Scottish Borders Council Indicative Habitat Networks Project

Report

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Environment SYSTEMS

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This is an amended version of the network report of November 2010, where the riparian zone has been re-evaluated and subsequently as potential areas for planting of woodland. The new node type areas were also re-evaluated, and those in close proximity to existing 'core' habitats were reclassified as potential due to the increased likelihood for possible network expansion.

Acknowledgements

Environment Systems would like to acknowledge the assistance provided by the Tweed Forum Partnership, SRDP Officers and Advisors for their help with the workshops. In particular, we would like to acknowledge the support and assistance of Dr Andy Tharme, Scottish Borders Council without whom the project would not have been possible.

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1. Introduction

This report explains the background methods and results of the Scottish Borders indicative habitat networks maps for woodland, heathland, grassland and peat based wetland habitats. The work arises from the Scottish Borders Single Outcome Agreement, which has a priority action to identify key Local Biodiversity Action Plan (LBAP) habitats and linkages, to inform future regional priorities under a revised SRDP. Creation and enhancement of the habitat networks of the region, particularly the woodland, wetland, grassland and upland habitat networks has been a key objective of the Scottish Borders LBAP and is embedded in its Habitat Action Plans.

The indicative habitats networks identified as part of this work provide a cost effective means of showing where habitat re-creation could deliver greatest benefit to existing networks and ecosystem resilience. Strong semi-natural habitat networks not only benefit biodiversity, but also bring multi-benefits by making the local environment more robust and adaptable to climate change, for example through amelioration of the worst effects of summer droughts and winter high rainfall. The habitat network approach is also being integrated into the Council's Flood Prevention Programme.

This report first outlines the importance of preserving biodiversity. It then considers the factors that contribute to successful habitat re-creations and looks at the restoration plans in place for the Scottish Borders region. The project is based upon the results from the Phase 1 habitat audit. Each of the networks are then described in terms of method of identification and the resultant network maps.

1.1 The importance of Biodiversity

Maintaining and enhancing biodiversity is a key priority for local authorities and government organisations in Scotland and the UK. There is a requirement under the UK Biodiversity Action Plan (UKBAP) process and particularly the LBAP process to identify key habitats and key species at a local level.

Scottish Borders contain a number of important habitat types, including woodland, wetland, species rich native grasslands and heathland. Each of these habitat types contribute significantly to the biodiversity of the area. All of them have unique characteristics and provide important ecosystem goods and services (Jongman and Pungetti, 2004). However, the amount of these habitats present is comparatively small and they are all under threat by other land uses, such as intensive agriculture, commercial coniferous forestry and urbanisation.

As the patches of native habitats become smaller, the habitats become more vulnerable to the influence of external factors such as the ingress of weeds or nutrient enrichment, which in turn leads to the loss of more specialist, rarer plants and insect populations. Once a patch has become very small and isolated, many species die out as the habitat is of insufficient size to maintain the populations. The habitat loses its biodiversity value, together with its considerable contribution to the ecosystem in general. It no longer provides a refuge from predator species for common agricultural pests and pollinating insects (a great concern with the global decline in bee species), water holding, cleaning capacity and many other ecosystem functions. This is to the

detriment of both the biodiversity and of the environment in general. A study into the rate of decline of locally rare and scarce species in Berwickshire has shown that within 20 years 42 of the 162 species of interest appeared to have been lost (Braithwaite, 2010).

The ideal situation for native habitats is one of large areas of habitat that are joined together forming a coherent network, with only small breaks between patches which many seeds, insects and other creatures can easily bridge. These networks are supported by other areas of semi-natural habitat that are more 'permeable' to native species than improved agricultural fields with post and wire fences. The networks therefore depend on each other to help their functioning and all four of the broad habitat groups should be regarded as of equal importance for biodiversity and ecosystem goods and service. An example of this type of habitat is shown in Figure 1.

Figure 1: Heathland with scattered native woodland, showing significant BAP habitats occurring in a mosaic together

1.2 Habitat Re-creation

Re-creation of native habitats has been studied scientifically for many years. These studies have found that the best restoration schemes are where the soil conditions model those which occur naturally as part of the native ecosystem (Walker *et al.*, 2007). These conditions are most likely to be found under areas of less intensive agriculture where the soil nutrient status has not been heavily modified by fertiliser application. Areas of less diverse vegetation stopped at an earlier stage of ecological development are also good restoration sites. An example of this would be steep bracken covered hillsides, which were once woodland (bracken is an understory woodland species). Over time these areas may revert to woodland. Therefore planting in such areas is just speeding up a natural process and can be particularly effective. Specific areas which have been a habitat in the fairly recent past are good sites for re-creation. An example of this would be a coniferous forestry plantation on a raised bog where the wetland could be restored by the careful felling of the trees.

Soil moisture regimes are very important for re-creation, especially for wetland re-creation, such as the high biodiversity peat based wetlands considered within this project. Most native habitats also have a specific relationship to the soil micro-fungi and bacteria, which spread very slowly. Therefore, the nearer the new sites are to existing habitat patches, the greater the chance of appropriate soil / vegetation relationships being established quickly.

The nearer the newly restored areas are to the existing habitat patches, the easier it is for native seed sources to invade and help diversify the habitat. The more diverse the seed source, the greater the genetic diversity and hence the more resilient the ecosystem is to changes, such as in climate. The benefits of establishing habitat in close proximity to existing areas is also very apparent when considering the necessary populations of insects associated with the habitats (Forup *et al.*, 2008). Figure 2 shows an area of rough fairly low intensity grassland in proximity to woodland, which would be an ideal location for expansion of the woodland habitat.

Figure 2: Photograph showing low productivity grassland adjacent to existing broadleaved woodland that would form an ideal site for woodland re-creation

This network project builds on these factors considering the best sites for restoration of habitats as those with appropriate soils or vegetation, adjacent or near to existing areas. A further category has been included which identifies areas further from existing habitats but with a suitable soil / vegetation type for restoration to habitat. In these areas it would be better to plan larger restoration schemes which may take longer to establish and be more costly to get functioning, but could form new 'nodes' for further expansion. Small restoration schemes in these areas are unlikely to become successful resilient ecosystems.

1.3 Restoration plans and targets for the Scottish Borders and Tweed catchment

UK biodiversity strategy targets three key principles:

- To maintain, create and restore functional combinations of habitats that will provide ecosystem services and reduce the vulnerability of isolated habitats and species populations
- To make sites more robust to environmental change by improving their quality and condition, reducing the impact of other pressures in the surrounding areas, buffering where appropriate to make them larger.
- To halt the decline of species diversity, and then maintain it, allowing for climate adaptation.

These three key principles are based on island biogeography theory which states that the most robust and species-rich habitats are large round areas, which are connected to each other through a network of smaller sites or habitats permeable to the seeds, insects and animals so that whole populations maintain a healthy sized gene pool (MacArthur and Edward, 1967 and Hanski, 1999).

The Scottish, UK and EU Governments have all pledge to halt the decline of biodiversity and to implement measures to protect existing features and to enhance blocks of habitat where this is practical. In particular, ambitious targets for new woodland planting were proposed by the Scottish Government Cabinet Secretary for Rural Affairs and the Environment, at the Forestry in the Low Carbon Economy conference, on 2 June 2010. Within this target, 7,500 hectares of new trees are due to be planted in the next 12 months with the Scottish Borders identified as one of the key areas for this woodland planting.

In addition to this, the Scottish Biodiversity Strategy has as a main objective "*to halt the loss of biodiversity and continue to reverse previous losses through targeted action for species and habitats".* Part 1 Nature Conservation (Scotland) Act 2004 obliges public bodies including Scottish Borders Council, Scottish Natural Heritage (SNH), Forestry Commission (FC), SEPA (Scottish Environment Protection Agency) and other members of the Tweed forum to take action to ensure habitats are maintained and enhanced where possible.

1.4 The habitat audit

In order to assist with the implementation of this legislation, within the Scottish Borders and Tweed catchment area, an audit of all habitats was carried out. This audit describes the Phase 1 habitats, together with the UKBAP and LBAP habitats in the Scottish Borders (Tweed Catchment Phase 1 Habitat Mapping Final Project Report). This inventory then formed the basis from which a series of existing broad habitat group networks were created.

This report builds on that work by looking at the habitat networks and outlines the opportunities for re-creation of habitats, highlighting those areas that are most suitable for targeting restoration for each of the broad habitat groups. The existing (core) areas of each network are mutually exclusive as the Nature Conservation (Scotland) Act 2004 requires all significant habitats to be maintained. Only in exceptional circumstances would it be appropriate to replace one Priority BAP habitat with another. However the areas with opportunities do sometimes overlap and then it must be up to practitioners on the ground to decide which habitat is best re-created in each area.

This work builds on previous studies and visions by providing a 'strategic' whole catchment / county view. The Scottish Borders Woodland Strategy published in 2005 was developed along similar lines as a user-friendly decision support tool, and is therefore widely used. However this strategy, developed when little was known of the exact habitats in each location, was necessarily very broad in its approach. The Woodland Strategy woodland expansion targets aim for there to be a total of 118,575ha of woodland by 2050, an increase of 30,829ha from 2005. The advent of the Phase 1 habitat map means that the lessons learnt from this strategy can now be further refined into a new network and opportunities map.

The Forest Habitat Network programmes (Ray *et al.,* 2003) have led the way in developing landscape evaluation tools for biodiversity. This study gave a detailed and well-modelled assessment of the potential for restoration, based on the known areas of semi-natural ancient

woodland. The output however, was presented as a series of 12 GIS layers with technical terminology, and the data is therefore difficult for the non-specialist to use and interpret. It was a very detailed study and only considered the very best areas of land for broadleaved woodland planting and fell short of the amount of land that is likely to be needed to meet woodland expansion targets.

This report outlines the methodologies used to produce the new cost-effective and innovative habitat network planning tool which uses the Phase 1 habitat data as the baseline. The maps identify potential habitat networks for the habitats of primary conservation interest in Scottish Borders: woodlands, heathlands, grasslands and peat-based wetlands. It is designed to be straightforward to use, in order to support decision-making to aid delivery of the appropriate habitat enhancement. It has an ecosystem services focus, consistent with the emerging biodiversity and land use agenda.

Building up a network of existing sites and suitable sites for restoration of habitats will not only help the success of individual schemes but also the overall resilience, diversity and ecosystem functioning of the Scottish Borders region.

2. Method

2.1 Approach

This work builds on the Phase 1 habitat audit project which identified the habitats across the whole of the Scottish Borders and Tweed catchment area. The networks were modelled based on the vegetation types. Soil types were mainly inferred from the vegetation. For example, all blanket bogs and raised bogs are assumed to be on deep peat. The only exception to this was some additional information on the location of deep peat modelled from the Borders Wetland Vision (Ball *et al*, 2006) together with the flood plain data. Landform is also extremely important for some habitat groups and was included in the models. All wetland areas had a slope of less than 3°. Cleuchs were modelled by combining the NEXTMap Britain-derived slope layer and the stream layer from Ordnance Survey MasterMap. These landscape features have significance, particularly in the woodland network.

This product is designed to give a 'landscape' view of the networks and opportunities, to deliver a guide for the best places for re-creation and where there may be existing habitats that also need protecting. As the Phase 1 audit was carried out from air photo interpretation the habitats have approximately 85% accuracy, therefore some of the areas may have more or less 'core' habitats than those shown. Specific detailed field visits and the maps produced by these visits by professional ecologists and soil scientists should take precedence for localised re-creation plans. Any changes in the habitats by future surveys should be reported to the Wildlife Information Centre at admin@lothianwildlife.co.uk who are responsible for keeping the Phase 1 map up to date as a 'living document'.

As the network maps have been built up from habitats, the existing designated site boundaries have not been considered. All of the 'core' BAP habitats should however be identified, so the existing sites should be shown as either 'core' or 'sensitive' in each network, For example, the large upland SSSIs will comprise, heath, bog and acid unimproved grassland vegetation and therefore all be 'core' network areas. In addition the networks could help to buffer the existing sites. An area of heath grassland mosaic at the edge of one of the large SSSIs, for example, would still be suitable for a reduction in grazing density and a return to heathland. The designated sites are protected by law and any alteration of management would need to take this into account.

3. Woodland

3.1 Woodland method

Building on the work done in the design and implementation of the Scottish Forest Habitat Network project, in which the Scottish Borders area was a pilot area (Forest Research, 2008) all existing areas of semi-natural ancient woodland identified as 'core' habitat resource were chosen as the main 'core' areas in this study. However, because as much land as possible needed to be identified for potential woodland planting, planted broadleaved and planted mixed woodlands were also considered. These areas, although not of the same biodiversity quality as the semi-natural ancient woodland, will have a functioning woodland ecology and will therefore support common plants, insects, birds and animals that would help new areas of woodland planted nearby to establish a working ecosystem more quickly than areas remote from woodland. These woods have therefore been included as 'core' woods. For ease of interpretation they have been combined into one core area, although for specialist use they are available as two separate datasets.

Biogeography and network theory states the best chance of establishing functioning woodland ecosystems are to create large round woods (MacArthur and Edward, 1967 and Hanski, 1999), so the best areas to establish woodlands are adjacent to or within a short distance of existing woodland. The Forest Network specifies a distance of 1000m as that which a 'woodland generalist' species may travel from one patch to another. We have therefore used this as the distance from existing 'core' woodland areas for areas of search for suitable habitats. Woodlands planted on land previously used for arable crops take much longer for the fully functional woodland ecosystem to develop than woodland planted on less nutrient rich land (Quine and Watts, 2009). Furthermore this land is likely to be the best for food production and therefore should under an ecosystems goods and services viewpoint be retained for that purpose. Because of these factors we have excluded from the woodland potential areas, arable land and high intensity grassland where it has clearly been re-sown or cut for silage. These areas have been designated as unsuitable. If woodland planting is proposed on such areas, the scheme must be able to demonstrate how the soil conditions are to be altered to provide a suitable basis for the scheme.

Peat soils fulfil very important regulatory systems for water and forestry planting is undesirable on bogs, fens and flushes. Therefore these areas have been marked as sensitive, as have the 'core' areas of the other networks as these are BAP habitat in their own right and need to be protected. If a planting scheme is to impinge on one of these areas, a full NVC survey and ecological evaluation should be sought to minimise any loss of biodiversity.

There is a chance for establishment of functional woodland ecosystems on the less productive grass leys and permanent pasture grassland. These areas have been included as potential as it will be possible to establish on these areas and the decision on whether the land be used for planting or retained as grazing can therefore be made on economic grounds, where the land is best understood by the individual land manager.

Scrub and bracken are typical understory species for woodlands. Areas with these land cover classes will in all probability have been deciduous woodland at one time or another, they are therefore marked as having a high potential for woodland restoration opportunities. Marshy

grasslands which are not species rich or ecologically important have also been included in the areas for possible planting. All other core habitats have been excluded from the potential map.

The woodland map was initially run excluding semi-improved upland grassland, however it is found so often in mosaic with bracken on the steeper valley sides, which would have been tree covered that it was considered more sensible to include it in as part of the matrix of vegetation which could be considered suitable.

Other BAP habitats such as bog, heath and species rich grassland habitats are often 'permeable' to woodland species; that is a species will move within a typical range over specific types of habitat (its vector). For example a woodland bird or insect will travel over an area of heath as it can, if necessary, have places to stop and hide from predators. These habitats have therefore been designated as permeable in the analysis and removed from the map for the network layers. The analysis done to pull out the woodland ecosystem is shown in Figure 3.

Areas suitable for woodland planting at a distance from existing woodland habitats were recorded as having the potential for establishing new woodland nodes. Woodland in these locations may take longer to establish a viable ecosystem as there is less potential for native woodland plants and insects to establish. Where the riparian zone alongside rivers and streams has been identified, it is included in the potential areas rather than the new node areas as there are often scattered trees within this zone.

These network and opportunities maps are designed to support the development of broadleaved or mixed woodlands. Commercial coniferous plantations do not behave in the same way in terms of the ecosystems goods and services they provide. These can therefore be regarded as a crop. The best use of the networks in the case of coniferous plantation is to avoid the 'sensitive' areas which are core areas of other BAP priority habitats, therefore avoiding areas of high biodiversity. All other areas should be considered on their own merit.

The results for the woodland networks are shown in Figure 4 following. The dark red/brown core areas comprise the scarce existing broadleaved and mixed woodland resource, the orange to yellow colours represent the areas available for new broadleaved woodland planting, the density of the colour, donating the desirability of the area for re-creation of the habitat. The potential areas for new woodland nodes should be considered for larger restoration schemes. Small schemes away from existing woodlands will have little chance of establishing functioning ecosystems within a reasonable period and projects of in the region of 50ha plus would be desirable.

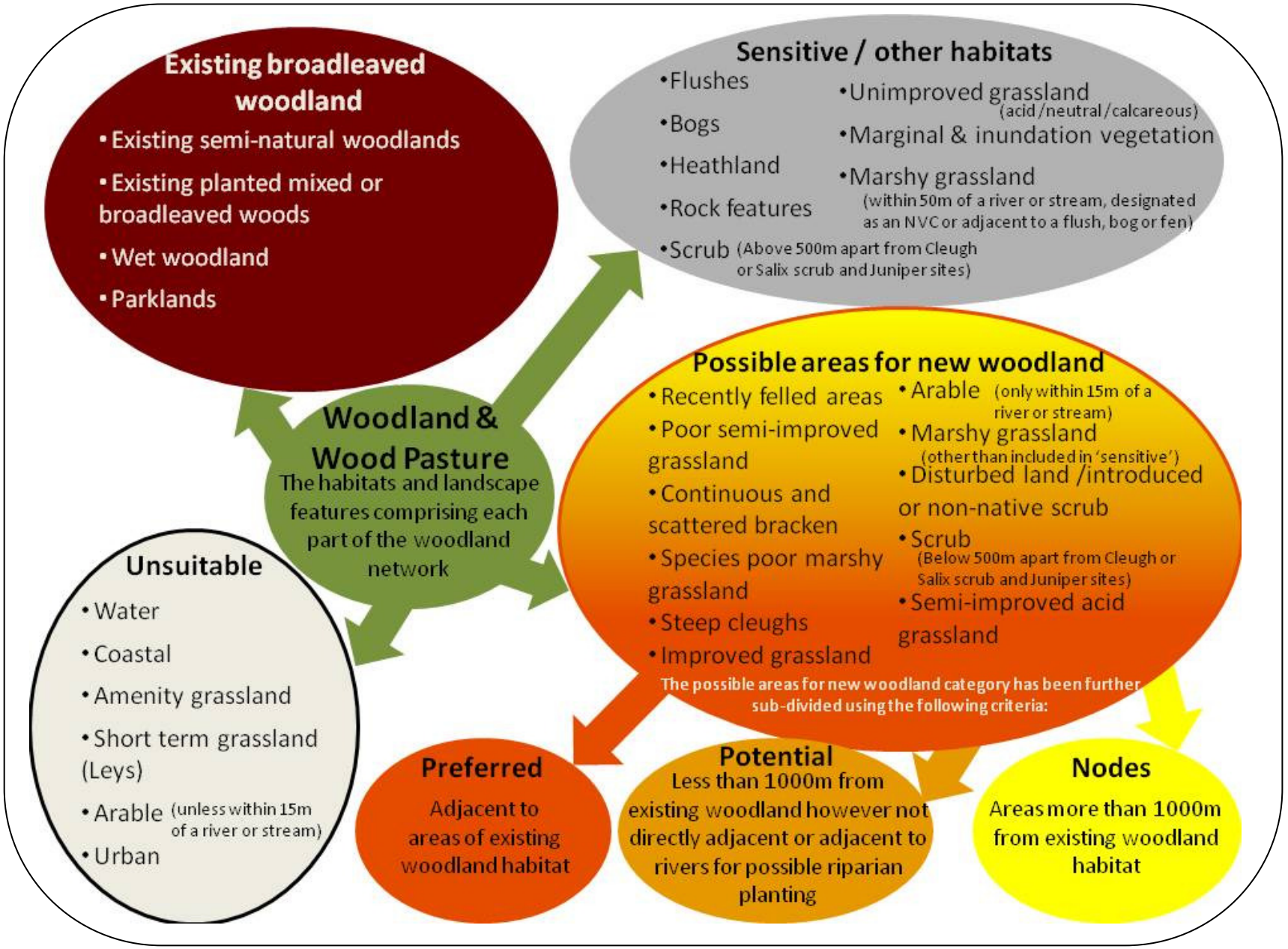

Figure 3: diagram of the different communities that comprise the woodland network and opportunities map

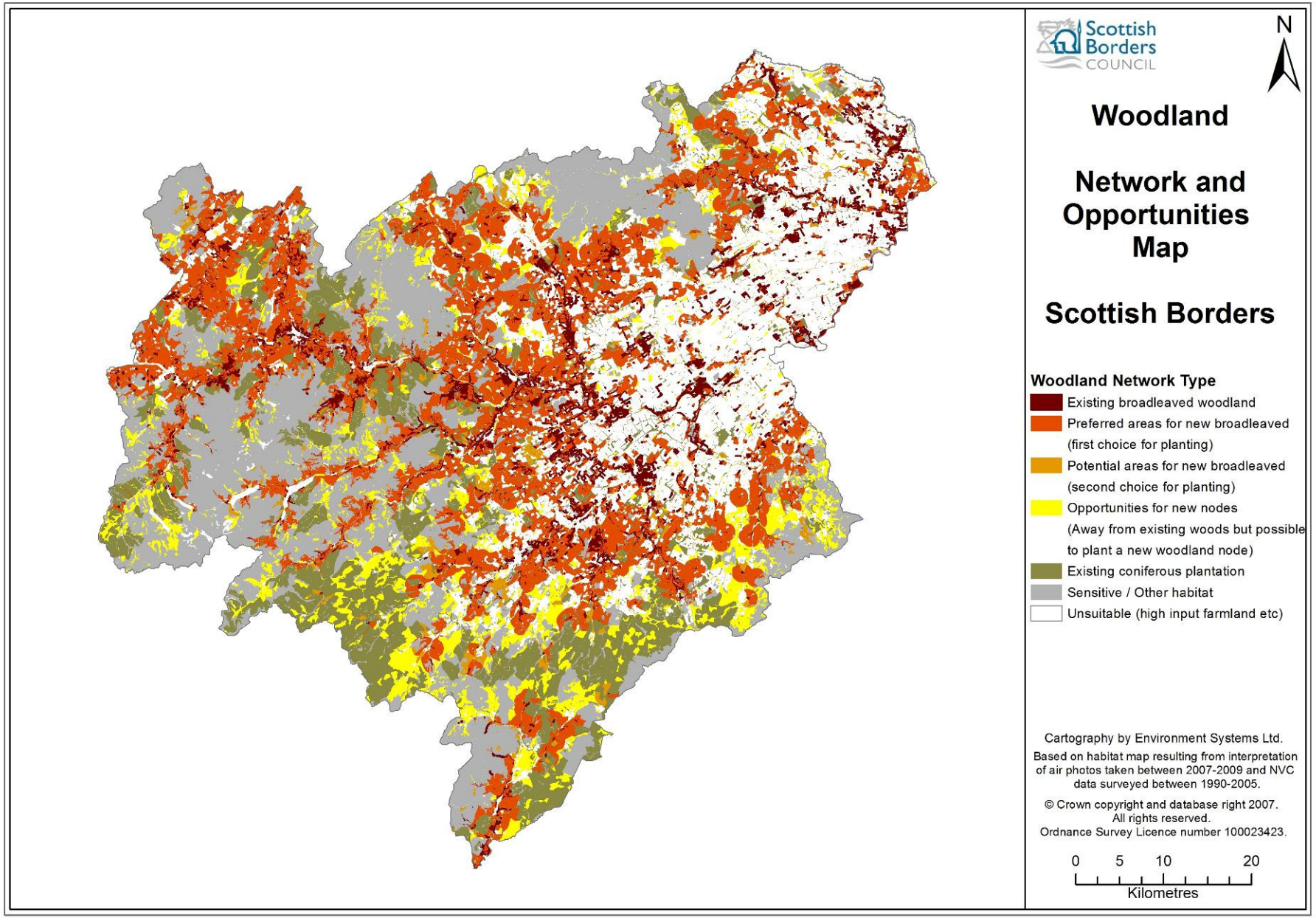

Figure 4: Woodland network and opportunities map

3.2 Woodland results

Table 1 shows that most of the existing woodland resource in the Scottish Border is coniferous plantation, (Figures for the Tweed catchment are given in Appendix 1). However there is a reasonably large amount of suitable land for planting within 1000 metres of existing woodland and a good proportion of upland areas suitable for larger planting schemes to establish new woodland 'nodes'. However the amount of sensitive and unsuitable land does show the pressure the semi-natural and BAP habitat area under the ambitious woodland planting programmes.

Table 1: Amount of woodland in each network category in the Scottish Borders area

Network Type	**ha**
'Core' existing broadleaved and mixed woodland	12,241
Preferred	110,075
Potential	8,188
Possible area for new woodland 'node'	37,485
Existing coniferous	67,499
Sensitive	117,818
Unsuitable	120,957

The woodland opportunities map shows the network follows the rivers and streams up the valleys and onto the steeper valley sides in the uplands and occur in the less intensively managed areas of the lowland. These areas will provide the best opportunities for the relatively quick and easy restoration to suitable native woodland. However, if more remote areas are available a large restoration scheme could be undertaken, it should be done with a view to building in several smaller woodlands in the 'preferred area' near to its boundary to provide 'stepping stones' for insect pollinator and seed vectors. Importing some leaf mould from existing woodland, if carefully done, may also help to enhance the ecology of the site by introducing suitable soil organisms more quickly than may otherwise be the case.

Table 2: Breakdown of potential network made up from improved grassland

Network Type	Amount of land within each part of the woodland network (ha)	Land within woodland network that comprises Improved grassland B4 (ha)	Amount of land not improved grassland within each part of the network (ha)
Preferred	80,164	41,180	10,021
Potential	3,987	1,684	720
Possible area for new woodland 'node'	3,915	3,448	7,178

The preferred areas for woodland planting in the upland are often in the valleys and there will be a conflict here with the amount of improved grassland for grazing and planting schemes. It is interesting to note that out of the 110,082ha of preferred woodland network in the Scottish Borders area, 80,164ha is classified as improved grassland, see table 2 above. The Woodland Strategy woodland expansion targets aim for there to be a total of 118,575ha of woodland, (both coniferous and broadleaved) by 2050, an increase of 30,829ha from 2005. To reach these targets it would be necessary to plant up half of the land identified for growth of the woodland network, if planting on improved pasture is not desired by the landowners. The preferred, potential and new nodes areas often overlap with other habitat potential networks therefore the amount of land available for other restoration projects could be constrained by these targets. It is hoped that this strategic map of woodland and other networks will assist landowners and advisers when negotiating the use of land.

4. Grassland

4.1 Grassland method

It is possible to create 'improved' grass leys on almost any type of land apart from deep peat, blanket and raised bogs. However, as with woodlands, the establishment of semi-natural grassland which will become species rich and support a wide range of plants and insects to help facilitate pollination of surrounding crops, pest control etc depends on the vicinity to existing sites and the site soil condition. Many species in natural grasslands have relationships with soil mycorrhizal fungi, and these ensure the health of the plants and the fixation of nitrogen which keeps the system in balance. Recent research on *Primula veris* has outlined the importance of linear features with native species present such as hedges and ditches in allowing the seeds to spread from one area to another. Therefore with the grassland networks the parameters were set so that areas (again excluding arable land) of suitable habitat types are adjacent to existing semi-natural grasslands.

Because of the complex relationships in native species rich grasslands with the soil fauna and flora and the insect and pest / predator species supported it is very important to maintain existing sites, as rarely if ever can the species rich assemblages be truly recreated. In terms of grasslands therefore the first priority should always be to protect existing species rich sites.

If grassland restoration is to be suggested on productive agricultural grassland, suitable soil amelioration must be considered. In particular high levels of soil phosphorous is a barrier to the development of species assemblages (Tibbett and Diaz, 2005). In any grassland re-creation there is a very strong argument that very locally sourced seed sources need to be used. Exotic species mixes, even though they contain flowers found in other parts of the UK, are no more than an interesting nectar crop and cannot be considered native grassland re-creation.

An attempt was made using rock features from the OS maps to pull out the Hummel areas on the ridges (see figure 5). In nearly all cases these features were already part of existing semi-improved grasslands and are considered part of the existing 'core' grassland networks.

Figure 5: Hummel species rich 'core' grassland

It is possible to restore native grasslands on or adjacent to the river banks where some native seed sources are present and agricultural intensity is lower. These areas are mainly shown as suitable for new grassland 'nodes' but could aid flood and water quality management, if sensitive restoration was attempted.

Marshy grasslands are broken down into two categories, species rich or significant marshy grasslands which are included in the wetland network. All other marshy grassland is generally species poor and considered as suitable for restoration. Areas of search for grassland re-creation are limited, however many disused railway lines can hold good native seed banks and this feature was digitised and where appropriate included in the network.

Parklands do sometimes have species rich grassland, but have been included in the woodland areas as wood pasture is an important woodland Priority BAP habitat type. It is interesting to note that the grasslands show as the most fragmentation of the networks. However this may be mitigated in some cases by the effect of the seed bank in the hedgerows. A hedgerow layer is available for visual interpretation but no assessment has been made as to their species richness and many of them may have little value, they have not therefore been integrated into the model.

The method for identification of grassland sites and the network categories is shown below in Figure 6.

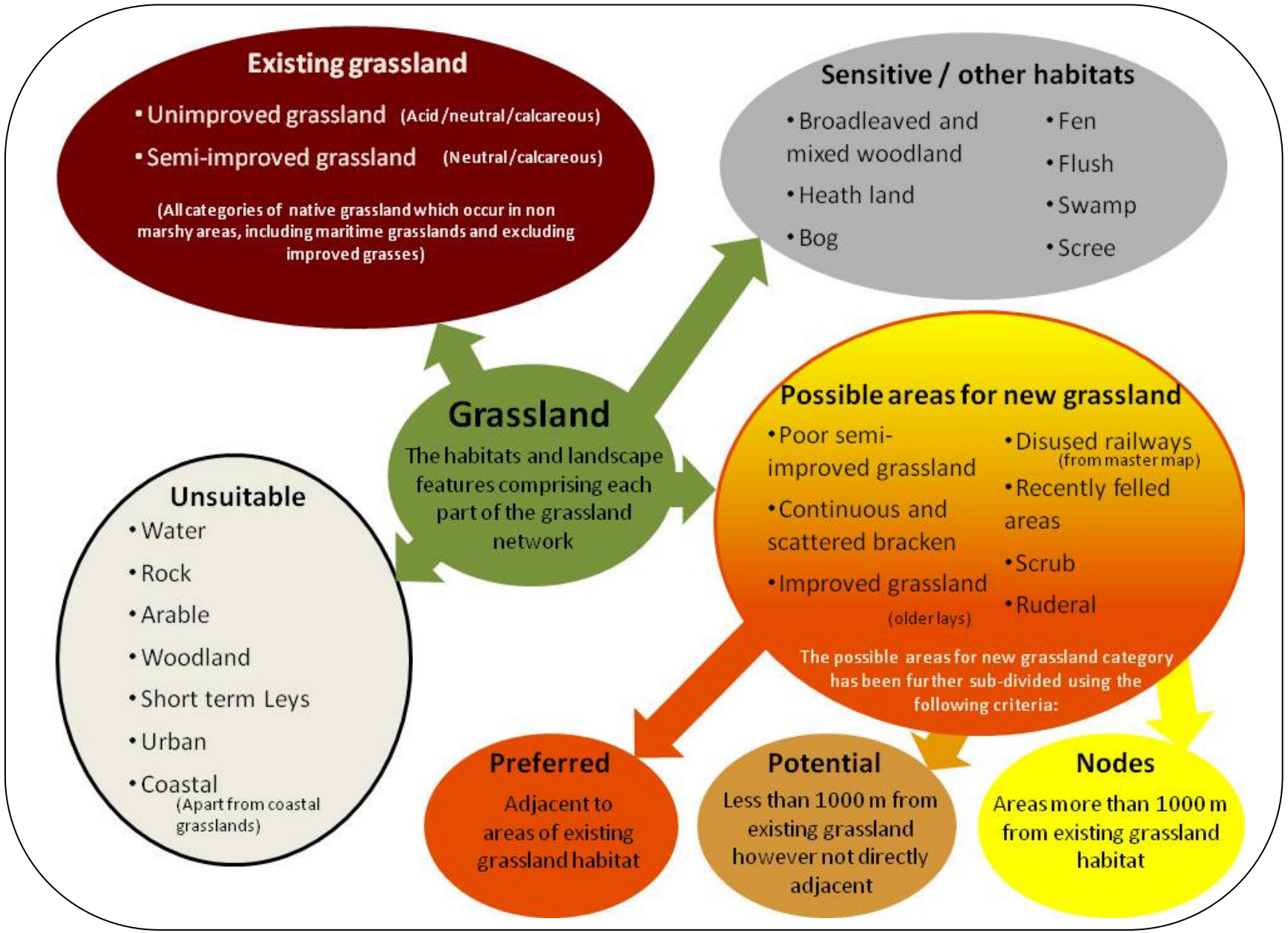

Figure 6: diagram of the different communities that comprise the grassland network and opportunities map

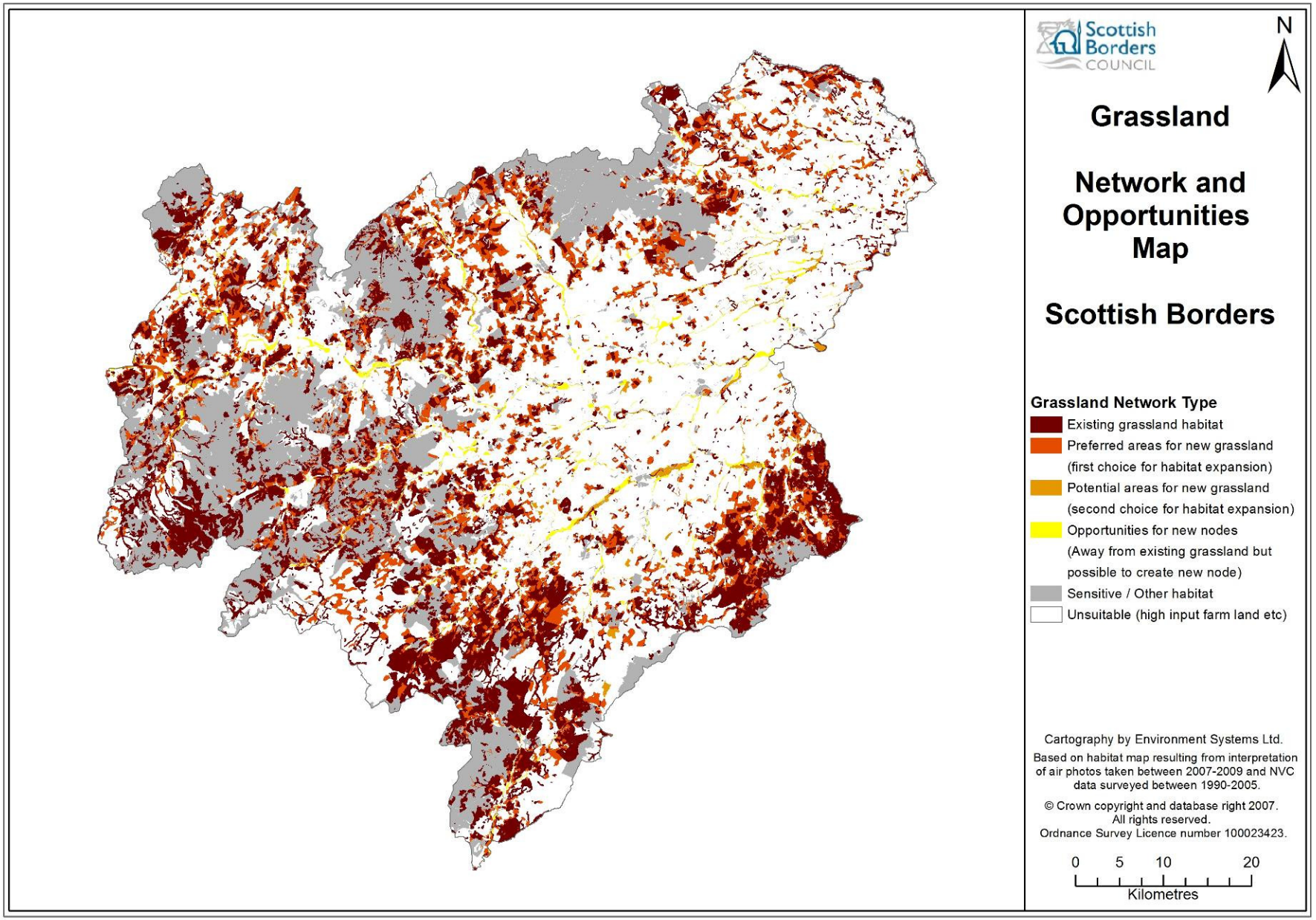

Figure 7: Grassland networks and opportunities map

4.2 Grassland Results

The map in Figure 7 shows the scattered nature of the existing 'core' grasslands networks, particularly in the lowlands. This is likely to be particularly problematic for insect populations which need several species rich grasslands in close proximity to maintain a healthy metapopulation. The existing grasslands in the uplands are generally unimproved acid grasslands of National Vegetation Classification types U4 Festuca ovina-Agrostis capillaris-Galium saxatile grassland or U2 Deschampsia flexuosa grassland (Rodwell, 1992), whilst these classes are not especially species rich they form an important part of upland mosaics, giving structural diversity.

The lack of land with suitable low nutrient soil conditions for high quality grassland restoration is reflected in table 3 below. This shows that there are only comparatively low amounts of potential land area for new nodes. Much of the preferred land is adjacent to the unimproved acid grassland and is likely to be bracken covered slopes, which have their own issues in grassland restoration and will also be prime targets for woodland planting.

Table 3: Amount of grassland in each network category in the Scottish Borders area

Network Type	**ha**
'Core' existing grassland	63,801
Preferred	61,599
Potential	4,440
Possible area for new grassland 'node'	4,971
Sensitive	95,835
Unsuitable	243,617

It is possible that using the hedgerow data layer as a guide, a search at the field scale by a suitably qualified ecologist could help to identify areas of species rich hedges where grassland seed and fauna resources are present and where existing site conditions may be beneficial for grassland restoration.

5. Heathland

5.1 Heathland method

Heathland are a particularly significant habitat for Scotland, as Scotland holds so much of the international resource for this habitat. Heathlands form on acid soils with a thin peaty layer, or on skeletal acid soils. They therefore have a very specific environmental niche and are consequently more restricted in their occurrence and the potential for restoration. The best potential for restoring heathland is on land which has been heath in the past, for example Ling heather (*Calluna vulgaris*) in particular has a persistent seed bank and Bilberry (*Vaccinum myrlulis*) form strong communities with mycorrhizal fungi. Therefore in this analysis the highest potential was given to land that is now grass / heath mosaic or that has been coded as having a secondary vegetation type in a mixed habitat as heath. Adjacent to these areas, and on suitable soils, grasslands and other appropriate habitats have been marked as having the potential to re-establish heath.

This heathland data set will be important if commercial conifer plantation is required on the upland. In order for Scotland to maintain its undertaking in terms of biodiversity targets, any heathland planted with forestry should be mitigated with a heathland restoration scheme, in order to keep the amount of the habitat at least in existing quantities.

Areas of known Juniper heath and upland willow scrub are included in this important habitat type. There are very limited areas of these habitats in the Scottish Borders and their protection is highly desirable.

Many coniferous plantations were made on heathlands and these areas do still contain the components on the more open rides and clearings. They have the potential to be areas of heathland restoration. These areas, on steeper slopes covered with coniferous woodland with some sign of heath species present, were therefore pulled out as areas for new' nodes' of heathland planting.

The diagram in Figure 8 below shows the habitats and methods used to create the different parts of the heathland networks.

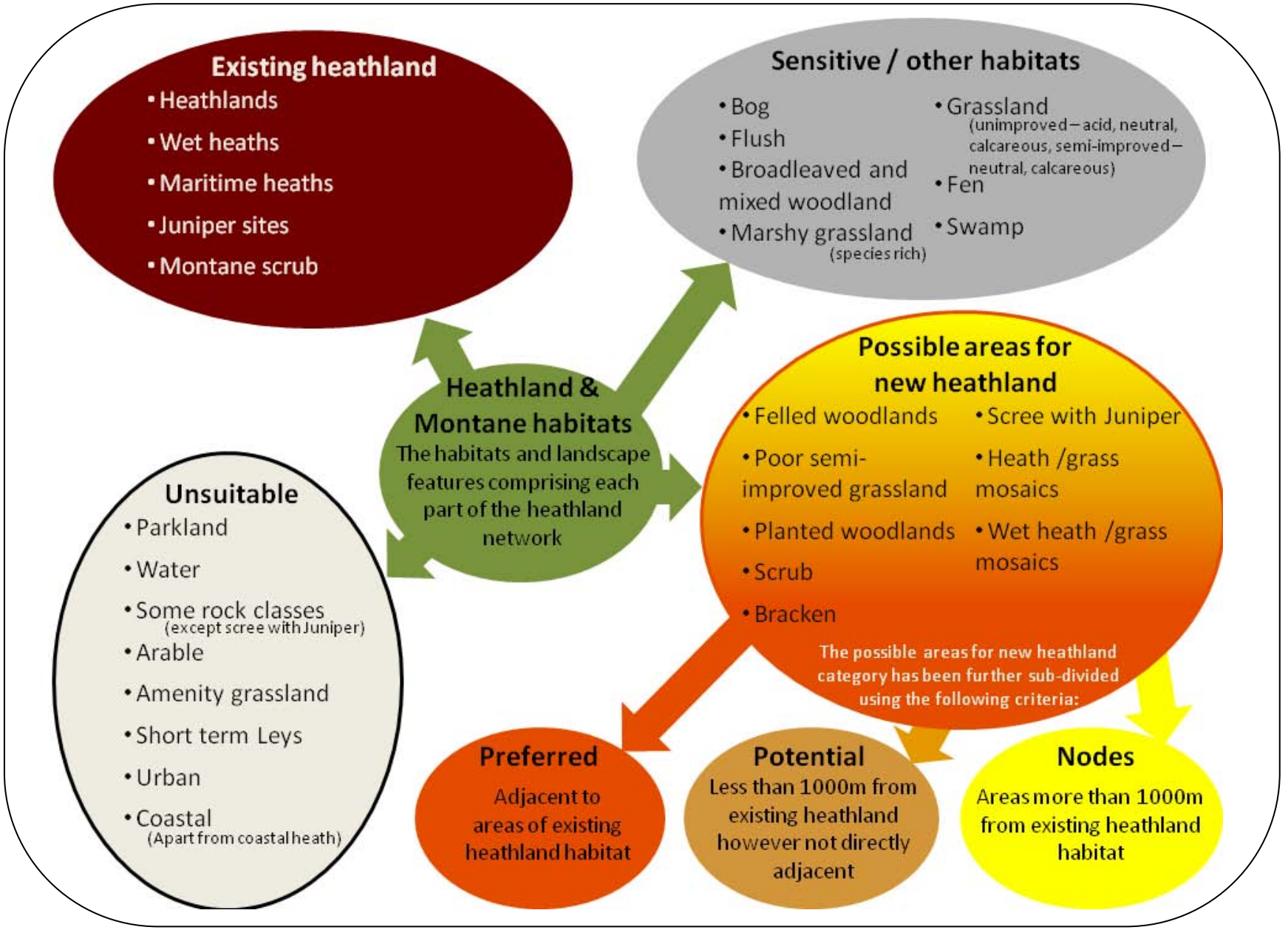

Figure 8: diagram of the different communities that comprise the heathland network and opportunities map

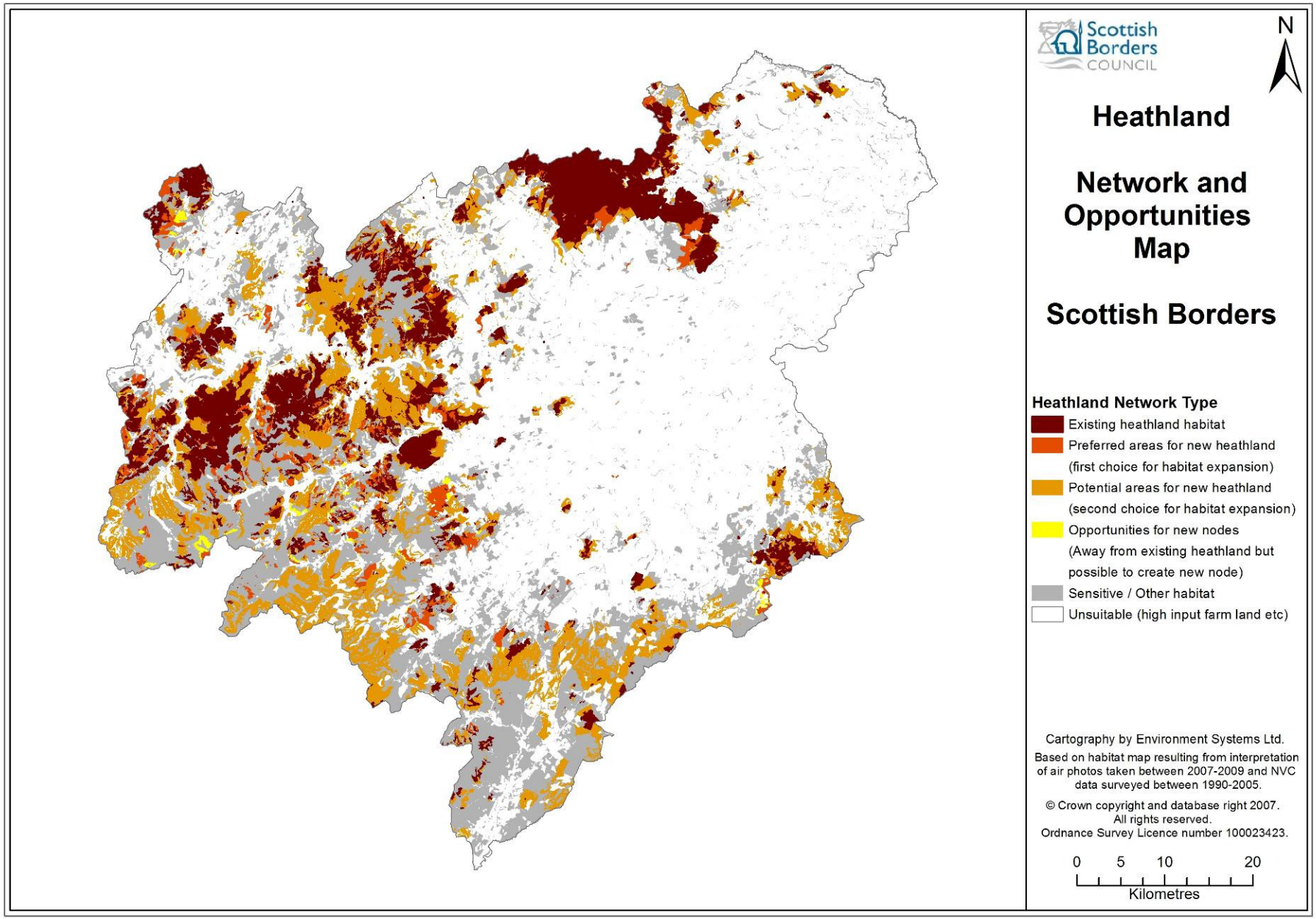

Figure 9: Heathland network and opportunities map Scottish Borders area

5.2 Heathland Results

Heathland is found in the uplands and in a few specialist places on rocky outcrops in the central areas of the Tweed catchment. Although ling heather (*Calluna vulgaris*) can be established in gardens, Bilberry (*Vaccinium myrtillus*) establishes beneficial rhyzomartal communities with soil fungi and therefore the best chance of getting a heath to establish is where there is currently a remnant of heath species (e.g. grass heath mosaic). Typically where soil conditions are still favourable or where land is adjacent to existing heathland and the nutrient regime is not too enriched, and therefore the heath species will not be outcompeted by more competitive course grasses. These effects are reflected in the heathland maps in Figure 9, with the main opportunities for re-establishing heathland being specifically around the existing heathland blocks. Table 4 below shows the area in hectares covered by each part of the heathland network.

Table 4: Areas of heathland in each network category in the Scottish Borders area

Network Type	ha
'Core' existing heathland	43,155
Preferred	12,528
Potential	60,253
Possible area for new heathland 'node'	1,491
Sensitive	96,463
Unsuitable	260,373

Opportunities for establishing new nodes are more limited than in the other networks and are shown only when there is a heath component present as a subordinate component of another native habitat type. The current extent and distribution of heathlands is therefore very significant and steps should be taken to ensure existing areas are not compromised.

Within grassland types there is sometimes the need to undertake field visits to establish if there is a remnant heathland component in the soil. If such field visits find evidence of heathland species, then these areas can be considered suitable for restoration. It will be particularly important to check areas of marshy grassland for cross-leaved heath (*Erica tetralix*) as this may indicate the possibility of restoring a wet heath system to the area.

6. Wetland

6.1 Wetland method

There is already a comprehensive data set showing wetlands across the Scottish Borders region. This work has been built upon to include sites designated as wetland and to show areas suitable for wetland restoration. This model does however concentrate on the species rich peat based wetlands rather than those supported by surface water.

Wetlands have very specific soil and slope requirements. Utilising the peaty soils data from the Wetland Vision dataset slope criteria of less than 3^0 was included. Suitable habitats are most likely to be found adjacent to existing wetland sites and the ecosystems as a whole will benefit most if existing sites are buffered. Scotland holds important amounts of many of the wetland habitats in an international context. Species rich marshy grassland, marshy grassland adjacent to wetlands and those marshy grasslands with NVC survey information have been included in the model. All other marshy grassland is considered as potential for restoration. Suitable soil and vegetation types within the predicted 200 year flood zone also highlighted as areas of potential for new nodes. New nodes have also been designated on areas of raised bog planted with coniferous woodland. Data on the spread of focal species associated with wetland show that they are less widely dispersed than woodland, grassland and heathland species and a buffer of 500m was therefore used with this model.

The following diagram in figure 10 shows the habitats and landscape features used within the wetland model.

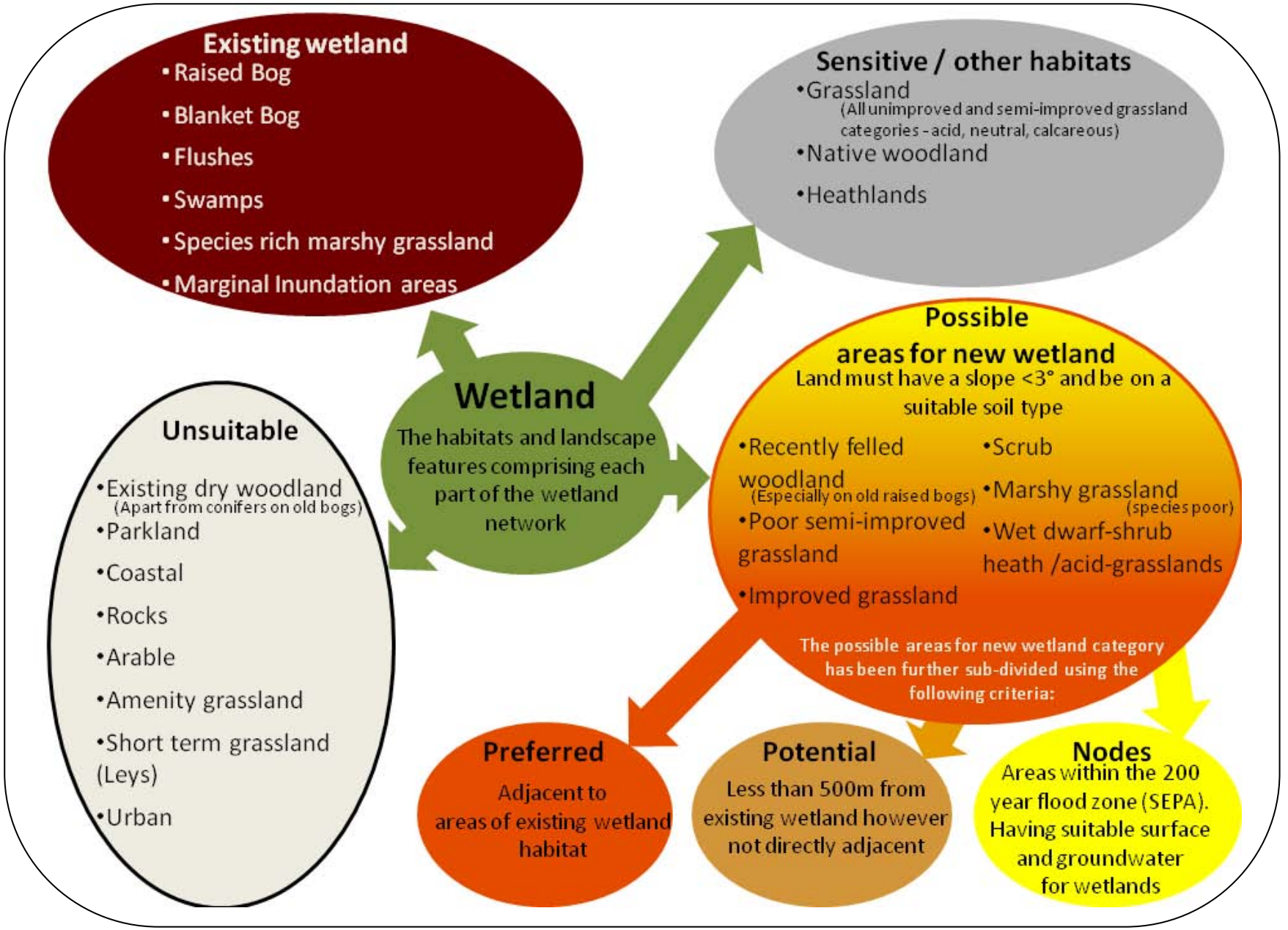

Figure 10 - diagram of the different communities that comprise the wetland network and opportunities map

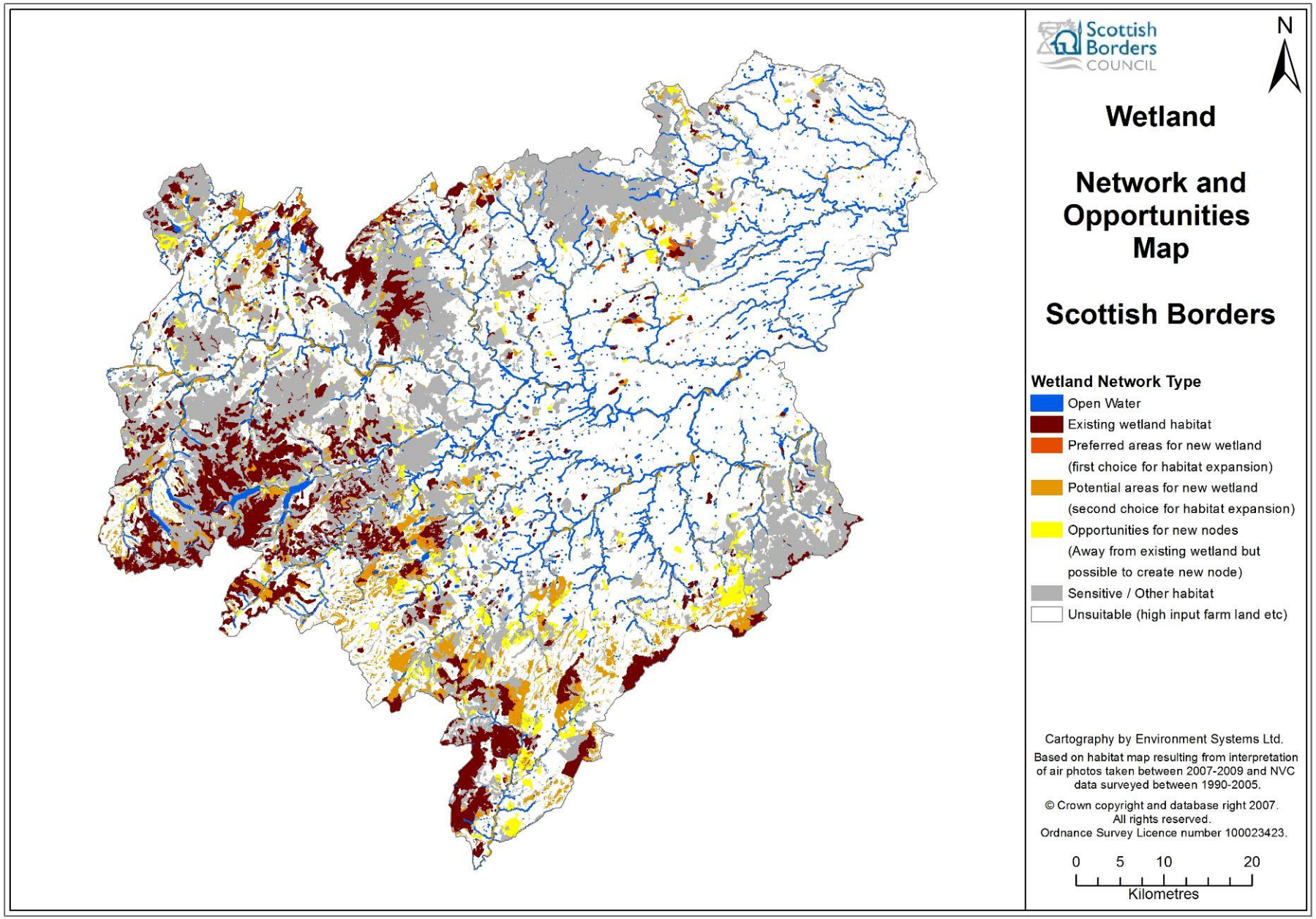

Figure 11: Wetland network and opportunities map, Scottish Borders

6.2 Wetland results

The wetland existing network shown in figure 11 outlines the larger areas of blanket bog in the uplands and the very small areas remaining of raised bogs and wetland in the lowlands. Lowland raised bogs are a priority BAP and Annex I habitat and these sites should be targeted for re-creation efforts in the land that buffers them as this will assist in the maintenance and resilience of these sites. Table 5 below shows the area in hectares covered by each part of the wetland network.

Table 5: Areas of wetland in each network category in the Scottish Borders area

Network Type	ha
'Core' existing wetland	29,964
Preferred	1,720
Open water	3,524
Potential	25,879
Possible area for new wetland 'node'	10,270
Sensitive	101,775
Unsuitable	301,084

The other areas of land suitable for wetland creation are the small hollows in the 'Hummels, Haughs and Knowes' landscape. These areas on the ground are long, narrow features of small size and will be difficult to identify from existing data sets. However, if such features are identified by detailed field work then these areas should be added to the Phase 1 audit data and the model re-run to include them. Wetlands have the most restricted opportunities; this is because the ground conditions are very restricted.

7. Uses of the networks and next steps to further their development

These indicative network and opportunities maps have been developed to give guidance to planners, land managers and owners and Rural Development Plan (RDP) advisers as to the most probable location of good quality habitats and where restoration would bring the maximum benefit. They should also be used to highlight possible conflicting land uses under development proposals. If such conflicts are identified detailed field survey will need to be used to establish the exact conditions at any particular site. Any alterations to the Phase 1 maps should be reported so that the data is kept up to date over time and that its quality is continually improved. The Phase 1 audit and networks could also be updated regularly. Satellite imagery is becoming an increasing useful tool in looking at specific habitats and its availability is increasing. This could provide a mechanism for wide area update and monitoring in the future.

The models are capable of further refinement and sophistication and this could include the use of indicator species for a particular restoration scheme, and sophisticated modelling of meta-populations (Humphrey *et al*., 2007). We recommend this approach for specific larger projects so that the most advantageous area possible is chosen for habitat expansion.

Within the Scottish Borders area the main mechanism for re-creation of habitats is through the SRDP. These indicative networks are designed particularly with the project officers and clients of the SRDP in mind. They will indicate how the networks can be developed and if the particular landowner has land within one of the potential areas it will make evaluation and consideration of their claim easier. Workshops run with SRDP officers would be a useful next step as a mechanism to communicate this data to landowners and advisers. A short briefing note to be sent out by email to advisers when the data is available on the Local View website drawing their attention to the models and how they may be used would be very useful. However a fully interactive implementation that they could use locally on their computers would also be advantageous. The use of the model may also help encourage joint applications for landscape scale re-creation schemes.

The models should be useful to planners when evaluating the best places to provide mitigation for proposed schemes. The tool may also allow the user to gain the wider appreciation of landscape scale issues without the need to have visited large amounts of the area. The following groups are envisaged as users of this network:

- ***Local Strategy and policy*** - A Working Countryside Group**,** Scottish Borders Woodland Strategy, Tweed Catchment Management Plan, Tweed Wetland Strategy, LBAP
- ***Key delivery by local NGOs -*** The Borders Forest Trust, Tweed Forum, The Southern Uplands Partnership e.g. native woodland, black grouse, collaborative SRDPs
- ***Ecosystem service delivery –*** Integration for multi-benefit delivery e.g. planning (wind farms), natural flood management, River Basin Management Plans
- ***Biodiversity projects*** – to encourage draw down of additional resources

If enough effort and money are put into a project it is possible to re-create habitats virtually anywhere; however these maps serve to indicate the best ‘value’ sites and highlight those areas of worth focussing on to get the best environmental and economic returns.

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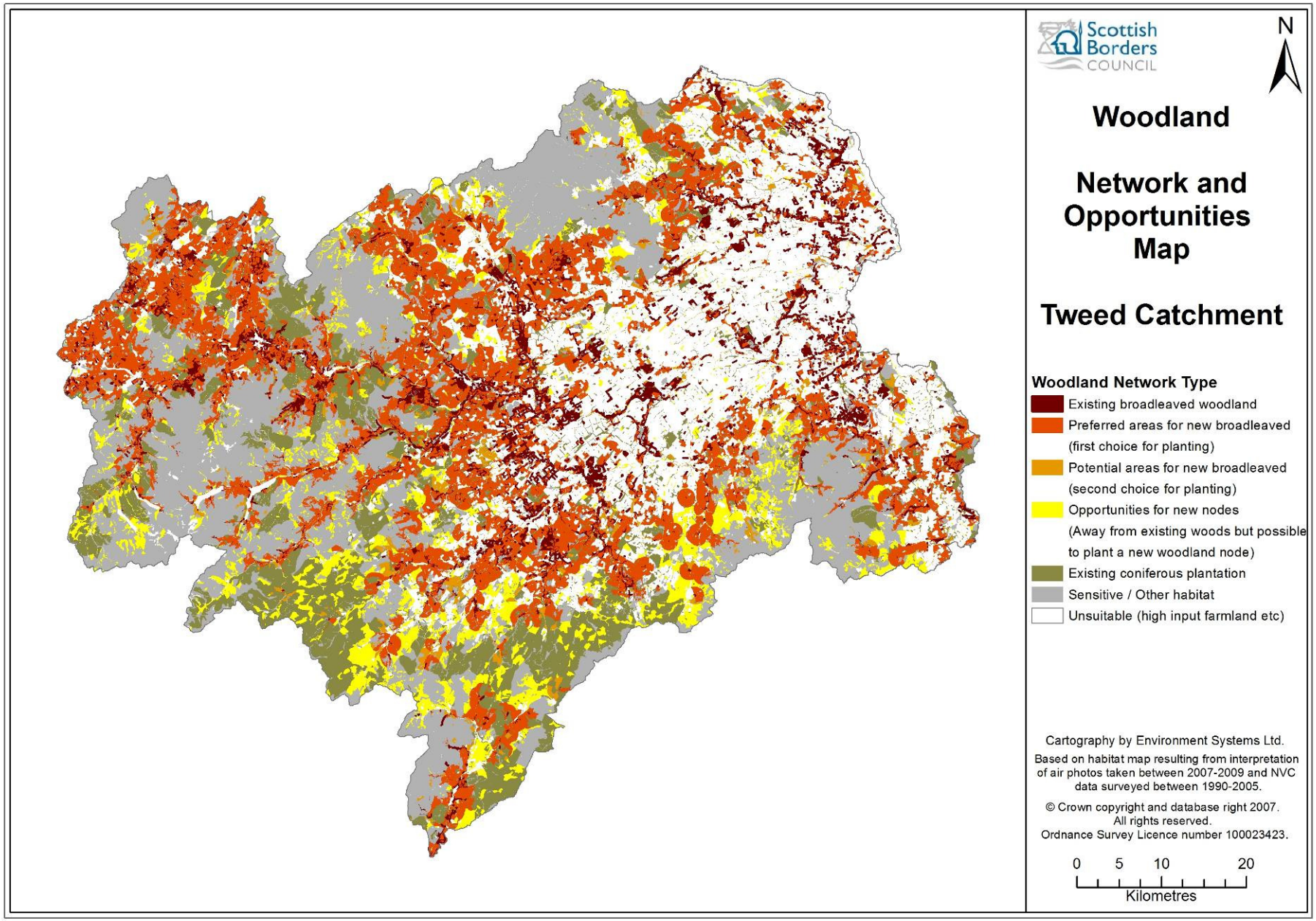
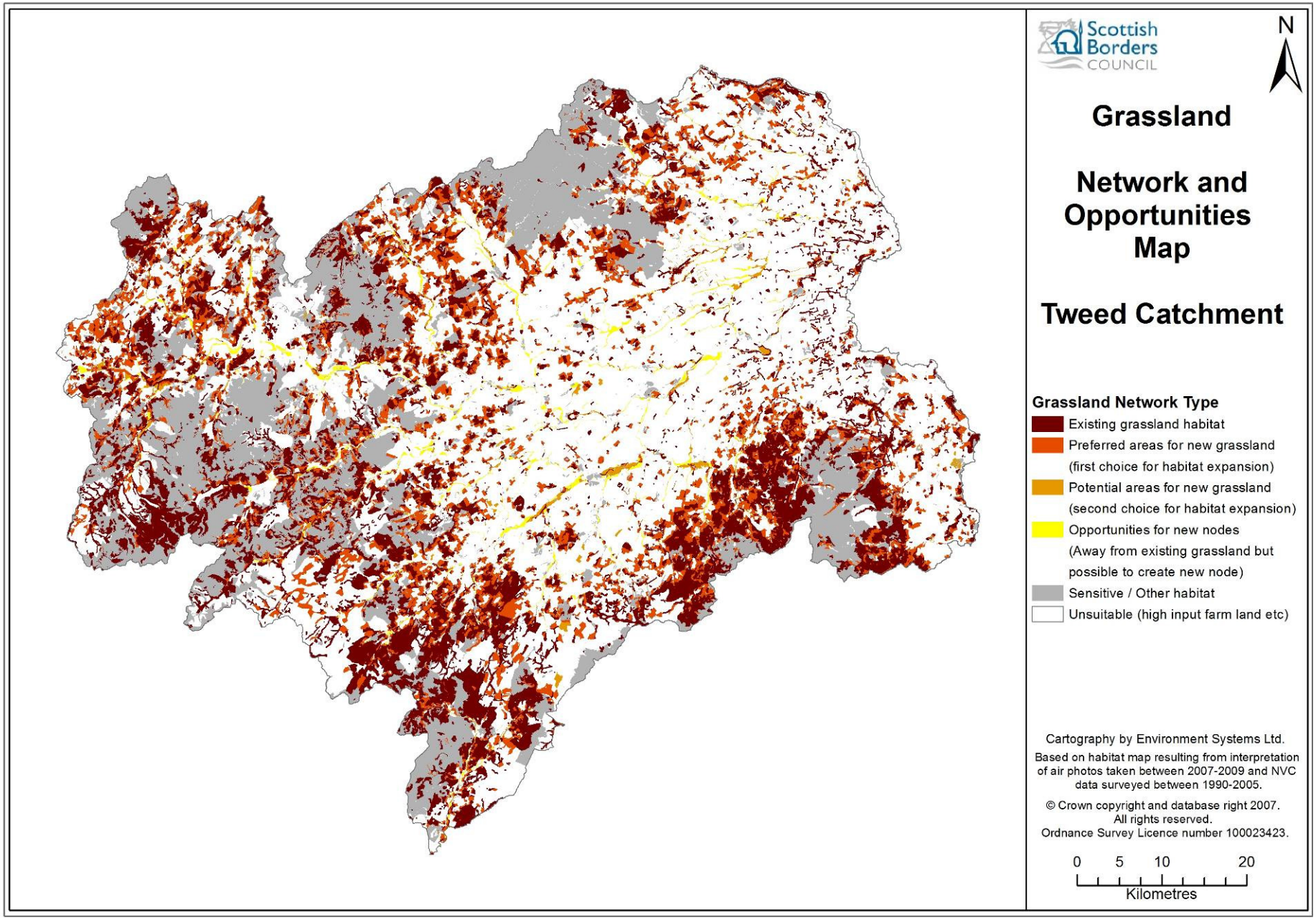
Appendix 1: Network maps and statistics for the Tweed Forum Area




Scottish Borders COUNCIL
N
Grassland
Network and Opportunities Map
Tweed Catchment
Grassland Network Type
Existing grassland habitat
Preferred areas for new grassland (first choice for habitat expansion)
Potential areas for new grassland (second choice for habitat expansion)
Opportunities for new nodes (Away from existing grassland but possible to create new node)
Sensitive / Other habitat
Unsuitable (high input farm land etc)
Cartography by Environment Systems Ltd.
Based on habitat map resulting from interpretation of air photos taken between 2007-2009 and NVC data surveyed between 1990-2005.
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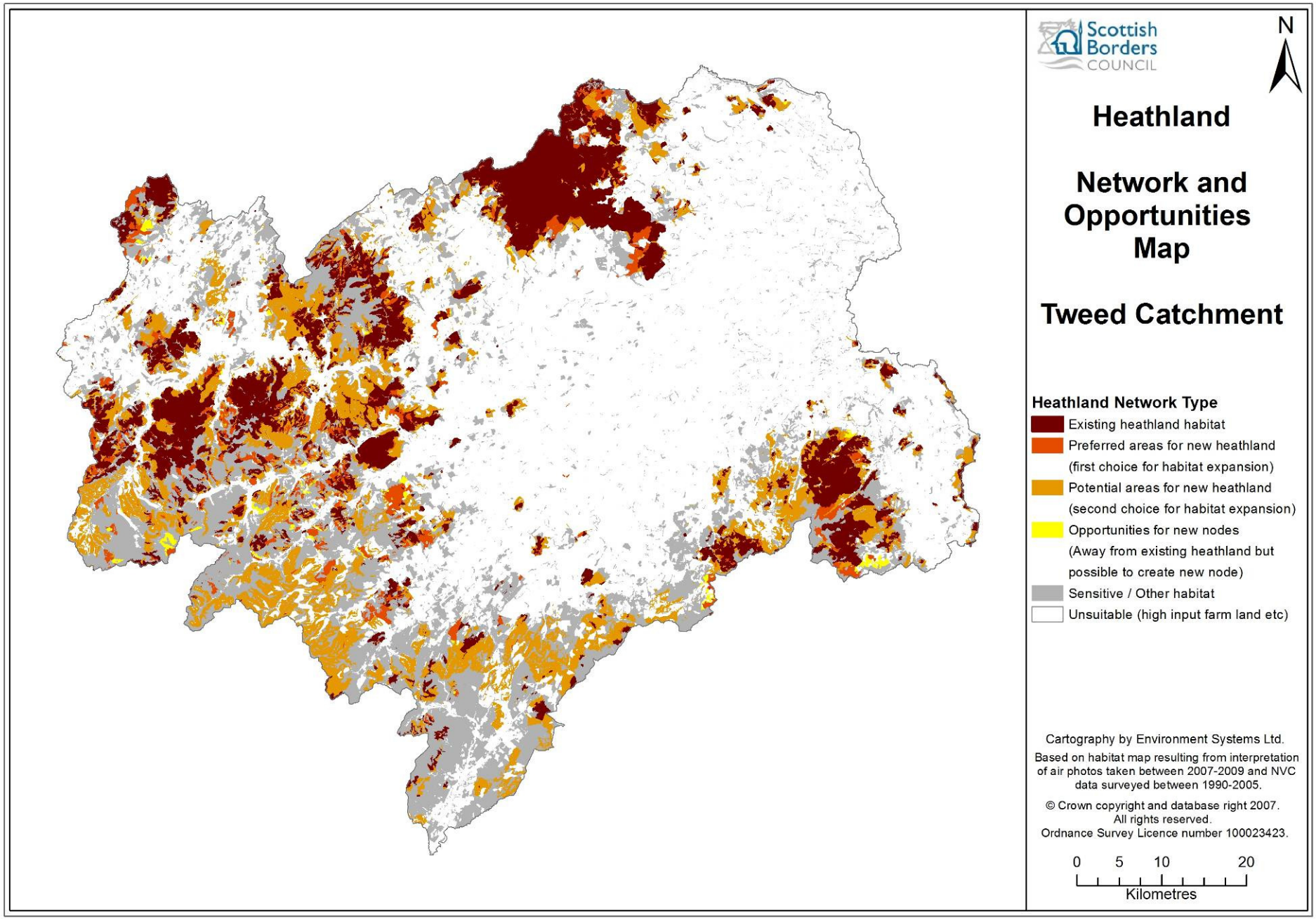
Scottish Borders COUNCIL
N
Heathland
Network and Opportunities Map
Tweed Catchment
Heathland Network Type
Existing heathland habitat
Preferred areas for new heathland (first choice for habitat expansion)
Potential areas for new heathland (second choice for habitat expansion)
Opportunities for new nodes (Away from existing heathland but possible to create new node)
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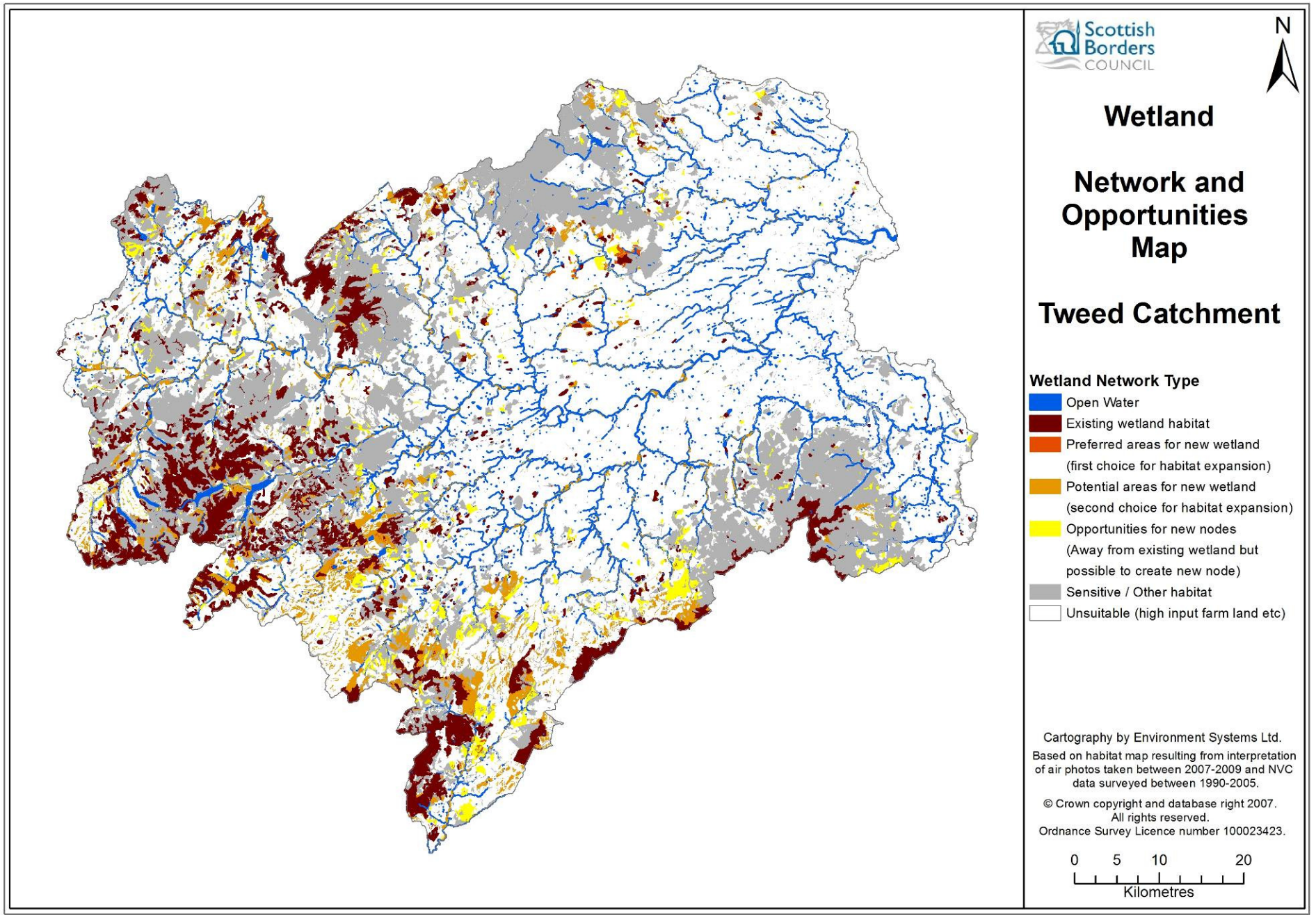
Scottish Borders COUNCIL
N
Wetland
Network and Opportunities Map
Tweed Catchment
Wetland Network Type
Open Water
Existing wetland habitat
Preferred areas for new wetland
(first choice for habitat expansion)
Potential areas for new wetland
(second choice for habitat expansion)
Opportunities for new nodes
(Away from existing wetland but possible to create new node)
Sensitive / Other habitat
Unsuitable (high input farm land etc)
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Based on habitat map resulting from interpretation of air photos taken between 2007-2009 and NVC data surveyed between 1990-2005.
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Kilometres

Table showing component of Woodland networks for the Tweed Forum Area

Network Type	Ha
'Core' existing broadleaved and mixed woodland	14,496
Preferred	125,468
Potential	9,399
Possible area for new woodland 'node'	41,408
Existing coniferous	72,229
Sensitive	140,139
Unsuitable	153,950

Table showing component of Grassland networks for the Tweed Forum Area

Network Type	Ha
'Core' existing grassland	73,686
Preferred	72,131
Potential	4,724
Possible area for new grassland 'node'	5,046
Sensitive	112,358
Unsuitable	289,144

Table showing component of Heathland networks for the Tweed Forum Area

Network Type	Ha
'Core' existing heathland	55,248
Preferred	14,413
Potential	67,290
Possible area for new heathland 'node'	1,847
Sensitive	105,331
Unsuitable	312,961

Table showing component of Wetland networks for the Tweed Forum Area

Network Type	Ha
'Core' existing wetland	31,922
Open water	4,193
Preferred	1,720
Potential	26,632
Possible area for new wetland 'node'	11,241
Sensitive	126,323
Unsuitable	355,011

Appendix 2: Outputs, Copyrights and Licensing

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