Costing potential actions to offset the impact of development on biodiversity – Final Report - Annexes

Defra

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ANNEXES

Annex 1 Using Metrics and Multipliers to Assess Overall Offset Requirements

A1.1 Introduction

The costings model estimates the area of the following habitat groupings that will be affected by development and therefore require offsets:

- BAP priority habitats on Greenfield sites.
- Other Greenfield land – predominantly agricultural land and plantation forestry
- Open mosaic habitats on previously developed (Brownfield) land, which is now a BAP priority habitat.

In order to assess the costs of offsetting, we need to estimate the area of offsets required for each of these groups and combine these with estimates of the unit costs of providing offsets. This can be achieved by specifying appropriate ratios that estimate the offsets required for the different types of sites affected by development.

Proposed metrics and multipliers have been developed through papers by Adrian Jowitt of Natural England which identify the different factors that need to be considered in calculating offset requirements and propose ratios that can be applied in particular circumstances.

The key factors to be taken account of in specifying the relevant ratios are:

- Habitat value – taking account of the relative distinctiveness and quality of what is lost and what is provided in return;
- Risk and uncertainty – taking account of the fact that we can know what biodiversity is being lost as a result of development but that creating or restoring habitat is always subject to risks that the offset will fail to deliver habitat of the expected quality;
- Time preference – taking account of the fact that we would prefer to have a given amount of biodiversity now rather than at some point in future. While the loss of habitat due to development is immediate, creation or restoration of habitats may take many years.

These different factors will give rise to different offset requirements for the different habitat groups listed above, given the requirement for no net loss of biodiversity through the provision of offsets. For example, where priority habitats are developed, the requirement for offsets will be high relative to the area of habitat loss, as risk and time preference mean that more hectares will need to be created or restored compared to those lost. Where intensive farmland of low distinctiveness is developed, and this is be replaced with more distinctive habitats, equivalence can be achieved with relatively fewer hectares of offsets.

The Natural England papers propose metrics and multipliers to be applied in individual cases. For the purposes of the costings, we need to define some more general scenarios which enable us to define overall ratios that can be used to relate the area developed to the area of offsets required.

We first consider the metrics required to achieve equivalence between the sites impacted and the offsets provided, and then combine these with multipliers for risk and time preference to identify overall ratios that can be applied.

A1.2 Metrics for Habitat Value

In assessing the need for offsets it is necessary to take account of the net value of habitat lost and gained and to specify an appropriate metric that achieves equivalence between the two, ensuring that there is no net loss of biodiversity. Development results in a loss of habitat and its replacement with built land, and a gain through the offset as a result of habitat creation or restoration, typically on Greenfield land of low biodiversity value – the net change in habitat value in each case needs to be considered.

The Natural England papers measure these changes through a points system based on:

- Habitat distinctiveness – with BAP priority habitats rating high on distinctiveness and intensively used land rating low;
- Habitat condition – with habitats within each distinctiveness class rated as poor to optimum based on their relative quality.

The metrics are given in Table A1.1.

Table A1.1 Matrix showing how condition and distinctiveness scores are combined to give the habitat score for a potential offset

		Biodiversity Distinctiveness		
		Low (2)	Medium (4)	High (6)
Condition	Optimum (4)	8	16	24
	Good (3)	6	12	18
	Moderate (2)	4	8	12
	Poor (1)	2	4	6

Assessing changes in condition is more difficult than changes in distinctiveness, as the resulting condition of the new habitat is difficult to predict. A starting point of optimum condition is assumed when assessing damage[1].

Generalised scenarios based on the metrics in the Natural England papers are given as follows. In each case we have calculated the number of hectares of the newly created or restored habitat equivalent to one hectare of developed land.

Development on intensive farmland

The land developed is of low distinctiveness and assumed to be of optimum condition

8 credits are required to offset each hectare of land developed

Creation of high distinctiveness habitat:

Assuming the land used for offsets is also of low distinctiveness and in moderate condition (habitat score = 4), creation of new high distinctiveness habitat of good condition (habitat score =18) gives a net gain = 14 credits per hectare

This implies a **0.57 : 1 ratio** to achieve equivalence, i.e. each hectare of habitat lost needs to be offset by 0.57 hectares of newly created habitat.

In some cases, and over time, the offset habitat may reach high distinctiveness optimum condition (habitat score = 24), and this gives a net gain = 20 credits per hectare

This implies a **0.4 : 1 ratio** to achieve equivalence, i.e. each hectare of habitat lost needs to be offset by 0.4 hectares of newly created habitat.

Restoration of a high distinctiveness habitat:

Restoration of a BAP priority habitat from moderate to good condition over 10 years gives a net gain = 6 credits per hectare

[1] This is based on an assumption from a conservation perspective that protecting habitat in location is always preferable to undertaking actions elsewhere to replace it. And whilst the condition of a habitat at a proposed development site might not be high in nearly all cases it would have retained the potential to have its condition improved had it not been destroyed.

Therefore there is a need to restore 8/6 = **1.33 hectares** of habitat for every hectare of land developed, in order to achieve equivalence

It should be noted that, as with the creation option, the overall area of habitat declines but that restoration secures a qualitative improvement in habitat elsewhere to offset that lost through development.

Restoration of a BAP priority habitat from moderate to optimum condition gives a net gain = 12 credits.

In the latter case there is a need to restore 8/12 = **0.67 hectares** of habitat for every hectare of land developed to achieve equivalence

Development on priority habitats

The land developed is of high distinctiveness and assumed to be of optimum condition

24 credits are required to offset each hectare of land developed.

<u>Creation of high distinctiveness habitat:</u>

Assuming the land used for offsets is also of low distinctiveness and in moderate condition (habitat score = 4), creation of new high distinctiveness habitat of good condition (habitat score = 18) gives a net gain = 14 credits per hectare

This implies a **1.71 : 1 ratio**, i.e. each hectare of development needs to be offset by 1.71 hectares of newly created habitat to achieve equivalence

In some cases, the offset habitat may reach high distinctiveness optimum condition (habitat score = 24 points), and this gives a net gain = 20 credits

This implies a **1.2 : 1 ratio**, i.e. each hectare of habitat developed needs to be offset by 1.2 hectares of newly created habitat to achieve equivalence

<u>Restoration of a high distinctiveness habitat:</u>

Restoration of a BAP priority habitat from moderate to good condition gives a net gain = 6 credits per hectare

There is a need to restore 24/6 = **4 hectares of habitat** for every hectare of habitat developed, a **4:1 ratio** to achieve equivalence

Restoration of a BAP priority habitat from moderate to optimum condition gives a net gain = 12 credits per hectare

There is a need to restore 24/12 = **2 hectares** of habitat for every hectare of priority habitat developed, a **2:1 ratio** to achieve equivalence

Development of brownfield habitats

The land developed is of medium distinctiveness and assumed to be of optimum condition

16 credits are required to offset each hectare of land developed

<u>Creation of high distinctiveness habitat:</u>

Assuming the land used for offsets is also of low distinctiveness and in moderate condition (habitat score = 4), creation of new high distinctiveness habitat of good condition (habitat score = 18) gives a net gain = 14 credits per hectare

This implies a **1.14 : 1 ratio**, i.e. each hectare of development needs to be offset by 1.14 hectares of newly created habitat to achieve equivalence.

In some cases, the offset habitat may reach high distinctiveness optimum condition (habitat score = 24), and this gives a net gain = 20 credits per hectare

This implies a **0.8 : 1 ratio**, i.e. each hectare of development needs to be offset by 0.8 hectares of newly created habitat to achieve equivalence

<u>Restoration of a high distinctiveness habitat:</u>

Restoration of a BAP priority habitat from moderate to good condition = 6 credits per hectare

There is a need to restore 16/6 = **2.67 h**ectares of habitat for every hectare of habitat developed, a **2.67:1 ratio** to achieve equivalence

Restoration of a BAP priority habitat from moderate to optimum condition gives a net gain = 12 credits per hectare

There is a need to restore 16/12 = **1.33 hectares** of habitat for every hectare developed, a **1.33 : 1 ratio** to achieve equivalence.

Table A1.2 Summary of Calculations

Development scenario	Offset scenario	A. Credits required per hectare developed	B. Baseline score for habitat scheme	C. Score achieved by habitat scheme	D. Net credits per ha gained by habitat scheme (C-B)	E. Equivalence ratio (A/D)
Lower gain scenario:						
Development on low distinctiveness farmland	Creation of priority habitat	8	4	18	14	0.571
	Restoration of priority habitat	8	12	18	6	1.333
Development on priority habitat	Creation of priority habitat	24	4	18	14	1.714
	Restoration of priority habitat	24	12	18	6	4.000
Development on brownfield land	Creation of priority habitat	16	4	18	14	1.143
	Restoration of priority habitat	16	12	18	6	2.667
Higher gain scenario:						
Development on low distinctiveness farmland	Creation of priority habitat	8	4	24	20	0.400
	Restoration of priority habitat	8	12	24	12	0.667
Development on priority habitat	Creation of priority habitat	24	4	24	20	1.200
	Restoration of priority habitat	24	12	24	12	2.000
Development on brownfield land	Creation of priority habitat	16	4	24	20	0.800
	Restoration of priority habitat	16	12	24	12	1.333

Summary of Equivalence Ratios

Table 3 summarises the equivalence ratios derived from these different scenarios. In each case the "low" ratio is derived from the higher credit gain scenario, and the "high" multiplier is derived from the lower credit gain scenario. If the midpoint of these values is taken, this effectively assumes that 50% of projects achieve the higher credit gain by achieving optimum habitat condition.

Table A1.3 Summary of Equivalence Ratios*

Development scenario	Offset scenario	Equivalence ratio		
		Low	High	Midpoint
Development on low distinctiveness farmland	Creation of priority habitat	0.40	0.57	0.49
	Restoration of priority habitat	0.67	1.33	1.00
Development on priority habitat	Creation of priority habitat	1.20	1.71	1.46
	Restoration of priority habitat	2.00	4.00	3.00
Development on brownfield land	Creation of priority habitat	0.80	1.14	0.97
	Restoration of priority habitat	1.33	2.67	2.00

**Equivalence ratio = Hectares of habitat to be restored or created to achieve biodiversity gain equivalent to loss from 1 hectare of land developed*

A1.3 Multipliers for Time Preference and Risk

Time preference

Multipliers for time preference are given in the Natural England paper and reproduced in Table A1.4.

Table A1.4 Multipliers for different time periods using a 3.5% discount rate

Years to target condition	Multiplier
5	1.2
10	1.4
15	1.7
20	2.0
25	2.4
30	2.8
More than 30	3.0

Different types of habitat creation and restoration projects have different timescales. For example:

- Simple restoration projects may be achieved within 5-10 years – e.g. restoration of lowland heathlands, woodland or reedbed through removal of scrub or non native tree species
- Some habitats may be re-created within a short time period of 10 years – e.g. wetlands
- More complex restoration projects may take many decades to reach the required habitat condition – e.g. restoration of blanket bog

- Creation of some semi-natural habitats may take many decades or even hundreds of years to reach optimum condition – e.g. semi-natural woodland.

If we assume that an average restoration project takes 10 years and an average creation project takes 20 years, this implies a time based multiplier of 1.4 for restoration and 2.0 for creation.

Risk of failure

The Natural England paper suggests the following multipliers for risk of failure of projects (Table A1.5).

Table A1.5 Multipliers for different categories of risk

	Risk	Multiplier
Low	< 0.1	1
Medium	0.1 – 0.25	1.5
High	0.25 – 0.5	3
Very High	>0.5	10

We would expect restoration projects to have a relatively low risk of failure and creation projects to have a higher risk of failure. The following averages could be assumed:

- Restoration – low/medium risk – average multiplier of 1.25
- Creation – medium/high risk – average multiplier of 2.25

Risks associated with the spatial location of the offset

A further multiplier needs to be applied where the offset is in a spatially less favourable location than the impacted site. The multipliers proposed in the Natural England paper are given in Table A1. 6.

Table A1.6 Multipliers for spatial risk

Offset type	Location parameters	Multiplier
Within type	Directly contributing to a spatially identified BAP target or objective for the habitat in question – this includes restoration and Expansion of a site.	1:1
Out of type	Directly contributing to a spatially identified BAP target or objective	1:1
Within type	Buffering or linking a spatially identified habitat target or restoring or Expanding a BAP habitat outside of a spatially identified area	1:2
Out of type	Buffering or linking a spatially identified habitat	1:1
Any offset	Delivering the offset such that it makes no contribution to a spatially identified habitat	1:3

For the purposes of the costing exercise it is assumed that in the majority of cases it will be possible to provide an offset in a spatially appropriate location and that a 1:1 multiplier can be used.

A1.4 Combined Offset Ratios

The equivalence ratios and time preference and risk multipliers given above can be combined to assess the overall requirement for offsets for each hectare of land developed under the different scenarios (Table A1.7).

Table A1.7 Combined Ratios* for Different Offset Scenarios

Development scenario	Offset scenario	Equivalence ratio	Time multiplier	Risk multiplier	Combined offset ratio
Development on low distinctiveness farmland	Creation of priority habitat	0.49	2.00	2.25	**2.19**
	Restoration of priority habitat	1.00	1.40	1.25	**1.75**
Development on priority habitat	Creation of priority habitat	1.46	2.00	2.25	**6.56**
	Restoration of priority habitat	3.00	1.40	1.25	**5.25**
Development on brownfield land	Creation of priority habitat	0.97	2.00	2.25	**4.37**
	Restoration of priority habitat	2.00	1.40	1.25	**3.50**

**Combined Ratio = Number of hectares of offset required per hectare of land developed (= Equivalence ratio x time multiplier x risk multiplier*)

The combined ratios suggest a need to undertake conservation activity on between 1.75 hectares and 6.56 hectares of habitat, per hectare of habitat lost to development. These ratios reflect the overall change in biodiversity value of the site developed and the site on which conservation action takes place.

We can observe from this that:

- The ratios for creation are slightly higher than those for restoration. The additional biodiversity gains per hectare are insufficient to compensate for the greater timescales and risks involved in habitat creation;
- The largest ratios are for priority habitats, but even building on farmland of low distinctiveness requires conservation action on around 2 hectares of land per hectare developed, when taking account of the combined effect of time preference and risk;
- The costs of the policy are sensitive to the assumptions employed – varying the metrics and multipliers above could significantly reduce the overall estimates of the offsets required and their costs.

A1.5 Sensitivity of Ratios and Costs to Assumptions Employed

This section examines the sensitivity of overall offset requirements to the assumptions employed above. The effects of varying two assumptions are considered:

1. Removal of the risk multiplier. If no additional multiplier is required to account for the risk of failure of offset provision, this reduces the overall offset requirement, particularly for habitat creation schemes deemed to have a moderate to high risk of failure. This could be appropriate if an alternative policy was used to mitigate risk, e.g. through use of

bonds or some other form of assurance scheme designed to minimise risk by offset providers.

2. Assuming that land that is developed is in moderate rather than optimum condition. This reduces the number of credits required and hence the amount of conservation activity required to offset each hectare of development.

Table A1.8 Sensitivity of Combined Offset Ratio to Variations in Assumptions

Development scenario	Offset scenario	Combined Offset Ratio			
		Under Core Assumptions	If risk multiplier is removed	If land developed is in moderate rather than optimum condition	If risk multiplier is removed and land developed is in moderate rather than optimum condition
Development on low distinctiveness farmland	Creation of priority habitat	**2.19**	0.97	1.09	0.49
	Restoration of priority habitat	**1.75**	1.40	0.88	0.70
Development on priority habitat	Creation of priority habitat	**6.56**	2.91	3.28	1.46
	Restoration of priority habitat	**5.25**	4.20	2.63	2.10
Development on brownfield land	Creation of priority habitat	**4.37**	1.94	2.19	0.97
	Restoration of priority habitat	**3.50**	2.80	1.75	1.40

Varying these assumptions has the following effects:

- Removing the risk multiplier reduces the overall offset requirements by 56% for habitat creation and 20% for restoration projects. The combined offset ratio for creation is now less than that for restoration;
- Assuming that the developed land is in moderate rather than optimum condition reduces the overall offset requirement by 50% for both creation and restoration;
- Combining both of the variations above reduces the overall offset requirement by 78% for creation and 60% for restoration.

The overall estimated costs of offsets are sensitive to the assumptions in a similar way.

A1.6 Hedgerows

We note that offsets need to be provided separately for hedgerows which are a BAP priority habitat and subject to a no net loss policy.

These are provided through creation (rather than restoration) and the Natural England paper proposes metrics to reflect the fact that new hedgerows will be worth less in biodiversity terms than established ones. It is assumed that a high quality hedge is lost and that a newly planted hedge is of low quality, so that each 1m lost needs to be offset by 3m of newly planted hedge.

The costs of offsets for hedgerows are being estimated as follows:

1. Estimate the area of farmland on which development takes place annually (this is the Greenfield non priority habitat minus any non farmed habitats like plantation forestry plus farmed priority habitats such as grasslands)
2. Estimate the average number of metres of hedgerow per hectare of farmland – this can be based on the existing estimate of BAP hedgerow habitats in England divided by the number of hectares of agricultural land in England
3. Estimate the annual loss of hedgerows to development (i.e. 1 x 2) annually
4. Estimate the number of new hectares of hedge to be provided annually as offsets (assuming 3m of hedge is planted for each metre lost). It is assumed that a low quality hedge can be provided within a short timescale and that no additional multipliers for risk or time preference are therefore required.
5. Estimate the costs of this based on the annualised costs of hedgerow creation (plus admin and regulatory costs) – no land purchase

A1.7 Species

In most cases it is assumed that the loss of species is addressed either through existing legal measures or through the habitat based offsets. In certain cases there may be a need to address the loss of species through separate offsets – however this is likely to limited and the costs are unknown. No additional costs are therefore assumed.

Annex 2 Potential for habitat restoration and re-creation

A1.1 Progress on Habitat Action Plan targets

The UK Biodiversity Action Plan (BAP) sets out a programme for the conservation of the UK's biodiversity in response to the Convention on Biological Diversity (CBD) in 1992. The BAP originally included action plans for 45 habitats, which has been expanded to 65 priority habitats in 2007. The status of these habitats is among the indicators used to assess progress towards halting biodiversity loss. The Habitat Action Plans (HAPs) potentially include targets for achieving favourable condition, maintaining the extent of the current habitat, as well as restoring or expanding habitats.

The 2008 reporting round on progress towards meeting HAP targets indicates that similar progress has been made on targets for achieving condition and restoration, as for habitat expansion. For most habitats, there has been some progress on meeting targets, but delivery is behind schedule. For many habitats , no data has been entered. No progress has been made towards expanding saltmarsh or upland hay meadows, although other targets are ahead of schedule or have been exceeded (see Figures A1.1 and A1.2).

Figure A1.1 Progress on condition and restoration targets for habitats (N = 87)

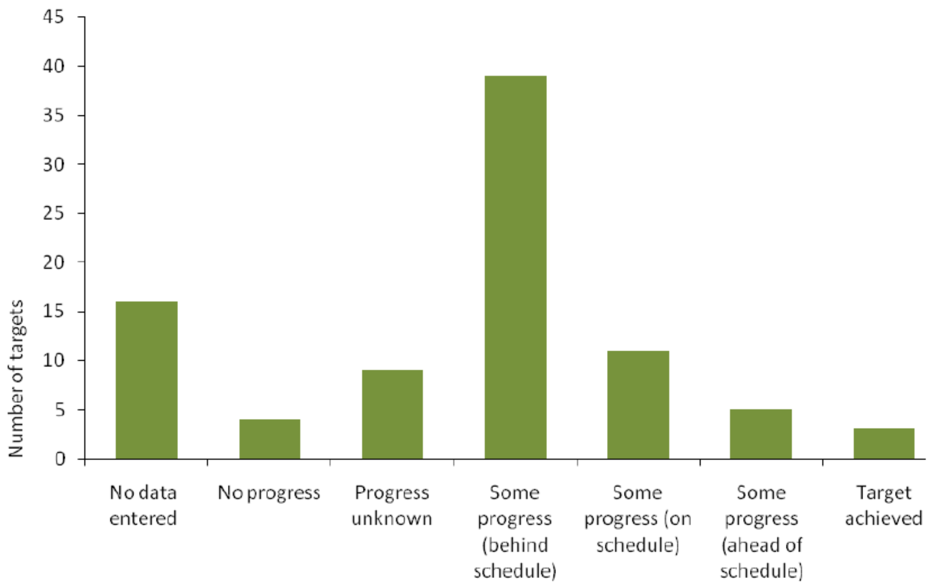
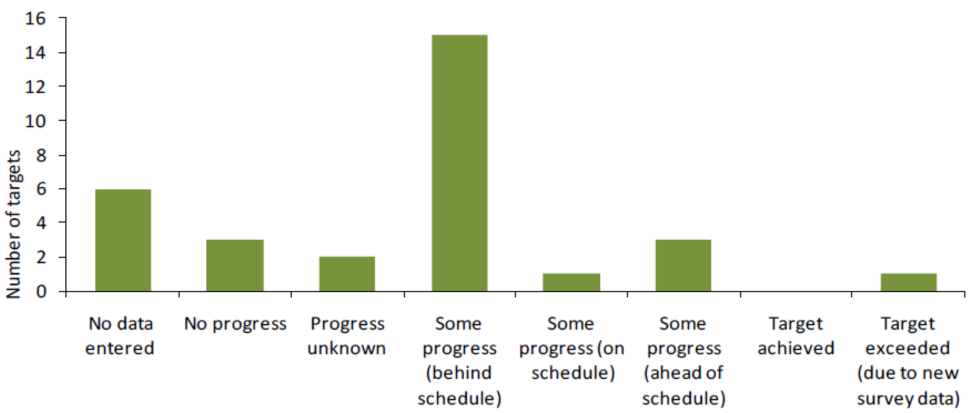


Figure A1.2 Progress on habitat expansion targets (N = 31)



A few regions have also published progress reports on their regional HAP targets. Two examples are given below of the West Midlands (Table A1.1) and the North East (Table A1.2), where data was easily available. The two examples show some similar trends. For instance, both regional plans indicate that woodland restoration appears to be more difficult than woodland expansion, while lowland heathland appears to be particularly difficult to expand and restore. Lowland meadows and reedbeds on the other hand, seem relatively easy to restore and expand as both plans are on track or have already exceeded their targets. Some differences are apparent however, notably for fens, lowland dry acid grassland and purple moor-grass and rush pasture, where West Midlands targets are on track to be delivered, whereas little or no progress has been made in the North East. Alternatively, more progress has been made in the North East on lowland calcareous grassland and coastal floodplain and grazing marsh. These results indicate that whilst much depends on the habitat being restored, other factors (e.g. the availability and quality of available sites, the underlying biological resources, and geological and geographical characteristics) also play a determining role in the restorability of a habitat.

Table A1.9 HAP restoration and expansion targets and their progress in the West Midlands

Habitat type	Habitat	2015 Targets	
		Restore	Expand
Heath	Lowland heathland	n/a	430 ha
	Upland heathland	n/a	No target set
Grassland	Lowland meadows	100	35
	Lowland dry acid grassland	28	35
	Lowland calcareous grassland	15	60
	Purple Moor-grass & rush pasture	10	10
	Coastal and floodplain grazing marsh	300	25
Freshwater	Eutrophic standing waters	Prevent further deterioration 449 Tier 2/3 sites	
	Mesotrophic lakes	Prevent further deterioration 17 Tier 2/3 sites	
Fen/bog	Lowland raised bog	110	n/a
	Fens	120	n/a
	Reedbeds	n/a	50
Woodland	Native woodland		5479 ha (new target)
	Woodland Restoration	4,750	
	Wood pastures and parkland	60 sites	18 sites

Source: West Midlands Biodiversity Partnership (available from: http://www.wmbp.org/strategy_and_targets)

red = target will currently not be met;
amber = target is unlikely to be met / more work is required to confirm the situation;
green = target is on track to be delivered

Table A1.10 HAP restoration and expansion targets and their progress (North East) (targets for achieving condition or maintenance are not shown; where % complete is over 100%, the target has been exceeded)

Habitat	**Restoration**			**Expansion**		
	Target	Additional gain still required	% complete	Target	Additional gain still required	% complete
Native Woodland	500 ha	376	37%	2800 ha	0	106%
Wood Pasture and Parkland	10 sites	6	40%	5 ha	2	60%
Lowland Meadows	50 ha	20	60%	50 ha	0	195%
Upland Hay Meadows	100 ha	0	154%	-	-	
Lowland Dry Acid Grassland	17 ha	16	6%	10 ha	9.65	14%
Lowland Calcareous Grassland	25 ha	7.1	72%	50 ha	19	63%
Lowland Heathland	-	-		60 ha	43	28%
Lowland Raised Bog	30 ha	30	57%	-	-	
Fens	100 ha	100	1%	-	-	
Reedbeds	-	-		50 ha	0	100%
Coastal and Floodplain Grazing Marsh	60 ha	17	72%	80 ha	11	86%
Coastal Sand Dunes	25 ha	-	360%			
Maritime Cliffs and Slopes				10 ha	10	0%
Saline Lagoons				10 ha	5.5	45%
Purple Moor-Grass and Rush Pasture	10 ha	10	0%	5 ha	5	0%

Source: adapted from Delivery Plan for North East Regional Biodiversity Habitat Targets

red = little or no progress has been made towards delivering the target;
amber = some progress has been made towards delivering the target;
green = target has been delivered

A1.1 The restorability of habitats

Sipkova et al. (2009) notes that achieving BAP targets is not just a matter of money and appropriate management, but is also a reflection of challenges associated with habitat restoration. By assessing the regeneration ability of German biotopes and comparing these with Annex I habitats, Sipkova et al. find that the majority of habitats with an unfavourable conservation status have medium (15 years plus) or long term (150 years plus) regeneration capabilities (Table A1.11). They also suggest that the potential for functional compensation or regeneration of habitats is largely overestimated in many impact assessments, which could potentially lead to slow permanent loss of high quality habitat areas within Natura 2000. The broad categories of habitats, and their estimated regeneration abilities, are given in the table below.

Table A1.11 Regeneration ability of habitat groups (On a scale of 1 to 3, where 1 is high (<15 years) and 3 is low or none (>150 years))

Habitat type	Regeneration ability
Coastal (e.g. sandbanks, sea cliffs, sand dunes, mudflats)	2.2
Heathland	2.3
Grassland (e.g. calcacerous grassland, hay meadows)	2.4
Wetlands (e.g. bogs, mires, peat, fens)	2.7
Mountainous (e.g. scree, rocky slopes, caves)	2.75
Open water (e.g. rivers, lakes, ponds)	2.8
Woodland (e.g. oak woods, beech woods, pine woods)	3

Source: adapted from Sipkova et al. (2009)

Morris et al. (2007) however, assessed the restoration abilities of UK habitats and found significant differences in the necessary timescales to establish habitat which is of a comparable quality to 'high quality' examples (Table A1.12). For instance, whilst some wetlands may take just a few years to restore, some woodland could take hundreds of years.

Table A1.12 The feasibility and time-scales of restoring selected habitat types

Habitat	Time-scale	Feasibility
Temporary pools	1-5 years	May never support some faunas e.g. Triops and Cheirocephalus, but rapidly colonised by water beetles.
Eutrophic ponds	1-5 years	Creatable provided adequate water supply. Readily colonised by water beetles and dragonflies but faunas restricted to those with limited specialisms. Include ponds created for Great Crested Newts Triturus vulgatus.
Mudflats	1-10 years	Dependent upon position in tidal frame and sediment supply.
Eutrophic grasslands	1-20 years	Dependent upon availability of propagules.
Reedbeds	10-100 years	Will readily develop under appropriate water conditions.
Saltmarshes	10-100 years	Dependent upon availability of propagules, position in tidal frame and sediment supply.
Oligotrophic grasslands	20-100 years +	Dependent upon availability of propagules and limitation of nutrient input.
Chalk grasslands	50-100 years +	Dependent upon availability of propagules and limitation of nutrient input.
Yellow Dunes	50-100 years +	Dependent upon sediment supply and availability of propagules. More likely to be restored than re-created.
Heathlands	50-100 years +	Dependent upon nutrient loading, soil structure and availability of propagules. No certainty that vertebrate and invertebrate assemblages will arrive without assistance. More likely to be restored than re-created.
Grey dunes and dune slacks	100-500 years	Probably not recreatable but potentially restorable.
Ancient Woodlands	500 - 2000 years	No certainty of success if ecosystem function is sought - dependent upon soil chemistry and mycology plus availability of propagules. Restoration a possibility for plant assemblages but questionable for rarer invertebrates.
Vegetated shingle structures	500 - 5000 years	Dependent upon sediment supply and coastal processes. Essentially un-recreatable.
Blanket Bogs	1,000 - 5,000	Probably un-recreatable but will form in these timescales.

	years	
Raised Bogs	1,000 - 5,000 years	Probably un-recreatable but will form in these timescales.
Limestone Pavements	10,000 years	Un-recreatable but will form if a glaciation occurs.
Pingoes	10,000 years	Un-recreatable but will form if a glaciation occurs.
Turloughs	10,000 years	Un-recreatable but will form if a glaciation occurs.

Source: Morris et al. (2007)

The two studies show some similarities but also some differences. Grasslands and heathlands for instance generally seem to fall into the medium timescale for restoration. A key difference however seems to be the timescales given for open waters, with Morris et al. noting timescales of 1 to 5 years, whilst Supkova et al. give considerably longer timescales. This difference however is likely to be a reflection of the type of open water habitats being considered; Morris et al. only consider temporary pools and ponds, whilst Supkova et al. tend to consider much larger habitat features such as rivers and lakes. Both however suggest that coastal habitats are potentially easier to restore than terrestrial habitats. This coincides with the conclusion made by Crooks et al. (1992), that restoration in coastal areas offers a higher success rate than for terrestrial systems. This is encouraging news for the future of biodiversity offsetting, given that infrastructure developments are likely to disproportionately affect coastal areas.

A much earlier study by English Nature in 1994 attempted to clarify the replaceability of habitats in order to determine which natural assets should be considered Critical Natural Capital (CNC), and which are therefore are therefore ‘irreplaceable’ or ‘too difficult or expensive to replace in human times scales’. The assessment finds that whilst most older habitats (e.g. ancient woodland, grassland, etc.) would take centuries to replace, secondary habitats (e.g. secondary woodland, grassland, heathland etc.) could take less time, potentially only taking decades to replace (Table A1.5). Some ancient habitats though (e.g. ancient heathland), might be replaceable in decades although centuries might also be necessary in some cases. Peat forming systems are found to take centuries to replace, whilst open water systems can take as little as years, but only as much as a few decades. Wetland systems are the most variable, potentially taking anywhere from a few years to centuries to replace.

The evidence suggests that most (if not all) habitats are restorable, *if given sufficient time*. The critical question however, is whether these time-scales are acceptable. The time-scales required to restore some habitats, may be so considerable as to make them essentially irreplaceable (.g. ancient woodland, raised lowland mires, limestone pavement). For instance, even if an ancient habitat is eventually successfully replaced after (e.g.) 500 years, in that time the original habitat would have been 1000 years old, but will actually only be 500 years old. Consequently, even though the habitat could be considered ‘restored’, historical continuity has nonetheless been lost (EN, 1994).

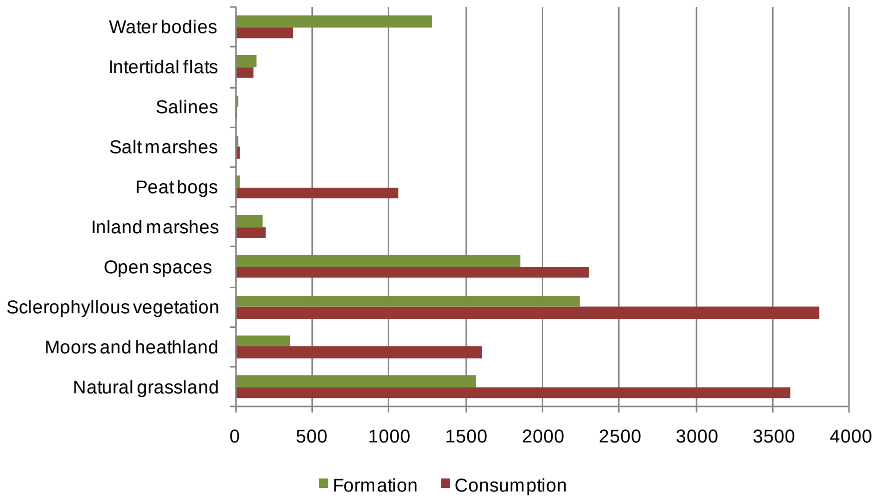
The English Nature papers draw an interesting connection between the principles of sustainable development and the point at which habitats should be considered ‘irreplaceable’. It notes that, by the principles of sustainable development and intergenerational equity, if a habitat is not replaceable within 25 years, then it should be considered Critical Natural Capital and is therefore ‘irreplaceable’; “if we are unable to pass on to the next generation at least what we currently enjoy in environmental terms, then we are failing to achieve sustainable development” (EN, 1994) Taking this view, the majority of the habitats above would be considered irreplaceable by the timescale of their restoration. Given this criteria and collating the evidence above, the following habitats from the sample above have the *potential* of being sustainably restored:

Table A1.13 Possible habitats with the potential for being sustainably restored (i.e. within 25 years)

Habitat type (with examples)	Examples of timescales
Pioneer plant communities	Years
Open water systems - temporary pools - eutrophic ponds	Years / Decades 1-5 years 1-5 years
Coastal habitats mudflats) - mudflats - reedbeds - saltmarshes	Decades / Centuries 1-10 years 10-100 years 10-100 years
Secondary heathland	Decades
Secondary woodland	Decades / Centuries
Secondary grassland - oligotrophic grassland	Decades / Centuries 20 – 100 years
Ancient heathland	Decades / Centuries
Wetlands	Years / Decades / Centuries

Another potential indication of the restorability of different habitats is to use European land use accounts which illustrate the extent to which different habitats have been created or lost (Figure A1.3). The results show that considerably more water bodies have been formed than those that have been lost to other land uses, whilst the opposite is the case for moors and heathland. Roughly the same amount of intertidal flats and inland marshes have been created as those which have been consumed. Overall, the data seems to indicate that the habitat that is least likely to be created once it is lost is peat bog, where very little has been formed to replace the amount that has been lost. Although a fair amount of natural grassland and sclerophyllous vegetation has been formed, almost twice as much has been lost in the case of sclerophyllous vegetation, with almost three times as much has been lost in terms of natural grassland. Of note here is that these land use accounts do not consider the quality of the habitats that are formed compared to those which have been lost. If this were considered, it is possible that the data on formation would be lower for certain habitats. Again, the results indicate that wet habitats are potentially more easily to restore (with the exception of water bodies), in that considerably more dry habitats have been lost to other land uses than wet habitats.

Figure A1.3 The formation and consumption of dry semi-natural land and wetland (km2), 1992 – 2000



Source: EEA, 2006

A1.2 Factors limiting the success of habitat restoration and/or recreation

Elliot et al. (undated) note that the successful restoration of a habitat requires seven key elements:

- Technologically feasible
- Economically viable
- Socially desirable/tolerable
- Legally permissible
- Administratively achievable
- Politically expedient

Within the scope of this project's timescales, only a few of these factors are examined. The technical feasibility has to some extent been detailed above in terms of the timescales required for habitats to be restored, but this element will be further considered below in the context of site-specific ecological and geographical constraints. The economic viability of restoring certain habitats is considered as well in terms of the associated management and capital costs. Legal and political elements are largely context specific, and therefore are not considered here. In terms of administrative capabilities, the extent to which knowledge and understanding are important is briefly discussed.

Overall, important considerations for restoring or recreating a habitat include (TEC, 2009; Parker et al., 2004):

- Technical issues (whether it is possible and/or appropriate to achieve restoration or enhancement given availability of suitable land and any technical, process or environmental constraints)
- Environmental issues
  - Landscape context (connectivity, linkages and connectivity);
  - Existing nature conservation interest;
  - The long term sustainability of the site
- Social and recreational issues (e.g. implications for local community use and access);
- Statutory and legal issues (e.g. potential conflicts with local planning and other policies; existing ownership and political acceptability)
  Institutional/administrative issues (e.g. sufficient regulatory capacity and resources; accessibility and availability of reliable information)

A1.3.1 Location, location, location: ecological and geographical constraints

Although there is likely to be a sufficient supply of suitable land for some habitats (e.g. in the case of land that is economically marginal in terms of agriculture or forestry), in other cases, the options for restoration may be limited by the geographical distribution of resources as individual sites have varying potential for restoration depending on their functions and ecological character. Some habitats are inherently restricted in their distribution, by, for instance, the presence or absence of particular soils or geological features (e.g. calcareous grassland) (EFTEC et al., 2010). This constraint may be exacerbated where the physical requirement of the habitat coincides with other high-value land uses. For example, habitats in fluvial coastal floodplains which require fresh water supplies are likely to conflict with high land value areas for human settlement (EFTEC et al., 2010).

Habitat restoration guidelines therefore usually recommend that sites are created as near as possible to the original habitat which has been affected (DEFRA, 2009). For instance, for wetland mitigation, it is preferable to develop on-site mitigation as wetland functions are site specific and cannot be satisfactorily replaced with ease. The value of wetland is largely dependent on the context of the landscape they are in. For example, the ability of wetlands to remove nutrients and mitigate the effects of flooding depends on the extent to which they are upstream or downstream (EFTEC et al., 2009). Opportunities for restoration are thereby restricted as geographic options are limited (EFTEC, 2009).

In some cases however, restoring habitats to their previous location may not be possible if the more recent management of the land has permanently changed its ecological characteristics. For instance, a high residual soil fertility associated with repeated fertiliser applications critically constrains grassland restoration. High nutrient levels are also more likely to promote the growth of competitive grasses and weedy perennials can dominate the early stages of grassland restoration and re-creation, greatly restricting opportunities for the establishment of species more typical of semi-natural swards. Nitrogenous fertiliser applications can also significantly affect soil microbial and fungal communities on which the ecosystem functions of semi-natural grasslands depend (Walker et al., 2004). Previous agricultural management of a site is not the only land use which can constrain restoration; species rich grasslands are also far less easily restored if the site has passed through a cycle of forest planting or prolonged woodland cover (FC, 2009).

One way of determining the extent to which different habitats are restricted to certain areas is to consider maps of their current distribution. This approach is based on the assumption that suitable locations are best found in close proximity to the original habitat. The results are summarised in the table below (Table A1.14), where broad habitat types are colour coded according to the degree to which they are geographically constrained, both in terms of their distribution (where they are located) and their extent (how abundant they are relative to other habitats of that type). Maps of their distribution are given in section A1.4 below. As offsets will only apply to land outside of Natura 2000 sites, the table also indicates the proportion of the habitat which is located outside of SSSIs to give an indication of the extent of the habitat that would be available for offsets. The table also shows the type of pressures affecting the habitats, highlighting where this includes infrastructure development. Where data could not be found within the project's timescales, cells have been left blank.

Table A1.14 The extent to which habitats are geographically constrained in England

Habitat type (HT)	Pressures	Priority habitats	Distribution	Extent (% of HT)	% outside SSSIs
Semi-natural grassland	▪ Changes in agricultural management practice ▪ Agricultural intensification ▪ Atmospheric nitrogen deposition and climate change	Lowland calcareous grassland	Most located in the SW, but areas are found throughout England although these are limited in extent in the North and WM	49%	21%
		Upland calcareous grassland	Most located in the NW, NE and in YH.	11%	31%
		Lowland dry acid grassland	Present in all regions except for the NE, but is most common in the EE, and to a slightly lesser degree in the EM and the SW	11%	40%
		Lowland meadows	Spread relatively evenly across the regions, but least in the NE and most in the SW.	19%	46%
		Upland hay meadows	The rarest grassland habitat type in England (2% of semi-natural grassland), with all located either in the NE, NW or YH.	2%	27%
		Purple moor-grass and rush pastures	Located almost exclusively in the SW	8%	55%
Heathland	▪ Changes to agricultural management practices ▪ Development – housing, industry, roads (lowlands), wind farms (uplands) ▪ Afforestation ▪ Atmospheric deposition, acid precipitation and climate change	Lowland heathland	Mainly concentrated in the southern regions, but with key botanical differences across the range. Lowland heathland is nonetheless found to some degree throughout England.	23%	33%
		Upland heathland	Extensively across the English uplands in the North and YH. A significant amount is also found in the SW, and some in the EM and the WM, but none is present in the EE or the SE.	77%	26%
		Mountain heaths and willow scrub		-	-
Woodland, wood pasture & parkland	▪ Overgrazing ▪ Changes in woodland/forestry management ▪ Development – housing, quarrying, tourist/recreational facilities	Lowland beech and yew woodland	There are few areas of England that do not have at least a few ancient or broadleaved woodland sites. Most woodlands however are located in the SE and the SW, with broadleaved woodland and ancient woodland are concentrated in the SE. There are large gaps in the distribution of broadleaved woodland, which often correspond to former lowland wetlands. Clusters of quite large woods are often associated with former Royal Forests or the location of extensive wood-using	-	89%
		Lowland mixed deciduous woodland			
		Upland mixed ashwoods			
		Upland oakwood			

	▪ Air pollution/climate change/ agricultural changes ▪ Isolation and fragmentation	Wet woodland	industries. In prime farming counties ancient woods are often small and scattered.		
		Wood-pasture and parkland			
Arable field margins, orchards and hedgerows	▪ Changes in agricultural mng practices ▪ Agricultural intensification ▪ Development (e.g. housing)	Arable field margins	Important arable plant areas are concentrated in the lowlands of England, particularly in the SE, EE, WM, and SW	-	-
		Hedgerows	Hedgerows are found across almost all of lowland England but are most common in southern regions. There are however key botanical differences across the range. 84% are considered BAP habitat	-	-
		Traditional orchards	Orchards are dispersed throughout the lowlands of England but with concentrations in the SE, EE, WM, and SW. 80% of intensive orchards and 50% of traditional orchards occur in six counties within this area.	-	-
Inland rock	▪ Lack of suitable management (e.g. overgrazing) ▪ Recreational pressure ▪ Redevelopment (housing, industry, commercial, waste; targeted on brownfield land) ▪ Atmospheric pollution / climate change	Calaminarian grassland	Very locally distribution; almost exclusively located in the NE, with a small amount in YH. Occur on soils that have high levels of heavy metals, which are toxic to most plant species.	~0.2%	~60%
		Inland rock outcrops and scree habitats	Widespread in upland areas of England, but limited occurrence in the lowlands. Acidic rock and scree are widespread, whereas calcareous communities are more restricted, and good stands of tall-herb ledge vegetation also tend to be confined by heavy grazing	~5%	~20%
		Limestone pavement	Limited in its distribution, large majority found in the NW and YH. Found on the Carboniferous limestone of northern England, from Morecambe Bay in Cumbria to the Yorkshire Dales.	~2%	40%
Open waters	▪ Pollution ▪ Invasive and non native spp ▪ Inappropriate physical modification (channel widening/straightening / deepening) ▪ Drainage ▪ Inappropriate fish stocking	Rivers	Small water bodies are found throughout England. Larger water bodies are concentrated in three 'lake districts' of England. Some English regions (e.g. SW) have very few natural lakes. In others, (e.g. SE) artificial water bodies are more numerous than natural lakes. There are distinct patterns in the distribution of different lake types, corresponding to the distribution of rock types across the country. However, there are notable exceptions where local geology leads to lakes that do not fit with this general pattern (see below).	-	98%
		Ponds			~60% (all standing water)
		Aquifer fed naturally fluctuating water bodies			
		Eutrophic standing waters			
		Mesotrophic lakes	Oligotrophic and mesotrophic waters are generally located in the north and west, whilst in the south and east most water bodies are naturally eutrophic. Exceptions include the acid sands associated with lowland heathlands which support		
		Oligotrophic and			

		dystrophic lakes	oligotrophic waters that have a species assemblage more typical of northern water bodies. Such lakes are rare across Europe.		
Wetlands	▪ Changes in agricultural management practices ▪ Drainage and water abstraction (agriculture, flood defence, infrastructure and housing development in the lowlands, and to improve quality of grazing in the uplands) ▪ Diffuse pollution	Blanket bog	Significant majority located in the NE, NW and YH, although some is found in the EM and SW, with a small amount also present in the WM.	48%	31%
		Coastal and floodplain grazing marsh	Located throughout England, but concentrated in the SW, with significant areas also in the EE, SE, NW.	45%	84%
		Lowland raised bogs	Concentrated in the NW and YH	2%	12%
		Reedbeds	Mostly found in the EE, SE and SW, although some is present in the NW and YH	1%	16%
		Lowland fens	Found in small patches throughout the regions, but mostly in the EE, SE and SW and to a smaller extent in the NW	4%	11% (all fen)
		Upland fens, flushes and swamps			
Coastal	▪ Inappropriate development (particularly housing, industrial infrastructure, development on the coast) ▪ Inappropriate coastal management (sea defences, cliff stabilisation, coastal squeeze) ▪ Water pollution ▪ Changes in agricultural management practice ▪ Climate change ▪ Public access / disturbance	Coastal saltmarsh	Occur in all regions except for the WM, with the most significant amounts being found in the NW.	87%	2%
		Intertidal mudflats			
		Coastal vegetated shingle	Only occurs in the southern (SE and SW) regions and the EE, with none in the middle or northern regions	1.8%	5%
		Maritime cliff and slopes	Found in almost all regions, although the most occurs by far in the SW, with some in the SE. Smaller amounts are found in the SE, NE and the YH	5.5%	48%
		Coastal sand dunes	Occurs in all regions except the WM, with most in the SW and the NW	5%	15%
		Saline lagoons	Largely limited to the southern regions (SE and SW) and the EE, with none in the middle or northern regions	0.7%	12%
		Intertidal boulder communities	-	-	-
		Intertidal chalk	-	-	-
Marine	▪ Infrastructure development	14 priority UK BAP marine habitats[2]	A comprehensive assessment of marine habitats not possible as existing surveys are few and are restricted to	5% SAC (of marine	

[2] Blue mussel beds, Estuarine rocky habitats, Fragile sponge and anthozoan communities on subtidal rocky habitats, Horse mussel beds, Maerl beds, Mud habitats in deep water, Peat and clay exposures, Sabellaria alveolata reefs, Sabellaria spinulosa reefs. Seagrass beds, Sheltered muddy gravels, Subtidal chalk, Subtidal sands and gravels, Tide-swept channels

(coastal defence works, dreging, and to a lesser extent, industrial and port infrastructure) ▪ Fisheries practices ▪ Poor water quality ▪ Climate change ▪ Human disturbance	to a few areas	resource)

Source: adapted from Natural England, 2008.

NE: North East; NW: North West; YH: Yorkshire and the Humber; EM: East Midlands; WM: West Midlands; EE: East of England; SE: South East; SW: South West.

Considering all the information in the table above (i.e. vulnerability to infrastructure development, distribution, extent, presence outside of SSSIs), differences are apparent in the potential for different habitats to be recreated or restored. For instance, **woodlands appear to be particularly amenable to offsetting, being both vulnerable to development pressures, being found in most regions and with significant amounts being found outside of SSSIs.** On the other hand, inland rock habitats show the least potential for restoration / recreation given their limited distribution and extent, although they are vulnerable to development pressures.

In the case of grasslands, it appears that while some (e.g. lowland calcareous grassland, dry acid grassland and lowland meadows) are suitable for offsetting (i.e. relatively widespread distribution, significant areas outwith SSSI designation), grasslands are not as vulnerable to the effects of infrastructure development as others. Instead, grasslands are more affected by changes in agricultural factors, such as agricultural management or intensification.

Heathlands, on the other hand, are vulnerable to many infrastructure development pressures, including housing and industrial developments, as well as particular pressures in the lowlands (e.g. transport) and uplands (e.g. wind farms). Considering just the current distribution and extent of heathlands, the information suggests that the potential for restoration or recreation is relatively good; whilst lowland heathland is not as abundant as upland healthland, it is distributed throughout England. The opposite is the case for upland healthland; although relatively abundant compared to lowland heathland, it is more restricted in its range, but still has an extensive presence across the uplands.

In terms of wet habitats, whilst some open water habitats are widely distributed and most are not located within SSSI, they are not as significantly affected by development pressures. Wetlands present a varied picture; whilst development pressures are significant (especially in the lowlands), only some wetland habitats (e.g. coastal and floodplain grazing marsh and fens) show relatively good potential to be restored, whilst the potential for others to be restored or recreated are more limited (e.g. lowland raised bogs, reedbeds). This is consistent with the findings from the restoration timetables, with wetland restoration varying anywhere from a few years to possible centuries (see Table 1.5).

A similar situation presents itself with coastal habitats as with wetlands, with some habitats having greater potential for offsetting than others. However, whilst coastal habitats are certainly vulnerable to development pressures (arguably disproportionately so), much of them are already found largely within SSSI designation. For instance, while coastal saltmarsh and intertidal mudflats are widely distributed and relatively abundant compared to other coastal habitats, only 2% are found outside of SSSIs.

A1.3.2 Absolute duplication: an unattainable goal

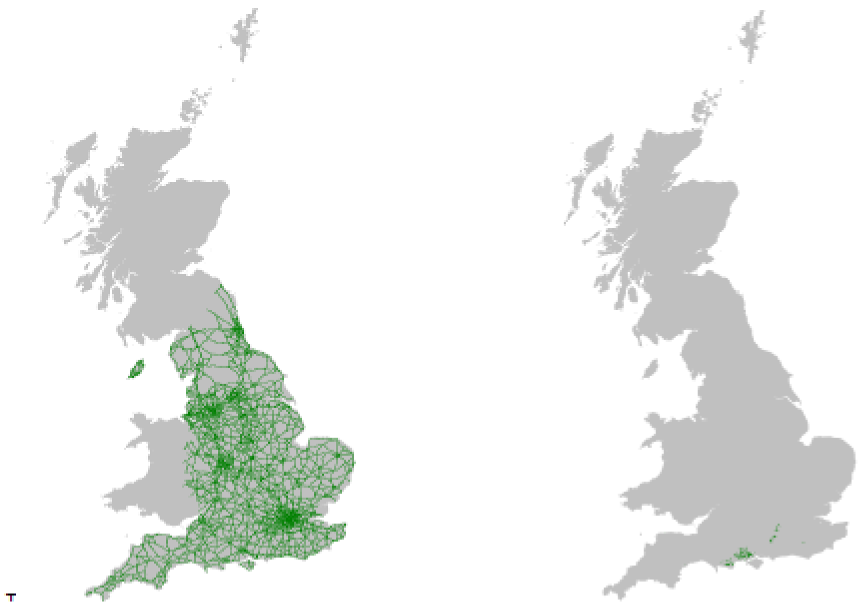
The complexity of habitats means there is considerable risk and uncertainty in attempting to restore habitat functions after the original habitat has been lost. The number of factors involved, and the complex interactions between them, means that replacing or restoring a habitat to its exact earlier state is virtually impossible. For instance, total duplication of natural wetlands is unfeasible due to the complexity and variations in natural systems, and the subtle relationship between hydrology, solid, vegetation, animal life, and nutrients which may have developed over thousands of years.

The extent to which a habitat can be successfully restorable significantly depends on the goal being considered; sometimes a fully comparable habitat may not be required, for instance when a habitat is being mainly restored to support a certain species. The goal of a restoration project is crucial to determining how a habitat will be restored, what activities are undertaken, and what the end result will be (Parker et al., 2004; Ehrenfeld, 2000). For instance, whilst restoring some habitats to early successional states may be relatively easy, restoring them to their complete mature state may be considerably more difficult. Some habitats can be more readily restored for particular species, especially semi-natural and manmade habitats, rather than as a mature, whole habitat / ecosystem. Nonetheless, these early successional stages can be highly valuable as these are often rare in many parts of Europe, and may be nonetheless beneficial to particular species. Numerous LIFE Nature projects have successfully created reedbed habitats for the Bittern. Ponds may also be readily restored for some species, as shown by a LIFE project that restored and created habitat for two declining species - the Great Crested Newt and the Common Spadefoot Toad. The project showed that habitat restoration and creation can rapidly increase the populations of threatened pond-breeding amphibians if implemented at the landscape scale, taking into account the habitat requirements of target species and the ecological connectivity of populations.

However, for some species, restoration needs to be initiated long before the vulnerability threshold was reached; in some cases, habitat loss and fragmentation have so eroded the species' demographic potential that halting population declines is limited more by demographic factors than the amount of available habitat. Habitat restoration therefore may not always be sufficient to rescue declining populations (Schrott et al., 2005).

Moreover, some species (as with habitats) have such specific requirements that suitable conditions for their restoration are inherently rare, thereby limiting practical opportunities for offsetting. Some species are limited to certain areas of a certain type of habitat. If a habitat of that type is lost, restoring the same habitat elsewhere may not ensure that the same species are present. For instance, Treweek et al (1998) illustrate how the strategic trunk road network coincides with areas where lowland heathland is located, but only a very small area in which such heathland could also be expected to support the Dartford warbler and the sand lizard (two possible indicators of higher quality habitat). Options to compensate for impacts on these two species are therefore limited (see Figure A1.4 below). Essentially, this example illustrates that whilst elements of a habitat may be restored, exact replication is much more difficult. The extent to which a habitat is restorable therefore depends on what elements are considered important (and what the timescales are for restoration). For instance, while recreated species-rich grasslands are often indistinguishable from NVC communities from a botanical point of view in a short space of time, invertebrate assemblages are much more difficult to re-establish. Whilst the botanical value of the restored grassland may therefore be high, the invertebrate value is more questionable, with knock on implications for the establishment of certain grassland species which depend on the presence of certain invertebrate species (Walker et al., 2004)

Figure A1.4 The distribution of the UK National trunk road network (left) and the distribution of lowland heathland which supports populations of sand lizard and Dartford warbler (right)



A further consideration is that maintaining a restored habitat in its preferred condition may require additional management which might not have been originally required, due to changes that have been made to the ecological character of the site since the habitat had been lost. For instance, the restoration of calcifugous assemblages (e.g. acid grassland or heathland) on land formerly managed for intensive agriculture is inhibited by the elevated soil pH asa result of the application of liming agents, and can only be achieved if the pH is reduced (e.g. by applying nitrogenous fertilisers) (Walker et al., 2004).

The degree to which a habitat is self-regulatory (e.g. with no inputs of energy or material) is key to successful ecological restoration. This might be a factor in the higher success rates normally seen in wet habitats. Whilst the problems above are particularly evident in terrestrial habitats such as mature forests and peat systems, a higher degree of success has been achieved in restoring and recreating wetlands in estuarine, coastal and freshwater marshes, in that order. For instance, the high success rate in recreating tidal wetlands is a reflection of the he dynamic and self-regulatory nature of coastal systems (EFTEC et al., 2009). The extent to which a restored habitat needs to be managed also has cost implications, which can significantly affect the financial viability of habitat restoration.

A1.3.3 Knowledge and understanding

Given the significant number of the various factors on which successful habitats depend, and the complexity of the interactions between all the necessary elements, it is clear that offsetting development impacts through the restoration of habitats would be inappropriate in cases where an understanding of the ecological requirements is poor or if there are no tried and tested techniques, as the chance of successful restoration would be significantly reduced. For instance, a general lack of understanding of the first principles of wetland science is thought to be a potentially key factor in the relatively high number of failures to restore wetlands (Crook et al., 1999).

A1.3 Maps on the distribution of habitat types (NE, 2008)

Figure A1.5 Distribution and extent of semi-natural grassland in England

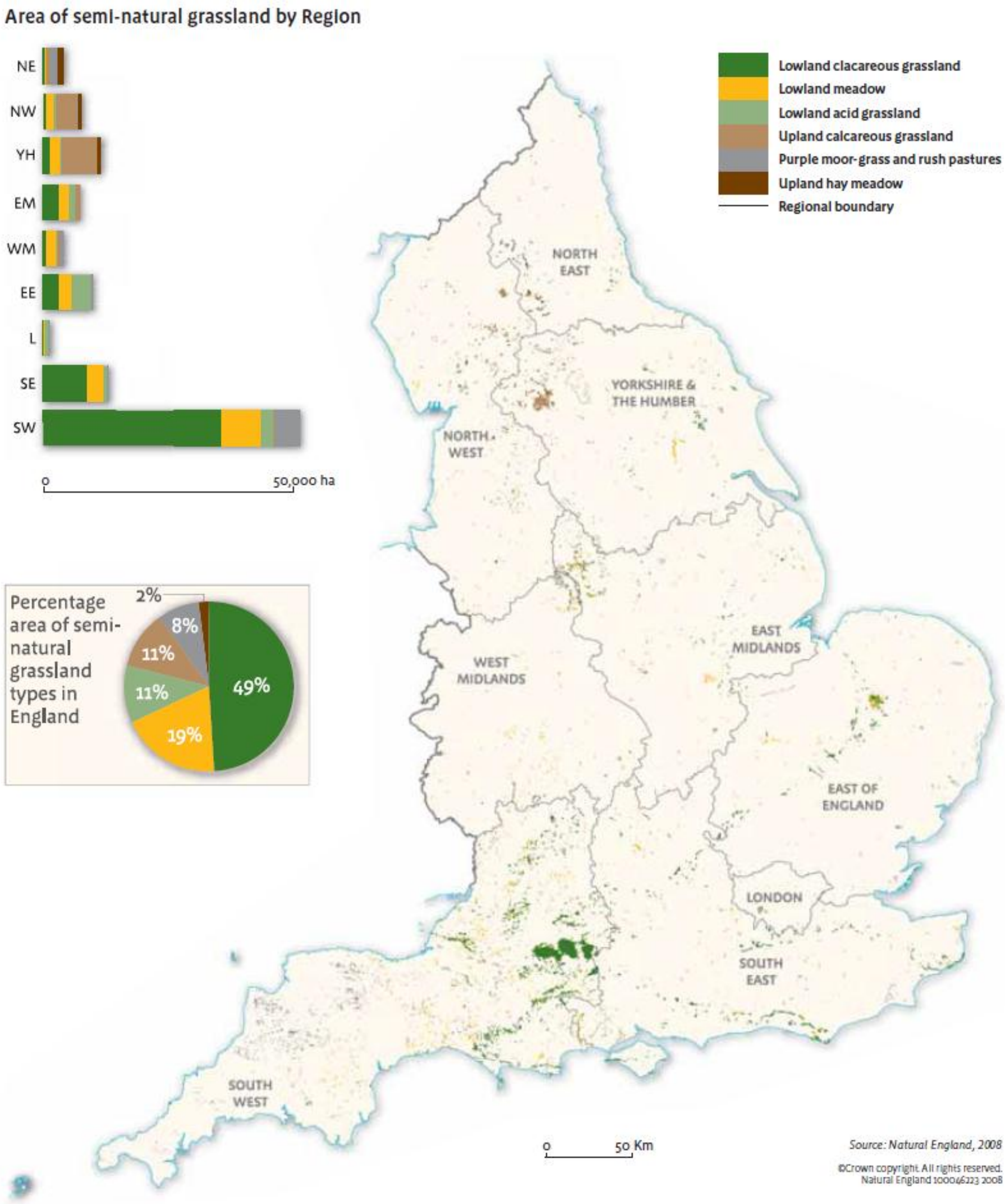


Figure A1.6 Distribution and extent of heathland in England

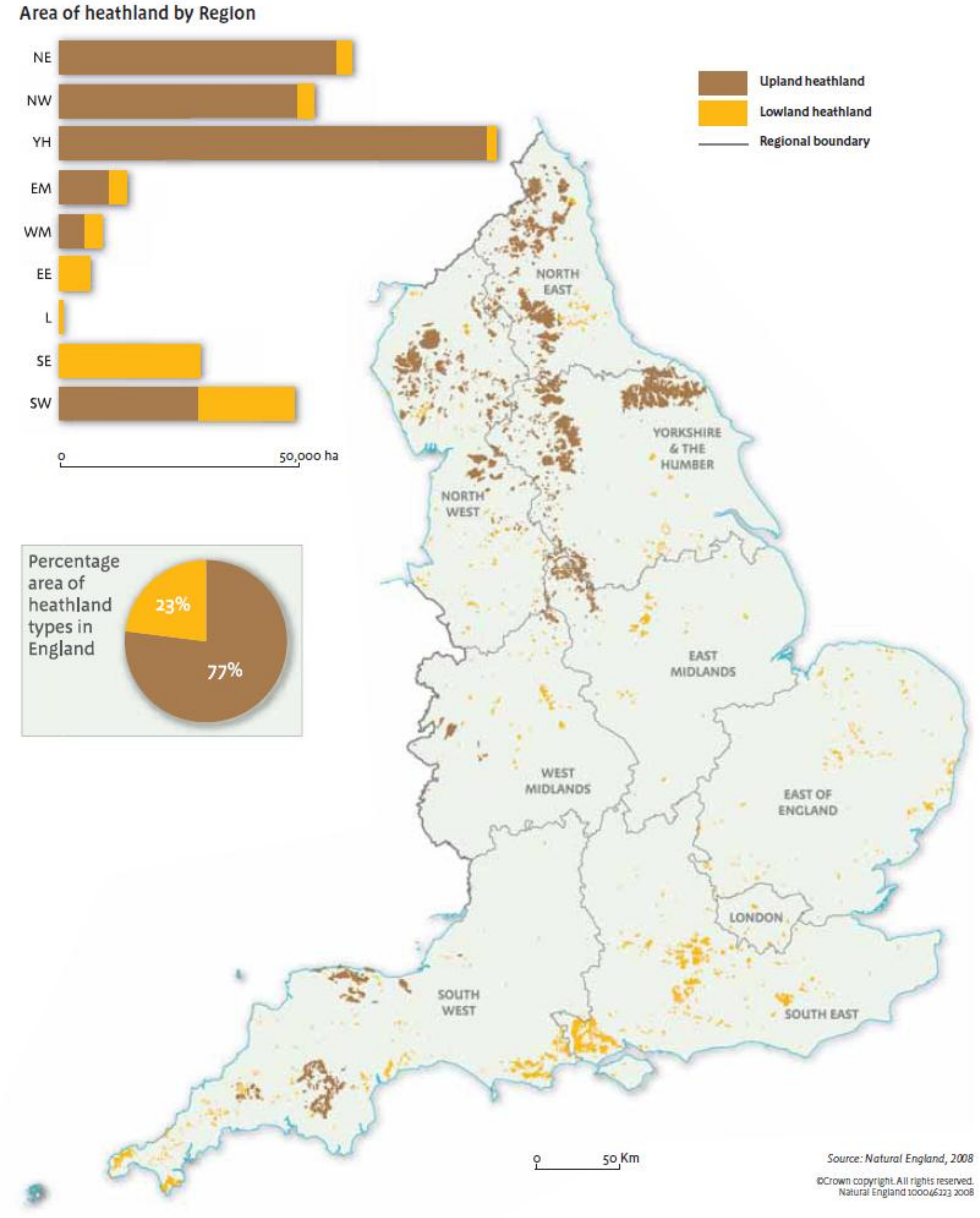


Figure A1.7 Distribution of woodland in England

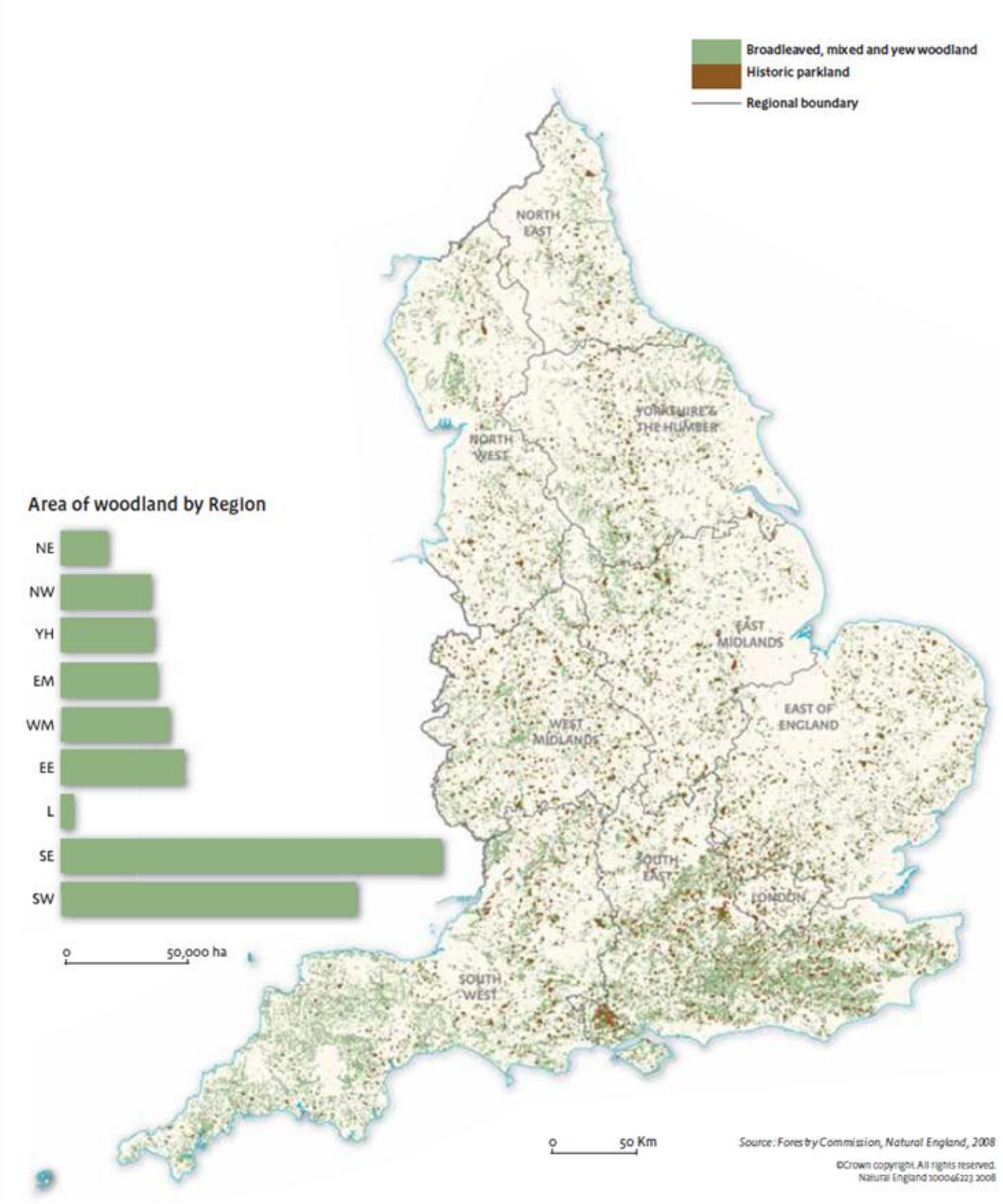


Figure A1.8 Distribution of orchards in England

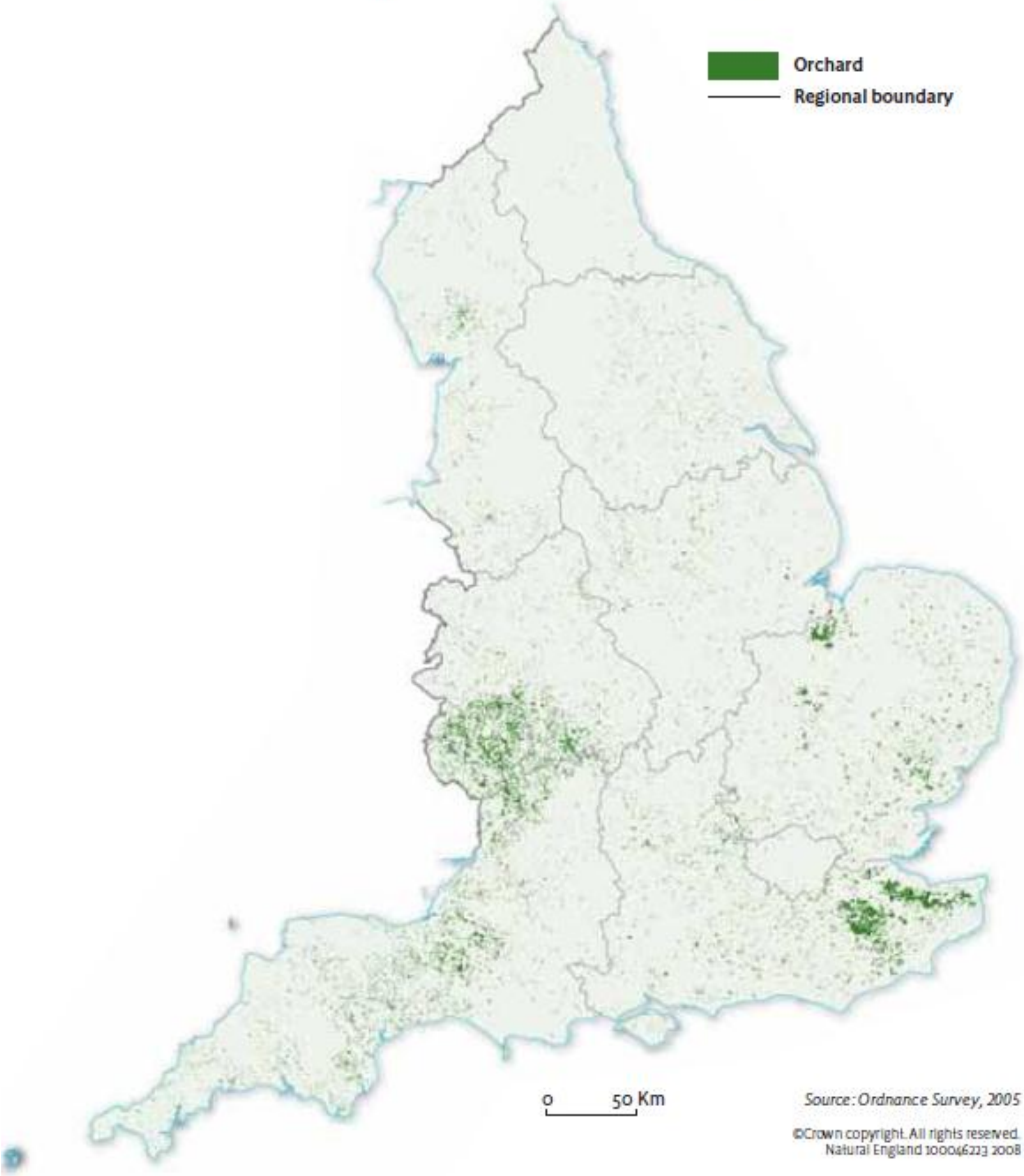


Figure A1.9 Distribution and Extent of wetland in England

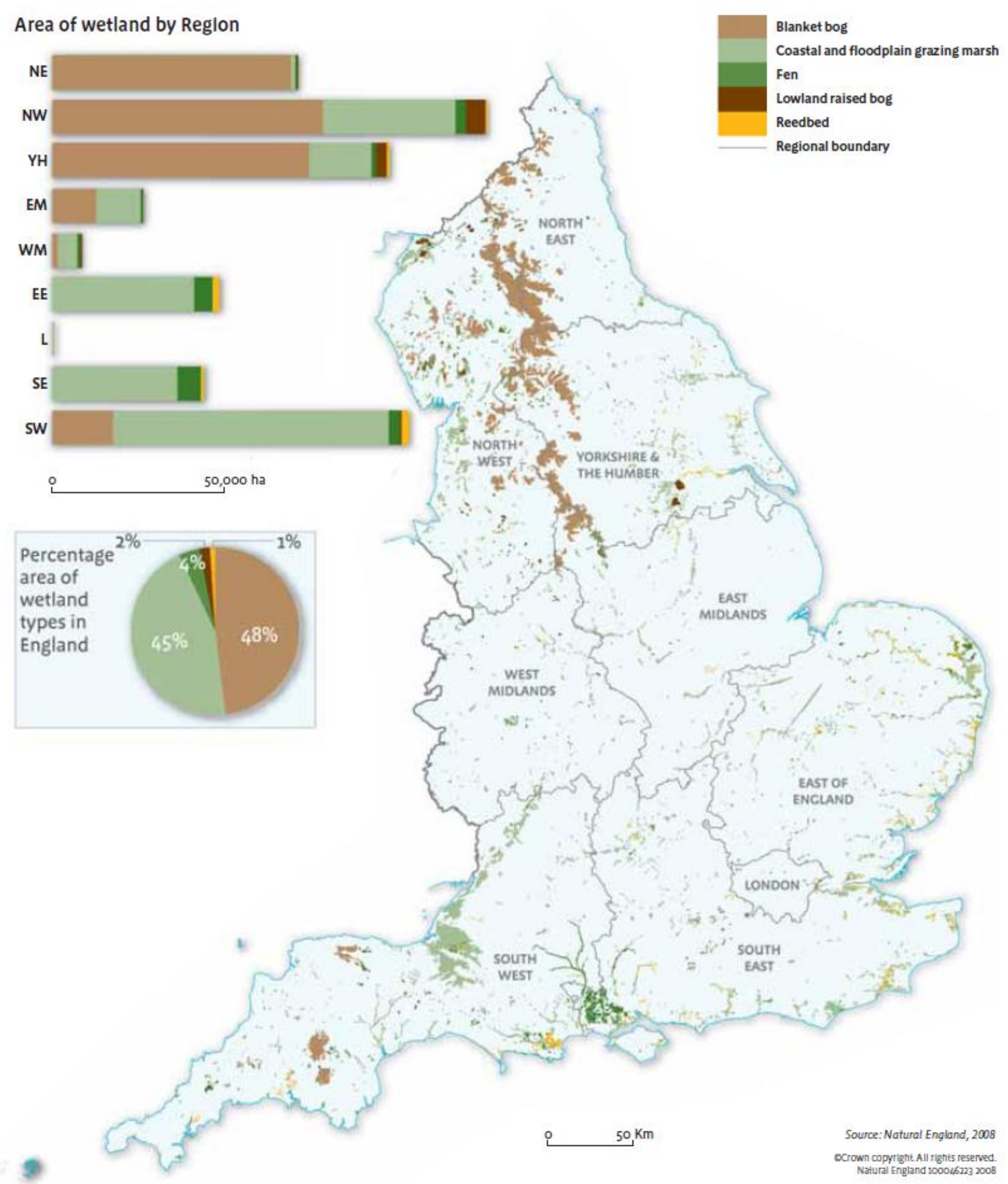


Figure A1.10 Distribution of SSSIs with inland rock habitat in England

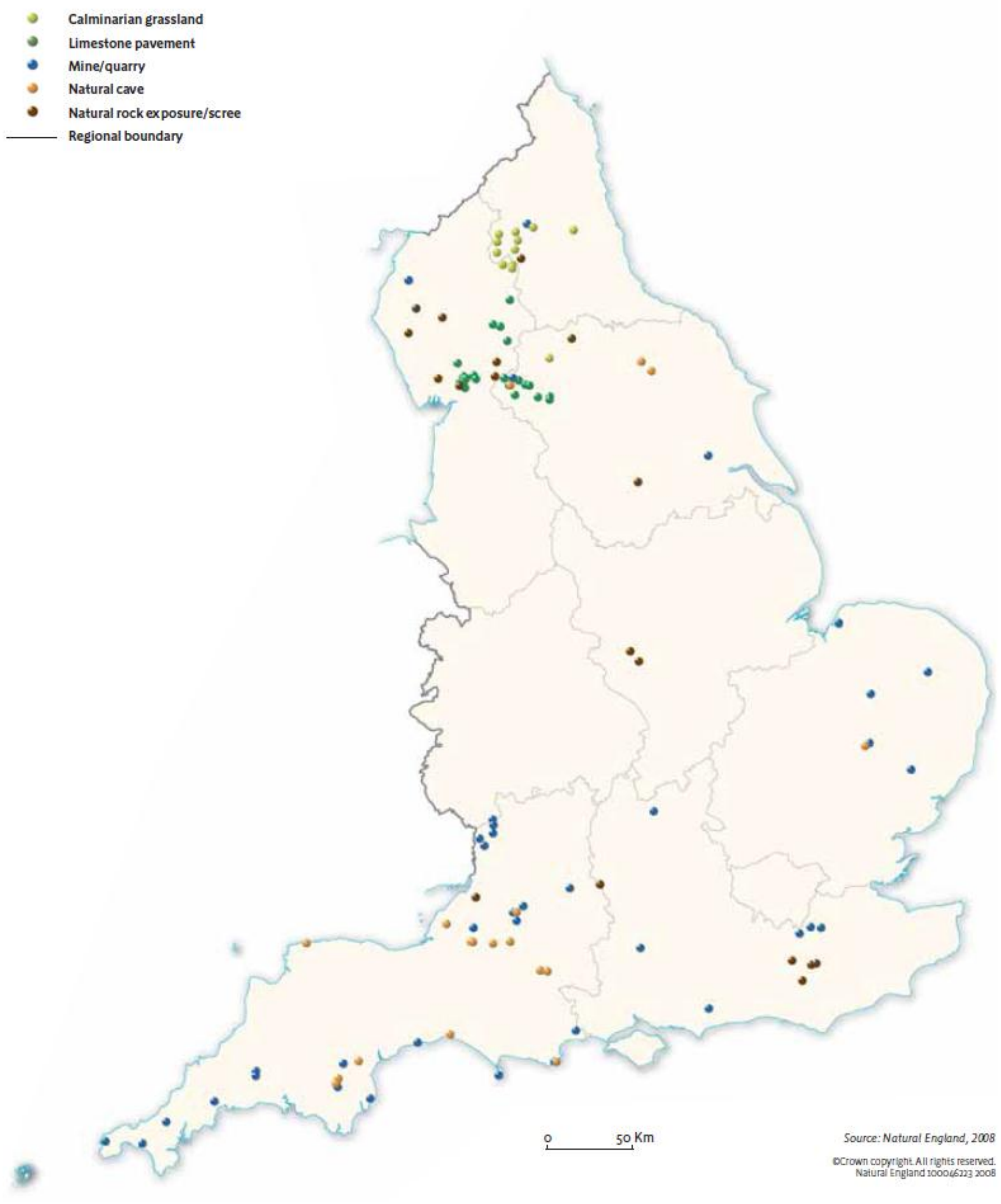


Figure A1.11Distribution and extent of coastal habitat in England