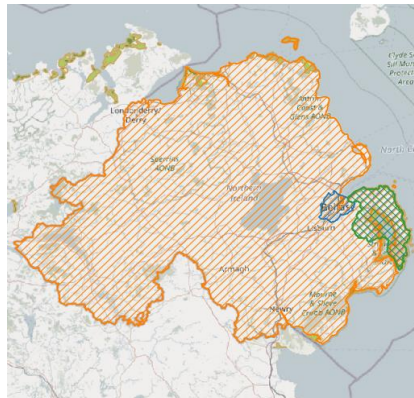
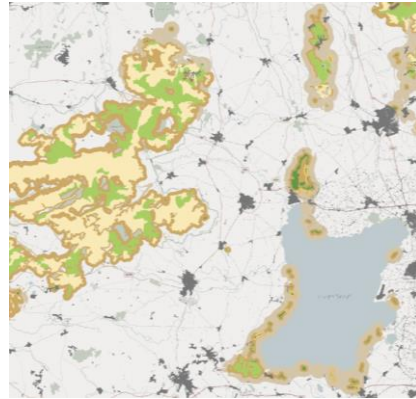


# Developing Habitat Networks in Support of a Northern Ireland Nature Recovery Network Mapping Framework



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Northern Ireland Nature Recovery Network Mapping Framework

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## 1. Introduction

### 1.1 Background

In 2017, the directors of the National Trust, RSPB, The Wildlife Trusts and Woodland Trust came together to sign the Landscape Partnership agreement, agreeing to work more closely and collaboratively on landscape-scale nature conservation across the UK. In the spirit of this agreement, and with funding from the National Lottery Heritage Fund, a goal of the four organisations is to build capacity to deliver Nature Recovery Networks in Northern Ireland. A methodology for creating habitat networks<sup>1</sup> as the backbone for Nature Recovery Networks has been developed by Natural England (Edwards *et al.*, 2020) and used to produce a suite of habitat networks for individual and grouped habitat types. However, until now no habitat networks have been developed for Northern Ireland. The habitat networks comprise vector datasets that map areas of land into different network categories, based on how favourable the land is for restoration to priority habitat, and how effective restoration in each area would be at enhancing connectivity of the priority habitat, based on proximity to existing habitat patches. A description of these network categories is provided in Table 1.

**Table 1: Data classes mapped by the habitat networks**

Habitat Network Class	Description
Primary Habitat	Existing patches of the priority habitat which is the focus of the individual habitat network map e.g. Ancient Semi-natural Woodland.
Associated Habitat	Other priority habitat types that are frequently found in association/in mosaic with the primary habitat, supporting the primary habitat in question, including the species relying on it.
Restorable Habitat	Areas where the primary habitat is present in a degraded or fragmented form, with potential to restore or create the primary habitat.
Fragmentation Action Zone	Land connecting existing patches of fragmented primary and associated habitat, which is likely to be suitable for creation of the primary habitat, with a resulting reduction in the degree of fragmentation.
Network Enhancement Zone 1	Land connecting existing patches of primary, associated and restorable habitat which is likely to be suitable for creation of the primary habitat. Action here would expand and join up existing habitat patches and improve the connections between them.
Network Enhancement Zone 2	Land connecting existing patches of primary, associated and restorable habitat which is less likely to be suitable for creation of the primary habitat. Action here would improve the biodiversity value through land management changes and/or green infrastructure provisioning to support the primary habitat in question.
Network Expansion Zone	Land within Enhancement Zone 1 connecting existing patches of fragmented primary and associated habitat, which is likely to be suitable for creation of the primary habitat. Action here would address the most fragmented areas of the primary habitat.

<sup>1</sup> Nature Recovery Networks Northern Ireland - Useful terminology

[https://www.ulsterwildlife.org/sites/default/files/2021-11/NRN\\_Useful%20Terminology\\_19\\_11\\_21.pdf](https://www.ulsterwildlife.org/sites/default/files/2021-11/NRN_Useful%20Terminology_19_11_21.pdf)

## 1.2 Aims

This project was commissioned to use the Natural England methodology as a basis for producing the first Nature Recovery Networks (NRNs) for Northern Ireland. It is envisaged that these networks could then be used to help identify possible locations for actions to improve ecological resilience of the current habitat network, in line with the 'Lawton' principles of making habitats bigger, better and more joined-up (Lawton *et al.*, 2010), and to guide decision-making in development of plans to ensure that 30% of land is managed effectively for nature by 2030 ('30 by 30'), as a means of tackling the biodiversity and climate crises.

Development of the habitat networks followed the following process:

1. Review of Priority Habitat lists, Natural England's FME-based NRN workflow and network mapping rules, and adaptation as necessary to the Northern Ireland context
2. Collate and review spatial datasets available for mapping the Northern Ireland priority habitat networks, and select data to use in the habitat network production
3. Run the analysis to produce a suite of national scale habitat networks for Northern Ireland.
4. Run the analysis to produce a suite of local scale habitat networks for selected case study areas.
5. Conduct an exploratory analysis of the capacity of habitat networks to deliver '30 by 30' in Northern Ireland.

## 2. Methodologies

### 2.1 Review of priority habitats and habitat networks for inclusion

A review was undertaken of the existing Natural England habitat networks and the Northern Ireland Priority habitat list, to identify how well the existing NRN categories and parameters could map the priority habitats of Northern Ireland, given the differences in the definition of some habitat types, and the fact that some English priority habitats may not occur in Northern Ireland, and vice versa.

The Natural England process specifies parameters to map the NRN for many of England's priority habitats, with some exceptions (e.g., no Natural England NRNs exist for hedgerows or field margins). In cases where no existing process existed for creating a priority habitat network, consideration was given as to whether one could (in cases where there is sufficient data) or should (e.g., considering whether the priority habitat type occurs in Northern Ireland) be created for Northern Ireland.

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In the case of priority habitats where the English and Northern Irish equivalents were similar but not identical, consideration was given as to whether these habitat types needed to be split or combined in order to better define the Northern Ireland priority habitat. An example is calcareous grassland, which is subdivided into upland and lowland variations in England, giving rise to two separate NRNs. However, in Northern Ireland no distinction is made between lowland and upland calcareous grassland, therefore all calcareous grassland types were grouped into a single habitat network for calcareous grassland.

Consideration was also given to the functional connectivity between habitats at the landscape scale; this factor was attributed with more importance than the need to separate habitats based on their definition as 'upland' or 'lowland' varieties. Furthermore, no definitive spatial boundary to distinguish between upland and lowland areas in Northern Ireland was available to the project; creation of such a dataset proved complex due to the interrelationships between altitude and east-west variation in rainfall levels, and insufficient time and resource were available to validate such a dataset. Therefore, the decision was taken to merge upland and lowland habitat variations, to create a single functional habitat network. A record of the outcome of this decision-making process is provided in Appendix A.

Once these decisions had been taken, and for priority habitats where the English description already matched the Northern Ireland habitat description, it was necessary to review the parameters used to define the habitat and its network, and refine them as necessary to create the Northern-Ireland-specific habitat networks (see Section 2.3 Spatial data and schema mapper review)

## **2.2 FME workbench development**

Feature Manipulation Engine (FME) is a data integration platform that allows users to connect and transform data, and which accepts data held in many different file formats (e.g. different types of vector and raster data). It is intended especially for use with spatial data; it allows data be read in as one file type, processed in some way, and exported as a different file type if desired. Such operations are carried out in a window known as a 'workbench', which can be used to develop complex processing chains.

*A FME workbench to create a range of habitat networks had previously been developed by Natural England, and was supplied for use in the project to facilitate replication of the key methodology, while making amendments where necessary to ensure the networks could be created in a Northern Ireland context. The workbench was amended to run in the 2021 version of FME, and to convert all outputs to the Irish Grid TM65 projection system. Additionally, the data input procedure was simplified to allow the process to call input data from specified input directories classified by habitat type, as opposed to linking to each individual dataset. Guidelines for running the modified FME workbench are provided in*

### 2.3 Spatial data and schema mapper review

The Natural England FME workflow links to a .csv file called a schema mapper, which contains the habitat, soil and topographic parameters, and numeric thresholds used to define each network. A description of these parameters and the mapping process can be found in Edwards *et al.*, 2020. The process identifies particular habitat types that are supportive of the main priority habitat type, or occur in mosaic with it ('associated habitats'); habitats that could be suitable targets for restoration to the priority habitat type ('restorable habitats'); and areas of known habitat creation projects ('habitat creation').

The existing Natural England schema mapper parameters were reviewed to assess their suitability for mapping the Northern Ireland habitat networks. In some cases, additional habitat types were added to the list of Associated and Restorable Habitats associated with the primary habitat type; these amendments are detailed in Appendix A.

Creation of the 'Restorable Habitat', 'Fragmentation Action Zone', 'Network Enhancement Zones' and 'Network Expansion Zone' depends on the underlying soil conditions being deemed suitable for the primary habitat in question. In order to define the soil parameters, areas of primary habitat were analysed against the underlying soil type, to determine which soil types were primarily associated with the primary habitat. For some habitat types (e.g., woodland), soil parameters were not included, in order to acknowledge the very broad range of conditions in which different woodland types could be established.

Additional datasets were used for some network types to further refine the geographic areas that could be classed as suitable for restoration of primary habitat:

- information pertaining to the underlying geology was used to limit the possible network extent of limestone pavement habitat.
- For the areas of potential suitability for maritime cliff and slope habitat, the soil dataset was substituted for a spatial dataset identifying the location of cliff areas. This was generated by combining existing spatial data which mapped cliff habitats, with an analysis of SRTM elevation data, to identify the location of sea cliffs based on slope, elevation, and distance from the sea.
- For the local reedbed and coastal saltmarsh networks, high resolution flood extent data were provided, and used in addition to soil type to define the topographic conditions (i.e., floodplain areas) that would be suitable for these habitat types.

A list of abbreviations used in the schema mappers, and their descriptions, is provided in Appendix CB. The schema mappers for the national and local habitat networks have been provided as separate .csv datasets to accompany the FME workbenches.

A large number of spatial datasets were reviewed for potential inclusion as input datasets to define the Primary, Associated and Restorable habitat types, as well as other relevant factors:

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- Datasets were received in a variety of formats, scales of mapping, age, and accuracy. It should be noted that few of the datasets had supporting metadata, so their precise lineages could not be established.
- The majority of datasets related to mapping of habitat types, although soil and geology data, topographic data, land management boundaries including designated sites, and flood risk data were also included.
- Datasets were excluded from the analysis if they were duplicates or older versions of other datasets already selected for inclusion; if the habitat classification was ambiguous or of insufficient accuracy; or if the dataset contained no usable attributes for the purpose of defining habitats types/ the biophysical properties supporting particular habitats.
- Insufficient data was available to identify parameters for habitat creation; while in some cases (e.g. CANN peatland data) a broad area of restoration activity was known, the data attribution did not identify specific mapped features where restoration was taking place. As a result, the data filtering focussed on identifying areas of priority, associated and restorable habitat for each habitat network.

A full list of datasets selected for inclusion in the habitat network mapping, at both the national and local scales, is provided in Appendix BC.

Datasets selected for inclusion as inputs to the habitat networks were split by attributes to create selections of data that defined each of the habitat types listed within the schema mapper. For example, if a vector dataset contained a field named 'Phase 1' containing Phase 1 habitat class codes for each polygon, selections were made to create data subsets for each unique priority habitat.

In the case of the national Priority Grasslands dataset, where many polygons were attributed as containing a mosaic of grassland types (classified by NVC community), a single polygon could be selected as an input feature for multiple primary habitat types (e.g., both acid grassland and calcareous grassland), depending on the combination of habitat communities recorded in the attribute table.

In the case of river mapping the primary input dataset was a detailed dataset of polyline features, which was simplified to select only the major channels prior to processing, due to the very large number of associated habitat types for this network, and their very large geographical extent, creating computational challenges.

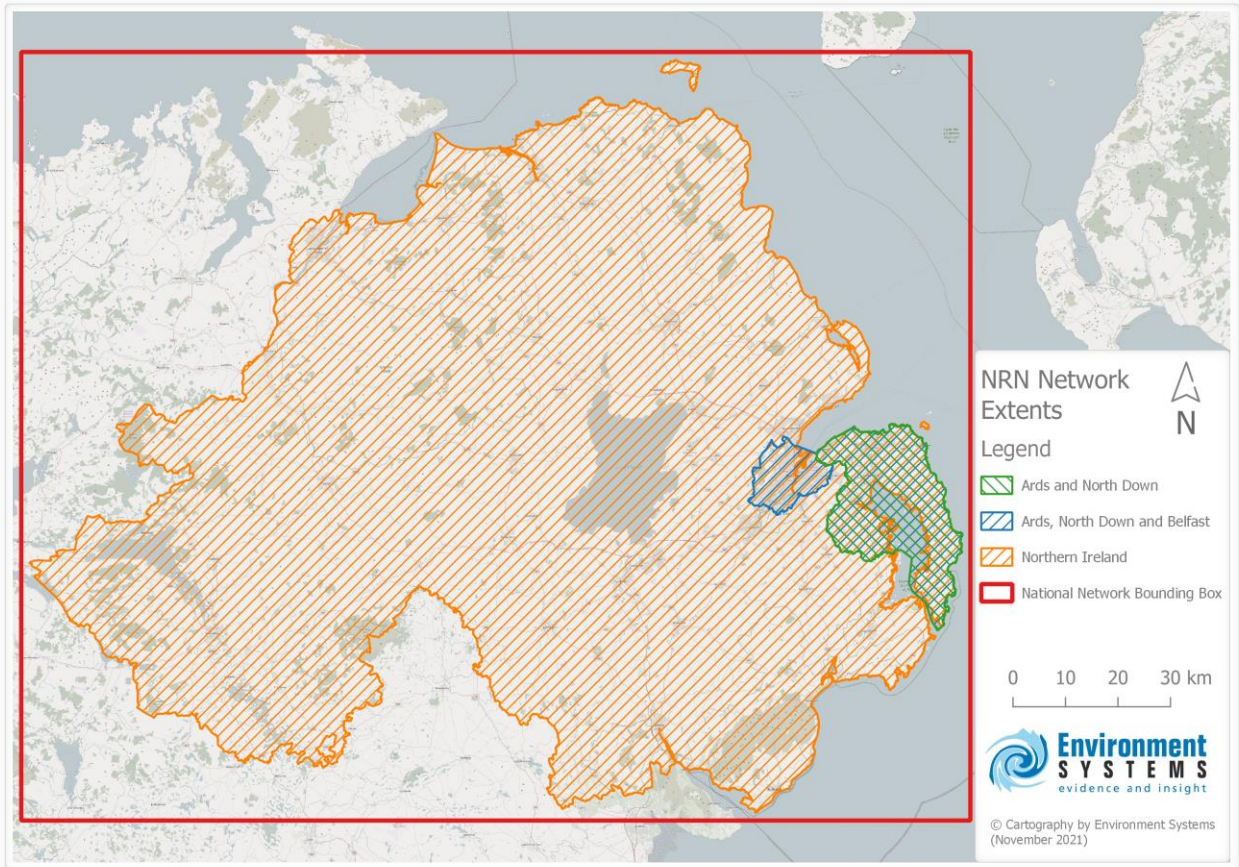
### 2.4 Habitat network production

The full suite of habitat networks was processed at both the national and local scales, and are suitable for viewing at a scale of up to 1:10000. Not all primary habitat types were present in the local network region of interest, and in some cases insufficient local data was available to produce a localised habitat network map, therefore fewer habitat types could be modelled at the local scale for this area. The full list of habitat networks produced is provided in **Error! Reference source not found..**

Figure 1 shows the geographic extents of the national and local habitat networks. National habitat networks cover Northern Ireland plus part of the Republic of Ireland, with this extent



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formed from a bounding box of the Northern Ireland boundary. Woodland local networks were produced for the area combining Ards & North Down Borough Council and Belfast; other local networks were produced for the Ards & North Down Borough Council area only. For the local networks, the region of interest was buffered by 1500m before running the analysis, after which the final habitat networks were clipped by the administrative boundaries. All habitat networks have been produced as ArcGIS compatible shapefiles and geodatabases, together with INSPIRE compliant metadata in Irish Grid TM65.



**Figure 1: Areas covered by national and local habitat networks**

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**Table 2: List of habitat networks produced at the national and local scale**

Alias	Individual Network Name	National Scale	Local Scale	Group
AGL	Acid Grassland (upland and lowland)	Yes	Yes	Grassland
ASNW	Ancient Semi Natural Woodland	Yes	Yes	Woodland
BOG	Bog (upland and lowland)	Yes	Yes	Wetland
CGL	Calcareous Grassland (upland and lowland)	Yes	No	Grassland
CSD	Coastal Sand Dunes	Yes	Yes	Coastal
CSM	Coastal Saltmarsh	Yes	Yes	Coastal
CVS	Coastal Vegetated Shingle	Yes	Yes	Coastal
DWL	Deciduous Woodland	Yes	Yes	Woodland
FEN	Fen (upland and lowland)	Yes	Yes	Wetland
HTH	Heath (upland and lowland)	Yes	Yes	
LAK	Lake	Yes	Yes	
LMW	Lowland meadow	Yes	Yes	Grassland
LSP	Limestone Pavement	Yes	No	
MCS	Maritime Cliff and Slope	Yes	No	Coastal
PMG	Purple Moor Grassland and Rush Pasture	Yes	No	Grassland
PON	Pond	Yes	Yes	
RBD	Reedbed	Yes	Yes	Wetland
RIV	River	Yes	Yes	
TRO	Traditional Orchard	Yes	No	Woodland
WPP	Wood Pasture and Parkland	Yes	No	Woodland

## 2.5 Data limitations

The habitat networks were produced using the most complete and accurate spatial datasets available at the time, but confirmatory ground-checks should be made before making firm decisions on priority areas and actions for habitat network enhancement. When interpreting the habitat networks, it is important to understand the limitations of any input datasets, such as how clearly the attribution identifies the target habitat type, and how up-to-date this information is, and bear these factors in mind before making firm decisions based on the data. Habitat definition spreadsheets have been produced to accompany this project report and the habitat networks, detailing the combination of datasets and their attributes used to define each individual habitat type, to facilitate traceability between the input data and the output habitat network class.

The Network Enhancement Zones and Network Expansion Zone are generated based on proximity to existing habitat patches, and the suitability of the underlying soil/topographical conditions. However, no other suitability filters have been applied, and it is important to consider that it may not be appropriate to take restorative action within some areas within these zones; for example, the zones could contain an area of habitat that is of high importance for a different habitat network, or which supports a population of a protected species. Alternatively, the zones could contain highly productive agricultural land, significant urban areas, or could encroach on marine areas; users should use supporting datasets to spatially locate the real-world constraints to habitat restoration and creation, and use these in combination with the habitat networks to create a complete and balanced picture.

The habitat networks should not be considered a 'one-stop-shop' for identifying the locations of important habitats, and prioritising sites/ habitats for protection, restoration or habitat creation. Most effective use of the habitat networks can be made by using them in combination with other spatial datasets, such as the existing designated site network, and the locations of populations of important species; overlaying these types of information could considerably alter the prioritisation of different sites that may appear equally promising, or less so, by analysis of the habitat networks alone. Furthermore, comparisons should be made between the different habitat networks in order to assess the level of overlap between the habitat networks for different habitat types, and identify any potential conflicts where action to support one habitat type could negatively impact another habitat type. Conversely, such an overlay analysis can also identify areas where actions could enhance multiple habitat networks simultaneously.

The current habitat networks do not reflect the contribution of the extensive hedgerow network in Northern Ireland, or field margins, to the current stock of primary habitat, and the enhanced ecological connectivity these features provide; this exclusion is due to a lack of data to map these features. These agricultural areas are likely to be characterised as places where there are gaps in the habitat networks. Such gaps could be interpreted as a lack of opportunity to take action for nature recovery in those areas. However, this may not adequately reflect the situation on the ground where there may be many on-farm opportunities to take action for biodiversity and connectivity enhancement; these opportunities may not be adequately represented in the national scale habitat network maps, further highlighting the need for more detailed investigation of possible target sites.

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It is important to consider that the current habitat network coverage could be greatly expanded, and the size of the gaps reduced, should datasets mapping the missing habitat features, namely hedgerows and field margins, become available in the future. Should the data to map these missing features become available in the future, they could readily be incorporated into the existing habitat networks, and used to create bespoke habitat networks for hedgerow and field margin priority habitat; in these networks the opportunity zone for habitat creation could be defined by buffering the boundaries of agricultural fields, where no hedgerow/field margin habitats exist at present.

### **3. Capacity of national habitat networks to deliver 30 by 30**

The '30 by 30' ambition forms one of the targets of the draft global biodiversity framework, developed by the UN Convention on Biological Diversity, to be proposed at COP-15. The current wording of this target, which has gained political support throughout the United Kingdom, states that engaged actors should:

*"Ensure that at least 30 per cent globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes."* (CBD, 2021)

In order for the '30 by 30' ambition to succeed in Northern Ireland, important areas of habitat will need to be identified, protected and monitored. However, the way in which these objectives could be achieved is under debate. The habitat networks can form an important evidence base to inform the ongoing discussions on developing an effective system for achieving the '30 by 30' goal.

Areas of Special Scientific Interest (ASSIs) are an important existing network of protected sites that could form the starting point for identifying new priority sites for protection; identifying suitable areas that are adjoining existing protected sites would support the 'Lawton' principles of buffering and expanding existing high-quality sites, and increasing their connectivity through the landscape, promoting increased resilience.

NNRs and AONBs have been cited as examples of existing designated areas that could be used to support the '30 by 30' ambition. However, these areas offer a much lower level of protection than the ASSI and Natura 2000 network of sites; particularly in the case of AONBs, which are landscape designations that offer relatively little protection to habitats and biodiversity. However, should habitat protection and monitoring be strengthened in these designations they could make a valuable contribution to the '30 by 30' ambition.

A spatial analysis of the locations of designated sites in relation to the habitat networks was out of the scope of the current project. However, in order to explore some of the possibilities for existing designated sites to contribute to the '30 by 30' ambition, a series of statistical analyses were undertaken in order to quantify the potential for conservation and creation of

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priority habitat areas, with a focus on existing designated and publicly owned/managed sites, and the resulting analyses were supplied as a separate spreadsheet document.

Northern Ireland has a total land area of 1,340,867.191 ha, excluding urban areas: therefore, to meet the '30 by 30' target, a total of 424,543.1 ha of habitat would need to be effectively protected, managed and monitored.

### **3.1 Total habitat network summary statistics**

Area calculations were made for each network class (e.g., primary habitat, associated habitat) within each national habitat network. Prior to calculating the area statistics, urban areas were clipped out of each network using an urban mask generated through combination of urban categories selected from Corine, Land Cover Map, and NIHE Grounds Maintenance datasets.

The total network extents are presented in Appendix E, along with calculations of the percentage area of Northern Ireland each class comprises. Summing the total extent of Primary Habitat within Northern Ireland shows that there are currently 383,692 ha of Primary Habitat, representing 27.1% of the total land area of Northern Ireland. Some of these Primary Habitat areas are located within protected sites, and some are not. Therefore, extending protection and monitoring to more existing sites of primary habitat would be a rapid way of moving towards the '30 by 30' goal. However, even if all areas of existing Primary Habitat could be protected in this way, the 30% land area target could not be reached; therefore, some degree of habitat restoration and creation will be needed throughout Northern Ireland in order to achieve the target.

**It is not appropriate to sum the areas / percentages for the remaining network categories (e.g., Associated Habitat, Network Expansion Zones) to attempt to calculate a national total, because these classes are not mutually exclusive between the different habitat networks; there is overlap between them, therefore summing them would over-estimate the amount of available opportunity area. Conversely, the Primary Habitats are largely mutually exclusive, with the exception of some areas of overlap between grassland habitat types, due to the way in which habitat mosaics have been classified (see section**

2.5 Data limitations. However, given the relatively small habitat areas involved, the calculations represent a good approximation of the extent of these habitats.

Statistical summaries for the five most extensive Primary Habitat types are shown in Table 3. The most extensive habitat type is semi-natural/deciduous woodland, at 7.4% national cover, followed by bog and heath habitat (both 4.9%), lakes (4.5%) and rivers (2.7%). However, the extent of rivers is likely to have been underestimated due to the majority of these features being mapped as polylines rather than polygons, and smaller stream features are likely to have been excluded.

The largest extent of opportunity areas within the Restorable Habitat Class were found in the bog network, at 11.8% area of Northern Ireland. The bog network also contained large opportunity areas within Network Enhancement Zone 1 (8.5%) and Network Enhancement Zone 2 (6.5%). Considerable areas of Restorable Habitat and Network Expansion Zone opportunity were also identified within the heath network (4.6%; 12.5%; 6.3%). Although the fen network contributes a very small amount to the national area (0.4%), there is considerable potential to expand this habitat network through the Restorable Habitat and Network Expansion Zones (6.3%; 13.8%; 5.6%). A very large extent of network enhancement potential exists for the deciduous woodland network (64.1% within Network Enhancement Zone 2), highlighting that a very large area of land is suitable for woodland planting.

These sample figures highlight that, in terms of the biophysical parameters incorporated into the schema mapper rule base, and given the existing distribution of Primary Habitat patches, there is ample opportunity space to initiate habitat restoration projects that would deliver the '30 by 30' goal, while simultaneously enhancing the existing ecological connectivity. However, it should be anticipated that the decision-making process to determine which habitat type should be prioritised in which location, and consideration of other real-world constraints, will decrease the final extent of available opportunity space.

**Table 3: Selected area summaries and percentage of Northern Ireland for national habitat networks (excluding urban areas)**

Network	Primary Habitat		Restorable Habitat		Network Enhancement Zone 1		Network Enhancement Zone 2	
	Area (ha)	% NI	Area (ha)	% NI	Area (ha)	% NI	Area (ha)	% NI
BOG	69494.5	4.9	167670.1	11.8	120788.9	8.5	91629.2	6.5
DWL	104241.5	7.4	682.7	<0.1	0.0	0.0	907749.8	64.1
FEN	6332.0	0.4	89571.1	6.3	195805.3	13.8	79857.8	5.6
HTH	70033.7	4.9	64700.1	4.6	176798.5	12.5	89611.3	6.3
LAK	64093.2	4.5	49290.2	3.5	0.0	0.0	107938.3	7.6
RIV	38900.0	2.7	0.0	0.0	0.0	0.0	817759.9	57.8

### 3.2 Contribution of the ASSI network

The ASSI spatial dataset utilised by the project contained attribution that identified the primary habitat type cited in the reason for designation, e.g., whether the site was primarily designated for particular woodland, bog, grassland, or other habitat types that can be grouped into the 'primary habitat' categories used to produce the habitat networks (DWL,

BOG, CSD etc). An analysis was carried out to calculate the area summaries for these primary habitat areas that lie within ASSIs, that have been designated for that habitat type; these areas could be assumed to be the highest quality examples of the primary habitat type within Northern Ireland. Area extends for other habitat network categories within the ASSIs were also calculated, to give an indication of the potential for further strengthening ecological resilience within the protected sites through habitat restoration or creation. However, the attribution within the ASSI dataset is likely to underestimate the number of priority habitats present within the ASSI, and so these results (supplied in the accompanying statistics spreadsheet) should be considered indicative only.

Visual representation and comparison of the protected sites network in a GIS alongside the habitat networks will allow key landscape linkages between the sites to be explored, assisting prioritisation of specific locations for protection and monitoring, and also assisting prioritisation of habitat management actions to ensure that the highest priority and most appropriate habitat networks are supported.

### 3.3 Contribution of other designated sites

AONB, NNR, EFS, Ulster Wildlife and RSPB reserve site boundaries were clipped against the site boundaries of ASSIs, SACs, SPAs and Ramsar sites, to ensure that parts of reserves/sites that were covered by an existing stronger designation status were not included in the area calculations. Habitat network extents for the remaining areas were then calculated, and the extents of all Primary Habitats summed; the resulting area summaries are shown in Table 4.

Primary Habitats within designated sites offering a high level of protection (Ramsar, SAC, SPA and ASSI) account for a total of 9.2% of Northern Ireland. Given that earlier calculations revealed a total of 27.1% Primary Habitat, this means that 17.9% of Primary Habitat in Northern Ireland is not currently covered by the strongest level of protection a site designation can offer.

Summing the total extent of Primary Habitat within all types of designated sites reveals that Primary Habitat covering 17.4% of Northern Ireland is covered by some kind of existing designation. However, the level of protection and monitoring of these sites is variable. AONBs contribute to 5.5% of Primary Habitat within Northern Ireland, therefore strengthening habitat protection within AONB sites could significantly contribute to the '30 by 30' target in terms of the extent of habitat protected. However, it may not be the case that the habitats located within the AONB boundaries are best-located for enhancing habitat connectivity across the landscape scale, or for delivering best value for money in terms of multiple ecosystem service delivery. Therefore, while strengthening habitat protection within an existing designation framework could go part way towards meeting the '30 by 30' goal, it is unlikely to provide a satisfactory, complete solution as a standalone measure.

**Table 4: Area summaries and percentage of Northern Ireland for summed Primary Habitat types (national networks) within designated sites,**

Site type	Primary Habitat Extent (ha)	% NI
Ramsar/SAC/SPA/ASSI	130874.1	9.2
NNR	217.4	<0.1
Ulster Wildlife reserve	310.2	<0.1

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RSPB reserve	712.6	0.1
EFS	19,330.7	1.4
AONB	77,658.3	5.5
Historic parks & gardens	16,505.6	1.2
<b>Total</b>	<b>245609.0</b>	<b>17.4</b>



## 4. Next steps

The habitat networks are an important first step in developing a framework for Nature Recovery Networks in Northern Ireland, by developing the first national habitat network maps for priority habitats, which utilised a comprehensive range of input habitat data. The data preparation stages for running the FME workbench have been simplified, providing flexibility to add and remove datasets from the network analyses, and re-run the networks in order to refine the results and incorporate the latest available data.

The habitat networks provide a good overview of the location of opportunity areas for enhancing the connectivity of existing habitat, and form a strong starting point for considering which areas should be prioritised. The next stage in the development of the framework should be to further analyse the habitat networks in combination with other spatial data including protected site and protected species data. In addition, it would be beneficial to consider a wider range of factors including the provision of ecosystem services such as surface water regulation, carbon storage, air quality regulation, food production and recreational value; all of which need to be considered in combination to enable a balanced and effective prioritisation of land for conservation and restoration, in order to maximise the benefits achieved.

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## Appendix A

Habitats selected for habitat network modelling, their derivation from the original priority habitat list, and modifications made to the Natural England schema mapper list of Associated and Restorable habitats assigned to each network type.

Priority habitat	Natural England NRN	Decisions	Northern Ireland habitat network alias
Arable field margins	none	Insufficient data to model at present	N/A
Hedgerows	none	Insufficient data to model at present	N/A
Upland hay meadows	UHM	Not applicable to Northern Ireland	N/A
Calaminarian grasslands	none	Not applicable to Northern Ireland	N/A
Inland rock outcrop and scree habitats	none	Insufficient data to model at present	N/A
Open mosaic habitats on previously developed land	none	Insufficient data to model at present	N/A
Coastal and floodplain grazing marsh	none	Insufficient data to model at present	N/A
Marl lake	none - habitat not found in England	To be included in the Lake network. Add coniferous plantation as Restorable Habitat.	LAK
Saline lagoons	none (included in LAK)		
Aquifer-fed naturally fluctuating water bodies	none (included in LAK)		
Eutrophic standing waters	none (included in LAK)		
Mesotrophic lakes	none (included in LAK)		
Oligotrophic and dystrophic lakes	none (included in LAK)		
Lowland calcareous grassland	LCG	Upland / lowland distinction is not recognised in the NI priority habitat list; combine into a single calcareous grassland network.	CGL
Upland calcareous grassland	UCG		CGL

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Montane heath	included in UHL	Upland and lowland heathland habitats merged to form a single heath network. Add lakes and rivers as Associated Habitats. Add coniferous plantation as Restorable Habitat. For the local version of the network, include scrub as Restorable Habitat.	HTH
Lowland heathland	LHL		
Upland heathland	UHL		
Ancient Semi-Natural Woodland	ASNW	Natural England NRN parameters reviewed; no habitat additions made to Associated/Restorable habitat list	ASNW
Mixed ashwoods	none unless part of ASNW	A 'semi-natural woodland' habitat network will be created for Northern Ireland, which will incorporate all mapped areas of semi-natural woodland. For the semi-natural woodland network areas of farm woodland creation will be added as Associated Habitat, and coniferous plantation and other restorable woodland as Restorable Habitat. For the local version of the network, intact hedges and edge habitat will also be included as Associated Habitat.	DWL
Oakwoods	none unless part of ASNW		
Wet woodland	none unless part of ASNW		
Parkland	WPP	Review Natural England NRN parameters and modify as necessary. Add semi-natural woodland as Associated Habitat. For the local version of the network, include scrub as Restorable Habitat.	WPP
Traditional orchards	TRO	Natural England NRN parameters reviewed; no habitat additions made to Associated/Restorable habitat list. For the local version of the network, include scrub as Restorable Habitat.	TRO
Coastal saltmarsh	CSM	Review Natural England NRN parameters and modify as necessary: Add maritime cliff & slope along the exposed north coast (e.g. Giant's	CSM

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		Causeway) to the list of Associated Habitats	
Coastal sand dunes	CSD	Natural England NRN parameters reviewed; no habitat additions made to the national Associated/Restorable habitat list. For the local version of the network, include scrub as Restorable Habitat.	CSD
Coastal vegetated shingle	CVS	Natural England NRN parameters reviewed; no habitat additions made to Associated/Restorable habitat list	CVS
Maritime cliff and slopes	MCS	Review Natural England NRN parameters and modify as necessary. Add saltmarsh and sand dunes as Associated Habitats.	MCS
Ponds	PON	Review Natural England NRN parameters and modify as necessary. Add semi-natural woodland as Associated Habitat.	PON
Rivers	RIV	Review Natural England NRN parameters and modify as necessary. Add semi-natural woodland, rivers and ponds as Associated Habitats.	RIV
Lowland meadows	LMW	Natural England NRN parameters reviewed; no habitat additions made to Associated/Restorable habitat list	LMW
Lowland dry acid grassland	LAG	Include upland and lowland equivalent habitat in a single network	AGL
Purple moor-grass and rush pastures	PMG	Review Natural England NRN parameters and modify as necessary. Add upland heathland as Associated Habitat. For the local version of the network, marshy grassland will also be included as Associated Habitat.	PMG
Limestone pavements	LSP	Natural England NRN parameters reviewed. Add blanket bog to Associated Habitat list.	LSP
Blanket bog	BBG		BOG

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Lowland raised bog	LRB	Upland and lowland habitats merged to form a single bog network. Add areas of perennial rye grass on peat surrounding lowland raised bogs as Restorable Habitat.	
Lowland fens	LFN	Upland and lowland habitats merged to form a single fen network. Add calcareous grassland, lakes, ponds and rivers as Associated Habitats. For the local version of the network, include scrub and marshy grassland as Restorable Habitats.	FEN
Upland flushes, fens and swamps	UFS		
Reedbeds	RBD	Natural England NRN parameters reviewed; no habitat additions made to Associated/Restorable habitat list	RBD

## Appendix B

List of habitat abbreviations used in the habitat network schema mappers

Habitat	Description	Schema Mapper Parameter	habitat network Scale
AFTMQB	Lowland Raised Bog (Quaking Bog)	Main habitat, associated habitat	National and local
ASNW	Ancient Semi-Natural woodland	Main habitat, associated habitat	National and local
BBG	Blanket Bog	Main habitat, associated habitat	National and local
CGL	Calcareous grassland	Main habitat, associated habitat	National and local
CPL	Coniferous plantation	Restorable habitat	National and local
CSD	Coastal Sand Dunes	Main habitat, associated habitat	National and local
CSM	Coastal Saltmarsh	Main habitat, associated habitat	National and local
CVS	Coastal Vegetated Shingle	Main habitat, associated habitat	National and local
DPT	Degraded peatland	Restorable habitat	National and local
DWL	Semi-natural deciduous woodland	Main habitat, associated habitat	National and local
EDG	Edge habitat	Associated habitat	Local only
GQSIG	Good quality semi-improved grassland	Restorable habitat	National and local
Intact_hedge	Intact hedge	Associated habitat	Local only
LAK	Lake	Main habitat, associated habitat	National and local
LCG	Lowland Calcareous Grassland	Main habitat, associated habitat	National and local
LFN	Lowland Fens	Main habitat, associated habitat	National and local
LHL	Lowland Heathland	Main habitat, associated habitat	National and local
LHL_DP	Lowland heath - on peat	Restorable habitat	National and local
LMW	Lowland Meadows	Main habitat, associated habitat	National and local
LRB	Lowland Raised Bog	Main habitat, associated habitat	National and local

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LSP	Limestone Pavement	Main habitat, associated habitat	National only
MCS	Maritime Cliff & Slopes	Main habitat, associated habitat	MCS
MDF	Mudflats	Main habitat, associated habitat	MDF
MGL	Marshy grassland	Associated habitat, restorable habitat	MGL
NONE	Dummy	Restorable habitat	NONE
PAWS	Plantation on ancient woodland	Restorable habitat	PAWS
PMG	Purple Moor Grass & Rush Pastures	Main habitat, associated habitat	PMG
PON	Pond	Main habitat, associated habitat	PON
RBD	Reedbeds	Main habitat, associated habitat	RBD
RIV	River	Main habitat, associated habitat	RIV
SAL	Saline lagoon	Main habitat, associated habitat	SAL
SCRUB	Scrub	Restorable habitat	Local
TRO	Traditional Orchards	Main habitat, associated habitat	TRO
UCG	Upland Calcareous Grassland	Main habitat, associated habitat (Natural England schema mappers only)	N/A
UFF	Upland Fen & Flush	Main habitat, associated habitat	UFF
UFS	Upland Flushes Fens & Swamps	Main habitat, associated habitat	UFS
UHL	Upland Heathland	Main habitat, associated habitat	UHL
UHL_DP	Upland Heath - on peat	Restorable habitat	UHL_DP
UHLDP	Upland Heathland (Deep Peat)	Main habitat, associated habitat	UHLDP
WPP	Parkland / Wood Pasture & Parkland	Main habitat, associated habitat	WPP

**Appendix C**

List of datasets included in the habitat network mapping at national and/or local scale

<b>Dataset title</b>	<b>Owner/ Source</b>	<b>Geometry</b>	<b>National Networks</b>	<b>Local Networks</b>
Belfast City Council Tree survey	Belfast City Council	Point		Y
PeatlandRestoration_Ballynahone	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
PeatlandRestoration_Cranny	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
PeatlandRestoration_Curran	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
PeatlandRestoration_FairyWater	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
PeatlandRestoration_Garry	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
PeatlandRestoration_Moneygal	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
PeatlandRestoration_PeatlandsPark	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
PeatlandRestoration_Tully	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
HabitatMap2019_Cuilcagh	Collaborative Action for the Natura Network (CANN)	Polygon	Y	Y
Habitats_NI	Corine	Polygon	Y	Y
EFS_PriorityWoodland_NI	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y



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ASSI_NI	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y
NNRandNR_NI	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y
PriorityHabitats_Fens	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y
PriorityHabitats_GrasslandInventory	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y
PriorityHabitats_Heathland	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y
PriorityHabitats_Lakes	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y
PriorityHabitats_Peatland	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y
PriorityHabitats_Woodland	Department of Agriculture, Environment and Rural Affairs (DAERA)	Polygon	Y	Y
WoodlandBasemap	Forest Service / DAERA	Polygon	Y	Y
HabitatActions_NationalTrust	National Trust	Polygon	Y	Y
HabitatInventory_NationalTrust_NI	National Trust	Polygon	Y	Y
RiverSegments_OSNI	Ordnance Survey Northern Ireland	Polyline	Y	Y
SurfaceWaterBodies_OSNI	Ordnance Survey Northern Ireland	Polygon	Y	Y
AncientLongEstablishedWoodland_Rol	???	Polygon	Y	Y
SemiNaturalGrasslandHabitats_Rol	Irish Semi-natural grassland survey 2007-2012	Polygon	Y	Y











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NationalNativeWoodlandHabitats	National Native Woodland Survey	Polygon	Y	Y
GroundsMaintainence	Northern Ireland Housing Executive	Polygon	Y	Y
AncientWoodlandInventory_WoodlandTrust	Woodland Trust	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Slievenacly	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Balloo	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Ballynahone Bog	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Bog Meadows	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Cottage Farm	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Edenderry	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Feystown	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Glenarm	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Glendun	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Inishargy	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Inishcreagh	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Isle of Muck	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Milford Cutting	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Moyola Waterfoot	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Namanfin	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Straidkilly	Ulster Wildlife	Polygon	Y	Y
UlsterWildlife Phase 1 habitat data for Umbra	Ulster Wildlife	Polygon	Y	Y
AFBI Soil 50k	Northern Ireland Spatial Data Infrastructure	Polygon	Y	Y
Ards & North Down Borough Council Phase 1 habitat data	Ards & North Down Borough Council	Polygon		Y













## Appendix D

Guidelines for running the NI habitat network FME workbenches.

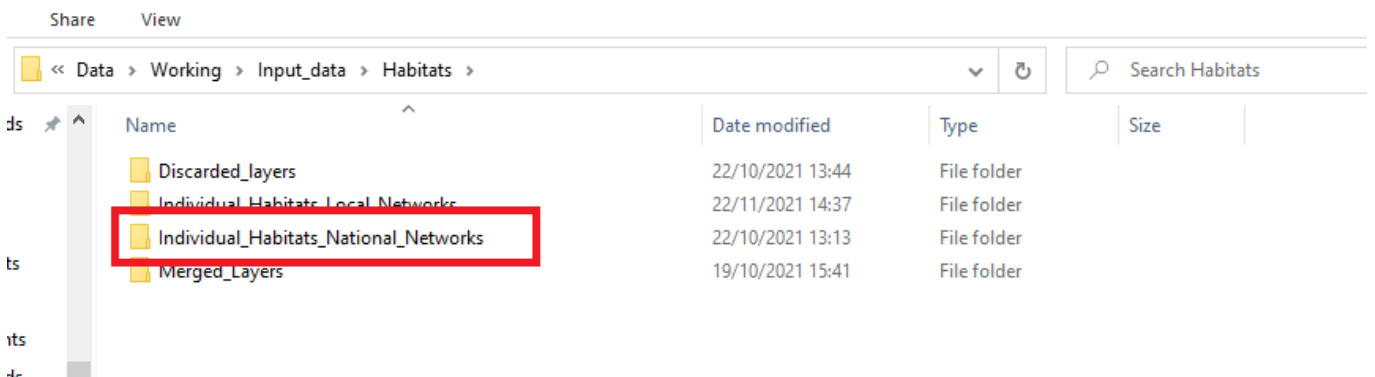
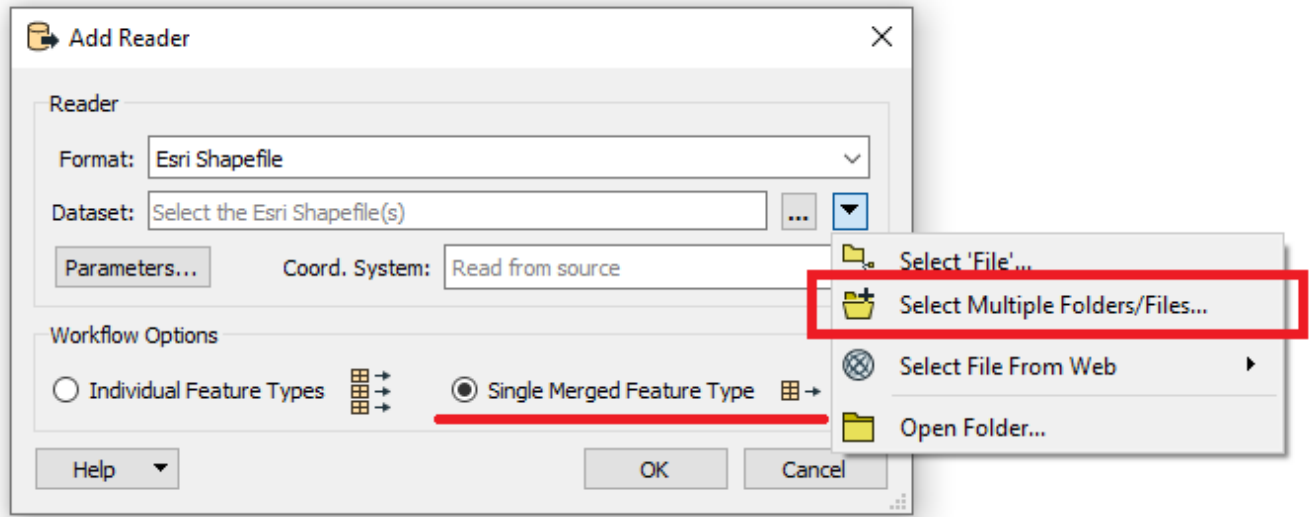
1. Within your chosen file location (in this example a folder named "Individual\_Habitats") create an input folder for each habitat alias contained in the schema mapper, containing all of the datasets/dataset selections for the habitat. These files are spatial datasets, or subsets of spatial datasets, that classify areas of primary, associated and restorable habitat types (or habitat creation types).

Working > Input_data > Habitats > Individual_Habitats	
Name	Date modified
 AFTMQB	20/10/2021 10:58
 ASNW	20/10/2021 11:04
 BBG	20/10/2021 11:04
 CGL	20/10/2021 11:04
 CPL	20/10/2021 11:04
 CSD	20/10/2021 11:04
 CSM	20/10/2021 11:04
 CVS	20/10/2021 11:04
 DPT	20/10/2021 11:04
 DWL	20/10/2021 11:04

2. Within each habitat folder, paste the datasets to be used to define the habitat type in question. In the example below, the AFTMQB folder has been populated with three datasets that map the extent of AFTMQB habitat. Input datasets can be full inventory datasets so long as every feature belongs to AFTMQB habitat; if the dataset contains areas mapped as alternative habitats e.g. woodland and grassland polygons, these should first be removed.

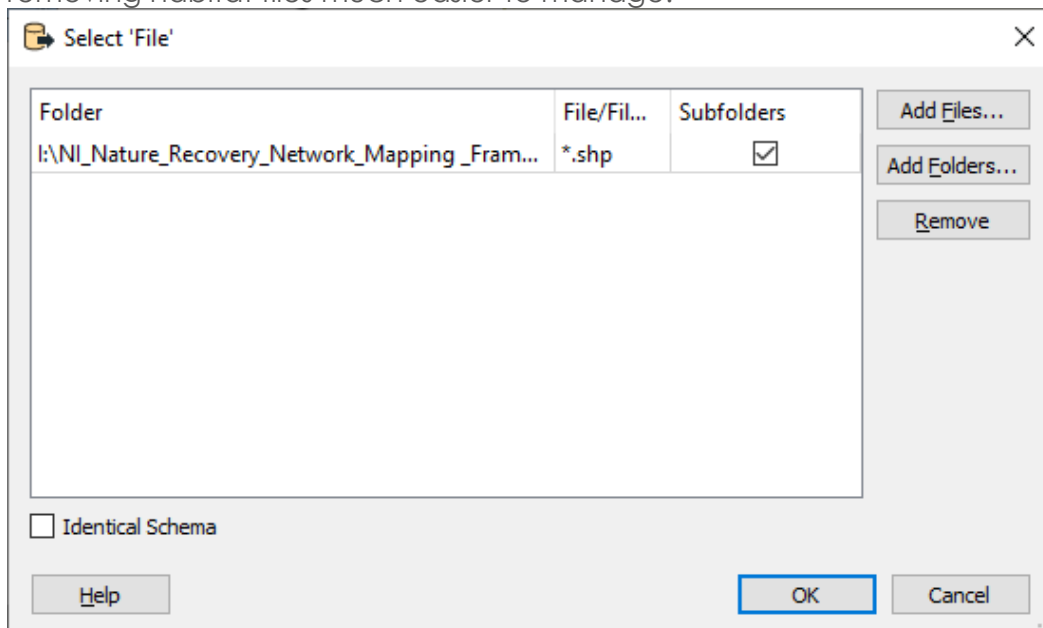
Working > Input_data > Habitats > Individual_Habitats > AFTMQB			
Name	Date modified	Type	
 5_Peatland_AFTMQB.cpg	07/10/2021 14:13	CPG	
 5_Peatland_AFTMQB.dbf	11/10/2021 13:03	Oper	
 5_Peatland_AFTMQB.prj	07/10/2021 14:13	PRJ F	
 5_Peatland_AFTMQB.shp	11/10/2021 13:03	SHP	
 5_Peatland_AFTMQB.shx	11/10/2021 13:03	SHX	
 6_Peatland_AFTMQB.cpg	07/10/2021 14:14	CPG	
 6_Peatland_AFTMQB.dbf	11/10/2021 13:03	Oper	
 6_Peatland_AFTMQB.prj	07/10/2021 14:14	PRJ F	
 6_Peatland_AFTMQB.shp	11/10/2021 13:03	SHP	
 6_Peatland_AFTMQB.shx	11/10/2021 13:03	SHX	
 8_Peatland_AFTMQB.cpg	07/10/2021 14:16	CPG	
 8_Peatland_AFTMQB.dbf	11/10/2021 13:03	Oper	

3. Create a reader and point it to the folder containing all the data in the Individual\_Habitats folder (the folder structure created during step 1).



4. Instruct the reader to read sub directories. It will take the name of the habitat folder and apply that to all the data contained within that folder during the process.

This will increase the run time of the process relative to the original Natural England workbench, as it will read all the habitat data available, but makes set up and adding or removing habitat files much easier to manage.

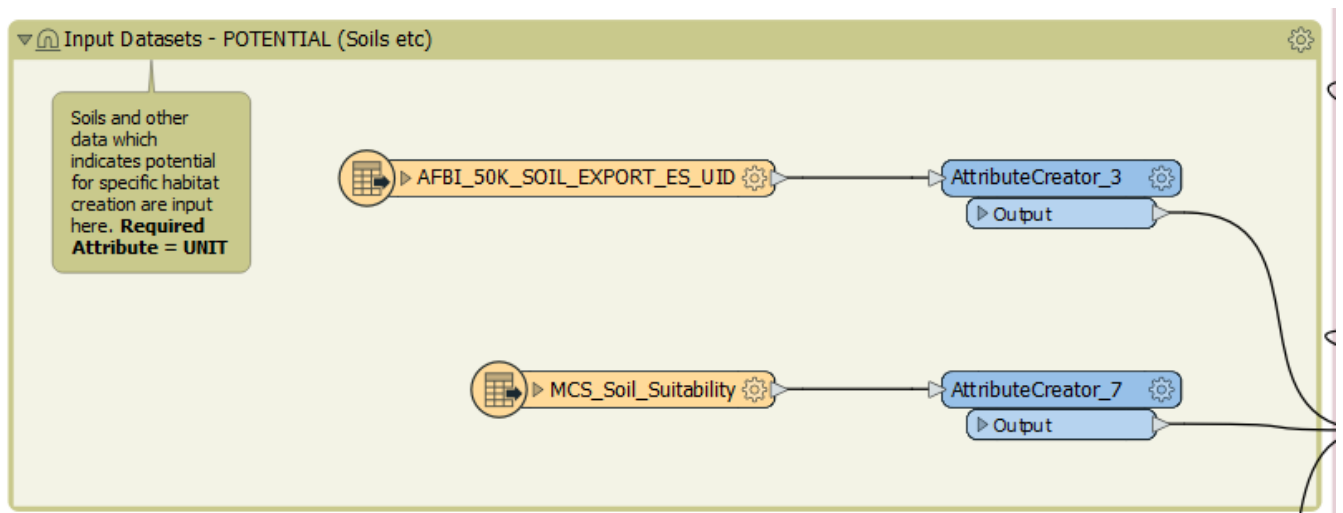


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sta > Working > Input\_data > Habitats > Individual\_Habitats\_National\_Networks > CSD

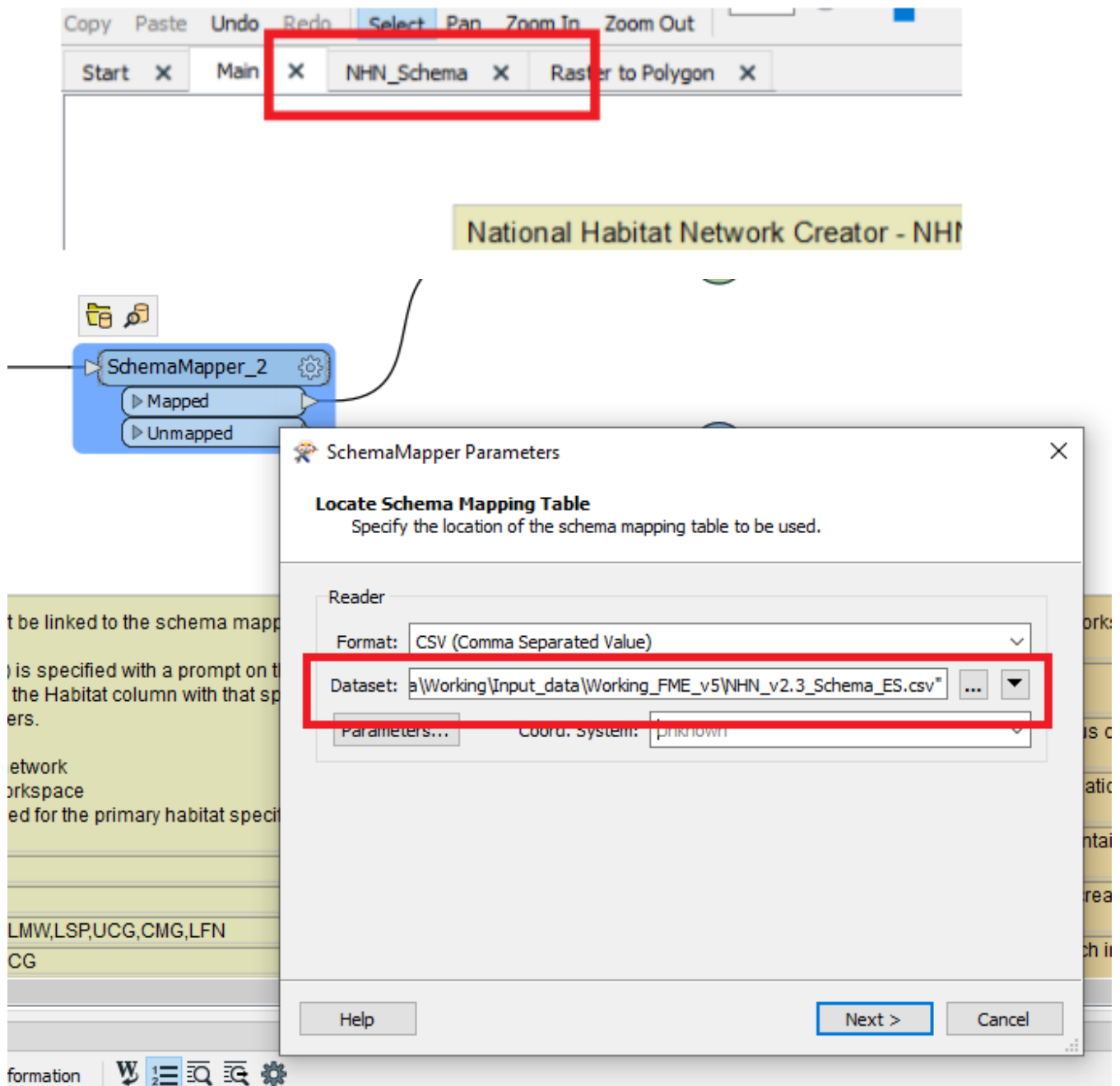
Name	Date modified	Type	Size
14_Habitats_CSD.cpg	08/10/2021 09:49	CPG File	1 KB
14_Habitats_CSD.dbf	11/10/2021 13:18	OpenOffice.org 1....	43 KB
14_Habitats_CSD.prj	08/10/2021 09:49	PRJ File	1 KB
14_Habitats_CSD.shp	11/10/2021 13:18	SHP File	561 KB
14_Habitats_CSD.shx	11/10/2021 13:18	SHX File	2 KB
24_ASSI_CSD.cpg	08/10/2021 10:17	CPG File	1 KB
24_ASSI_CSD.dbf	11/10/2021 13:18	OpenOffice.org 1....	4 KB
24_ASSI_CSD.prj	08/10/2021 10:17	PRJ File	1 KB
24_ASSI_CSD.shp	11/10/2021 13:18	SHP File	24 KB
24_ASSI_CSD.shx	11/10/2021 13:18	SHX File	1 KB
43_National_Trust_CSD.cpg	08/10/2021 10:08	CPG File	1 KB
43_National_Trust_CSD.dbf	11/10/2021 13:18	OpenOffice.org 1....	25 KB
43_National_Trust_CSD.prj	08/10/2021 10:08	PRJ File	1 KB
43_National_Trust_CSD.shp	11/10/2021 13:18	SHP File	8 KB
43_National_Trust_CSD.shx	11/10/2021 13:18	SHX File	1 KB
46_National_Trust_CSD.cpg	08/10/2021 10:15	CPG File	1 KB
46_National_Trust_CSD.dbf	11/10/2021 13:18	OpenOffice.org 1....	356 KB
46_National_Trust_CSD.prj	08/10/2021 10:15	PRJ File	1 KB
46_National_Trust_CSD.shp	11/10/2021 13:18	SHP File	330 KB
46_National_Trust_CSD.shx	11/10/2021 13:18	SHX File	2 KB
Net_Hab1_CSD.dbf	22/10/2021 12:32	OpenOffice.org 1....	6 KB
Net_Hab1_CSD.prj	22/10/2021 12:32	PRJ File	1 KB
Net_Hab1_CSD.shp	22/10/2021 12:32	SHP File	17 KB
Net_Hab1_CSD.shx	22/10/2021 12:32	SHX File	1 KB

5. Create a separate input reader in FME for the soil dataset and cliff zone (if needed), and connect those to the potential inputs.



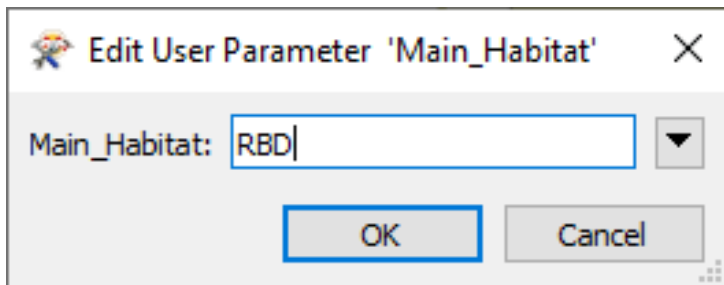
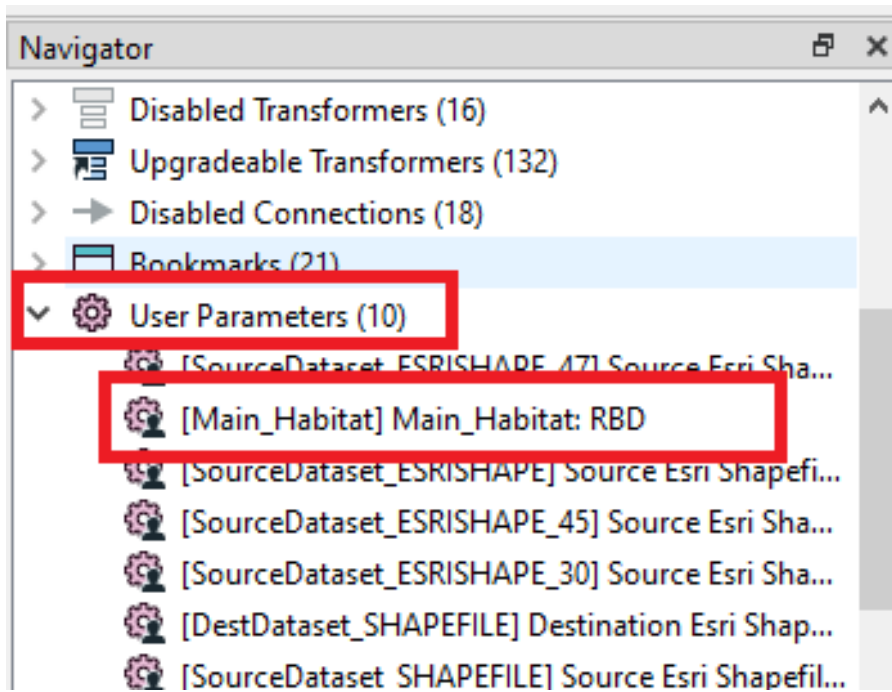
## Northern Ireland Nature Recovery Network Mapping Framework

6. Ensure the process is connected to the correct schema mapper (i.e. schema mapper for local network modelling or schema mapper for national network modelling).



7. Set an appropriate output folder location

8. Set the user parameter [Main\_Habitat] to the habitat type of the network you would like to create, then select run.



## Appendix E

Area summaries and percentage area of Northern Ireland for each national habitat network (excluding urban areas)

Network	Primary Habitat		Associated Habitats		Restorable Habitat		Fragmentation Action Zone		Network Enhancement Zone 1		Network Enhancement Zone 2		Network Expansion Zone	
	Area (ha)	% NI	Area (ha)	% NI	Area (ha)	% NI	Area (ha)	% NI	Area (ha)	% NI	Area (ha)	% NI	Area (ha)	% NI
AGL	1587.0	0.1	28316.6	2.0	54949.3	3.9	544.0	<0.1	7911.9	0.6	32400.9	2.3	13452.1	1.0
ASNW	3637.0	0.3	14487.0	1.0	3669.1	0.3	676.7	<0.1	0.0	0.0	60749.0	4.3	0.0	0.0
BOG	69494.5	4.9	76043.9	5.4	167670.1	11.8	18548.1	1.3	120788.9	8.5	91629.2	6.5	157918.4	11.2
CGL	2490.0	0.2	5314.8	0.4	12443.4	0.9	1038.0	0.1	9657.1	0.7	3568.9	0.3	21180.9	1.5
CSD	1518.4	0.1	621.6	<0.1	843.0	0.1	110.0	<0.1	570.1	<0.1	1321.8	0.1	987.7	0.1
CSM	632.8	<0.1	6299.7	0.4	1935.5	0.1	962.2	0.1	4884.9	0.3	4993.1	0.4	14768.5	1.0
CVS	136.0	<0.1	1425.6	0.1	744.7	0.1	22.3	<0.1	0.0	0.0	6602.1	0.5	0.0	0.0
DWL	104241.5	7.4	382.5	<0.1	682.7	<0.1	907.9	0.1	0.0	0.0	907749.8	64.1	0.0	0.0
FEN	6332.0	0.4	175165.7	12.4	89571.1	6.3	3816.2	0.3	195805.3	13.8	79857.8	5.6	215927.7	15.3
HTH	70033.7	4.9	123506.3	8.7	64700.1	4.6	1861.6	0.1	176798.5	12.5	89611.3	6.3	161875.9	11.4
LAK	64093.2	4.5	88315.1	6.2	49290.2	3.5	3881.6	0.3	0.0	0.0	107938.3	7.6	0.0	0.0
LMW	2656.5	0.2	3108.4	0.2	19930.7	1.4	4333.7	0.3	26525.0	1.9	4752.7	0.3	75459.6	5.3
LSP	6828.0	0.5	1596.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	3910.3	0.3	0.0	0.0
MCS	1648.1	0.1	4794.5	0.3	0.0	0.0	39.0	<0.1	223.3	<0.1	12302.7	0.9	172.6	<0.1
PMG	7226.8	0.5	20460.8	1.4	0.0	0.0	5677.3	0.4	32501.8	2.3	4631.1	0.3	94631.9	6.7
PON	68.0	<0.1	72782.1	5.1	0.0	0.0	0.0	0.0	0.0	0.0	35393.5	2.5	0.0	0.0
RBD	214.3	<0.1	65544.0	4.6	0.0	0.0	28.0	<0.1	13612.7	1.0	54594.8	3.9	11999.8	0.8



