Biodiversity Offsets:

Testing a Possible Method for Measuring Biodiversity Losses and Gains at Bardon Hill Quarry, UK

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Introduction

Biodiversity offsets can be defined as 'measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken' (BBOP 2009). The goal of biodiversity offsets is to achieve no net loss (or preferably a net gain) of biodiversity on the ground. Biodiversity offsets are required by law in a number of countries (reviewed by Biodiversity Neutral Initiative 2005, McKenney and Kiesecker 2010), and have been adopted voluntarily by a small but growing set of private sector companies with 'no net loss' or 'net positive impact' policies (*e.g.* Rio Tinto 2004 and 2008, TEEB 2010). The potential for greater use of biodiversity offsets in the UK and the EU is currently being investigated (Defra 2009, EU 2010[1]).

A key aspect of biodiversity offsetting is the quantification of biodiversity losses and gains. This poses significant challenges because of the inherent complexity of biodiversity, and the variety of ways in which its components can be measured (*e.g.* area of a habitat, species diversity of an ecological community, population size of a species). Methods are needed that are transparent, rigorous, and that adequately capture the different aspects of biodiversity whilst remaining straightforward to apply in practice. In the last issue of *In Practice* (September 2010), Treweek *et al.* proposed a possible method for quantifying biodiversity losses and gains that might be appropriate for the UK context. This paper tests the proposed method on a real-world example – the proposed extension of Bardon Hill Quarry in Leicestershire.

In this particular case study, offsets were designed qualitatively through an Environmental Impact Assessment (EIA). The mitigation and compensation measures described below were presented in the planning application to reduce and offset predicted biodiversity impacts. Quantitative loss-gain measures following the Treweek *et al.* (2010) method were fitted to the data post-hoc, to test the method and to seek additional evidence that the offsets and other mitigation and compensation measures proposed were of an appropriate nature and magnitude to compensate for residual losses.

Case Study: Bardon Hill Quarry

The case study is a proposed extension to Bardon Hill Quarry, Leicestershire, owned by Aggregate Industries UK Ltd (Holcim Group). Application has been made for planning permission for a 66 ha extension, yielding 130 mT of pre-Cambrian rock over the next 50 years. The application has been submitted but not yet approved. Bardon Hill is a 500 ha estate consisting mainly of low-intensity pasture and arable, with woodland and lowland heath.

Ecological Baseline Conditions

Baseline ecological surveys undertaken in 2007-2009 identified a long list of valued ecological receptors, including:

- Bardon Hill Site of Special Scientific Interest (SSSI);
- semi-natural grassland habitats, including damp neutral grasslands (NVC MG4) and dry hay meadows (NVC MG5);
- species-rich hedgerows;
- uncommon lichens on acidic rock outcrops and dry-stone walls;
- wet woodlands, mature plantation and ancient woodland habitats;
- aquatic habitats of a tributary of the River Sence;
- ponds and *Sphagnum* pools (a Local Biodiversity Action Plan habitat);
- terrestrial invertebrate populations; and
- protected fauna, including badgers, six species of bats, breeding birds, reptiles, and amphibians, including a great crested newt population.

Predicted Impacts

Habitat loss, fragmentation and isolation through land-take was the major impact identified, with a total of 138 ha, approximately 27% of the site area, being lost or heavily disturbed by quarry operations. A total of five non-statutory proposed Local Wildlife Sites and five parish designated sites would be lost as a result of the proposals.

Other impacts identified included effects on flora and fauna through habitat loss, fragmentation and isolation; noise and visual disturbance; impacts resulting from changes in air quality caused by dust or pollutants; alterations to groundwater, surface water flow and quality and also impacts associated with the proposed restoration scheme.

Mitigation and Compensation (Offsets) Measures Proposed

Specific biodiversity mitigation and compensation measures proposed by the developer include commitments to habitat translocation for hedgerows, lichen-covered rocks and lowland wet grassland; mitigation for protected species, including amphibians, badgers and bats; restoration and land management of the Bardon Hill Estate under a more extensive Biodiversity Action Plan than the current version; and the commitment to manage a degraded lowland heathland site outside the estate.

The biodiversity mitigation and offsets for the project were designed by the EIA Team (SLR Landscape and Ecology, and Aggregate Industries) and identified three types of potential biodiversity gains at Bardon Hill Quarry:

- 'Restoration gains'; *i.e.* habitat re-created on areas totally cleared by quarrying and associated activities.
- 'On-site offset gains'; *i.e.* on-site areas not directly impacted by quarrying that will be brought under appropriate conservation management and that are subsequently predicted to improve in condition.
- 'Off-site offset gains', *i.e.* off-site areas (Ratchett Hill) that will be brought under appropriate conservation management and that are subsequently predicted to improve in condition.

Offsets for two particularly high value habitat types found on site, lowland wet grassland and lowland heath, are discussed in more detail below.

Offset for Lowland Wet Grassland

Approximately 1 ha (26%) of the total area of MG4 grassland identified would be lost as a result of the development. To offset for the loss of this habitat the following measures have been proposed:

- the creation of new neutral wet grassland habitats in the new stream corridor;
- restoration and enhancement of approximately 8 ha area of semi-natural grasslands throughout the study area; and
- enhancement, through spreading green hay, of retained existing wet grassland fields within the estate (this has already commenced).

The developer also proposes to minimise residual losses of lowland wet grassland by translocating damp neutral grassland (NVC MG4 community) turves from existing habitats to an agreed donor site, and by translocating soils of species-rich grassland types, including a small area of soil currently supporting a dry meadow (NVC MG5) community. This work would be undertaken several years prior to agreed extraction to ensure some success before loss.

Offset for Lowland Heath: Ratchett Hill

The like-for-not-like offset at Ratchett Hill became available following a review of the developer's other landholdings in the area and through stakeholder discussions. It is proposed to bring 7.5 ha of derelict lowland heathland into active management at Ratchett Hill. A 2009 survey identified less than one hectare of open heathland habitat remaining, with the majority of site supporting secondary birch woodland and bracken. The aim of management, principally the selected clearance of trees and a change in grazing patterns, would be to create a mosaic of lowland heathland, mature oak and birch woodland, and natural rock outcrops.

Table 1. Offset scoring matrix

		Biodiversity Distinctiveness			
		Very Low (0)	**Low (2)**	**Medium (4)**	**High (6)**
Condition	**Optimum (4)**	0	8 [0.33]	16 [0.67]	24 [1.00]
	Good (3)	0	6 [0.25]	12 [0.50]	18 [0.75]
	Moderate (2)	0	4[0.17]	8 [0.33]	12 [0.50]
	Poor (1)	0	2 [0.08]	4 [0.17]	6 [0.25]

Table 2. Biodiversity losses and offset credits required

Phase 1 code	Habitat type	IHS code	Total area (Ha) [1]	Area lost (Ha) [1]	Condition	Distinctiveness	Matrix score	Offset credits required
1. Phase 1 habitats								
A1.1.1	Broad-leaved Semi-natural Woodland	WB3	16.4	1.3 (8%)	Good	3	0.75	1.0
A1.1.2	Broad-leaved Plantation Woodland	WB0	53.9	0	Moderate	2	0.33	0
A1.3.2	Broad-leaved Mixed Plantation	WB1	26.8	0	Moderate	2	0.33	0
A2.1	Dense/Continuous Scrub	WB2	4.0	1.0 (25%)	Good	2	0.5	0.5
A2.2	Scattered Scrub	UH0	1.7	0.3 (18%)	Good	2	0.5	0.15
B1.1	Unimproved Acid Grassland	GA1	0.1	0.1 (100%)	Poor	3	0.25	0.02
B2.1	Un-improved Neutral Grassland	GN1	8.3	1.7 (20%)	Moderate	3	0.5	0.85
B2.2	Semi-improved Neutral Grassland	GNZ	1.0	0	Moderate	2	0.33	0
B4	Improved Grassland	GI0	60.0	26.4 (44%)	Poor	1	0.08	2.1
B5	Marsh/Marshy Grassland	GNZ	0.9	0.8 (89%)	Poor	2	0.17	0.14
B6	Poor Semi-improved Grassland	GI0	85.2	12.6 (15%)	Poor	1	0.08	1.1
C1.1	Bracken (Continuous)	BR0	0.1	0.1 (100%)	Moderate	1	0.17	0.02
C3.1	Tall Ruderal	UH0	12.7	0	Moderate	1	0.17	0
D1.1	Acidic Dry Dwarf Shrub Heath	HE1	1.4	0.1 (7%)	Moderate	3	0.5	0.05
F1	Swamp	EM1	0.2	0	Good	3	0.75	0
G1	Standing Water	AS41	2.0	0.2 (10%)	Moderate	3	0.5	0.1
I1.1.1	Acid/Neutral Natural Inland Cliff	RE111	0.2	0.1 (50%)	Good	3	0.75	0.07
2. Specific habitat types and other biodiversity features of conservation concern								
n/a	NVC MG4 Damp neutral grassland habitats of high conservation value	GN1	3.8	1 (26%)	Good	3	0.75	0.75
n/a	Continuous hedge	LF11	12651	7517	Moderate	2	0.33	2480
n/a	Important hedge (Hedge Regs 1997)	LF111	7678	4202	Good	3	0.75	3151
n/a	Ancient semi-natural woodland	WB3	11.6	0	Good	3	0.75	0
n/a	Plantation on ancient woodland sites	WB3	22.5	0	Poor	2	0.17	0

[1]Or length in metres for hedgerows

Quantifying Biodiversity Losses and Gains

Post-project offset analysis was undertaken by SLR Consulting and The Biodiversity Consultancy to explore the utility of a simple metric to quantify biodiversity losses and gains predicted in the EIA. The analysis seeks to answer the question of whether 'no net loss' would be reached within 25 years, the timeframe of the project's Biodiversity Action Plan management commitment.

In the Treweek *et al.* (2010) system, the main ways to generate measurable biodiversity gains are by improving the condition of a particular habitat (*e.g.* by bringing a degraded lowland heathland into appropriate management) or by elevating distinctiveness category (*e.g.* by converting a Category 1 habitat such as 'improved grassland' to a Category 3 habitat such as 'unimproved neutral grassland' habitat).

Losses and gains were projected for all major habitat types at the site (based on Phase 1 habitat classification (JNCC 2003), converted to standardised Integrated Habitat System categories[2]). Additionally, losses and gains were projected for specific habitats and biodiversity features of conservation importance, for example NVC MG4 grassland, ancient woodland and hedgerows. Losses and gains were measured using the Treweek *et al.* (2010) metric of *Area*[3] *x Condition x Distinctiveness* (Table 1).

Assessing Habitat Condition

Current habitat condition at Bardon Hill and Ratchett Hill was assessed based on expert judgement. It would in theory be possible to draw on established methods to assess habitat condition, such as those used on nationally designated sites (Natural England 2008), but for the purposes of the present analysis we concluded that expert judgement was sufficient to classify areas of habitat into four broad condition categories – optimum, good, moderate and poor.

Assessing Habitat Distinctiveness

There are no universally agreed methods for assessing levels of biological distinctiveness in the UK. A consultation exercise is currently underway within the framework of the Natural Capital Initiative[4] to test the extent to which consensus can be reached if ecologists assign UK habitats to distinctiveness categories *a priori* and without in depth assessment on a case-by-case basis. The preliminary results from this consultation were used to assign different habitat types a distinctiveness score from 0 to 3, where for example a score of zero would be assigned to hard surfaces, or 'technotope' (*e.g.* as applied by Kyläkorpi *et al.* 2005) and a score of 3 to BAP and Annex 1 habitat categories (EU Habitats Directive[5]).

Balance Sheet: Losses and Gains

The area of habitat to be lost, multiplied by the score from the Treweek *et al.* matrix (Table 1) gives the credits, or 'habitat units' required for the offset. If several habitat types are present, the assessment must be repeated for each one and the results summed to give the overall offset requirement. To achieve 'No Net Loss', the offset must deliver an overall ratio of 1:1 (or better) when offset gains are compared with the predicted losses due to development. In some projects, the offset ratio is set to be greater than 1:1 to account for temporal loss and uncertainty.

There are different ways of setting the appropriate ratio, for example through the use of multipliers (*e.g.* three units of compensation are required for every one unit lost), or through the use of economic time discounting models. Multipliers are simpler to apply but can be somewhat arbitrary, whereas time discounting rates can in theory be set based on empirical data, although for biological systems these data are often lacking. An alternative solution for dealing with temporal loss and uncertainty, although one that would not apply for this particular case study, would be for the gains to already have been achieved through 'habitat banking' (*e.g.* Briggs *et al.* 2009). The results of the loss and gains analyses are shown in Tables 2-4. Table 4 gives the balance of losses versus gains, both for a standard 1:1 ratio and for a 3:1 ratio (which was arbitrarily set to test the consequences of using a multiplier).

Table 3. Restoration gains (habitat re-created on areas totally cleared by quarrying and associated activities)

Habitat type	Area to be restored (Ha)[1]	Estimated condition in +25 years	Distinctiveness	Matrix score	Offset credits gained
1. Phase 1 habitats					
Broad-leaved Plantation Woodland	64	Moderate	2	0.33	21.1
Unimproved Acid Grassland	10.6	Moderate	3	0.5	5.3
Un-improved Neutral Grassland	4	Moderate	3	0.5	2
Semi-improved Neutral Grassland	5.5	Moderate	2	0.33	1.8
Acidic Dry Dwarf Shrub Heath	10.6	Moderate	3	0.5	5.3
Standing Water	2	Moderate	3	0.5	1
2. Specific habitat types and other biodiversity features of conservation concern					
NVC MG4 Damp neutral grassland habitats of high conservation value	1.0	Moderate	3	0.5	0.5
Continuous hedge	3300	Moderate	2	0.33	1089

[1]Or length in metres for hedgerows

Table 4. 'Balance sheet' showing losses due to mining and predicted gains due to restoration and offsets that are predicted to accrue over 25 years (the management commitment of the Bardon Hill Biodiversity Action Plan)

Habitat type	Area lost[1] (Ha)	Losses (offset credits)	Restor-ation gains (offset credits)	On-site offset gains (offset credits)	Off-site offset gains (offset credits)	Net position (if 1:1 ratio req'd)	Net position (if 3:1 ratio req'd)
1. Phase 1 habitats							
Broad-leaved Semi-natural Woodland	1.3 (8%)	-1.0		3.8		**2.8**	0.9
Broad-leaved Plantation Woodland	0	0.0	21.1	9.2		**30.3**	30.3
Broad-leaved Mixed Plantation	0	0.0		4.6		**4.6**	4.6
Dense/Continuous Scrub	1.0 (25%)	-0.5				**-0.5**	-1.5
Scattered Scrub	0.3 (18%)	-0.2				**-0.2**	-0.5
1b. Phase 1 woodland habitats	2.6 (2.5%)	-1.6	21.1	17.5	0.0	**37.0**	33.7
Unimproved Acid Grassland	0.1 (100%)	0.0	5.3			**5.3**	5.2
Un-improved Neutral Grassland	1.7 (20%)	-0.9	2.0	1.7		**2.8**	1.1
Semi-improved Neutral Grassland	0	0.0	1.8	0.2		**2.0**	2.0
Improved Grassland	26.4 (44%)	-2.1		0.0		**-2.1**	-6.3
Marsh/Marshy Grassland	0.8 (89%)	-0.1		0.0		**-0.1**	-0.4
Poor Semi-improved Grassland	12.6 (15%)	-1.0		7.8		**6.8**	4.8
1c. Phase 1 grassland habitats	42 (26.8%)	-4.1	3.8	9.6	0.0	**14.6**	6.4
Bracken (Continuous)	0.1 (100%)	0.0				**0.0**	-0.1
Tall Ruderal	0	0.0				**0.0**	0.0
Acidic Dry Dwarf Shrub Heath	0.1 (7%)	0.1	5.3	0.3	3.8	**9.3**	9.2
Swamp	0	0.0				**0.0**	0.0
Standing Water	0.2 (10%)	0.1	1.0	0.0		**0.9**	0.7
Acid/Neutral Natural Inland Cliff	0.1 (50%)	0.1				**-0.1**	-0.2
1d. Total - all Phase 1 habitats	138 (27%)	0.2	6.3	0.3	3.8	**61.8**	49.8
2. Specific habitat types and other biodiversity features of conservation concern							
NVC MG4 Damp neutral grassland habitats of high conservation value	1 (26%)	0.75	0.5	0.7		**0.5**	-1.1
Continuous hedge	7517	2481	1089	873		**-519**	-5480
Important hedge	4202	3152		869		**-2282**	-8585
Ancient semi-natural woodland	0	0		2.9		**2.9**	2.9
Plantation on ancient woodland sites	0	0		3.024		**3.0**	3.0

[1]Or length in m for hedgerows

Discussion and Conclusions

The analysis showed that 'no net loss' would be achieved for most habitat types at Bardon Hill. In most cases where there are losses, these are outweighed by much larger gains in a similar but more 'valued' habitat type. For example, there is a small residual loss of 'improved grassland', but this is outweighed by gains in 'unimproved neutral grassland' and 'unimproved acid grassland'. The most obvious exception is for hedgerows. Assuming that a 1:1 offset ratio is required, there would be a residual loss of -2,282 'units' (condition x distinctiveness x length in metres) for important hedgerows and -519 units for other continuous hedgerows. In this case, it would in theory have been possible for the developer to propose a 'like for like' offset for the continuous hedgerows at least by increasing the length of new hedge to be planted (important hedgerows cannot be replanted from scratch). However, the developer and restoration design team decided upon a restoration principally to woodland and heathland habitats in response to local stakeholder consultation and landscape character assessment, *e.g.* The National Forest Landscape Strategy.

In order to compensate for predicted residual losses in hedgerows, gains in other habitats such as dwarf shrub heath (a Biodiversity Action Plan habitat), broad-leaved woodland, unimproved grassland, and other compensation measures proposed, are considered a 'like for not like' offset.

This paper provides the first 'field test' of the Treweek *et al*. (2010) method for measuring biodiversity losses and gains in the context of biodiversity offsets and demonstrates that the method can be successfully applied to a real-world example. Several issues and points for discussion that the authors noted are briefly discussed below.

First, it is worth noting that the 'area x distinctiveness x condition' metric (or a similar metric) can be applied to other kinds of biodiversity features, not just habitats. In the present study, a similar metric 'length x distinctiveness x condition' was used for hedgerows.

Second, distinctiveness category scores broad-leaved semi-natural woodland with a higher value than broad-leaved plantation. This may be the case for long-established semi-natural woodland, but may be difficult to justify in terms of woodland creation. It is typical for created woodland in restoration schemes to be planted, usually using a mix of native species. However, the methodology suggests that higher scores for offsetting can be gained from woodland allowed to naturally regenerate, as it is a more distinctive habitat. Dependent upon individual situations, *e.g.* distance from existing semi-natural woodlands and proximity of seed sources of non-native invasive species, woodland creation using plantation may, in the 25-year term we are considering here, lead to a higher quality woodland than natural regeneration.

Third, when estimating habitat condition in the Bardon Hill Quarry example, several issues required careful thought to ensure a pragmatic outcome:

'Optimum' condition implies that the habitat is in the best possible state; a condition that rarely is achieved in the real world. For the example presented, we have interpreted this category pragmatically, using it where a habitat could be considered to be in favourable condition and is stable or improving (using terminology defined by Natural England for condition assessments of SSSIs).

In the UK, it is difficult to avoid 'condition' and 'distinctiveness' scores being conflated to a degree, because management is often the main factor determining distinctiveness. This was particularly apparent when considering condition scores for grassland habitats. We decided that the condition of heavily man-modified agricultural grasslands should use the semi-natural habitat equivalent as a reference mark; *i.e.* all semi-improved and improved neutral grasslands are compared to the unimproved neutral grassland type. In this way improved grassland is assessed as poor condition for the neutral grassland type; rather than assessing improved grassland as being habitat in optimum condition for fattening cows. In practice, our interpretation was such that improved grassland could only achieve a condition score of Poor–Moderate and semi-improved grassland Poor–Good. This approach avoided an apparent overstatement of the biodiversity value of agricultural grasslands.

Notes

[1] http://ec.europa.eu/environment/enveco/index.htm

[2] Integrated Habitat System (HIS) was used because it encompasses all UK terrestrial, freshwater and marine habitats, including European and BAP habitats (www.ihs.somerc.co.uk). It is also now widely used at local and regional scales for mapping and collating habitat data recorded in other classifications (*e.g.* Butcher 2008, SERC 2007).

[3] Or *length x condition x distinctiveness* in the case of hedgerows

[4] www.naturalcapitalinitiative.org.uk

[5] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora

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