Forest Research

Ecological network mapping for Chichester District Council

May 2014

The Research Agency of the
Forestry Commission

Forest Research is the Research Agency of the Forestry Commission and is the leading UK organisation engaged in forestry and tree related research. The Agency aims to support and enhance forestry and its role in sustainable development by providing innovative, high quality scientific research, technical support and consultancy services.

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Project background

Chichester District Council commissioned Forest Research to map ecological networks within the Chichester District Council (CDC) boundary in 2012 and it was completed in 2014. This work is intended to fulfil their commitment to the National Planning Policy Framework, which states that local planning 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;*

- *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.*

The outcomes of the work was also intended to inform the Development Management process.

CDC has considerable data on protected species, as well as sites of international, national and local importance for biodiversity, and areas of priority habitat, through a service level agreement with Sussex Biodiversity Records Centre. However, the other components of ecological networks including corridors, stepping stones and buffers have not been mapped. CDC (Stephanie Evans) appointed Forest Research (order number: eDBC001035) to develop an approach to map ecological networks beyond the existing species point data, in order to identify key components of the ecological networks.

On completion of the work, the ecological networks will have been identified and mapped, consistent with the requirements of the National Planning Policy Framework.

Methods

The work adopts a species-based approach to define ecological networks in recognition that networks are species-specific, what appears to be fragmented habitats for one species may be fully connected for another.

Focal species

Ecological networks were defined for six focal species, to represent key habitats and landscape features within the CDC study area (Table 1). These focal species were developed in consultation with CDC.

Table 1. Selected focal species to represent key habitats and landscape features within Chichester District Council landscape

Focal species	Habitat/Landscape feature
Water Voles	Riparian
Woodland Bats	Woodland (All woodlands and linear features)
Barn Owls	Semi-natural grassland
Northern Lapwing	Farmland
Chalkhill Blue Butterfly	Chalk grassland
Dormice	Woodland & hedgerows

For each focal species a set of rules and assumptions were developed about the species and their habitat requirements and potential movement, to allow the construction of six species-specific ecological networks. This information for the six focal species is detailed in Appendix 1. This includes the primary sources of information, including selected species experts and published research and guidance (section 1). This is followed by a summary of the key points on species habitat requirements and movement (section2). The underlying spatial data used to define the habitats and networks is defined in section 3, while section 4 details the actual GIS methodology to create the ecological networks for each species.

Network modelling

A key element of mapping ecological networks is to take into account how the species can potentially move across or through the landscape from their preferred habitat. Where the species was predicted to move fairly freely across the landscape (e.g. a bird) a simple buffer was used around selected habitat patches. When the surrounding landscape was believed to either impede or promote species movement a least-cost modelling approach was used (Watts *et al.* 2010). This approach simply compresses or extends the buffer around suitable habitat patches, to indicate reduced or increased movement. These matrix resistance values (high resistance equates to lower movement; low resistance to high movement) were defined from expert opinion and published literature where available. In general terms, semi-natural habitats are considered to have lower resistance and allow higher movement than more intensively managed landscape features, such as intensive agriculture or urban areas (Eycott *et al.* 2011; 2012)

Figure 1 illustrates the basic network mapping process. The preferred habitat is selected (a). If the species is believed to move freely across the landscape a simple Euclidean buffer is drawn around the patches to represent a certain degree of movement (b). Where these buffers intersect a network is created, in this illustration patches 1,2,3 and 6 are within a network. However, if the surrounding matrix is believed to impact on species movement a resistance layer can be created (c), in this illustration dark colours signify high resistance and low movement and lighter colours lower resistance and higher movement. This resistance layer has the impact of compressing the buffer over high resistance features and extending over low resistant features (d). In contrast to the network defined in (b) there are now two least-cost networks consisting on patches 1,2 and 5 in one, and 2 and 6 in the other.

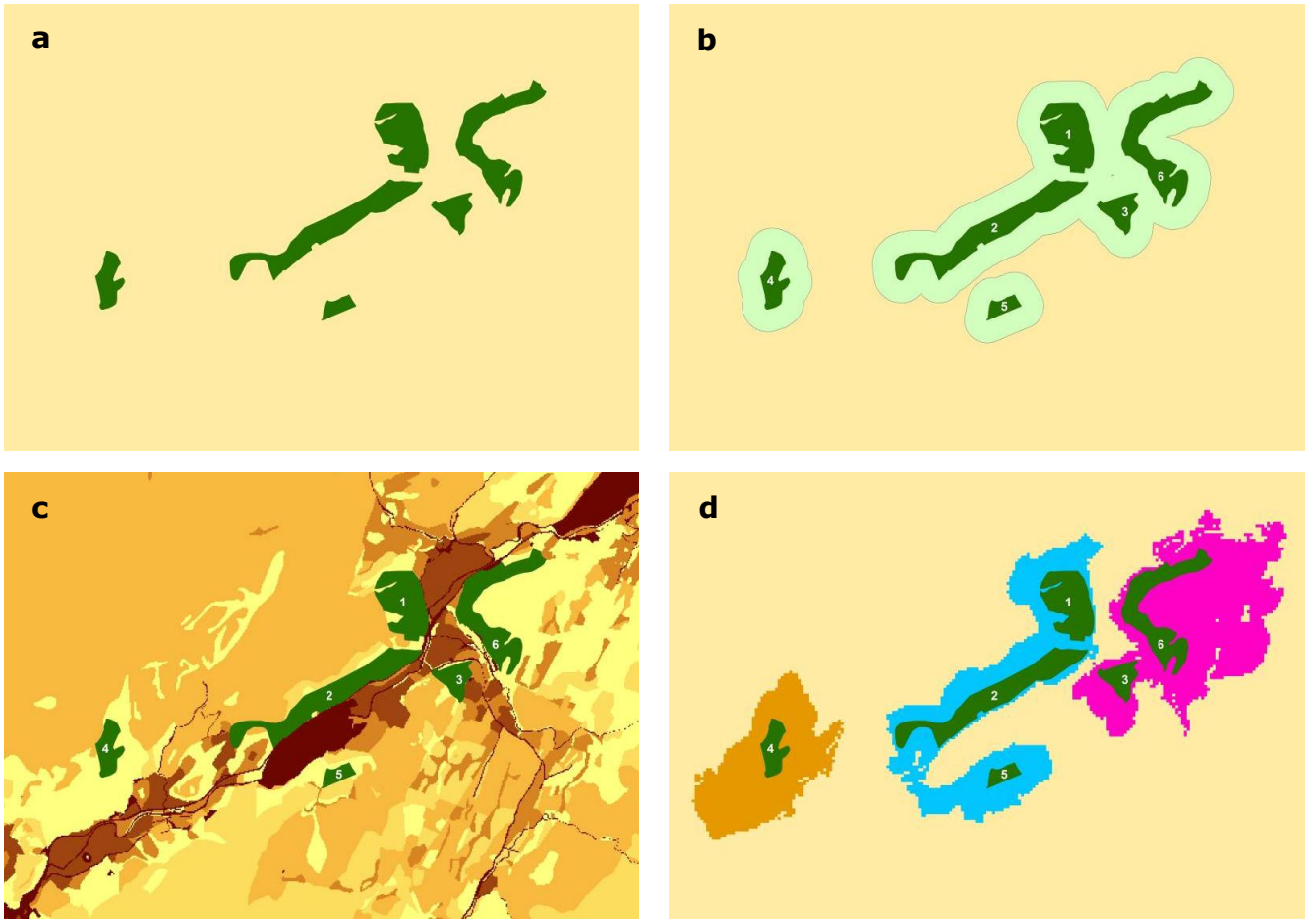


Figure 1. Illustration of fragmented habitat patches (a) connected by simple Euclidean buffers (b) which represent the surrounding landscape as uniform to potential species movement. If certain features of the surrounding landscape are believed to promote (light colours) or hinder (darker colours) species movement, the resulting least-cost buffers are simple extended or compressed to reflect these impacts (d).

Once the potential network areas are mapped for each of the six selected, they then can be defined as occupied and unoccupied by overlaying with the existing species point data as supplied by CDC. Parts of the network could be identified as unoccupied either because the species isn't found there or because surveys have not been undertaken which identify their presence.

Results

Ecological networks for the six selected focal species are presented below.

Figure 2. Ecological networks for Water Voles, unoccupied (a) and occupied (b).

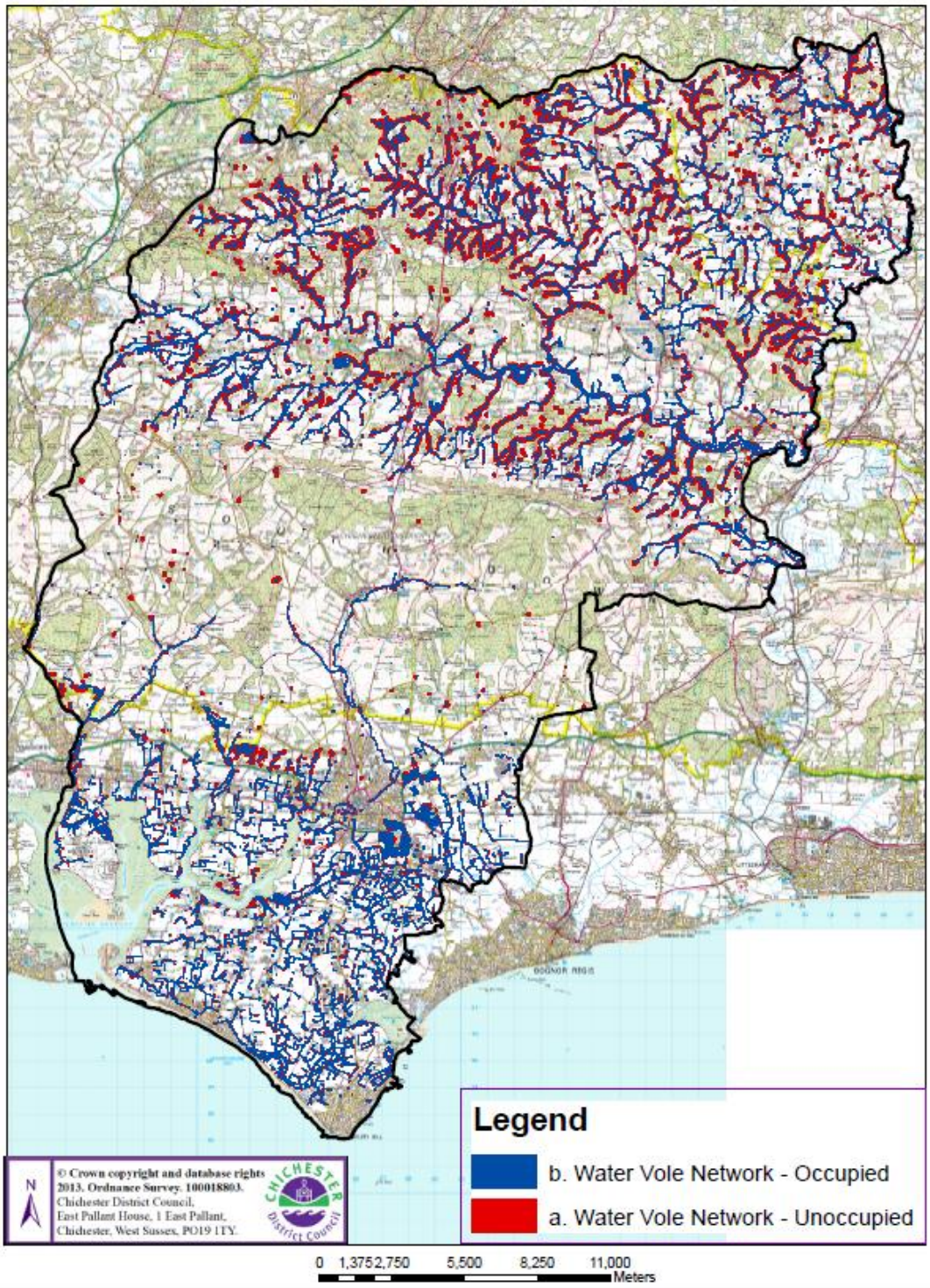


Figure 3. Ecological networks for Woodland Bats, unoccupied (a) and occupied (b).

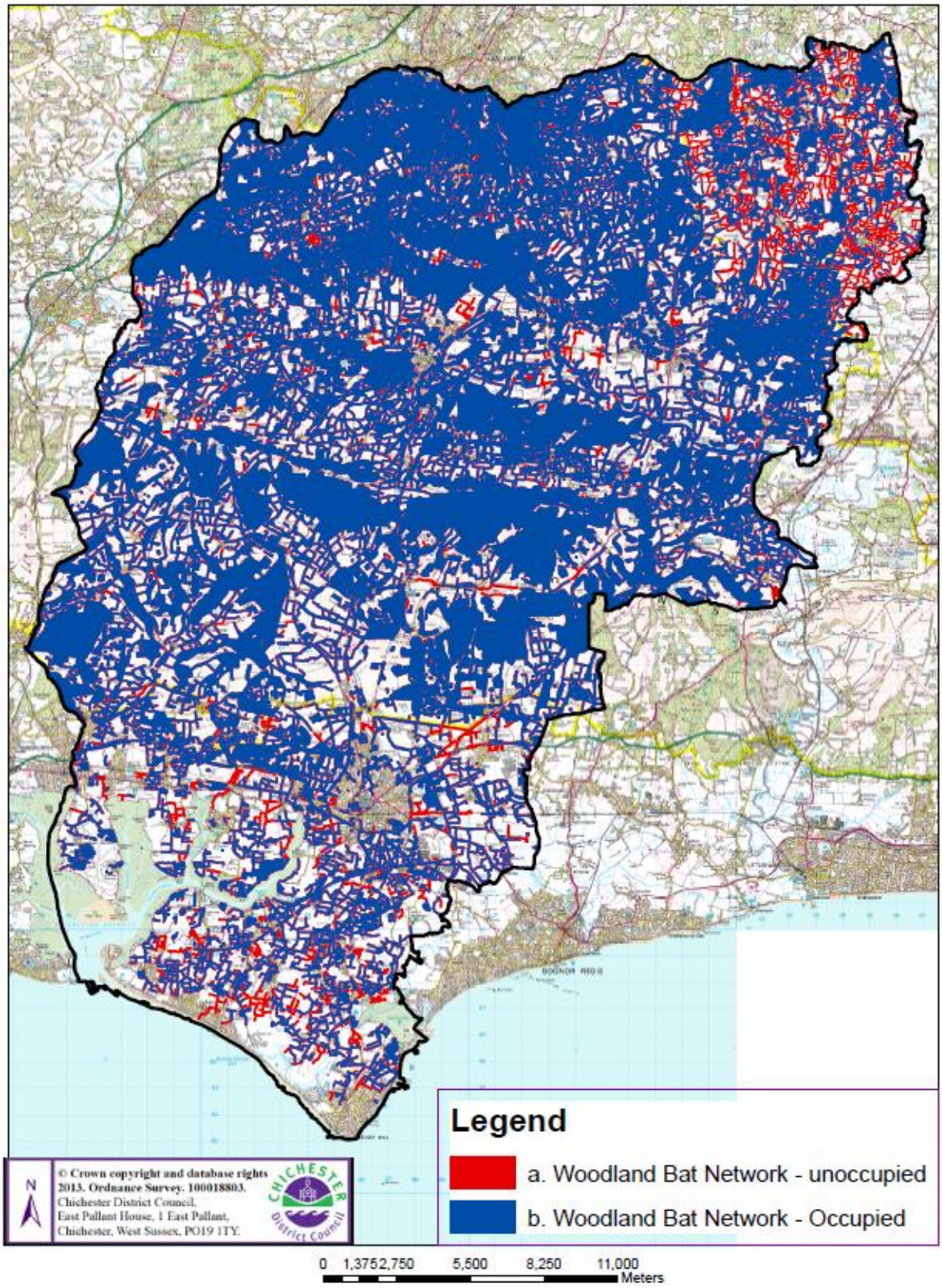


Figure 4. Ecological networks for Barn Owls, unoccupied (a) and occupied (b).

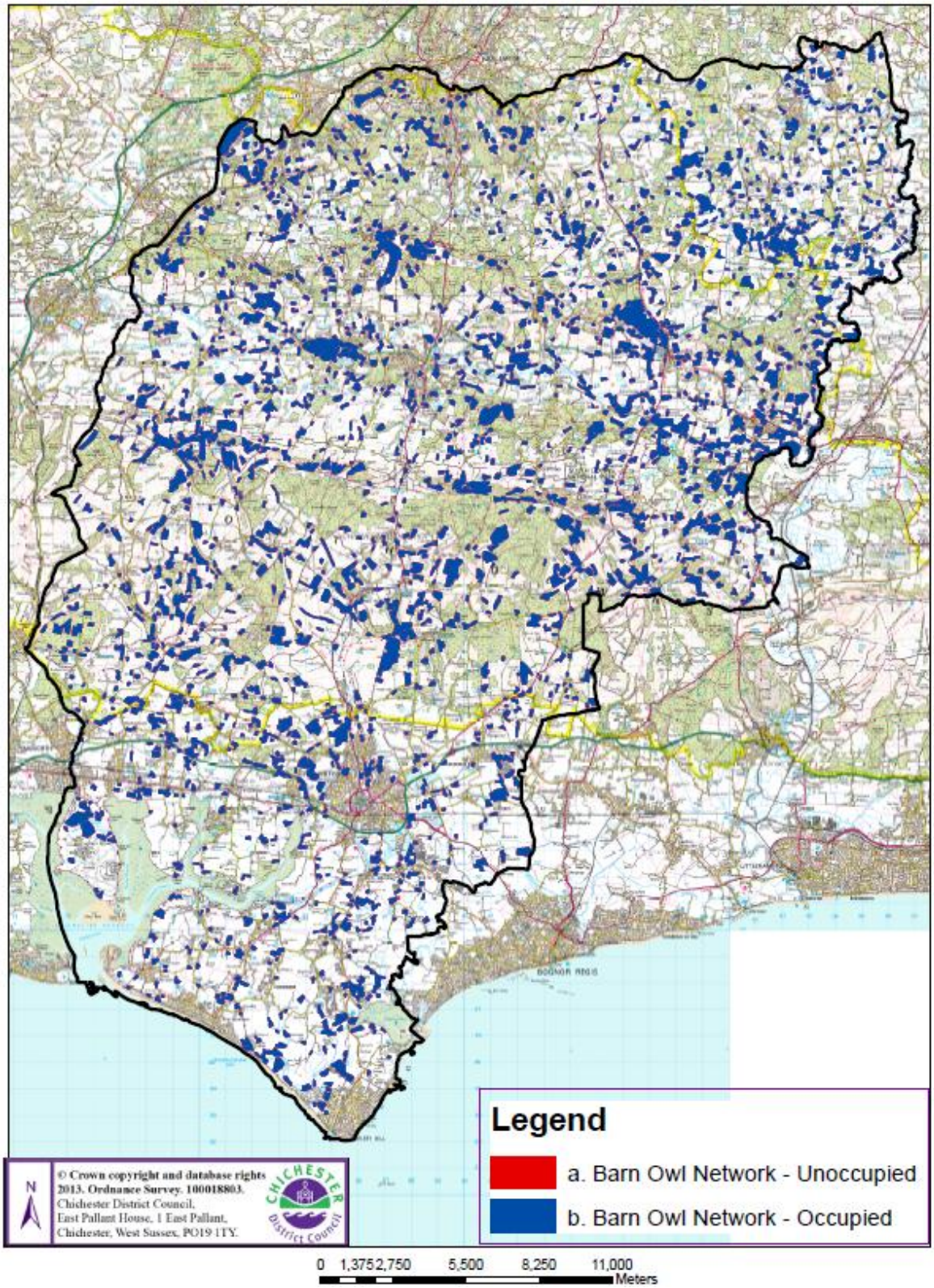


Figure 5. Ecological networks for Northern Lapwing, unoccupied (a) and occupied (b).

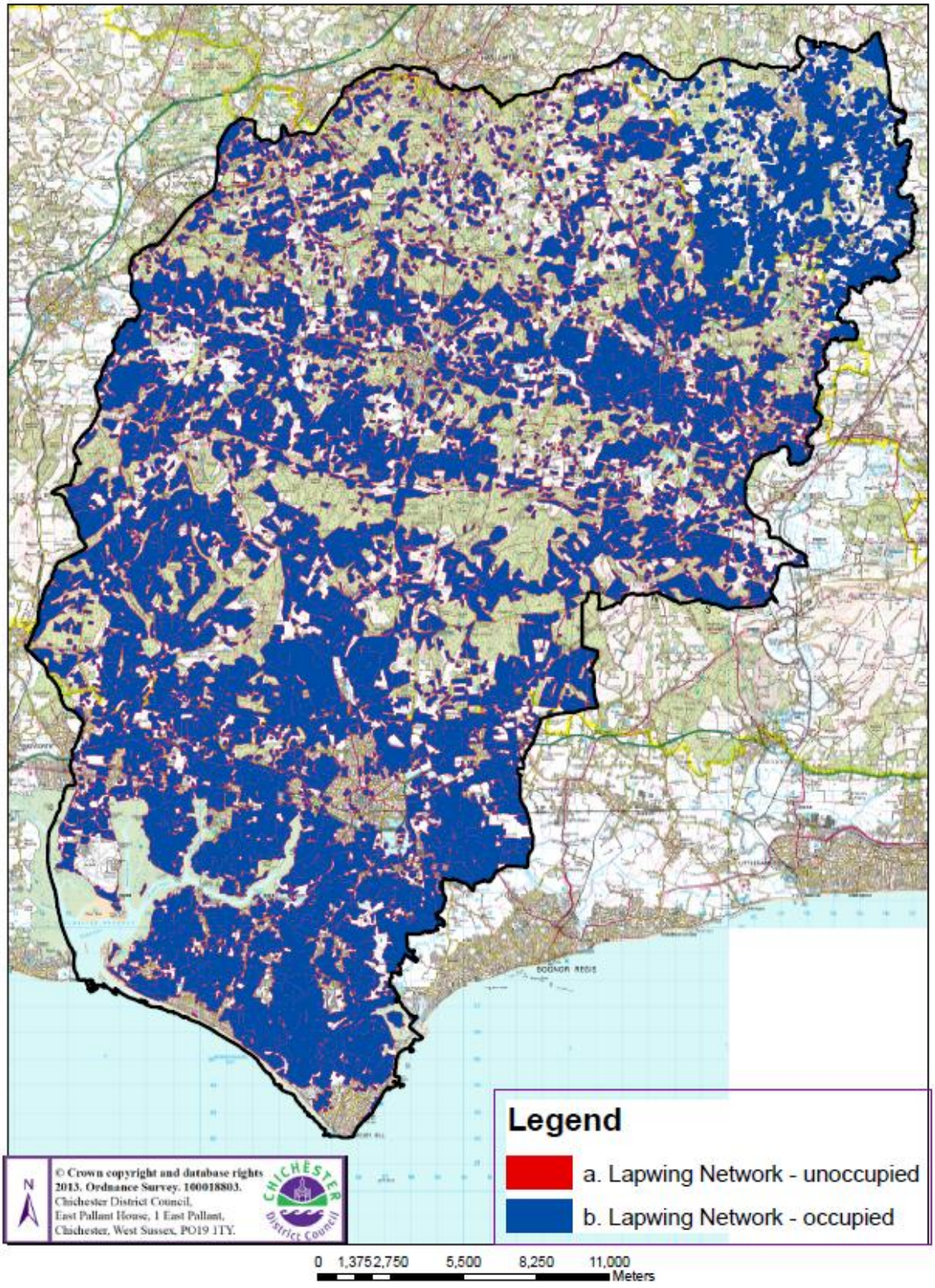


Figure 6. Ecological networks for Chalkhill Blue Butterfly, unoccupied (a) and occupied (b).

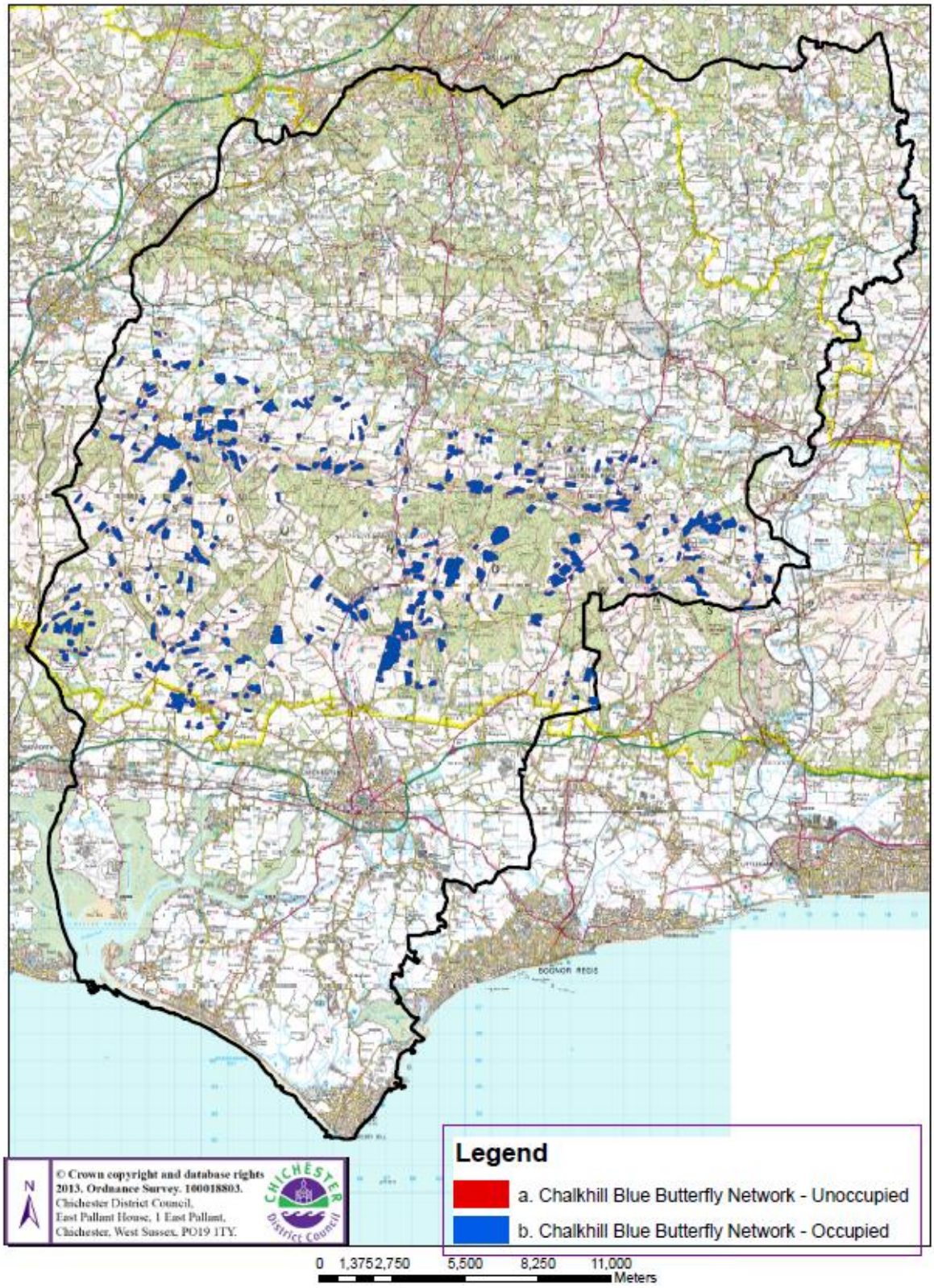
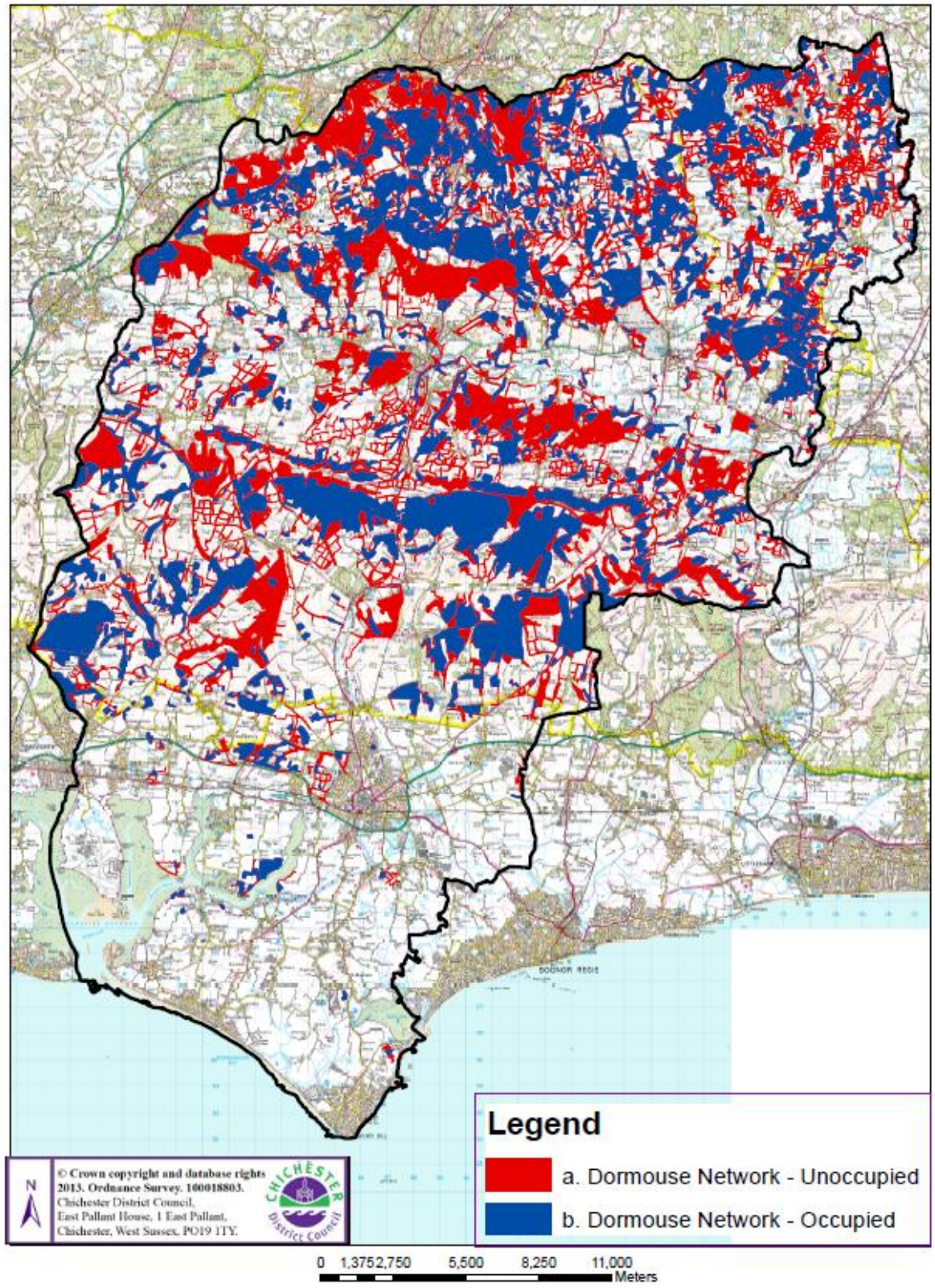


Figure 7. Ecological networks for Dormice, unoccupied (a) and occupied (b).



Conclusions

CDC commissioned Forest Research UK to map the ecological networks within Chichester District Boundary. This was to assist them in meeting their obligations under the National Planning Policy Framework, to inform the development of the Local Plan and the Green Infrastructure Strategy, to assist with the master planning of Strategic Development Sites, to contribute to the Development Management Process (individual planning applications) and to identify key areas for improvements or enhancements to the Network.

The mapped networks will also help to identify which further species and habitat surveys may be required to inform both strategic planning and the development management process. These further surveys will help to ground truth the mapped networks.

References

Eycott, A. E., Marzano, M. and Watts, K. (2011). Filling evidence gaps with expert opinion: The use of Delphi analysis in least-cost modelling of functional connectivity. Landscape and Urban Planning 103 (3-4), 400-409 http://dx.doi.org/10.1016/j.landurbplan.2011.08.014.

Eycott, A.E., Stewart, G.B., Buyung-Ali, L. M., Bowler, D. E., Watts, K. and Pullin, A.S. (2012). A meta-analysis on the impact of different matrix structures on species movement rates. Landscape Ecology 27 (9), 1263-1278. http://dx.doi.org/10.1007/s10980-012-9781-9.

Watts, K., Eycott, A.E., Handley, P., Ray, D., Humphrey, J.W. and Quine, C. (2010). Targeting and evaluating biodiversity conservation action within fragmented landscapes: An approach based on generic focal species and least-cost networks. Landscape Ecology 25 (9), 1305-1318. http://dx.doi.org/10.1007/s10980-010-9507-9.

Appendix – 1

1.1. Water Vole

1.1.1. Information

Expert	Sarah Hughes
Papers	Water Vole Conversation Handbook (Rob Strachan)

1.1.2. Key Points

Water:

- Permanent water.
- Slow flowing watercourse.
- Less than 3m Wide and 1m deep.
- Limited fluctuation of water levels.

Bank side:

- Earth bank with steep incline.
- Dense vegetation with 2m of waters edge (Reed, Rushes & Sedges).
- Continuous (> 60% groundcover) tall riparian plants.
- Sub-optimal urban sites may be used due to lower predation rates.

Landscape:

- Range usually 20-300m, 1km is known but unusual.
- May occupy inundate marshland adjacent to watercourses.
- Avoid dry land at all costs.

1.1.3. Datasets

Dataset	Purpose	Modification
LCM2007 (CEH)	General Landcover	N/A
OSMM OpenWater (OS)	Water	Only polygons classed as "Inland Water" kept. "DESCRIPTIV" in ('General Surface,Inland Water' , 'Inland Water' , 'Inland Water,General Surface' , 'Inland Water,Natural Environment' , 'Inland Water,Road Or Track' , 'Inland Water,Structure' , 'Landform,Inland Water' , 'Structure,Inland Water') ** This command may need amending or replacing with "DESCRIPTIV" LIKE '%Inland Water%' **
Detailed River Network (DRN) (EA)	Water	DRN & DRNOFFLINE DRAINAGEFEATURE combined in dataset. RIVERTYPE NOT IN [6, 9,91] – see table below New dataset buffer by 50 cm.(Major features should already be captured by OS MM)
Water Vole Records (Sussex)	Locations	N/A

River type	Meaning	Included
1	Primary River	
2	Secondary River	
3	Tertiary River	
4	Lake Reservoir	
5	Extended Culvert	x
6	Underground River	x
9	D/S of High Water Mark	x
10	Canal	
51	Canal Tunnel	
91	D/S Seaward extension	x

1.1.4. Method

1. Create Home Habitat Dataset

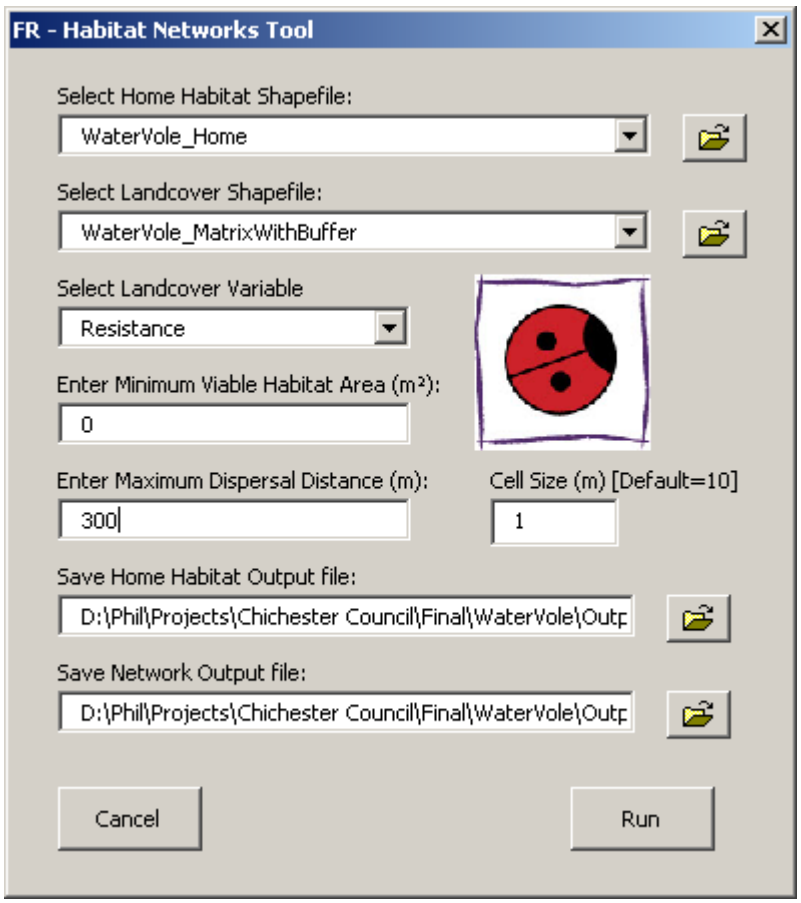
- Create new dataset from OSMM OpenWater and DRN (ArcGIS Union Tool)
- Spatially dissolve dataset (ArcGIS Dissolve Tool)

2. Create Matrix Resistance Dataset

- Create new dataset by buffer Home habitat by 2m (ArcGIS Buffer Tool)
- Create new dataset from Home Habitat, Home Habitat 2m buffer and LCM2007 - order as listed (ArcGIS Union Tool)
- Attach cost/resistance for a Water Vole moving across the landscape (ArcGIS Join).

Landscape feature	Cost/Resistance	
		Within 2m
OS MM Inland Water (Home Habitat)	1	n/a
Arable bare	50	25
Arable unknown	50	25
Bare	50	25
Deciduous	4	1
Despoiled land	50	25
Estuary	50	25
Felled	4	1
Hay	50	25
Heather and dwarf shrub	4	1
Heather grass	50	2
Improved	50	25
Inland Water	1	1
Lake	4	1
Littoral mud	50	25
Littoral sand	50	25
Mixed	4	1
Neutral grassland	50	2
River	4	1
Rough low-productivity grassland	50	2
Saltmarsh	50	25
Sand dune	50	
Sand dune with shrubs	50	25
Scrub	4	1
Sea water	50	
Shingle	50	25
Suburban	50	2
Supra-littoral rock	50	25
Urban	50	2
Urban industrial	50	2

3. Run FR's Habitat Networks Tool



4. Calculated Water Voles Present/Absent in Networks

- Select networks within 25m of Water Vole networks (ArcGIS Spatial Select)
- Give selected networks a value Present=3, otherwise Present=1.

1.2. Barn Owl

1.2.1. Information

Expert	Barrie Watson
Papers	Habitat Management (The Barn Owl Trust) The effects of land-use and landscape Structure on barn owl breeding success in southern England (Bond et al, 2004)

1.2.2. Key Points

Nest:

- Nest boxes (98%).
- Buildings.
- Trees.

Dispersal Distance:

- 2KM.
- Will forage up to 7KM from roost site.

Foraging:

- Permanent rough grassland.
- Open land: young tree plantations, recently felled, orchards,
- semi-improved grassland.
- Linear habitats: headlands, woodland edges, river banks, ditches,
- hedgerows, road verges.

1.2.3. Datasets

Dataset	Purpose	Modification
LCM2007 (CEH)	General Landcover	N/A
Barn Owl Records (Sussex)	Locations	N/A

1.2.4. Method

1. Create Suitable Barn Owl Habitat dataset

    - Create new dataset by subsetting LCM2007 (keeping: "BHSUB" in ('Acid grassland' , 'Calcareous grassland' , 'Heather and dwarf shrub' , 'Heather grass' , 'Neutral grassland' , 'Rough low-productivity grassland', 'Scrub')) (ArcGIS Export).

2. Calculate Barn Owl Home Ranges

    - Buffer Barn Owl Records by 1000m (ArcGIS Buffer Tool).

3. Calculate Presence/Absence of Barn Owls in Suitable habitats.

    - Combine Suitable Barn Owl Habitat and Home ranges dataset (ArcGIS Union Tool).
    - Where Suitable and Home Range: Present=3 otherwise Present =1.

1.3. Woodland Bats

1.3.1. Information

Expert	Brenda Mayle
Papers	Habitat management for bats: A guide for land manager, Landowners and their advisors (JNCC)

1.3.2. Key Points

Woodland Bats (Barbastelle, Bechstein's bat, Brandt's bat, Brown Long-eared bat, Grey Long-eared bat, Lesser Horseshoe bat, & Whiskered bat)

Important habitats:

- Freshwater
- Woodland
- Grassland
- linear habitats

Habitat corridors which allow bats to move freely between roosts and feeding areas.

Even gaps as small as 10m may prevent small species travelling between areas causing isolation.

Roosts:

- Buildings, trees, bat boxes, tree holes & under bark

Foraging:

- Woodland (Deciduous, Conifer, Wet, Bankside)
- Parkland, Orchards, Gardens, Some meadows/grassland

Movement:

- Woodland rides
- bankside vegetation
- hedgerows

1.3.3. Datasets

Dataset	Purpose	Modification
OS MM Trees (OS)	Woodlands under 0.25 ha	Only polygons classed as “Trees” kept. "DESCRIPTIV" LIKE '%Trees%'
National Forest Inventory (NFI) (FC)	Woodlands over 0.25 ha	N/A
Hedgerow data (Chichester)	Linear Habitat	Buffer by 2.5m to create polygon.
DRN (EA)	Linear Habitat	DRN & DRNOFFLINE DRAINAGEFEATURE combined in dataset Keep data where RiverType = Tertiary River or lower Buffer by 2.5m to create polygon.
Bat Record (Sussex)	Location	Only species listed were kept.

1.3.4. Method

1. Create Woodland Dataset
    - Combine NFI and OSMM Trees to create Woodland Dataset (ArcGIS Union Tool)
    - Spatially dissolve dataset (ArcGIS Dissolve Tool)
2. Create Linear Habitat Dataset
    - Combine Hedgerow and DRN to create Linear habitats Dataset (ArcGIS Union Tool)
    - Spatially dissolve dataset (ArcGIS Dissolve Tool)
3. Create Ecological Networks
    - Buffer Woodland by 10/25m (ArcGIS Buffer Tool)
    - Buffer Linear Habitats by 10/25m (ArcGIS Buffer Tool)
    - Select Linear habitats which intersect with Woodlands (ArcGIS Spatial Select)
    - Combined selected Linear Habitat with Woodland dataset (ArcGIS Union Tool).
    - Spatially dissolve networks (ArcGIS Dissolve Tool)

4. Calculated bats Present/Absent in Networks

- Select networks with 25m of Bats networks (ArcGIS Spatial Select)
- Give selected networks a value Present=3, otherwise Present=1.

1.4. Dormouse

1.4.1. Information

Expert	Roger Trout
Papers	The dormouse conservation handbook (English Nature).

1.4.2. Key Points

Prime Habitat:

- Oak as canopy trees with Hazel and Bramble providing understory
- Deciduous woodland with secondary cover
- PAWS
- Species Rich Hedgerows
- Scrub, young plantation

Occasional Use:

- Gorse scrub
- Heathland
- Alder trees among reeds

Movement: Usually remain with 70m of nest

1.4.3. Datasets

Dataset	Purpose	Modification
OS MM Trees (OS)	Woodlands under 0.25 ha	Only polygons classed as "Trees" kept.
National Forest Inventory (NFI) (FC)	Woodlands over 0.25 ha	N/A
Hedgerow data (Chichester)	Linear Habitat	N/A
Ancient Woodland Inventory (NE)	Home Habitat	n/a
Dormouse (Sussex)	Location	

1.4.4. Method

1. Create Woodland Dataset

    - Combine NFI,OS MM Trees & Hedgerow to create Woodland Dataset (ArcGIS Union Tool)
    - Spatially dissolve dataset (ArcGIS Dissolve Tool)

2. Create Home Habitat Dataset

    - Clipped to NFI data to maintain consistency, and agreed with principle of most conservative approach (ArcGIS Clip Tool)
    - Spatially dissolve dataset (ArcGIS Dissolve Tool)

3. Create Ecological Networks

    - Select Woodland which intersect with Home Habitat (ArcGIS Spatial Select)
    - Give unique ID and spatially join ID to Home Habitat (ArcGIS: Spatial Join)

4. Calculated Dormouse Present/Absent in Networks

    - Select networks with 25m of Dormouse points (ArcGIS Spatial Select)
    - Give selected networks a value Present=3, otherwise Present=1.

1.5. Lapwing

1.5.1. Information

Expert	-
Papers	Conservation management of Lapwing *Vanellus vanellus* on lowland arable farmland in the UK (Sheldon et al, 2004) The relevance of non-farmland habitats, uncropped areas and habitat diversity to the conservation of farmland birds (Fuller et al, 2004) Habitat models of bird species' distribution: an aid to the management of coastal grazing marshes (Milsom et al, 2000) Should conservation strategies consider spatial generality? Farmland birds show regional not national patterns of habitat association (Whittingham, 2007)

1.5.2. Key Points

Lapwing is usually associated with cropped agricultural land.

Use of landscape will vary regionally and seasonally

- Farmland (50%)
- Coastal (Saltmarsh, Grazing) (13%)
- Moorland (12%)
- Rural/Suburban & Urban (5%)
- Woodland (4%)

1.5.3. Datasets

Dataset	Purpose	Modification
LCM2007 (CEH)	General Landcover	N/A
Lapwing Records (Sussex)	Locations	N/A

1.5.4. Method

1. Create Suitable Lapwing Habitat dataset

- Create new dataset by subsetting LCM2007 (keeping: 'Acid grassland' , 'Arable bare' , 'Arable unknown' , 'Calcareous grassland' , 'Hay' , 'Heather and dwarf shrub' , 'Heather grass' , 'Neutral grassland' ,'Rough low-productivity grassland' , 'Saltmarsh') (ArcGIS Export).

2. Calculate Lapwing Home Ranges

- Buffer Lapwing Records by 1000m (ArcGIS Buffer Tool).

3. Calculate Presence/Absence of Lapwing in Suitable habitats.

- Combine Suitable Lapwing Habitat and Home ranges dataset (ArcGIS Union Tool).
- Where Suitable and Home Range: Present=3 otherwise Present =1.

1.6. Chalk-Hill Blue Butterfly

1.6.1. Information

Expert	-
Papers	The impact of habitat fragmentation on trophic interactions of the monophagous butterfly Polyommatus coridon (Bruckmann et al, 2010) Increasing patch area, proximity of human settlement and larval food plants positively affect the occurrence and local population size of the habitat specialist butterfly *Polyommatus coridon* (Lepidoptera: Lycaenidae) in fragmented calcareous grasslands. (Rosin et al, 2011)

1.6.2. Key Points

Habitat:

- Specialised on Calcareous (semi-natural) grasslands.
- Small patches often maintain no viable populations
- Best model used patch area & distance to nearest human settlement.

Movement:

- Sedentary to moderate dispersing species
- Average migration distance 2km (range 0.5-3km)
- Observed movement: intra (22.4m +/- 1.9m)
    - intra (63.1m +/- 5.0m)

1.6.3. Datasets

Dataset	Purpose	Modification
LCM2007 (CEH)	General Landcover	N/A
Chalk-Hill Blue Records (Sussex)	Locations	N/A

1.6.4. Method

Least-cost distance method:

1. Create Home Habitat Dataset

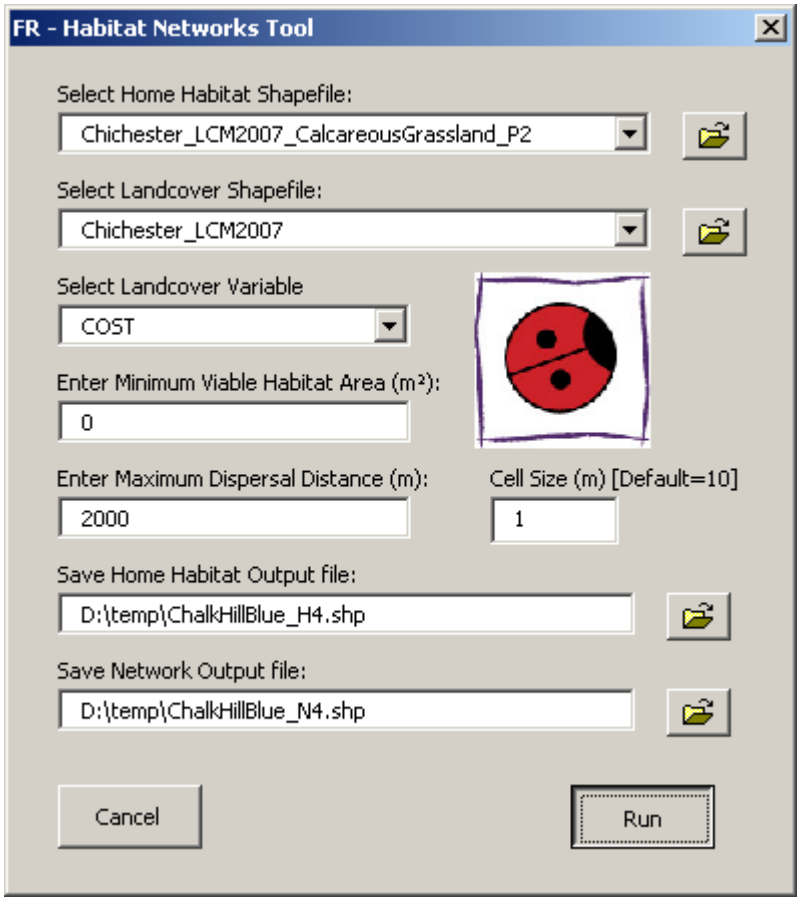
- Select BHSub= "Calcareous grassland"
- Spatially dissolve dataset (ArcGIS Dissolve Tool)

2. Create Matrix Resistance Dataset

- Attach cost/resistance for a Chalk-Hill Blue moving across the landscape (ArcGIS Join).

Landscape feature	COST
Acid grassland	1
Arable bare	10
Arable unknown	10
Bare	10
Calcareous grassland	0
Conifer	10
Deciduous	10
Despoiled land	10
Estuary	10
Felled	10
Hay	10
Heather and dwarf shrub	10
Heather grass	10
Improved	10
Lake	10
Littoral mud	10
Littoral sand	10
Mixed	10
Neutral grassland	1
River	10
Rough low-productivity grassland	1
Saltmarsh	10
Sand dune with shrubs	10
Sand dune	10
Scrub	10
Sea water	10
Shingle	10
Suburban	10
Supra-littoral rock	10
Urban industrial	10
Urban	10

3. Run FR's Habitat Networks Tool



4. Calculated Chalk-Hill Blue Present/Absent in Networks

- Select networks within 25m of Chalk-Hill Blue networks (ArcGIS Spatial Select)
- Give selected networks a value Present=3, otherwise Present=1.

Euclidean distance method:

1. Create Home Habitat Dataset

- Select BHSub= "Calcareous grassland" from LCM2007
- Spatially dissolve dataset (ArcGIS Dissolve Tool)

2. Create Euclidean Buffer Dataset

- Buffer Home Habitat Dataset by 2000m *Do not dissolve* (ArcGIS Buffer Tool).

3. Create Euclidean Network Dataset

- Select BHSub in ("Acid grassland","Calcareous grassland", "Neutral grassland"," Rough low-productivity grassland") from LCM2007 where it is also falls with the 2000m buffer (ArcGIS Clip Tool)

4. Calculated Chalk-Hill Blue Present/Absent in Networks

- Select networks (Step 3.) within 25m of Chalk-Hill Blue networks (ArcGIS Spatial Select)
- Give habitat within selected networks a value Present=3, otherwise Present=1.