The Greater Manchester Spatial Framework

The Natural Environment

Priority Green and Blue Infrastructure – May 2018

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1 Introduction

1.1 The Greater Manchester Spatial Framework

Greater Manchester is committed to growth and has a vision of a vibrant modern economy, with communities enjoying a high quality of life. The Local Authorities of Greater Manchester are working together to produce a joint Plan to manage the supply of land for jobs and new homes across Greater Manchester. The Greater Manchester Spatial Framework (GMSF) will ensure that the area has the right land in the right places to deliver the homes and jobs that will be needed up to 2035, along with identifying the new infrastructure (such as roads, rail, Metrolink and utility networks) required to achieve this.

It is recognised that this growth needs to be underpinned by a healthy and attractive natural environment, and needs to be sustainable. The GMSF is therefore committed to addressing the environmental capacity of Greater Manchester, setting out how and where to enhance and protect the quality of the natural environment, conserve wildlife and tackle low carbon and flood risk issues. To achieve these goals the protection and enhancement of Priority Green Infrastructure needs to be embedded into the GMSF.

This Report, forming part of the evidence base of the GMSF, describes an approach to identify and map the Priority Green Infrastructure of Greater Manchester.

1.2 What is Green Infrastructure?

Green Infrastructure (GI) is an over-arching phrase used to describe all the green and blue spaces in and around towns and cities. The term allows us to refer to – and consider the collective value of – all of these spaces at once. Component elements of green infrastructure can include parks, private gardens, agricultural fields, hedges, trees, woodland, green roofs, green walls, rivers, canals and ponds. The term covers all land containing these features, regardless of its ownership, condition or size. In the past, green spaces have often been valued for single uses, such as for sport/recreation, or simply for their aesthetic appeal. The term Green Infrastructure reflects the fact that green spaces can perform a wide range of functions and services, often simultaneously, and therefore can act as 'infrastructure' in a similar way that roads and railways deliver services.

One GI site could be providing several functions at once, providing us with multiple benefits, or a site could deliver a single important service. Sometimes GI services are not complementary – for example, areas which are useful for flood alleviation may not necessarily be of high importance for food production.

In recognition of the importance of GI in land-use planning the National Planning Policy Framework (NPPF) states that Local Authorities should -

"*set out a strategic approach in their Local Plans, planning positively for the creation, protection, enhancement and management of networks of biodiversity and* ***green infrastructure***"

The NPPF defines Green Infrastructure as –

"*A network of multi-functional green space, urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities*".

Natural England have expanded on the definition of Green Infrastructure as follows -

"[*Green Infrastructure is*] *a strategically planned and delivered network comprising the broadest range of* ***high quality*** *green spaces and other environmental features. It should be designed and managed as a multifunctional resource capable of delivering those* ***ecological services*** *and quality of life benefits required by the communities it serves and needed to underpin sustainability. Its design and management should also respect and enhance the character and distinctiveness of an area with regard to habitats and landscape types*.

Green Infrastructure includes established green spaces and new sites and should thread through and surround the built environment and connect the urban area to its wider rural hinterland Consequently it needs to be delivered at all spatial scales from sub-regional to local neighbourhood levels, accommodating both accessible natural green spaces within local communities and often much larger sites in the urban fringe and wider countryside"

(*NE 2015, author's highlighting*)

This expanded definition provides some pointers as to how Green Infrastructure can be valued. It can be assessed in terms of the **ecological services** and **quality of life benefits** that it provides to communities.

1.3 The Natural Environment of Greater Manchester

Greater Manchester is often thought of in terms of its built environment, and particularly relating to its internationally important industrial and commercial history. But Greater Manchester also supports a rich and diverse natural heritage.

It is fringed to the north and the west by the West and South Pennine Hills supporting wide open moorlands. From the upland peatlands Rivers flow south and east through into the urban centres, linking open countryside with more built-up areas. Along the River Valleys many areas of species-rich ancient woodland survive and thrive.

In the west, as the land levels and the river flows are slowed, lowland raised bogs, ponds and lakes can be found on the open, more level expanses of Chat Moss in Wigan and Salford.

The industrial heritage has left a legacy of unusual habitat mosaics, including reservoirs, mining subsidence flashes, railway sidings and areas of old industrial waste. Many rare and uncommon plants and animals depend on the Canal networks – many Canals are now protected nature conservation sites and nature reserves, some of the old collieries have been transformed into Country Parks and the ponds once associated with the cotton mills are now havens for wildlife, often in an otherwise deeply urban context.

The River Medlock running into the heart of Manchester City Centre has been transformed from a former industrial wasteland into publicly-accessible greenspace

Greater Manchester has been a world leader in restoring previously degraded sites. Extensive new tree planting over the last thirty years has provided new and enhanced places for public recreation, has improved air quality and reduced flood risks and has led to sometimes dramatic increases in the populations of some species associated with woodland, like great spotted woodpeckers and long-tailed tits.

In the suburbs, particularly in the south, established private gardens have been shown to support valuable concentrations of species which are becoming rare in the wider, intensively farmed countryside (including iconic Manchester bees).

The extensive networks of parks and public greenspace, which include some of the oldest public parks established anywhere in the world, provide much-needed breathing spaces for sometimes dense urban populations and valuable habitats for a wide range of wildlife.

Even in the heart of the city and town centres wildlife can be found – for example peregrine falcons breed in the heart of Manchester and Salford City Centres.

Peregrine in front of Manchester Cathedral

1.3.1 The Natural Environment of Greater Manchester in Numbers

The health and variety of Greater Manchester's natural Environment is evident in the numbers of protected greenspace sites and in the diversity of species found in the area.

Across Greater Manchester close to 5,000 different species have been recorded –

Taxon Group	Species Count
Flowering plants	1116
Fungus	761
Moths	562
Beetles	493
Flies	366
Birds	284
Bees, Wasps, Ants and Sawflies	191
Mosses	169
Lichens	152
True Bugs	142
Spiders	100

Molluscs	55
Liverworts	46
Mammals	43
Mites and Ticks	40
Butterflies	36
Segmented worms	30
Caddis Flies	29
Ferns	27
Conifers	26
Fish	24
Dragonflies	24
Crustaceans	22
Stoneflies	17
Mayflies	15
Millipedes	15
Harvestman	15
Springtails	12
Lacewings	11
Slime moulds	11
Grasshoppers, Locusts and Crickets	11
Centipedes	10
Flatworms	7
Reptiles	7
Amphibians	6

Horsetails	5
Alga	4
Scorpion Flies	3
Other	21
TOTAL	4908

Specially protected nature conservation sites cover more than 10% of the land area of Greater Manchester, approximtaely 140 sq km. Woodlands cover 10% of the land area (*source City of Trees*).

More than half of the total land area of Greater Manchester could be classified as green infrastructure and even in the City of Manchester at least 20% of the City is greenspace.

Much of this diverse and extensive Natural Capital is readily accessible to very large numbers of people. For example Heaton Park in north Manchester attracts around 1.5 million visitors each year, and the Parklife festival held in the Park attracts close to 140,000 people in just the two days of the festival. Haigh Hall in Wigan attracts close to 500,000 visitors each year, and in 2017 Dunham Massey in Trafford attracted close to 289,000 visitors. Etherow Country Park in Stockport sees more than 250,000 visitors each year, while in the eastern uplands the developing Dovestones RSPB Reserve now attracts tens of thousands of people each year. The recently refurbished Alexandra Park very close to Manchester City Centre sees 250,000 visitors each year, dominated by visits by people who are very local to the Park.

These visits provide a wide range of services to people, including access to nature, boosts to mental and physical health, provision of social and cultural spaces and access to play spaces and formal sporting facilities.

2 Important Services delivered to people by Greater Manchester's Green Infrastructure include –

2.1 Water storage, drainage, flood prevention and water purification

Typical Sustainable urban drainage

2.2 Mitigating climate change (for example by storing carbon)

Trees can act as carbon stores

2.3 Providing greenspace for recreation, improving physical and mental well-being

Openshaw Park, Bury

2.4 Tourism

The East Lancashire Railway

2.5 Providing habitats for wildlife

Kingfisher

2.6 Providing sustainable transport links

Sustainable Transport

2.7 Food production

Food production

2.8 Providing inspiration for culture, art and design

Sculpture, Burrs Country Park

2.8 Providing a 'sense of place'

Peel Tower provides a distinctive sense of place

2.9 Improving Physical and Mental Health

Walking in the hills above Dovestones Reservoir

2.10 Preventing soil erosion

Soil erosion

2.11 Supply of raw materials (for example wood, biofuels, plant oils and raw materials for the production of medicines)

Coppicing woodland for fuel

2.12 Visual and Aesthetic impacts (Landscape Value)

Landscape views, Holcombe Moor

2.13 Mitigating Air and Noise Pollution

Tree planting along motorways can reduce noise and air pollution

3 The Scope of this Study

The definitions of GI are very broad and wide-ranging, and while it is recognized that very many green spaces in very many places can deliver useful functions and services, for the term to be useful in strategic planning terms it is necessary to **prioritise** the Green Infrastructure that is delivering services at a strategic, Greater Manchester scale. That is, the protection given to some areas of green infrastructure will inevitably be ascribed greater weight in the land-use planning system than others because of the relative importance of the Ecosystem Services that these areas provide.

The work reported in this document has re-visited and built on a range of existing data and studies, and considered new information, to re-define and update existing work aimed at identifying this **Strategic Priority Green Infrastructure** for Greater Manchester**.**

It does not ignore the fact that small areas of GI can have value at a more local level and does not imply that more local GI is unimportant; all areas of GI should of course be considered on merit when considering development.

By identifying Networks of Strategic Green Infrastructure for Greater Manchester it will be possible to further the development of strategic Ecological Networks. The Ecological Network can essentially be seen as a 'sub-set' of the wider Network of Green Infrastructure.

3.1 Ecosystem Services

As already outlined above, Ecosystem Services can be defined as "the benefits people obtain from ecosystems". Ecosystem Services are the services that Green Infrastructure provides to people. For example, woodlands have the capacity to slow the flow of water and in riparian locations particularly they can stabilise river beds and banks and so potentially reduce flooding downstream. If that reduction of flooding is considered a benefit to people, perhaps because houses and businesses are at risk and the woodland reduces this risk, then it can be regarded as an *ecosystem service*.

Green spaces can deliver a very wide ranging number of Ecosystem Services. A 'long-list' could include

- flood defence and flood mitigation,
- agriculture and local food production,
- water quality and mitigation of water pollution,
- recreation,
- green (sustainable) travel,
- mitigation of air pollution,
- carbon storage and sequestration,
- nature conservation, timber production,
- moderation of urban heat island effects,

- contribution to a sense of place,
- inspiration for art and cultural services,
- contribution to public health

One way of prioritising strategic GI (that is, deciding which parts of a GI network are potentially more important than others and should therefore be given greater weight for protection and/or enhancement within a land-use planning system, than others) is to assess the benefits that GI can deliver in terms of particular Ecosystem Services. For the purposes of this study the most important Ecosystem Services that Green and Blue Infrastructure can provide for the people of Greater Manchester have been identified as –

- Surface water and fluvial flood management
- Carbon storage and sequestration
- Water quality management
- Habitat and wildlife conservation
- Public recreation and sustainable travel

These Ecosystem Services have been prioritised by the Greater Manchester Natural Capital Group (NCG).

By using available datasets to assess and analyse which areas of Green Infrastructure are most important for the delivery of these key services, either alone or in combination, the broad locations of the most important Strategic Green Infrastructure can be mapped.

3.2 Limitations of Green Infrastructure Assessments using Ecosystem Services

Objective assessments of the value of greenspace based on ecosystem services can only be made where there is sufficient information of appropriate quality available in order to measure such value.

This limitation can restrict the scope of any assessment, although in recent years advances in information technology, significant improvements in the availability and quantity of information concerning the natural environment and remote sensing and digital mapping techniques have enabled relatively comprehensive assessments to be undertaken. In fact it can sometimes be challenging to analyse, understand and clearly present (map) the large amounts of data from many different datasets, collected in different ways and sometimes at different resolutions, in a logical way.

However some data limitations have affected which Ecosystem Services have been prioritised for assessment in this study; where there is no reliable data available the ESS value cannot be assessed. The important implication of this limitation is that if some sites and areas are not identified in this study through ESS analysis this may simply mean that

there is insufficient information available to assess their value rather than because the sites are without value.

One important example of the limitations of the ESS methodology is in assessing the value of the natural environment for health and well-being. This service has been widely recognised and is regarded as a very important ecosystem service for GM, where in a number of areas health outcomes could very likely be improved by providing better access to well-managed green infrastructure. Although some recent work has been undertaken to attempt to assess the monetary value of some green infrastructure in Greater Manchester (source - *Natural Capital Account and ESS Opportunity Mapping, Natural Course Project 2018*) as yet there are no readily available empirical datasets available to map the health benefits of large areas of GI in Greater Manchester in order to properly inform this study.

However, some of the most popular greenspaces in terms of visitor interest / numbers *have* been included as Priority GI, and it is a fair assumption that by including these sites and areas some of the most important green places for promoting and improving health and well-being will have been captured in the mapping process.

It is also recognised that any attempt to objectively measure and assess the quality of a particular area of greenspace using ecosystem services may overlook or undervalue the local *intrinsic* value of the area to local people. Innate, deep-seated connections between local people and 'their' local green spaces can be difficult to objectively measure but are nevertheless important.

3.3 Natural Capital Accounting

All the Green Infrastructure delivering valuable ecosystem services in a particular area can together be defined as the 'Natural Capital' of the area.

Natural Capital Accounting is an emerging methodology which attempts to ascribe an economic value to Natural Capital. It is hoped that by capturing the economic value of green infrastructure it will place an overall higher value on GI assets and prove useful to decision makers for presenting a case for the protection of GI and for the continued investment in GI management and improvement.

Natural Capital Accounting has recently (2017) been used most notably in London and Sheffield to assess the Natural Capital value of entire municipal areas. In London it has been estimated that the city's greenspaces bring at least £5 billion worth of value each year.

Natural Capital Accounting has recently (2018) been used to assess areas along the River Irwell and projects are underway to extend this assessment to larger areas of Greater Manchester. But it is an expensive and time-consuming process that requires depth of expertise from a range of disciplines and access to big and up-to-date data sets. The results of such assessments are not yet widely accepted and the accounting methodology has not

yet been applied to the land-use planning system in Greater Manchester. No GI sites have yet been protected in GM through the land-use planning system simply because of their ascribed monetary value for delivering ESS.

This study has not therefore applied Natural Capital Accounting to Greater Manchester's Green Infrastructure, but acknowledges that the methodologies are likely to be used in near future, most likely applied to individual developments.

3.4 Access to Local Green Infrastructure

This is a strategic study. It has not been possible to capture the value of *all* of the greenspaces across all of Greater Manchester. This is partly a question of scale – sites below a certain threshold size have been excluded from some of the analysis – and partly due to a lack of evidence as to the value of local sites for delivering ecosystem services.

It is acknowledged that very many more local sites will be of value to local people but there is often no empirical evidence available at a GM-wide scale to measure this value. But the GMSF is not a replacement for more Local Plans; it is the place and function of these District Plans to identify and where necessary protect these more local green spaces.

3.5 Ecological Networks

Many remaining species-rich and important natural habitats in the UK are small and fragmented. It has long been recognised that to make nature conservation efforts more effective in future the existing 'patches' of natural habitat must be made larger and better connected. The NPPF places significant weight on the creation of Ecological Networks as a mechanism to achieve this.

The most relevant parts of the current NPPF relating to Ecological Networks say that Strategic Plans should -

- *set out a strategic approach in their Local Plans, planning positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure;*
- *plan for biodiversity at a landscape-scale across local authority boundaries;*
- *identify and map components of the local ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity, wildlife corridors and stepping stones that connect them and areas identified by local partnerships for habitat restoration or creation;*
- *promote the preservation, restoration and re-creation of priority habitats, ecological networks and the protection and recovery of priority species populations, linked to national and local targets, and identify suitable indicators for monitoring biodiversity in the plan";*

Providing that Wildlife and Habitat Conservation is used as one of the ecosystem services used for defining Priority Green Infrastructure, and that datasets relating to the distribution of important habitats and species are used in the identification of Priority GI, it is possible to identify important components of Ecological Networks. The Ecological Network essentially becomes a 'sub-set' of a Green Infrastructure Network.

The Defra 25 Year Environment Plan calls for the establishment of large-scale '**Nature Recovery Areas'** as important parts of developing Ecological Networks.

3.6 Biodiversity Net Gain, Biodiversity Opportunity Areas, the Enhancement of Wildlife Corridors and wider Environmental Enhancement

The NPPF (2017 consultation draft) states that -

To protect and enhance biodiversity and geodiversity, plans should:

a) *identify and map components of local wildlife-rich habitats, including the hierarchy of designated sites of importance for biodiversity; wildlife corridors and stepping stones that connect them; and areas identified by local partnerships for habitat restoration or creation;*

and

b) *promote the conservation, restoration and re-creation of priority habitats, ecological networks and the protection and recovery of priority species; and identify and pursue opportunities for securing* ***measurable net gains for biodiversity*****.**

And the **Defra 25 Year Environment Plan** (2018) states that -

> *"We [government] will embed an 'environmental net gain' principle for development, including housing and infrastructure".*

The idea is that all, or most, developments should aim to achieve a net gain in biodiversity value. This will involve measuring the current biodiversity value of sites using an accepted, transparent metric to calculate the value of sites existing value in terms of 'Units of Biodiversity'. The aim should then be to not only compensate for any Unit losses but also to go above and beyond compensation to achieve net gain in Units.

It could be that in would not be possible, or it would not be very effective, to achieve net gain within development site boundaries. But net gain could be achieved by making a contribution (financial or practical) to nature conservation in other areas. This is the idea behind the identification of 'Priority Biodiversity Opportunity Areas' in the Plan. These are sites and areas where it has been identified that measures to enhance wildlife conservation would be best directed.

Opportunity areas and wildlife corridors should not be seen as constraints; they are identified to inform development proposals and to guide the design of new developments.

In order to build a coherent ecological network it will be necessary to join up existing designated wildlife sites and areas of opportunity. Wildlife corridors have therefore been identified and mapped.

Taken together, the designated wildlife sites, corridors and opportunity areas can be considered to form a **coherent ecological network** for Greater Manchester and fulfil the requirements of the NPPF with regards to Biodiversity conservation.

Of course, enhancement of Green Infrastructure should not be confined to Biodiversity. Green Infrastructure should be enhanced across the board because of the advantages that improvements to ecosystem service delivery can bring. But at the moment there are no established and standardised metrics available for accurately assessing the value of sites for their capacity to deliver all of the wider range of services, although such metrics are rapidly emerging. Recently (2018) a study has been completed to identify opportunity sites and areas for ESS enhancement along the Irwell Valley, and this study has used metrics for measuring the current value of sites for their delivery of more holistic environmental improvements in order to identify areas where there are the most pressing deficits and opportunities.

But it is the case that high-quality habitats generally deliver more and better ecosystem services than degraded areas; a well-managed woodland will store more carbon, better mitigate flood risk, support more biodiversity and provide an enhanced visitor experience.

Identifying Opportunity Sites and Areas for Biodiversity Enhancement and requiring net gain for biodiversity from development will inevitably improve the delivery of a wide range of services, not just nature conservation interests.

Details of one metric used to calculate the biodiversity of sites, and therefore to work out what might constitute net gain, can be found in the DefraTechnical Paper " *the metric for the biodiversity offsetting pilot in England March 2012"*

> https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69531/pb13745-bio-technical-paper.pdf

Net gain can be achieved across smaller areas than the area of land that may be affected by a development. Smaller areas of high-quality and well-managed habitat can deliver the same or better wildlife value as large, unmanaged and featureless sites. This is referred to as the '**quality multiplier'**.

Mechanisms for achieving Net Gain

At the time of writing a Task Group facilitated by Natural England has been established to develop the necessary policies, tools and mechanisms for delivering Biodiversity net gain in Greater Manchester. The Task Group will report its findings before the final publication of the GMSF.

4 Review of Existing Studies

There are a number of existing valuable studies available that have informed this current project to identify Priority Green Infrastructure.

4.1 The Greater Manchester Green Infrastructure Framework

This study was commissioned by AGMA and natural England in 2008, with part of the work being carried out by the consultants TEP. The work mapped a large number of GI functions by drawing on existing datasets and compiling some new data, and then overlaid these maps; where a number of map layers (representing ecosystem services) coincided, these areas were used to define Priority Green Infrastructure to Support Growth.

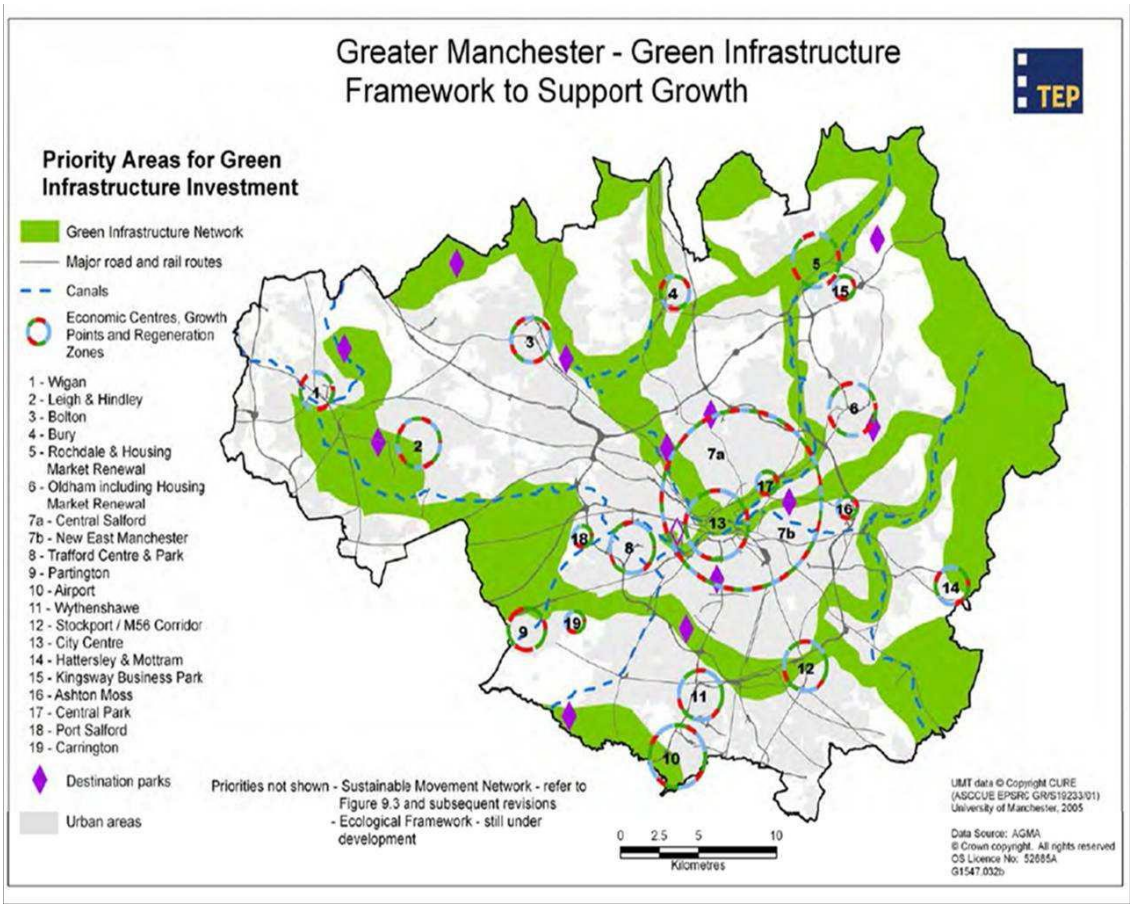


Fig 1 The existing map of 'priority' green infrastructure in Greater Manchester (2008)

Some of the datasets used in the preparation of this study are now rather outdated. Further, the study did not go on to characterize the areas of highest value for delivery of particular Ecosystem Services; that is, some high value areas of GI may be more useful for mitigating climate change, while some may be more useful for recreation.

4.2 The existing Network of important (designated) nature conservation sites

Greater Manchester has a well-established and robust system of sites designated for their nature conservation value. These sites include –

- European protected sites (Special Protection Areas and Special Areas of Conservation)
- Nationally protected sites (Sites of Special Scientific interest and National Nature Reserves)
- Local Wildlife Sites, including Sites of Biological importance and Local Nature Reserves

These sites are offered protection through statute and through the land-use planning system. Together they form the basis (core components) of an Ecological Network for Greater Manchester.

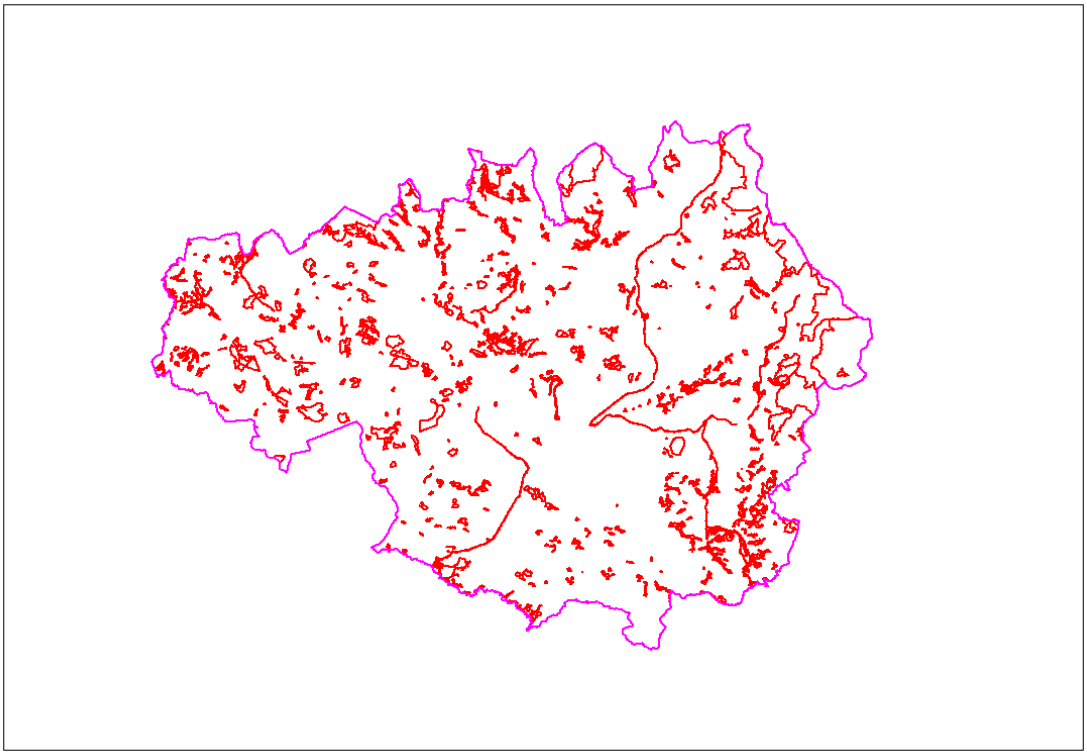


Fig 2 the existing Network of existing designated nature conservation sites across Greater Manchester (boundaries in red, GM boundary in pink)

4.3 The Greater Manchester Ecological Framework

This study undertaken by the Greater Manchester Ecology Unit and the University of Salford dating from 2005/6 used existing species and habitat datasets to define a range of 'ecological character areas' across Greater Manchester. The character areas included 'most natural areas' (woodlands and uplands), 'garden spaces', 'habitat mosaics' and 'urban'.

The Framework was based on relatively poor and incomplete species datasets available at the time and therefore is not considered to be particularly robust. The study has not been well used in the land-use planning system.

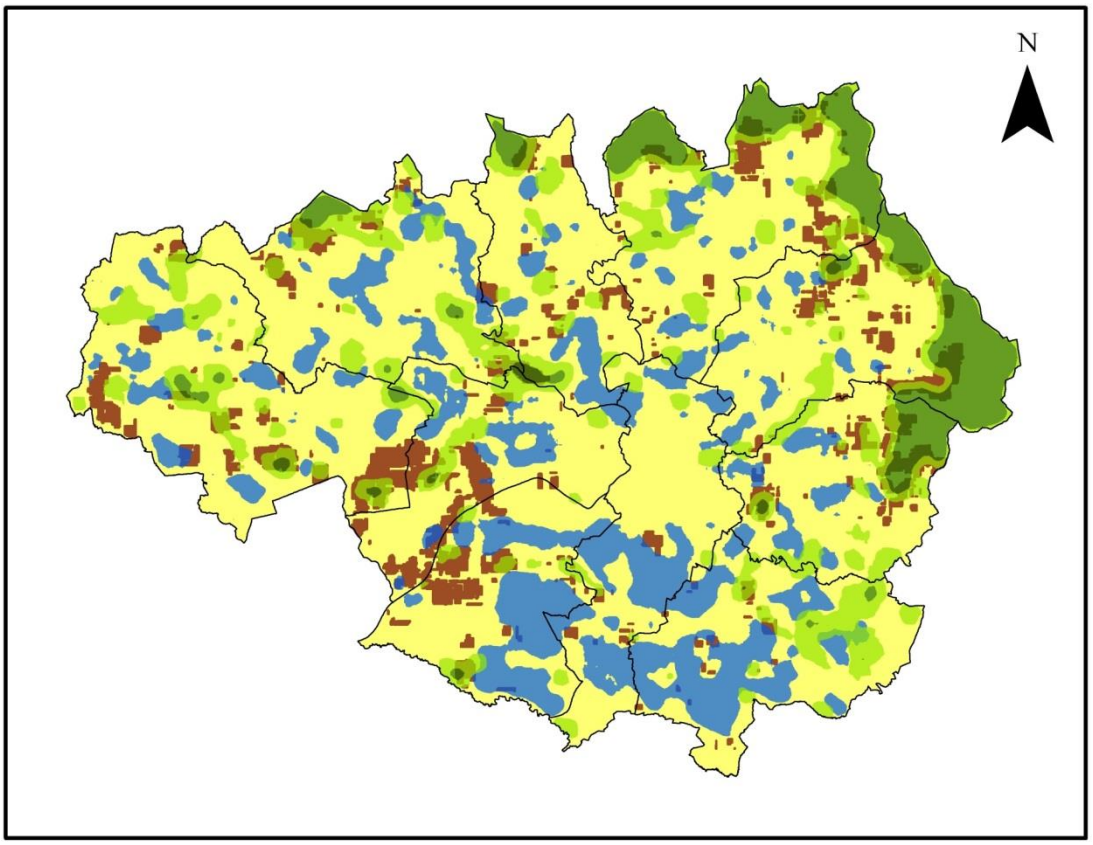


Fig 3 The 2006 Ecological Framework for Greater Manchester. Each colour represented a different 'ecological character area'. Blue is gardens, dark green is uplands, light green woodlands, orange is habitat mosaic and yellow no dominant ecological character.

4.4 The GM Priority Ecosystem Service Pinch Points Study

Commissioned by the GM Combined Authority and Natural England, and prepared by the Red Rose Forest and Countryscape in 2014, this study used a Logical Frameworks Analysis and GIS analysis of a wide range of datasets to produce a 'Heat Map' of the areas of Greater Manchester considered to have the highest (and lowest) value in terms of the delivery of Ecosystem Services. This exercise used a longer list of Ecosystem Services than have been used in the current study, including urban heat island effect and food production.

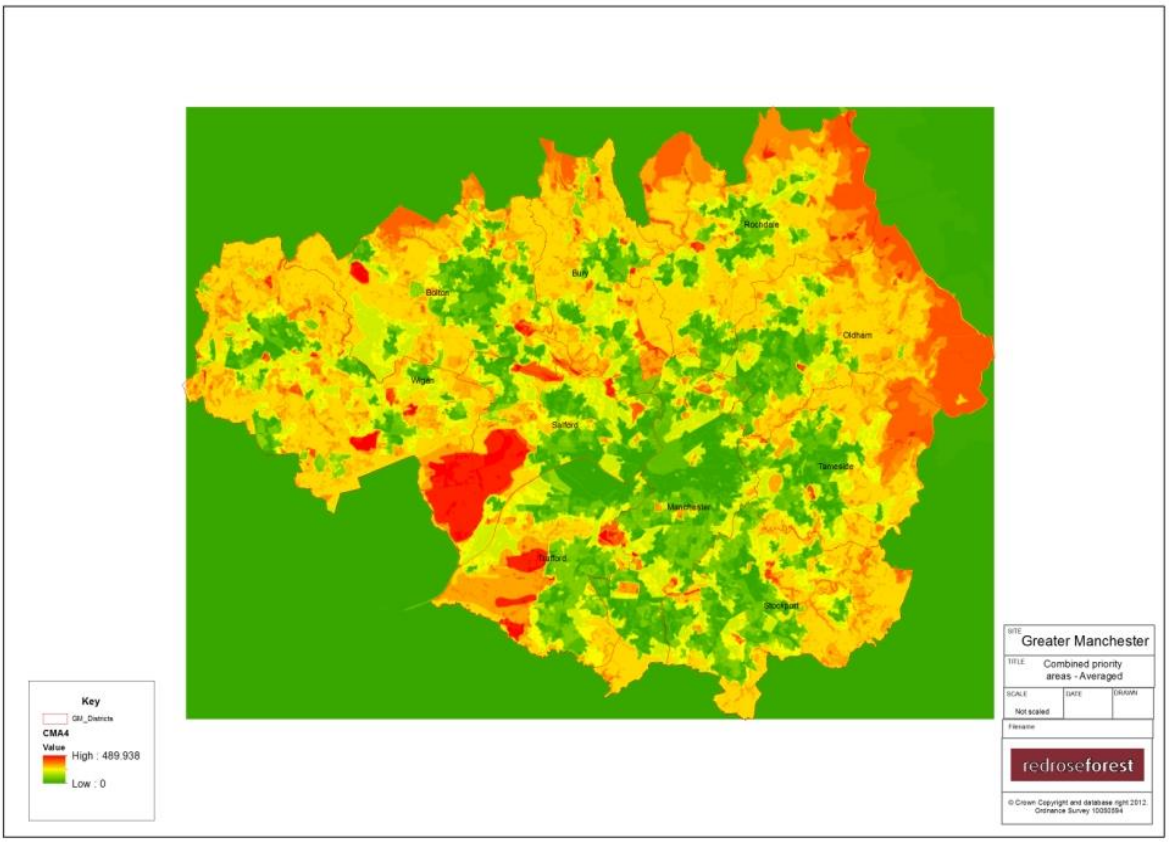


Fig 4. The 'Averaged Combined Ecosystem Services Priority Areas' for Greater Manchester identified in the Pinch Points study

The resulting map, although very valuable, is somewhat difficult to interpret from a land-use planning point of view. Also, like the previous GI analysis, the overall map does not *characterize* the areas of highest value for delivery of Ecosystem Services; that is, some high value areas may be more useful for mitigating climate change, while some may be more useful for recreation, although this characterization is picked up in the underlying datasets used in the mapping.

5 Datasets used in the updated analysis

5.1.1 Carbon Storage and Sequestration

Dataset	Rationale for use	Limitations
Blanket Bog Priority Habitat type	Priority habitats will support vegetation communities most likely to be capable of forming new peat (active bog)	Does not map peat as a substrate, only the habitats it supports
Lowland Raised Bog Priority Habitat type	Priority habitats will support vegetation communities most likely to be capable of forming new peat (active bog)	Does not map peat as a substrate, only the habitats it supports
Woodlands – Priority Habitat type	Trees can act as a carbon store and growing trees can sequester carbon	Trees not in woodlands are not picked up in this mapping
Woodlands – GM Tree Audit	Trees can act as a carbon store and growing trees can sequester carbon	Some isolated trees may not have been picked up
Soils	Peat soils are a carbon store	Does not include information concerning the depth or condition of the peat

5.1.2 Wildlife and Habitat Conservation

Dataset	Rationale for Use	Limitations
SBI boundaries (GMEU)	Up-to-date and robust dataset. The majority of important habitats in GM are known to be within SBIs.	Some important species populations are found outside of designated sites
SSSI boundaries (NE)	Up-to-date robust dataset of statutory protected sites.	Some important species populations are found outside of designated sites
SAC/SPA boundaries (NE)	Up-to-date robust dataset of statutory protected European sites.	Some important species populations are found outside of designated sites

Local Nature Reserves (GM Districts)	LNRs also include sites with value to the local community.	Some important species populations are found outside of designated sites
Distributions of protected species (GMEU)	Up-to-date and robust dataset. Data is relatively straightforward to analyse. Concentrations of important species can correlate well with other Ecosystem services.	
Distributions of priority species (GMEU)	Up-to-date and robust dataset. Data is easy to analyse. Concentrations of important species can correlate well with other Ecosystem services.	
Habitats vulnerable to climate change (NE)	Includes priority habitats as defined by Natural England	Not ground-truthed, data collected mainly by remote sensing.
Aerial photography	Enables accurate boundaries of some habitat types to be identified	Can be difficult to identify particular habitat types from aerial photography.

5.1.3 Flood Risk Alleviation

Dataset	Rationale for Use	Limitations
Main rivers and waterways (EA)	Main rivers and waterways are clearly very important for drainage	Does not include many minor waterways and drains
Greenspace in Floodzone (particularly zones 3a and 3b) – from UMT data and OS Greenspace data	Flood zones, very robust dataset	Sometimes difficult to exclude built-up areas, which are at risk of flooding but are not 'GI'
Environment Agency Catchment Management Plans	Useful landscape-scale mapping	Wide-ranging raster dataset, not easy to analyse or incorporate into methodology
LIDAR data (topography)	Useful, robust landscape-scale mapping of potential flood-risk areas which includes areas	Difficult to interpret and often too fine-grained for this study; data

	that could be 're-wetted' to aid nature conservation interests and carbon sequestration	missing in some places
Lowland Wetlands (lowland raised bog and main water bodies)	May contribute to flood risk alleviation by acting as water storage and 'slowing the flow'	Does not identify hydrological connectivity, therefore some assumptions made about value to mitigating flood risks

5.1.4 Water Quality

Dataset	Rationale for Use	Limitations
Blanket Bog Priority Habitat type	Active bog can reduce water run-off and peat can act as a water store.	Does not map peat as a substrate, only the habitats it supports. A (very) indirect measure of quality
Main rivers and waterways	Maps all waterways for later water quality data to be overlaid onto	Does not distinguish differentiations in water quality
Riparian woodlands	Woodland can reduce water run-off	A (very) indirect measure of quality

5.1.5 Recreation and Green Travel

No accurate, comprehensive and up-to-date counts of visitor numbers are available for many Parks and Countryside and 'Recreational' Greenspaces in Greater Manchester, particularly those that are free to access (which is very many of them).

For these Ecosystem Services a 'long list' of potential priority Parks and Countryside sites and areas was compiled from the existing knowledge base of Parks and Countryside staff across GM, broadly estimating numbers of visitors. Most small sites and areas (below 5 ha) were then excluded as not delivering a strategic function.

Freely available datasets were then analysed to determine those sites from the long list that are most often named in or referred to, for example, in internet searches and social media.

Because this methodology does not involve measuring the actual numbers of visitors using particular sites and areas it has obvious limitations –

- Local people who regularly use sites are unlikely to use internet searches to locate and research sites. Some local sites may therefore be undervalued by using this methodology.
- Some demographics that do not regularly use the internet or social media may not be represented.

For the above reasons the list of sites and areas identified were then 'sense-checked' by reference to local (district) knowledge to try to ensure that no important sites had been excluded from the list.

6 The Analysis

The detail of the analysis of species and habitat data is given in Appendix 2. Species and habitat data was given significant weighting in the initial analysis because the data was very wide-ranging, robust and open to detailed analysis and also because biodiversity does underpin other Ecosystem Services.

For other datasets for each ecosystem service these were simply combined (overlaid) using GIS tools to give an indication of spatial priority areas, and then the priority areas for the different Ecosystem Services were then combined to give the provisional indication of the Priority GI in Greater Manchester. This methodology mirrors that undertaken during the mapping of 'ESS Pinch Points' undertaken by the RRF for the Combined Authority, albeit mapping fewer services.

This type of GIS analysis allows **heat maps** to be prepared (using thematic maps functions) to combine ESS maps. A **heat map** (or **heatmap**) is a graphical representation of data where individual values contained in a matrix are represented as colours and concentrations of values can be represented as darker colours. Such heat maps can provide useful information about the concentrations of particular attributes or functions, and they can be powerful visual tools, but they can also rely on the creation of 'buffers' around points and polygons that can result in diffuse boundaries. In the case of this study some datasets were available only at a 'grid-square' level.

Sometimes with big datasets (e.g. lots of species records) patterns can be hidden. Diffuse boundaries can therefore be useful in identifying priority 'areas of search' for particular functions or attributes **but they are not always useful for setting precise Policy boundaries for land-use Plans because it may not be clear where a particular Policy should be applied**. Because combined 'heat maps' are composed from a range of different datasets, sometimes in different formats, the combined maps can become 'GIS constructs' which need to be sense-checked against up-to-date aerial photography and/or ground truthing if they are to become more meaningful in a land-use planning context.

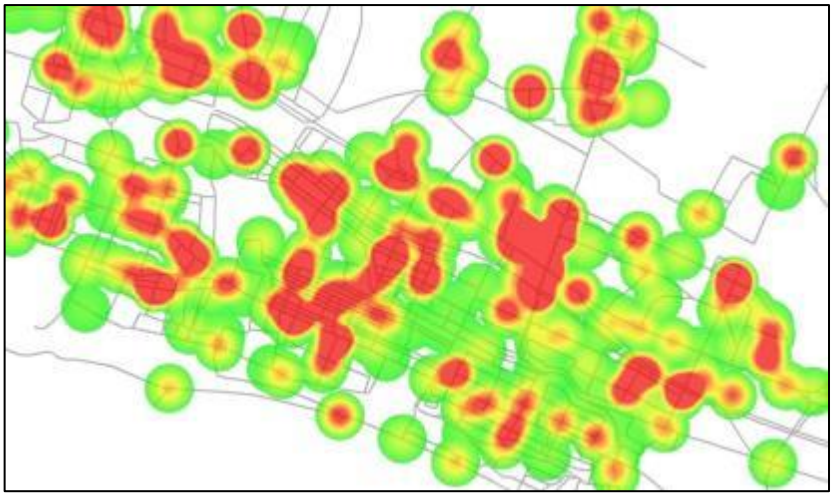


Fig 5 A typical Heat Map with diffuse boundaries

Inevitably the results of this analysis are therefore presented more as 'key diagrams' or 'areas of search' for Priority Green Infrastructure rather than providing precise, definitive policy boundaries.

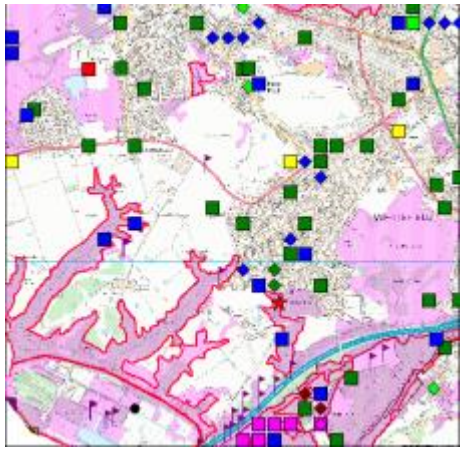
Example Methodology for simplistic overlaying GIS datasets – biodiversity example

Broadleaved Woodland dataset

Woodland + SBI datasets

Woodland + SBIs + Local Nature Reserves

Woodland + SBIs + Local Nature Reserves + priority habitats + protected species datasets



Woodland + SBIs + Local Nature Reserves + priority habitats + protected species + priority species datasets

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The Importance of Water

Greater Manchester's geography and its economy have been significantly shaped by water. Generally, rainfall in the upland areas of the region in the east and north flows south and west through the main towns and settlements, reaching the more open flat plains in the south and west. Water flows originally provided the power for nascent industry, and the damp climate helped to ensure that cotton threads could be spun without breaking. Water captured in reservoirs in the uplands provided fresh water for the growing urban populations. The waterways then helped to facilitate movement of raw materials and finished goods across the conurbation and beyond, in addition to playing a key role in some industrial processes.

The rivers and waterways now form an essential part of a GI Network and obviously play a crucial role in flood risk mitigation. They also form the most important wildlife corridors across Greater Manchester, and important routes for sustainable travel.

Rivers and waterways were therefore weighted heavily in the analysis.

Initial Results and further analysis

The first attempts to map the sites and areas of Green Infrastructure across Greater Manchester in terms of the 'priority' ecosystem services they deliver using even the limited number of datasets above resulted in maps that included very many sites and very large areas of Greater Manchester –

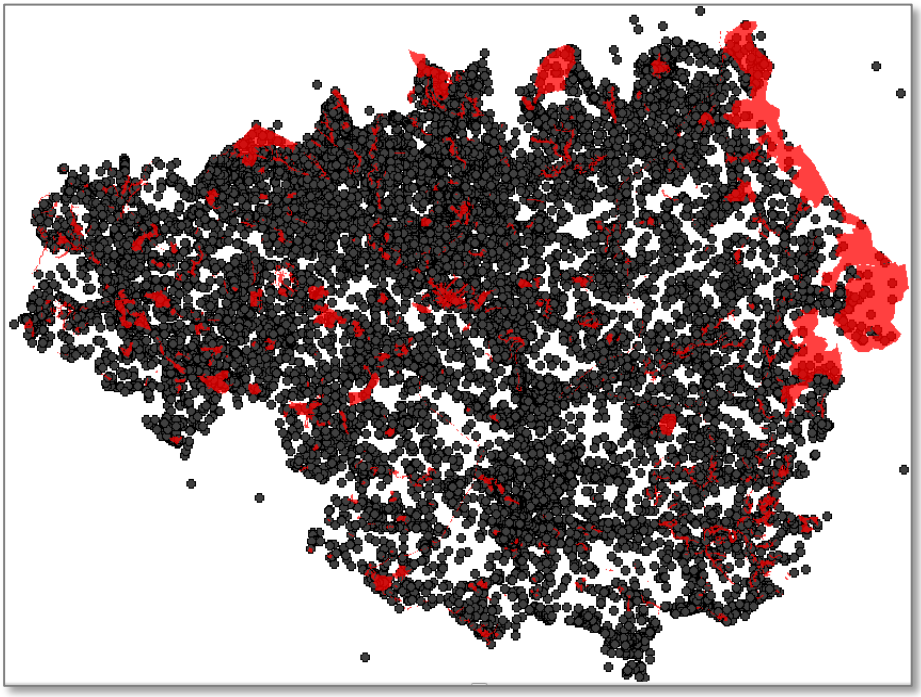


Fig 6 Initial attempts at mapping Priority GI in Greater Manchester resulted in very many sites and areas being identified

While it is clearly the case that there is a lot of Green Infrastructure in Greater Manchester delivering at least some level of Ecosystem Service, it was questionable to describe *all* of these sites and areas as being of 'strategic' priority importance. For example a large number of sites, although scoring highly in terms of services being delivered, were relatively isolated and did not form part of a coherent network, one of the definitions of GI as given in the NPPF.

Further, more subjective analysis of the data was therefore carried out to exclude sites that were regarded as too small (less than 5ha), fragmented (unconnected to obvious clusters of ESS or linking corridors and/or did not obviously form part of a coherent network.

7 Summary Results

The following diagram shows the results of the first summary analysis; essentially, the areas shaded green represent the identified Priority Green Infrastructure for Greater Manchester. The 'point' data (green dots) represent the locations of strategically important Parks and Countryside sites considered to be of most value for recreation.

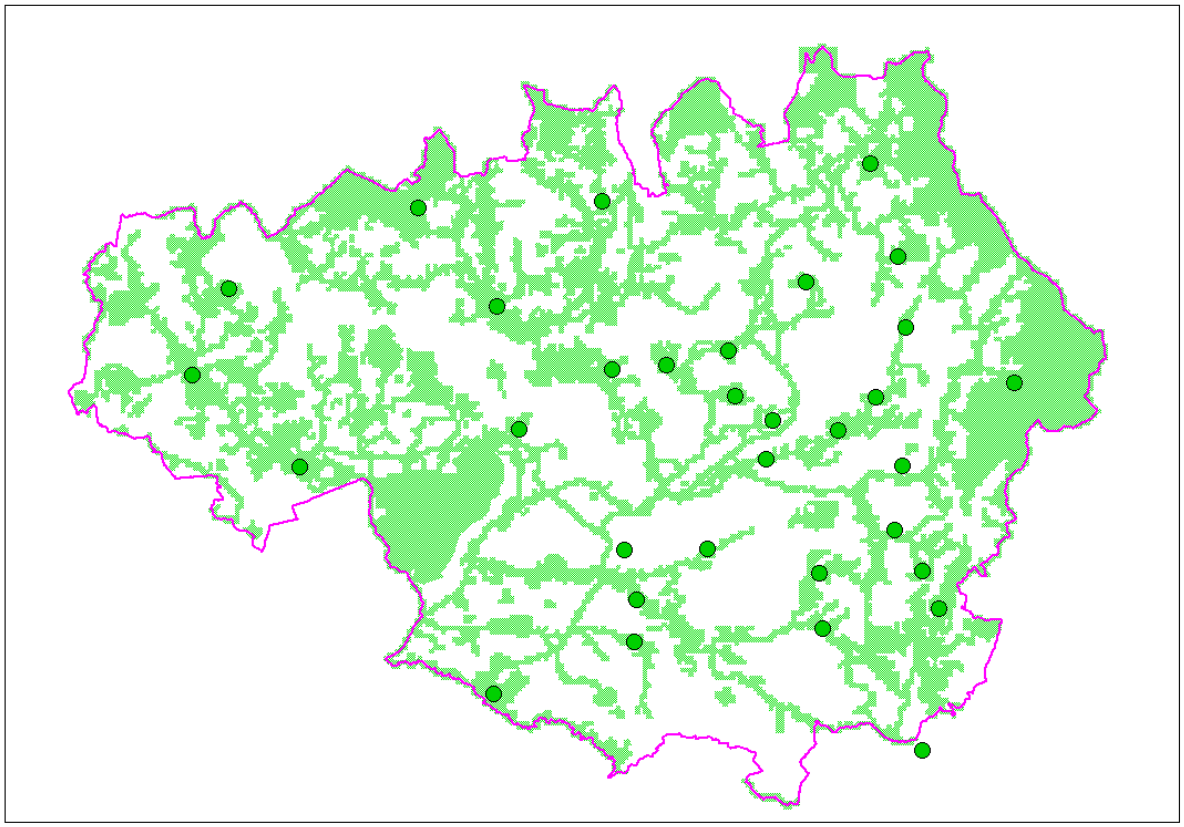


Fig 7 The summary Priority GI Network for Greater Manchester. The green dots represent major parks and public greenspaces

The overall figure above represents the most likely spatial distribution *actual* green infrastructure assets; it is not aspirational and does not include priority areas for the possible creation or enhancement of new GI. It is as discussed something of a 'GIS construct' based on grid square analysis, so the areas identified should be looked at as *areas of search* where Priority GI is most likely to be found rather than being used to set specific land-use policy boundaries.

In terms of a Strategic Plan it is more likely to be of use as a Key Diagram of assets rather than as a policy boundary map.

8 The Development of an Ecological Network for Greater Manchester

The use of habitat data in the analysis enables areas of Priority Green Infrastructure to be characterized not only by the Ecosystem Services that they deliver but also by habitat type.

This in turn enables coherent Ecological Networks to be constructed based on different broad habitat types considered most important in a Greater Manchester context. The following broad habitats were identified -

- **Uplands**
- **Lowland Wetlands**
- **River Valleys and Canals**
- **Woodlands and Trees**
- **Major Parks and Greenspaces**

In line with the requirements of the NPPF and the requirements of Ecological Network development to **enhance** networks of natural habitats by identifying areas for the creation of new habitats, species records, distributions and ecology, aerial photography and OS map bases were used to identify broader areas than those identified during the mapping of GI assets. These broader areas were in part arrived at by considering the effective distribution ranges of some key species most associated with the groups of component habitats of the themes. They also include areas where it is logically considered that there would be opportunities to create new habitats in keeping with the identified ecological character of the area concerned, based on prevailing soil types, topography, open-ness and proximity to existing habitats. Many species have very limited movement patterns in GM, both because of their inherent ecology and because the landscape of Greater Manchester is in many places very fragmented. Improvement/enhancement zones are therefore often closely connected with existing

Characterizing the identified priority GI into broad habitat types also provides the opportunity to further explain the particular importance of parts of the wider priority GI network and to propose opportunities that would be most effective in particular locations for enhancing the delivery of specific Ecosystem Services.

Very few habitats in Greater Manchester can be regarded as pristine and not capable of improvement, including habitats within designated nature conservation sites. For example many upland areas are within protected sites but nevertheless have significant scope for habitat enhancement. Designated sites can therefore be *both* existing priority areas for supporting GI and opportunity sites and areas for enhancement.

8.1 The Broad Habitat Character Areas

8.1.1 Uplands

A typical upland landscape

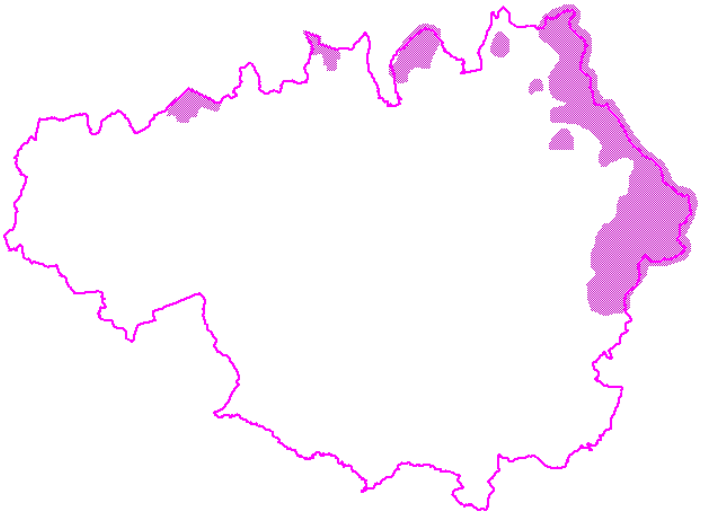


Fig 8 The Uplands GI Network

Description

This character area includes the South and West Pennines, part of the Pennine ridge of hills, lying between the Peak District National Park and the Yorkshire Dales National Park. This is a landscape of large-scale sweeping moorlands, pastures enclosed by drystone walls, and gritstone settlements contained within narrow valleys. The Uplands are found In Tameside, Rochdale, Oldham, Bury and Bolton in the east and north of Greater Manchester, with a smaller area represented in Stockport.

The area contains internationally important mosaics of moorland habitats that support rare birds such as merlin, short-eared owl and twite; large areas of the Uplands have been specially designated for their important wildlife value. There are strong links to upland areas within adjacent administrative boundaries, forming a wider Ecological Network.

The peat soils, including blanket bog, store significant volumes of carbon and active bogs (those forming new peat) have the potential to sequester carbon from the atmosphere and to store significant volumes of water.

The high levels of rainfall and impervious rocks make this area important for water supply, with many reservoirs supplying water to the nearby conurbations of Greater Manchester.

The open landscapes of the Southern Pennines in particular are also important for recreation due to the extensive open access areas and footpaths, and the sense of escapism they offer, along with the ease of access from large towns.

Upland character areas are identified using data representing upland habitat types, species associated with upland habitats, soil types and topography

Table x datasets used to characterise Upland character areas

Data	Included
Habitats	Blanket Bog, Upland Heathland, Upland Acid Grassland, Flushes
Species	Whimbrel, Short-eared Owl, Peregrine, Long-eared Owl, Skylark, Curlew, Small heath butterfly, Golden Plover
Soil Types	Peat
Topography	Land above 250m

Priority Ecosystem Services provided by the Uplands

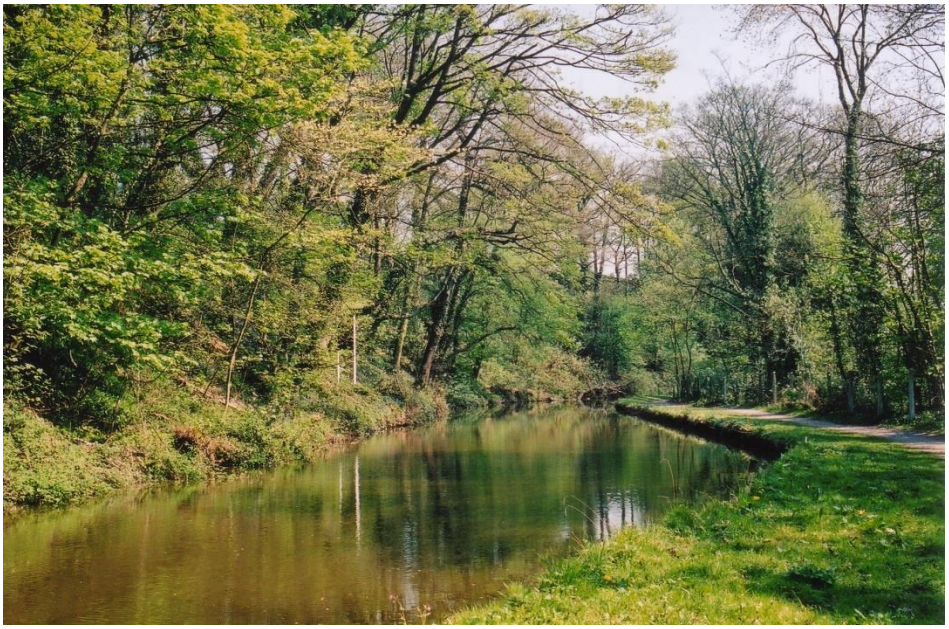
- Carbon Storage and sequestration (within stored peat and during peat formation in active bogs)
- Water Storage (by active peat and *Sphagnum* sp in blanket bogs)
- Water Quality Management (by reducing peat erosion and run-off)

- Recreation

Opportunities for Enhancement

- Restoration of Peat Bogs (blanket bog)
- Improvement of upland meadows for wildlife
- Improvement of public access and promotion of enjoyment of the landscape

8.1.2 River Valleys and Canals



Canal

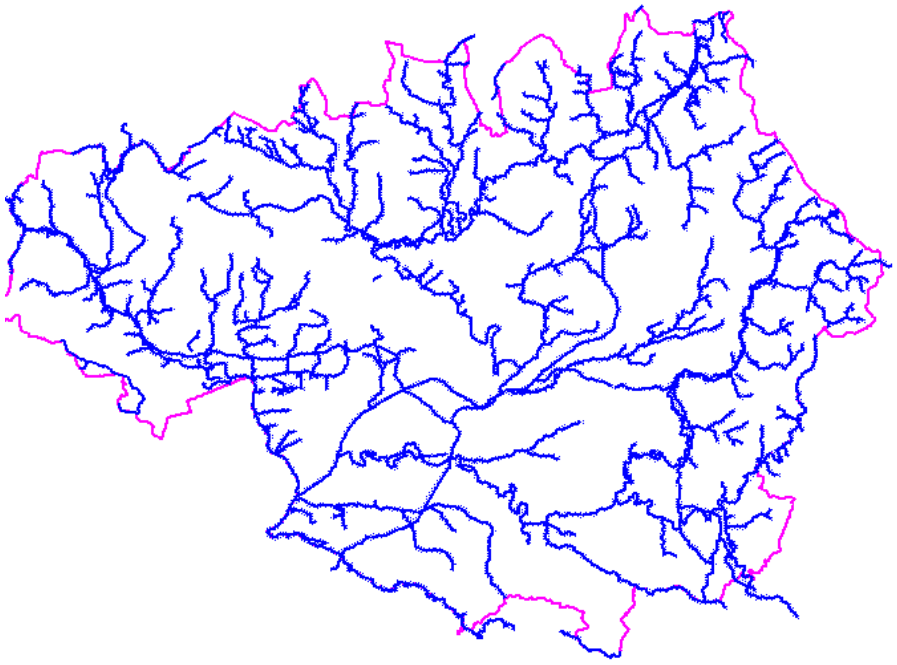


Fig 9 the River Valleys and Canals GI Network

Description

River Valleys and Canals form very important corridors of semi-natural habitats and natural greenspace throughout Greater Manchester – with open grassland, woodland and wetland all being closely linked to the water courses – linking urban centres with open countryside. Canals that weave through the centre of the conurbation not only offer opportunities for access and recreation, but also form a network of important wetland habitats in their own right. For example, sections of the Rochdale Canal have been designated as being of international importance for nature conservation as a Special Area of Conservation (SAC) and many of the main rivers and sections of Canals are important Local Wildlife Sites.

Rivers flow from the Pennine moors to the east and north, and the Peak District to the south-east, across the Conurbation and through sometimes very dense urban development and towards the lower-lying areas of the south and west. Important River Valleys include those of the Mersey, Irwell, Roch, Tame, Etherow, Goyt, Medlock, Irk and Bollin.

The Manchester Ship Canal, included in this priority area, follows in places the original routes of the Rivers Mersey and Irwell. The Manchester Ship Canal, the Bridgewater Canal, the Leeds and Liverpool Canal, and the Rochdale Canal are all inter-connected, linking the Manchester Conurbation with surrounding areas.

Rivers and Canals character areas are identified using data representing major rivers and canals, species associated with riverine environments, habitats associated with rivers and canals

Table x datasets used to characterise Rivers and Canals character areas

Data	Included
Habitats	Rivers, Canals,
Species	Otter, Water Vole, Kingfisher, Goldeneye, Daubentons Bat, white-clawed crayfish, Floating water plantain

Priority Ecosystem Services provided by River Valleys and Canals

- Surface Water and Fluvial Flood Management
- Water Quality Management
- Public Recreation and Sustainable Travel Routes
- Wildlife and Habitat Conservation

Relationship to previous studies

The River Valleys have long been recognised for their important to Greater Manchester; the first Policies advocating the protection and/or improvement of the River Valleys were included in the very first Greater Manchester Structure Plans more than 40 years ago and have been carried through into Unitary and Local Plans up to the present. There have been numerous initiatives in support of these Policies over many years, and many of these important initiatives are on-going (e.g. recent restoration of parts of the river Medlock in central Manchester).

Opportunities for Enhancement

- Improving water quality
- Re-naturalising rivers and waterways
- Improving public access to waterways
- Improving opportunities for sustainable travel along waterways

8.1.3 Woodlands and Trees

Typical woodland in Greater Manchester

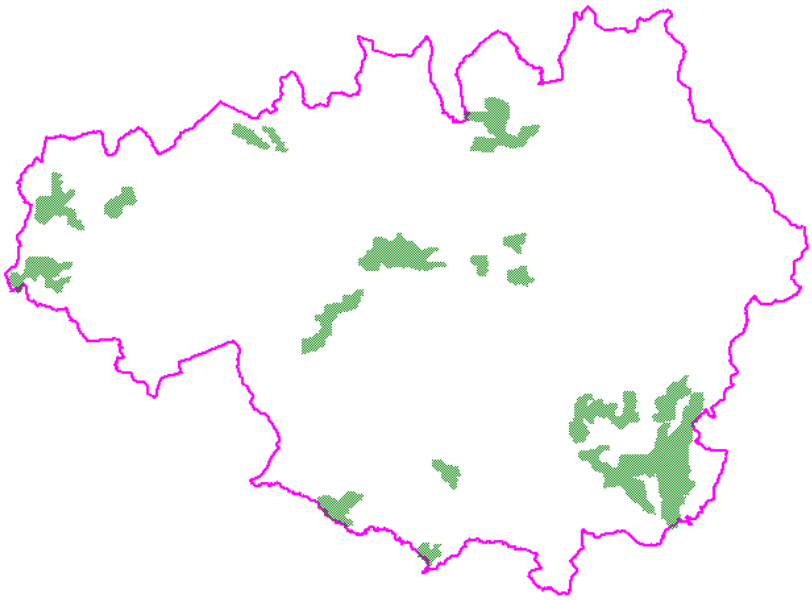


Fig 10 the Woodland GI Network

The Greater Manchester Tree Audit, which was co-ordinated by Red Rose Forest in 2011, estimated that there are 12 million trees in Greater Manchester covering on average 10 per cent of the land area on average, just above the national average.

Stockport had the most tree cover with close to 25 per cent cover while Oldham had the least with just 9.2 per cent cover. But there are also important woodland networks towards the centre of the conurbation associated with the Irwell Valley, and in the north-west close to the borders of west Lancashire. Greater Manchester's woodlands vary in character, from upland oak woods to wet woodland and from ancient broadleaved woodland to plantation and young woodland. Woodland provides a valuable wildlife resource, and many important woodlands have been designated for their nature conservation interest.

Impressive efforts have been undertaken over the past three decades to increase tree cover and the results of these efforts are now being realised. Maturing woodlands provide significant areas of Greater Manchester with a character that now appears much less grey and more green than previously. Woodland wildlife, including deer, woodland birds such as woodpeckers, jays and chiffchaffs and woodland butterflies such as Speckled Wood have all increased in numbers and distribution.

Table x datasets used to characterise Woodlands character areas

Data	Included
Habitats	Ancient woodland, Broad Leaved Woodland, Mixed Woodland
Species	Bluebell, Brown long-eared bat, Noctule Bat, Eurasian Badger, Lesser-spotted Woodpecker, Natterer's Bat, Spotted Flycatcher, Wood Warbler

Priority Ecosystem Services provided by Woodlands

- Recreation
- Carbon storage and sequestration (existing trees and new tree planting)
- Flood mitigation (trees reduce soil erosion and abstract large quantities of water from soil)

Opportunities

- New Tree Planting
- Positive Woodland Management
- Management of Recreational Pressures and provision of new opportunities for recreation

8.1.4 Lowland Wetlands

Lowland raised bog restoration, Chat Moss

Pennington Flash, Wigan

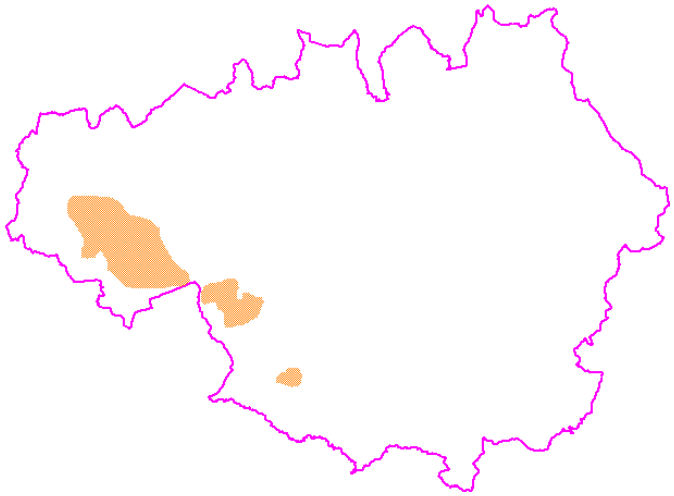


Fig 11 The Lowland Wetland Network

Description

This character area includes the large areas of remnant Mossland across areas of Salford and Wigan and the Wetlands associated with past industrial activity in Wigan.

The Mosslands includes areas of 'lowland raised bog' and areas that were formerly bogs, but which have now been converted to farmland.

Lowland raised bogs are areas of deep peat, which have developed over thousands of years in lowland areas where drainage has been poor. Poor drainage leads to the area becoming water-logged. Peat is then formed because the lack of oxygen slows down the decomposition of plant materials. Instead of rotting, the dead plant materials build up as peat. This process lifts the surface above the surrounding area to create a distinctive dome shape - the "raised bog".

Undamaged raised bogs support a range of bog mosses (sphagnum), together with cotton grasses, cross-leaved heath, bog rosemary and sundews. They also support a range of invertebrates. Over the last few hundred years most of this habitat has been lost through development farming and peat extraction. It has been estimated that the extent of remaining undamaged raised bog has declined in the UK by 94%, from 95,000 hectares at the beginning of the nineteenth century, down to approximately 6,000 hectares in the mid 1990s.

Locally it has been estimated that there were originally some 2,650 hectares of lowland raised bog covering the overall area now known as Chat Moss (which lies in the south west of Salford and extends into Wigan). However, by the 1990s around 1,900 hectares of this had been drained and fertilised to create agricultural land. 310 hectares of relatively undamaged peat deposits remained in four peat extraction sites mostly in Salford. Additionally, some land in Wigan retained some remnants of previous mosslands vegetation such as cotton grass.

In Wigan in particular, extensive valuable wetland habitats have formed on many former industrial sites where undermining has resulted in the formation of many subsidence flashes and ponds. A series of flashes between Wigan and Leigh now contribute significantly to the area's sense of place and offer an extensive mosaic of important wildlife habitats.

The Flashes are particularly significant for their variety and quality of habitats present, including open water, fen, swamp, woodland and grassland. These habitats are important for overwintering wildfowl, bittern, gadwall, breeding birds including willow tit, and several species of dragonfly. Water vole populations are found at many of the wetland sites, such as at Red Moss and the Wigan Flashes.

The Flashes are important areas for recreation and for sustainable travel.

Much of this Character Area is within the 'Great Manchester Wetland' Nature Improvement Area (NIA)

Table x datasets used to characterise Lowland Wetlands character areas

Data	Included
Habitats	Open Water, Ponds, Lowland Raised Bog, Marshy Grassland
Species	Barn Owl, Bittern, Corn Bunting, Cuckoo, Grasshopper warbler, Great crested newt, Lapwing, Marsh harrier, Greenshank, Reed Bunting, Wigeon, Wood sandpiper, Yellowhammer, Tree sparrow, Pintail, Northern shoveler, Cettis Warbler
Topography	Land below 50m

Priority Ecosystem Services provided by Lowland Wetlands *(most important in bold)*

- **Carbon Storage and Sequestration** (stored in peat substrates and sequestered in newly-forming peat in active bogs)
- Flood mitigation (water is stored in *Sphagnum* sp. in active bogs)
- Public recreation and sustainable travel
- Habitat and wildlife Conservation

Opportunities for Enhancement

- Restoration of lowland raised bog habitats
- Enhance opportunities for open access

8.1.5 Major Parks and Greenspaces

Typical Urban Parkland

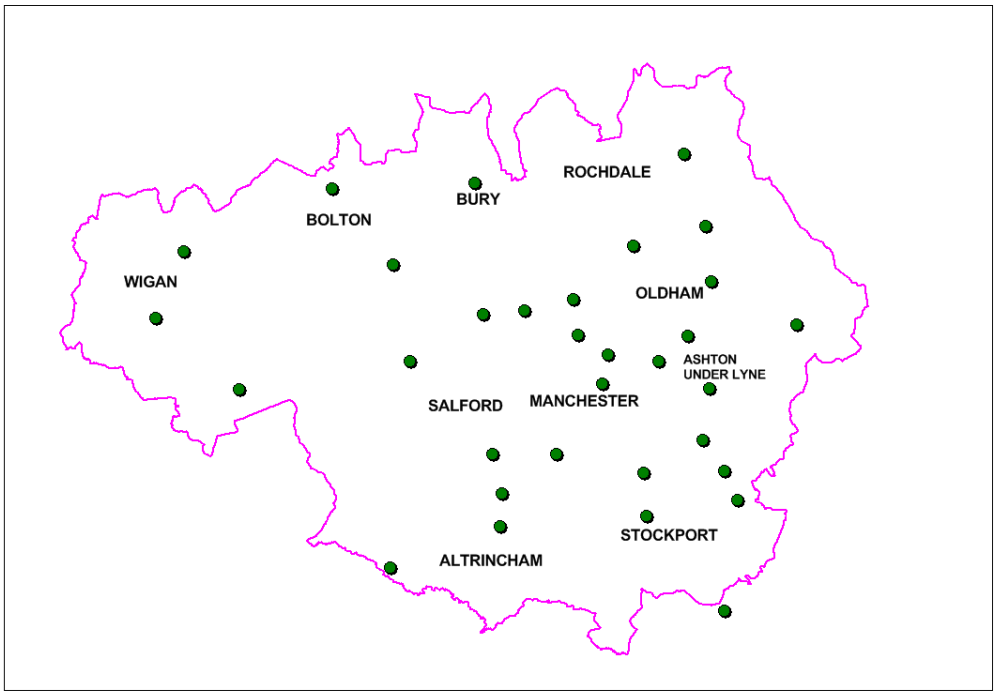


Fig 12 Locations of 'Major' Parks

Table 1 Major Parks and Greenspaces in Greater Manchester

Ref no	Name	District
37	Alkrington Woods	Rochdale
12	Boggart Hole Clough	Manchester
31	Buile Hill Park	Salford
7	Burrs Country Park	Bury
9	Chorlton Water Park / Mersey Valley	Manchester / Trafford
14	Clayton Vale	Manchester
32	Clifton CP	Salford
18	Crompton Moor	Oldham
27	Daisy Nook	Oldham / Tameside
26	Dovestones	Oldham
6	Dunham Park	Trafford
24	Etherow	Stockport
34	Fallowfield Loop	Manchester
28	Haigh Hall	Wigan
11	Heaton Park	Manchester
17	Hollingworth Lake	Rochdale
22	Hyde Park	Tameside
38	Jumbles	Bolton
35	Longford Park	Trafford
25	Lyme Park	*Outside GM but significant resource*
4	Moses Gate	Bolton
13	Moston Brook	Manchester / Oldham
20	Park Bridge and Surrounds	Tameside
2	Pennington Flash	Wigan
8	Philips Park (Prestwich Forest Park, Bury)	Bury
33	Platt Fields Park	Manchester
30	Queens Park Heywood	Rochdale
15	Reddish Vale	Stockport
3	Smithills	Bolton
29	Stalybridge CP	Tameside
21	Stamford Park	Tameside
19	Strinesdale	Oldham
16	Tandle Hill	Oldham
36	Vernon Park / Woodbank Memorial Park	Stockport
23	Werneth Low	Tameside
1	Wigan Flashes	Wigan
5	Worsley Woods	Salford
10	Wythenshawe Park	Manchester

Description

Publicly accessible parks and open greenspaces provide people with the opportunity to be physically active, facilitate social interaction, reduce stress and enhance a sense of well-being and provide opportunities for people to experience biodiversity first-hand. People are often passionately connected to 'their' park or greenspace.

Greater Manchester has a wide range of 'strategic' green spaces that are readily accessible to all, with widely differing characters.

There are formal parks and gardens like Wythenshawe Park, Historic Parklands like Dunham Massey and large, open upland areas like Dovestones. All are of high value for use by people for active and passive recreation, but they also perform a wide range of other ecosystem services such as flood risk management and provision of wildlife habitats.

Priority Ecosystem Services provided by Major Parks and Greenspace

These sites and areas are very varied; many ecosystem services can be delivered from single sites and areas. But they are perhaps most important for use by people.

(most important in bold)

- **Public Recreation and Green Travel Routes**
- Surface Water and Fluvial Flood Management
- Water Quality Management
- Wildlife and Habitat Conservation

Opportunities for Enhancement

- Investment in improving Access for All
- Investment in Management

8.2 Further Development of the Ecological Network

As already discussed the NPPF states –

Para. 117. To minimise impacts on biodiversity and geodiversity, planning policies should:

- plan for biodiversity at a landscape-scale across local authority boundaries
- identify and map components of the local ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity, wildlife corridors and stepping stones that connect them and areas identified by local partnerships for habitat restoration or creation
- promote the preservation, restoration and re-creation of priority habitats, ecological networks and the protection and recovery of priority species populations, linked to national and local targets, and identify suitable indicators for monitoring biodiversity in the plan

Networks are needed because many habitats are fragmented and isolated, hampering species movements and expansion of species populations. This makes species vulnerable, particularly in a time of changing climate. In Greater Manchester the landscape is very fragmented by built development, roads, railways and other infrastructure. A landscape that species can move through easily allows re-colonisation of areas after disturbance events, preventing local extinctions and facilitating population expansion. In the long term, as our climate begins to change, well connected habitats offer opportunities for populations to move as conditions become more or less suitable. The movement of individuals between populations in a connected landscape maintains genetic diversity which allows populations to adapt to future changes in environmental conditions.

Ecological networks can be defined, and designed, in various different ways but an emerging 'classical' network model involves the identification of a small range of network elements, including -

- Core areas, generally existing nature reserves and designated nature conservation sites
- Buffer zones around core areas to mitigate 'edge effects' on small habitat areas
- Logical corridors and stepping stones in the landscape to link core areas and important landscape elements and allow species movement
- Opportunity Sites and Areas where there is considered to be the highest potential to achieve ecological restoration

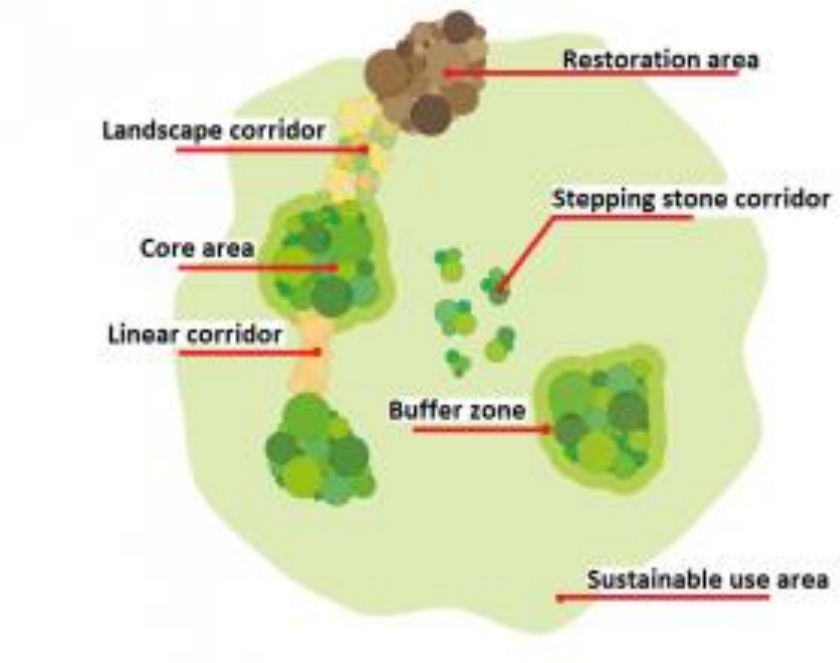


Fig A 'classical' Ecological Network Model
Source - TVERC

Core Areas

In Greater Manchester the Core Areas include –

- European designated nature conservation sites (Special Areas of Conservation, Special Protection Areas, Ramsar Sites)
- Nationally designated nature conservation sites (Sites of Special Scientific Interest)
- Regionally and Locally Designated Sites (Sites of Biological importance)
- Local Nature Reserves
- Areas with high densities of certain specially protected and priority species

Analysis of the dominant habitat types and the distribution of certain key species within clusters of core areas and sites allows for 'themed' core areas to emerge, very similar to the GI themes discussed above. The list of key species used in the analysis is dependent on there being sufficient evidence of distribution over a significant time period (at least 10 years) to give a reasonable robust data set of distribution. This limitation means that the species datasets used mainly relate to birds because this taxa provides the most reliable, comprehensive dataset available.

The major themes are woodlands, rivers and canals, uplands and lowland wetland.

Table x Major Habitat types and datasets and species used to define core area themes

Core Area	Habitat Types / Datasets	Species
Woodland	Broadleaved woodland, ancient woodland, mixed plantation woodland	Bluebell, brambling, Brown long eared bat, *Cladonia coniocraea,* Eurasian badger lesser redpoll, lesser spotted woodpecker, natterers bat spotted flycatcher, wood warbler
Uplands	Blanket bog, upland heathland, upland acid grassland	Brown hare, *Cladonia diversa Cladonia Floerkeana*, common lizard, dotterel, golden plover goshawk, grey partridge, long eared owl, merlin, mountain hare, peregrine, reindeer moss ring ouzel, short eared owl skylark, small heath, twite, curlew
Lowland Wetlands	Lowland raised bog, open water, ponds, wet woodland, wet grassland, fen, marsh	Barn owl, bittern, corn bunting, cuckoo, grasshopper warbler, great crested newt, lapwing, marsh harrier, greenshank, reed bunting, wigeon, wood sandpiper, yellowhammer, tree sparrow, pintail, northern shoveler, cettis warbler
Rivers and Canals	Rivers (OS open rivers dataset) and Canals	Daubentons bat, European otter, water vole, goldeneye, kingfisher, noctule bat, white clawed freshwater crayfish, floating water plantain

Buffers

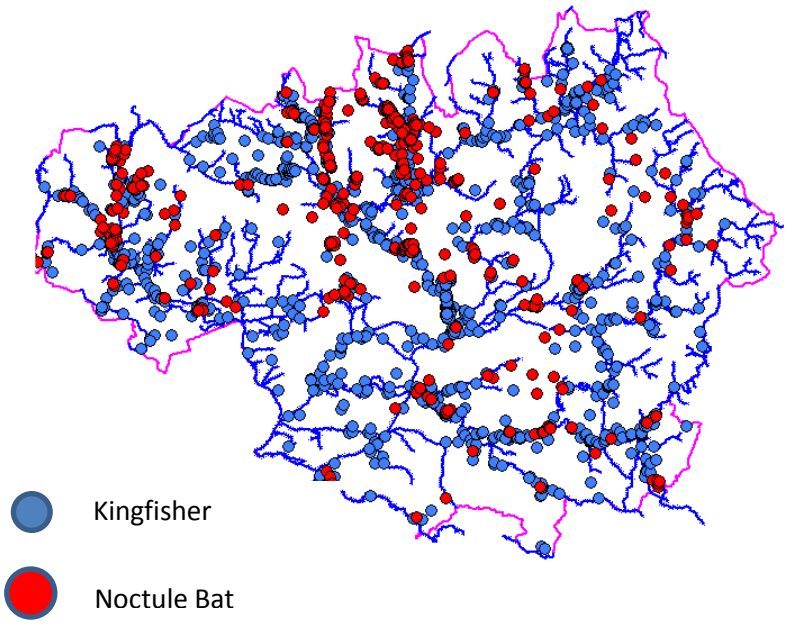
Buffers around core sites and areas have been arrived at by analysis of species movement patterns, available land, predominant land uses and the degree of landscape fragmentation. The buffers are necessarily GIS constructs and should be viewed as 'areas of search' for where the protection or creation of buffers should be considered as part of any land use or land management proposals.

Corridors

The volume and quality of species datasets used in the development of the priority GI Network enables Wildlife Corridors in Greater Manchester to be identified better defined in terms of the species which use the corridors. Below is an example of the distribution of species records from across Greater Manchester; the **red** dots are Noctule bats and the **blue** dots are Kingfishers, overlaid onto the Rivers and Canals part of the Network.

For very many species the River and Canal network offers the only apparent properly coherent corridors through Greater Manchester because of the high degree of landscape fragmentation caused by built development, roads, railways and other infrastructure in the landscape.

The importance of the network for the movement of these species is readily apparent, as are the gaps in the distributions where more work is needed to enhance these waterways for the species concerned.



Priority Opportunity Areas

Since the creation and enhancement of habitats will inevitably benefit a range of ESS in addition to biodiversity the Opportunity Areas should be regarded as providing opportunities both for habitat creation and improvement and for GI in general.

The identification of Strategic Opportunity Areas and Sites was based on a range of objective factors and more subjective criteria.

Objective Criteria

Example – Chat Moss Opportunity Area

To recreate wetlands, and particularly lowland raised bogs, certain ecological and geo-environmental conditions are required –

- For bog restoration there needs to be peat present at a depth of at least 50 cm
- The peat needs to be in relatively good condition
- There needs to be a supply of relatively clean water and methods for keeping standing water in place in order to re-wet the peat and allow Sphagnum moss to colonise and spread
- Depressions and basins are required to form new wetlands and sustainable ponds
- Habitats of good and reasonable quality need to be nearby to enable colonisation and dispersal of species to occur

The following available datasets can be used to identify and map these criteria –

- Soil type and depth
- LIDAR data
- Drainage patterns and watercourses
- Habitat and species distribution datasets

Of course Network models need to be as ambitious as possible and aspirational. But identification of sites and areas specifically for the development of a Land-use Plan requires a certain amount of realism to be included in the models.

An assessment of the realistic prospect of sites being improved within a reasonable (Plan) period needs to be made. This more subjective assessment is based on asking the following questions -

- Knowledge base – do we know how to restore the habitat types concerned?
- Do management plans and/or enhancement plans exist for areas concerned or similar areas?

- Land ownership / management – do we have an idea of who owns and/or manages the necessary land? Is land ownership very fragmented? Is there any evidence that landowners may be sympathetic to landscape and habitat improvements?
- Are there any existing land management partnerships or initiatives operating in relevant areas?
- Are there any funding mechanisms available or in prospect that could facilitate enhancement?

For Chat Moss –

Question	
Is the knowledge base available?	Yes, there are numerous examples of wetland restoration in practice, including examples from other areas of Chat Moss
Do enhancement plans already exist?	Yes, prepared by Salford and Wigan Councils and private land owners, and by the Lancs Wildlife Trust
Land ownership / management	Land ownership on the Moss is understood, with few major landowners, some of whom have already demonstrated support for wetland restoration
Are there any existing management partnerships?	Yes, an established Nature Improvement Area supported by Natural England includes Chat Moss. Salford and Wigan Councils have long supported the aspiration for improvement on the Moss.
Are there any funding mechanisms available?	Yes, current funding for enhancement is coming from various sources including the HLF, Defra, the Lancs Wildlife Trust and private landowners. The emerging 'net gain' approach to land-use planning may provide a future funding mechanism for enhancement.

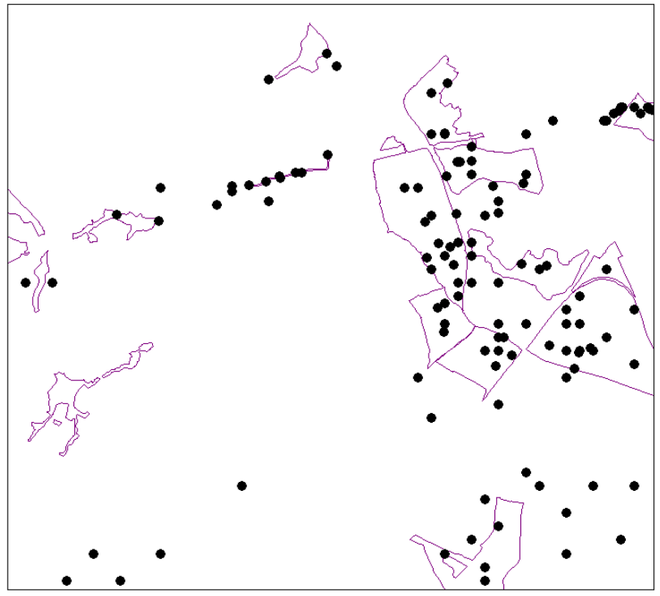
Wider Opportunities

Of course opportunities for biodiversity enhancement and the enhancement of GI in general for ESS delivery, can occur almost anywhere. For example, planting trees in urban areas can assist flood mitigation measures, add to biodiversity, improve the appearance of an area and potentially mitigate the harmful effects of air pollution. And very many areas of GM could benefit from new street trees.

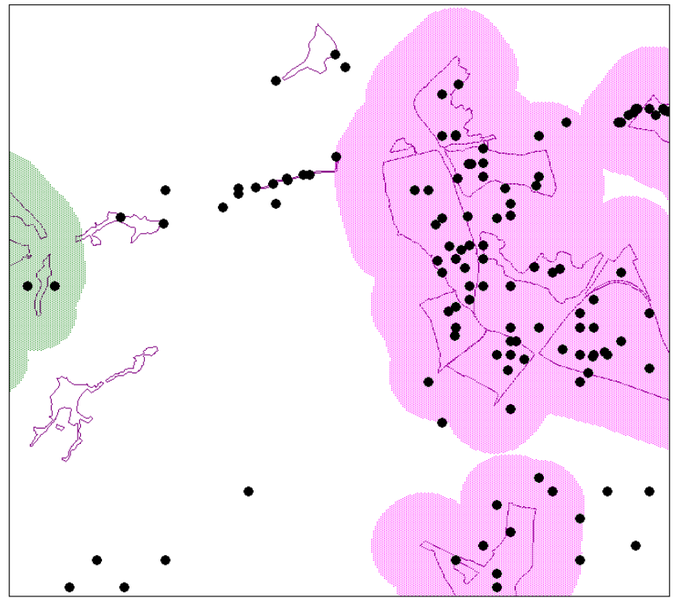
Street Tree Planting, Salford *(City of Trees)*

Elements of a Greater Manchester Ecological Network – worked example

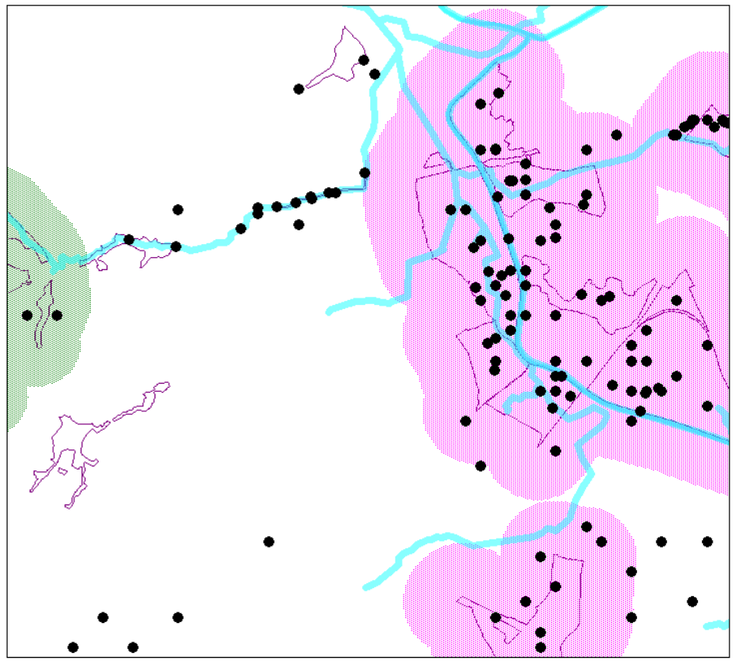
Core (Node) Sites – SSSIs, SACs, SBIs, LNRs



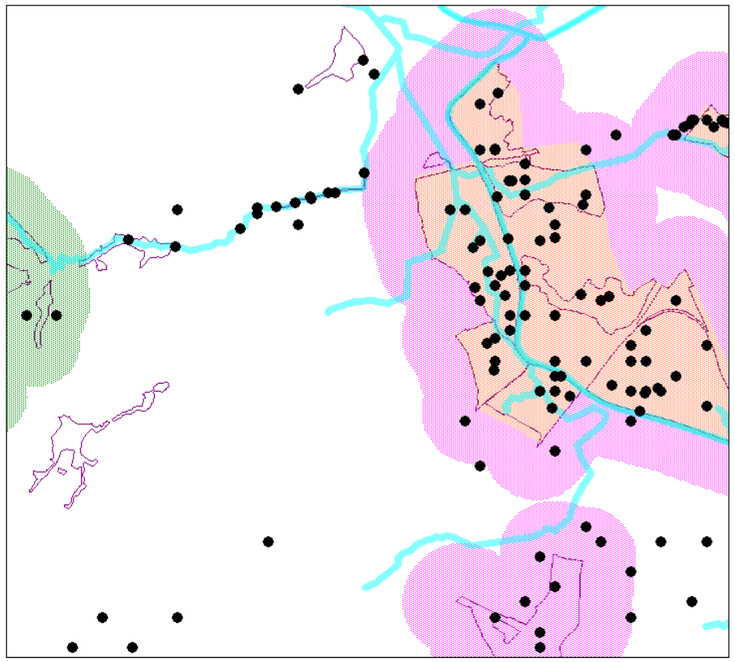
Core (Node) Sites with notable species included (poins); species communities are selected on the basis of known distribution over time and ecology, particularly related to dispersal



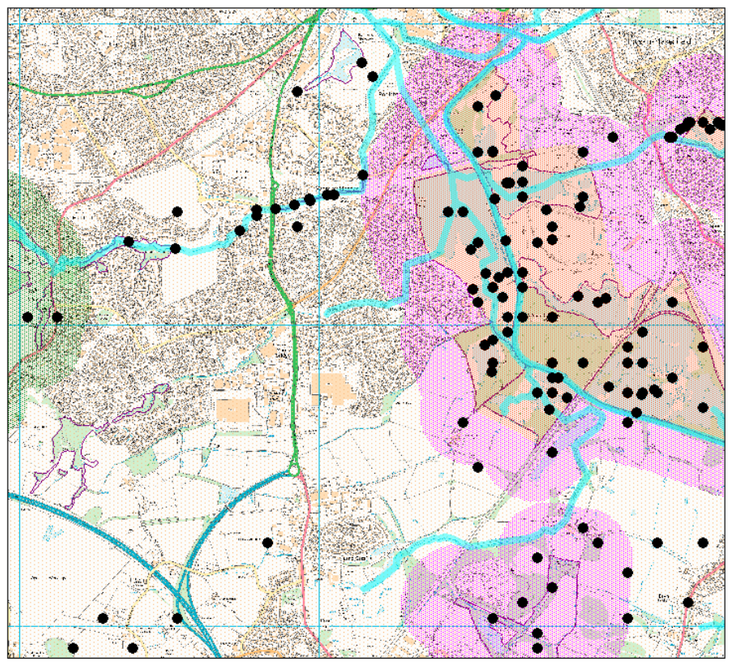
Buffered Core Sites, buffers based in part on ecology of notable species. Buffers are themed for broad habitat types, in this example pink is lowland wetland and green is woodland



Corridors are now added in (blue)



‘Opportunity Sites’ for priority biodiversity enhancements now added in (orange areas)



Network with OS Base for scale and location; this is part of Wigan, a Lowland Wetlands and Woodlands area

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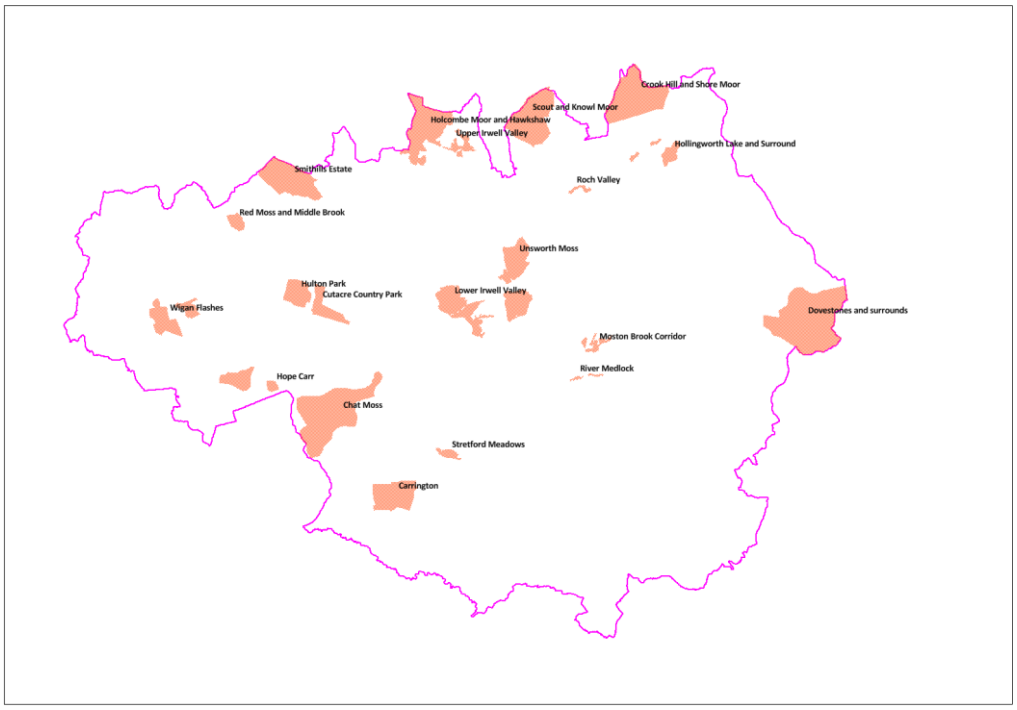
9 Summary Opportunity Sites and Areas

Details of Identified sites and areas for GI Enhancement (including biodiversity enhancement) are included in Appendix 1 of this Report.

Below is a summary figure showing the broad distribution of currently identified Opportunity Sites across Greater Manchester–



10 Summary Representation of the developing GM Ecological Network (example area)

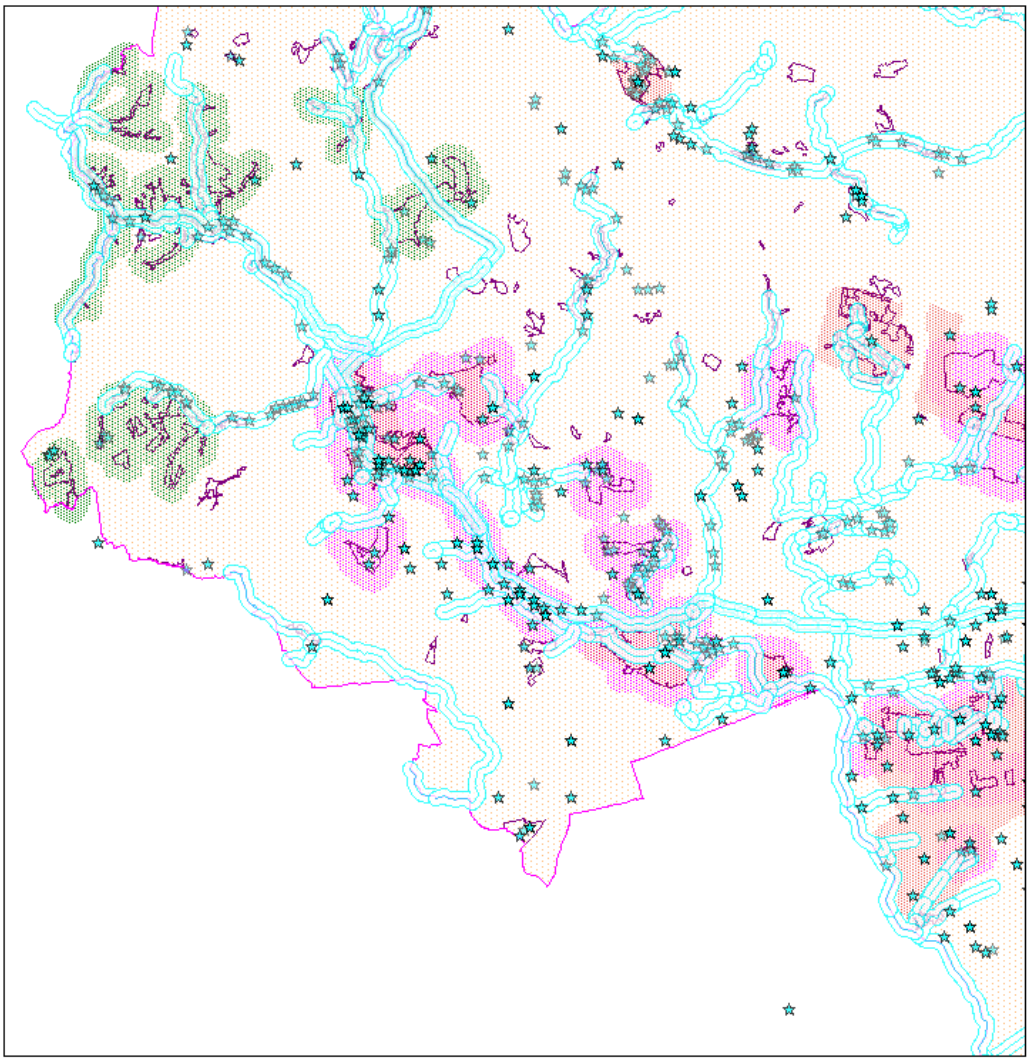


Fig Example of part of the developing Ecological Network (lowland wetlands, Wigan Flashes).

Includes core sites, buffers, corridors and opportunity areas, together with slected species/taxa point data

11 Relationship of the Priority GI Network to the GM Green Belt

The methodology for the development of the GM Priority GI Network did not use the criteria which are used to define Green Belt. In particular Landscape Value and degree of 'open-ness' and separation function, important in the identification of Green Belt, were not used to identify priority GI.

For this reason the priority GI Network is **not the same** as the Green Belt and the two are not comparable. In addition, the methodology used to map priority GI results in something of a 'GIS construct', including areas of search most likely to support priority GI, so it is not possible to compare actual areas of Green Belt with Priority GI.

However, the Priority GI Network *could* be used to inform an exercise in analysing the value of particular sites or areas within the Green Belt for their capacity to deliver Ecosystem Services.

12 Relationship to the Great Manchester Wetland Nature Improvement Area (NIA)

Nature Improvement Areas (NIAs) were established by government as a mechanism for creating joined up and resilient ecological networks at a landscape scale. They are run by partnerships of local authorities, local communities and landowners, the private sector and conservation organisations, in some cases with funding provided by the Department for the Environment, Food and Rural Affairs (Defra) and Natural England.

The Great Manchester Wetland NIA is an ambitious scheme focusing on the restoration of the lowland wetlands of Wigan and the Mosslands of Chat Moss and Risley Moss to the west and southwest of Manchester. The boundary of the NIA was not defined using analysis of ecosystem service delivery; it is rather a construct to include all of the major *opportunities* for new wetland and habitat creation. However, the boundary of the NIA includes large areas of Priority GI as defined in this study. Further, the ecological character of the Priority GI within the NIA is dominated by lowland wetlands, which supports the designation of the NIA in this area.

The NIA has been included as a 'Strategic Opportunity Area' in this study.

In the 2018 Defra 25-year Environment Plan NIAs have been renamed as 'Nature Recovery Areas'.

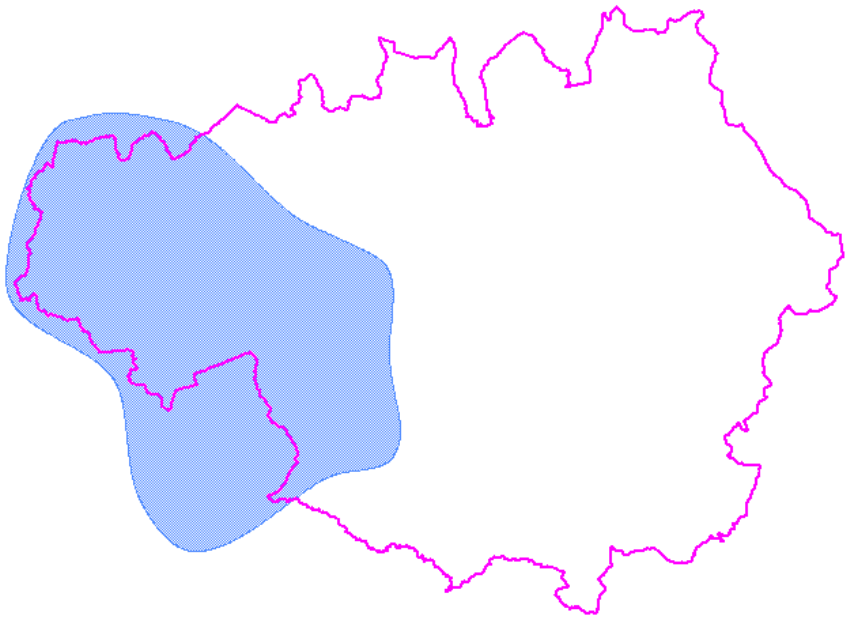


Fig 14 The Great Manchester Wetland NIA

13 Ecological Networks in Neighbouring Authorities

It is a requirement of the NPPF that strategic plans should **'**plan for biodiversity at a landscape-scale across local authority boundaries'. Whilst the developing GM Ecological Network based on the wider GI network is cross-boundary in the sense that it does cross local authority boundaries within GM, it is good practice to ensure, as far as possible, that GI and Ecological Networks in GM correspond to developing Networks out-with GM.

13.1 Lancashire

Lancashire has developed a draft Ecological Network for the County, probably the most advanced such network in North West England, based on GIS analysis of **habitat typologies**.

The Typlogies include 'grassland', 'wetland and heath' and 'woodland', There is direct connectivity between the 'Wetland and Heath' Lancashire typology and the 'Wetland' GM typology and the 'Woodlands' typology, particularly between Rossendale and Rochdale, which when taken together form a coherent cross-boundary ecological network -

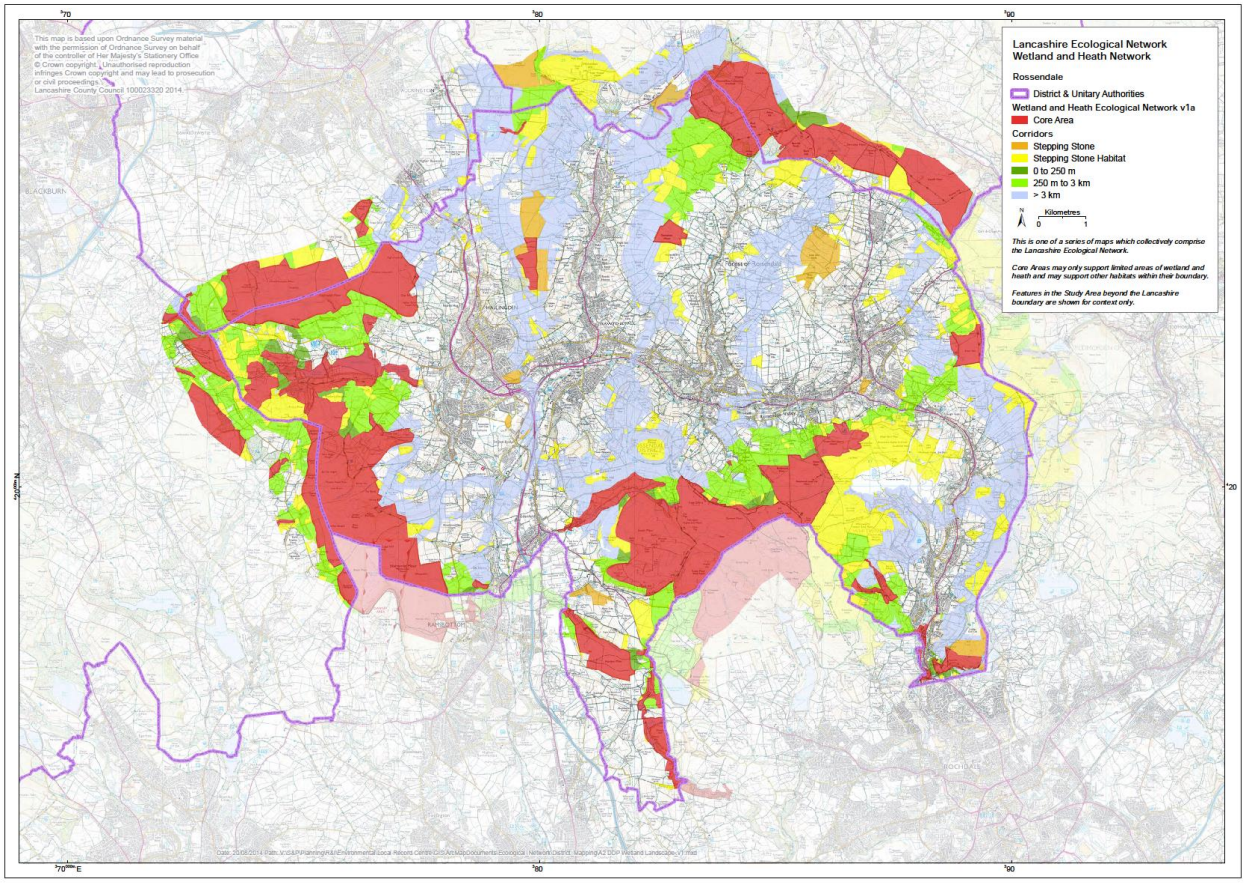


Fig 15 sample map of the Lancashire 'Wetland and Heath' ecological network in Rossendale, bordering in particular with Rochdale

13.2 Cheshire

Cheshire has developed an ecological network based on 'core' biodiversity areas and habitats, called the 'Cheshire Econet'.

Although the methodology used in identifying these priority areas for biodiversity conservation was in places similar to the methodology used in the identification of priority GI in Greater Manchester (in that the network was identified using habitat and species distribution datasets and using core areas and corridors) there is limited direct connectivity between these 'core' network areas and the GI Network in GM because of the narrow focus of the Cheshire Econet on very high-value and statutorily protected habitats. No part of the identified Cheshire EcoNet directly borders on areas of Greater Manchester.

13.3 Other Areas

The Ecological Networks in other neighbouring authorities (most notably Derbyshire) are not yet well enough developed to facilitate meaningful comparisons with the GM Network.

14 Targets and Standards

If the enhancement of Green Infrastructure and the achievement of net gain, both for biodiversity and for green infrastructure in general, is to be meaningful it is important to set targets and standards for improvement.

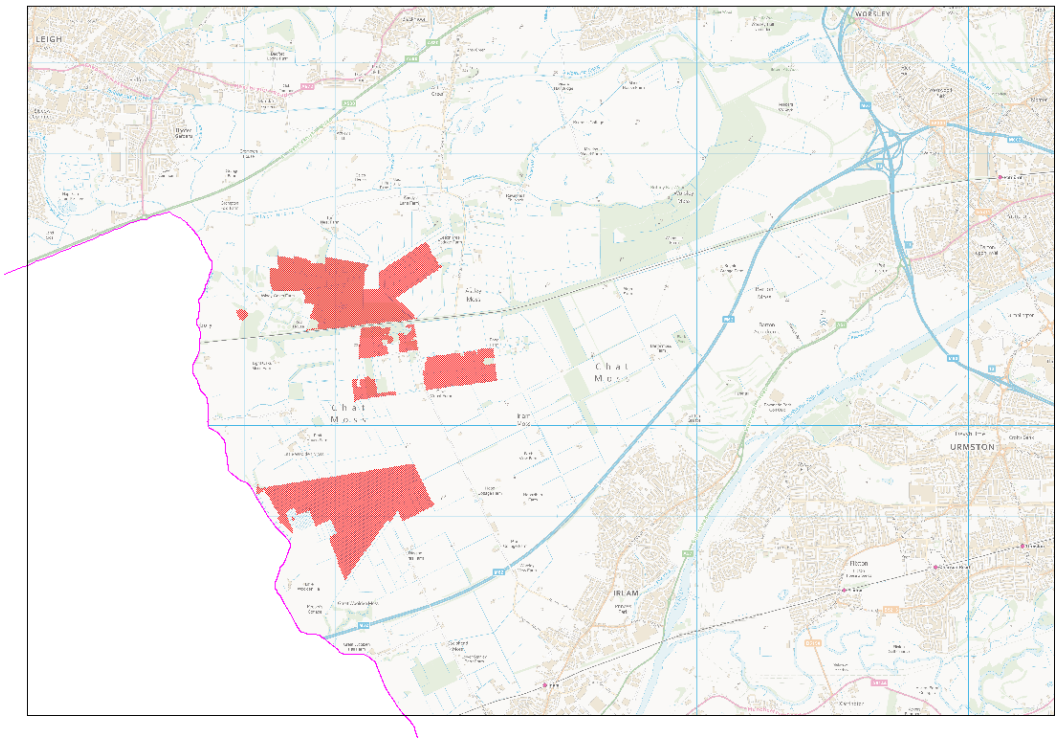
In principle it is recognised that target setting should relate in some way to the actual impact of planned development(s) on Green Infrastructure and Natural Capital. The process of assessing the impact of a development, process or operation and then preparing and implementing a strategy or action plan to mitigate these impacts is known as 'Natural Capital Accounting'. In practice, for a very large-scale strategic plan where the quantum of development and it broad locations are known but the detail of individual developments is an unknown it is very difficult to apply accurate Natural Capital Accounting methodologies and metrics; most available accounting methods and tools have been developed to deal with discrete developments and business operations as a way of setting targets for improved environmental performance. The approach taken in this paper is therefore to try to identify the likely *broad* impacts of the GMSF on Natural Capital and then to develop meaningful and deliverable targets that would address these broad impacts in general terms rather than attempting to directly relate the targets to specific, measurable impacts. This approach should not rule out the possibility (probability?) of applying Natural Capital Accounting metrics to specific developments as and when the details of such developments come forward.

One way of setting targets for the conservation, improvement and creation of Priority Green Infrastructure as put forward in the GMSF is to establish targets for the 'component habitats' that make up an overall GI 'theme'. For example to set an overall target for the enhancement of Lowland Wetlands targets could first be established for the component habitats making up the overall theme – lowland raised bog, ponds, open water *etc* – and then these component targets could be totalled to give an overall target for Lowland Wetlands.

This apparent bias towards the restoration of semi-natural habitats will not simply address the nature conservation ecosystem service. It is the case that diverse, well-managed habitats are often the places that deliver most in terms of services. For example a new woodland will store carbon mitigate flood risk, improve air quality and provide a pleasant public amenity.

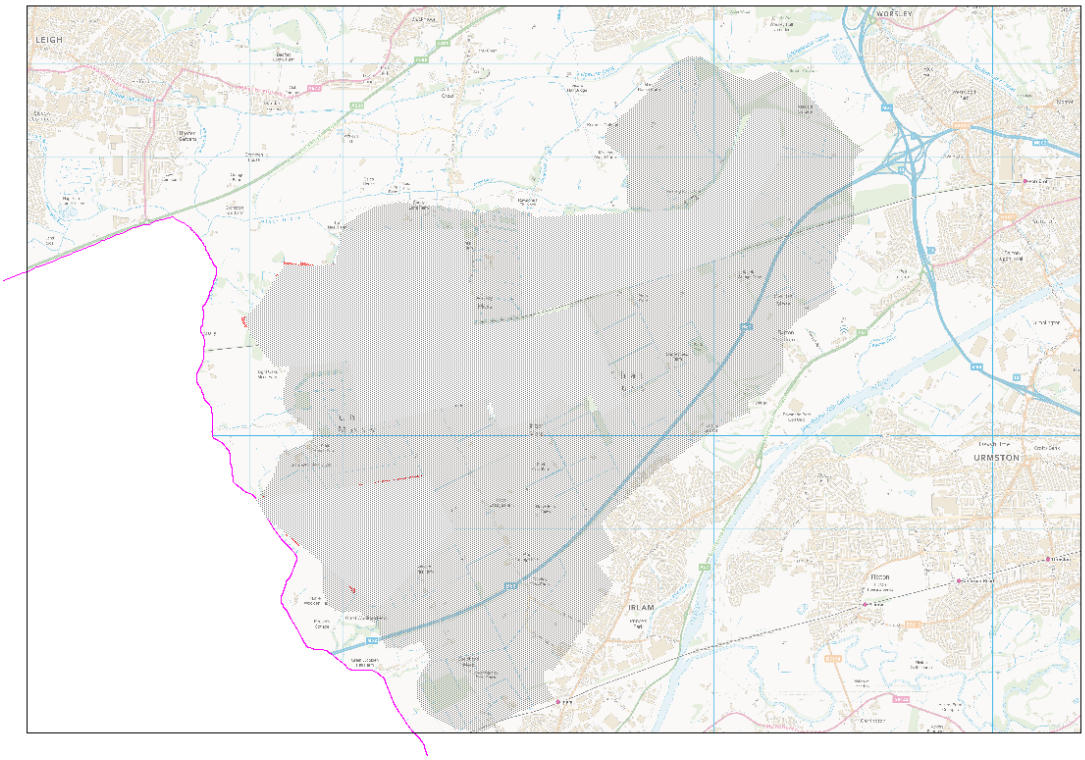
14.1 Example of how targets have been developed – 1 Lowland Raised Bog (Lowland Wetlands GI Theme)

Currently there are estimated to be approximately 170ha of lowland raised bog habitat in reasonable condition in Salford /Wigan. The extent and distribution of the habitat type is shown in Fig 3 below -



Areas of existing Lowland raised Bog, Chat Moss Salford/Wigan

Across Chat Moss as a whole there are approximately 2,000ha of underlying peat substrates



Extent of peat substrates, Chat Moss and surroundings areas

In theory then there is *potential* to re-create more than 1,800 ha of lowland raised bog, because the substrate and prevailing climatic conditions and local topography and hydrology may support this. This would add very significantly to carbon storage and sequestration potential, to water storage capacity and to biodiversity value.

But to set this 1,800 ha as a target would be to make a number of significant assumptions; for example, that

- all the peat is of a suitable depth / quality for restoration to be effective,
- that the local topography would support re-wetting of the peat,
- that there are no competing land uses,
- that comprehensive mechanisms are available to support bog restoration *etc etc*.

Some of these are unreasonable assumptions.

In addition, the harm that may be caused by future development in the area is unlikely to be so extensive to justify restoring more than 1,000 ha of lowland bog to off-set any harm.

The most basic target for lowland raised bog would be to retain in favourable condition some 170 ha of the existing habitat type, while the target for bog restoration / creation would then lie somewhere between 170ha and 1,800 ha.

To arrive at a meaningful target for bog restoration and creation within this range we must take into account 'real world' factors, in this case including –

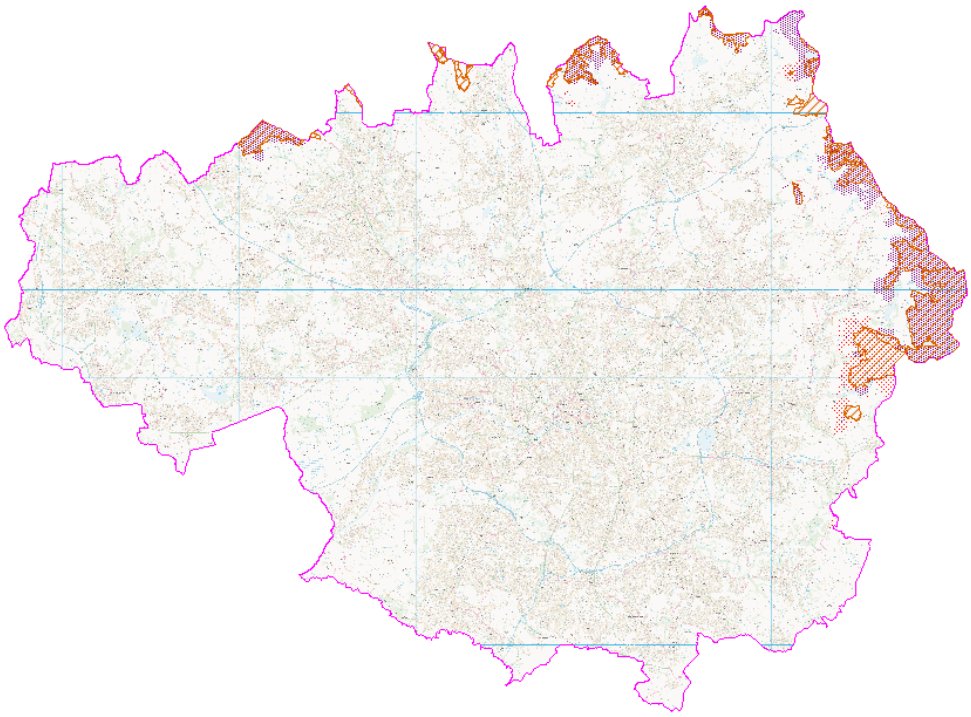
- Land allocated or scheduled for allocation for future development over peat
- Other competing land-uses where bog restoration would be very unlikely to come forward in the foreseeable future (e.g. where the current land-use is woodland or agriculture)
- Sites already being actively restored
- Local topography (i.e. would re-wetting of the peat in fact be possible)
- Existing and future potential mechanisms for facilitating bog restoration (arrived at by analysis of how much bog is currently being restored and using which mechanisms)

When these elements are factored in, realistic targets for lowland raised bog would be

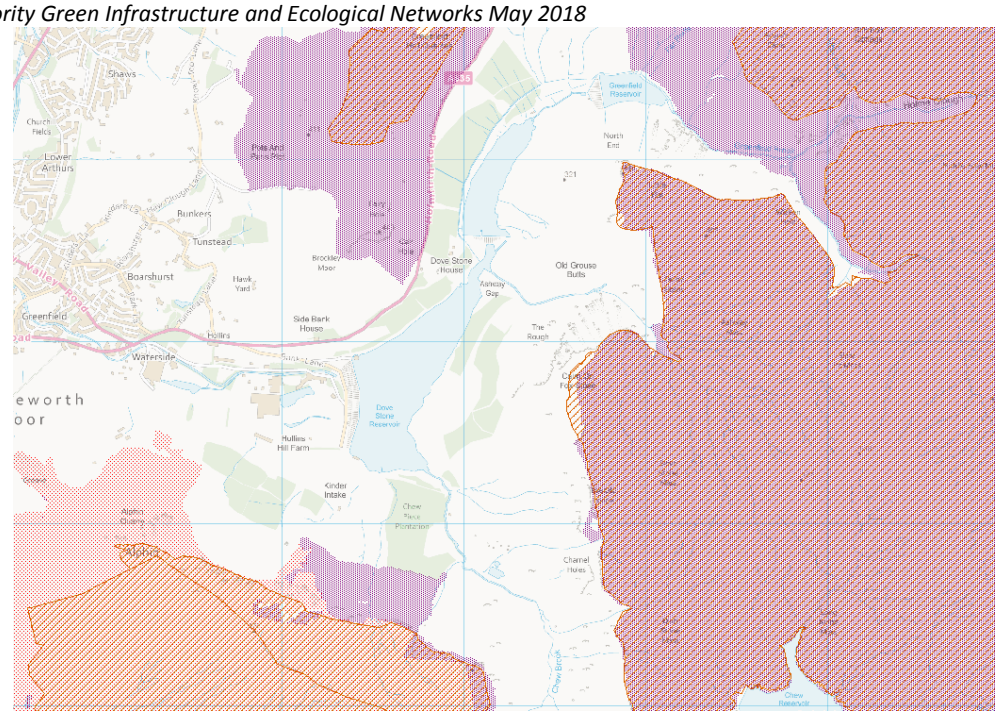
Objective	Target	Extent (ha)
Maintain extent	Maintain the existing extent of Greater Manchester lowland raised bog resource	170
Maintaining extent of substrate for future restoration	Ensure no further loss of peat deposits	435
Achieving favourable condition	Rehabilitate existing raised bog resource to favourable condition	170
Restore	Restore lowland raised bog on suitable areas of peat	160

14.2 Setting Targets Example 2 – Uplands GI Theme

If we take as a starting point for the Uplands Theme the extent of current upland habitat types (all habitat types included within the GI Theme 'Uplands') and the extent of abiotic factors that could potentially support upland habitats in GM we arrive at an overall extent of some 4,000 ha.



The extent and distribution of existing habitats and physical and biotic factors that could support upland habitats in Greater Manchester



Closer-grain mapping of existing upland habitat types and abiotic factors that could support upland habitats in Greater Manchester

Making a (probably) reasonable assumption that the majority of the habitat types are not in a favourable condition (based on descriptions and assessments of designated nature conservation sites) and could be restored, an overall target for maintaining the extent of the existing habitat and achieving favourable condition could be as high as all 4,000 ha. But similar to lowland raised bog this is probably not a reasonable assumption.

Potential constraints on meeting targets in upland areas, particularly a target for achieving favourable condition, are

- fragmented land ownership,
- common land rights,
- resistance of landowners, tenants and commoners to enhancement because of competing land uses (e.g. agriculture),
- topography and
- peat condition (which may preclude re-wetting of peat).

Taking these factors into account, realistic targets would be –

Objective	Target	Extent (ha)
Maintain extent	Maintain the existing extent of Greater Manchester Upland habitat resource	4,000
Maintaining extent of substrate and abiotic conditions for future restoration	Ensure no further loss of abiotic factors (e.g. peat deposits)	4,000
Achieving favourable condition	Rehabilitate existing raised bog resource to favourable condition	500
Restore	Restore lowland raised bog on suitable areas of peat	500

14.3 Woodlands and Trees

The methodologies described above can also applied to the 'Woodlands' GI Theme to arrive at the following targets

Objective	Target	Extent (ha)
Maintain extent of woodland	Maintain the existing extent of Greater Manchester lowland broadleaved, upland oak and wet woodlands	3,500
Achieve favourable condition	By appropriate management, restore the diversity of structure and species to favourable condition	2,500
Expand Woodland habitat	Through natural regeneration and woodland planting	480
Maintain extent of hedgerow		2,700 km
Plant new hedgerow		20 km
Plant new trees*	By woodland planting and all other tree planting (e.g. street tree planting)	1 million trees

14.4 Rivers and Canals

It is proposed that the Target for the Rivers and Canals Theme should be the existing target developed by the Environment Agency for River Basin Management Plans – i.e. **to achieve 'good' status (as defined in the WFD) for all major water bodies by 2027**.

14.5 Major Parks

The first target for Major Parks is to maintain their current extent.

14.6 Urban, Suburban, Peri-Urban and 'Local' GI targets

It is recognised that target setting for the conservation, enhancement and creation of semi-natural greenspace in 'deep urban' or peri-urban locations, particularly associated with new development proposals cannot readily be addressed through improvements to habitats contained in one of the GI strategic themes because the green space typologies found in urban areas are not included in the major GI Themes proposed in the GMSF

While it can be argued that the conservation and enhancement of habitat types in the open countryside will undoubtedly, albeit indirectly, improve the quality of life or the urban population by delivering useful ecosystem services it is the case that it is the green infrastructure close to the places where people live and work that is most likely to have a more immediate positive effect on well-being and quality of life.

In other parts of the UK targets and standards have been set which are relevant to the delivery and improvement of urban, peri-urban and local green infrastructure

Some examples are –

- The Urban Greening Factor (the UGF) for London
- The Leeds City Council targets for urban greenspace provision
- The proposed Woodland Trust target of requesting tree planting and woodland creation as a part of new developments and
- The Fields in Trust targets for the provision of 'active' greenspace for recreation

While targets can be an important starting point for ensuring that improvements to urban greenspace are achieved there is a genuine concern that not all developments, particularly in an urban context, lend themselves easily to the provision of green infrastructure; space is limited and at a premium. Provision of greenspace can be more difficult in an urban context and therefore more expensive to implement; this has the potential to make some schemes unviable.

And the implementation of targets for green infrastructure provision might be used as a replacement to getting expert advice on how to integrate green infrastructure in a meaningful way. Often *quality* and *design* can be more important than quantity and type. If targets are too rigidly applied there is a danger that they become a 'tick box' exercise, e.g.

developers would always aim for the minimum target. These limitations apply to the Leeds standards and to the London UGF.

The Woodland Trust tree planting target is not easily applicable in a deep urban context where there is little available space for new tree planting in dense developments, and the Fields in Trust targets are useful but address a narrow range of ecosystem services associated with active recreation.

Nevertheless standards or guidelines for developments in urban areas would at least help to facilitate a conversation between developers and planners, initiating innovative design-led solutions for the provision of GI in urban spaces (e.g. green roofs, green walls, sustainable urban drainage systems). They would act as a means of increasing urban greenspace in the absence of other current mechanisms for securing this increase.

An innovative solution for the provision of GI in deep urban environments

By definition it is impossible to be prescriptive about the provision of 'novel' and 'innovative' GI provision solutions and difficult to set quantitative targets for improved provision.

While the contribution that individual developments / allocations within the urban fabric could make to the enhancement of Natural Capital could be significant it is suggested that the extent of such contributions (and local Landscaping Standards / Targets) may be best decided at a Local Plan level, particularly when local context needs to be taken into account.

But the GMSF should at least set the framework for the development of such standards by setting **an overall requirement that new development should contribute to the improvement of high quality Green Infrastructure / Natural Capital.**

15 Applying existing and developing Natural Capital standards and targets to the GMSF (Natural Capital and GI)

Many ESS contributing to Natural Capital will be protected and enhanced though other Policies to be included in the GMSF that are not directly related to Green and Blue Infrastructure.

15.1 Air Quality

Commitment through the development and implementation of robust policies contributing to the achievement of established International, UK and Local Air Quality Standards.

15.2 Water Quality

Commitment through the development and implementation of robust policies contributing to the achievement of established International, UK and Local Water Quality Standards.

15.3 Climate Change

Commitment through the development and implementation of robust policies to contributing to the achievement of established targets in the GM Climate Change Strategy

15.4 Soils and Geology

Commitment to developing a Soils and Geodiversity Action Plan for Greater Manchester

15.5 Priority GI Themes – summary targets

15.5.1 Uplands

Objective	Target	Extent (ha)
Maintain extent	Maintain the existing extent of Greater Manchester upland habitat resource	4,000
Maintaining extent of substrate and abiotic conditions for future restoration	Ensure no further loss of abiotic factors (e.g. peat deposits)	4,000
Achieving favourable condition	Rehabilitate existing raised bog resource to favourable condition	500
Restore	Restore lowland raised bog on suitable areas of peat	500

15.5.2 Woodlands and Trees

Objective	Target	Extent (ha)
Maintain extent of woodland	Maintain the existing extent of Greater Manchester lowland broadleaved, upland oak and wet woodlands	3,500
Achieve favourable condition	By appropriate management, restore the diversity of structure and species to favourable condition	2,500
Expand Woodland habitat	Through natural regeneration and woodland planting	480
Maintain extent of hedgerow		2,700 km
Plant new hedgerows		20 km
Plant new trees*	By woodland planting and all other tree planting (e.g. street tree planting)	1 million trees

** proportion of City of Trees 3 million target within the lifetime of the GMSF*

15.5.3 Lowland Wetlands

Objective	Target	Extent (ha)
Maintain extent of lowland wetland habitats	Maintain the existing extent of Greater Manchester lowland broadleaved, upland oak and wet woodlands	5,500
Achieve favourable condition of lowland wetland habitats	By appropriate management, restore the diversity of structure and species to favourable condition	650
Expand lowland wetland habitats	Through natural regeneration and woodland planting	270

15.5.4 Rivers and Canals

Achievement of 'good' condition for all major waterbodies and watercourseswithin the lifetime of the Plan

15.5.6 Major Parks and Greenspaces

Objective	Target	Extent (ha)
Maintain extent of major (priority) Parks and Greenspaces		??, *to be calculated*
Improve Condition of Major (priority) Parks and Greenspace	By appropriate management, restore and improve the capacity of major parks and greenspaces to deliver ecosystem services	??

16 Potential Mechanisms for achieving the targets

There are a wide range of existing mechanisms that could be used to help to achieve the targets, for example -

1. Environmental Stewardship
2. Development - direct (e.g. requirement for new landscaping, contribution to habitat improvement, provision of public greenspace on site)
3. Development (indirect – natural capital and biodiversity off-setting / net gain off-site)
4. Utilities Investment
5. Charitable investment (e.g. RSPB, Wildlife Trusts)
6. Central government investment (e.g. new NIA grants, Defra peat restoration grant)
7. HLF Funding
8. EU Funding *(Brexit makes future uncertain)*

Policies in the GMSF related to highlighted points 2 and 3 above are capable of making a contribution towards targets for GI enhancement but the GMSF will not be the only means of achieving the targets.

Work is underway to develop a meaningful and effective 'net gain' approach to all developments.

Appendix 1

Priority GI Opportunity Areas and Sites

Separate paper

Appendix 2 Greater Manchester Spatial Framework Priority GI Analysis Methodology – the analysis of Habitats and Species data as a contribution to the identification of Priority GI (*from GMEU*)

The (tested, correct) assumption was made that the highest quality areas of valuable natural and semi-natural habitats in Greater Manchester are within designated nature conservation sites. Complex, mature, high-quality habitats deliver a significant range of Ecosystem Services – there is a high degree of correlation between the spatial distribution of semi-natural habitats and the distribution of important ESS.

For example high quality, well managed mature woodland contributes to flood alleviation, mitigation of harmful air pollution, public recreation, biodiversity, carbon storage and sequestration. And most such woodland is found in designated sites.

High concentrations of species are an indicator of habitat quality; the best available (spatial) information on the distribution of species relates to the distributions of species specially protected species. And many of these are good indicator species for the delivery of ESS – Kingfishers, for example, survive on water courses which support fish and so can be an indicator of reasonable water quality.

Mapping the highest quality habitats across Greater Manchester together with the known distributions of important species was therefore considered to be a reasonable starting point for identifying and mapping areas of Priority GI across Greater Manchester.

The methodology used to analyse this habitat and species information is given below.

1. The Joint Nature Conservation Committee (JNCC) are the authority upon species designations within the UK. We took the JNCC master conservation designations spreadsheet, *available from* http://jncc.defra.gov.uk/page-3408, and created a sub list containing any species with one or more of the following protective designations:

    - Wildlife & Countryside Act
    - UK list of Priority Habitats and Species, *this designation superseded 'UK BAP'*
    - Natural Environment and Rural Communities (NERC) Act – species of principle importance in England
    - Habitats Directive

- Birds Directive
- Protection of Badgers Act

The following Greater Manchester rarities were also added after consultation with the Greater Manchester County Bird Recorder because these species can be closely associated with particular habitat types

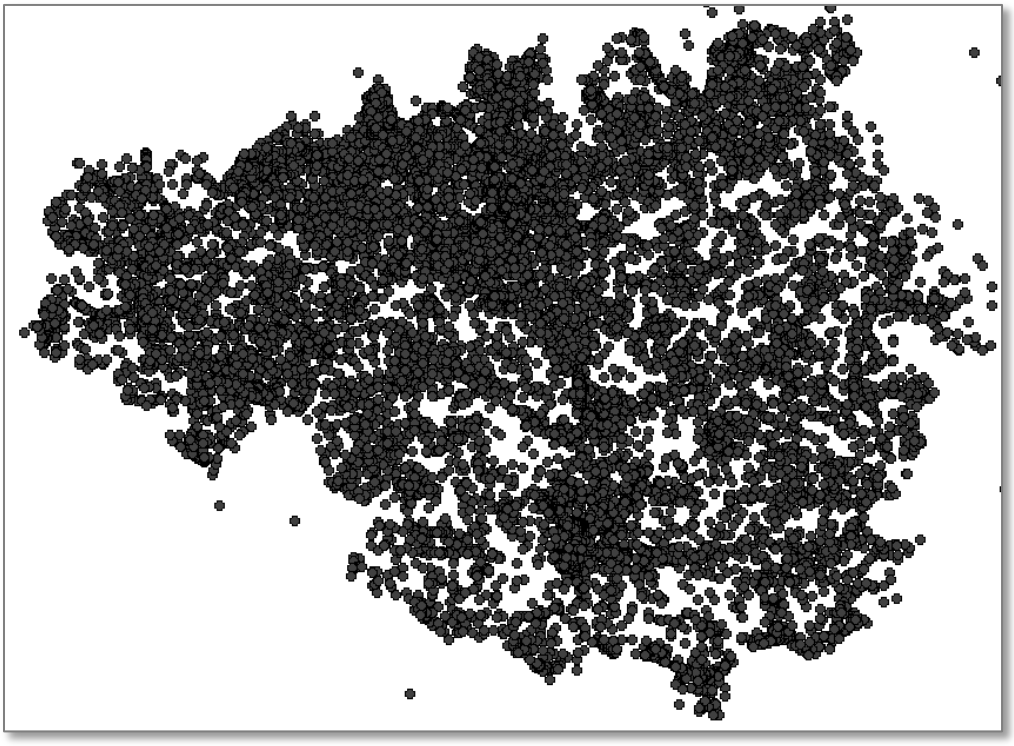
- *Anas acuta* [Pintail]
- *Anas clypeata* [Northern Shoveler]
- *Anas penelope* [Wigeon]
- *Asio otus* [Long-eared Owl]
- *Aythya ferina* [Pochard]
- *Podiceps grisegena* [Red-necked Grebe]

2. The species list created above was used to query our master species database, adding the following additional filters

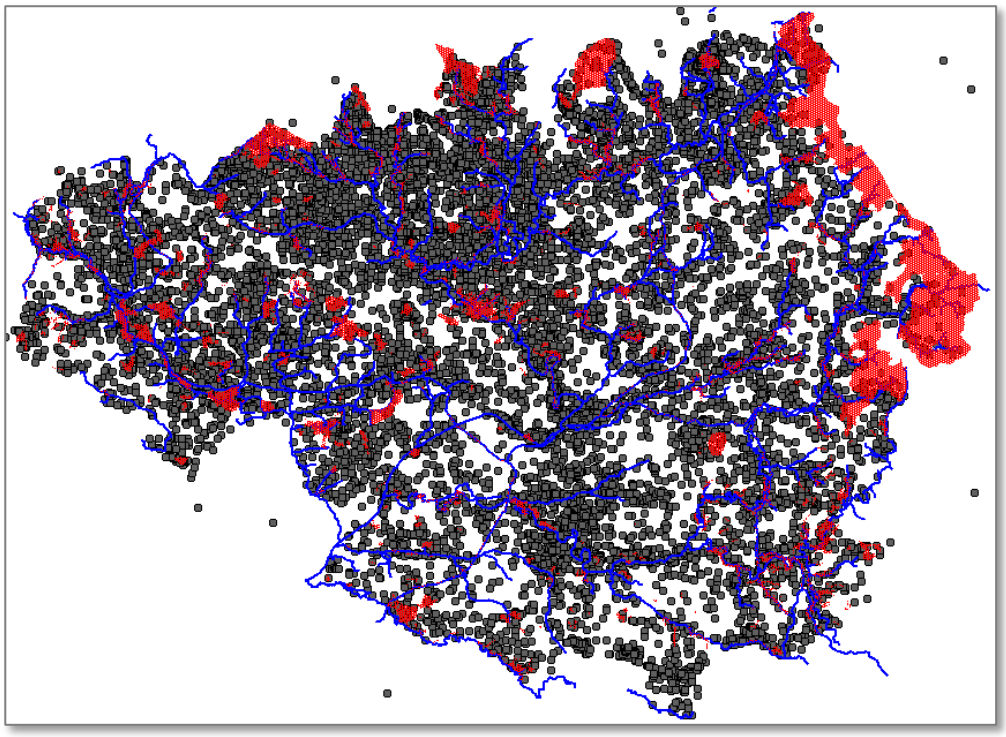
    - Observations made prior to the 01/01/1996 were excluded *n.b. over 65% of the returned records related to observations made since the 01/01/2006*.
    - Observations with a vague precision (less than 100m^2) were excluded
    - Observations which had failed verification or were considered to be likely incorrect were excluded
    - Observations which had been revisited and were now confirmed absences were excluded

3. The dataset was 'de-duplicated', leaving behind only distinct species and grid reference combinations. The aim was to reduce the effect of recorder bias e.g. If an individual had recorded the same barn owl nest, at the same location, month on month, year on year this would now only appear as a single record for the purposes of our analysis.

4. The de-duplicated observations were imported into MapInfo GIS as a table of point data. The centroids of the corresponding grid references were used as coordinates for each observation. For instance an observation made with the 10m^2 grid reference SJ93869890 would be plotted at the centre of that 10m^2 grid square using the coordinates x: 393865, y:398905



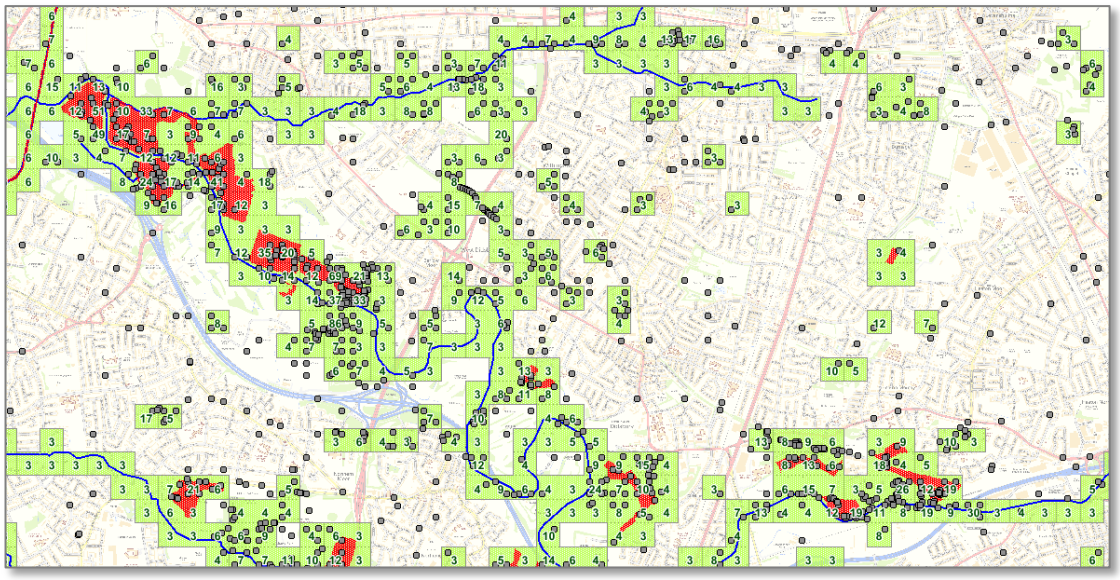
5. The Greater Manchester Site of Biological Importance (SBI) layer and the Ordnance Survey Open Rivers layer were then overlaid. SBIs are non-statutory designated sites within Greater Manchester which are known to be of local substantive ecological importance. The SBI GIS layer includes nationally designated sites (SAC, SPA and SSSI). The SBIs include the majority of the most important (priority) habitat types in Greater Manchester. SBIs are reviewed regularly as part of a 5 year rolling programme by ecologists at the Greater Manchester Ecology Unit. *Our SBI polygons are available at full detail via data.gov.uk, under the terms of the Open Government Licence (OGL)*. The Ordnance Survey Open Rivers data includes only the main rivers for Greater Manchester which act as valuable ecological corridors.



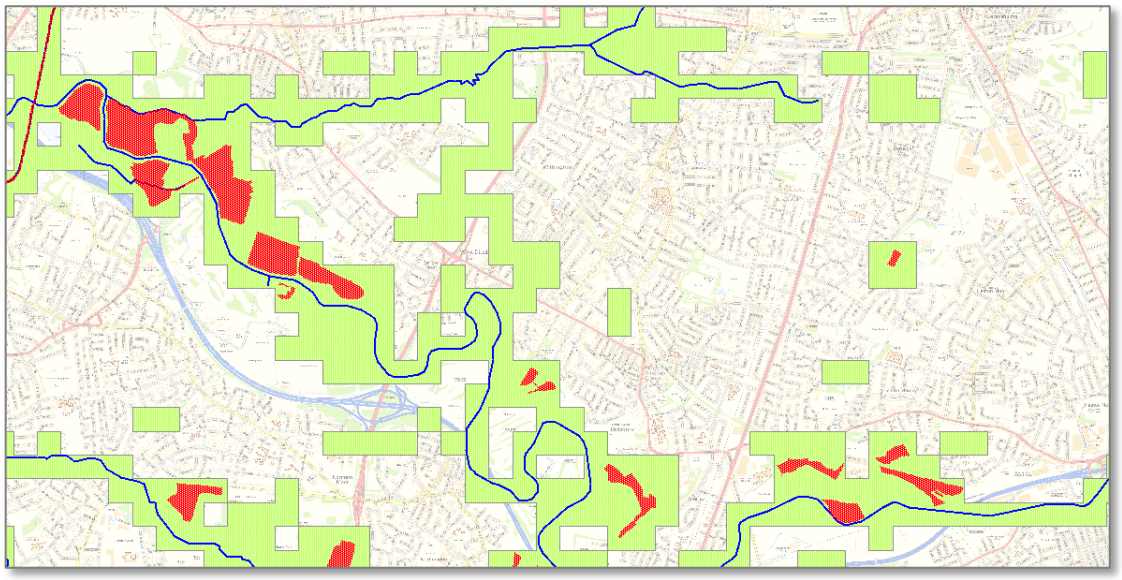
The de-duplicated species observations, SBI boundaries and main river courses were analysed against a 200m^2 grid covering the whole of Greater Manchester. The following scoring criteria were decided upon:

a. Each grid was awarded a single point for each distinct species and grid reference combination contained within it
b. Each grid that intersected with one or more SBI regions was awarded an additional three points
c. Each grid that intersected with one or more major river sections was awarded an additional three points

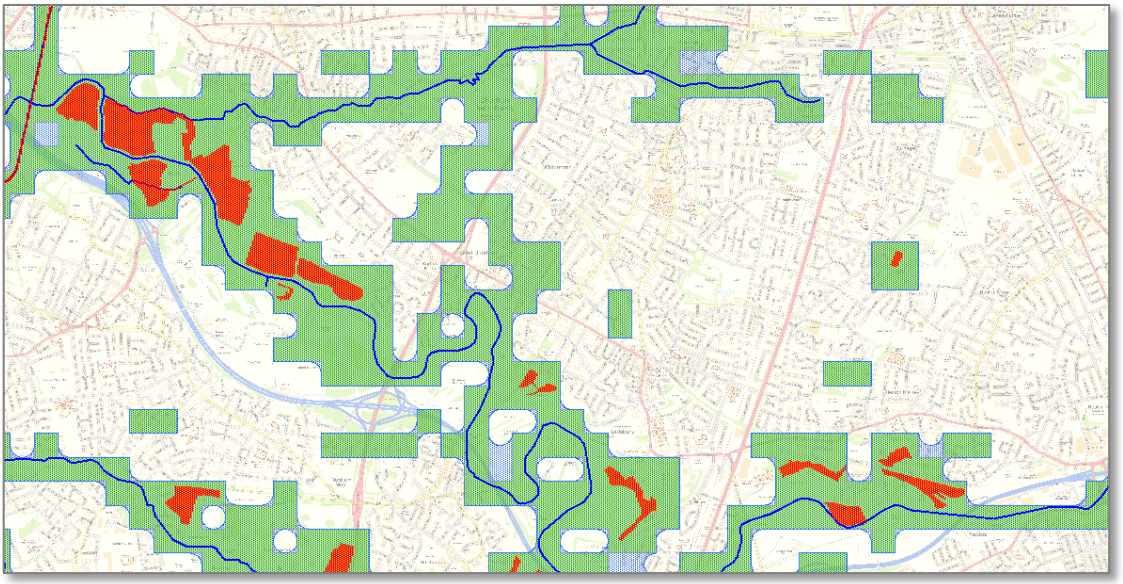
We then removed any 200m^2 grids with a score less than three in order to reduce noise e.g. an ad-hoc record of a hedgehog from within an individual's back garden would be removed

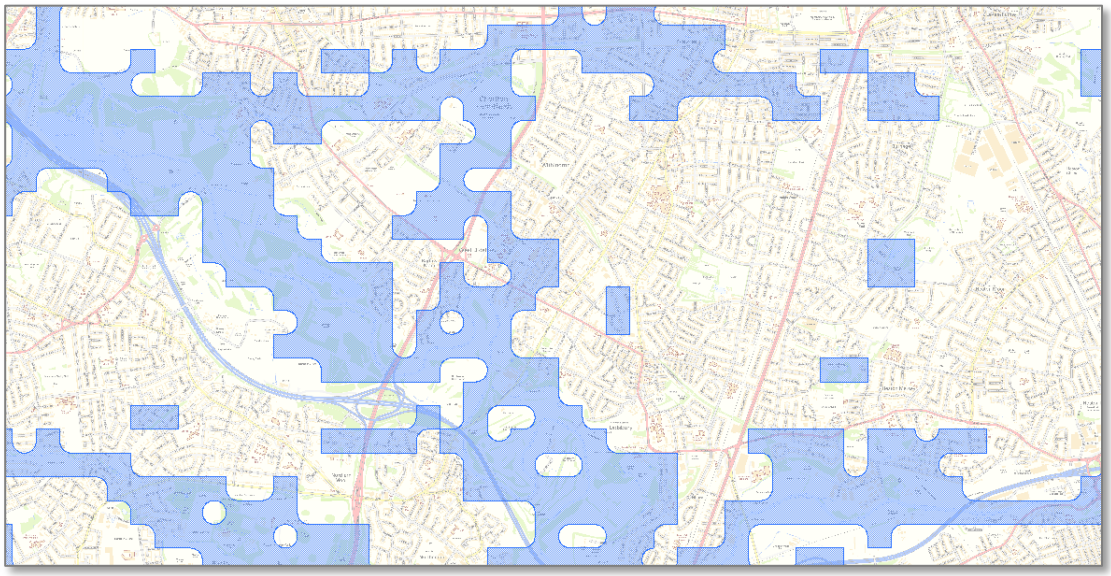


6. A dissolve algorithm was applied to the remaining 200m^2 grids. This process merged any grids that shared a common border section into a single region. In order to reduce noise further e.g. grids relating to an individual's garden or school field which happens to be biodiverse, we then deleted any regions with an area less than 0.05km^2 (regarded as not strategic)

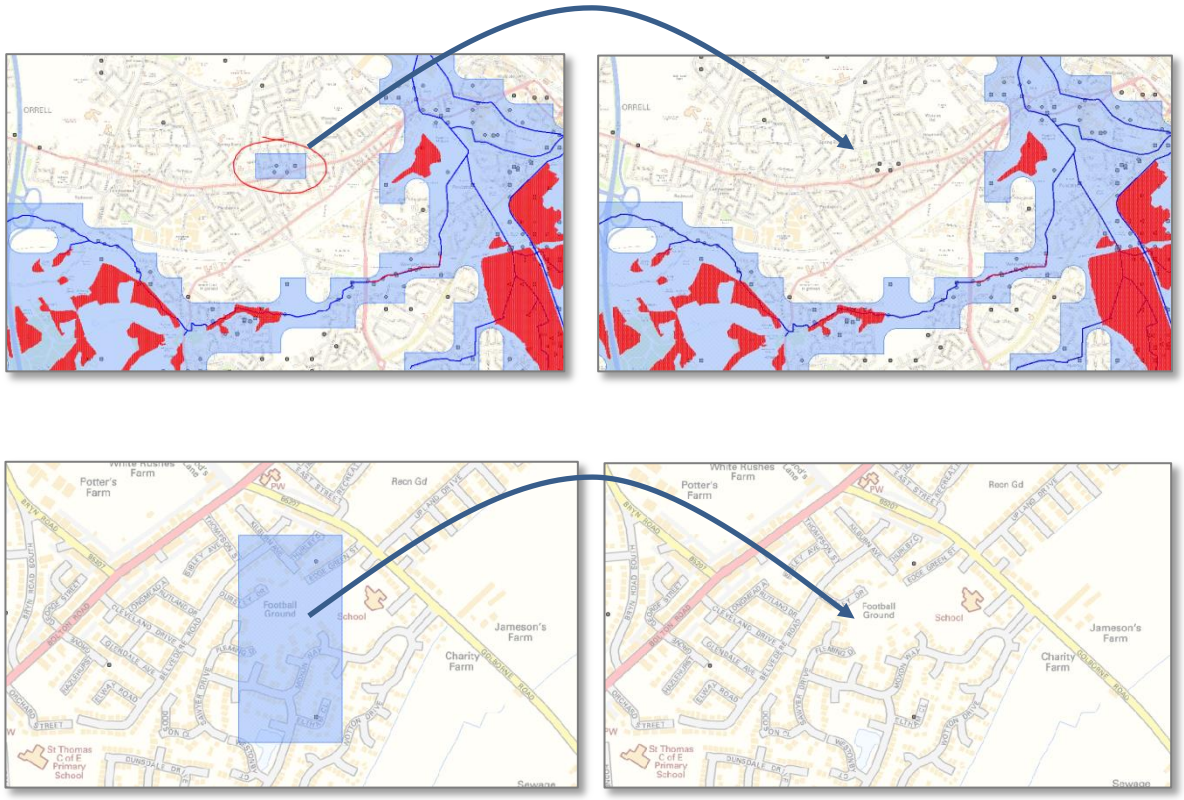


7. Finally a 100 metre buffer-debuffer smoothing process was applied to the remaining regions to provide generalised boundaries that tightly circumscribe the originals. This approach was preferred over convex hull / Hermite spline smoothing etc. as it more tightly follows the original boundaries whilst reducing the overall artificial 'blocky' appearance of the 200m^2 grids.





8. To 'clean up' the layer further and to ensure that the areas identified formed a coherent strategic network (which was the brief) we then manually reviewed the smaller 'islands' of records which remained. The aim was to 'sense-check' the data to remove any anomalies. The sites we were targeting with this process included: well recorded and diverse school playing fields, private gardens, sites which have since been developed and would no longer support a given species etc. To facilitate this review of sites we compared the underlying records against recent aerial photography (2009 onwards) and up to date OS base maps.



Limitations of the methodology

1. Only confirmed records of designated / protected species were included in this exercise. As such there are likely to be other sites, which support a diverse range of non-designated species, which do not appear in the resulting dataset.
2. We don't know what we don't know. There may be important sites missing from the resulting dataset which support a range of designated species but do not show up on this map because we have never received a record for them.
3. Important linear features like rivers and canals appear fragmented in the resulting dataset as records are associated with the actual grid in which they occur and are not attached to the linear feature
4. We chose to exclude older records and records with lower precisions in order to increase the accuracy of the boundaries in the resulting dataset. As such important breeding bird data collected at 1km and 2km precision only is not accounted for.

APPENDIX 3 THE OVERALL GREATER MANCHESTER NETWORK OF 'PRIORITY' STRATEGIC GREEN INFRASTRUCTURE