Falkirk Integrated Habitat Networks

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Executive Summary

Background to research
This report describes a detailed desk study using digital data on a geographic information system (GIS) to identify Integrated Habitat Networks (IHNs) in the Falkirk area. The analyses used a landscape ecology model from the 'BEETLE' (Biological and Environmental Evaluation Tools for Landscape Ecology) suite of tools to assess the spatial position and extent of functional habitat networks.

The BEETLE least-cost focal species approach was chosen to map and analyse the integrated habitat networks. This approach negates the need to carry out a vast number of individual species analyses, which is particularly important as data regarding species habitat requirements and dispersal through the landscape is lacking.

Objectives of research
To identify:

- Focal species appropriate for the region, and to research and describe elements of their autecology to classify their functional interaction with habitat and the matrix of the wider landscape. These will be determined at a stakeholder workshop, but are likely to be woodland, unimproved grassland, wetland (fen, marsh & swamp), and raised/intermediate bog. Elements of the focal species autecology will be researched and described to classify their functional interaction with habitat and the matrix of the wider landscape
- Key areas for native woodland restoration and expansion in order to link core woodland habitats within Falkirk and between neighbouring networks (*e.g.* in the Lothians and Glasgow & Clyde Valley)
- Key areas for expansion or restoration of a number of identified open ground habitats to link core habitat areas within Falkirk and between neighbouring areas, to maintain their ecological function and viability, as well as creating a functionally connected network
- The land-use conflicts and the trade-offs required to deliver an integrated habitat network that combines several specific habitat types
- Conflicts and opportunities for habitat networks associated with development proposals, historic landscapes, and landscape character
- The opportunities to enhance and expand the Integrated Habitat Network associated with Local Plan Core Development Areas, and the prescriptions required for development to contribute towards this

Key findings and recommendations

- Integrated Habitat Networks (IHNs) were defined, for species using woodland, wetland, or grassland habitat, as landscape structures through which species can disperse freely between numerous habitat patches. These networks can be used to prioritise conservation effort
- The IHNs should be used within a GIS as part of the decision-making process; they do not provide answers on their own
- Priority Enhancement Areas can be used to identify opportunities where effort can be undertaken to strengthen existing habitat networks
- The strength of the BEETLE approach lies in taking account of local conservation priorities and making best use of local expertise. Engaging with local stakeholder groups has been vital part of this process and will enable the networks to relate to local on-going projects

- LBAPs, Single Outcome Agreements, and SNH Natural Futures provide appropriate scales and mechanisms for determining network priorities and for informing the regional targeting of agri-environment incentives
- Delivery of the network requires tech transfer to the biodiversity officers and planners
- The implementation of habitat networks requires the integration of local and national policy conservation priorities and planning mechanisms with network modelling and “on- the-ground” advice and execution
- The integration of the Falkirk HELIX project and links with other regional habitat networks should be a priority.
- Computer generated visualisations of network development provide a useful tool for evaluating the likely impacts on the visual aspects of landscape character. These outputs can help with the consideration of landscape constraints and subsequent refinement of the IHN outputs
- The manipulation and interpretation of oblique aerial photographs could be of value as a tool for communicating the visual impact of network development at a larger scale and to a wider group of stakeholders
- The availability of good land cover data is also essential for the modelling. Phase 1 survey information on semi-natural habitats is the main data requirement. It is recommended that Phase 1 be reviewed and supplied in digital format for the whole of the region. Once data has been improved, the changes could be incorporated into the landcover data set and the network analyses re-run
- Habitat and land cover surveys should be undertaken to update and improve landcover data, particularly for Phase 1 surveys
- The modelling of “people networks” would add to the planning of a green network approach, enabling targeted improvement of greenspace to achieve multiple objectives
- Methods for monitoring the success of habitat network implementation and development include: assessing habitat condition and ecosystem development, tracking the distribution and dispersal of both focal and functional species, recording evidence of species use of new habitats and undertaking post-hoc genetic analysis to infer patterns of migration
- Ecosystem development should be monitored to provide feedback on the effectiveness of improvement strategies
- The concept of applying a multi-criteria analysis to prioritise IHNs has been explored through consultation with an assembled group of biodiversity officers, agency staff, and planners. Further development is required through engaging a wider number and range of stakeholders (NGOs, landowning bodies (NFU / SRBPA), funding bodies, COSLA, to determine which of the factors are considered influential.
- Integration of the IHN to inform future reviews of the Falkirk Council: Development Plan; Biodiversity & Development Supplementary Planning Guidance, *e.g.* site specific surveys to reflect wider IHN implications, including LBAP, Derelict Land, and Central Scotland Forest
- The timing of reviews of other plans would enable a review of the IHN / data update to be undertaken to contribute to these reviews
- Areas of new habitat should be as large as possible and of high quality and structural complexity. The planting of street and ornamental trees will have little impact on improving the biodiversity of the region.

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1. Introduction

The project identifies the thematic and locational priorities for habitat restoration through the development of an Integrated Habitat Network (IHN) in the Falkirk area. IHNs were developed, using the Forest Research Biological and Environmental Evaluation Tools for Landscape Ecology (BEETLE), for a range of habitats and focal species, reflecting local landscapes. These outputs can then be used to prioritise conservation effort.

BEETLE - Biological and Environmental Evaluation Tools for Landscape Ecology

The development of habitat networks is widely seen as a key mechanism for reversing the effects of fragmentation on biodiversity while delivering a range of other social and environmental benefits, such as enhancement of local landscape character and greater opportunities for public access and recreational use. Tools to address habitat fragmentation have evolved from landscape ecology principles examining the metapopulation theory, landscape metrics (*e.g.* FRAGSTATS – McGarigal *et al.*, 2002) and focal species modelling (*e.g.* LARCH – Bruinderink *et al.*, 2003; BEETLE – Watts *et al.*, 2005). Application of these principles has enabled assessment of network connectivity and identified opportunities for action at national, regional, and local scales. There is growing interest in applying the concepts to planning and management of rural, peri-urban and urban areas.

The BEETLE network analysis model developed by Forest Research is well documented (Watts *et al*., 2005) and has been used to determine the habitat network extent and distribution in the Scottish Borders, West Lothian, Edinburgh & the Lothians, Wales, and now across the whole of Scotland (see www.forestresearch.gov.uk/habitatnetworks). The analyses have been developed with, and found favour from, a range of stakeholders across a variety of settings. A study of Lowland Habitat Networks (Humphrey *et al.*, 2005; 2007) has been undertaken to consider the potential for developing networks of non-wooded agricultural habitats and to look at ways of integrating these with forest habitat networks in different landscape settings. Assessments of Forest Habitat Networks (FHNs) are being used to advise funding, *e.g.* Woodlands in and around towns initiative (WIAT) http://www.forestry.gov.uk/forestry/infd-5w2nfz, determine the spatial extent of Atlantic Oakwood networks (Moseley *et al.*, 2006), spatially direct new planting proposals (Moseley *et al.*, 2007.), and focus attention of Local Biodiversity Action Plans. Attention is increasingly turning towards the peri-urban and urban environment, consistent with recent Scottish Executive policy. Networks describing ecosystem functionality across urban and rural environments have been identified (Ray *et al*., 2004; Ray & Moseley, 2006) and Forest Research are now proposing options for an integrated habitat network approach for Glasgow and the Clyde Valley.

2. Objectives

The project work programme focused on the following objectives to identify:

- Focal species appropriate for the region, and to research and describe elements of their autecology to classify their functional interaction with habitat and the matrix of the wider landscape. These will be determined at a stakeholder workshop, but are likely to be woodland, unimproved grassland, wetland (fen, marsh & swamp), and raised/intermediate bog. Elements of the focal species autecology will be researched and described to classify their functional interaction with habitat and the matrix of the wider landscape
- Key areas for native woodland restoration and expansion in order to link core woodland habitats within Falkirk and between neighbouring networks (*e.g.* in the Lothians and Glasgow & Clyde Valley)
- Key areas for expansion or restoration of a number of identified open ground habitats to link core habitat areas within Falkirk and between neighbouring areas, to maintain their ecological function and viability, as well as creating a functionally connected network
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3. A modelling approach to develop Integrated Habitat Networks

3.1 Study area

The study area for this work was defined by the Falkirk Unitary Authority boundary, plus a 5km buffer to determine where networks extend out to into other Unitary Authorities (Figure 1).

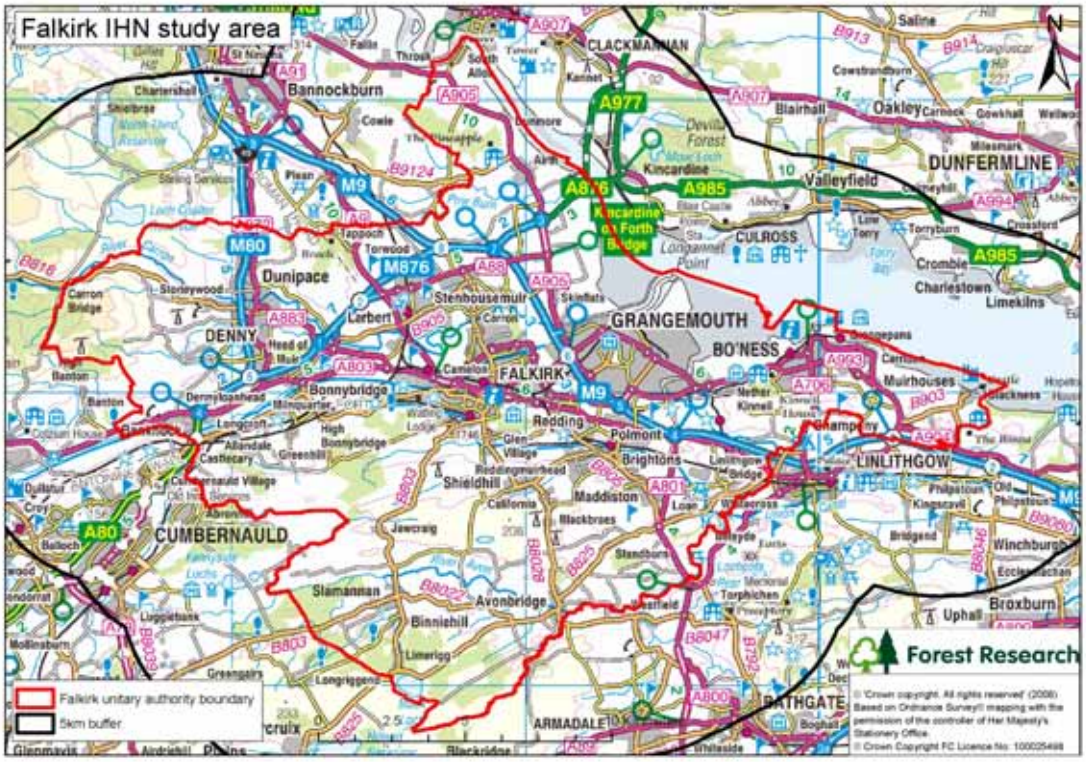


Figure 1 – Study area for the Falkirk Integrated Habitat Network

3.2 The modelling approach

The approach is based on a GIS-based model from 'BEETLE' (Biological and Environmental Evaluation Tools for Landscape Ecology) developed by Forest Research (see www.forestresearch.gov.uk/habitatnetworks). The model considers how areas of habitat are spatially aligned within the whole landscape, and how species can utilise and disperse between patches of habitat. Part of this model is a focal species tool that utilises habitat area requirements and dispersal characteristics to identify functional habitat networks for a given species.

The BEETLE focal species approach was chosen to map and analyse the integrated habitat networks. This approach negates the need to carry out a vast number of individual species analyses, which is particularly important as data regarding species habitat requirements and dispersal through greenspace is lacking. Species which can populate the habitat types were then associated in relation to their particular requirements.

Focal Species
A focal species can be simply defined as 'the species being focused on to examine a particular issue'. A more detailed definition evaluates landscapes in relation to the requirements of all the species present (Lambeck, 1997), focusing on the key issues of habitat requirements and dispersal capability to identify species with the strictest requirements.

3.3 Preparation of geo-referenced data including focal species autecology

3.3.1 Stakeholder Workshop

A Stakeholder workshop was held at the start of the project to help identify priorities and conservation concerns across the area, secure buy-in to the concept and to identify the most important species and habitats for use in the BEETLE modelling to develop an integrated habitat network for Falkirk. Stakeholders included representatives from Farm Woodland Advisory Group, Central Scotland Forest Trust, Scottish Natural Heritage, Scottish Environmental Protection Agency, and Forestry Commission Scotland. The discussions identified the following habitats for the modelling process:

- Unimproved grassland
- Floodplain management wetlands
- Woodland Habitats using different woodland types
- Raised/intermediate bog

A full report of the stakeholder workshop can be found in Appendix I.

The Generic Focal Species (GFS) derived from these habitats types for the BEETLE modelling were:

- Grassland generalist
- Lowland grassland specialist
- Lowland acid grassland specialist
- Wetland specialist
- Woodland generalist
- Broadleaved specialist
- Ancient broadleaved specialist
- Raised bog specialist

3.3.2 Focal species autecology

A list of species of conservation concern were drawn up to identify appropriate focal species that are representative of the identified priority habitats, and their dispersal abilities and minimum area requirements were assessed through a review of autecological accounts (Table 1). This was carried out through a literature search, discussions with appropriate species experts, and the involvement of a stakeholder workshop to guide the process. Surrogate species were employed where autecological data was scant or if species from the local list did not span the spectrum of sensitivity to landscape fragmentation.

Table 1 – Ecological profiles of focal species used in the Falkirk IHN analysis

Species	Mean dispersal Km	Maximum dispersal Km	Category	Habitat
Triturus cristatus	0.02	0.15	Amphibian	Wetland
Coenonympha tullia	0.5	2.0	Insect	Heath, raised bogs, upland blanket bogs and moorland
Sympetrum danae		1.75	Insect	Peatland, wetland, Bog
Lycaena phlaeas	0.05	1.4	Insect	Grassland, wasteland, heath, bog
Polyommatus icarus	0.25	5.0	Insect	Grassland, heath, sand dunes
Vanessa atalanta	0.5	2.0	Insect	Woodlands, heath, moors and bog, coastal, riverbanks
Vanessa cardui	0.5	2.0	Insect	Woodlands, heath and moors, bog
Aglais urticae	0.5	2.0	Insect	Woodlands, heath/moors, bog
Inachis io	0.5	2.0	Insect	Woodlands, heath/moors, bog
Aphantopus hyperantus	0.5	2.0	Insect	Woodlands, heath/moors, bog
Coenonympha pamphilus	0.5	2.0	Insect	Woodlands, heath/moors, bog
Epirrita filigrammaria	0.4	2.0	Insect	Heath, Blanket Bog
Anarta myrtilli	0.4	2.0	Insect	Heath, bog
Lutra lutra	4.22	11.46	Mammal	Freshwater
Mustela putorius	2.29	5.16	Mammal	Woodland and river banks
Lepus timidus	2.0	5.5	Mammal	Pine plantations
Arvicola terrestris	1.0	2.0	Mammal	Freshwater
Erinaceus europaeus	0.88	3.02	Mammal	Woodland, grassland and urban
Lepus europaeus	0.58	2.8	Mammal	Grassland/Woodland
Mercurialis perennis	0.14	0.84	Plant	Woodland
Geum rivale	0.1	1.0	Plant	Unimproved Grassland

Appropriate landcover types were defined as habitat for each of the analyses.

1. Unimproved grassland was derived from the Phase1 categories unimproved grassland and marshy grassland, where available or from IACS data. Lowland acid grassland was defined as enclosed unimproved acid grassland below 300 m and is species-rich and equates to lowland acid grassland HAP type. Lowland grassland was defined as neutral grassland and species-rich grassland in the lowlands and equates to the lowland hay meadow HAP type. Upland Nardus-Molinia grassland is ubiquitous in the uplands and is included in the grassland generalist and does not have any BAP designation.

2. Wetland was defined as all wetland habitats identified in the wetland and grassland NVC survey ranging from small open water bodies to wet woodlands. Great Crested Newts have been identified within the Falkirk LBAP and are a suitable surrogate for wider wetland biodiversity. Improving connectivity for this species

would greatly benefit the habitats for a wide range of other wetland species, many of which are of conservation concern within the Falkirk area.

3. Woodland was defined as all areas of woodland from the MasterMap and Phase1 categories, with broadleaved woodland (including ancient broadleaved woodlands) being identified as a separate group. A 50 m internal buffer was applied to broadleaved woodland and to ancient broadleaved woodland to represent the requirement of ‘core’ woodland of many broadleaved woodland specialists.

4. Raised bogs were defined as sphagnum rich vegetation found on flood plains and other level areas with impeded drainage in the Lowlands, lying on peat more than 5 m deep with the water table at or just below the water surface and no input of water from the surrounding land.

3.4 BEETLE analysis

The identification of key areas for habitat restoration and expansion required to link core areas of habitats within and with out the region were undertaken using Forest Research's BEETLE landscape ecology tool. This used the focal species identified in work package 1 with a Falkirk land cover data set assembled from a range of spatial data sets (Table 2) to assess functional connectivity.

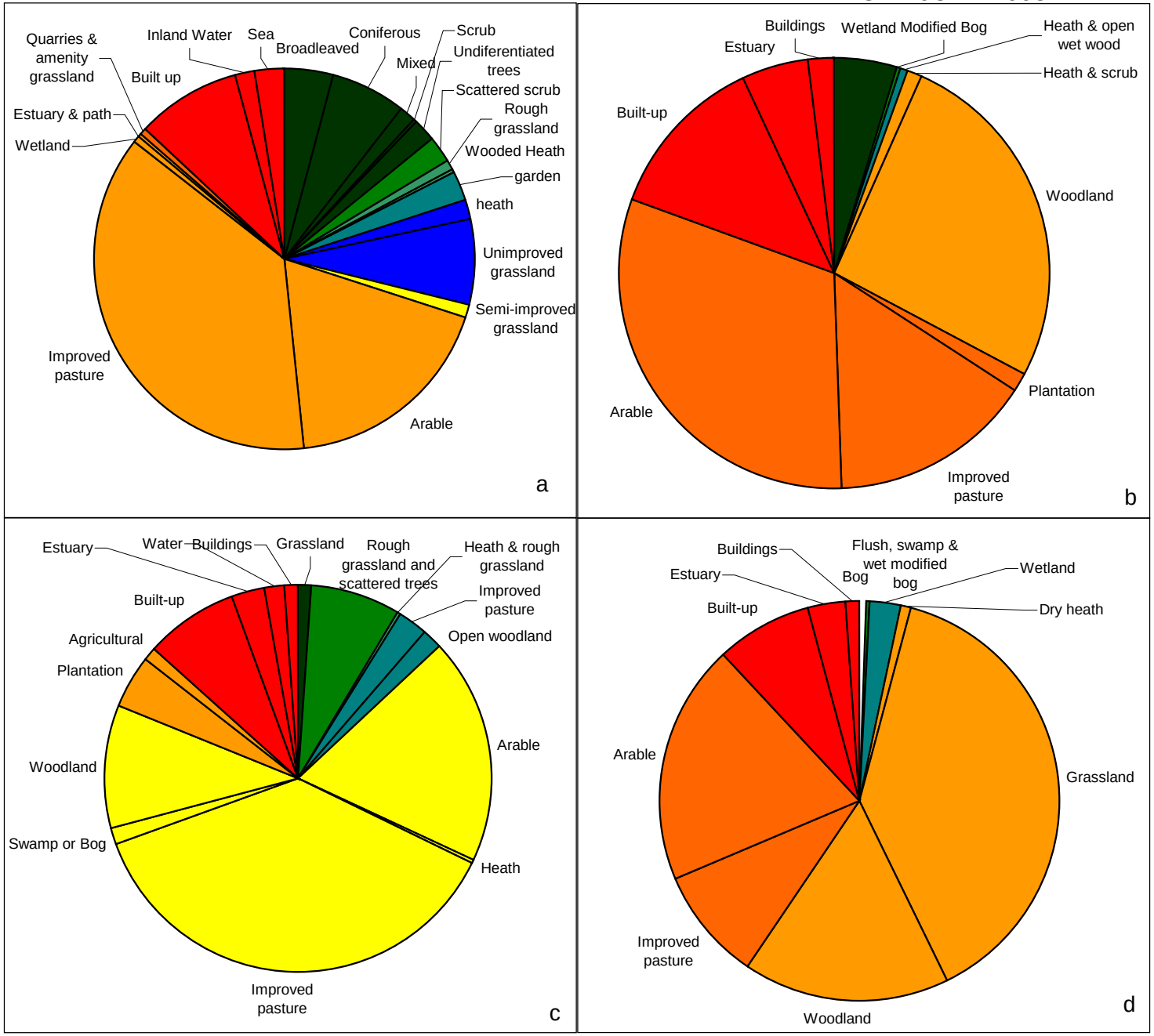
Table 2 – Description of land cover datasets used in the project – reproduced in part from Humphrey et al. (2005)

Data	Description	Value
Ordnance Survey® Pan-Government product portfolio	Products include: 1) for large scale mapping - OS MasterMap; Land-Line; 1:10,000 Scale Raster; 2) for small scale mapping – 1:50,000 Scale Colour Raster; 1:50,000 Scale Gazetteer; 1:250,000 Scale Colour Raster; Strategi®; Meridian 2	MasterMap is the definitive, large-scale digital map of Great Britain, containing information on roads, tracks, paths etc. Gives accurate representation of woodland areas and boundaries and can identify linear features which can act as barriers to dispersal or as corridors
Phase 1 Habitat Survey	Broad scale field mapping approach giving information on the extent and distribution of natural and semi-natural habitats	Ideal source of good quality habitat information, but limited in coverage to specific regions. Often only in paper format.
Land Cover Scotland 1988 (LCS88)	Remote sensed dataset derived from aerial photography taken in 1988; provides broad habitat definitions at 1:25,000 scale	Covers the whole of Scotland focusing on semi-natural habitats, is out of date, but currently being updated ("New Image of Scotland")
Land Cover Map 2000 (LCM)	Satellite derived remote-sensed datasets providing broad habitat definitions	Covers the whole of Scotland, but there are problems with accuracy in mapping some upland habitat types
Unitary Authority boundaries	Locations of Local Authority areas	Establishes link between network modelling, local authority areas and LBAPs
Local Plan constraints (settlement areas & proposed housing and industrial areas), and additional new woodland polygons.	Locations of proposed areas of development	Identifies areas in which development are planned, which can be incorporated into scenario development.
SNH BAP priority habitat report and maps	Maps and description of UK BAP priority habitats summary of all previous phase 1 and phase II survey information in Scotland	Provides information on location of key habitats in Scotland
SAC, SPA, NNR and SSSI boundaries	Boundaries of protected areas/sites	Give indication of areas of high conservation value in general

Table 2 – continued…

Data	Description	Value
National Inventory of Woodlands and Trees (NIWT)	Derived from LCS88 dataset plus updated to 1995 from FC sources; provides information on broadleaved/conifer woodland > 2ha and small woods and trees (0.1-2ha)	Baseline data source on woodland for Scotland
Scottish Forestry Grant Scheme and Woodland Grant Schemes	Regularly updated records of new planting	Gives composition and extent of new woodland areas which can give indication of habitat value
Scottish Semi-Natural Woodland Inventory (SSNWI)	Constructed over the period 1995-2001 using interpretation of aerial photographs taken in 1988. Map of all woodlands > 0.1 ha classified according to degree of semi-natural character	Identifies all semi-natural woodland, useful when combined with NIWT to locate sites of high conservation importance
Scottish Ancient woodland Inventory (AWI)	Map of all ancient (existing since 1750) woodlands over 2 ha in size	Identifies areas of key importance for woodland biodiversity
National Vegetation Classification survey data	Various surveys covering SACs, SSSIs and other habitats of high conservation value in Scotland	Coverage is geographically limited and information can be too detailed to make meaningful links with species requirements
Scottish Integrated Agricultural Control System (SIACS)	Contains information on field sizes and crop types for very field in Scotland	Shape files and data available for individual holdings

To graphically illustrate the way in which the BEETLE model was parameterised to express landscape permeability for woodland generalists, wetland generalists, grassland generalists, and bog specialists areas of generalised land cover type for the region were used to proportionally divide the charts of Figure 2 a-d. Each chart is colour coded to reflect the relative degree of permeability in classes described as ‘very permeable’ to ‘extreme barrier’. The analysis shows that woodland generalists have a larger proportion of habitat compared to wetland specialists and bog specialists, but the degree of permeability over large parts of the landscape is poor for all three. Wetland and bog specialists are particularly limited across the landscape by areas of poor permeability. Grassland generalists have a relatively large habitat area but more extensive areas of more moderate (better) permeability than the woodland, wetland, or bog specialists and generalists.



Permeability code	Value
Habitat	0
Very permeable	1-2
Moderatly permeable	3-4
Slightly permeable	5
	7
Moderate Barrier	10
	15-20
	+20-30
Extreme Barrier	50

Figure 2 – A comparison of the landscape matrix permeability of Falkirk to:

a) Woodland generalists

b) Wetland specialists

c) Grassland generalists

d) Bog specialists.

4. Interpretation and applications of the networks

The network outputs constitute part of the decision-making system for strategies designed to reduce the impacts of habitat fragmentation and improve habitat connectivity and biodiversity. The interpretation and suggestions for the application of these outputs are part of this process but need to be implemented in conjunction with sound judgement, based on ecological principles.

The criteria for identifying prime sites for habitat restoration and expansion for Falkirk were developed and tested through identification of the most valuable core areas of habitat, particularly identified priority habitats. For each habitat network, the following tasks were undertaken:

1. Identification of priority habitat networks & development of IHNs
2. Use of BEETLE to assess functional connectivity improvements over current situation arising from IHN development scenarios
3. Interpretation of connectivity maps to identify key areas where habitat restoration, creation or expansion could significantly improve functional connectivity
4. An easy to interpret description of the landscape consequences of the habitat expansion scenarios, including the area of habitat and indices of connectivity

Habitat networks were calculated separately for each of the 8 GFS, and for 3 dispersal distances of: 500 m, 1 km and 2 km. The dispersal distances have been derived from the autecological assessment, with the smaller distance representing a mean dispersal, and 2 km representing the maximum. By overlaying the 1 km network onto the 2 km network, and the 500m network onto the 1 km network, we can examine the extent of dispersal overlap of larger networks surrounding the smaller dispersal networks (Figure 3). This allows an assessment of the degree of permeability of the matrix (land cover types not classed as habitat) surrounding a woodland generalist network.

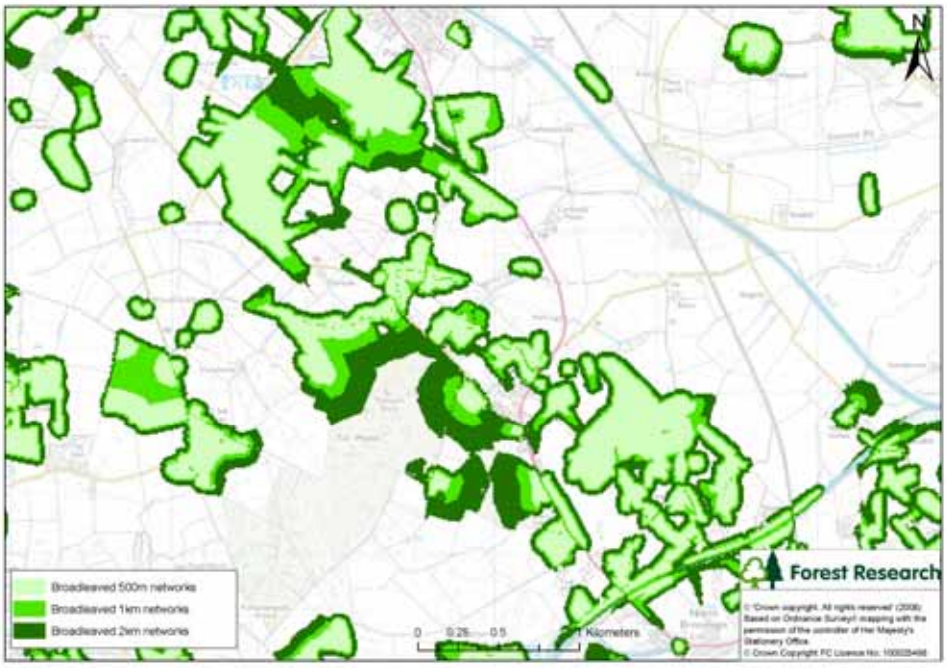


Figure 3 – Examination of network opportunities using three different maximum dispersal distances of 500m (light green), 1km (mid-green), and 2km (dark green) for broadleaved specialists.

4.1 Woodland networks

Figure 4 shows 3 distributions of networks for specialists of ancient broadleaved woodland, all broadleaved woodland and all other woodland. The map provides a spatially referenced index of a range of woodland networks of varying biodiversity value in Falkirk. In particular, it provides an estimate of the degree of linkage of ancient broadleaved woodland (Priority Enhancement Areas) with adjacent broadleaved woodland. It can be used to determine and locate those woodland areas which should be protected and expanded. The maps also show how woodland expansion might seek to link existing structures, to form stepping-stones between two or more networks. This will be explored in detail with the plans for the core development areas.

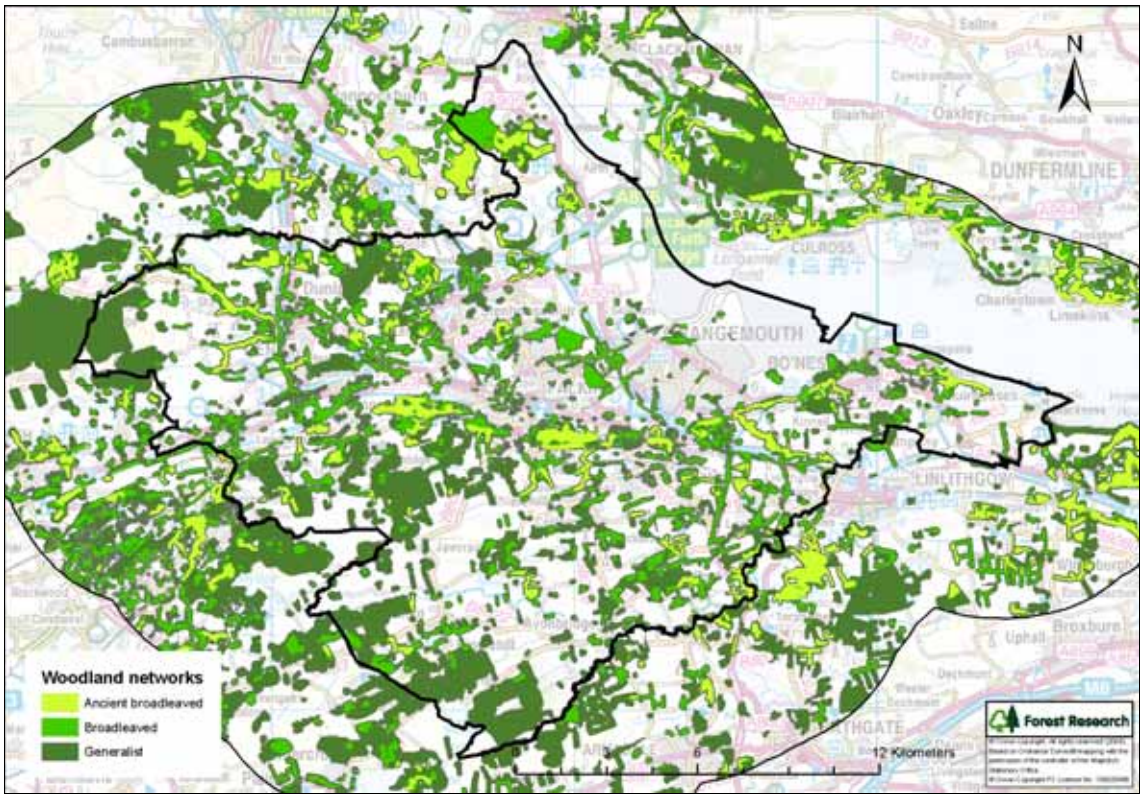


Figure 4 – Woodland habitat networks within the study area at a maximum 2km dispersal. Ancient broadleaved are nested within broadleaved specialist networks, which in turn are nested within woodland generalist networks.

The metrics (Table 3a-c) for 500m show 1928 broadleaved networks covering 6 701 ha. Of these, there are 395 ancient broadleaved woodland networks covering 2 961 ha. The figures show that the ancient broadleaved woodland blocks tend to be larger, on average, than the broadleaved woodland blocks, indicating that there are many very small broadleaved woodlands. The 500m to 2,000m dispersal sensitivity analysis shows that the number of ancient broadleaved woodland specialist networks is reduced by 50% with a 2.4 times increase in network size (Table 3c). Networks of this type constitute small sections of the woodland generalist network, they are slightly more fragmented than, for example, broadleaved specialist networks (reduction in networks - 62%, size increase 2.5 times), but the abundance of broadleaved woodland networks suggests that they may be good opportunities for expanding the ancient woodland, through careful management of existing broadleaved woodland corridors. The woodland specialist sensitivity analysis does not show the disproportionate reduction in network numbers between 500m and 1,000m dispersal, coupled with an increase in mean network size, than was apparent for woodland generalists. The matrix is much less permeable to specialists than generalists.

Table 3 – Landscape metrics for the three woodland generic focal species analyses in the study area (Falkirk Council region and a 5 km external buffer).

a) Woodland generalists

Max. dispersal distance (m)	Number of networks identified	Total area of networks (ha)	Mean area of networks (ha)	Area of largest network (ha)	Area of less favoured habitat network (ha)	Percentage less favoured habitat in network (ha)
500	2,097	17,460	8.3	1,119	6,072	34.8%
1000	1,086	22,525	30.7	1,632	11,136	49.4%
2000	581	31,122	53.6	2,650	19,733	63.4%

b) Broadleaved woodland specialists (50 m internal buffer applied)

Max. dispersal distance (m)	Number of networks identified	Total area of networks (ha)	Mean area of networks (ha)	Area of largest network (ha)	Area of less favoured habitat network (ha)	Percentage less favoured habitat in network (ha)
500	1,928	6,701	3.5	175	3,572	53.3%
1000	1,190	10,186	8.6	408	7,056	69.3%
2000	738	16,611	22.5	702	13,482	81.2%

c) Ancient Broadleaved woodland specialists (50 m internal buffer applied)

Max. dispersal distance (m)	Number of networks identified	Total area of networks (ha)	Mean area of networks (ha)	Area of largest network (ha)	Area of less favoured habitat network (ha)	Percentage less favoured habitat in network (ha)
500	395	2,961	7.5	149	1,824	61.6%
1000	256	4,370	17.1	176	3,234	74.0%
2000	196	6,973	35.6	216	5,837	83.7%

The Scottish Forestry Strategy includes an aspiration to achieve 25% woodland cover in Scotland by 2050, requiring the creation of 10,000 ha of new woodlands per year (Forestry Commission Scotland climate change action plan draft for consultation). Although some of this can be achieved through the National Forest Estate, it is likely that much of the new woodland creation will occur on private land. Grants to support this expansion are likely to be accessed through Rural Development Contracts (RDCs), based on a scoring system linked to the proximity or inclusion within existing networks, as discussed in the RPAC process. The habitat networks can be used to inform this process by prioritising those applications that contribute towards the development of integrated habitat networks, rather than using a spatially unconstrained approach. Other planned projects, such as the HELIX project which intends to plant 750,000 trees, can have a large contribution to expansion of the woodland networks if they are incorporated into a landscape scale approach, rather than being considered as isolated projects.

Priority Enhancement Areas (Figure 5) were identified through further analysis of the habitat networks to create encompassing networks. Those PEAs completely out with the Falkirk area were removed. Priority Enhancement Areas were identified by selecting those with a) the largest encompassing networks, b) the greatest area of habitat within these networks, and c) the largest number of the contained habitat networks. This approach takes account of the permeability of the intervening landcover to indicate that expansion and creation of additional semi-natural habitat can create larger areas of functionally linked habitat networks (Table 4 and Figure 7).

Table 4 – Priority Enhancement areas within the Falkirk study area (including 5km boundary)

1 Dunipace	7 Bonnybridge
2 Dunmore	8 Allandale - Cumbernauld
3 Kinnaird	9 South Falkirk town
4 Denny	10 Linlithgow
5 Muirhouses	11 Dinniehill
6 Whitecross	12 Slamannan

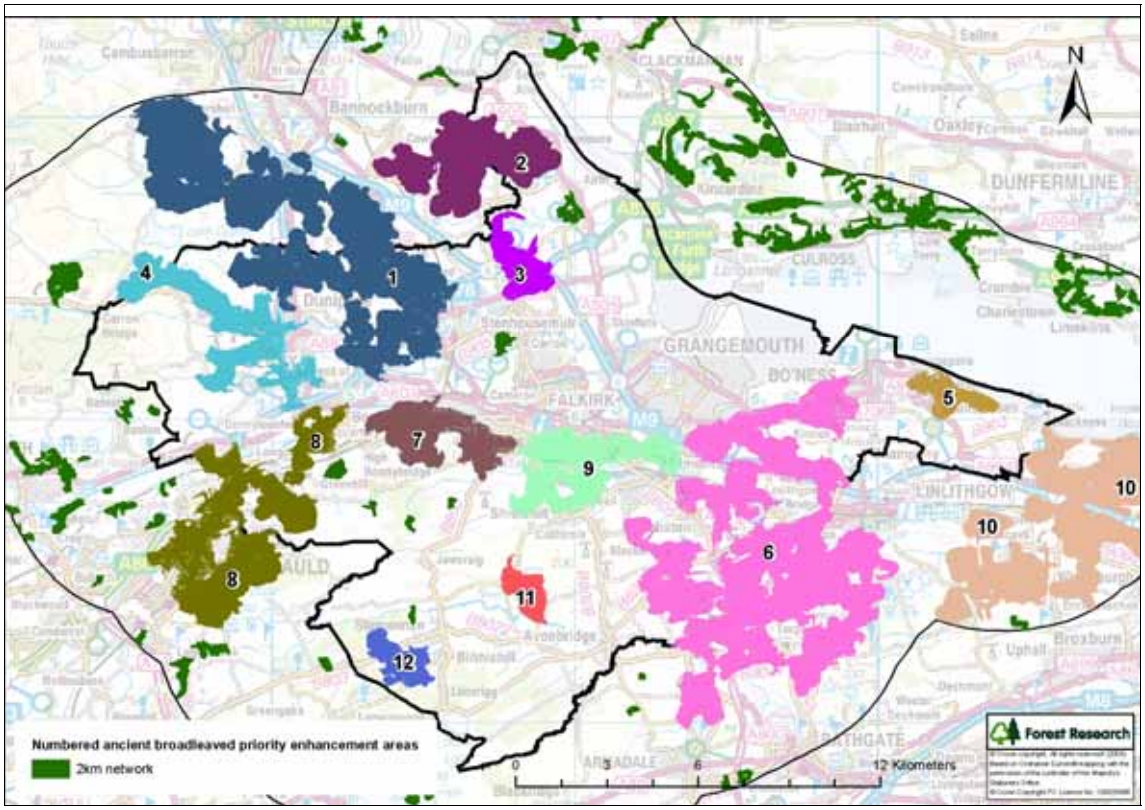


Figure 5 – Priority enhancement areas for woodlands within Falkirk. Each numbered area contains those woodland habitat networks identified as having the best prospects for improvement and linkage within the region.

The Whitecross and Linlithgow PEAs represent key linkage areas to the Edinburgh and Lothians Forest Habitat Network (FHN), indicating where a consolidated approach to woodland improvement could be undertaken to facilitate species dispersal across Unitary Authority boundaries. Opportunities for linking with the Glasgow and Clyde Valley woodland networks should be concentrated on the Allandale – Cumbernauld PEA, where a large number of networks extend across the North Lanarkshire Unitary Authority boundary. These areas fall within the Central Scotland Forest Trust (CSFT) boundary; CSFT and Forestry Commission Scotland may be able to facilitate woodland improvement strategies. The Dunipace and Dunmore PEAs provide additional opportunities for linkage of Falkirk IHNs with the Carse of Stirling and towards the Lomond and Trossachs National Park. On a regional scale, the PEAs can be further prioritised by their proximity to designated sites (Figure 6).

The PEAs can be used to identify opportunities for consolidating existing networks within each area, *e.g.* within South Falkirk Town, or by linking PEAs, *e.g.* 7 and 8 (Figure 7). Networks outside PEAs are also important, but have a lower strategic priority.

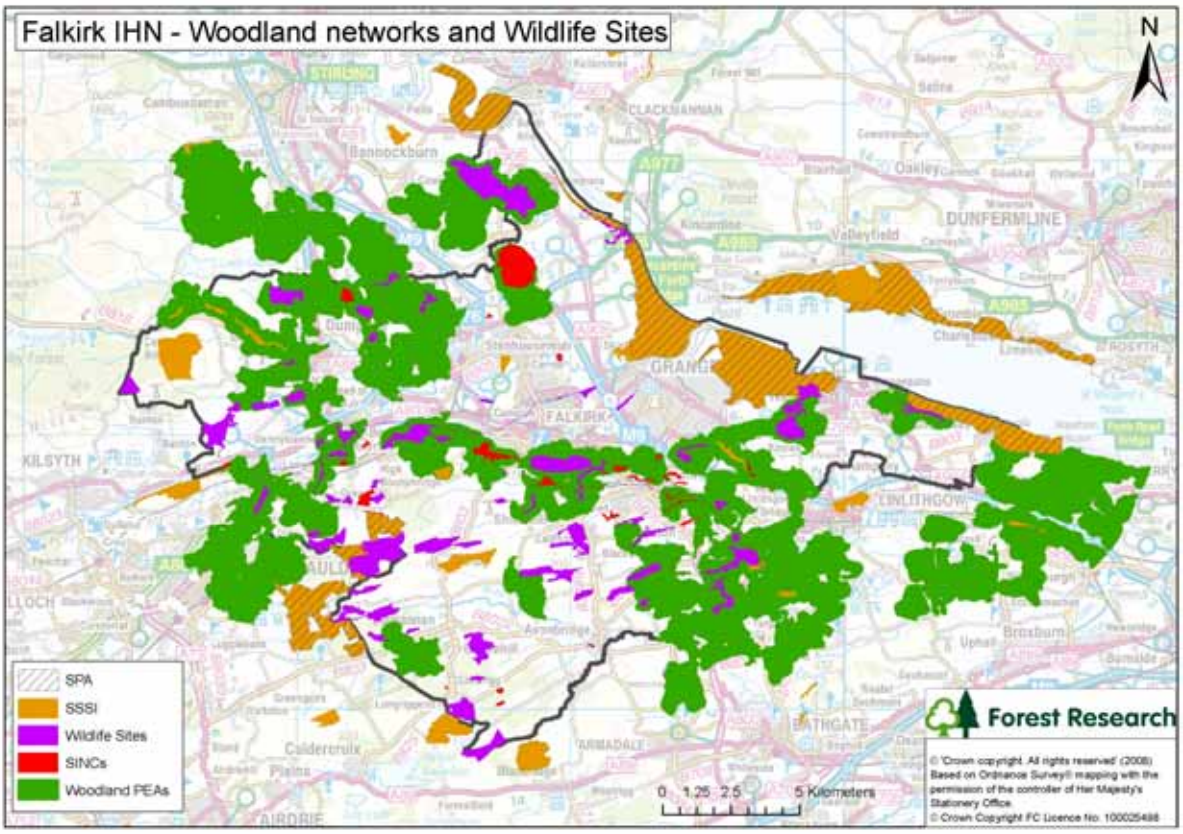


Figure 6 – Woodland Priority Enhancement Areas in relation to designated sites.

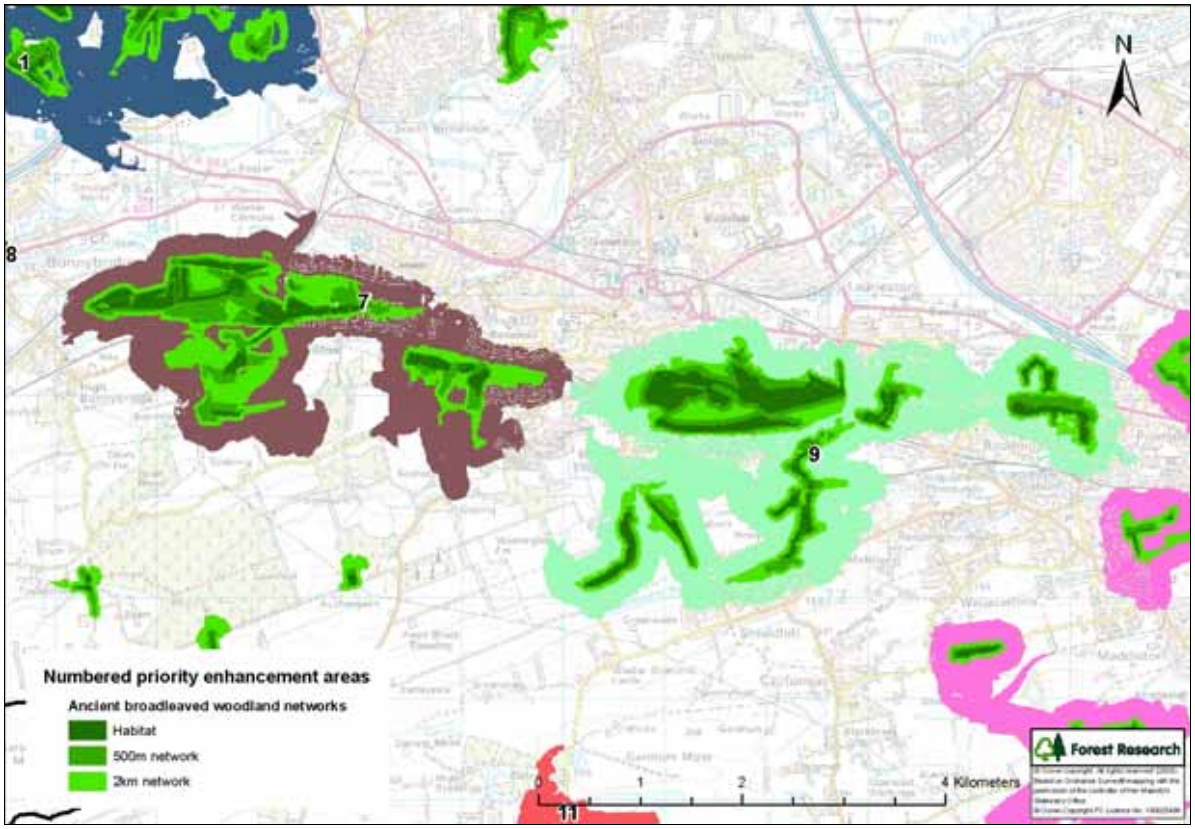


Figure 7 – Detail of two Priority Network Areas (Bonnybridge and South Falkirk Town) and their contained habitat networks indicating opportunities for creating larger areas of functionally linked habitats.

Network development should be initially guided by priority enhancement areas and then by the prioritisation of the following management principles (highest priority first)

- **Protect** and **manage** high quality habitat
- **Restore** and **improve** sites with restoration potential
- **Improve** and **manage** other sites
- **Improve** the **landscape matrix** by reducing land use intensity
- **Create/recreate new habitat** and semi-natural habitat

Figure 8a-d demonstrates the effect of first targeting the high quality habitat (ancient broadleaved woodland) within the networks for enhancement and expansion to provide larger and more robust networks. This process should be further applied to the broadleaved woodlands and subsequently to areas of other woodland. Mixed or conifer woodland may, where appropriate, be modified to create a more natural structure and composition.

Figure 8 – Demonstration of how the three woodland networks could be used to reduce woodland fragmentation and improve biodiversity. Image (a) shows existing networks, with ancient broadleaved networks indicated in dark green, broadleaved networks in light green and woodland networks in brown. Image (b) shows a larger high biodiversity network through buffered expansion and targeting adjacent broadleaved woodland for improvement. Image (c) shows the potential for expanding the high biodiversity network through other woodland types. Image (d) shows how these woodlands, which are part of an existing Priority Expansion Area (PEA) can link to other PEAs.

4.2 Wetland networks

The wetland generalist networks within Falkirk are again slightly limited by the lack of digital Phase1 data, but indicate a number of opportunities for enhancement both within the region and to link with networks within the GCV IHN (Figure 9). The prioritisation of these opportunities can be guided through the use of Priority Enhancement Areas identified in Figure 10.

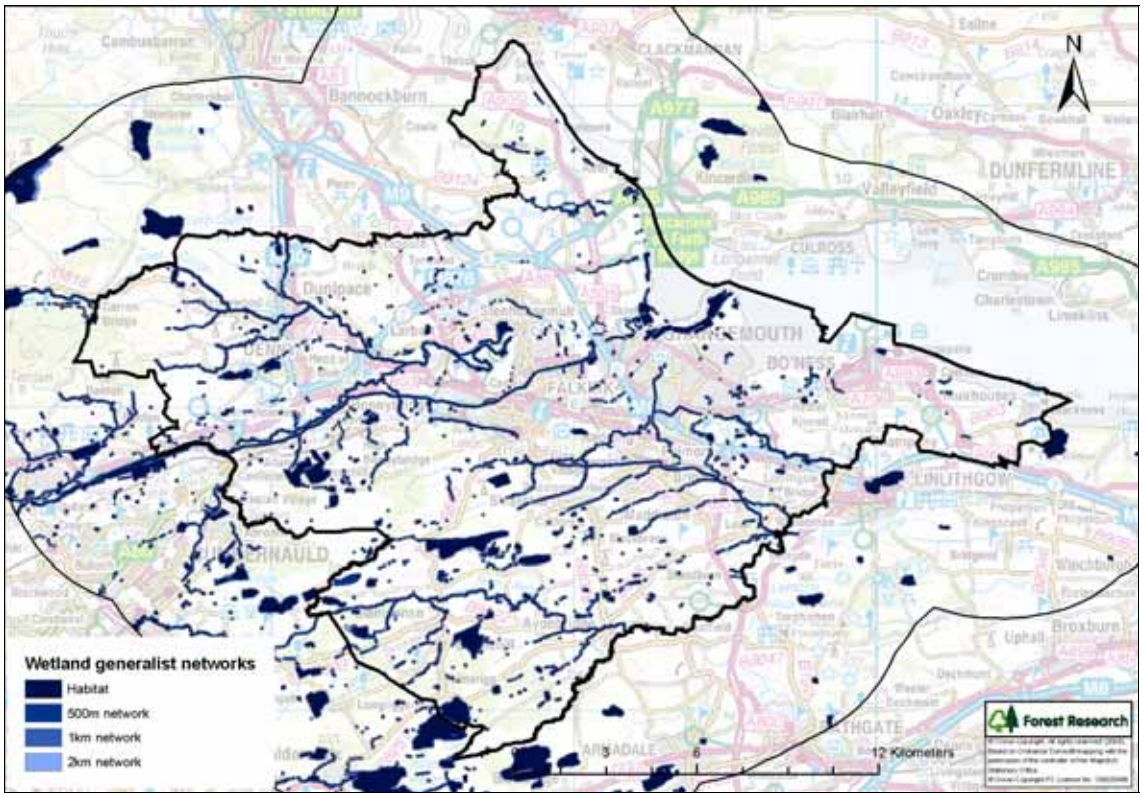


Figure 9 – Wetland habitat networks within the study area at a maximum dispersal distances of 500m, 1km, and 2km nested within one another.

Table 5 – Landscape metrics for wetland generalist generic focal species analyses in the study area (Falkirk Council region and a 5 km external buffer).

Max. dispersal distance (m)	Number of networks identified	Total area of networks (ha)	Mean area of networks (ha)	Area of largest network (ha)	Area of less favoured habitat network (ha)	Percentage less favoured habitat in network (ha)
500	2,648	3,434	1.3	231	1,069	31.1%
1000	1,487	4,614	3.1	299	2,249	48.7%
2000	727	7,230	9.9	1,254	4,865	67.3%

Priority Enhancement Areas for wetlands were created as for woodlands, but the analysis excluded rivers and large lochs to avoid these connecting non-clustered areas (Table 6 and Figure 10).

Table 6 – Priority Enhancement areas within the Falkirk study area (including 5km boundary)

1 Carron Estury	5 Darnrig moss
2 Larbert	6 Fannyside Lochs
3 Kilsyth - Bonnybridge	7 Crossburn
4 Greenhill	8 Blawhorn moss

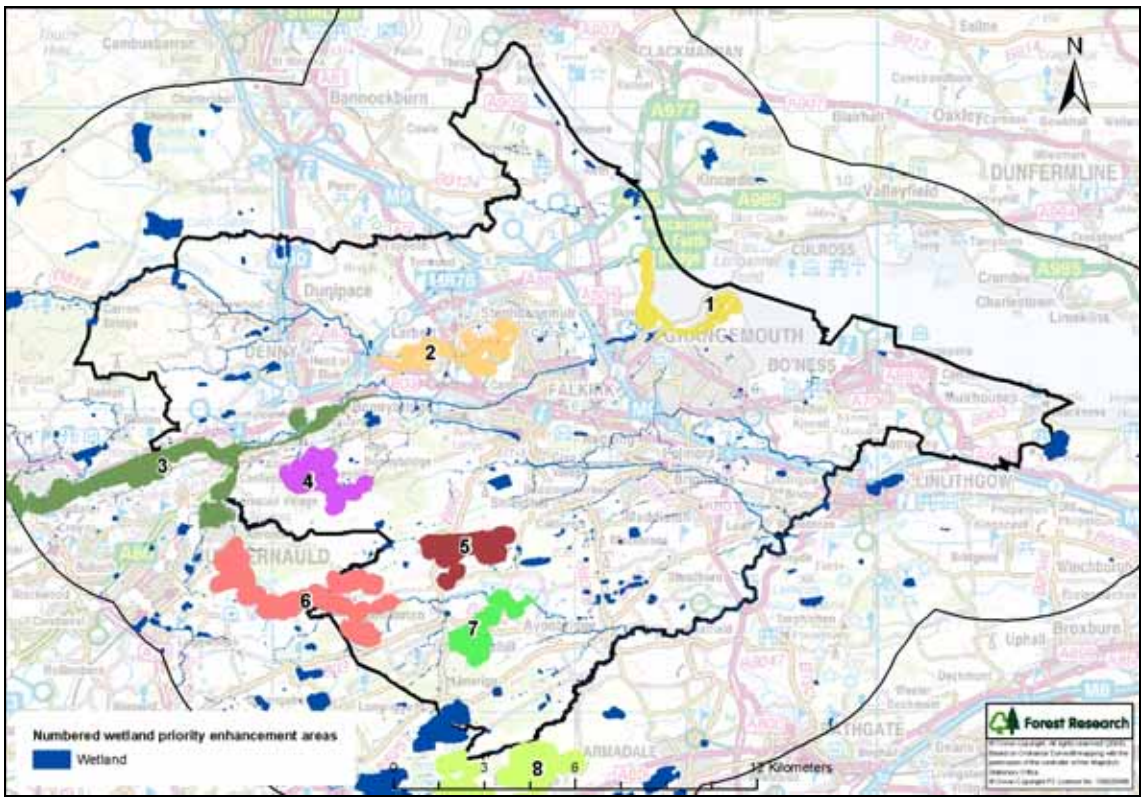


Figure 10 – Priority enhancement areas for wetlands within Falkirk. Each area contains those wetland habitat networks identified as having the best prospects for improvement and linkage within the region.

The Carron Estuary PEA is at the saline end of the wetland networks, but has it's own intrinsic value and is likely to have high biodiversity value. The Kilsyth – Bonnybridge, Fannyside Lochs, and Blawhorn moss PEAs provide strategic links to wetland habitat networks within the GCV IHN. On a local scale, there are a number of opportunities for improving wetland habitat networks within and between the PEAs (Figure 12). Existing broadleaved riparian habitat could be expanded to consolidate and expand the networks, whilst conversion of conifer woodlands adjacent to wetland habitat to wet woodland would create more robust networks within PEAs. Opportunities can be considered with strategies to enhance existing designated sites (Figure 11).

Figure 12 illustrates in more detail the potential for increasing wetland network connectivity with Falkirk. The map shows potential pinch points along riparian corridors where the addition of wetland habitat or conversion of conifer to wetland habitats could be encouraged. Restoring wet wood, fens, Carr and wet meadows would increase connectivity of wetland habitats, begin to restore floodplain functionality, and help consolidate wetlands within the region. In developing functional flood plains and targeting actions for LBAP species, wetland successional processes also need to be considered (although beyond the scope of this project). For example the development

of temporal networks of ponds, fens and wet woodland to represent the full range of successional development of wetland habitats.

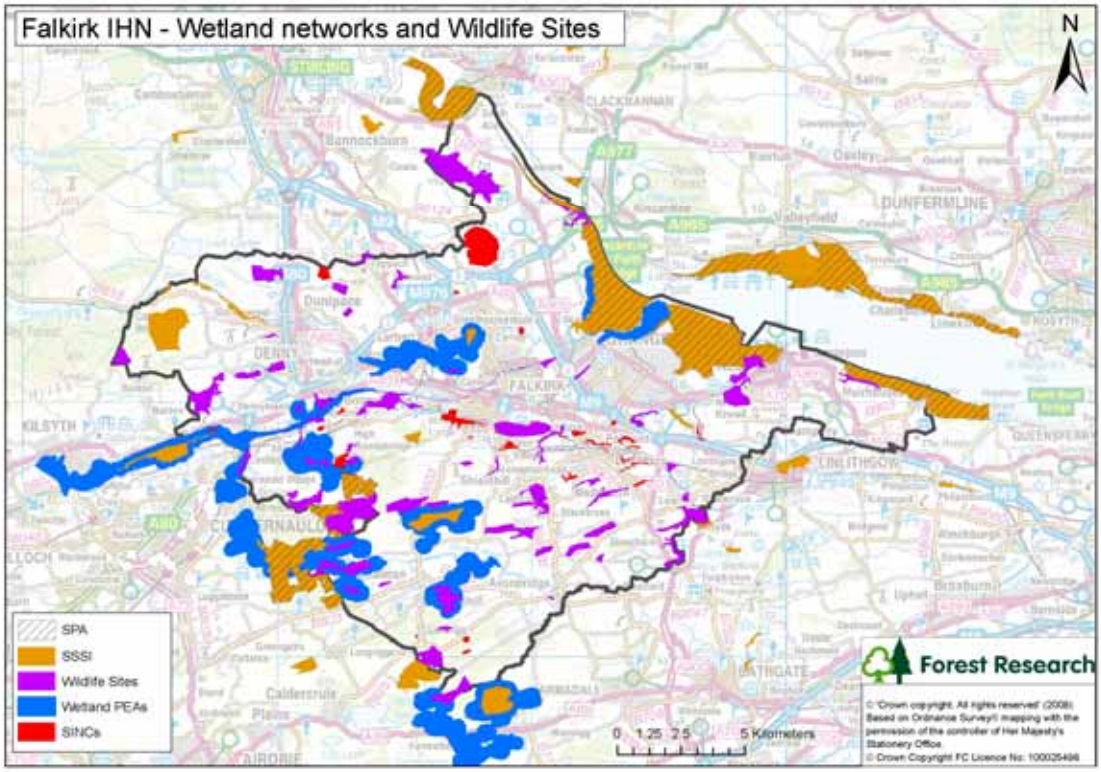


Figure 11 – Wetland Priority Enhancement Areas in relation to designated sites.

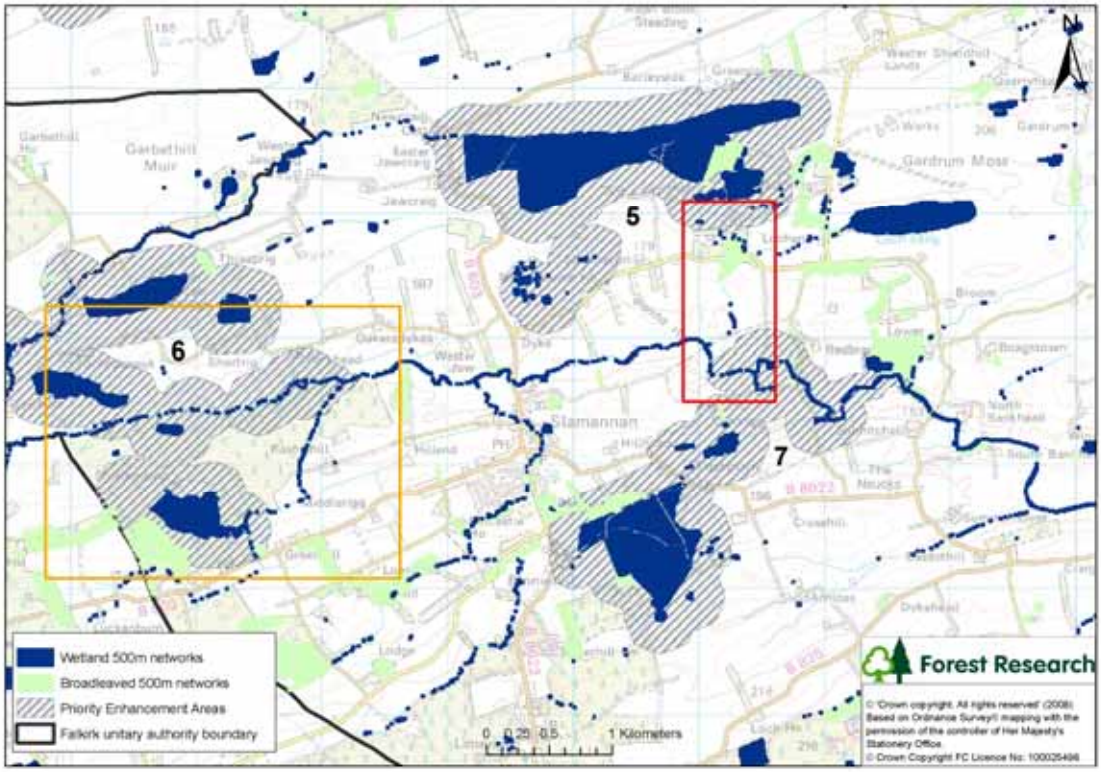


Figure 12 – Close up of three priority enhancement areas for wetlands within Falkirk, indicating opportunities for enhancement by expanding wetland habitat along broadleaved networks (red box) or through conversion of conifer (orange box).

Within urban areas, the integration of new greenspace through the planning process using spatially located Sustainable Urban Drainage Systems (SUDS) could also help to enhance the biodiversity of riparian and wetland areas (Figure 13) by introducing new areas of habitat. The development of habitat networks is seen as an important mechanism for reversing the effects of fragmentation on biodiversity while delivering a range of other environmental benefits: in this case flood control. There is the potential to develop a more integrated approach to planning land-use change, which takes account of conservation objectives for the full suite of habitats and species associated with different types of land use while also addressing environmental issues. The aim would be to develop more sustainable methods of flood control that are also ecologically functional.

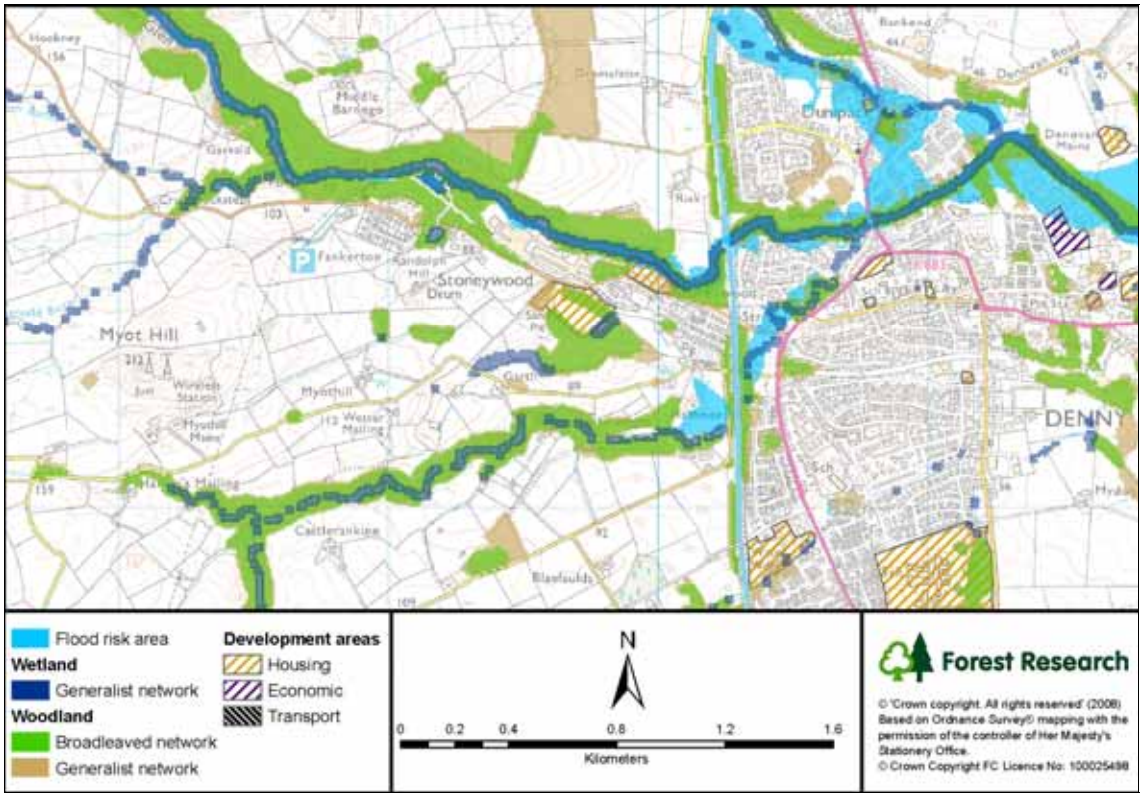


Figure 13 – Opportunities for using the IHNs with flood-risk data and development areas to indicate how to address flood-risk whilst enhancing biodiversity. Further addition of wet woodland and associated wetland habitat could strengthen the two major wetland and broadleaved woodland networks.

4.3 Grassland networks

The opportunities for improving grassland habitat networks within the study area appear to be limited, although this may be largely influenced by the lack of digital data within Falkirk. There are a number of networks outside of Falkirk, but within the 5km boundary of the study area; these have been identified using the Phase1 digital data available within the Glasgow & Clyde Valley (Figure 14).

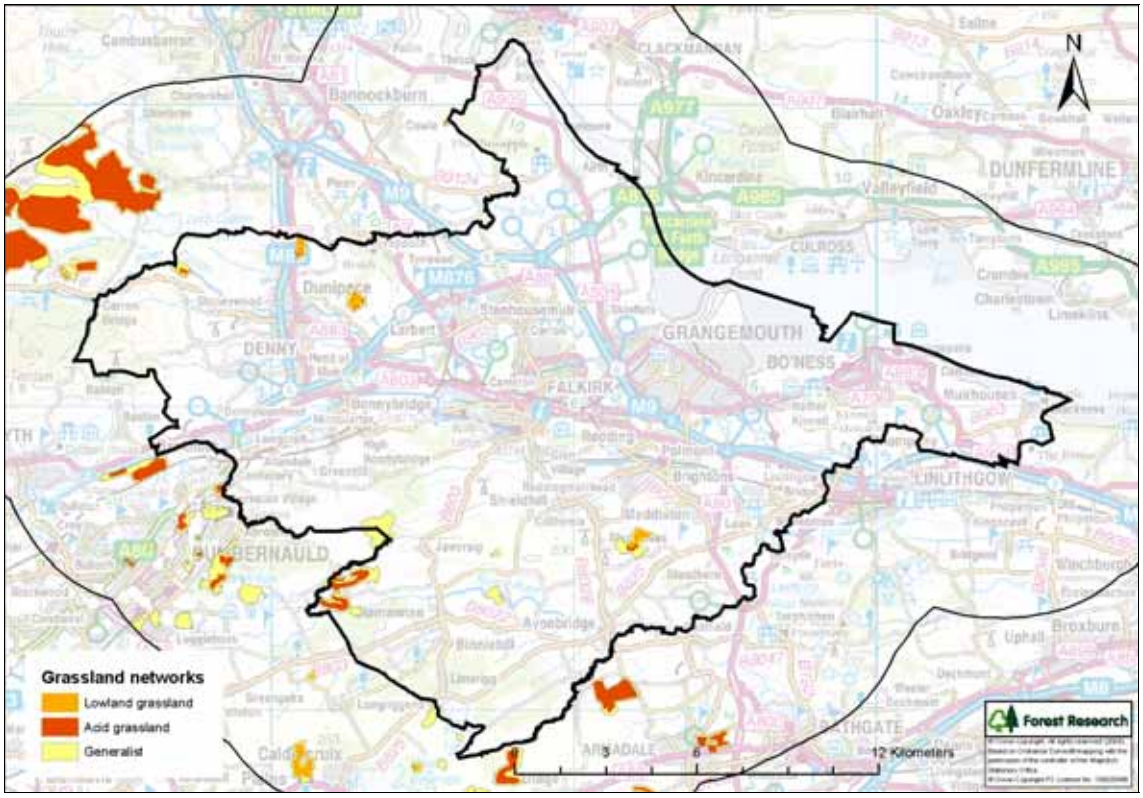


Figure 14 – Grassland networks (lowland – orange, acid – red, generalist – yellow) within the Falkirk study area. Networks may be limited by the lack of digital data.

The metrics (Table 7a-c) for 500m show 90 grassland generalist networks covering 1,407 ha. Of these, there are 57 lowland acid grassland specialist networks covering 1,252 ha and 13 lowland grassland specialist networks covering 101 ha. The figures show that the areas of lowland acid grassland blocks tend to be larger, on average, than those of the other grassland areas, indicating that these may be the most consolidated. The lowland grassland networks are particularly small and the 500m to 2,000 m dispersal sensitivity analysis shows that the number of lowland grassland specialist networks is reduced by 31% with a 2.2 times increase in network size (Table 7c). Networks of this type constitute very small sections of the grassland generalist network, and have a relatively similar fragmentation to lowland-acid grassland specialist networks (reduction in networks - 40%, size increase 1.9 times). The matrix is much less permeable to lowland grassland specialists than to the other GFS. Opportunities for expanding the existing higher biodiversity grassland networks within Falkirk are limited, as many of the networks, and particularly the larger ones, are located within the 5km buffer surrounding Falkirk. The major concentration of grassland networks identified within Falkirk are located near Slamannan (Figure 15) where opportunities exist for targeting fields close to the networks to create larger areas of species-rich habitat.

Table 7 – Landscape metrics for the three grassland generic focal species analyses in the study area (Falkirk Council region and a 5 km external buffer).

a) Grassland generalists

Max. dispersal distance (m)	Number of networks identified	Total area of networks (ha)	Mean area of networks (ha)	Area of largest network (ha)	Area of less favoured habitat network (ha)	Percentage less favoured habitat in network (ha)
500	90	1,407	15.6	349	406	28.8%
1000	67	1,863	27.8	412	861	46.2%
2000	49	2,793	57.0	954	1,792	64.1%

b) Lowland-acid grassland specialists

Max. dispersal distance (m)	Number of networks identified	Total area of networks (ha)	Mean area of networks (ha)	Area of largest network (ha)	Area of less favoured habitat network (ha)	Percentage less favoured habitat in network (ha)
500	57	1,252	22.0	349	625	49.9%
1000	46	1,607	34.9	412	980	61.0%
2000	34	2,331	68.5	954	1,703	73.1%

c) Lowland grassland specialists

Max. dispersal distance (m)	Number of networks identified	Total area of networks (ha)	Mean area of networks (ha)	Area of largest network (ha)	Area of less favoured habitat network (ha)	Percentage less favoured habitat in network (ha)
500	13	101	7.8	26	35	34.9%
1000	11	142	12.9	34	76	53.7%
2000	9	223	24.8	68	157	70.5%

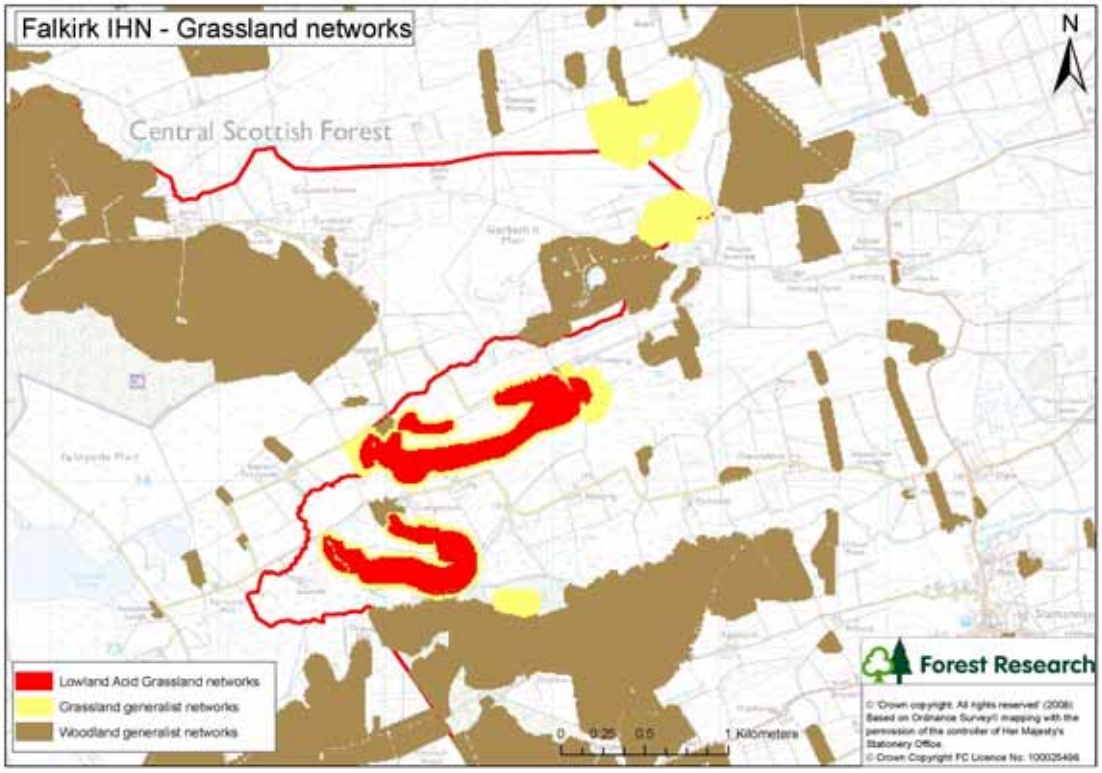


Figure 15 – Grassland networks near Slamannan, South Falkirk. Lowland acid grassland specialist networks (red) are nested within grassland generalist networks (yellow).

Modelling of semi-natural grassland networks can pinpoint fields with a high restoration potential where incentives could be targeted to help consolidate existing sites of high conservation value, for example SSSIs. Within these areas, the networks can be used to identify which fields are most likely to provide the greatest contribution to reducing fragmentation of the grassland habitat. An example of how to prioritise which immediately joining fields will provide the best contribution to the grassland habitat networks is shown in Figure 16. Although all the fields have the potential to contribute, it is not feasible or practical to do so. A large proportion of this land will be intensively managed arable fields, which have had high nutrient and pesticide inputs and so restoration or conversion to unimproved grassland would not be practical either ecologically or economically.

Coincidence mapping, where 4 or more records of grassland quality indicator plant species occur (following JNCC Common Standard Monitoring Guidelines for Grassland SSSIs (JNCC, 2004)), can be used to identify 'nodes' where there may be grassland ecological processes persisting. Where a node coincides with a field that adjoins the grassland network area, then irrespective of whether that field is under grass or arable management, the potential for restoration is highest as it is more likely that there are remnants of grassland processes together with functional connectivity to nearby existing grasslands.

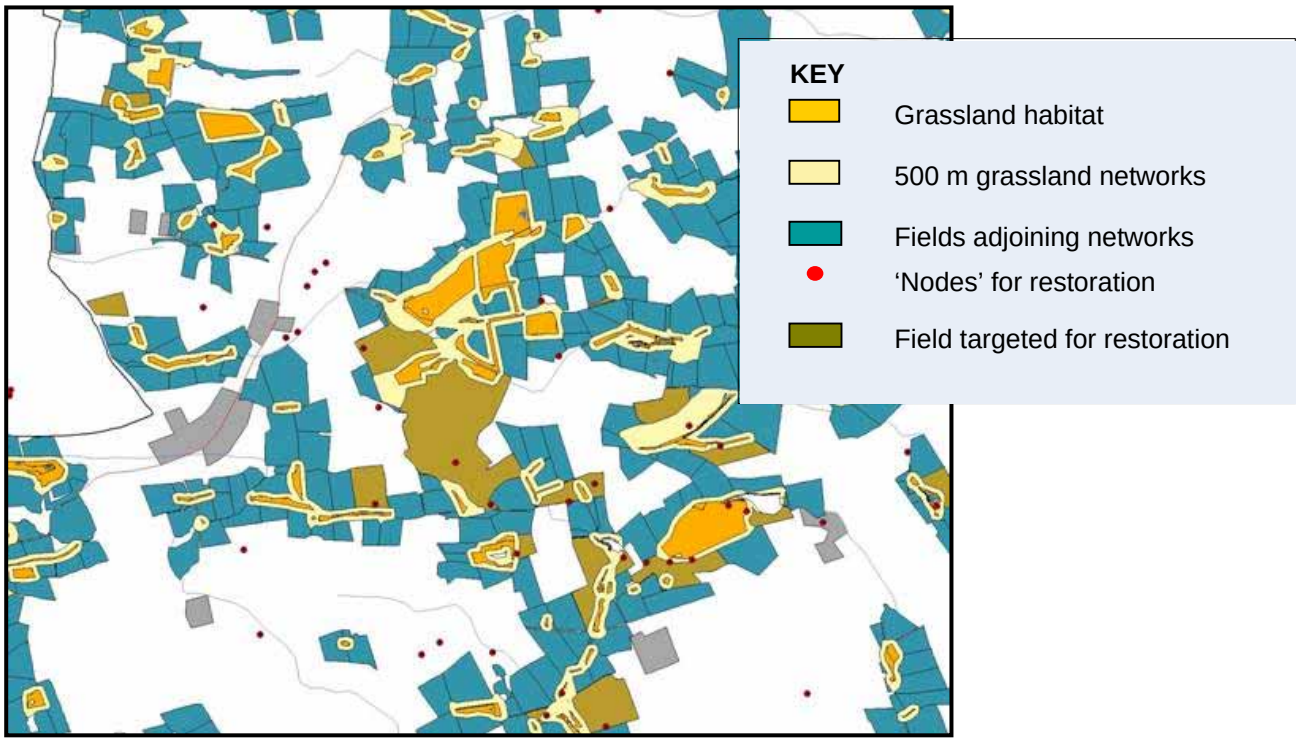


Figure 16 – Distribution of "nodes" (red dots) and priority fields (brown) for restoration in relation to grassland habitat (pale yellow) and networks (orange).

Areas for restoration should be targeted to reverse habitat fragmentation and recreate larger areas of grassland and transitions with other semi-natural habitats (Figure 17). Sites that have this potential for contributing to greater eco-integrity may be more suitable for restoration. A three stage approach to consolidating designated sites is proposed: a) protecting and enhancing the sites themselves; b) creating/restoring semi-natural grassland in fields that coincide with "nodes" (Figure 16); c) creating/restoring semi-natural grassland in fields that are part of, or adjoin, existing networks. SNH Natural Care Grants (which will be included as RDC tier 3 measures in the future) for

consolidating designated sites could be spatially targeted using this three-stage approach.

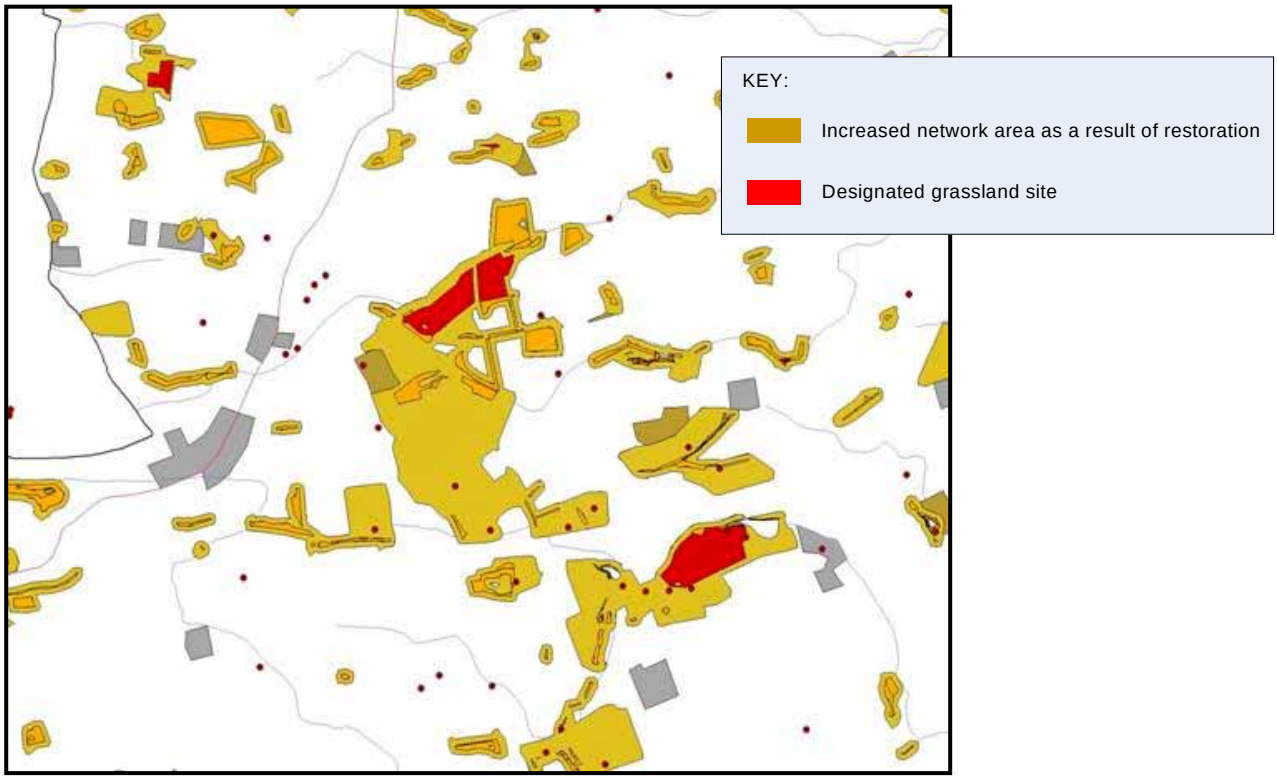


Figure 17 – Development of grassland networks through targeted restoration of fields. The red grassland sites have increased the overall extent of the grassland networks (brown).

4.4 Raised bog networks

The raised bog data for the Falkirk study area were derived through the digitisation of Phase2 paper maps. Areas of modified bog were not included as home habitat for the analysis, but have been included within the interpretation to allow the identification of opportunities to restore these degraded habitats (Figure 18). Modified bogs that are adjacent to the raised bog habitat networks should be prioritised for restoration.

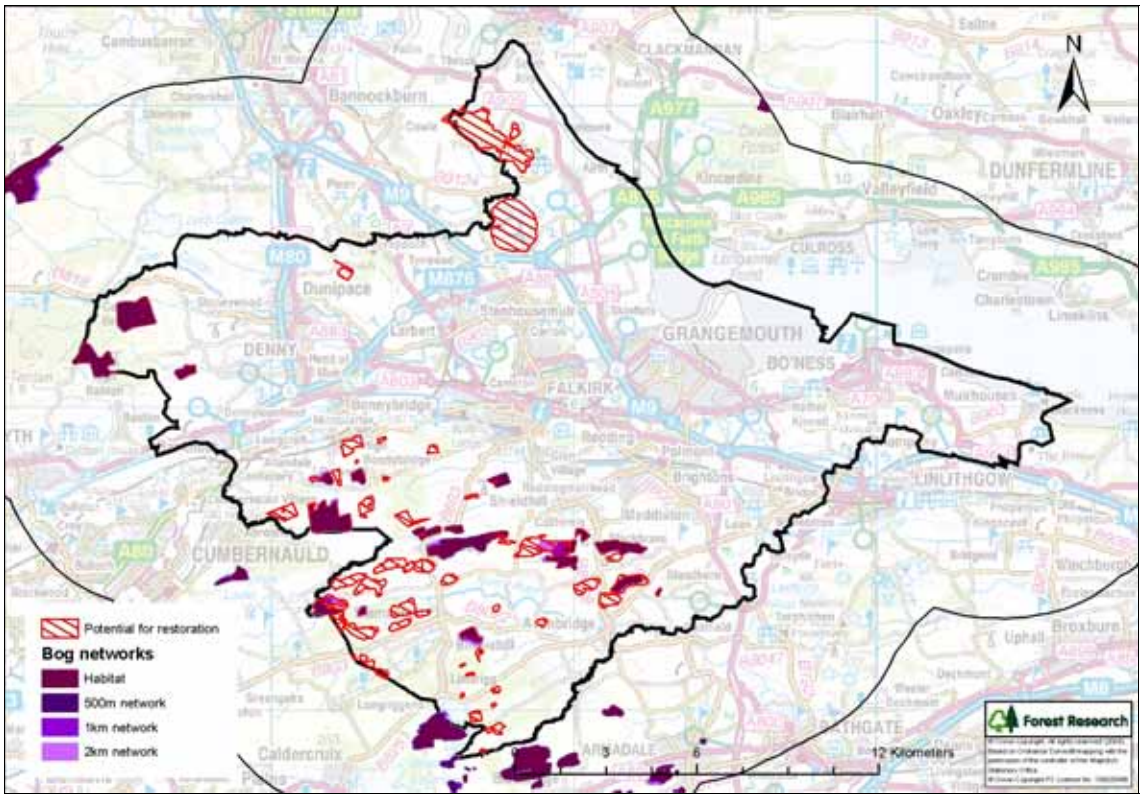


Figure 18 – Raised bog habitat networks at 500m, 1km and 2km (purple) within the Falkirk study area with areas for potential for restoration marked by the red hatching.

Table 8 – Landscape metrics for raised bog specialist generic focal species analyses in the study area (Falkirk Council region and a 5 km external buffer).

Max. dispersal distance (m)	Number of networks identified	Total area of networks (ha)	Mean area of networks (ha)	Area of largest network (ha)	Area of less favoured habitat network (ha)	Percentage less favoured habitat in network (ha)
500	56	1,122	20.0	131	199	17.7%
1000	49	1,297	26.5	142	374	28.8%
2000	44	1,631	37.1	166	708	43.4%

4.5 Integrated habitat networks

All the IHN outputs should be used with a GIS to identify where opportunities exist for reducing habitat fragmentation and enhancing biodiversity within Falkirk, and to ensure that improvements can be undertaken to complement a range of habitats. Figure 19 and Figure 20 show the Priority Enhancement Areas for wetland, grassland, and woodland habitat networks within the Falkirk study area, demonstrating where the networks overlap and strategies to reduce habitat fragmentation may need to be more carefully considered.

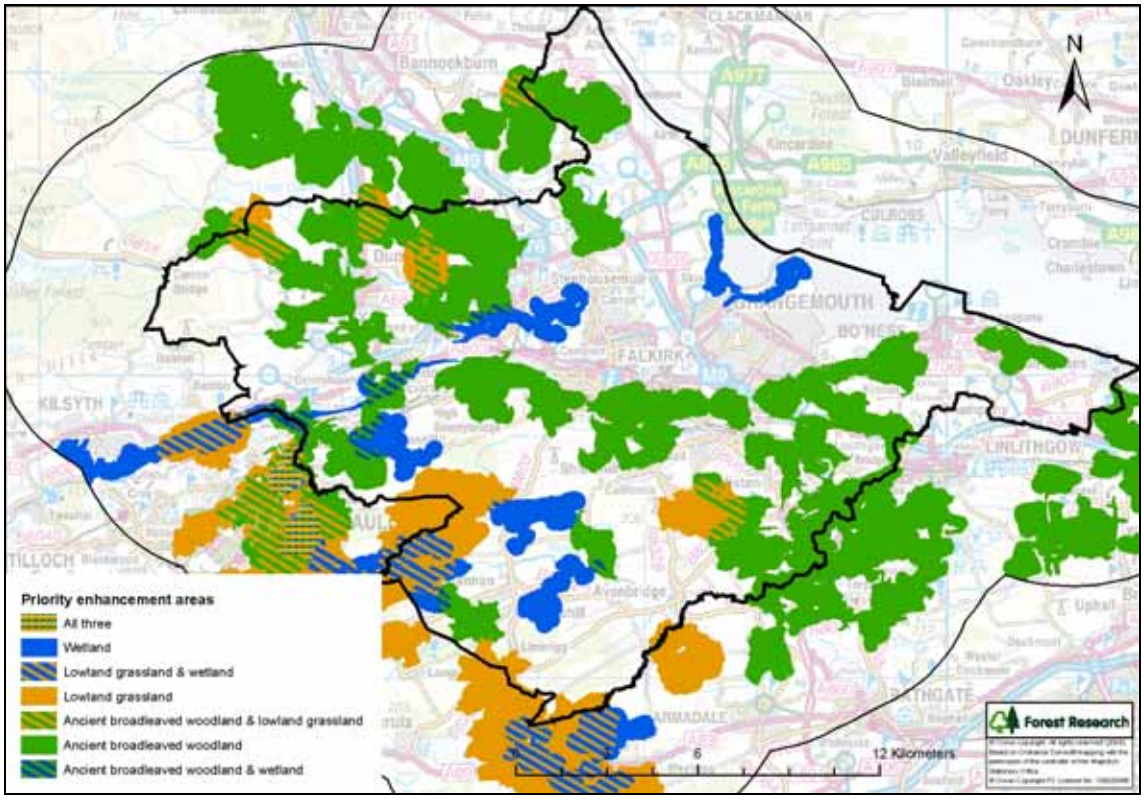


Figure 19 – Priority Enhancement Areas for wetland, grassland, and woodland habitat networks with the Falkirk study area.

The use of all the habitat networks together is only the first stage of an Integrated Habitat Network approach within the planning system; other information including development areas (Figure 21), flood-risk data (Figure 22) and designated sites all need to be considered to ensure an effective policy to address habitat fragmentation is attainable.

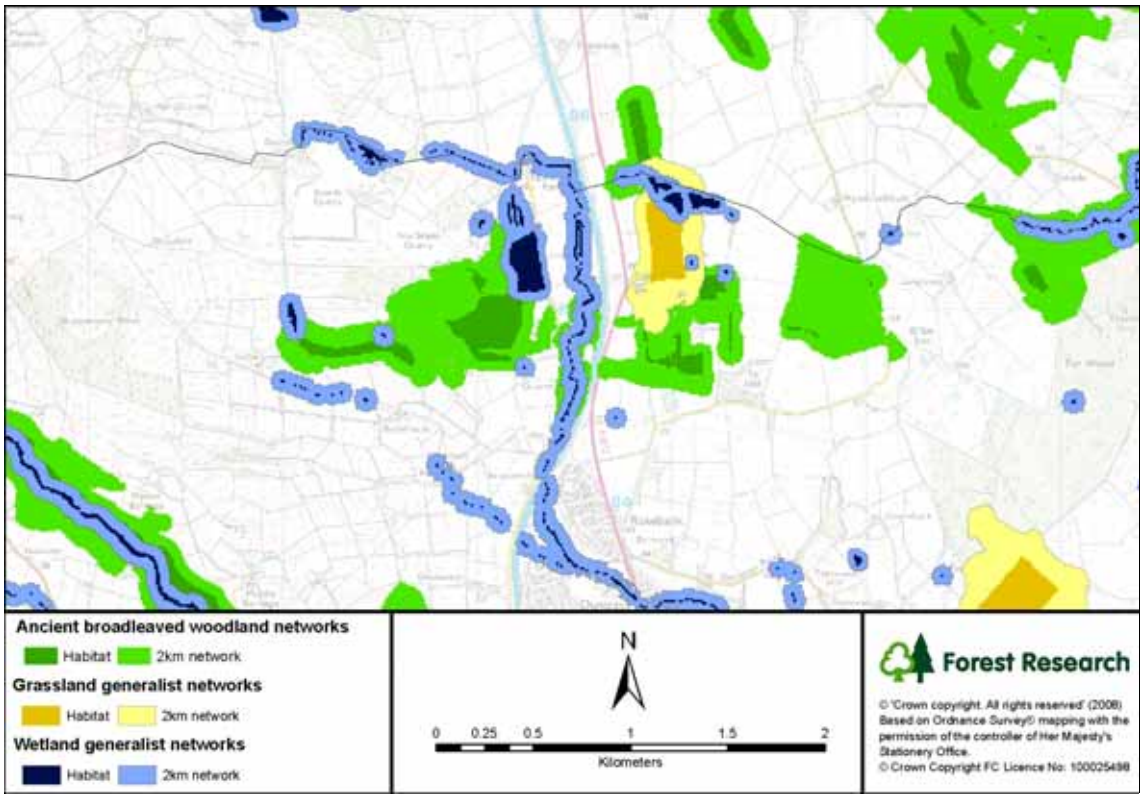


Figure 20 – Overlap of Woodland, grassland, and wetland habitat networks at a local scale, all of which must be considered as part of an Integrated Habitat Network.

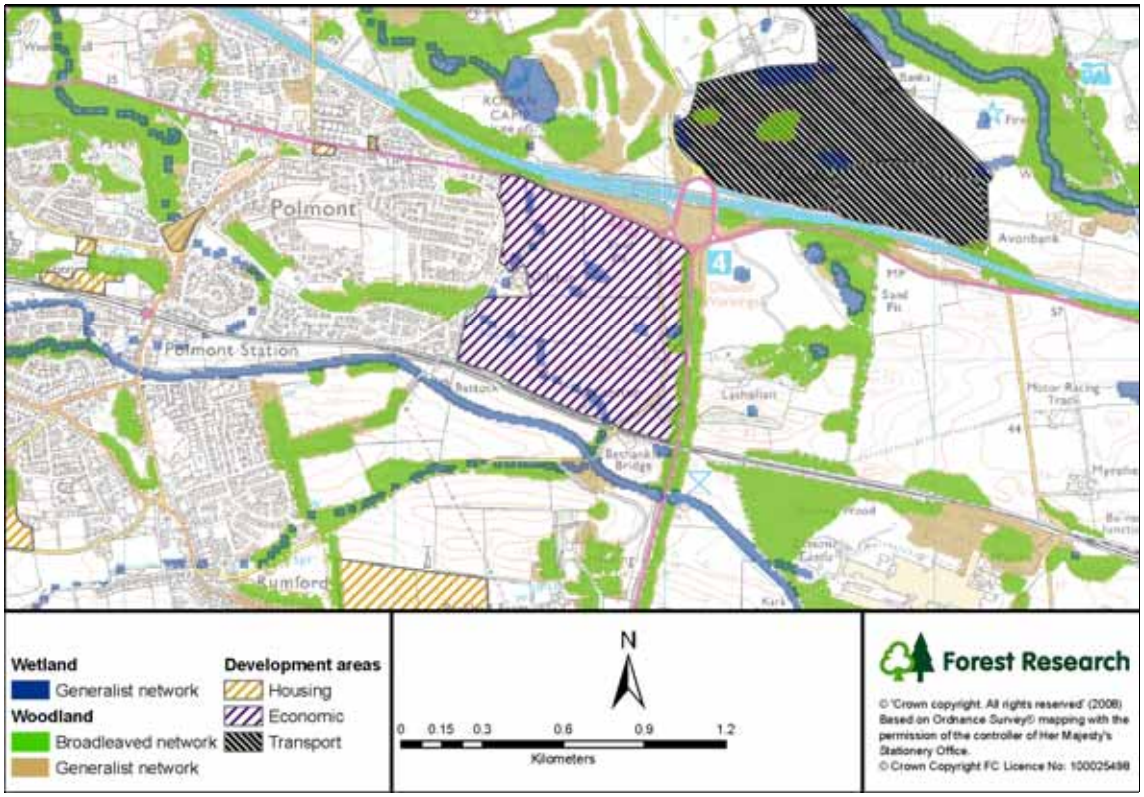


Figure 21 – Incorporating development areas with wetland and woodland habitat networks to identify opportunities to reduce habitat fragmentation within the Polmont area of Falkirk.

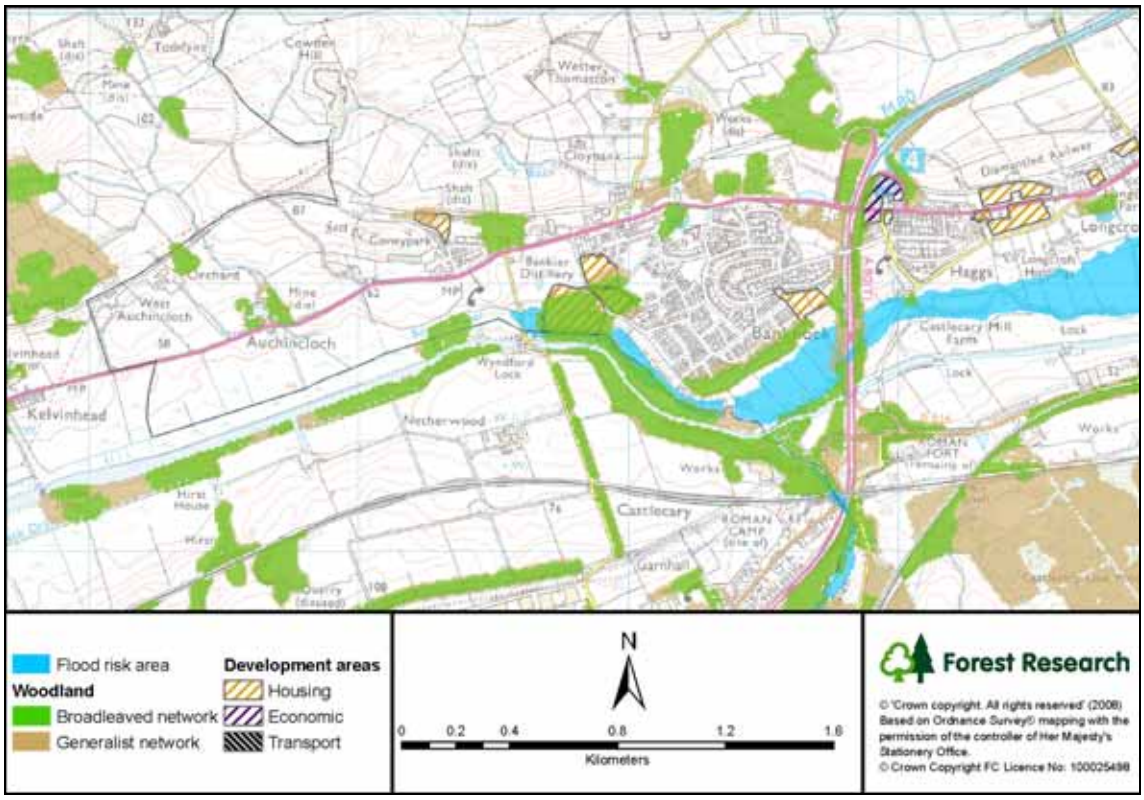


Figure 22 – Incorporation of flood-risk and development area information with woodland habitat networks to indicate opportunities to introduce soft-engineering methods to alleviate flood-risk whilst enhancing biodiversity.

4.6 Prioritisation of network applications

Although networks derived using the BEETLE landscape ecology tool can highlight where there are interactions between different networks (Figure 19 and Figure 20), the model does not indicate the relative importance of these in terms of conservation priorities.

A rule based multi-criteria analysis was developed to help with this prioritisation based on political priorities at different levels, *e.g.* local (LBAP) v regional (SBS) v national (UK BAP) and using the expert knowledge that exists at these different levels. The draft tables below form part of the interaction with stakeholders and the components and values shown are open for discussion. The values attributed to the categories in these tables were derived through an exercise during the presentation of the report findings. Additional policies to which the IHNs can contribute were identified by participants and are indicated in bold in Table 11, with the scores for these derived from a smaller sample. The multi-criteria analysis shown here is considered to be a first step in an iterative process than will help to inform prioritisation of IHN applications.

A number of these policies contribute towards Falkirk Council's Vision, Goals and Values, *e.g.* Key Theme: *Creating a Sustainable Local Environment and Improving Transport* and the Goal *Enhancing and sustaining an environment in which people want to live, work and visit.* The IHNs can be used towards: the aspiration of a greener Falkirk by *'Protecting the natural environment through adherence to the development plan, guided by the IHNs'* and to promote action on biodiversity working with the Falkirk Biodiversity Partnership; *Improving our neighbourhood*, including *natural heritage encompassing both built and natural environments* through the future priorities to

improve the quality of the built and natural environment and *contribute to action addressing climate change*.

Table 9 – Management actions to improve IHNs

Management actions	**Score**
1. Protect and manage high quality habitat *e.g.* ASNW, designated sites, priority habitat	20
2. Restore and improve sites with restoration potential *e.g.* PAWS, planted raised bogs, drained wetlands, keystone structures and nodes	15
3. Continual management of habitat restoration schemes	10
4. Improve the landscape structure by reducing land use intensity	5
5. Create/recreate new woodland and semi-natural habitat	3

Table 10 – Locational factor to which management actions contribute

Locational factors	**Score**
Area within existing habitat network	15
Within a Priority Enhancement Area	14
Increases the area of a habitat network	12
Contains recorded species	10
Improves degraded habitat to increase the contribution to landscape diversity and character	12

Table 11 – Policies to which management actions contribute

Policy drivers	**Score**
Habitats Directive	13
Biodiversity conservation strategies	12
UK BAP	13
LBAP	12
Article 10 – develop ecological network for Natura 2000 sites	12
Scottish Forestry Strategy	13
WIAT	11
Rural Development Contracts (RDCs) / RPACS	11
National Planning Framework 2	11
Nature Conservation Act	12
Planning and open space	12
NPPG14	12

Table 12 (continued) – Policies to which management actions contribute

Policy drivers	Score
Climate change	14
Structure Plan	**13**
Local Plan	**13**
Community Plan	**13**
Core Paths Networks	**10**
Greenspace Strategy	**10**
SRDP	**16**
Water Framework Directive	**14**
Flooding Bill	**18**

4.7 Integrating the Falkirk IHN with other regional Habitat Networks

Falkirk shares its boundaries with neighbouring habitat networks produced in the Glasgow & Clyde Valley (GCV) and Edinburgh & the Lothians, providing crucial links to create a truly integrated approach to enhancing biodiversity in central Scotland. The major opportunities for integrating the regional IHNs discussed through the use of Priority Enhancement Areas in Section 1 are further developed here. The woodland networks of West Lothian have great potential for linking to the East Side of Falkirk (Figure 23), particularly through the HELIX project which is planned to extend from Carronshore to Polmont. The planning of the HELIX project can be accounted for within the Falkirk IHN to ensure that the creation of habitat provides the greatest benefit for biodiversity by demonstrating opportunities to link to the wider IHN. The Priority Enhancement Area near Cumbernauld (Figure 24) contains a number of key woodland networks with a high biodiversity potential, which also provide recreational opportunities for populations from Falkirk and Lanarkshire Unitary Authorities. These are priority areas for protection and expansion, where possible.

Figure 23 –*Overlap of Falkirk IHN woodland networks (light green) with the Edinburgh and Lothians woodland generalist networks (dark green).*

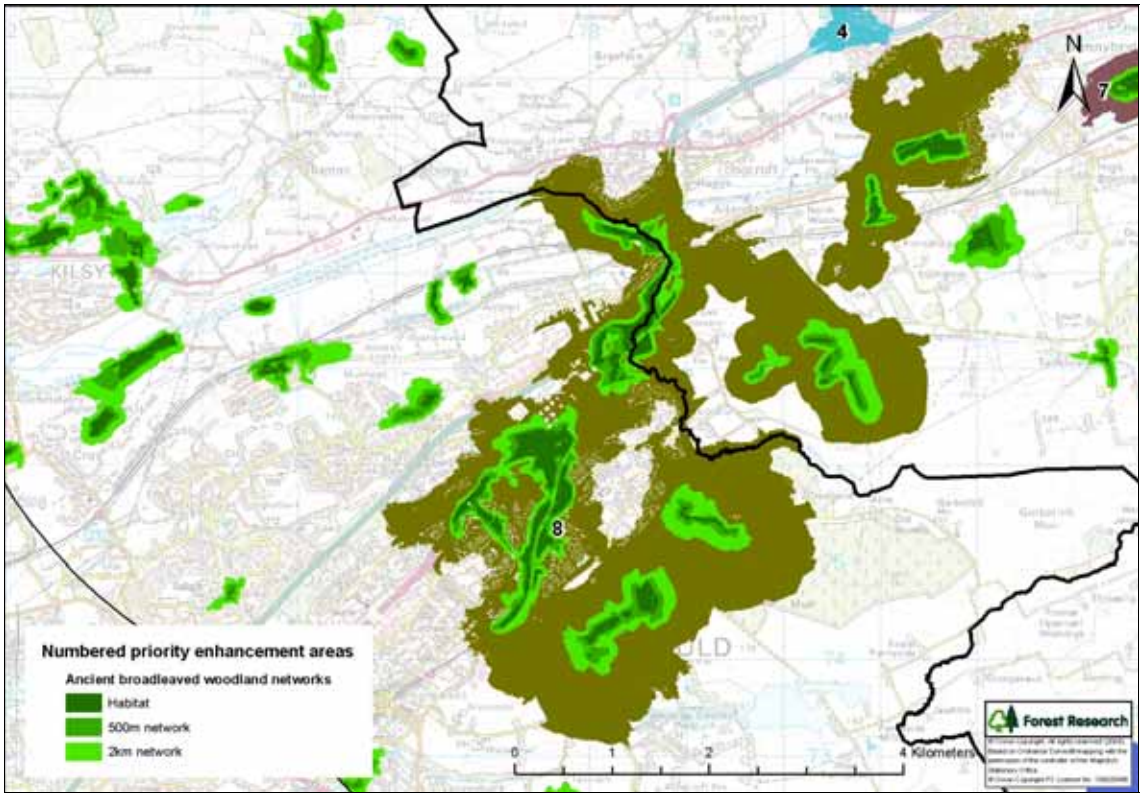


Figure 24 –Overlap of Falkirk IHN and GCV IHN woodland networks, indicating the importance of cross-authority co-operation to address woodland fragmentation and woodland management.

4.8 Linking the integrated habitat network approach into the planning process

An integrated habitat network approach to deliver a range of benefits to meet environmental, economic and social targets is strongly supported within planning policies. The networks can inform the wider land-use planning process, contributing information and ideas to discussions during the detailed planning phase of development zones outlined in both the regional structure plan and local plans. IHN plans can also contribute information relating to the location, specification and types of habitat to complement and mitigate development impact, and protect and enhance biodiversity.

Planning Advice Note 65 – Planning and Open Space (Scottish Executive 2003) highlights the importance of woodlands in promoting biodiversity, and in the control of air and water pollution. Trees and woodlands also enable the movement of wildlife and people through networks in both urban and rural environments. Trees can also help to soften the impact of new developments, making green and civic spaces more appealing.

The National Planning Framework 2 (NPF2) discussion draft makes reference to the integration of the network approach with a number of initiatives within the Central Belt, including the Central Scotland Forest, the Glasgow and the Clyde Valley Green Network and the Falkirk HELIX "to achieve a step change in environmental quality". "A substantial increase in woodland cover will improve landscape quality, biodiversity and amenity and help to absorb CO2. Improvements can also be made to networks of other habitats, including wetlands, to counter fragmentation and allow for changing patterns of species migration." Reference is also made to provision for recreation, particularly through the development of footpath and cycleway networks to encourage more active, healthier lifestyles. This should be developed through a Central Belt Green Network to "complement improvements in rail, road and communications infrastructure, making the Edinburgh–Glasgow corridor a more attractive place to do business." Clearly this is a valuable opportunity to create a larger, more robust network links through the Falkirk IHN and HELIX project. The NPF2 draft also suggests that green networks and community woodland initiatives be used to guide rehabilitation of brownfield sites

Additionally, the IHN plan can identify opportunities for FWAG or SAC action for landowners as well as prioritising community projects. The IHN outputs could then be used to examine how priority open ground and woodland habitats interact with the built environment. The current suite of agri-environment measures in Scotland provides a framework for determining possible changes in agricultural practices and the scope for spatial targeting. Rural Development Contracts (RDCs) were introduced in 2005 and are a whole farm system of support, which makes payments for the delivery of environmental, social and economic benefits for public good. The RDC menu scheme is separate from past and existing agri-environment schemes, namely the Rural Stewardship Scheme (RSS), the Countryside Stewardship Scheme (CSS), the Environmentally Sensitive Areas (ESA) and Habitats Schemes. In 2007 all these schemes were superseded by the Tier 3 scheme which will deliver tailored environmental benefits.

In addition, incentives are available for capital works such as pond construction, which will benefit invertebrates, and amphibians such as Great Crested Newt. Uptake of Tier 2 and RSS measures are included within the IACS database and are therefore available for spatial modelling. Stakeholders were interested specifically in how measures could be spatially targeted to consolidate existing designated sites and habitat networks

Core development areas and flood risk areas, obtained for Falkirk, were used to indicate opportunities for linking IHNs into local plans which have identified areas of land for housing and business as an integral part of the regional planning strategy.

Westquarter (Figure 25)
The area has important riparian habitat network, which should be protected by buffered expansion. The large-scale development areas which can be used to consolidate and expand networks by creation of additional habitat as part of a planning proposal.

Avonbridge (Figure 26)
Developments that are smaller in scale, although proportionally large in relation to the existing built environment, may provide opportunities to increase the provision of woodlands for people whilst supporting small woodland networks

Denny (Figure 27)
Many of the woodland networks around Denny are focused around riparian routes and flood-risk areas, and are obviously an important component of flood alleviation. These should be targeted for protection and expansion, so maximise the positive benefits broadleaved trees and associated wetland vegetation provide for the reduction of low flows. Development proposals should account for the increased risk in surface water flow and reduction in biodiversity if habitat were to be removed.

Bonnybridge (Figure 28)
This is another area where the maintenance of broadleaved woodland and wetland alongside watercourses should be of high priority. Some development areas appear to be located within flood-risk areas and these require careful consideration.

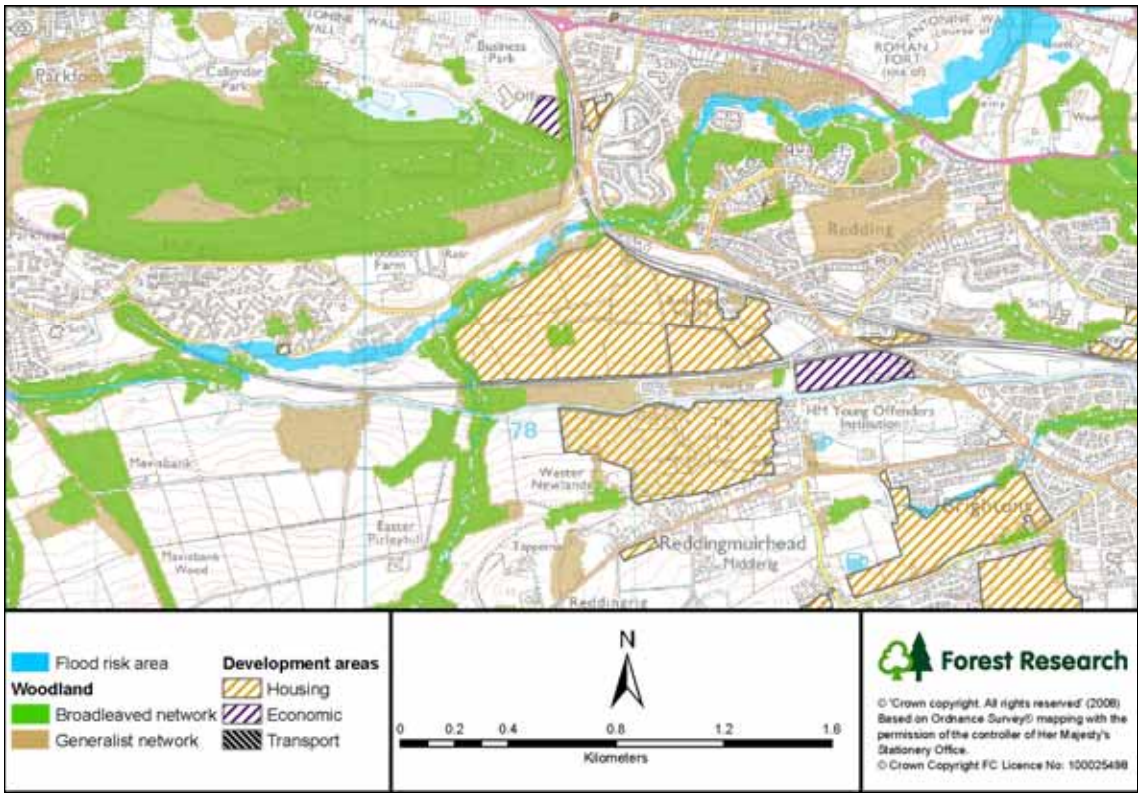


Figure 25 – Westquarter riparian network adjacent to a housing development area could be substantially extended into a larger broadleaved habitat network by judicious planting.

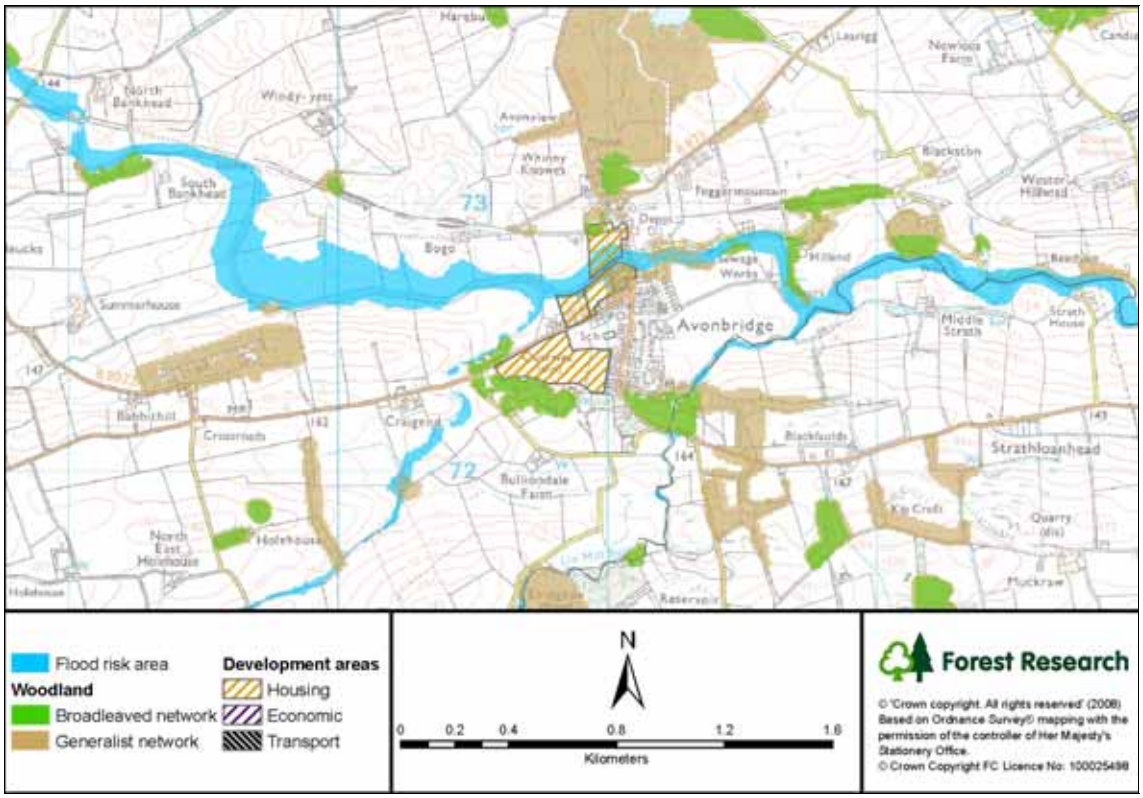


Figure 26 – Opportunity for expanding the broadleaved habitat networks, indicated in green, alongside housing development (hatched area) at Avonbridge.

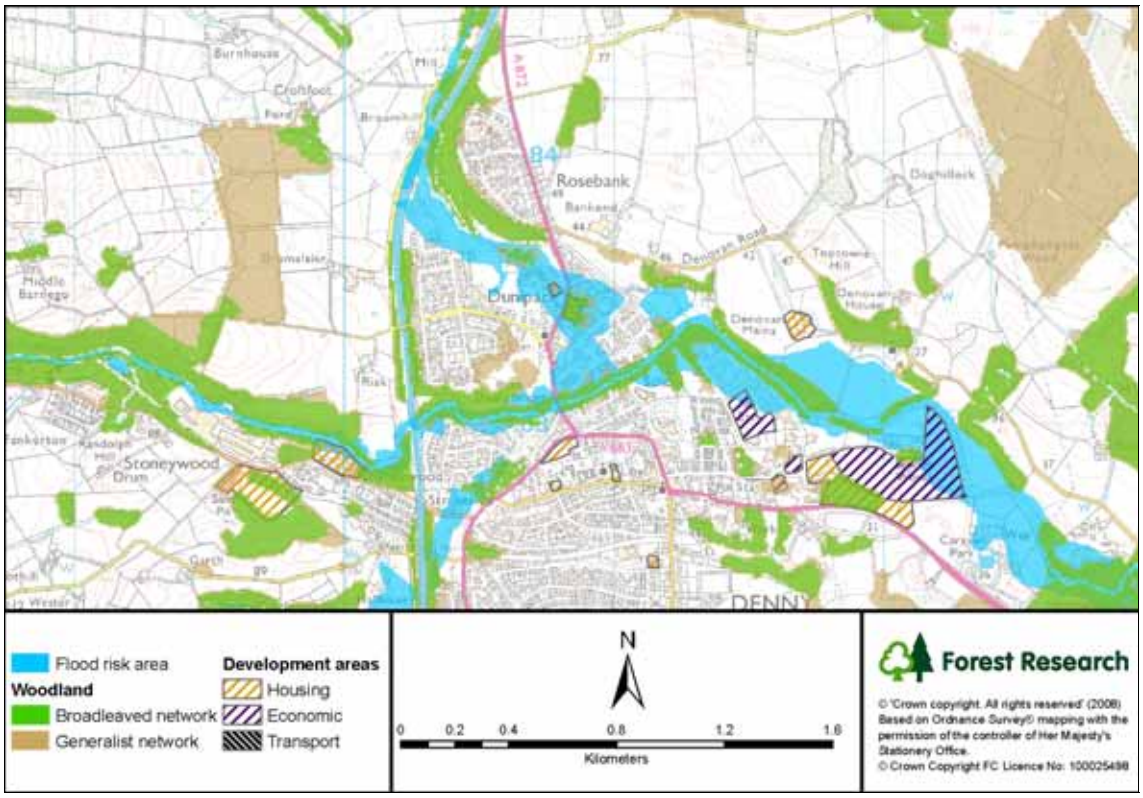


Figure 27 – Woodland networks (green and brown) focused along the riparian areas at Denny. Many of these are associated with the blue flood risk areas.

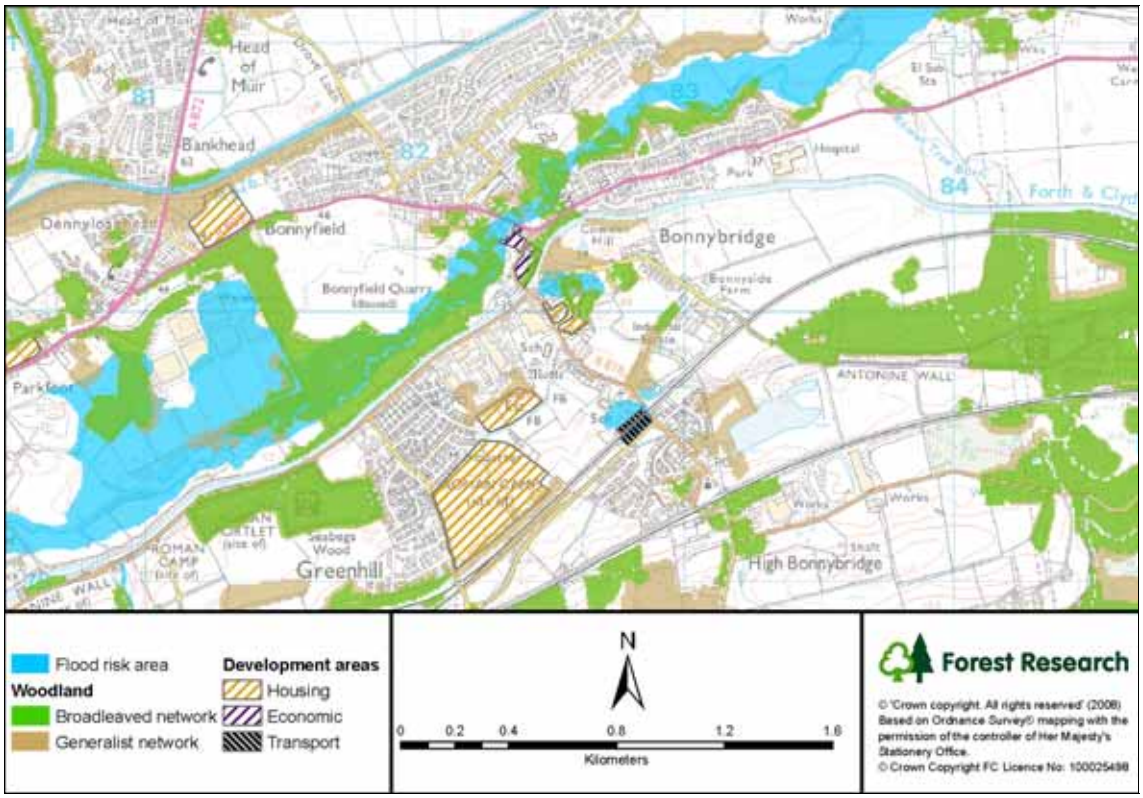


Figure 28 – Woodland networks (green and brown) associated with flood-risk areas at Bonnybridge, with large broadleaved networks within 1km of the town.

5. Visualisation of development sites

The visualisation of sites where new development is proposed was undertaken using 2D-image rendering visualisation software. The objective of this work was to demonstrate the application of computer visualisation software techniques to aid interpretation of proposals for an integrated habitat network for the Falkirk area. Visualisation techniques were demonstrated by application to locations / scenarios in which the creation of new habitat, or habitat restoration, was suggested (Figure 29).

Reconnaissance visits were undertaken to locations throughout the Falkirk Council area during January 2008 to compile digital photographs, which provided points of reference and comparison for visualisation work. Areas visited included a number of tracts of open land identified by Falkirk Council as being possible future foci of residential development where habitat network creation and augmentation would be potentially appropriate. Also included were many areas of remnant semi-natural habitat within the Falkirk area, including woodlands and floodplain wetlands, together with areas of former industrial land uses where some measure of habitat restoration has already begun.

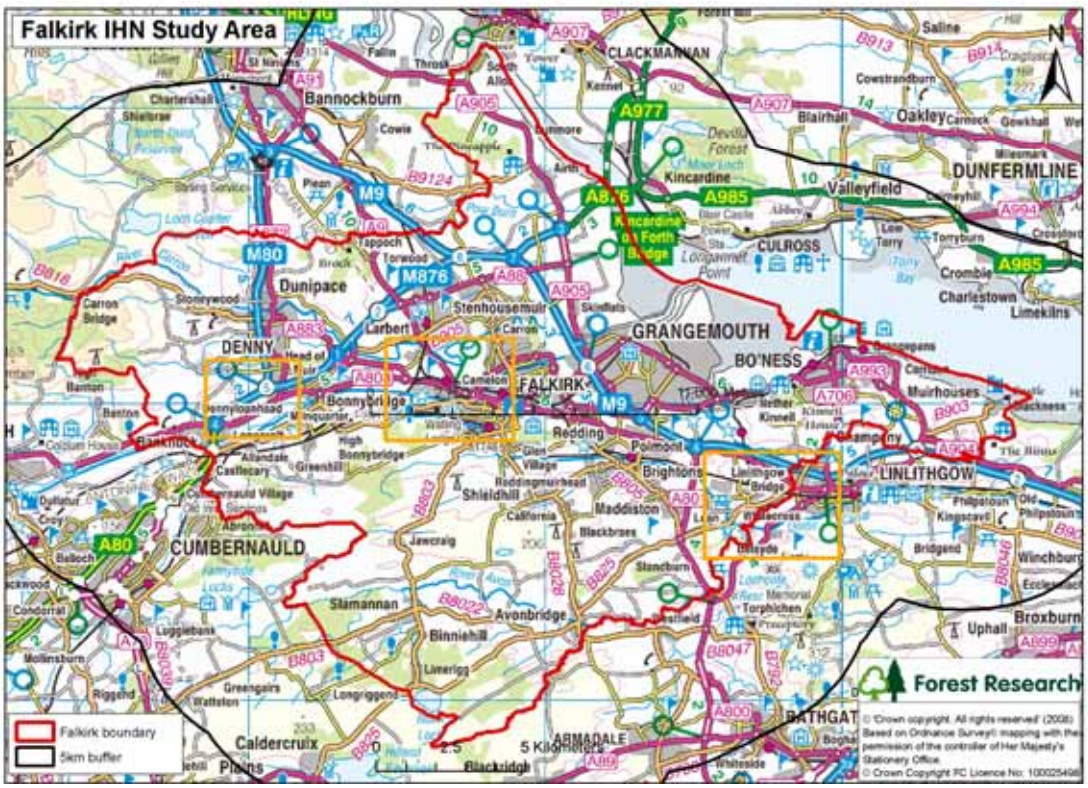


Figure 29 – Areas for visualisation indicated by the orange boxes (Banknock, Tamfourhill, and Whitecross).

The first two visualisations focus on Whitecross (Figure 30) and Tamfourhill (Figure 31 and Figure 32), indicating possibilities for expansion of woodlands, guided by the permeability indicated by the habitat networks.

The Banknock visualisation (Figure 33 and Figure 34) incorporated development plans for the region to compare existing and potential future habitat networks. These outputs can be used alongside the GIS shapefiles to guide a development and ensure that it is undertaken to enhance, rather than compromise the existing habitat networks.

5.1 Whitecross

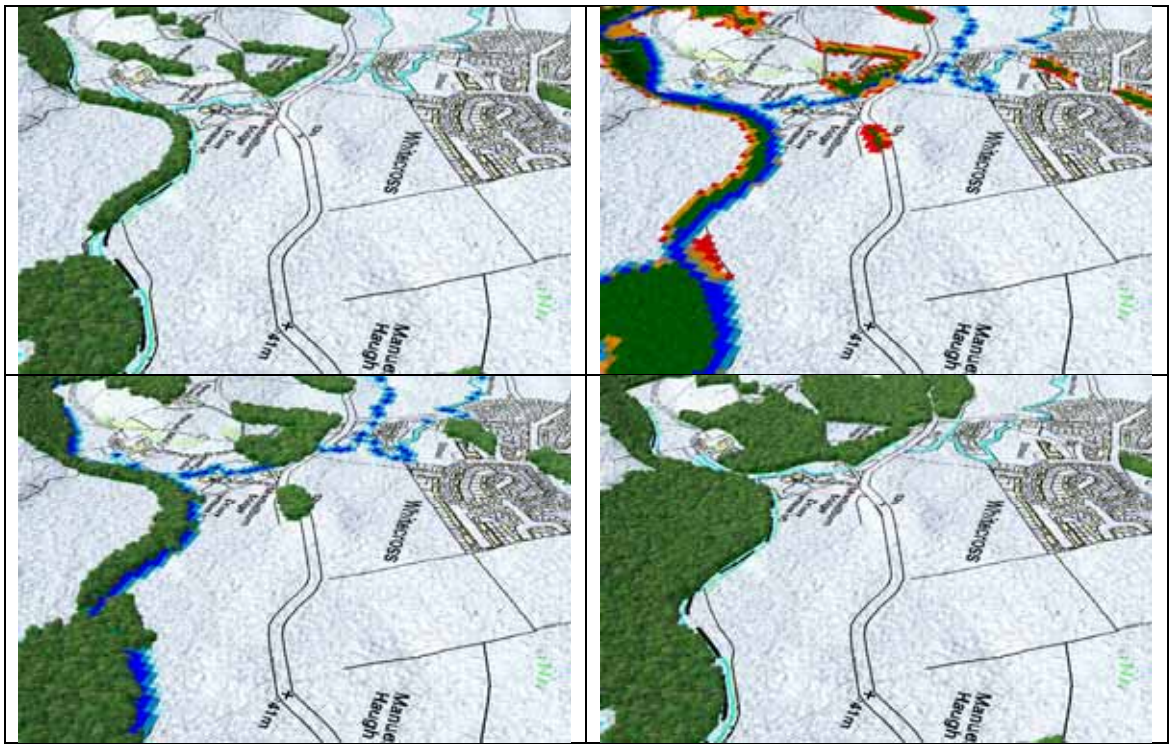


Figure 30 – Perspective visualisation series for the south of Whitecross village, indicating existing networks and potential expansion zones for woodland within the habitat network dispersal zones, with the fourth image showing how extensive afforestation would appear.

5.2 Tamfourhill

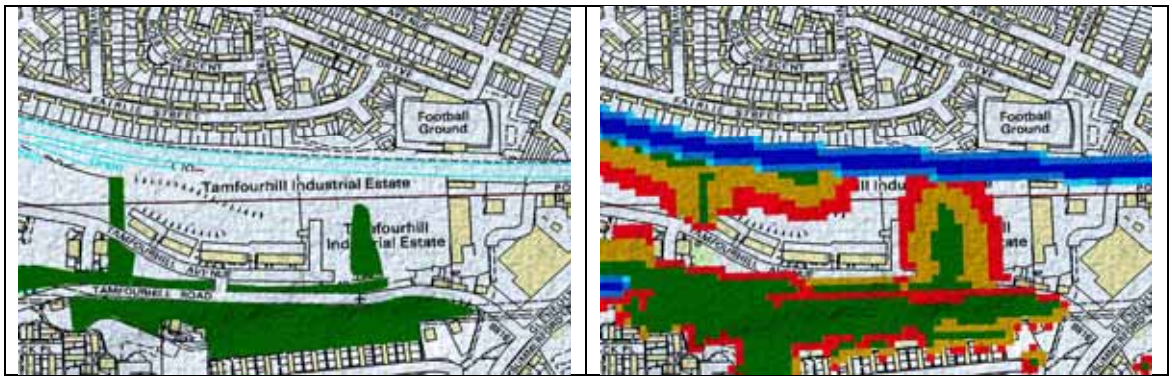


Figure 31 – Planimetric view of Tamfourhill Industrial Estate, indicating (left image) existing woodland and wetland areas. The image on the right indicates woodland habitat networks (green areas surrounded by orange and red networks) and wetland networks (blue).

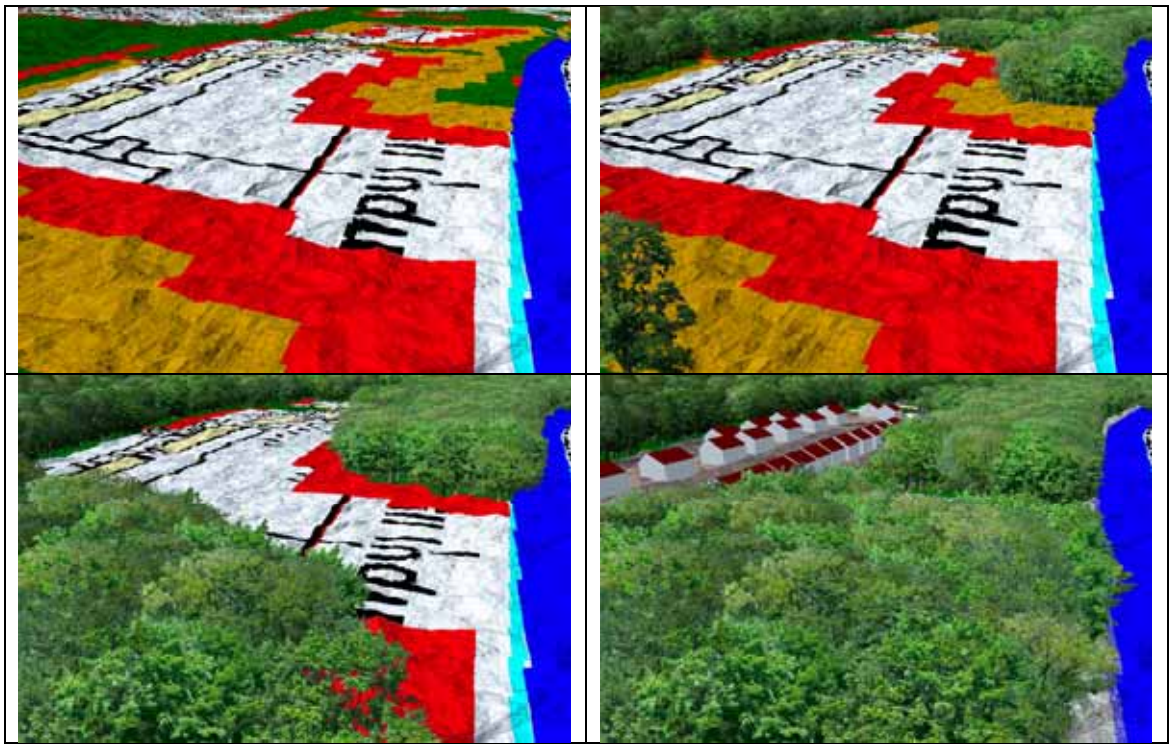


Figure 32 – Perspective visualisation series of Tamfourhill Industrial Estate, indicating existing networks and potential expansion zones for woodland within the habitat network dispersal zones, with the fourth image showing the incorporation of housing development.

5.3 Banknock

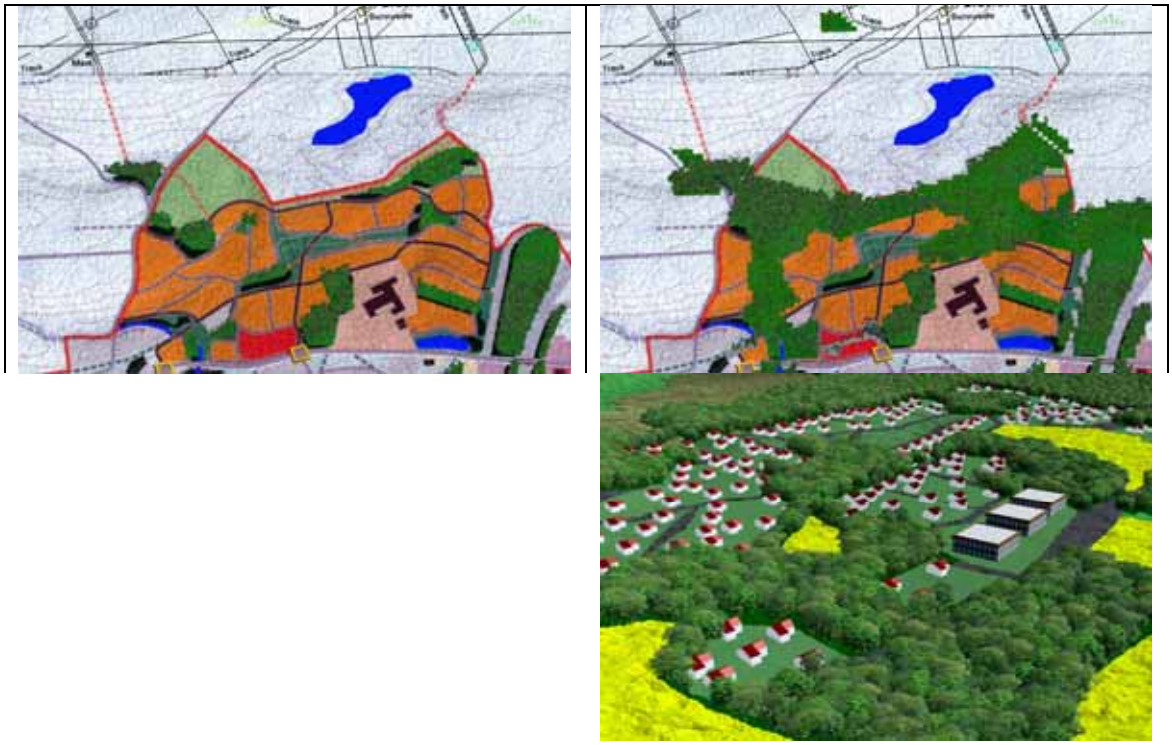


Figure 33 – Broadleaved woodland analysis at Banknock showing, from clockwise, existing woodland habitat, potential woodland habitat networks, perspective of potential woodland habitat with buildings.

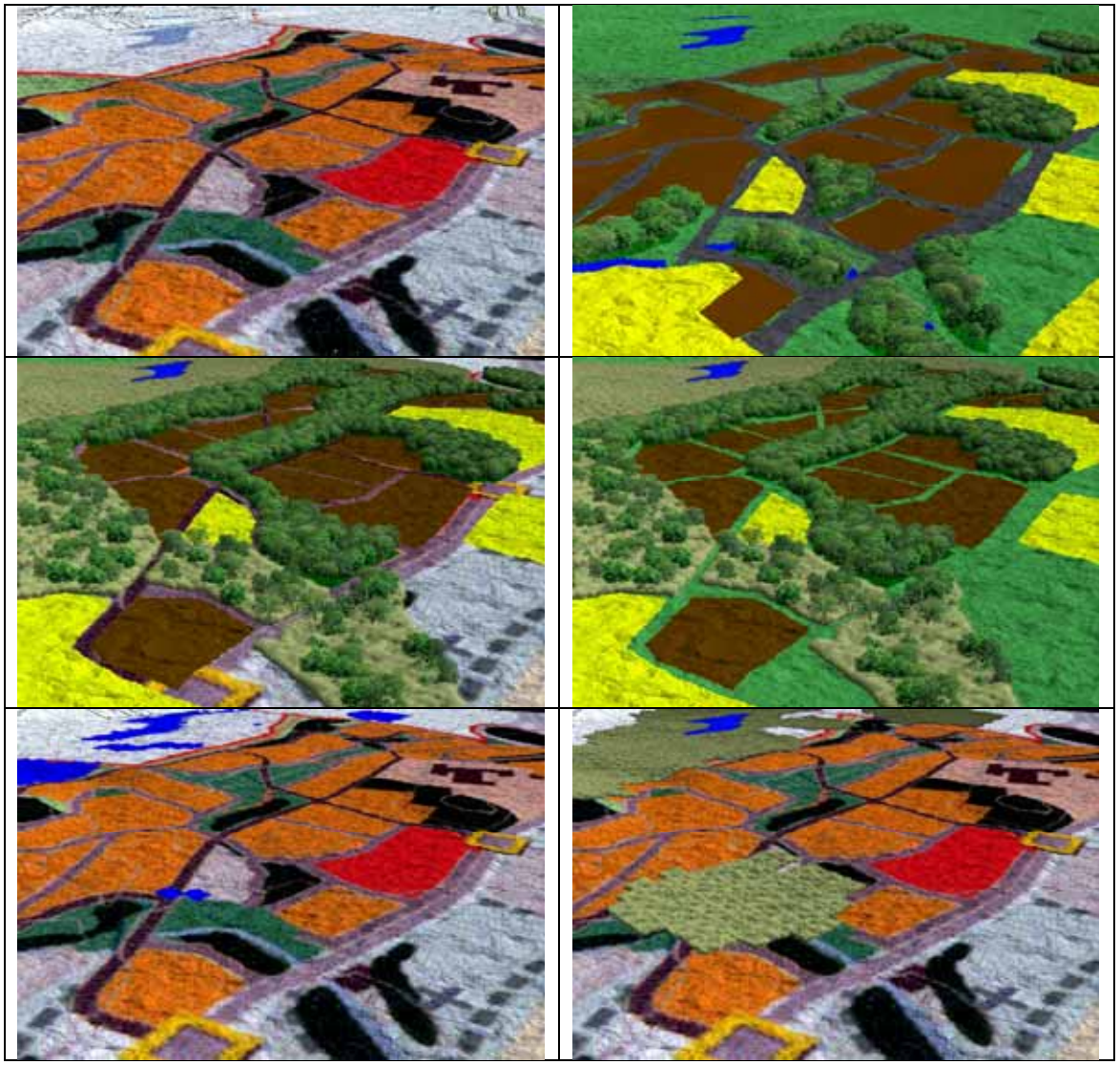


Figure 34 – Wetland analysis sequence showing additional wetland habitat creation opportunities, including wet woodland, at Banknock.

Landscape effects

Although the human activity has dramatically changed the natural habitats and landscapes of Falkirk, the pattern of land-use today continues to reflect the important natural influences of geology, climate, landform, drainage and soils.

Clearly, the impact on landscape character and the visual landscape from the development and expansion of, particularly, woodland habitat networks throughout the study area will be significant. The expanded habitat network, as projected by the BEETLE model and reviewed in the computer generated visualisations from the selected viewpoints, will potentially impose a new and dominant spatial element on the field pattern. The new habitat will have the effect of reorganising the spatial experience of the landscape, and disrupt existing views of the area.

The implication is that from these representative selected viewpoints, views from settlements, individual dwellings, travel routes and vantage points could potentially be affected by the habitat expansion proposals. If undertaken sympathetically, this can

enhance visual amenity and enjoyment. Alternatively, if views of the landscape were obscured, filtered or reduced in extent, the inevitable consequence may be a loss of visual amenity. For people – be they residents, visitors or travellers – accustomed to the relatively open pastoral landscapes, there would be an appreciable reduction in their experience and enjoyment of the landscape. It is recommended, therefore, that planning of habitat change be undertaken in conjunction with a landscape assessment.

Ecological effects

Ecologically, those existing landscapes may be made up of a number of habitats, interdependent and creating a unity which is itself to be valued. To satisfy the requirements of one focal species would imply not only expansion of the appropriate habitat but also the spatial location of those features in the landscape and the overall relationship of one patch to another to influence the biodiversity value associated with the habitat for the selected species.

Clearly, the implications of considering the development and expansion of a woodland habitat network will have a potentially significant effect on the landscape. The above computer visualisations of the BEETLE model of that expanded habitat network illustrate both the potential extent and spatial implications of an expanded woodland cover. Also, an implicit consequence of such a significant shift in land-use balance between woodland and open ground is the potential implications for existing lowland habitat networks established throughout the farmland and other open ground areas.

Cultural effects

Falkirk itself became established as a centre of heavy industry during the Industrial Revolution, particularly the centre of a large iron and steel industry in the 18th and 19th Centuries. In the last 50 years or so the vast majority of Falkirk's heavy industrial base has disappeared, with the economy of the town becoming increasingly services orientated. The waterways, which were historically instrumental in the transport of goods, have recently been restored and will form a component of the HELIX project, which aims to “transform the landscape between Falkirk and Grangemouth into a thriving environmental community”.

Clearly, there will be potentially significant cultural implications of considering the development and expansion of an integrated habitat network throughout this study area. For example, an expansion of woodland habitat could potentially jeopardise the integrity of archaeological features where trees were established over them, but also potentially disrupt the appreciation of their relevance and context in the wider landscape.

6. General discussion

Integrated habitat networks can deliver wider environmental and social benefits by providing increased opportunities for recreational access to the countryside and urban greenspace. For example, developing linear features as part of ecological networks such as riparian zones, buffer strips along field margins will also in theory encourage access, especially if farmers also apply for RDC Tier 2 subsidies for improving access. Current legislation (Land Reform (Scotland) Act 2003 – www.scotlandlegislation.hmso.gov.uk) provides rights of access to farmland and this is likely to be focused in wildlife rich areas both by accident and design as economic crops are excluded from rights of access. It is important to consider the positive

benefits (*i.e.* greater access for viewing wildlife) as well as the negative ones (increased risk of disturbance to wildlife).

6.1 Taking forward the delivery of Integrated Habitat Networks in Falkirk

Implementation

This document forms the basis for determining the extent of the regional IHNs and provides a framework for identifying opportunities for improvement. The analysis and prioritisation of all areas for development is outside the scope of this project but clearly forms the next step for implementation. Refinement of the data used in the project is an additional area to be considered to meet data limitations (see below); this may be undertaken through a service level agreement. It is suggested that an approach examining networks for people and biodiversity would ensure that strategies to improve greenspace access for people are integrated into the biodiversity networks. The integration of the Falkirk HELIX project and links with other regional habitat networks should be a priority.

The statutory and policy framework for biodiversity conservation in Scotland (*e.g.* The UKBAP, the Nature Conservation Scotland Act 2004, and the Natural Environment and Rural Communities Act 2006), places a duty on landowners and public bodies to maintain and restore important semi-natural habitats where practicable, and to implement measures in the wider landscape to enhance biodiversity. Translation of these principles into on the ground action requires synergy between Local Authority Structure Plans, RDCs, the LBAP process, landowners and advisors.

The IHN approach has a role in helping to guide the spatial targeting of actions to restore and enhance biodiversity. The availability of the tool to landuse planners and advisors should help with the practical implementation of networks. Procedures are in place to get plans working on the ground. For example, FWAG and SAC are involved in whole farm conservation audits and the provision of advice to farmers as to what prescriptions and habitat management actions would potentially be best to implement on the farms. Integrating the IHNs with recreation and landscape requirements can also help identify constraints and opportunities and are essential elements within the planning process.

Multifunctional aspects of an Integrated Habitat Network approach

The wetland analysis can be used to indicate areas where expansion and creation of habitat suitable for a range of wetland species could benefit the functional connectivity of existing networks. There is a valuable opportunity for wetland creation close to urban areas to complement, and be a part of, Sustainable Urban Drainage systems. Local Plans can guide where these opportunities may be incorporated within development areas, by determining where they overlap, or are adjacent to, IHNs.

Recreation and access to greenspace

In addition to providing benefits for species dispersal and reducing habitat fragmentation, Integrated Habitat Networks encompass a range of greenspace and recreational opportunities. Greenspace comprises all urban open space ranging from public and private greenspaces to accessory open space along roads and railway lines. Access to greenspace is a vital part of land use planning, linking homes with local amenities and providing a sense of community. The promotion of greenspace can attract people into their local natural environment by improving community access, recreation opportunities and environmental and ecological quality close to, and within, communities (*e.g.* CABE Space, 2004). Reviews of greenspace usage support the

hypothesis that local access to safe natural greenspace and attractive scenery is associated with high levels of physical activity within communities (Bird, 2007), and can benefit mental health, leading to a significant improvement in self-esteem, depression and mood (Pretty *et al.*, 2007; Mind, 2007).

Interaction with greenspace allows people to identify with, and value, the greenspace in their neighbourhood, which can transform environmental quality in former run-down urban areas, with a corresponding increase in the economic value of the area and a stimulation of economic activity and investment (Anon 2005; Luther & Gruehn, 2001). Such evidence holds much weight with decision-makers, but it is often the less tangible values of greenspace which local people may most readily identify as important in their lives. These include benefits that improve people's quality of life such as community cohesion, empowerment and development (Land Use Consultants, 2004). Active participation in projects that aim to increase the quality or functionality of greenspace can enhance these benefits (see also DTLR, 2002).

Sustainable development as part of land use planning considers environmental, social, economic and cultural dimensions (Maruani and Amit-Cohen, 2007; Anon, 2007). In particular, the recognition of the value of greenspace within urban areas in Britain has led to the publication of planning documents, setting out guidelines identifying, protecting and encouraging its use, *e.g.* SPP11 – Physical Activity and Open Space (Scottish Executive, 2006); Enhancing Urban Greenspace (NAO, 2006). There is general acceptance that greenspace has a role in both naturalistic (*e.g.* biodiversity friendly) and formal landscape planning in the UK (Özgüner et al., 2007). Planning Advice Note 65 (PAN 65) – Planning and Open Space (Scottish Executive, 2003) highlights the importance of greenspace in promoting social interaction, sustainable planning, and improving the environment. For example, woodlands can promote biodiversity, and aid in the control of air and water pollution. Trees, woodlands and other semi-natural environments can also enable the movement of wildlife and people through networks in both urban and rural environments. Greenspace can also help to soften the impact of new developments, making green and civic spaces more appealing.

<u>Data limitations</u>

Incorporating the OS MasterMap data into landcover allows high spatial definition of landcover boundaries to be analysed. Although this high level of detail increases GIS processing time, it does allow for a much greater level of detail to be incorporated within the urban environment. For example, it allows for permeability of gardens of differing sizes to be assessed. The biodiversity contribution of gardens is beginning to be appreciated and quantified with larger gardens found to be more likely to have a greater range of landcover types, vegetable patches, and trees over 2 metres in height present, indicating a potential for higher biodiversity. However, it is recognised that small gardens can behave like parts of larger gardens, contributing to a larger interconnected network of greenspace. There is also evidence of a general trend of increasing garden size in relation to house type from terrace to semi-detached to detached. The antiquity of gardens is also likely to be a factor, with older gardens likely to have been managed to include a range of landcover types. This was assessed in GIS looking at the relationship between area of house to garden using OS MasterMap data and age of development (making the assumption that larger gardens in general are older, contain a wider range of structure type and are more permeable.

OS MasterMap provides accurate spatial information and provides a uniform basis for integrating the IHN outputs into existing planning systems, but it lacks detailed habitat information. Ideally, Phase 1 habitat information should be the minimum requirement for focal species modelling work as it informs the location and extent of semi-natural

habitat. Without Phase 1 information, modelling can still be carried out using detailed woodland datasets, but it will lack the more complex open habitat details. Good quality aerial photography is now available for Scotland and efforts should be made to translate this into an updated land cover map.

7. Conclusions and recommendations

7.1 Use of the IHNs

- Integrated Habitat Networks (IHNs) were defined, for species using woodland, wetland, or grassland habitat, as landscape structures through which species can disperse freely between numerous habitat patches. These networks can be used to prioritise conservation effort
- The Integrated Habitat Networks should be used within a GIS as part of the decision-making process; they do not provide answers on their own
- The strength of the IHN approach lies in taking account of local conservation priorities and making best use of local expertise. Engaging with local stakeholder groups has been a vital part of this process and enables the networks to relate to local on-going projects
- Priority Enhancement Areas can be used to identify opportunities where effort can be undertaken to strengthen existing habitat networks

7.2 Delivery mechanisms

- LBAPs, Single Outcome Agreements, and SNH Natural Futures provide appropriate scales and mechanisms for determining network priorities and for informing the regional targeting of agri-environment incentives
- Delivery of the network requires tech transfer to the biodiversity officers and planners
- The implementation of habitat networks requires the integration of local and national policy conservation priorities and planning mechanisms with network modelling and “on- the-ground” advice and execution
- The integration of the Falkirk HELIX project and links with other regional habitat networks should be a priority

7.3 Habitat creation

Areas of new habitat should be as large as possible and of high quality and structural complexity. It is recognised that many opportunities will be constrained by the size of area available, but should aim towards:

- Within all of the urban fringe, and particularly within the Core Development Areas, planners and developers should be encouraged to take every opportunity to protect existing and add new open ground and woodland; to safeguard the biodiversity of the region, mitigate the impact of climate change, and improve community landscapes. This should be over and above the duty of planning authorities “to ensure planning permissions make adequate provision for the preservation or planting of trees”, as stated in section 159 of the Town and Country Planning (Scotland) Act 1997 (Scottish Executive 1999). An additional recommendation is that, where development involves the loss of trees, permission should normally be conditional on a replanting scheme with trees of appropriate species in appropriate numbers.
- Woodland planting on development sites should be substantial; 150m width will eventually provide 50 m of core woodland conditions. This is the minimum recommended size for new woodland. The planting of street and ornamental trees will have little impact on improving the woodland biodiversity of the region.

Under these circumstances, development would only increase the fragmentation of neighbouring woodland habitat.

- Grassland habitat networks may be enhanced by the creation of small areas of high quality species-rich grassland as these can act as stepping stones for grassland species.
- New developments should endeavour to ensure Space for People targets, suggesting accessibility to woodlands of 2 ha or more within 500 m, are not compromised.

7.4 Visualisation

- Computer generated visualisations of network development provide a useful tool for evaluating the likely impacts on the visual aspects of landscape character. These outputs can help with the consideration of landscape constraints and subsequent refinement of the IHN outputs
- The manipulation and interpretation of oblique aerial photographs could be of value as a tool for communicating the visual impact of network development at a larger scale and to a wider group of stakeholders

7.5 Data

- The availability of good land cover data is also essential for the modelling. Phase 1 survey information on semi-natural habitats is the main data requirement. It is recommended that Phase 1 be reviewed and supplied in digital format for the whole of the region. Once data has been improved, the changes could be incorporated into the landcover data set and the network analyses re-run
- Habitat and land cover surveys should be undertaken to update and improve landcover data, particularly for Phase 1 surveys

7.6 Further development

- The modelling of “people networks” would add to the planning of a green network approach, enabling targeted improvement of greenspace to achieve multiple objectives
- Methods for monitoring the success of habitat network implementation and development include: assessing habitat condition and ecosystem development, tracking the distribution and dispersal of both focal and functional species, recording evidence of species use of new habitats and undertaking post-hoc genetic analysis to infer patterns of migration
- Ecosystem development should be monitored to provide feedback on the effectiveness of improvement strategies.
- The concept of applying a multi-criteria analysis to prioritise IHNs has been explored through consultation with an assembled group of biodiversity officers, agency staff, and planners. Further development is required through engaging a wider number and range of stakeholders (NGOs, landowning bodies (NFU / SRBPA), funding bodies, COSLA, to determine which of the factors are considered influential.
- Integration of the IHN to inform future reviews of the Falkirk Council: Development Plan; Biodiversity & Development Supplementary Planning Guidance, *e.g.* site specific surveys to reflect wider IHN implications including LBAP, Derelict Land, and Central Scotland Forest
- The timing of reviews of other plans would enable a review of the IHN / data update to be undertaken to contribute to these reviews

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Further reading

Forestry Commission Information Note 073 Evaluating biodiversity in fragmented landscapes: principles

Forestry Commission Information Note 085 Evaluating Biodiversity in Fragmented Landscapes: Applications of Landscape Ecology Tools

Forestry Commission Information Note 089 Evaluating Biodiversity in Fragmented Landscapes: Use of Focal Species.

Appendix I – Falkirk Integrated Habitat Network Stakeholder workshop

Darren Moseley & Mike Smith, Forest Research

8 November 2007, Dawson Community Centre, Falkirk

Introduction

Aim of workshop

The aim of the workshop was to identify the key conservation issues within the Falkirk case study area (Figure 1) and to tease out the most important species and habitats that could be used in the BEETLE model to develop an Integrated Habitat Network (IHN). A list of attendees is included at the end of the appendix.

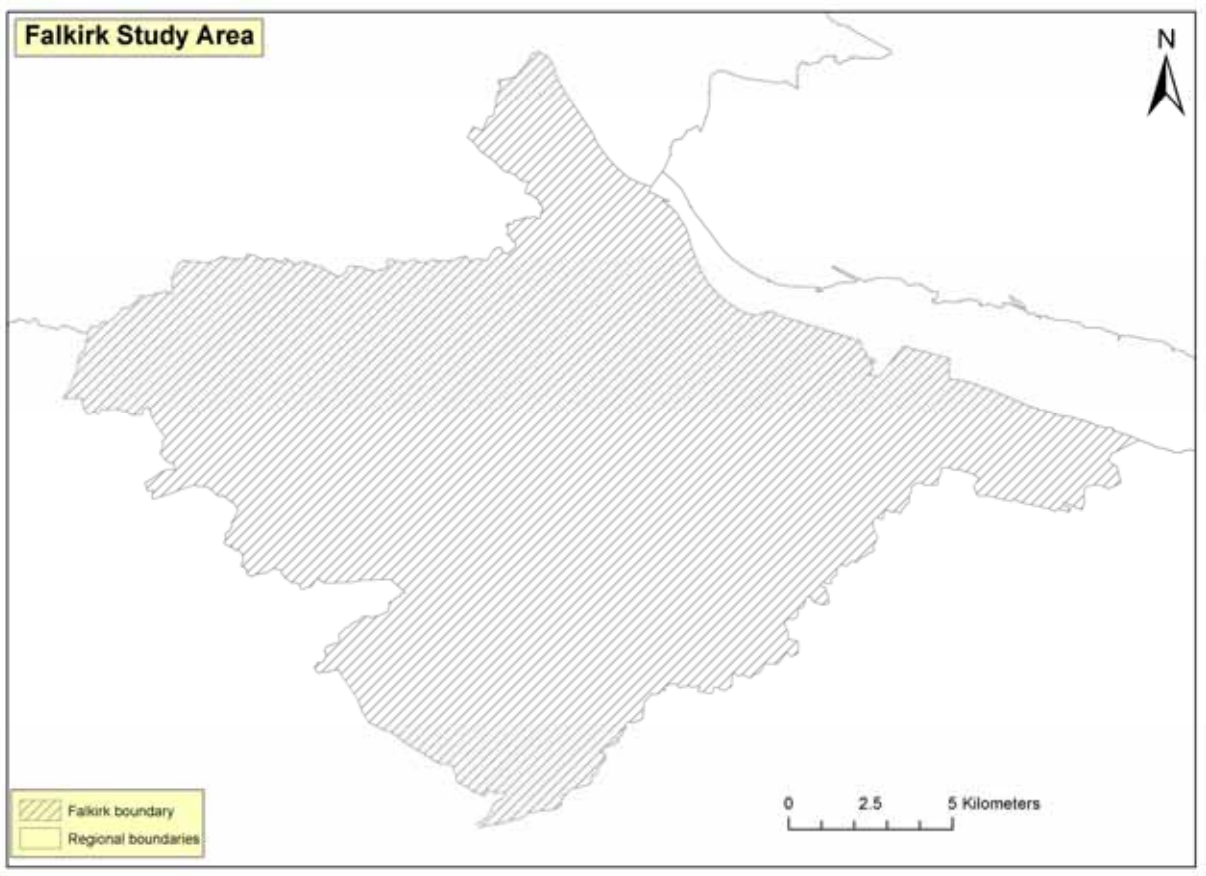

Figure 1. Study area for the Falkirk Integrated Habitat Network.

BEETLE modelling presentation

Darren Moseley and Mike Smith presented the principles of the BEETLE modelling approach, with some examples of how these can be applied to address conservation and biodiversity issues. One of the objectives was to show that species autecology is a very important component in determining the focal species used to construct a robust model to define IHNs using the BEETLE methodology.

This was followed by a more general description of the modelling process, which proved useful as it allowed those with little knowledge of the modelling process to become more familiar with the concept and its potential applications.

Other GIS tools / remote sensing applications were then looked at to see how to target areas for potential restoration within network areas. For example, the OS 1st edition map can be used to highlight areas of past habitat were restoration is likely to be more successful. Another methodology was the use of coincidence mapping of species based on information held on Recorder by the environmental record centre based on the work carried out on unimproved grasslands in Fife. This also showed how the IHN approach could be used to target Land Management Contracts and the consolidation of Designated sites

Workshop on developing an Integrated Habitat Network

Each participant had been asked to identify 3 issues of conservation concern prior to the workshop. These were discussed within the workshop group to see if there was a relationship between these issues and the development of an IHN.

The workshop was split into two groups, which were led by Darren Moseley and Mike Smith. Species and habitats that were thought to be of relevance to an IHN were then discussed and whether there was the expert knowledge (and who held this knowledge) on these for use within the BEETLE modelling approach.

Each Group had a set of A1 maps showing:

- The case study area
- Designated sites
- Wetland areas (open water, swamp, marshy grasslands, *etc.*)
- Unimproved and semi-unimproved grasslands
- Peatlands (dry/wet heaths and blanket bog)
- Woodlands

These maps of areas were used to identify issues and information that would be useful for the development of an IHN and also allowed this information to be located geographically. Contact details of relevant experts were also included on this map (IHN contacts database is in the process of being constructed). This information was then collated and is summarised below.

Highlighted Conservation issues of concern.

The first element of the workshop asked each of the participants to identify 3 areas of conservation concern within the case study area. Although these could be ordered by strategic level (national, local or habitat network) or by issue, the latter is probably more useful as the main part of the workshop was to examine these issues and relate them to the concept of IHNs.

Wetland management

This was the focus of a large part of the discussion, raising a wide range of topics that come together under the Floodplain Management banner:

- Loss/fragmentation/lack of lowland floodplain wetland features.
- Loss/fragmentation/lack of riparian/wet woodland
- Distribution of ponds
- Loss of habitat for breeding waders
- Potential for further wetland expansion
- Flood Control

- Importance of linkage to watercourses
- Mires and Fens
- Use of flood maps to identify opportunities for new wetland creation
- Importance of Firth of Forth, water channel with adjacent salt marshes and mud flats that provide important habitat for a number of bird species.

These topics are all inter-related through ecological succession in that ponds become wetlands which will eventually become wet woodlands. It is proposed that these successional relationships be investigated both spatially and temporally through using the BEETLE model. This may help with decision making that allows for management of ecologically functional floodplains.

Potential wetlands focal species are members of the Odonata family and the water vole. It may be more useful to use Newt species as there is good autecology for these species and the fact they use a range of wetland habitats at different stages of the year.

Flood Control

Flood prevention and mitigation is high on the public agenda. It is becoming increasingly clear that the problem can no longer be solved by building ever higher flood defences and instead the emphasis must be on restricting development in the floodplain and pursuing 'softer', more sustainable methods of flood control. One aspect that has been attracting increasing attention is the potential for land use, and woodland in particular, to mitigate damaging floods. Wetlands, woodlands and woodland management practices have long been associated with affecting both the quantity and timing of stream flows, and there is a widespread belief that wetlands and woodland can help to reduce and smooth flood peaks. There are four main ways that wetland habitats could assist flood control:

1. Delayed Floodplain Flows
2. Delayed Channel Flows
3. Delayed Soil Runoff
4. Increased Water Use

The development of habitat networks is seen as an important mechanism for reversing the effects of fragmentation on biodiversity while delivering a range of other environmental benefits: in this case flood control. There is the potential to develop a more integrated approach to planning land-use change, which takes account of conservation objectives for the full suite of habitats and species associated with different types of land use while also addressing environmental issues. The aim would be to develop more sustainable methods of flood control that are also ecologically functional.

The integration of habitat networks with river basin planning can help to address issues such as livestock and diffuse pollution, improving river quality through the management of the surrounding margins and reducing barriers to salmon migration.

Woodlands

The woodlands of Falkirk are varied, comprising narrow shelterbelts, estate woodlands, ancient woodland remnants in river gorge settings, and more recent conifer plantations. Woodlands with high biodiversity are typically the remnants of what was once a more extensive cover, which has become fragmented over centuries as a result of land clearance for farming. This process has accelerated over recent decades with the adoption of more intensive farming practices, and the spread of settlements and transport infrastructure. Management and expansion of existing woodlands are now needed to conserve the remaining woodland biodiversity, and ensure its future viability and integrity. This is particularly urgent, as pressures of climate change will require some species to move to avoid local extinction.

It is thought that woodland should be split into different habitat types either by management type or by Habitat Action Plan types.

Riparian woodlands
Expansion of watercourse woodlands is important and should take into account species such as water voles and great crested newts.

Wet woodlands
These are important in relation to the wetland networks as well as the woodland ones.

Farm woodlands
The woodland map indicated that shelterbelt woodland is an important component of the landscape, providing connectivity links. Shelterbelts in the agricultural landscape have the potential to contribute greatly to wooded habitat networks and their importance should not be undervalued. Hedgerows and hedgerow trees can also contribute in a similar way. Tree sparrows, a UK priority species, are associated with hedgerows and woodland edge.

Ancient woodland
There are a number of ancient woodland sites within the study area; these long-established woodlands are important sources of biodiversity, often providing nodes for future dispersal events. Plantations on Ancient Woodland Sites indicate areas for expanding ancient woodland networks.

Conifer woodland
Conifer woodland constitutes a large component of the wooded landscape and is important for red squirrel issues.

Unimproved grassland
This is a key habitat in the case study area with a number of designated sites, and had been in serious decline as a result of agricultural improvement over the last 60 years. Some species and issues:

- Grass margins
- Small patch size
- Coincidence mapping list spp.
- Core 2nd 3rd level sites within networks and supporting existing sites
- Amenity grassland management issues
- Some areas a mosaic of grassland and woodland – link to grazing animal project and wood pasture
- Threats from woodland expansion

Peatlands
Upland raised bogs were identified as important habitats of the upland fringe, with recognition that a habitat network approach to enhancing these areas would have to focus on management, as creation of this type of habitat is not possible. Issues discussed included: degradation through peat cutting and its effect on drainage and wetlands; Importance of management of surrounding matrix.

Planning Process
Semi-natural habitats can fill the important role of softening new urban areas, providing a natural link between the urban and the surrounding landscape, and bringing wildlife into urban settings. Design criteria set down in Local Plans and in Habitat Network principles will guide developers to achieve robust landscape

frameworks as well as detailed landscape and access requirements for the new communities. Planning applications will be expected to address these issues, and the guidelines provided will apply in all circumstances.

IHNs can potentially influence the planning process in a number of ways, including:

- Guidance for planners
- Master plans
- Vacant and Derelict land (brownfield sites) – remediation and development as greenspace
- Improvement of 'sterile' areas
- River Basin Planning
- Flood alleviation
- Improved spatial targeting for multiple objectives
- Urban expansion and the threats and opportunities this creates.

Climate change

The BEETLE model can be used to address some of the issues that relate to species and habitats in relation to climate change these could include sea level changes, coastal erosion, and identifying suitable areas for managed retreat.

Species management in relation to climate change can also be addressed using the BEETLE model. There are several issues that relate to this, including whether a proactive or reactive approach should be taken to address species change as a result of climate change. For example:

- Species predicted to have an extended northern distribution *e.g.* nuthatch, certain butterflies species. Should we look to be accommodating potential new arrivals?
- Species that are southern end of their distribution. Should we target these species, as they are likely to disappear anyway?

Or should we look to creating checks in the system as and when changes are seen to be occurring and react as a result of these.

Invasive species

These are riparian issues in many ways but are being treated separately since the use of the modelling tools may well be able to address these issues but it is thought that this is not within the scope of this project – indeed it is a project all of its own.

- Invasive non-native plant species in the riparian zone.
- Japanese knotweed,
- Himalayan balsam
- Giant hogweed
- water vole
- mink
- riparian/ WFD River corridors

Agri-environment issues

Targeting of Agri-environment grants was raised by several of the participants and, while it is a broader national issue, it is one the modelling will hope to be able to help with and is part of the wider remit of the project. The case studies will investigate how this could be achieved in differing lowland situations related to:

- Change in agriculture/agri economics will result in changes in land use and habitat change. It will be possible to look at different scenarios in an attempt to predict how this might affect connectivity between different habitats
- Competition for agricultural land, particularly with rising prices, also biofuels
- Farmland – grassland improvement
- Engagement and co-operation of farmers; encouraging collaboration to target LMC funding
- Grazing – over management

Application

Practical application was seen as a very important aspect, with emphasis on the added value an integrated approach can bring. It is important to focus on:

- Application & implementation, including ownership issues
- Target audiences for output
- Links to other regional networks.
- Prioritising through habitat quality
- Identification of important habitats and their uses, *e.g.* riparian, links to brownfield, recreation.
- The prioritisation of expansion and improvement grants to avoid impact upon other habitats, particularly of woodland upon open habitat.

Balancing Priorities

It is envisaged that investigation into the relationship between different habitat networks to derive an IHN. While the BEETLE cannot resolve issues relating to the interaction between these habitats, it will highlight where these issues occur. In this way woodland, wetland, heathland, and other habitat networks can be overlaid to see where the interactions between networks exist. Another use suggested was to examine the potential impact of recreation on biodiversity and how WIAT schemes need to be designed to take these into account.

Data issues

The importance of good, reliable, species autecology and land cover data cannot be over emphasised, as it is this aspect that will give the model credibility. Areas for investigation include the amphibian/reptile group, IACS and a ponds and ditches dataset. Data issues were discussed and the collation of this will be a very important part of the ongoing IHN project.

Conclusions

There will not be time to run the BEETLE model on all of the above and so there will need to be a targeting exercise in consultation with stakeholders and steering group to select a reasonable number that can be investigated within the context of the project.

It is suggested that the following be selected for BEETLE modelling

- Unimproved grassland
- Floodplain management wetlands using newts as the focal species
- Woodland Habitats using different woodland types
- Raised/intermediate bog

That these will be looked at in terms of

- Functional connectivity
- Key areas for native woodland restoration and expansion in order to link core woodland habitats within Falkirk and between neighbouring networks (*e.g.* in the Lothians and Glasgow & Clyde Valley)
- Key areas for expansion or restoration of a number of identified open ground habitats to link core habitat areas within Falkirk and between neighbouring areas, to maintain their ecological function and viability, as well as creating a functionally connected network
- Land-use conflicts and the trade-offs required to deliver an integrated habitat network that combines several specific habitat types
- Balancing priorities/resolving conservation conflicts for habitat networks associated with development proposals, historic landscapes, and landscape character
- Opportunities to enhance and expand the Integrated Habitat Network associated with Local Plan Core Development Areas

List of attendees

Name	Organisation
Maida Ballarini	Forestry Commission Scotland
Louise Bond	SEPA
Richard Broadley	Falkirk Council
Craig Dinwoodie	Forestry Commission Scotland
Henry Dobson	SNH
Darren Moseley	Forest Research
Anna Perks	Falkirk Council
Tony Seymour	FWAG
Mike Smith	Forest Research
Emilie Wadsworth	CSFT
Scott Wilson	Consultant

Appendix II – Definitions

AWI	Ancient Woodland Inventory
BEETLE	Biological and Environmental Evaluation Tools for Landscape Ecology
CSFT	Central Scotland Forest Trust
CSS	Countryside Stewardship Scheme
DEM	Digital Elevation Model
EC	European Commission (now European Union)
ESA	Environmentally Sensitive Areas
FCS	Forestry Commission Scotland
FWAG	Farmland and Wildlife Advisory Group
GIS	Geographic Information System
GCV	Glasgow and Clyde Valley
IACS	Integrated Agricultural Control System
IALE	International Association of Landscape Ecology
IUCN	International Union for Conservation of Nature
IHN	Integrated Habitat Network
LBAP	Local Biodiversity Action Plan
NBN	National Biodiversity Network
NIWT	National Inventory of Woodland and Trees
NNRs	National Nature Reserves
NPF2	National Planning Framework 2
NPPG 14	National Planning and Policy Guidance 14
NVC	National Vegetation Classification
NWM	Native Woodland Model
RDB	Red Data Book
RDC	Rural Development Contracts
RPAC	Rural Project Assessment Committees
RSBP	Royal Society for the Protection of Birds
RSS	Rural Stewardship Scheme
SAC	Scottish Agricultural College
SAC	Special Area of Conservation
SBS	Scottish Biodiversity Strategy
SEERAD	Scottish Executive Environment and Rural Affairs Department
SEPA	Scottish Environment Protection Agency
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SPP	Scottish Planning Policy
SSNWI	Scottish Semi-Native Woodland Inventory
SSSIs	Sites of Special Scientific Interest
SUDS	Sustainable Urban Drainage Systems
SWT	Scottish Wildlife Trust
UK BAP	UK Biodiversity Action Plan
W & CA	Wildlife & Countryside Act
WIAT	Woodlands in and around towns