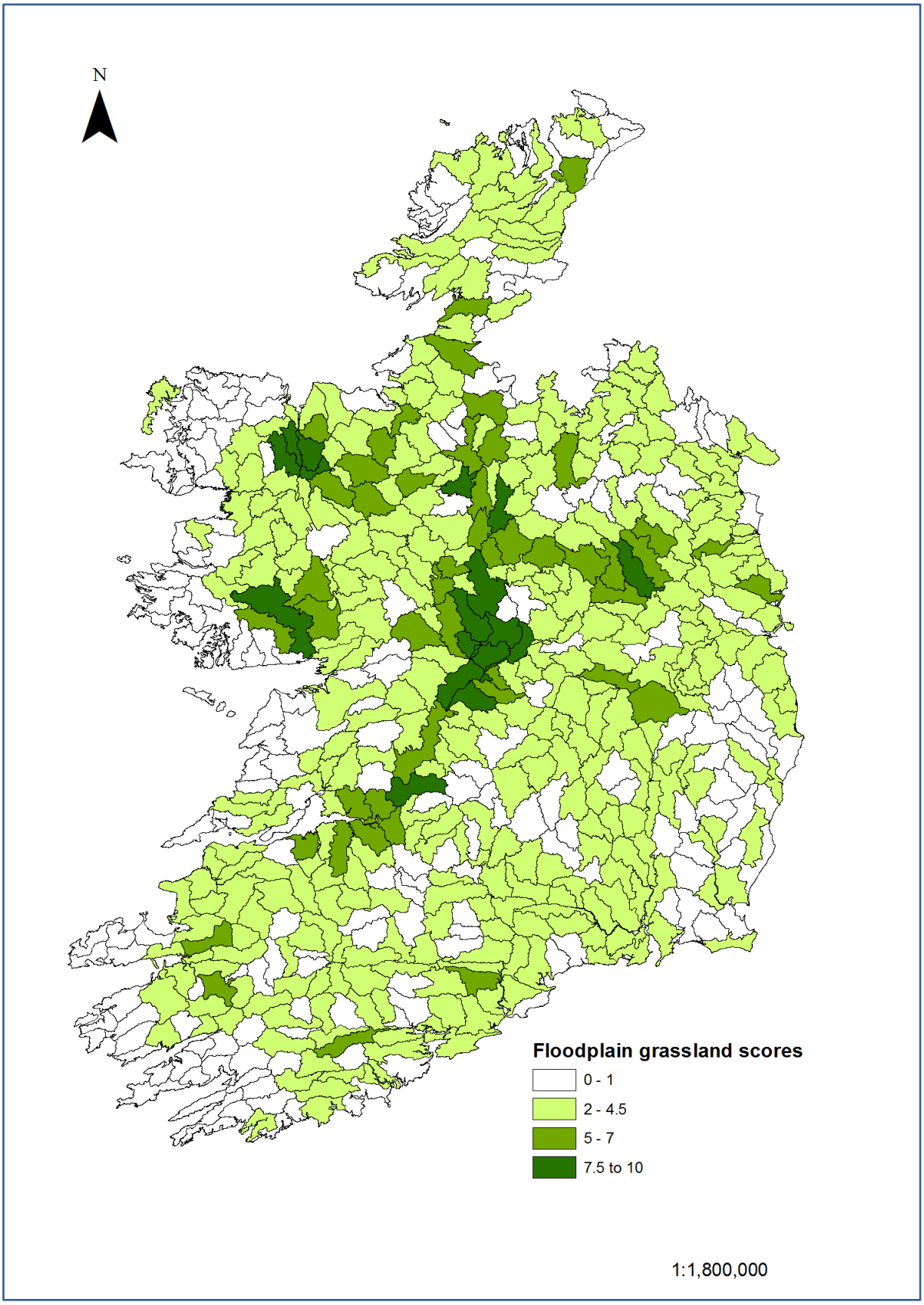

Figure 3 The location of the subcatchments with a low (score of 0 to 1), lower-middle (2 to 4.5), upper-middle (5 to 7), and high floodplain grassland score (7.5 to 10).

2.2.6 Site selection of subcatchments for a field survey

The aims of the site selection process for the field survey element of the project were three fold:

- Select sites within subcatchments that would be expected to support Annex I grassland habitats or habitats of high conservation value.
- Select sites that had not been recently monitored during the grassland monitoring survey (Martin *et al*. 2018)

Select sites within three Natural Heritage Areas (NHAs); Suck River Callows NHA (code 000222), River Little Brosna Callows NHA (code 000564), and Rinn River NHA (code 000691), where further information on floodplain grassland was required. All subcatchments with a score of one or less were discounted for further study, as they only scored within one of the categories listed in Table 5 and that was usually an area of potential floodplain grassland >5 ha. Site selection focused on subcatchments with upper middle or high floodplain grassland scores of five to 10 (Figure 3), but some sites were selected from subcatchments with lower middle scores to fulfil the broad aims of the site selection. Due to the large size of the subcatchments (average size was 12,185 ha) it was not possible within the time and resources of the study to survey each subcatchment in its entirety. Instead smaller areas were selected based on previous studies, such as Nairn *et al.* (1988), Heery (1993), and O'Neill *et al.* (2013), recommendations from ecologists who know the subcatchment, and by viewing each of the selected subcatchments with remote imagery.

In discussion with NPWS a total of 27 sites across 29 subcatchments were selected for a field survey. These 27 sites are listed in Appendix 2, together with the project site number that was carried forward for the field survey. The site numbers used for each site were the NHA site codes for the three NHAs, the ISGS site codes for sites that overlapped or were immediately adjacent to an ISGS site, and a new site code was generated for all other selected sites starting at 4000 (some of these new site codes such as 4002 and 4004 to 4011 were generated for areas that were mapped during the digitisation of historical data resources but were not selected for a field survey). The location of each of the selected field survey sites are shown in Figure 4 below. Where possible, data resources such as processed Copernicus data (*e.g.* the European Environmental Agency Water and Wetness (WAW) product (EEA 2018)), were used to provide additional evidence for flooding within the selected sites. This was especially important for grasslands outside the area covered by the OPW's flooding map, such as the O'Daly's Bridge site on the River Blackwater (Site 4016, Co. Cavan), where areas of grassland that overlapped with the 'Temporary water' and 'Temporary wet' categories within WAW (EEA, 2018) and were adjacent to permanent water (*e.g*. rivers and lakes) were judged to seasonally flood.

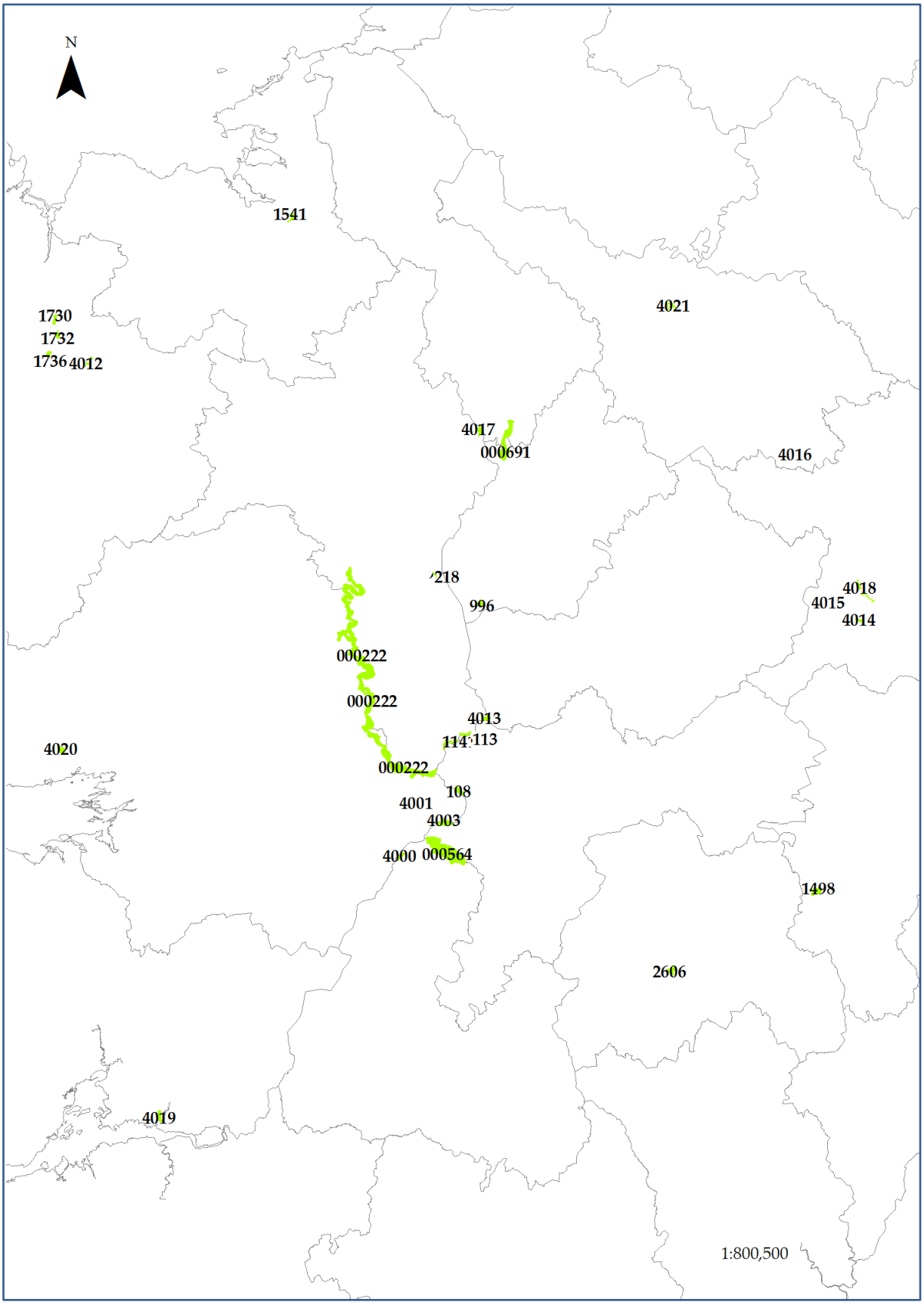

Figure 4 The location of the 27 floodplain grassland sites selected for a field survey. The site numbers that were used during the field survey are shown.

Table 6 The 27 floodplain grassland sites, listed by site number and name, the three NHA sites are listed at the end.

Site No.	Site name	Site No.	Site name
108	Leitra Callow	4012	Ballintemple
113	Drumlosh	4013	Kilgarvan
114	Cappaleitrim	4014	Ballyconnell (Meath)
218	Portrunny Bay	4015	Kilnagross
996	Newtown Cashel	4016	O'Daly's bridge
1498	Derryoughter East	4017	Roosky
1541	Cloonmacduff	4018	Kildalkey
1730	Sraheen	4019	Bunratty
1732	Foxford	4020	Lough Corrib
1736	Pollagh (Mayo)	4021	Derrygoss
2606	Barnadarrig (Shanahoe marsh)	000222	Suck River Callows NHA
4000	Redwood	000564	River Little Brosna Callows NHA
4001	Ballymacoolaghan	000691	Rinn River NHA
4003	Inishee and Esker Islands		

3 Section B: Field survey and site assessments

This section presents the methodology used to survey the 27 floodplain and callows grassland sites between May and September 2021 and the results from these surveys.

3.1 Field survey methodology

The field survey methodology details how the Fossitt and Annex I habitats and the management practices within each field (*i.e.* polygon) were recorded. The methodology also details the decision making process for recording vegetation plots, the mapping of waypoints, and for when PRIME2 polygons were split in the field. The last section of the methodology describes the collection of the data used to assess the target Annex I habitats recorded within the floodplain grassland sites.

3.1.1 Recording the Fossitt and Annex I habitats within each field

During the walkover survey of each site the ecologists recorded the percentage cover of the primary Fossitt habitat (*i.e*. the habitat with the highest cover) and primary Annex I grassland habitat (if present) within each PRIME2 vegetation polygon (often a single field). Habitats were recorded following the definitions in Fossitt (2000) and NPWS (2019) and using the Annex I assessment criteria presented in Martin *et al.* (2018) for the target Annex I habitats *Molinia* meadows (6410) and Lowland hay meadows (6510), and the criteria presented in O'Neill *et al.* (2013) for Hydrophilous tall-herb vegetation (6430). Percentage cover was recorded to the nearest 10%, with a few instances where the ecologist recorded to the nearest 5%. In addition to the primary Fossitt habitat, other Fossitt habitats present within each PRIME2 vegetation polygon were listed alphanumerically and comma-delimited (*e.g*. GM1, GS1, GS2, WS1). The mapping effort was focused on grasslands and associated target habitats such as fen meadows and tall-herb swamp vegetation; therefore boundary habitats such as treelines, hedgerows or boundary walls were generally not recorded and are not listed in the summary tables within this report.

Areas of *Molinia* meadows (6410), Hydrophilous tall-herb (6430) and Lowland hay meadows (6510) were recorded based on the presence of a threshold number of positive indicator species within the area being mapped. For both 6410 and 6510, this threshold was one high quality species and five to six positive indicators, and for 6430 the threshold was three positive indicator species. In addition, 6410 was only recorded when *Molinia caerulea* was present in the area, 6510 was only recorded when mowing was used in the management of the area, and 6430 was only recorded in areas with a tall sward (at least 50 cm tall) and where tall reeds and sedges were not a significant component of the vegetation (no greater than 33% cover).

3.1.1.1 Trialling criteria to record potential Annex I habitats

In addition, areas of potential 6410 and 6510 were recorded, with the following methodology trialled for identifying potential examples of these two Annex I habitats, based on a modified version of the criteria presented in Martin *et al.* (2018). A habitat was identified as a potential Annex I habitat if:

- one high quality plant species (*e.g*. *Cirsium dissectum* for *Molinia* meadows) plus <5 positive indicators were recorded within a polygon, or
- no high quality but >5 positive indicator species were recorded within a polygon, or
- for potential Lowland hay meadows only, if there was one high quality species (*e.g*. *Leucanthemum vulgare*) plus >5 positive indicators, but the area was managed by extensive (*i.e*. low intensity) grazing rather than mowing.

For the Annex I habitat 6430 some potential examples of this habitat were also mapped. Potential 6430 was mapped where the assessment criteria from O'Neill *et al.* (2013) were mostly met, except for broadleaf herb height, which was too low due to management by mowing.

3.1.2 Recording the grassland management within each field

The management within each polygon was recorded using the management categories listed in Table 3 (see Section 2.1 above). When recording the management type the ecologist noted if the management was extensive or intensive. Intensive management was recorded where examples of intensive agricultural practices were noted, such as slurry spreading, high stocking densities or the impacts of high stocking densities such as excessive poaching or a very short sward. Extensive management was recorded for situations where no intensive management practices were observed. For certain non-grassland Fossitt habitats, such as arable crops (BC1), no management type was recorded as none of the categories listed within Table 3 were appropriate. To add additional information on the management within each polygon an assessment was made of the appropriateness of the current management regime for floodplain grasslands and associated habitats such as marsh and fen meadow. If the management regime was appropriate and should be retained, the code 'R' was used; if the management level was low or the field was abandoned, the code 'I' was used to show that the management level should be intensified (*e.g*. increase the stocking rate); and if the management level was too intensive, the code 'L' was used to indicate that a less intensive management level was required.

3.1.3 Vegetation and monitoring plots

Generally, no 2 m x 2 m vegetation plots were recorded during the walkover surveys and instead a network of Annex I habitat vegetation monitoring plots were recorded at a subset of representative sites after all the floodplain sites had been visited. The exceptions to this were Annex I habitats within sites where access was problematic, meadow habitats that might be cut before the site was revisited, and some areas of the large Suck River Callows NHA that were surveyed towards the end of the field season.

The number of 2 m x 2 m monitoring plots per site was calculated following the guidelines listed in Table 7. With one or two of these plots full botanical relevés were also recorded, depending on the diversity of Annex I plant communities observed on the ground.

Table 7 Assessment plot-to-area guidelines (O'Neill *et al*. 2013).

Area of Annex I habitat	No. of assessment plots
<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+

Detailed botanical plots (*i.e*. recording the percentage cover of all vascular plants and bryophyte species) and assessment stops were largely limited to the Annex I habitats 6410 and 6510, but there were some plots recorded in other grassland habitats of high conservation value. Plots recorded within the three NHA sites and 13 new sites (sites numbered 4000 onwards) were numbered sequentially from one onwards within each site. Within sites that

overlapped or were immediately adjacent to ISGS sites, the plot numbers started at 30 to indicate that they were not recorded during the baseline survey (following on from the methodology of Martin *et al.* 2018). All plot data were recorded in Turboveg CE (Alterra, The Netherlands) and followed the nomenclature within the Turboveg species list Ireland2008v12; taxonomic standards for this list are: 1. Vascular plants, native and alien, list for Ireland: National Botanic Gardens, Glasnevin 2008; 2. Bryophytes, native and alien, list for Ireland, National Botanic Gardens, Glasnevin 2008; 3. Lichens: Coppins, B.J. Checklist of lichens of Great Britain and Ireland. London: British Lichen Society.

3.1.4 Additional information

Additional notes on the plant communities and management within each field were also recorded within the notes section of the SCAL20_Field_sites shapefile. These notes were used to describe management practices, such as the timing of mowing, or the abundance of particular species such as Soft rush (*Juncus effusus*), or species associated with the agricultural improvement of grasslands such as Perennial rye-grass (*Lolium perenne*). Additional notes were also used to describe the specific impact for the more generic EU pressures, for example to explain that A14 (Livestock farming) was used to refer to a stock feeder, or F07 (Sports, tourism and leisure activities) was used to record the trampling impact associated with a fisherman's walking route.

Waypoints were recorded using a Trimble nomad to record additional features that would add to the information within the PRIME2 polygons. Waypoints were used to record the presence of features and species of interest including the rare floodplain grassland species listed in Table 5 (see Section 2.2 above). Waypoints were also sometimes used to record the presence of target Annex I habitats that required additional location information, such as less common Annex I habitats.

Digital photographs were taken to record all vegetation plots, point features, and examples of the habitats observed within each site. Each image was labelled with a file name that included a subject and site location information. The general format that was used was to list the Annex I habitat (if present) first, then the Fossitt habitat, followed by polygon number and site number (*e.g*. 6510_GS2_1a_4000). If the image was of a particular species or management practice, this text was usually placed at the start of the label.

When surveying a site, if an obvious feature on the ground could be used to accurately split a PRIME2 polygon into different grassland habitats, this was done, for example an obvious fence that splits an area of pasture from an area of cut meadow. If PRIME2 polygons were divided in the field they were labelled a, b, c, *etc*., and all corresponding habitat and management data were recorded to correspond to each of the divided sections of a, b, c, *etc*. No merging of polygons was undertaken as the aim of the mapping was to retain all PRIME2 boundaries and only add detail by splitting polygons.

3.1.5 Annex I assessment methodology

For all areas of the three target Annex I habitats recorded during the field survey, a conservation assessment was undertaken at the site level, following the methodology used by Martin *et al.* (2018) and O'Neill *et al.* (2021), and the guidelines of DG Environment (2017). Annex I habitats were assessed using three parameters: *Area*, *Structure and functions*, and *Future prospects*. At a site level, the *Future prospects* assessment required an examination of the habitat's stability in terms of the other two parameters, *Area* and *Structure and functions*, and in the context of the impacts and activities (*i.e*. pressures) taking place in that Annex I habitat across the site (DG Environment, 2017). The balance between positive measures (beneficial management practices) and negative impacts (current pressures, future threats) was assessed and the *Future prospects* of the habitat at that site was evaluated. Each of the three parameters: *Area*, *Structure and functions*, and *Future prospects*, can receive an assessment of Favourable, Unfavourable-inadequate, or Unfavourable-bad, with parameter assessments combined to provide an overall assessment. It should be noted that a fourth

parameter, *Range,* was not assessed during this project, as this parameter is not assessed at the site level. The *Range* parameter is assessed separately at the national scale, as part of the National Conservation Assessment reporting (NPWS, 2019).

During this project conservation assessments were not conducted for potential areas of the target Annex I habitats, or for areas of non-target Annex I habitats (*e.g*. transition mires and alluvial wet woodlands) that were recorded during the survey. Generally, conservation assessments were also not undertaken for very small areas (<100 m²) of the target Annex I habitats.

Area parameter: For areas of the three target Annex I habitats that had been surveyed previously (*e.g*. Nairn *et al.,* 1988; Heery, 1993; O'Neill *et al.,* 2013) an assessment of any changes in the area of Annex I habitat over time could often be made. Where areas of Annex I habitat were mapped as part of the Article 17 National Conservation Assessments, any changes in area are highlighted in the results section below (see Table 9) for inclusion in the next round of Article 17 reporting. For areas of Annex I habitat where there were no previous data, the current survey provides the baseline data for the habitat and the *Area* parameter was scored as having not changed over time unless information collected during the field survey contradicted this assumption (*e.g.* information from the landowner). Investigating changes in area using remote imagery was considered, but based on previous experience (*e.g*. the ISGS and O'Neill *et al.,* 2021) it is very difficult to accurately assess any changes but the most obvious (*e.g.* new roads and houses), and it is also a very resource-intensive activity.

Structure and functions parameter: During the current study the time was not available to undertake a plot-based *Structure and functions* assessment for all areas of the three target Annex I habitats recorded during the field survey. Although some of these areas may be monitored by future NPWS surveys, an indicative assessment of the *Structure and functions* was developed, based on the polygon data (*i.e*. a field-based assessment rather than plot based) collected during the walkover surveys and additional notes that were recorded on habitat condition or species present. These additional notes were collected and stored primarily within the two notes fields within the SCAL20_Field_sites shapefile, two notes fields were required as each field within the shapefile can only store a maximum of 256 characters. Some additional notes were also stored in the notes field of the SCAL20_feature_points shapefile. It should be noted that the data collected for the field-based assessment of the *Structure and functions* criteria were collected on an *ad hoc* basis (*e.g.* notes written on the day and recorded within the SCAL20_Field_sites and SCAL20_feature_points shapefiles), with the overall assessment for the parameter made post survey, utilising these notes and photographs taken of the habitats during the field survey. This approach was not ideal and as discussed below, future surveys that utilise field-based assessments will need to be more specific in listing the individual criteria that have passed or failed, and the overall *Structure and functions* assessment (*i.e.* Favourable, Unfavourable-inadequate, Unfavourable-bad) for each target Annex I habitat within each field (*i.e.* polygon).

Future prospects parameter: As described above, the *Future prospects* assessment requires an examination of the habitat's stability in terms of two other parameters, *Area* and *Structure and functions*, in the context of the impacts and activities (*i.e*. pressures) that are taking place in that Annex I habitat.

If a target Annex I habitats was recorded within a polygon, the main pressures (Version 2.3 of the 2017 EU list of pressures available from DG Environment) acting on the habitat were recorded as either a negative or neutral pressure (no positive pressures were recorded during the field survey). Pressure intensity (Table 8) was assigned post-survey, using the approach developed from Ssymank (2009) by O'Neill *et al.* (2010). Overall percentage cover for each pressure was also assigned post-survey based on the area of the target Annex I habitat the pressure was recorded for. The conservation measures (Version 2.3 of the 2017 EU list of conservation measures) within each polygon were added post-survey based on the management categories recorded (see Table 3, Section 2.1) and the appropriateness of the current management regime. When appropriate management practices were observed (*e.g*.

extensive cattle grazing) with no negative pressures recorded, the code CA03: Maintain existing extensive agricultural practices was recorded. When inappropriate management practices (*e.g*. abandonment of grassland management) together with a corresponding negative pressure were observed, a conservation measure that should be applied in the future was recorded, such as CA05: Adapt mowing, grazing and other equivalent agricultural activities. The pressures and conservation measures within each polygon were recorded for the primary Annex I grassland habitat, if there were secondary Annex I habitats within the polygon, the pressures and management practices recorded were still applicable unless stated otherwise by the ecologist in the field.

Table 8 Ranking the intensity of a pressure on a site (O'Neill *et al*., 2010)

Intensity level	Subcategory
High	Great direct or immediate influence
Medium	Medium direct or immediate influence, mainly indirect influence
Low	Low direct or immediate influence, indirect influence

3.2 Results of the field survey

Section 3.2 presents the results from the field survey. The first section presents the general summary results for the data collected at the 27 floodplain sites, then the data collected for the assessment of the three target Annex I habitats across the 27 sites are presented, and the final section presents the overall floodplain grassland rankings for the sites based on the criteria listed in Table 5.

3.2.1 Summary results for the total survey area

Twenty-seven callows and floodplain grassland sites were surveyed between May 31st and September 10th 2021. A total of 1,026 fields covering 2,469.3 ha were surveyed and each field was represented by a polygon within the GIS shapefile (SCAL20_Field_sites). The largest survey areas were the three NHAs, with the Suck River Callows NHA by far the largest at 778.3 ha (32% of the total survey area), and the smallest site was O'Daly's Bridge (Site 4016, Co. Cavan) that covered 0.9 ha of potential Lowland hay meadows (p6510). The average size of the 27 floodplain grassland sites was 91.5 ha and the average site covered 38 polygons (*i.e*. fields) with 254 polygons within the largest site, the Suck River Callows NHA, and one polygon within the smallest site, O'Daly's bridge.

Across the floodplain sites that were selected based on the OPWs River Flood Extents shapefile, there was a high correlation between the boundary of the floodplain as mapped by the shapefile and the edge of the floodplain observed on the ground.

Across the 27 floodplain grassland sites 35 2 m x 2 m plots were recorded within 11 of the sites. Fourteen of the 2 m x 2 m plots recorded full botanical data (*i.e*. recording the percentage cover of all vascular plants and bryophyte species) and 21 of the plots recorded the assessment criteria listed in Martin *et al.* (2018) so that the *Structure and functions* parameter for the target Annex I habitats could be assessed. A plot-based assessment of the 6410 habitat was undertaken at five sites and a plot-based assessment of the 6510 habitat was undertaken at three sites. At the other three sites, plots were either recorded in a non-Annex I habitat or potential Annex I habitats. No plots were recorded within the 6430 habitat.

Across all 27 sites, the most common habitat surveyed was semi-natural wet grassland (Fossitt code GS4), which represented 62% of the survey area (Figure 5). Overall, semi-natural grassland and marsh habitats covered 70% of the total survey area. All habitat percentages are expressed as a percentage of the survey area classed as primary Fossitt habitat. These main, or primary Fossitt habitats accounted for 82% of the survey area, with minor or

secondary habitats – which were often the same 10 habitats (*e.g*. areas of FS1 and FS2 often occur as a minor component of a field where GS4 is the primary component) – accounting for the remaining 18%.

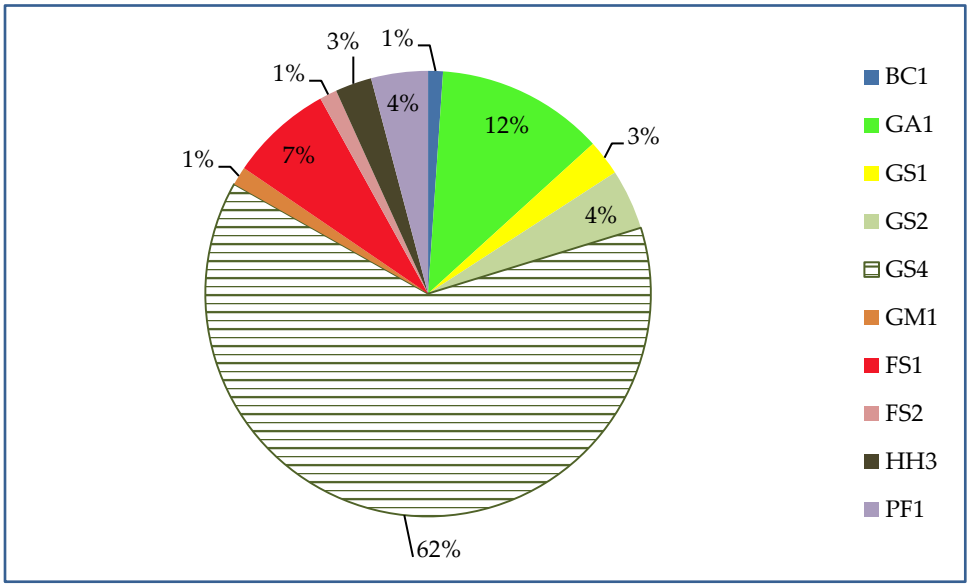

Figure 5 The percentage cover of the 10 most common Fossitt (2000) habitats recorded within the 27 surveyed sites. The most common habitat was semi-natural wet grassland (GS4) covering 62% of the survey area. The 10 habitats represent 98% of the area of primary habitats recorded during the survey.

At least one of the three target Annex I habitats, *Molinia* meadows (6410), Lowland hay meadows (6510), and Hydrophilous tall-herb (6430), or a potential target Annex I habitat was recorded within 25 of the 27 floodplain grassland sites. A total area of 90.6 ha of the three target Annex I habitats were recorded during the survey, of which 51% was potential Annex I habitat. The area covered by the three target Annex I habitats and potential Annex I habitats was 4% of the total survey area. The most abundant of the Annex I habitats was 6410 (Figure 6) with 20.3 ha recorded, and the most abundant potential Annex I habitat was 6510 with 27.8 ha recorded. The two sites where no target Annex I habitat or potential Annex I habitat were recorded were Kilnagross (Site 4015) and Kildalkey (Site 4018), both within the floodplain of the River Boyne and its tributaries in Co. Meath.

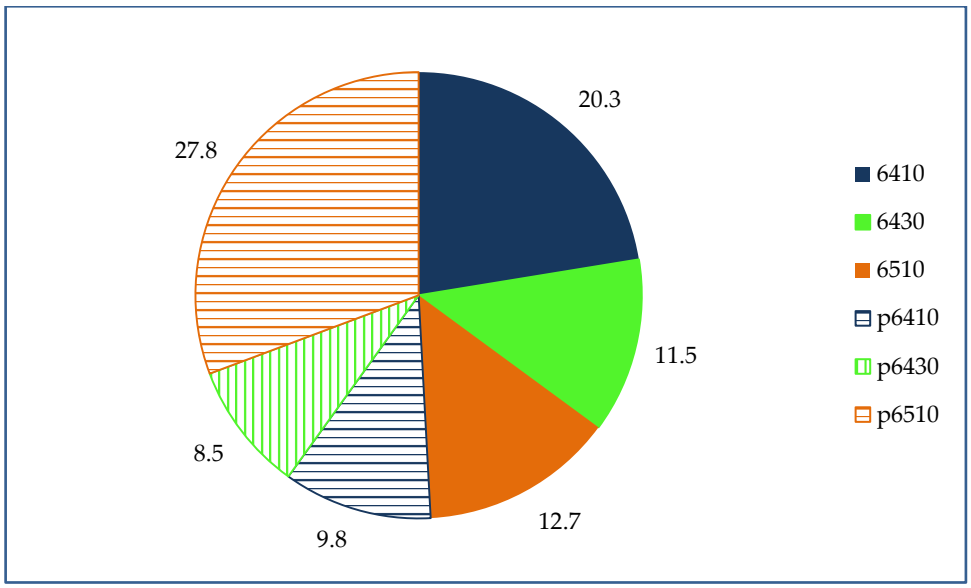

Figure 6 The total cover in hectares for each of the three target Annex I habitats; *Molinia* meadows (6410), Hydrophilous tall-herb (6430), and Lowland hay meadows (6510), and for the potential (p) target Annex I habitats.

The management practices within all polygons where a grassland or associated habitat was present were recorded. Management practices within habitats such as woodlands, private gardens and arable fields were not recorded. Extensive management practices were most commonly recorded (71% of the survey area), followed by intensive practices (15% of the survey area), and abandonment (14% of the survey area). Extensive cattle pasture was the most common management practice, recorded across 43% of the survey area. The 10 most common management practices account for 91% of the areas recorded during the survey (Figure 7).

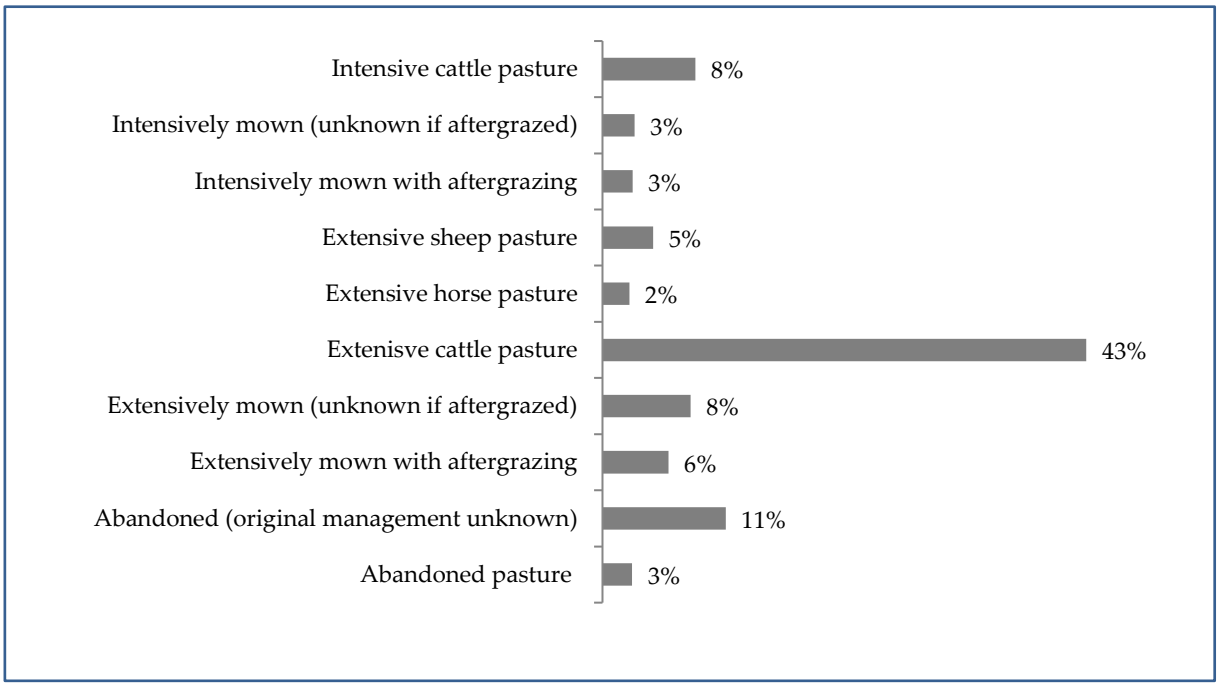

Figure 7 The percentage cover of the ten most common management practices within the floodplain grassland survey area.

3.2.2 Annex I conservation assessments

The conservation status for the three target Annex I habitats were assessed at the 23 sites where they were recorded; no assessment was undertaken for areas of potential Annex I habitat. For a more detailed discussion of the target Annex I habitats recorded within each of the sites consult the individual site reports (Appendix 3).

3.2.2.1 *Area*

The surveyed areas for the three target Annex I habitats at each of the sites is shown in Table 9. It should be noted that these are the areas for the primary Annex I grassland habitat recorded within each site and they don't include smaller secondary areas of Annex I habitat which were noted as present but no estimate of area was made. Due to the difficulty in detecting subtle changes in grassland habitats from remote imagery, and in the absence of baseline mapping with which to compare the current extent of Annex I habitat, the areas recorded during the current study were deemed to be the Favourable Reference Area (FRA) in all cases, except for the nine where baseline data were available (Table 9). The *Area* parameter for the three target Annex I habitats at the 23 sites where they were recorded was assessed as Favourable, except for the three instances highlighted in orange and red (Table 9) where the *Area* parameter was Unfavourable-inadequate due to a loss of area $\leq$1% decline in area per year, and Unfavourable-bad due to a loss >1% decline in area per year (DG Environment, 2017). Based on the data presented within the NCA a target Annex I habitat has been completely lost from one site, a 0.16 ha area of 6430 that has been lost from Sraheen (Site 1730, Co. Mayo). Based on a review of Heery (1993), that was undertaken during this project, a potential area of target Annex I habitat has also been completely lost, a 1.00 ha area of potential 6510 habitat that was not documented during the NCAs, but based on a review of Heery (1993) has been lost from Ballymacoolaghan (Site 4001, Co. Offaly). Overall, 41.57 ha of the total area of 44.50 ha of target Annex I habitats surveyed during the current study represented new areas that were not documented by previous NCAs (NPWS, 2019) and 5.64 ha previously documented by the NCAs had been lost from two sites (Cappaleitrim Site 114 and Sraheen Site 1730). These new data should be incorporated into the next round of Article 17 reporting.

Table 9 *Area* assessment for the three target Annex I habitats at each of the 23 floodplain sites where at least one of the habitats was recorded. The baseline data sources used were the NCA 2019 Article 17 reporting (NPWS, 2019) and Heery (1993). '-' = Annex I habitat not recorded, DATA = Unfavourable-inadequate, DATA = Unfavourable-bad, all other area data shown in the table were Favourable.

	2021 area data (ha)			
Site No.	**6410**	**6430**	**6510**	**Baseline data**
108	0.01	<0.01	0.22	NCA (0.21 ha of 6510)
113	-	0.09	0.07	None available
114	0.22	0.28	-	NCA (5.70 ha of 6410)
218	-	0.89	-	None available
996	0.04	0.08	-	None available
1498	0.44	-	-	None available
1541	0.69	<0.01	-	None available
1730	-	-	0.79	NCA (0.16 ha of 6430)
1732	-	<0.01	0.26	None available
1736	-	-	0.09	None available
2606	-	2.91	3.06	None available
4000	[1]5.83	<0.01	0.25	Heery 1993 (17.18 ha of p6410)
4001	-	<0.01	-	Heery 1993 (1.00 ha of p6510)
4003	1.07	0.25	-	None available
4012	0.04	<0.01	0.40	None available
4013	-	3.35	-	None available
4017	-	0.07	-	None available
4019	-	0.11	-	None available
4020	0.82	1.89	-	[2]NCA (1.21 6410; 3.47 ha 6430)
4021	-	<0.01	-	None available
000222	7.56	1.54	1.91	None available
000564	[1]10.95	-	5.58	Heery 1993 (28.83 ha of p6410); NCA (7.37 ha 6410)
000691	-	<0.01	0.10	None available
Total	27.67	11.46	12.73	The 6410 total includes 7.37 ha present within the floodplain of NHA 000564, that was not resurveyed in 2021

[1]See the Redwood (Site 4000) and River Little Brosna Callows (NHA 000564) site reports for discussions on why these areas were assessed as Unfavourable-inadequate

[2]For site 4020 the areas of 6410 and 6430 habitat were underestimated during the current survey as they were often recorded as secondary Annex I habitats, a judgement has been made that the area is unchanged from the baseline NCA data.

3.2.2.2 Structure and functions

The *Structure and functions* parameter was assessed based on plots at five 6410 sites and three 6510 sites; in all other instances an indicative field-based assessment of *Structure and functions* was undertaken, based on the polygon data collected and additional notes that were recorded on habitat condition or species present. No assessment plots were recorded within the 6430 habitat and all assessments for this Annex I habitat were field-based. The areas of 6410 and 6510 assessed using plots had a much lower instance of Favourable *Structure and functions* than the areas where a field-based assessment was undertaken. Only two sites (Site 1732 and NHA 000222) of the eight assessed using plots had a Favourable *Structure and functions*, whereas 11 of 15 areas of 6410 and 6510 assessed using a field-based assessment had Favourable *Structure and functions*.

Table 10 *Structure and functions* assessment for the three target Annex I habitats at each of the 23 floodplain sites where at least one of the habitats was recorded. '-' = Annex I habitat not recorded, NA = Annex I habitat area not assessed as it is <0.01 ha, Fav=Favourable, U-I=Unfavourable-Inadequate; U-B=Unfavourable-Bad.

	2021 area data (ha)			
Site No.	**6410**	**6430**	**6510**	**Note if assessment plot-based or field-based**
108	Fav	Fav	Fav	All field-based
113	-	Fav	U-B	6430 field-based, 6510 plot-based
114	Fav	Fav	-	All field-based
218	-	Fav	-	All field-based
996	Fav	Fav	-	All field-based
1498	U-B	-	-	6410 plot-based
1541	U-B	Fav	-	All field-based
1730	-	-	U-I	All field-based
1732	-	NA	Fav	6510 plot-based
1736	-	-	U-B	All field-based
2606	-	Fav	Fav	All field-based
4000	U-B	Fav	Fav	6410 plot-based, others field-based
4001	-	NA	-	No assessment
4003	U-B	Fav	-	6410 plot-based, 6430 field-based
4012	Fav	Fav	U-B	6410 & 6430 field-based, 6510 plot-based
4013	-	U-B	-	All field-based
4017	-	Fav	-	All field-based
4019	-	Fav	-	All field-based
4020	U-B	Fav	-	All field-based
4021	-	NA	-	No assessment
000222	Fav	Fav	Fav	6410 plot-based, others field-based
000564	Fav	-	Fav	All field-based
000691	-	NA	Fav	All field-based

The reason for the disparity between the two methods was the level of data recorded. A plot-based *Structure and functions* assessment recorded if each individual criterion passed or failed, whereas the field-based approach relied on the notes the individual ecologist recorded while walking through the area of Annex I habitat that was being assessed. As discussed in

Section 5 (see below) it is important that future studies that use a field-based assessment approach use a tick-sheet, or similar approach, to record if each of the individual *Structure and functions* criteria (*i.e.* high quality species, positive species, broadleaf herb cover, sward height, litter, bare soil, negative species, scrub/heath) from Martin *et al.* (2018) pass or fail.

It should be noted that in some instances, such as for the 6430 habitat at Leitra Callow (Site 108, Co. Offaly), a *Structure and functions* assessment was undertaken even though the area of the target Annex I habitat was <100 m². The individual site reports (Appendix 3) include a more detailed discussion on the *Structure and functions* of the target Annex I habitats recorded at each site (Table 10).

3.2.2.3 *Future prospects*

As shown in Table 11, nine pressures were recorded impacting on the three target Annex I habitats. Two of the pressures, A31: Drainage for use as agricultural land and F07: Sports, tourism and leisure activities, were only recorded as neutral pressures. The data presented show that L02: Natural succession resulting in species composition change and A06: Abandonment of grassland management, are the most frequent negative pressures recorded within the 6410 habitat; and A19: Application of natural fertilisers on agricultural land, is the most frequent negative pressure recorded within the 6510 habitat. These data provide some indication that abandonment and the consequences of undergrazing impact more on the 6410 habitat, whereas intensive management practices such as slurry spreading impact more on the 6510 habitat. Negative pressures were recorded less frequently within the 6430 habitat, with only seven negative pressures recorded within the 41 polygons where the habitat was recorded as a primary Annex I habitat, compared with 20 of the 33 polygons for 6410 and 17 of the 25 polygons for 6510. The impacts of individual pressures are discussed on a site-by-site basis within the individual site reports (Appendix 3).

Table 11 Summary of the pressures recorded within the primary areas of the three target Annex I habitats across all 23 sites. '-' = pressure not recorded.

	Negative pressure			Neutral pressure		
Pressure	**6410**	**6430**	**6510**	**6410**	**6430**	**6510**
A06: Abandonment of grassland management (e.g. cessation of grazing or mowing)	6	3	3	-	2	-
A09: Intensive grazing or overgrazing by livestock	-	1	-	-	-	-
A10: Extensive grazing or undergrazing by livestock	3	-	-	-	2	-
A13: Reseeding of grasslands and other semi-natural habitats	-	-	3	-	-	-
A19: Application of natural fertilisers on agricultural land	-	-	11	-	-	-
A31: Drainage for use as agricultural land	-	-	-	4	2	-
B01: Conversion to forest from other land uses, or afforestation (excluding drainage)	1					
F07: Sports, tourism and leisure activities	-	-	-	1	-	1
L02: Natural succession resulting in species composition change (other than by direct changes of agricultural or forestry practices)	10	3	-	2	-	-
Total	20	7	17	7	6	1

At the site level, the *Future prospects* assessment was an examination of the habitat's stability in terms of the two parameters, *Area* and *Structure and functions*, in the context of the impacts and activities (*i.e*. pressures) taking place within that Annex I habitat across each site. These assessments are presented within the individual site reports and summarised below in Tables 12 to 14.

The data presented in Table 12 shows that only two sites (Sites 108 and 4012), of the 11 where the 6410 habitat was assessed, have Favourable *Future prospects*. For some of these sites the reason for unfavourable *Future prospects* is clear, for example at three sites (Sites 1541, 4000, and 4020) the negative pressures of abandonment and undergrazing are negatively impacting the *Structure and functions* of the 6410 habitat. However, for other sites, such as the area loss at Site 114 and the unfavourable *Structure and functions* at Site 4003, it is unclear what pressures are negatively impacting the 6410 habitat and further data will need to be collected before conservation measures can be proposed. For two sites (Site 996 and NHA 000222) negative pressures have been identified, but no evidence of a significant impact on either the area of the 6410 habitat or the *Structure and functions* was identified. It should be noted that these pressures may have already contributed to a loss in the area of 6410 habitat at both these sites.

Table 12 *Future prospects* for the *Molinia* meadows (6410) habitat stability in terms of two parameters, *Area* and *Structure and functions*, and the pressures recorded. Fav=Favourable, U-I=Unfavourable-Inadequate; U-B=Unfavourable-Bad.

Site No.	FP of Area	FP of S&F	FP of site	Rationale
108	Fav	Fav	Fav	Positive and negative impacts in balance
114	U-B	Fav	U-B	A reduction in area over the last 22 years
996	Fav	Fav	U-I	Scrub encroachment is a negative pressure
1498	Fav	U-B	U-B	Unfavourable S&F (not enough positive species)
1541	Fav	U-B	U-B	Unfavourable S&F (high litter cover), negative pressures of abandonment and undergrazing
4000	U-I	U-B	U-B	Unfavourable S&F (high litter cover), negative pressures of abandonment and undergrazing
4001	Fav	U-B	U-B	Unfavourable S&F (low forb-to-graminoid ratio, not enough positive species)
4012	Fav	Fav	Fav	Positive and negative impacts in balance
4020	Fav	U-B	U-B	Unfavourable S&F (high litter cover, scrub encroachment, low broadleaf herb cover), abandonment ,and natural succession
000222	Fav	Fav	U-B	>25% of the area impacted by abandonment or natural succession
000564	U-I	Fav	U-B	>25% of the area surveyed during the current survey is impacted by natural succession resulting in species composition change, also area loss

Table 13 shows that 11 of the 15 sites where the 6430 habitat was assessed have Favourable *Future prospects*. At the other four sites, one is impacted by overgrazing (Site 113), one area of 6430 had a high cover of a negative species (Site 4013), and two of the sites (Sites 2606, 4020) are impacted by either abandonment or succession, that is often a consequence of abandonment.

Table 13 *Future prospects* for the Hydrophilous tall-herb (6430) habitat stability in terms of two parameters, *Area* and *Structure and functions*, and the pressures recorded. Fav=Favourable, U-I=Unfavourable-Inadequate; U-B=Unfavourable-Bad.

Site No.	FP of Area	FP of S&F	FP of site	Rationale
108	Fav	Fav	Fav	Positive and negative impacts in balance
113	Fav	Fav	U-I	Intensive grazing or overgrazing by livestock
114	Fav	Fav	Fav	Positive and negative impacts in balance
218	Fav	Fav	Fav	Positive and negative impacts in balance
996	Fav	Fav	Fav	Positive and negative impacts in balance
1541	Fav	Fav	Fav	Positive and negative impacts in balance
2606	Fav	Fav	U-B	Abandonment of management
4000	Fav	Fav	Fav	Positive and negative impacts in balance
4001	Fav	Fav	Fav	Positive and negative impacts in balance
4012	Fav	Fav	Fav	Positive and negative impacts in balance
4013	Fav	U-B	U-B	Unfavourable S&F (high cover of negative indicator species)
4017	Fav	Fav	Fav	Positive and negative impacts in balance
4019	Fav	Fav	Fav	Positive and negative impacts in balance
4020	Fav	Fav	U-B	Natural succession resulting in species composition change
000222	Fav	Fav	Fav	Positive and negative impacts in balance

The data presented in Table 14 shows that only four of the 11 site where the 6510 habitat was assessed, have Favourable *Future prospects*. For some of these sites the reason for unfavourable *Future prospects* is clear, for example at two sites (Sites 1736, and 4012) the negative pressure of the application of natural fertilisers (i.e. slurry spreading) is negatively impacting the *Structure and functions* of the 6510 habitat. For three of the 6510 sites (Sites 1732 and NHAs 000222 and 000564) negative pressures have been identified, but no evidence of a significant impact on either the *Area* or the *Structure and functions* was identified. These pressures may have already contributed to a loss in the area of 6510 habitat at these sites, or the fact the *Structure and functions* at all three sites was assessed using a field-based assessment, rather than plot-based, may have meant that a failing *Structure and functions* criterion were missed.

Table 14 *Future prospects* for the Lowland hay meadows (6510) habitat stability in terms of two parameters, *Area* and *Structure and functions*, and the pressures recorded. Fav=Favourable, U-I=Unfavourable-Inadequate; U-B=Unfavourable-Bad.

Site No.	FP of Area	FP of S&F	FP of site	Rationale
108	Fav	Fav	Fav	Positive and negative impacts in balance
113	Fav	U-B	U-B	Unfavourable S&F (low forb-to-graminoid ratio), abandonment of grassland management
1730	Fav	U-I	U-B	Unfavourable S&F (high litter cover), abandonment, reseeding and the application of natural fertilisers
1732	Fav	Fav	U-B	The application of natural fertilisers
1736	Fav	U-B	U-B	Unfavourable S&F (high cover of negative indicator species) and the application of natural fertilisers
2606	Fav	Fav	Fav	Positive and negative impacts in balance
4000	Fav	Fav	Fav	Positive and negative impacts in balance
4012	Fav	U-B	U-B	Unfavourable S&F (low number of positive species), application of natural fertilisers (slurry)
000222	Fav	Fav	U-I	>0-25% of the area impacted by re-seeding
000564	Fav	Fav	U-B	100% of the area is impacted by the application of natural fertilisers (slurry spreading) on agricultural land
000691	Fav	Fav	Fav	Positive and negative impacts in balance

3.2.2.4 Overall assessments

Of the three target Annex I habitats assessed across the floodplain grassland sites, 6430 has the most sites with a Favourable conservation status, 11 out of 15 assessed sites, for 6510 four of the 11 sites have a Favourable status, and for the 6410 habitat only two out of 11 sites have a Favourable conservation status. Within Section 5 (see below) these overall assessment data are discussed in the context of similar data reported by O'Neill *et al.* (2013).

Table 15 Overall assessment for the three target Annex I habitats for each of the 23 sites where at least one of the habitats was recorded. '-' = Annex I habitat not recorded, NA = Annex I habitat area not assessed as it is <0.01 ha.

Site No.	6410	6430	6510
108	Favourable	Favourable	Favourable
113	-	Unfavourable-inadequate	Unfavourable-bad
114	Unfavourable-bad	Favourable	-
218	-	Favourable	-
996	Unfavourable-inadequate	Favourable	-
1498	Unfavourable-bad	-	-
1541	Unfavourable-bad	Favourable	-
1730	-	-	Unfavourable-bad
1732	-	NA	Unfavourable-bad
1736	-	-	Unfavourable-bad
2606	-	Unfavourable-bad	Favourable
4000	Unfavourable-bad	Favourable	Favourable
4001	-	NA	-
4003	Unfavourable-bad	Favourable	-
4012	Favourable	Favourable	Unfavourable-bad
4013	-	Unfavourable-bad	-
4017	-	Favourable	-
4019	-	Favourable	-
4020	Unfavourable-bad	Unfavourable-bad	-
4021	-	NA	-
000222	Unfavourable-bad	Favourable	Unfavourable-inadequate
000564	Unfavourable-bad	-	Unfavourable-bad
000691	-	NA	Favourable
Total Favourable	2 (18%)	11 (73%)	4 (36%)

3.2.3 Ranking the floodplain grassland sites

The 27 floodplain grassland sites were ranked using the criteria listed in Table 5 (Section 2.2 above). The three NHAs were the three largest sites within the survey and the Suck River Callows NHA was ranked in first position, with the River Little Brosna Callows NHA ranked third, and the Rinn River NHA ranked fifth. The four lowest-scoring floodplain grassland sites were all within the River Boyne catchment in the east of the country.

Table 16 The 27 floodplain grassland sites surveyed during the 2021 field season ranked according to the categories listed in Table 5 (Section 2.2. above). The maximum possible score for each of the five categories is shown in brackets. The Suck River Callows (NHA) achieved the maximum score of 10 out of 10. The EPA subcatchment codes are shown as they include the name of the river within the code.

Site No.	Site name in this project	EPA subcatchment	Target Annex I habitats (3)	Hay meadow (1)	Area score (5)	Rare species (1)	Total score (10)
000222	Suck River Callows NHA	Suck_SC_040 to 100	3	1	5	1	10
4000	Redwood	Shannon[Lower]_SC_060	3	1	3	0	7
108	Leitra Callow	Shannon[Lower]_SC_030	3	1	2	0	6
000564	River Little Brosna Callows NHA	Shannon[Lower]_SC_060	2	1	3	0	6
113	Drumlosh	Shannon[Upper]_SC_100	2	1	1	1	5
114	Cappaleitrim	Shannon[Lower]_SC_020	2	1	1	1	5
1732	Foxford	Moy_SC_090	2	1	1	1	5
2606	Barnadarrig (Shanahoe marsh)	Nore_SC_040	2	1	2	0	5
4012	Ballintemple	Moy_SC_050	3	1	1	0	5
4013	Kilgarvan	Shannon[Lower]_SC_010	1	1	2	1	5
000691	Rinn River NHA	Shannon[Upper]_SC_050	2	1	2	0	5
1541	Cloonmacduff	Owenmore[Sligo]_SC_030	2.5	1	1	0	4.5
996	Newtown Cashel	Shannon[Upper]_SC_090	2	1	1	0	4
1498	Derryoughter East	Barrow_SC_060	1	1	2	0	4
1730	Sraheen	Moy_SC_100	1	1	1	1	4
4019	Bunratty	Owenogarney_SC_020	1	0	2	1	4

Table 16 (continued)

Site No.	Site name	EPA subcatchment(s)	Target Annex I habitats	Hay meadow	Area score	Rare species	Total score
218	Portrunny Bay	Hind_SC_010	1.5	1	1	0	3.5
4017	Roosky	Shannon[Upper]_SC_040	1.5	1	1	0	3.5
4020	Lough Corrib	Corrib_SC_010	2.5	0	1	0	3.5
4021	Derrygoss	Erne_SC_030	1.5	1	1	0	3.5
1736	Pollagh (Mayo)	Moy_SC_080	1	1	1	0	3
4001	Ballymacoolaghan	Shannon[Lower]_SC_040	1	1	1	0	3
4003	Inishee and Esker Islands	Shannon[Lower]_SC_040	2	0	1	0	3
4015	Kilnagross	Boyne_SC_070	0	1	1	0	2
4018	Kildalkey	Boyne_SC_070	0	1	1	0	2
4014	Ballyconnell (Meath)	Boyne_SC_050	0.5	0	1	0	1.5
4016	O'Daly's bridge	Blackwater[Kells]_SC_030	0.5	1	0	0	1.5

3.2.4 Site reports for the 27 individual sites

Extracts from the site report for Redwood (Site 4000) are shown as an example below. Appendix 3 includes the site reports for the 27 surveyed floodplain grassland sites ordered by site number, with the three NHA sites added at the end. It is recommended that the three shapefiles SCAL20_Field_sites (Field survey polygons), SCAL20_plot_points (2 m x 2 m plots), and SCAL20_feature_points (point features such as rare plants or the location of Annex I habitats) are viewed when reading the site reports. The unique identifier, made up of the site number and polygon number (*e.g.* 4000_1b) is used within the site reports to indicate the location of particular features, together with general location descriptors such as 'north-eastern end of site'.

The EU negative pressures recorded for the target Annex I habitats in the 2021 survey are listed within each site report. When neutral pressures were recorded at a site, these are also listed within the same table but with 'neutral' added in parentheses.

Using the data collected during the field survey, Appendix 4 presents examples of the maps that can be produced, using Redwood (Site 4000) within the River Shannon floodplain as an example. On the maps a stippling overlay was used to distinguish areas of primary Annex I habitat that accounted for less than 10% of the polygon area and cross-hatching was used to distinguish areas of Annex I habitat that were previously recorded within a site but were not relocated during the current survey.

3.2.4.1 Extracts from site report for Redwood (Site 4000, Co. Tipperary)

Redwood, Co. Tipperary (Site No. 4000):

Location data: Site centroid (ITM) 590000 709600, EPA subcatchment Shannon[Lower]_SC_060

2021 total area surveyed (ha): 71.29

Ranking: 2nd highest scoring site from 2021 field survey. Score of 7/10

2021 Fossitt habitats:

Primary habitats	Area (ha)	% of survey area
GS4	50.23	70.45
PF1	9.23	12.95
Secondary habitats	Area (ha)	% of survey area
FS1,FS2,GS1,GS2,GS4,PF1,PF3,WN2	11.83	16.60

2021 Annex I habitats; including any potential (p) target habitats:

Area (ha)	Area (ha)	% of survey area
6410	5.83	8.18
6510	0.25	0.35
7140	0.04	0.06
Secondary habitats	Area (ha)	% of survey area
6210,6430,7140	Not recorded	Not recorded

2021 management regime:

Management regime	Area (ha)	% of survey area
Abandoned pasture	0.23	0.32
Abandoned - original management unknown	3.32	4.66
Extensive mowing - aftergrazing unknown (i.e. it is unknown if aftergrazing is occurring)	8.40	11.79
Extensive pasture - cattle	59.33	83.23

2021 EU pressures recorded for the target Annex I habitats

Primary habitat	Pressures	Intensity	% of Annex I habitat impacted
6410	A06: Abandonment of grassland management (negative)	High	22.8
6410	A10: Undergrazing by livestock (negative)	High	<1

2021 EU conservation measures recorded for the three target Annex I habitats

Primary habitat	Conservation measures	% of Annex I habitat impacted
6410	CA03: Maintain existing extensive agricultural practices and agricultural landscape features	77.1
6410	CA04: Reinstate appropriate agricultural practices to address abandonment, including mowing, grazing, burning or equivalent measures	22.8
6410	CA05: Adapt mowing, grazing and other equivalent agricultural activities	<1
6510	CA03: Maintain existing extensive agricultural practices and agricultural landscape features	100

Description of the grassland, swamp and fen meadow habitats surveyed:

This is a diverse semi-natural site with no agriculturally improved grassland (GA1) recorded within the survey area. The areas of semi-natural grassland within this site represent a valuable conservation resource that supports a diversity of wildlife. The GS4 habitat within the site includes significant areas of the Annex I habitat *Molinia* meadows (6410) that were assessed in detail (see below). The *Molinia* meadows within the site are located within the higher areas of the floodplain (polygons 4000_1b, 4000_3, 4000_4, 4000_5). The majority of the wet grassland surveyed is non-Annex, often with extensive tussocks of *Juncus effusus* and *Juncus inflexus* or *Festuca arundinacea*. PF1 habitat was the most common habitat recorded within two (polygons 4000_1a, 40007b) of the 14 fields surveyed and the non-Annex fen meadow habitat was characterised by abundant *Carex nigra*. FS1 habitat was recorded within six of the 14 fields and it included either a tall-reed (e.g. *Phragmites australis*)-dominated community or a swampy grassland community (Figure 1) with *Glyceria maxima, Agrostis stolonifera, Caltha palustris* and *Carex* species. Areas of the Annex I habitat Hydrophilous tall-herb (6430) were recorded within the survey area (Figure 2) with species such as *Iris pseudacorus, Mentha aquatica, Equisetum fluviatile* and *Filipendula ulmaria* common within the habitat. Small areas of drier grassland were recorded within the site; one small area (northern end of polygon 4000_1a) that is managed by annual mowing corresponds to the Annex I habitat Lowland hay meadows (6510) and another small area (north eastern edge of polygon 4000_4) corresponds to Annex I Calcareous grassland (6210).

Swamp grassland habitat at Redwood (Site 4000). Photograph Fionnuala O'Neill

Hydrophilous tall-herb (6430) habitat at Redwood (Site 4000). Photograph Jim Martin.

Rare floodplain grassland plant species: No rare plant species were recorded at this site during the survey.

Conservation assessment for the Annex I habitats assessed at the site:

The *Structure and functions* of the 6410 habitat within the site (Figure 3) was assessed using six assessment plots. Two of the plots were complete botanical plots that were analysed using ERICA and assigned to the *Molinia caerulea - Potentilla erecta - Agrostis stolonifera* GL1D IVC community (6410 habitat in the north of the site) and *Carex nigra - Ranunculus flammula* FE3A IVC community (6410 habitat in the south of the site).

The *Area* parameter for the 6410 habitat at the site is assessed to be Unfavourable-inadequate based on expert judgement. The current area appears to have significantly decreased compared to the 17.18 ha of potential 6410 habitat mapped based on Heery (1993), who recorded a plant community very similar to 6410 in two additional fields (polygons 4000_7d and 4000_7e). However, as it is unclear what area of potential 6410 mapped based on Heery (1993) corresponded to the 6410 habitat expert judgement has been applied and it has been assumed that there has been some loss in habitat, but ≤1% decline in area per year. Smaller areas of the target Annex I habitats 6430 and 6510 were also recorded within the site; these Annex I habitats were not assessed using plots and instead an indicative assessment of their conservation status was made based on additional notes that were recorded on habitat condition or species present. The *Area* parameter for both 6430 and 6510 at the site is assessed to be Favourable in the absence of any previous data for these Annex I habitats.

The *Structure and functions* for 6410 at the Redwood site are assessed to be Unfavourable-bad, as only 33% of the assessment plots passed the litter criterion (Table 1).

Results of the 6410 *Structure and functions* criteria assessed at Redwood (Site 4000).

Assessment Criteria	% monitoring stops that passed each criterion
Positive indicator species (HQ)	100
Positive indicator species (HQ + Non-HQ)	100
Non-native species	100
Individual negative indicator species	100
Total cover negative indicator species	100
Encroachment	100
Sward height	100
Litter cover	33
Bare soil cover	100
Grazing & disturbance	100
Forb-to-graminoid ratio	50

Future prospects (FP) assessment for the three target Annex I habitats at Redwood (Site 4000). Fav=Favourable, U-I=Unfavourable-Inadequate; U-B=Unfavourable-Bad.

Habitat	FP of Area	FP of S&F	FP of site	Rationale
6410	U-I	U-B	U-B	Unfavourable S&F (high litter cover), negative pressures of abandonment and undergrazing
6430	Fav	Fav	Fav	Positive and negative impacts in balance
6510	Fav	Fav	Fav	Positive and negative impacts in balance

The overall assessment for the 6410 habitat at the site is Unfavourable-bad and due to the fact that the area the habitat occupies appears to have decreased compared to Heery (1993) the long-term trend for the 6410 habitat was judged to be decreasing. The overall assessment for the 6430 and 6510 habitats at the site is Favourable and no trend was assigned due to the absence of any previous data for these Annex I habitats at the site.

Overall assessment for the three target Annex I habitats recorded at Redwood (Site 4000).

Parameter	6410	6430	6510
Area	Unfavourable-inadequate	Favourable	Favourable
Structure and functions	Unfavourable-bad	Favourable	Favourable
Future prospects	Unfavourable-bad	Favourable	Favourable
Overall assessment	Unfavourable-bad	Favourable	Favourable

Site management:

Small areas of the site at Redwood are impacted by undergrazing and abandonment, but there are also areas where grazing levels are too high, with impacts such as poaching noted. On the day of the survey 12% of the floodplain was considered to be managed too intensively, 13% was abandoned or undermanaged, and the remaining 75% of the survey area was considered to be appropriately managed.

4 Appropriate management for callows floodplain grasslands in Ireland

As summarised in Floodplain Meadows - Beauty and Utility (Rothero *et al.,* 2016), the key conservation objective for semi-natural floodplain grasslands is to maintain or improve these plant communities, while maintaining and enhancing populations of other groups (*e.g*. breeding birds), and ensuring a good quality pasture or hay crop.

Typical management objectives to achieve these aims are:

- Where mowing takes place, ensure an annual hay cut at an appropriate time;
- Ensure the stocking density, livestock type, and timing of grazing are suitable for a site;
- Ensure the hydrological regime at a site is maintained (*e.g*. by maintaining ditches).

While typical management objectives such as these can be addressed by conservation practitioners and individual land managers (*e.g*. farmers), there are broader issues which also impact floodplain grasslands. These include: water pollution, which is monitored by the Environmental Protection Agency (EPA); large drainage schemes that are managed by the Office of Public Works (OPW); and the regulation of major rivers, such as the Shannon, Lee, Liffey and Erne, for hydro power (ESB, 2015) or for tourism by Waterways Ireland. For effective and appropriate management plans to be implemented for semi-natural floodplain grasslands all significant objectives need to be addressed and the coordination of private landowners, NGOs and state agencies will often be required.

When devising the management objectives for a floodplain grassland the historical management pattern for the site will be a key factor to consider, as the vegetation and fauna at the site will have evolved within this pattern. It is also important that the management objectives consider both the flora and fauna of the site (Owens, 2016). Objectives that focus on the requirements for only one particular habitat or species are not advisable as there may be unforeseen negative impacts on other features (Rothero *et al.,* 2016).

It should be noted that the management objectives discussed in this document focus on the appropriate management of floodplain grasslands for fauna and flora (*i.e*. biodiversity). However, policy makers may also need to take account of other ecosystem services, such as temporary water storage (*i.e.* flood mitigation), water quality, food production, and carbon storage (Parker *et al.,* 2016), when considering the management objectives for a site.

4.1 Management tools for floodplain grasslands

4.1.1 Mowing

Mowing and the removal of hay removes biomass and prevents the accumulation of nutrients that could otherwise result in a less diverse sward. Traditional mowing practices also involve leaving the cut hay in the field for at least three days where it is turned regularly to aid drying, with some advising turning the hay twice daily (Kilroy, 2014). The period of drying and turning the hay in the field is positive for species diversity as it allows seeds to drop from the hay to the soil.

Cutting hay just as it begins to set seed removes the maximum amount of nutrients from the system and creates hay with a high nutritional value (Rothero *et al.,* 2016; Kilroy, 2014). The nutrient content of the hay lowers as seeds are dropped and the plant returns nutrients to the base of the plant where they are stored. Nocera *et al.* (2005) showed that, within a subset of Canadian meadows, delaying cutting by 1.5 weeks after the optimal time resulted in a 2.1% reduction in hay nutritional quality, but there were beneficial trade-offs such as an increase in the rate of fledging for meadow bird species.

In most situations it is not critical that all species have set seed before mowing can take place. As outlined by Rothero *et al.* (2016), annual seed set is only significant for a few annual species (*e.g. Linum catharticum, Trifolium dubium, Rhinanthus minor, Bromus racemosus, Bromus commutatus,* and *Bromus hordeaceus*) and many floodplain grassland species are long-lived perennials.

The timing of a hay cut within a floodplain system will often vary from year to year according to the weather conditions. Heery (1994) states that on the Shannon callows, cutting dates varied depending on the weather and ground conditions; in a good year, such as 1992, 36% of meadows were cut before 19th July, while in a wet summer, such as 1993, only 4.5% of meadows were cut before the same date. A wet year can delay mowing or lead to missed cuts, and persistent late cutting can reduce species richness by allowing larger species that bulk up later in the summer, such as *Filipendula ulmaria*, to gain a strong competitive advantage. This scenario was observed in areas of the Shannon callows (*e.g*. Clonmacnoise) in the early 2000s and was the subject of research carried out by NUIG (Owens, 2016). The results of Owens (2016) and other studies (Newman, 2013) have shown that mowing twice in the summer is an effective way of controlling coarser species such as *Filipendula ulmaria* when they dominate an area of grassland.

Some of the botanical diversity found in traditionally managed floodplain meadows is due to a diversity in mowing times, either between years or between different areas within the same year. The staggering of cutting dates across an area of meadows within a season benefits biodiversity (Maher, 2013), and provides areas of refuge for birds and invertebrates (Rothero *et al.,* 2016). The staggering of mowing dates within a locality is often recorded within Irish floodplains due to ownership patterns (*i.e.* strips of adjacent land owned by different people) and different owners choosing to mow on different dates. It is important that management plans avoid becoming too prescriptive and encourage a diversity of approaches to prevent homogenous regimes that result in a reduction in species diversity.

Although traditional mowing practices should be encouraged, in some cases more modern and economically viable mowing systems could be considered to ensure that an area of floodplain grassland continues to be managed through mowing. McGurn (2008) discusses baled silage as an alternative mowing system, but warns against the increased fertiliser rates and earlier cutting times often associated with it and how these can lead to a detrimental change in species composition. McGurn (2008) proposes a hybrid approach where big bale silage is used as a management regime, but to maintain species composition other variables such as low fertility and late cutting should be retained. This hybrid approach has been adopted by farmers in areas such as north Leitrim and Fermanagh, with farmers taking a crop of hay in good years (drier and warmer summers) but in most years baling for silage or haylage (P. McGurn, pers. comm.). Where the hybrid system is implemented, delayed mowing or missed cuts in wet years, something that has been observed within the Shannon Callows (Owens, 2016), are avoided.

During the current survey extensive (*i.e*. low intensity) mowing was recorded within 15% of the surveyed area across the 27 floodplain grassland sites. Examples of best practice were recorded, including a handful of sites where annual mowing was used to manage a semi-natural wet grassland sward (GS4) with abundant *Phalaris arundinacea*. This *P. arundinacea* grassland community had affinities with swampy grassland and the Annex I habitat Hydrophilous tall-herb (6430). At Leitra Callow (Site 108, Co. Offaly), on the River Shannon, two fields with 15.4 ha of *P. arundinacea* dominated wet meadow were managed by appropriate extensive mowing. These two fields were particularly interesting as there is evidence that they have been managed as hay meadows since the site was first surveyed by Nairn *et al.* (1988). Based on the results of the walkover survey these fields were cut in August with the hay removed after cutting. There was no evidence that the meadows had been aftergrazed, but the fields are stock proof and therefore aftergrazing could take place in the years when the ground remains dry enough to avoid excessive poaching. In addition to the large area of wet meadow, these two fields also include a small area of the Annex I habitat Lowland hay meadows (6510). At a nearby floodplain grassland site on the River Shannon,

Kilgarvan (Site 4013, Co. Westmeath), large areas of a similar *P. arundinacea* wet grassland community were also managed appropriately by annual mowing, but at this site some areas were managed by alternating grazing and mowing. As already discussed, a diversity of extensive (*i.e*. low intensity) management regimes can be a good way to increase species diversity within a site.

4.1.2 Grazing

Grazing animals create sward heterogeneity by selective defoliation as a result of dietary choices (Rook *et al.,* 2004). Grazing animals also alter grassland communities through trampling and dunging (Crofts & Jefferson, 1999). Trampling creates bare ground, exposing buried seed and providing suitable niches for seeds to germinate, which is particularly important for annual species such as *Rhinanthus minor*. Dunging is an important part of nutrient cycling, returning some of the nutrients removed by grazing; however, neither dung nor urine is spread uniformly across a site and the locations of dung patches impact dietary choices, particularly in cattle that will not graze near them (Rook *et al.,* 2004). Overall, when considering the type of grazing animal to use to manage an area of floodplain grassland, Rook *et al.* (2004) list five factors to be considered: species (*e.g.* cattle, sheep), breed, body size, sex, and age of the animal The two most important factors to be considered, species and breed, are discussed further below. In addition to factors such as breed of animal, stocking density must also be considered, with suitable stock densities dependent on site-specific conditions and objectives. A key objective for floodplain grassland should be to avoid poaching, and for that reason, exact prescriptions regarding stock numbers and dates should be avoided, and flexibility is key.

The main grazing stock species to consider are cattle, sheep and horses, and each species exhibits different grazing, trampling and dunging behaviour. Cattle graze by wrapping their tongue around the vegetation and tearing away plants, leaving tufts of ungrazed vegetation and short grazed areas. Sheep are more selective feeders than cattle and have the ability to select high-quality plant parts such as flowers, pods and young shoots (Rook *et al*., 2004). Horses are able to graze closer to the ground than cattle and need to graze for longer periods of time than both cattle and sheep due to the difference in digestive physiology (Rook *et al.* 2004). If horses are grazing a site, latrine areas will need management (*i.e.* these areas will need to be regularly cleared and the dung removed off-site) to prevent the localised build-up of nutrients and weed species such as docks and thistles (Rothero *et al.*, 2016).

The use of traditional livestock breeds can often be recommended for nature conservation management due to their perceived hardiness and adaptation to local conditions. Ireland has seven native traditional breeds recognised by the Department of Agriculture, Food and the Marine (DAFM): the Connemara pony, Irish Draught horse, Galway sheep, and the cattle breeds Kerry, Dexter, Droimeann and Irish Moiled cattle (DAFM, 2020a). In addition to these breeds the Irish Rare Breeds Society also promotes the Kerry bog pony, the Cladoir sheep, and the Bilberry and Old Irish goat breeds. Although Rook *et al.* (2004) discuss the fact that there is currently little published scientific evidence on the advantages of using traditional breeds, this is probably due to the evidence not having been published in the scientific literature, rather than a lack of evidence *per se*. Currently NPWS is working with the Irish Native Rare Breed Society (INRBS) to promote the use of Irish indigenous breeds. As this project develops, the aim will be for multiple case studies to be documented on the INRBS website show-casing the advantages of these traditional breeds. One case study that has already been published on the INRBS website, on farming Droimeann cattle beside the Shannon estuary, highlights how this traditional breed is far hardier than conventional cattle breeds, requiring less animal husbandry. The Droimeann cattle could be out-wintered, the only additional feed they received was grass and silage, they required no mineral supplements, and there was no routine administration of medicines. However, as discussed by Rook *et al.* (2004), if traditional breeds are promoted, in addition to their positive traits such as hardiness, there should also be the potential for economically viable returns for farmers. In addition to the traditional breeds there is also a diversity of commercial breeds currently farmed in Ireland, and the DAFM

website (DAFM, 2020b) provides links to the 21 cattle, seven equine and two sheep-breeding organisations currently approved by the department.

The timing of grazing is important and spring-time grazing has the most direct impact on the growth of plants as this is when leaf production is at its greatest (Crofts & Jefferson, 1999). The date that grazing animals are removed from a site in the autumn will depend on the wetness of the site, but they should be removed promptly once conditions become too wet, and before poaching occurs, to avoid the detrimental impacts of compaction (Rothero *et al.,* 2016).

During the current survey, areas managed extensively by grazing (*i.e*. low intensity) were recorded within 56% of the survey area across the 27 floodplain grassland sites, with 77% of the extensively grazed land grazed by cattle. At Cappaleitrim (Site 114, Co. Roscommon), beside the River Shannon, 14.6 ha of semi-natural wet grassland (GS4) and fen (PF1) were managed appropriately by extensive mixed grazing, with cattle, horses, and sheep recorded grazing the floodplain. Mixed grazing, with cattle, horses, and sheep was uncommon within the 27 floodpalin grassland sites visited during the current survey, only accounting for 0.3% of the survey area. Extensive horse grazing was also uncommon and only accounted for 2.4% of the survey area across the 27 floodplain grassland sites. At Portrunny Bay (Site 218, Co. Roscommon), beside Lough Ree, 7.9 ha of GS4, PF1, and swamp habitats in the east of the site were managed appropriately by extensive horse grazing. The sensitive management across these four fields in the east of the site resulted in a diversity of habitats, including the Annex I habitat Hydrophilous tall-herb (6430). Further information on these examples of appropriate management using extensive grazing can be found in the individial site reports in Appendix 3.

Traditionally, floodplain meadows have been mown for hay and grazed because this allows the production of vital winter feed while maximising grazing opportunities (Rothero *et al.,* 2016). Within Ireland the practice of aftergrazing mown fields appears to be rare, with the practice only reported within one of the 18 Lowland hay meadows (6510) sites surveyed by Martin *et al.* (2018). However, during the current study aftergrazing was found to be relatively frequent within extensively mown fields, recorded for 142.3 ha of floodplain grassland, which was 40% of the area of extensive hay meadow surveyed across the 27 floodplain grassland site. The combination of grazing and mowing increases species diversity; hay-making removes nutrients and allows plants to flower and sometimes set seed while the meadow is shut off from grazing animals, and aftergrazing creates more diversity by providing areas of open soil for seeds to set into and reducing the dominance of bulky species. Under the Green, Low-Carbon, Agri-Environment Scheme (GLAS), farmers who select the traditional hay meadow option can graze the meadow up to April 15th. Mowing and aftergrazing produce a distinctive plant community that is different from floodplain grassland managed solely as pasture (Rothero *et al.,* 2016). Along the River Shannon the aftergrazing of meadows is uncommon in areas where commonage has been divided into thin strips that make stock management impractical.

During the current survey areas managed extensively by mowing followed by aftergrazing were recorded within 6% of the survey area across the 27 floodplain grassland sites. At Barnadarrig (Shanahoe marsh, Site 2606 Co. Laois), beside the River Nore, 20.4 ha of semi-natural wet grassland (GS4) and fen meadow (PF1) were managed extensively by annual mowing followed by aftergrazing. In addition to the large area of wet meadow, these two fields also include small areas of the Annex I habitat Lowland hay meadows (6510). The landowner of these areas farms sensitively, with no evidence of fertiliser application and the cattle are removed from the site before the ground becomes too waterlogged and suceptible to poaching.

It should be noted that permanently switching the management regime from hay meadows to permanent pasture results in a shift in species composition, with a decline in tall perennials and the loss of early-flowering species that need to set seed to persist, such as *Rhinanthus minor* (Rothero *et al.,* 2016). Sections of Bullock Island on the River Shannon provide an example of an area of floodplain grassland that has permanently switched from hay meadow (Nairn *et al.,* 1988) to pasture (O'Neill *et al.,* 2013); however, with no baseline vegetation plots

recorded by Nairn *et al.* (1988) at this site, it is not possible to examine how the species composition has changed.

4.1.3 Drainage

Although able to tolerate some flooding, most floodplain grasslands cannot survive prolonged waterlogging, particularly in summer (Rothero *et al.,* 2016). It is therefore important that the surface water inundating a site can drain away, and the maintenance of the drainage system, including ditches and shallow surface drains, is essential to the conservation of these grasslands.

The management of many of the largest drainage schemes within floodplain grassland in Ireland is undertaken by the OPW through arterial drainage maintenance works. Between 1945 and 1995, under the Arterial Drainage Act (1945), the OPW completed 34 Arterial Drainage Schemes on river catchments along with five estuarine embankment schemes (over 11,500 km of channel and 730 km of embankments). The OPW is statutorily obligated to maintain arterial drainage channels under the 1945 Arterial Drainage Act, and since their completion, maintenance of these Arterial Drainage Schemes has been ongoing, with the majority of channels maintained every five years. The use of embankments as part of the OPW's drainage schemes will have contributed to floodplain grasslands becoming disconnected from their rivers, resulting in the grassland no longer receiving nutrient-rich sediment during flooding events.

As Maher (2013) concluded, it is heterogeneity in hydrology, both spatial and temporal, that is determining much of the ecological diversity within floodplains, with the microtopography of sites also playing a vital role in promoting biodiversity.

4.1.4 Management for native fauna

Local native fauna (*e.g*. invertebrate, bird and mammal populations) within traditionally managed floodplain grasslands will have strategies to cope with traditional management practices, as well as the flooding regime. As a rule, all management plans within floodplain grasslands should aim to follow the guidance within the All-Ireland Pollinator Plan 2015-20 to help protect pollinators. It should be recognised that situations could arise where there will be a need to manage conflicts of interest, such as leaving uncut or late-cut areas for fauna when an earlier cut could benefit the plant community. In such situations it should be possible to resolve conflicts through the diversification of management practices, both spatially and temporally. During the current survey, management interventions to benefit wetland birds were recorded within the Shannon callows. At Ballymacoolaghan (Site 4001, Co. Offaly) a landowner explained how he was working with the local BirdWatch Ireland office to enhance the habitats on his land for wetland birds by providing accessible entrance/exit points to large drains by grading the sides at certain points along the drain.

4.2 Data and case studies that highlight current issues within floodplain grasslands

Over the last 50 years the intensification of floodplain grasslands through impacts such as drainage, re-seeding and fertilisation have undoubtedly contributed to a decline in the area of semi-natural floodplain grasslands in Ireland. Many of the examples discussed below are based on the data collected during the current study, the Irish Semi-natural Grasslands Survey (ISGS) 2007 to 2012 (O'Neill *et al.,* 2013), and the subsequent monitoring between 2015 and 2017 (Martin *et al.,* 2018).

4.2.1 Eutrophication

With the ongoing eutrophication of river systems in Ireland through waste-water discharge and the excessive use of slurry, increasing fertility within floodplain grasslands is inevitable. In

addition, in some areas of the country increased deposition of atmospheric nitrogen will also contribute to the fertility of floodplain grasslands.

The direct spreading of slurry onto semi-natural floodplain grasslands can be an issue and nutrient management plans are an important component of floodplain grassland management. It is also important that farmers follow the guidance published by Teagasc (2020) on fertiliser use near water bodies. A floodplain meadow beside the River Erne (ISGS site 1051 Drumcrow, Co. Cavan) lost a significant area of Annex-quality Lowland hay meadows (6510) due to slurry spreading, with plant species richness within the 2 m x 2 m plot reducing from 23 species in June 2009 (Figure 11a) to 14 plant species in June 2016 (Figure 11b) (Martin *et al,.* 2018). The restoration of these meadows will only be possible when an alternative area for spreading the slurry is found; even then, species diversity will have been impacted, as species such as *Rhinanthus minor* do not have a long-term seedbank (Westbury, 2004), unless native species, such as *R. minor*, are re-seeded into the meadow.

Figure 11a Species-rich lowland hay meadow on the River Erne floodplain site 1051 (Drumcarrow) in June 2009. Classified as IVC community GL3E *Festuca rubra* - *Rhinanthus minor* and as the EU Annex I habitat 6510. The plant species-richness in the 2 m x 2 m plot was 23 species.

Figure 11b The same hay meadow at site 1051 in June 2016 after the spreading of slurry on the habitat. Classified as IVC community GL4A *Agrostis capillaris* - *Trifolium repens* and as non-Annex, also the plant species-richness within the 2 m x 2 m plot had reduced to 14 species.

The Annex-quality Lowland hay meadows (6510) at Moorbrook (ISGS site 1731, Co. Mayo) on the Moy Callows have also been negatively impacted by the spreading of slurry, but at this site a population of the rare plant species *Sanguisorba officinalis* appears to be stable despite the slurry spreading (Martin *et al.* 2018). During the current survey slurry spreading was recorded within 11 of the 17 fields where the 6510 habitat was recorded.

The application of at least low levels of chemical fertilisers within semi-natural floodplain grasslands may be almost ubiquitous. Tubridy (1988) reported that all farmers on the Clonmacnoise Callows use NPK fertiliser, with 0:7:30 the most common ratio used. Tubridy (1988) also highlighted that fertiliser application can make farming such areas economically viable, with productivity of between 17 and 40 bales per ha with no fertiliser application, increasing to a maximum productivity of 67 bales per ha with fertiliser.

Maher (2013) studied 12 semi-natural floodplain grassland sites within the Shannon Callows and found that the farmers applied NPK fertiliser across nine of the sites during the period 1970 to 2010, with three of the sites treated with fertiliser for the whole period and the remaining six treated for between two and 30 years. The rate of fertiliser application for the nine sites where fertiliser was used varied from 12.14 to 50.99 kg/ha.

4.2.2 Herbicide use

Herbicide use should be avoided within semi-natural floodplain grasslands due to the negative impact it can have on plant species richness; however in certain cases there may be an argument for the limited use of spot spraying to remove problematic weed species such as *Senecio jacobaea*. From the limited data available it does not appear that herbicide use is common within semi-natural floodplain grasslands and the current survey did not record any instances of herbicide use within the 27 floodplain grassland sites that were surveyed. Maher (2013) studied 12 semi-natural floodplain grassland sites within the Shannon Callows area and found that within the period 1970 to 2010 four of the farms had used herbicide. Of these four sites, two applied herbicide every three to four years and at the other two sites herbicide had only been applied once prior to 2000. Only one farmer within the Shannon Callows at Clonmacnoise reported using herbicide in 1987 (Tubridy 1988).

4.2.3 Afforestation

There are examples of floodplain grassland sites, such as the Annex I *Molinia* meadows at Lacka (ISGS site 2708, Co. Limerick), where landowners have considered planting trees on the meadows. One example of afforestation within an area of floodplain grassland was recorded during the current survey, with approximately 35 ha of mixed woodland (mostly coniferous forestry) planted to the west of Athleague, just outside the Suck River Callows NHA (site code 000222), but within the high probability river flood extent (OPW, 2012a). One other documented example of afforestation on a floodplain is at Cloonlumney (Co. Mayo) where approximately 10 ha of conifer forestry has been planted on floodplain grassland just south of the River Moy, with the majority of the forestry within the River Moy SAC (002298) (M. Long, pers. comm.). These examples show that although the potential negative impacts of prolonged seasonal flooding should deter the establishment of commercial forestry plantations within floodplains it does not prevent afforestation occurring. There is also evidence for recent afforestation on areas of the Annex I habitat *Molinia* meadows, such as Tobernahulla (ISGS site 379, Co. Waterford) and Corry (ISGS site 837, Co. Leitrim) (Martin *et al.,* 2018), although these areas are outside the floodplain as indicated by the OPW fluvial flood maps (OPW, 2012a; OPW, 2012b).

4.2.4 Inappropriate use of ring feeders

On some farms, grazing is accompanied by stock feeding, or the use of ring feeders, and these practices can have negative impacts through high levels of trampling and dunging in the vicinity of the feeders and also via the feed acting as a seed source for undesirable agricultural species such as *Lolium perenne*. An example of this practice has been noted within the Lowland hay meadows at Letterfine (ISGS site 850, Co. Leitrim) and currently a results-based pilot scheme is trying to address this issue at the site (Byrne *et al.,* 2020).

4.2.5 Climate change

Climate change also has the potential to drive change within floodplain grassland in Ireland. A review by the EPA (2017) showed that average annual rainfall in Ireland increased by 60 mm, or 5%, in the period 1981 to 2010 and mean annual temperatures have increased by 0.8°C over the last 110 years. Due to increases in rainfall, in combination with changes in land-use practices, the mean flows recorded in Ireland's rivers have also increased (EPA, 2017). These changes have all contributed to the major flood events that were recorded within Ireland in 2009, 2012 and 2015 (Schindler *et al.,* 2016), with the 2009 flood levels on the River Shannon the highest since 1954, and in 2015 nearly half of the hydrometric stations on Ireland's river network registered their highest flood on record (OPW, 2016). Charlton *et al.* (2006) have predicted a probable increase in the magnitude and frequency of winter floods in the western half of Ireland before the end of this century in response to increased surface runoff. It is inevitable that these changes will impact the vegetation recorded within floodplain grasslands.

4.2.6 Appropriate management and agri-environmental schemes

Appropriate management has been implemented by a cohort of Irish farmers, some under their own initiative and others within schemes such as the Results-based Agri-Environment Programme (REAP), GLAS, the European Innovation Partnership for Agriculture Productivity and Sustainability (EIP-AGRI), the Results-based Agri-Environment Payment Scheme (RBAPS), the NPWS Farm Plan Scheme, or specific projects funded under the EU's LIFE programme. However, in general the current evidence is that the proportion of farmers who utilise these more appropriate practices, which are often extensive and more traditional, is decreasing over time (McGurn, 2008). Conservation practitioners need to try and halt this decline by encouraging those farmers who still implement appropriate management practices to continue to do so. In most cases this will be achievable within existing schemes, such as the NPWS Farm Plan Scheme. In addition, practitioners need to try to implement appropriate

management regimes across a larger area of floodplain grasslands by encouraging farmers who have either abandoned land or are farming more intensively to implement appropriate management. The most effective way to do this is through initiatives that encourage farmers and other stakeholders to adopt appropriate management through monitored agri-environment schemes (*e.g*. REAP, EIP-AGRI etc.). The use of participatory approaches by conservation practitioners, rather than ideas being imposed from the top down, can be key to ensuring that agri-schemes are successful as they ensure that the process is legitimised (through stakeholder participation), rationalised (because stakeholders have the opportunity to contribute their own ideas) and more efficient (through the trust it promotes between practitioners, stakeholders and the public) (Reed, 2008).

5 Discussion and recommendations

5.1 Summary

Based on three GIS datasets – ISGS (O'Neill *et al.,* 2013), NCA Article 17 reporting (NPWS, 2019), and OPW data (2020) – the first phase of the project (Stage A) identified 1,308 km² of potential floodplain grassland habitat, including 114 ha of the three target Annex I habitats, *Molinia* meadows (6410), Hydrophilous tall-herb (6430) and Lowland hay meadows (6510), across the EPA's 583 WFD subcatchments. The 1,308 km² of potential floodplain grassland represents 34% of the total area of 3,807 km² of floodplain reported for Ireland (EEA, 2020). The area of potential floodplain grassland mapped by this project is probably an underestimate, due to the fact that the OPW shapefiles that were used to derive this figure do not cover all the fluvial flooding events that occur in Ireland (OPW, 2012a). Based on Copernicus data, EEA (2020) presents a figure of 1,669 km² for the area of floodplain grassland within the country.

During the field study, a total of 1,026 polygons (*i.e*. fields) covering 2,469.3 ha were surveyed across the 27 sites that were selected for a field study, representing 2% of the area of potential floodplain grassland identified during the first phase of the project. Semi-natural wet grassland (GS4) was the most common Fossitt habitat recorded in the field. Additional areas of the three target Annex I habitats that were not documented by previous NCAs (NPWS, 2019) were identified during the field study and these 41.6 ha of Annex I habitat should be incorporated into the next round of Article 17 reporting. The 27 floodplain grassland sites were ranked based on the six floodplain grassland criteria listed in Table 5, and the Suck River Callows NHA was ranked in first position with a maximum score of 10. The four lowest-ranked floodplain grassland sites were all within the River Boyne catchment in the east of the country, with all four sites existing within a landscape that was the most intensively farmed of the areas visited during the field survey.

5.2 PRIME2 shapefiles

During the first phase of the project 'Data collation and site selection' the project team were provided with access to the PRIME2 shapefiles (OSI, 2018), a suite of shapefiles that map infrastructure, such as roads and buildings, and importantly for this project also map all field boundaries. Access to the PRIME2 shapefiles allowed this first phase of the project to focus more time and resources on data collection and data entry and less time on the detailed GIS mapping (*i.e*. digitisation) of the location data for this information. As the PRIME2 shapefiles provide digitised polygons, projects such as this one could simply add data, such as ecological or management data, to the polygons provided. When the project moved to the fieldwork phase, the PRIME2 shapefiles provided the ecologists with an up-to-date and accurate GIS shapefile to which the ecological field data could be added. Although there were some minor issues in adapting how data were recorded in the field, the availability of the PRIME2 shapefiles increased the rate at which data could be recorded in the field. Also the rate of both pre-survey and post-survey digital mapping of these data was increased.

During this project the field ecologists adapted the methodology for mapping grassland habitats, moving from the polygon-based approach that was used during the ISGS (O'Neill *et al.,* 2013), where each individual polygon of grassland habitat is mapped, to a field-based approach, where PRIME2 has already mapped the field and the percentage cover of the main grassland habitat within each field is then recorded. The field-based methodology of recording the primary habitat (the habitat with the highest percentage cover) within each polygon proved to work well for documenting the Fossitt habitats, but for the three target Annex I habitats this approach was less successful. For the three target Annex I habitats, which can often only exist within parts of a field or towards the margins of a field, this approach meant that areas of the Annex I habitats were underestimated where they existed as secondary Annex I habitats. For Annex I habitats it is particularly important that accurate area data are collected for monitoring

their conservation status. Therefore in future studies it is recommended that the percentage cover for all target Annex I habitats (*i.e*. 6410, 6430 and 6510 for this study), rather than only the primary Annex I habitat, are estimated for every polygon. Although the presence of the three target Annex I habitats as secondary Annex I habitats was not a common occurrence, it did occur for the 6430 habitat within 16 polygons, and for the 6410 habitat within four polygons.

During the analysis of the field data it became clear that the general notes recorded with each polygon (*i.e*. field) were variable, in terms of the amount and type of information collected. This meant that there was some difficulty rationalising these data, particularly for larger sites with a high number of polygons. Therefore, for future projects that follow this field-based approach, a more standardised approach to the written notes collected with each polygon should be adopted. Obviously, these requirements will vary from project to project; but in relation to describing habitats and plant communities, guidelines such as only listing one or two dominant species within each field, and then if relevant one to two characteristic species, could assist when interpreting these data. It should also be recognised that field-based information, often collected during a zig-zag walk through a field, can be biased towards more noticeable flowering herbs (*e.g*. *Filipendula ulmaria*) rather than less obvious grasses (e.g. *Agrostis stolonifera*). To overcome this it can be useful to choose one or two 'typical' areas within a field and make an assessment of abundant and characteristic species within these.

Overall, by providing accurately mapped field boundaries PRIME2 has saved time and resources that would have been spent on digitisation and could then be directed to other activities, such as data collection. In addition, PRIME2 reduces mapping errors and has the potential to facilitate the simple aggregation of the GIS datasets produced by different projects that utilise the PRIME2 shapefiles. However, it is important that, for this to occur without problematic overlaps or gaps, projects should not remap the outline of PRIME2 polygons, but instead should only conduct simple splits (*i.e*. cut polygons).

5.3 Floodplain grassland Annex I habitats

During the current study, new areas of the three target Annex I habitats, *Molinia* meadows (6410) and Hydrophilous tall-herb (6430) and Lowland hay meadows (6510), were mapped and a new field-based assessment methodology was developed for assessing both the *Structure and functions* and *Future prospects* of the target Annex I habitats. It was noted during the field study that two of the target Annex I habitats, 6410 and 6510, were generally only found towards the top of the floodplain, with only the 6430 habitat found in areas that were more frequently inundated. These observations in relation to the 6410 habitat are supported by data presented by Tynan (2021), which summarised UK data for the NVC community M24, a community synonymous with the 6410 habitat, reporting that the M24 community was not normally associated with inundation, except to a minor degree in the winter. Also it has been reported that the NVC community MG4, a community with a high affinity with the 6510 habitat, is sensitive to excessive waterlogging, with many of the component species being intolerant of anoxic soils during the growing season (Gowing *et al*., 2002; Jefferson & Pinches, 2011).

5.3.1 *Area*

During the field study, a total of 41.6 ha of new areas of the three target Annex I habitats that had not been documented during previous NCAs (NPWS, 2019) were mapped at 23 of the 27 floodplain grassland sites. At two sites (Cappaleitrim Site 114 and Sraheen Site 1730), 5.6 ha of 6410 and 6430 that had previously been documented by the NCAs had been lost. Overall, this represents a net increase of 36.0 ha for the three target Annex I habitats, an increase of 32% on the 114.0 ha that had been previously documented within floodplain grasslands.

The total area of the three target Annex I habitats recorded during the field study is 2% of the total area of floodplain surveyed (*i.e*. all habitats surveyed including arable, woodland, improved agricultural grassland *etc*.) and 3% of the 1,529 ha of primary semi-natural grassland

and associated habitats (*e.g*. marsh, tall-herb, and fen) surveyed. This last figure of 3% is less than the 5% reported by O'Neill *et al.* (2013) for the percentage of Annex I habitats within the total area of semi-natural grassland surveyed during the ISGS. There are multiple reasons for why this difference could have occurred, one of which being that Annex I Calcareous grassland (6210), the most extensive Annex I grassland habitat encountered during the ISGS, was not a target for the current project.

5.3.2 *Structure and functions*

In a departure from the ISGS (O'Neill *et al.,* 2013) and the Annex I grassland monitoring reporting in Martin *et al.* (2018), the *Structure and functions* parameter for the three target Annex I habitats was often assessed using a field-based rather than a plot-based approach. The plot-based approach was only used for five of the 11 6410 assessments, three of the 11 6510 assessments, and none of the 15 6430 assessments. A field-based approach had the advantages of being quicker to record than a plot-based assessment and allowing every field in which the Annex I habitat was recorded to contribute to the assessment. The plot-based approach provided more detailed information for the areas where plots were recorded, but was more time-consuming to record and tended to bias the conservation assessment to the areas where the plots were placed. Considering this was the first time the field-based approach was used, it worked reasonably well. It was important that the target Annex I habitats were only assessed within a polygon when the positive indicator species thresholds (including the high quality species) outlined in Section 3.1.1 were met, as then the record of presence could be used to infer that an adequate number of positive indicator species had been seen to pass the high quality and positive indicator species *Structure and functions* criteria.

To improve the accuracy of the field-based assessment approach it is important that additional *Structure and functions* assessment criteria, other than the high quality and positive indicator threshold, are consistently brought into the assessments. During the current project these other assessment criteria (*e.g*. broadleaf herb cover, sward height, litter etc.) were recorded on an *ad hoc* basis within the notes recorded for each polygon. Following on from the earlier recommendation in this discussion, that the percentage cover for all target Annex I habitats (*i.e.* 6410, 6430 and 6510 for this study) are estimated for every polygon, a rapid assessment of the *Structure and functions* using the main assessment criteria should be made for each polygon. This rapid *Structure and functions* assessment should utilise a data sheet where a simple pass or fail can be recorded for each of the eight most important *Structure and functions* criteria (*i.e*. high quality species, positive species, broadleaf herb cover, sward height, litter, bare soil, negative species, scrub/heath) from Martin *et al.* (2018). The data sheet should also record the overall *Structure and functions* assessment (*i.e*. Favourable, Unfavourable-inadequate, Unfavourable-bad) for each polygon, with notes added if expert judgement has been used to pass certain criteria, such as a slightly low broadleaf herb cover early in the growing season. There will be a certain amount of estimation as the criteria will be assessed by a walkover survey, but this field-based approach will allow larger areas to be assessed more rapidly than a plot-based approach. As field-based assessments of Annex I habitats are developed they should prove to be a useful tool to complement plot-based assessment data.

5.3.3 *Future prospects*

During the current survey, the field-based assessment of the pressures impacting on the target Annex I habitats provided detailed information on what specific pressures were impacting individual polygons within a site. With these field-based data it was now possible to propose conservation measures on a field-by-field basis to try to reduce these impacts. Based on the results from this study it is recommended that all future assessments of Annex I grassland habitats use a similar field-based approach for recording pressures, utilising the PRIME2 shapefile to provide the field polygons.

The pressures recorded within the target Annex I habitats (Table 10) provide a summary of the negative impacts acting on these habitats within floodplains. These data were compared with

the pressures reported in NPWS (2019) to investigate if similar pressures were recorded nationally. For all three of the target Annex I habitats, the pressures reported for floodplains were generally similar to the pressures reported nationally, with A06: Abandonment of grassland management, an important pressure for 6410, A19: Application of natural fertilisers on agricultural land (*i.e.* slurry spreading) an important pressure for 6510, and A09: Intensive grazing or overgrazing by livestock, an important pressure for 6430. However, some differences are apparent between the floodplain data collected during the current study and the national dataset (NPWS, 2019). One of these differences is that A02: Conversion from one type of agricultural land use to another, was a high-importance pressure reported nationally for both 6410 and 6510, but not reported within the floodplain grasslands dataset. The reason for this difference between the two datasets is probably due to the fact that it is difficult to identify A02 using baseline data alone. Successive monitoring visits are usually required to show how land use has changed over time and the majority of the data collected during the current study were baseline data. In addition, L02: Natural succession resulting in species composition change, was an important pressure within floodplains for both the 6410 and 6430 habitats, but was not one of the top-ranked pressures reported nationally (NPWS, 2019), and invasive species (*e.g*. *Impatiens glandulifera*) were an important pressure for the 6430 habitat nationally (NPWS, 2019) but were not reported within floodplain sites. Most of these differences between the nationally reported data and the current survey can probably be accounted for by the relatively small sample of 27 sites that were surveyed during the current project. A larger survey of floodplain grassland sites would probably produce a dataset that was more closely aligned to the national data. It should be noted that there were very few high-risk invasive species (Kelly *et al*., 2013) recorded within the 27 floodplain grassland sites, with the highly invasive Nuttall's Pondweed (*Elodea nuttallii*), Giant hogweed (*Heracleum mantegazzianum*) and American mink each recorded at one site, but never impacting on an Annex I habitat.

During this project we defined positive indicator species thresholds for potential areas of the three target Annex I habitats, so that the ecologists could record potential areas in a systematic way. This approach was very useful for flagging potential Annex I grassland areas that did not currently meet the criteria as outlined in NPWS (2019), detailed in O'Neill *et al.* (2013), and modified for the 6410 and 6510 habitats by Martin *et al*. (2018). Overall, 46.1 ha of potential 6410, 6430 and 6510 habitat were recorded, slightly more than the 44.5 ha of confirmed examples of the three target Annex I habitats.

5.3.4 Overall assessment

Of the three target Annex I habitats assessed across the floodplain grassland sites during the current survey, 73% of 6430 sites had an overall assessment that was Favourable, 36% of 6510 sites were Favourable, and 18% of the 6410 sites had a Favourable assessment. Overall, these data are more favourable than the overall data reported by the ISGS (O'Neill *et al.,* (2013), which found that 41% of 6430 sites, 29% of 6510 sites and 11% of the 6410 sites received a Favourable assessment. The monitoring reported by Martin *et al.* (2018) did not include the 6430 habitat and reported that 28% of 6410 sites and 11% of 6510 sites had an overall assessment that was Favourable. General comparisons between these three datasets are of little value as each of the surveys assessed the target Annex I habitats at different sites. The comparison of assessment data is only of real value when the same areas are monitored over the long-term using a consistent methodology. The current survey focused on areas that were previously unsurveyed, resulting in only one area, the area of 6510 within Leitra Callow (Site 108, Co. Offaly) having previously been assessed, by O'Neill et al. (2013). Based on a partial assessment, due to EU pressures only being collected from the second year of the ISGS, the overall assessment for the 6510 area in 2007 was Favourable, with a Favourable *Area* assessment and both plots that were recorded within the polygon that was also visited during the current survey passing the *Structure and functions* criteria. Using a field-based *Structure and functions* assessment the same area of 6510 was also assessed as Favourable during the current survey (see the site report in Appendix 3).

5.4 Recommendations for future actions

5.4.1 NPWS Farm Plan Scheme

All 27 sites that were selected for a field study would benefit from being included within an agri-environment scheme such as the NPWS Farm Plan Scheme, with the top ranking sites such as the Suck River Callows NHA the highest priority. Currently, only one of the 27 sites, Inishee and Esker Islands (Site 4003), is comprehensively covered by the NPWS Farm Plan Scheme, with five fields within Leitra Callow (Site 108) within the scheme, one field within the Suck River Callows NHA within the scheme, and no areas within the remaining 24 sites covered by the NPWS farm plan scheme (based on data provided by NPWS). The data collated during this project and particularly the field data provide important baseline information which can assist in identifying the fields, such as those with a high cover of semi-natural and Annex I habitats, that could be brought into agri-environment schemes.

When agri-environment schemes are put in place it is imperative that they focus on maintaining or implementing extensive grassland management regimes. Intensive practices (*e.g*. slurry spreading and re-seeding) and undergrazing and abandonment should be discouraged by using results-based incentives that encourage the farmers within the scheme to adopt extensive management practices. In situations where it is not possible to apply extensive management to whole fields, farmers should be incentivised to apply extensive practices to broad field margins (> 4 m wide).

5.4.2 Conservation measures

This study has highlighted 16 floodplain grassland sites where at least one of the three target Annex I habitats has an unfavourable status (Table 14). In all of these situations, specific conservation measures are required to improve the conservation status of these Annex I grassland habitats. In some cases these conservation measures are highlighted in the site reports, such as the 11 6510 sites where CA09: Manage the use of natural fertilisers and chemicals in agricultural production, is recommended as a measure to reduce the negative impacts of slurry spreading, or the six 6410 sites where CA05: Adapt mowing, grazing and other equivalent agricultural activities, is recommended to tackle the negative impact of abandonment. The study has also highlighted three sites where high-risk invasive species (Kelly *et al*., 2013) are an issue; Nuttall's Pondweed at Derrygoss (Site 4021, Co. Cavan), Giant hogweed at Derryoughter East (Site 1498, Co. Kildare), and American mink at Foxford (Site 1732, Co. Mayo). As a priority, management plans for the removal of these invasive species should be put in place at all three floodplain sites.

A review was undertaken of the 23 floodplain grassland sites where target Annex I habitats were recorded (the two sites where only potential target Annex I habitats were recorded were not included within this review), to prioritise sites for the implementation of conservation measures. The 6410 and 6510 habitats were both prioritised over 6430 as they were found to be more vulnerable, with the 6430 habitat assessed to have a Favourable status at 73% of sites, compared to 36% for 6510 and 18% for 6410 (Table 15). Annex I areas were also prioritised based on size, with a greater priority given to larger contiguous areas. The *Future prospects* parameter was also used to prioritise sites, with a greater priority given to areas with unfavourable *Future prospects*. As the *Structure and functions* of an Annex I habitat is included within the assessment of *Future prospects* there was no need to include this parameter separately. The four sites recommended for priority action are shown in Table 19. The sites listed within Table 19 only represent a first step. Future restoration programmes should consider all 16 floodplain grassland sites where one of the three target Annex I habitats currently has an unfavourable status. In addition, future management plans could look at managing areas of potential Annex I habitat so that they meet the *Structure and functions* criteria of the Annex I habitats.

Table 19 Five areas of floodplain grassland prioritised for measures to be implemented to conserve the Annex I habitat at the site. The polygons from the shapefile SCAL20_Field_sites are listed as the location for the proposed conservation measure.

Site No.	Site name	Annex I habitat	Conservation measure	Polygon area (ha)	Polygons
1730	Sraheen	6510	This field is abandoned and annual mowing needs to be reinstated	0.7	1730_44
4000	Redwood	6410	Both fields are undergrazed and extensive grazing or mowing should be reinstated	9.3	4000_1b, 400_3,
000222	Suck River Callows	6410	The area is abandoned and extensive grazing should be reinstated	1.7	000222_554
000564	River Little Brosna Callows	6410	Scrub encroachment was recorded within all three fields. Sensitive scrub clearance is required	14.6	000564_4, 000564_7c, 00564_11
000564	River Little Brosna Callows	6510	There is slurry spreading within both fields, which needs to be stopped or managed more appropriately	6.4	000564_277, 000564_269

The first stage in the implementation of conservation measures for each of these areas will be to contact the landowner. It is assumed that all sites are in private ownership, apart from Redwood (Site 4000), which is partly owned by the ESB.

5.4.3 Future studies and initiatives

Further areas of floodplain grassland, from the 1,308 km² of floodplain grassland identified across the 583 WFD subcatchments, should be considered for inclusion within future grassland surveys. The 27 floodplain grassland sites surveyed during the current survey only represent 2% of the 1,308 km² area, so there are still large areas of potential semi-natural grassland habitats, including potential areas of Annex I habitat, to be surveyed. The approach taken during this project – of focusing the field survey on relatively under-surveyed areas within the top-ranked WFD subcatchments, while including additional sites that were a priority for NPWS – was both logical and pragmatic and should form the basis for future surveys of floodplain grasslands within Ireland.

Another possible future study would be to survey the 68 potential 6430 plots, 47 potential 6410 plots, and three potential 6510 plots within areas of floodplain grassland, that were identified from the National Vegetation Database during this study and added to the SCAL20_NVD_grassland_plots shapefile. Re-visiting these plots could identify new areas of the three target Annex I habitats, as well as provide important data on how the floodplains where the plots are located have changed over time, with 82 of the plots recorded prior to the year 2000.

Using plot data to investigate vegetation change over time can involve less ambiguity that using habitat maps to investigate change. During this project, habitat maps produced by Heery (1993) and OPW (2020), and management and habitat maps produced by Nairn *et al.* (1988), were compared with the habitats and management recorded during the current project. Although some interesting comparisons could be made at certain sites (see Appendix 3), there was often a certain ambiguity involved when making comparisons. This ambiguity was either due to the different habitat classification schemes that were used, or the way that different ecologists classify habitats within the same classification scheme. In the future, the use of the

Irish Vegetation Classification (Perrin *et al*., 2018), for which a standard key is being developed, may remove some of the inconsistencies between ecologists when mapping grassland vegetation.

For the 27 sites where a habitat map was produced, this information can be used in the future to monitor both the semi-natural habitats and ecosystem services within their floodplains. The ecosystem services within each of these sites can be monitored by using the Habitat Asset Register of Ireland that was developed during the National Ecosystem and Ecosystem Service mapping pilot undertaken for the NPWS (Parker *et al.* 2016). The Habitat Asset Register allows each Fossitt and Annex I habitat to be scored based on how they support ecosystem services such as the regulation of water quality, water flow, and the regulation of the greenhouse gas CO_2.

As well as site-based actions this study has highlighted the requirement for multi-agency actions to address some of the broader issues which impact floodplain grasslands. Although it will be challenging to find solutions for these broader issues, such as water pollution and the regulation of major rivers, such as the River Shannon for hydroelectric power (ESB, 2015), it may be possible to use the EPA's catchment and subcatchment initiatives to initiate these solutions. In other cases, where pollution or other activities are negatively impacting the environment or qualifying interests (*e.g*. Annex I habitats) of Natura 2000 sites, they could be addressed via the Environmental Liability Directive or Article 6 of the Habitats Directive.

Strengthening the link between river basin, flood risk and Natura 2000 management plans could prove to be the key for achieving a good conservation status for species and habitats that depend on water (EEA, 2020). However, to achieve this outcome, multi-agency cooperation will be required, together with a recognition that stakeholders such as farmers must be fully engaged, with opportunities provided for all parties to contribute to the process.

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Appendix 1 Selected data resources for callows and floodplain grasslands

56 data resources ordered alphabetically by author, it is indicated if a resource was mapped within the projects GIS outputs. Notes are provided with further information on each of the resources

Resource title	Mapped	Notes
Anon. (1993) Unpublished report for the National Parks and Wildlife Service (1991-1993). Irish Rare Flora Survey: Protected Flora.	Yes	The dataset was collected 1991-93 and provided 9 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. None of the plots are potential Annex I grasslands. The dataset is recorded as NPWS 003 within the National Vegetation Database administered by the Biodiversity Data Centre
Anon. (1996) Unpublished report for the National Parks and Wildlife Service. Irish Rare Flora Survey: Scarce Species.	Yes	The dataset was collected 1985-96 and provided 2 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. None of the plots are potential Annex I grasslands. The dataset is recorded as NPWS 005 within the National Vegetation Database administered by the Biodiversity Data Centre
Beltman, B., Van den Broek, T., Martin, W., Ten Cate, M. and Güsewell, S. (2003) Impact of mowing regime on species richness and biomass of a limestone hay meadow in Ireland. Bulletin of the Geobotanical Institute , 69: 17–30	No	Study of calcareous hay meadow communities, there is no evidences that any of the communities were floodplain grassland
Borggreve, C. and de Groot, C. (1996) Vegetation of the Shannon Callows at Bullock Island, Ireland. BSc thesis, Wageningen Agricultural University, Netherlands	Yes	This project recorded plots along three transects, one in a hay meadow, on in a pasture and the third in an abandoned field. A digital copy of the data was located but currently all plots are mapped to just one location. The dataset was collected in 1995 and provided 22 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. None of the plots are potential Annex I grasslands (6410, 6430, and 6510). The dataset is recorded as NPWS 043 within the National Vegetation Database administered by the Biodiversity Data Centre
Bourke, D., Hochstrasser, T., Nolan, S., Schulte, R. (2007) Unpublished report for the National Parks and Wildlife Service. Historical Grassland Turboveg Database Project: 2067 Relevés Recorded by Austin O'Sullivan 1962-1982.	Yes	The dataset was collected 1962-1982 by Austin O'Sullivan and provided 22 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. None of the plots are potential Annex I grasslands (6410, 6430, and 6510). The dataset is recorded as NPWS 057 within the National Vegetation Database administered by the Biodiversity Data Centre
Bron, W. and de Heer, M. (1996) Synecology of the Shannon Callows, Ireland. The relation between vegetation and flooding, soil chemistry, geology and management in a floodplain. MSc thesis, Wageningen Agricultural University, Netherlands	No	A digital copy of the data was located but currently all plots are mapped to just one location
Browne, Dunne, Roche (2002) A preliminary study of the Upper Shannon floodplain. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin.	No	Not mapped as the habitat assessments appeared to be almost all based on aerial photo interpretation
Byrne, C. (1996). Unpublished Ph.D. Thesis, Trinity College, Dublin. Semi-natural Grassland Communities in Eastern Ireland: Classification, Conservation and Management.	Yes	The dataset was collected 1993-1994 and provided 4 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. Three of the plots are potential Annex I grasslands (6410). The dataset is recorded as TCD 009 within the National Vegetation Database administered by the Biodiversity Data Centre
Conaghan, J., Roden, C., Fuller, J. (2006) Unpublished Report for the National Parks and Wildlife Service. A Survey of Rare and Scarce Vascular Plants in County Galway: Volumes 1, 2, and 3.	Yes	The dataset was collected 2006 and provided 1 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. This plot is not potential Annex I grasslands (6410, 6430, and 6510). The dataset is recorded as NPWS 049 within the National Vegetation Database administered by the Biodiversity Data Centre
Conaghan, J., Fuller, J. (2005) Unpublished Report for the National Parks and Wildlife Service. A Survey of Rare and Threatened Vascular Plants in County Roscommon.	Yes	The dataset was collected 2005 and provided 2 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. Both of the plots are potential Annex I grasslands (6430). The dataset is recorded as NPWS 039 within the National Vegetation Database administered by the Biodiversity Data Centre

Resource title	Mapped	Notes
Conaghan, J., Fuller, J. (2005) Unpublished Report for the National Parks and Wildlife Service. A Survey of Rare and Threatened Vascular Plant Species in County Longford.	Yes	The dataset was collected 2005 and provided 2 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. One of the plots is potential Annex I grasslands (6430). The dataset is recorded as NPWS 053 within the National Vegetation Database administered by the Biodiversity Data Centre
Donaghy, A.M. (2007) Management of habitats on the Shannon Callows with special reference of Corncrake Crex crex PhD thesis. NUI Cork.	No	Could not access a copy of the thesis
Doyle, G. J. (1982). Journal of Life Sciences. Royal Dublin Society. Vol. 3, 143-146 (1982) No.1. Minuartio-Thlaspietum alpestris (Violotea calaminariae) in Ireland.	Yes	The dataset was collected in July 1980 and provided 3 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. None of the plots are potential Annex I grasslands. The dataset is recorded as Indep 027 within the National Vegetation Database administered by the Biodiversity Data Centre
Dwyer, R., Wann, J. (2005) Reports produced for National Parks & Wildlife Service (Moyne Division). Surveys of Glen Lough, Fisherstown Bog, Killyconny Bog and Ballinderry and Ballynagrenia Bogs.	Yes	The dataset was collected 2005 and provided 2 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. 1 of the plots is potential Annex I grasslands (6430). The dataset is recorded as NPWS 016 within the National Vegetation Database administered by the Biodiversity Data Centre
French, L. (2005) Published Ph.D. Thesis, Trinity College Dublin. Ground Flora Communities in Ireland's Plantation Forests: Their Diversity, Structure and Composition.	Yes	The dataset was collected 2001-2003 and provided 3 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. None of the plots are potential Annex I grasslands (6410, 6430, and 6510). The dataset is recorded as TCD 003 within the National Vegetation Database administered by the Biodiversity Data Centre. This is also published as: French, L., Smith, G.F., Kelly D., Mitchell, F., O'Donoghue, S., Iremonger, S., McKee, A.M. (2008) Elsevier: Forest Ecology and Management 255 (2008) 476–494. Ground flora Communities in Temperate Oceanic Plantation Forests and the Influence of Silvicultural, Geographic and Edaphic Factors.
Galway County Council (2017) Unpublished data collected for the Galway City Transport Project.	Yes	The dataset was collected 2013-14 and provided 70 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. 28 of the plots are potential Annex I grasslands (6410, 6430, and 6510). The dataset is recorded as Ext 003 within the National Vegetation Database administered by the Biodiversity Data Centre
Heery, S. (1983) Published Report for National Association of Regional Game Councils NARGC, Ireland. A Vegetation Study of the Little Brosna Floodplain Grasslands.	Yes	The dataset was collected 1983 and provided 122 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. None of the plots are potential Annex I grasslands (6410, 6430, and 6510). The dataset is recorded as NPWS 042 within the National Vegetation Database administered by the Biodiversity Data Centre. This is also published as: Heery, S. (1991) Proceedings of the Royal Irish Academy, Vol 91B, 1-19. The Plant Communities of the Grazed and Mown Grasslands of the River Shannon Callows.
Heery, S. (1991) The plant communities of the grazed and mown grasslands of the River Shannon callows. Proceedings of the Royal Irish Academy 91B: 199-217.	No	Phyto-sociological study using 267 relevés, mostly from Little Brosna, Bullock Island and Clonmacnoise. Releves from Nairn et al 1988 and Heery 1983 used in this publication. No digital copy of these data could be located
Heery, S. (1993) The Shannon floodlands: a natural history of the Shannon callows. Tír Eolas, Kinvara, Co. Galway. 165pp.	No	A well-illustrated account with chapters on pre-history, flooding, plant-life, bird-life, farming and nature conservation.
Heery, S (1993) National ASI (Areas of Scientific Interest) Survey: Ecologists site card. River Shannon Callows Athlone to Portumna. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin.	Yes	These site cards were completed for various subsites within the Shannon callows by Stephen Heery. Information from the site cards and associated maps were added to the GIS for all floodplain grassland areas that had not been mapped more recently by O'Neill *et al.* (2013)

Resource title	Mapped	Notes
Heery, S. (1994) Corncrake map of options project: North Donegal, Shannon callows and Moy valley. Unpublished report for the National Parks and Wildlife Service, Dublin	No	This data source was not prioritised for digitisation
Heery, S. (1995) Flooding in Spring on the Callows at Shannon Harbour, 1961-94. Biology and Environment: Proceedings of the Royal Irish Academy 95B: 3, 179-182.	No	Presents flooding regime at weekly intervals, in graphic form, during the months of Mar, Apr, May, 1961 - 1994, based on data correlating the automatic river-level gauge readings with actual flooding conditions, 1987-1993, and extrapolating back to 1961.
Heery, S. (1998) Rare and scarce plants on the Shannon Callows. Unpublished report to Dúchas, The Heritage Service, Dublin.	No	Presents occurrence and plant communities, at 24 sites, for the following plant species on the Shannon Callows: opposite-leaved pondweed Groenlandia densa, summer snowflake Leucojum aestivum; green-winged orchid Orchis morio; meadow barley Hordeum secalinum; and marsh pea Lathyrus palustris.
Heery, S. (2003) Callows and floodplains, In: Wetlands of Ireland: Distribution, Ecology, Uses and Economic Value (Ed: Otte)	No	Background paper; information source rather than providing data to be mapped in GIS
Heery, S. (2008) Corncrake habitat in the Moy Valley. Unpublished report to NPWS.	No	Could not access the report
Heery, S. and Mayes, E. (2009) Natura Impact Statement: Proposed pumphouses at Meelick and Portumna. Unpublished report prepared for ESBI, Ireland	No	Background report; information source rather than providing data to be mapped in GIS
Heery, S. and Keane, S. (1999) Shannon Callows Management Plan. MPSU. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin.	Yes	It was decided that for the national mapping of floodplain grasslands it would be a better use of resources to utilise the previous mapping of this dataset that had been carried out for the 2013 Article 17 reporting. These polygon were available as part of the NCA distribution 6410 and 6510 shapefiles that NPWS produced as part of the 2019 Article 17 reporting
Hessel, P and Rubers, W. V. (1968) Flora, Vegetatie en bodem in het stroomgebied van de Shannon, met name in de omgeving van Lough Ree. Report from a doctoral study, University of Utrecht.	No	Translation of title ‘Flora, vegetation and soil in the Shannon river basin, particularly in the Lough Ree area’. This is a report of a doctoral thesis edited at the Institute for Systematic Botany of the University of Utrecht
Jefferson, R.G. and Pinches, C.E. (2011) The conservation of floodplain meadows in Great Britain: an overview. Fritillary, 5. The Journal of the Ashmolean Natural History Society of Oxfordshire and the Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust.	No	Overview paper; information source rather than providing data to be mapped in GIS
Lockhart, N. (1986) The vegetation of Clonmacnoise callows, Co. Offaly. Unpublished report that was included within the data published in Tubridy, M. (1988) Clonmacnoise heritage zone project: a portfolio of management plans. Final report to the EEC, project no. 6611/85/08/1, Trinity College, Dublin.	No	Some of the plots recorded as part of this dataset were added to the NVD_grassland_plots shapefile (see below Tubridy 1988)
Lockhart, N. D. (1992) Unpublished report for the National Parks and Wildlife Service. A Report on the Wetland Vegetation of the Mulkear River Catchment, Counties Limerick and Tipperary.	Yes	The dataset was collected 1991 and provided 24 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. 10 of the plots are potential Annex I grasslands (6410, 6430, and 6510). The dataset is recorded as NPWS 036 within the National Vegetation Database administered by the Biodiversity Data Centre

Resource title	Mapped	Notes
Long, M.P. and Brophy, J.T. (2019) Monitoring of sites and habitat for three Annex II species of whorl snail (Vertigo). Irish Wildlife Manuals, No. 104. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Dublin	Yes	The dataset was collected 2014-2017 and provided 2 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. 1 of the plots is potential Annex I grassland (6430). The dataset is recorded as EXT 004 within the National Vegetation Database administered by the Biodiversity Data Centre
Maher, C. (2013) An examination of how flooding patterns and farming practices affect plant and marsh fly communities on unregulated floodplain meadows in Ireland. PhD thesis, National University of Ireland, Galway.	No	This PhD thesis includes important plot data and mapping, including a digital elevation model of the Shannon catchment and hydrometric maps, but no digital copy of these data could be located
Maher, C., Gormally, M., Williams, C. & Sheehy Skeffington, M. 2014. Atlantic floodplain meadows: influence of hydrological gradients and management on sciomyzid (Diptera) assemblages. Journal of Insect Conservation 18: 267-282.	No	Background paper; information source rather than providing data to be mapped in GIS
Maher, C., Sheehy Skeffington, M. & Gormally, M. 2015. Hydroperiod and traditional farming practices drive plant community composition on unregulated Atlantic floodplain meadows. Wetlands 35: 32-35.	No	Background paper; information source rather than providing data to be mapped in GIS
Martin, J.R., O'Neill, F.H. and Daly, O.H. (2018) The monitoring and assessment of three EU Habitats Directive Annex I grassland habitats. Irish Wildlife Manuals, No. 102. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Dublin.	No	Provided the data for the 2018 update of the grassland GIS shapefile ISGS15_Habitats.shp
Martin, W.L. (1991) Survey of hay meadows in the area of west Corrib, Co. Galway. Irish Naturalists' Journal, 23, 365-371.	No	Background paper; information source rather than providing data to be mapped in GIS
McGough, H.N. (1984) Unpublished report for the National Parks and Wildlife Service. A Report on the Grasslands and Closely Related Vegetation of the Burren Region in the West of Ireland. Unpublished report for the National Parks and Wildlife Service.	Yes	The dataset was collected 1984 and provided 1 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. This plot is not potential Annex I grassland. The dataset is recorded as NPWS 001 within the National Vegetation Database administered by the Biodiversity Data Centre
McGurn, P. (2008) Hay Meadow Management Systems in Fermanagh. PhD thesis, University of Ulster, Coleraine.	No	Background report; information source rather than providing data to be mapped in GIS
MhicDaeid, C. (1976) Unpublished Ph.D. Thesis, Trinity College, Dublin. A Phytosociological and Ecological Study of the Vegetation of Peatlands and Heaths in the Killarney Valley.	Yes	The dataset was collected 1965-1972 and provided 7 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. 5 of the plots are potential Annex I grassland (6410). The dataset is recorded as TCD 007 within the National Vegetation Database administered by the Biodiversity Data Centre
Mooney, E. (1991) Published Ph.D. Thesis, National University of Ireland, Galway. A Phytosociological and Palaeoecological Study of the Wetlands of the Lower Corrib Basin, Co. Galway, Ireland.	Yes	The dataset was collected 1986-89 and provided 66 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. 64 of the plots are potential Annex I grasslands (6410, 6430). The dataset is recorded as NUIG 005 within the National Vegetation Database administered by the Biodiversity Data Centre This was also published as: Mooney, E., O'Connell, M. (1990) Proceedings of the Royal Irish Academy. Vol. 90B, 57-97 . The Phytosociology and Ecology of the Aquatic and Wetland Plant Communities of the Lower Corrib Basin, County Galway.

Resource title	Mapped	Notes
Nairn, R. (1991) Floodplain agriculture in Ireland and its significance for bird conservation. In Birds and Pastoral Agriculture in Europe, Proceedings of the Second European Forum on Birds and Pastoralism, Port Erin, Isle of Man, 26-30 October 1990. Editors D.J. Curtis, E.M. Bignal, M.A. Curtis. Scottish Chough Study Group, 1991	No	Could not access the proceedings without purchasing the book
Nairn, R, Herbert, I.J. and Heery, S. (1988) Report on a Survey of the Breeding Birds and Plant Communities in the River Shannon Floodplain. Unpublished report to Irish Wildbird Conservancy, Dublin.	Yes	Information from this report was mapped and added to the GIS for all floodplain grassland areas that had not been mapped more recently by O'Neill *et al.* (2013)
Natura Environmental Consultants (2007). Unpublished report for the National Parks and Wildlife Service. Botanical Surveys 2006: North Midlands cSACS.	Yes	The dataset was collected 2006 and provided 16 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. 3 of the plots are potential Annex I grasslands (6410, 6430). The dataset is recorded as NPWS 019 within the National Vegetation Database administered by the Biodiversity Data Centre
O'Hara, R., Green, S. and McCarthy, T. (2019) The agricultural impact of the 2015–2016 floods in Ireland as mapped through Sentinel 1 satellite imagery. Irish Journal of Agricultural and Food Research 58: 44-65	No	Background paper information source rather than providing data to be mapped in GIS
O'Neill, F.H. & Martin, J.R. (2018) The Irish Juniper Monitoring Survey 2017. Irish Wildlife Manuals, No. 101. National Parks and Wildlife Service, Department of Culture Heritage and the Gaeltacht, Ireland.	Yes	The dataset was collected 2017 and provided 1 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. This plot is not a potential Annex I grassland (6410, 6430, and 6510). The dataset is recorded as EXT 007 within the National Vegetation Database administered by the Biodiversity Data Centre
O'Neill, F.H., Martin, J.R., Devaney, F.M. and Perrin, P.M. (2013) The Irish semi-natural grasslands survey 2007-2012. Irish Wildlife Manuals, No. 78. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin.	Yes	Provided the majority of the data for the grassland GIS shapefile ISGS15_Habitats.shp, also provided 469 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile, dataset is recorded as NPWS 062 within the National Vegetation Database administered by the Biodiversity Data Centre
OPW (2012) The national preliminary flood risk assessment (PFRA): Overview report. Flood relief and risk management division engineering services. Office of Public Works.	No	Overview report; information source rather than providing data to be mapped in GIS
OPW (2012) The national preliminary flood risk assessment (PFRA): Designation of the areas for further assessment. Flood relief and risk management division engineering services. Office of Public Works.	Yes	Project that led to the production of the OPW's three datasets that map high (10%), medium (1%) and low (0.1%) probability of present day river flood extents. Merged together in the GIS shapefile public_ex_f_c_001_ITM.shp
OPW (2020) Flood relief scheme: Environmental spatial data specification. Flood risk management data management. Office of Public Works.	Yes	The background report for the OPW's GIS shapefile national_hma.shp (this OPW shapefile records the Fossitt and Annex I habitat polygons mapped as part of the flood relief scheme environmental spatial data collected from 2013-18)
Owens, J. (2016) Restoring high conservation value to hay meadows on the River Shannon floodplain; controlling Filipendula ulmaria and investigating its dominance. MSc Thesis, NUI Galway, Ireland	No	Grid references were only provided for the centroid of the 10 main study sites. A digital copy of the individual plot data is available but there is no associated location data and the plots could not be mapped
Reynolds, S., Conaghan, J., Fuller, J. (2006) Unpublished Report for the National Parks and Wildlife Service. A Survey of Rare and Scarce Vascular Plants in County Limerick.	Yes	The dataset was collected 2006 and provided 2 of the potential floodplain grassland plots within the NVD_grassland_plots shapefile. Neither plot is potential Annex I grassland. The dataset is recorded as NPWS 050 within the National Vegetation Database administered by the Biodiversity Data Centre

Resource title	Mapped	Notes
Schindler, S., O'Neill, F.H., Biró, M., Damm, C., Gasso, V., Kanka, R., van der Sluis, T., Krug, A., Lauwaars, S.G., Sebesvari, Z., Pusch, M., Baranovsky, B., Ehlert, T., Neukirchen, B., Martin, J.R., Euller, K., Mauerhofer, V. & Wrbka, T. 2016. Multifunctional floodplain management and biodiversity effects: a knowledge synthesis for six European countries. Biodiversity and Conservation 25:1349-1382.	No	Overview paper; information source rather than providing data to be mapped in GIS
Spink, A., Sparks, R. E., Van Oorschot, M. and Verhoeven, J.T. A. (1998) Nutrient dynamics of large river floodplains. Regulated Rivers: Research and Management. 14: 203–216	No	Overview paper; information source rather than providing data to be mapped in GIS
Tolkamp, W. (2001) Gradients in floristic composition of callow grasslands, Co. Longford, Ireland. BSc thesis, Wageningen Agricultural University, Netherlands	No	This project recorded plots along three transects, one in a hay meadow, one in a pasture and the third in an abandoned field. The grid references for the individual plots were not available
Tubridy, M. (1988) Clonmacnoise heritage zone project: a portfolio of management plans. Final report to the EEC, project no. 6611/85/08/1, Trinity College, Dublin.	Yes	22 plots that were clearly mapped in the report were added to the NVD_grassland_plots shapefile. None of the plots are potential Annex I grasslands (6410, 6430, and 6510). The dataset is recorded as Tubridy_1988.
van Helsdingen, P. J. (1996) The Spider Fauna of Some Irish Floodplains. The Irish Naturalists' Journal, Vol. 25, No. 8, pp. 285-293	No	Overview paper; information source rather than providing data to be mapped in GIS

Appendix 2 The 29 WFD subcatchments selected for a field survey

Appendix 2 lists the 29 WFD subcatchments where a field survey site was selected. Twenty-seven field survey sites were selected with some of these sites, such as the Suck River Callows NHA, covering multiple WFD subcatchments. There were also three subcatchments where two field study sites were selected within the one subcatchment. It was not possible to survey all of the floodplain grassland within each subcatchment and the field study sites represented a subsample of the floodplain grassland within each subcatchment. The target Annex I habitats for this project were *Molinia* meadows (6410), Hydrophilous-tall-herb (6430), and Lowland hay meadows (6510). The rare floodplain grassland species of note during this project were: *Bromus racemosus, Carum verticillatum, Colchicum autumnale, Hordeum secalinum, Juncus compressus, Lathyrus palustris, Mentha pulegium, Oenanthe fistulosa, Sanguisorba officinalis, Spiranthes romanzoffiana*.

Subcatchment ID	Name of EPA subcatchment	Confirmed Annex I habitats within floodplain (1 for each target Annex I habitat)	High potential of Annex I habitats within floodplain (0.5 for each target Annex I habitat)	Confirmed traditional hay meadow (non-Annex or Annex I) within floodplain (score=1)	High potential traditional hay meadow (non-Annex or Annex I) within floodplain (score=0.5)	*Rare floodplain grassland species (Max score of 1 for the presence of one species	The total area of confirmed target Annex I habitats	Total area (ha) of all floodplain grassland	Notes	Project site number
07_12	Boyne_SC_050	2	0	1	0	0	24.36	1289.70	The site is based on OPW data (OPW, 2020)	4014
07_13	Boyne_SC_070	2	0	0	0	0	16.81	1281.54	The site is based on OPW data (OPW ,2020)	4015 and 4018
07_8	Blackwater[Kells]_SC_030	2	0	0	0	0	10.56	688.03	The site is based on OPW data (OPW, 2020)	4016
14_18	Barrow_SC_060	2	0	0	0	0	3.78	1737.20	Includes ISGS site 1498 that was not resurveyed during the GMS	1498
15_10	Nore_SC_040	0	0	0	0	0	0.00	442.10	Shananhoe marsh site recommended by NPWS. Selected site adjacent to ISGS site 2606	2606
25B_1	Shannon[Lower]_SC_040	2	0	1	0	0	12.37	474.95	Inishee Island and eastern shore recommended by NPWS.	4001 and 4003
25B_2	Shannon[Lower]_SC_030	2	0.5	1	0	1	35.15	726.07	Includes part of ISGS site 108	108
25B_5	Shannon[Lower]_SC_060	1	0.5	0	0.5	1	7.37	1775.98	Site 4000 based on Nairn *et al*. (1988) and Heery (1993) data. Other site selected	4000 and

Subcatchment ID	Name of EPA subcatchment	Confirmed Annex I habitats within floodplain (1 for each target Annex I habitat)	High potential of Annex I habitats within floodplain (0.5 for each target Annex I habitat)	Confirmed traditional hay meadow (non-Annex or Annex I) within floodplain (score=1)	High potential traditional hay meadow (non-Annex or Annex I) within floodplain (score=0.5)	*Rare floodplain grassland species (Max score of 1 for the presence of one species	The total area of confirmed target Annex I habitats	Total area (ha) of all floodplain grassland	Notes	Project site number
									based on the River Little Brosna Callows NHA (code 000564)	NHA 000564
26C_5	Shannon[Upper]_SC_040	2	0	0	0	0	2.18	1143.46	Site selected to increase survey area within the Upper Shannon	4017
26C_9	Shannon[Upper]_SC_050	3	0	1	0	1	8.07	1105.60	Selected as part of the Rinn River NHA site (site no. 000691)	NHA 000691
26D_1	Suck_SC_070	0	0	0	0	0	0.00	567.21	Selected as part of the Suck River Callows NHA site (site no. 000222)	NHA 000222
26D_2	Suck_SC_080	1	0	0	0	0	3.16	588.02	Selected as part of the Suck River Callows NHA site (site no. 000222)	NHA 000222
26D_3	Suck_SC_100	0	0	0	0	0	0.00	784.64	Selected as part of the Suck River Callows NHA site (site no. 000222)	NHA 000222
26D_4	Suck_SC_040	0	0	0	0	0	0.00	670.27	Selected as part of the Suck River Callows NHA site (site no. 000222)	NHA 000222
26D_5	Suck_SC_090	1	0	0	0.5	0	0.00	1349.65	Selected as part of the Suck River Callows NHA site (site no. 000222)	NHA 000222
26D_6	Suck_SC_060	0	1	0	0	0	0.00	556.06	Selected as part of the Suck River Callows NHA site (site no. 000222)	NHA 000222
26E_5	Hind_SC_010	2	0	1	0	0	1.72	467.72	Adjacent to ISGS site 218	218
26E_6	Shannon[Upper]_SC_090	3	0	1	0	1	3.36	2569.29	Adjacent to ISGS site 996	996
26G_1	Shannon[Lower]_SC_020	2	0	1	0	1	7.43	816.19	Followed Nairn et al. 1988 site, adjacent to ISGS site 114	114
26G_2	Shannon[Upper]_SC_100	3	0	1	0	1	26.64	1523.89	Followed Nairn et al. 1988 site adjacent to ISGS site 113	113

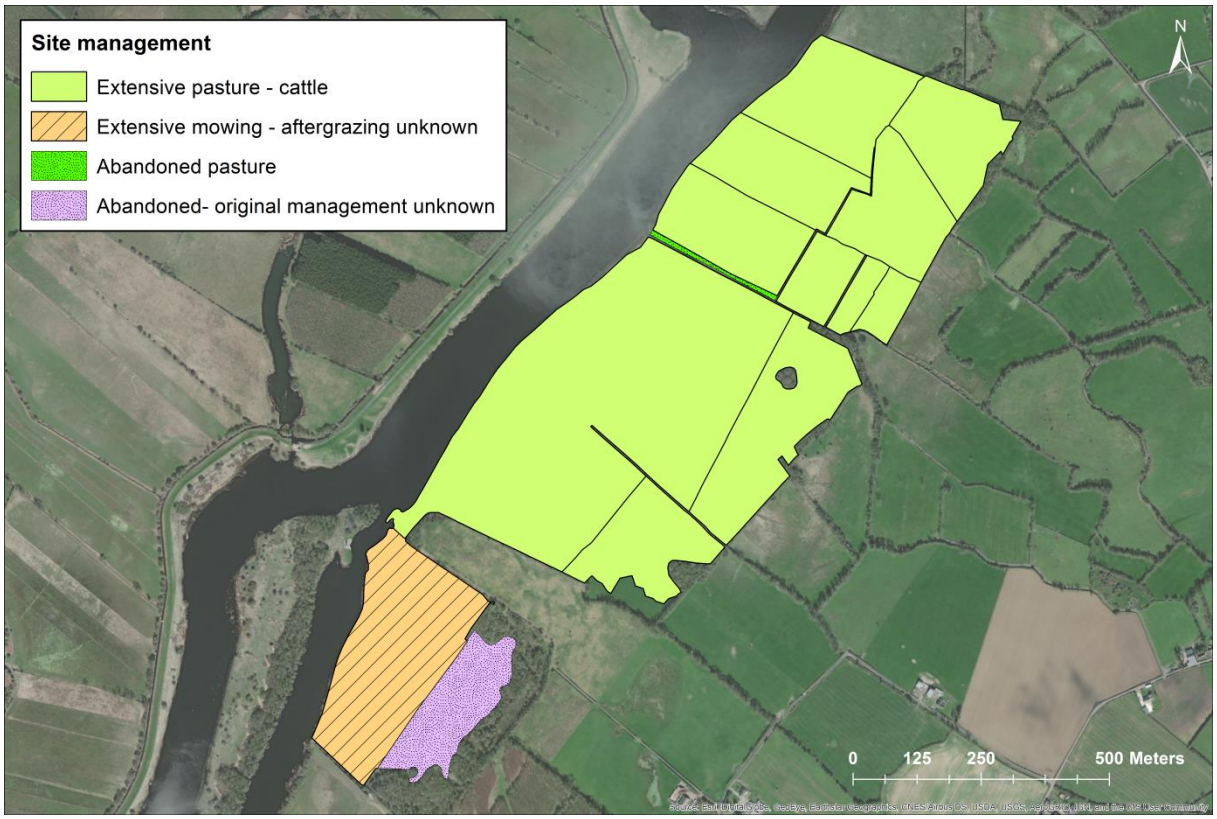
Subcatchment ID	Name of EPA subcatchment	Confirmed Annex I habitats within floodplain (1 for each target Annex I habitat)	High potential of Annex I habitats within floodplain (0.5 for each target Annex I habitat)	Confirmed traditional hay meadow (non-Annex or Annex I) within floodplain (score=1)	High potential traditional hay meadow (non-Annex or Annex I) within floodplain (score=0.5)	*Rare floodplain grassland species (Max score of 1 for the presence of one species	The total area of confirmed target Annex I habitats	Total area (ha) of all floodplain grassland	Notes	Project site number
26G_3	Shannon[Lower]_SC_010	2	0.5	1	0	1	53.31	1243.96	Followed Heery (1993) site	4013
27_12	Owenogarney_SC_020	1	0	0	0	1	1.46	838.47	A River Fergus site	4019
30_18	Corrib_SC_010	3	0	1	0	1	14.34	1264.43	A Lough Corrib site	4020
34_10	Moy_SC_090	3	0	1	0	1	6.60	555.89	Adjacent to ISGS site 1732	1732
34_12	Moy_SC_080	1	0.5	1	0	1	8.61	519.19	Includes ISGS site 1736 that was not resurveyed during the GMS	1736
34_17	Moy_SC_050	1	0	0	0	0	1.56	824.25	These sites are based on OPW data (OPW 20020)	4012
34_6	Moy_SC_100	3	0	0	0	1	16.94	648.14	Includes part of ISGS site 1730 that was not resurveyed during the GMS	1730
35_2	Owenmore[Sligo]_SC_030	2	0.5	0	0	0	5.54	400.66	Selected area opposite ISGS site 1541	1541
36_21	Erne_SC_030	2	0	1	0	1	2.05	446.39	Site was added to include a site from the River Erne	4021

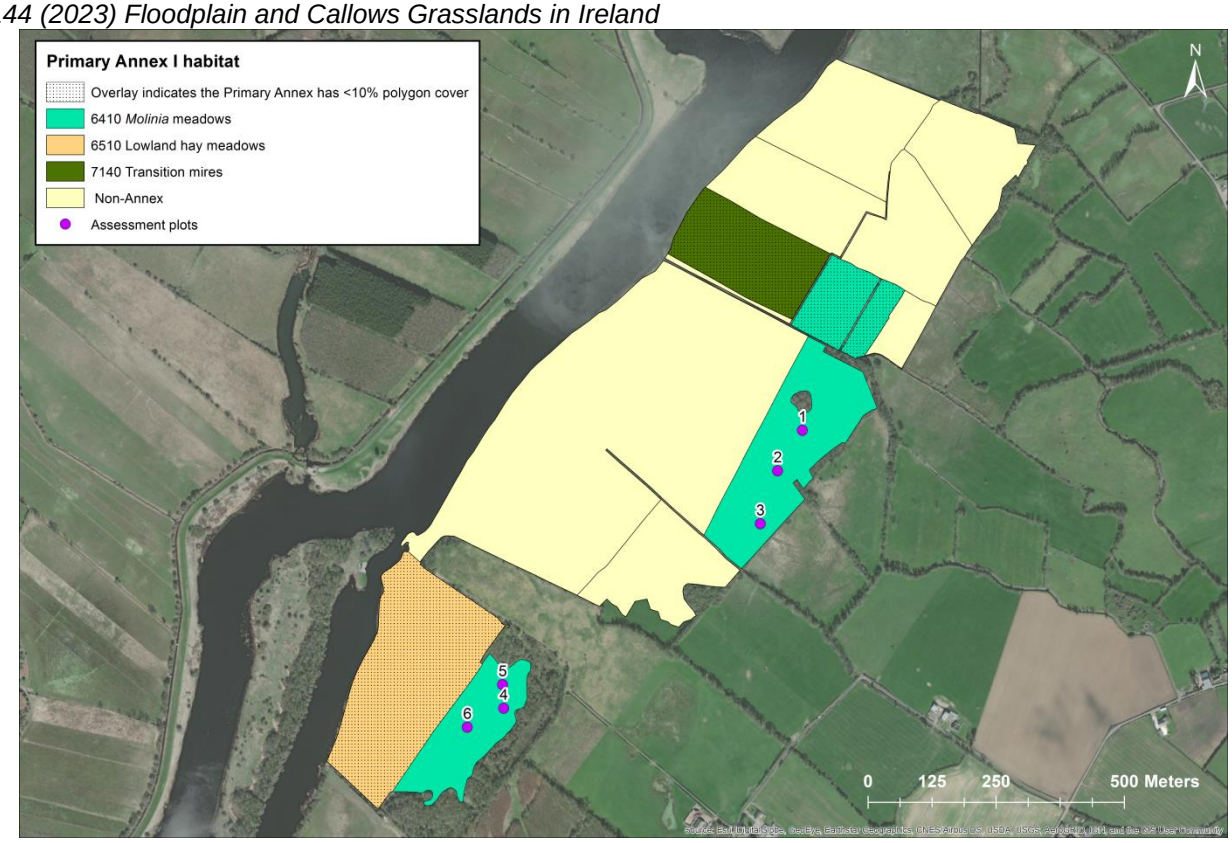
Appendix 3 Site reports for the 27 field surveyed floodplain sites

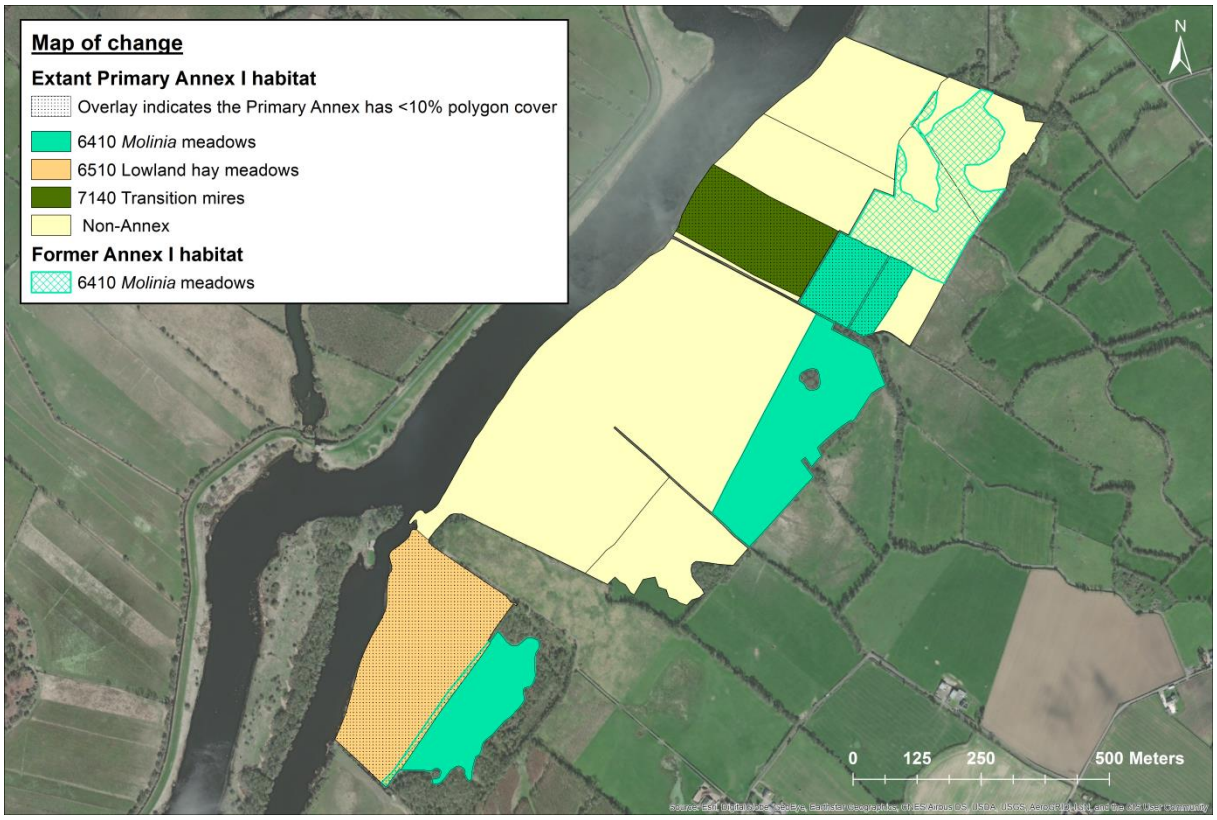
The site reports for the 27 surveyed floodplain grassland sites are presented in a separate document that is available at – https://www.npws.ie/sites/default/files/publications/pdf/IWM144%20Appendix%203.pdf. They are ordered by site number, with the three NHA sites added at the end. It is recommended that the three shapefiles SCAL20_Field_sites (Field survey polygons), SCAL20_plot_points (2 x 2 m plots), and SCAL20_feature_points (point features such as rare plants or the location of Annex I habitats) are viewed when reading the site reports. The unique identifier, made up of the site number and polygon number (e.g. 4000_1b) is used within the site reports to indicate the location of particular features, together with general location descriptors such as 'north-eastern end of site'.

The EU negative pressures recorded for the target Annex I habitats in the 2021 survey are listed within each site report. When neutral pressures were recorded at a site, these are also listed within the same table but with 'neutral' added in parentheses.

Appendix 4 Four example floodplain grassland maps produced for Redwood (Site 4000)




Primary Annex I habitat
Overlay indicates the Primary Annex has <10% polygon cover
6410 *Molinia* meadows
6510 Lowland hay meadows
7140 Transition mires
Non-Annex
Assessment plots
N
1
2
3
4
5
6
0
125
250
500 Meters


Map of change
Extant Primary Annex I habitat
Overlay indicates the Primary Annex has <10% polygon cover
6410 *Molinia* meadows
6510 Lowland hay meadows
7140 Transition mires
Non-Annex
Former Annex I habitat
6410 *Molinia* meadows
N
0
125
250
500 Meters

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Government of Ireland