Improvement Programme for England's Natura 2000 Sites (IPENS) – Planning for the Future IPENS049

Case Study C: Atmospheric nitrogen profile for Birklands and Bilhaugh SAC

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Atmospheric nitrogen profile for Birklands and Bilhaugh Special Area of Conservation (SAC)

This document has been produced as part of IPENS049. Please read this site profile in conjunction with the report (Dragosits *et al.* 2014) that explains the methods and background. For more information visit - Improvement Programme for England's Natura 2000 sites (IPENS)

Conclusions:

- Birklands and Bilhaugh SAC is located in suburban/rural landscape in the Midlands. Its designated habitat, *Dry oak-dominated woodland,* is very sensitive to atmospheric nitrogen (N) with Critical Loads (CL) ≤ 10 kg N ha^{-1} yr^{-1}.
- Current N deposition in the wider area is estimated to exceed the designated feature's critical load by 17- 23 kg N ha^{-1} yr^{-1}, using the UK 5 km grid data. The level of exceedance may be underestimated locally for some areas of the site, given the proximity of likely local emission sources.
- The majority of N deposition received by the site originates from non-agricultural emission sources. No major local emission sources have been identified in close proximity to the site (<2 km). However, the Whitwell lime production plant, situated within 10 km of the site, emits a substantial amount of NO_x (> 1,000 t NO_x-N yr^{-1}).
- Road transport sources are estimated to contribute ~ 17 % of the total N deposition received by the site. While the nearest road is just over 200 m away from the site, estimated NO_x emissions are substantial at > 1.7 t NO_x km^{-1} yr^{-1} and may therefore make a considerable contribution to local N deposition. Measures targeting road transport are therefore suggested for the area.
- Measures targeting livestock emissions are not thought to be relevant here, given that there are very few agricultural holdings with livestock present in a 2 km zone surrounding the SAC. The agricultural emission density surrounding the site is very low (<1 kg N ha^{-1} yr^{-1}), with large areas of the 2 km zone not under agricultural use. However measures to reduce fertiliser emissions may be useful, given the considerable proportion of the site boundary directly bordering agricultural land.

1. Site characteristics

***Site area*:** 2.7 km^2

Designated features:

Table 1 - Designated features for Birklands and Bilhaugh

Interest Code	Interest Lay Name	Sensitivity to nitrogen deposition	Expected Exceedance Impact N
H9190	Dry oak-dominated woodland	Very sensitive (Mapping CL ≤ 10 kg N ha^{-1} yr^{-1})	Decrease in mycorrhiza, loss of epiphytic lichens and bryophytes, changes in ground vegetation

***Landscape context*:** The site is situated in a suburban region of the Midlands and is comprised of two sub-sites of 2.2 km^2 and 0.5 km^2, which are separated by the A616. There are large areas of woodland which border the site, while the southern edge of the larger sub-site and the northern and western edge of the smaller sub-site are adjacent to arable fields.

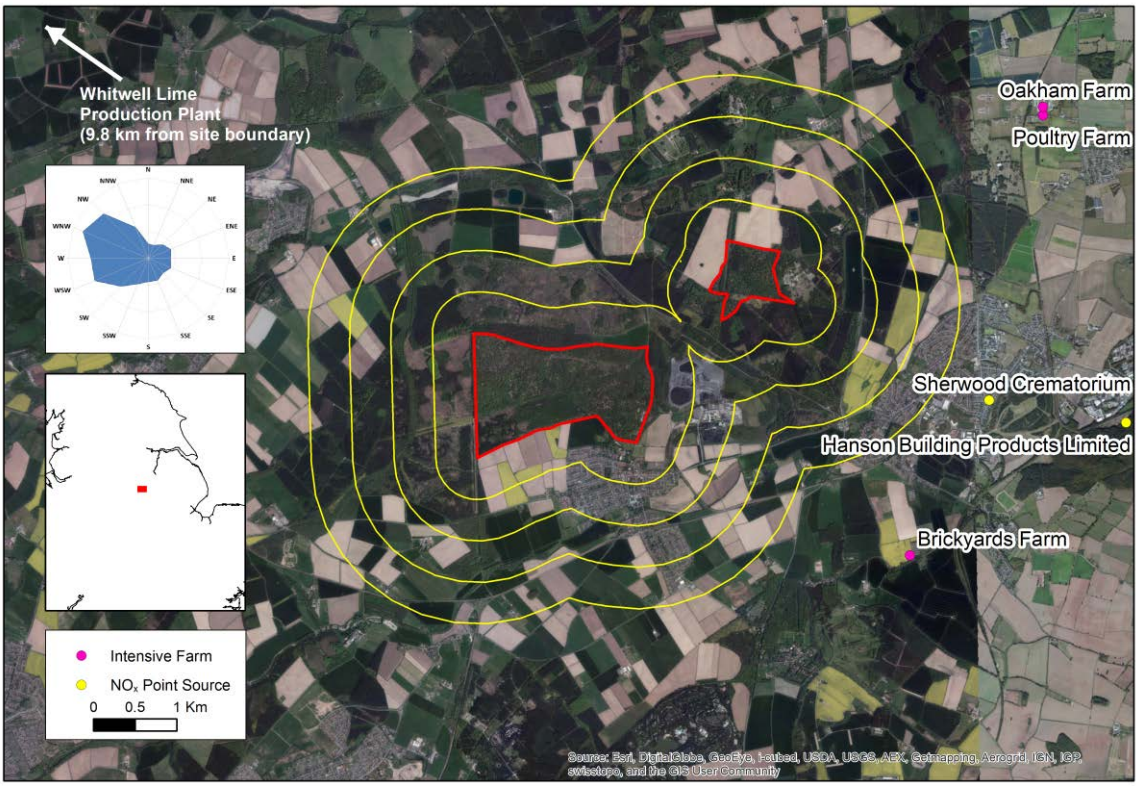

Figure 1 - Location of the Birklands and Bilhaugh SAC, with locations of intensive farms and identified non-agricultural NO_x sources. The wind rose shows the annual average (06/13 - 06/14) wind direction (%) in Selston (approximately 20 km SW of site), data from Windfinder (accessed 22/07/14).

2. Deposition and concentration estimates

5 km deposition modelling: The most recent available model estimate of N deposition at the site is in exceedance of the designated feature's critical load by 17- 23 kg N ha^{-1} yr^{-1} (CBED model output for 2010 - 2012, from APIS). N.B. the 2010-2012 estimates of N deposition are slightly lower than those estimated for 2005, the most recent year with source attribution data (FRAME model output, 2005). Given the large spatial variability of N at the landscape scale, the exceedance values presented in Table 2 may be an underestimate in close proximity to N sources near the site boundary (such as application of mineral fertiliser and potentially manure spreading right up to the site boundary here).

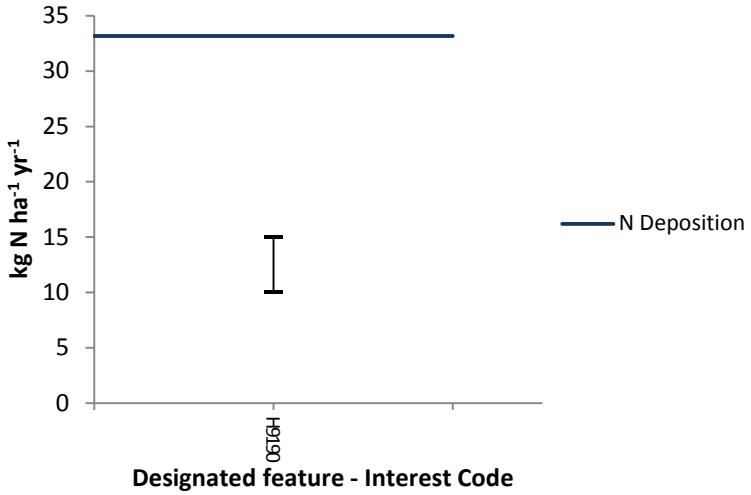

Figure 1 - Critical load exceedance for Birklands and Bilhaugh designated feature (woodland), from APIS 2012. H9190 - Dry oak-dominated woodland *N.B. N deposition values are derived from the 2010-2012 CBED data (also available on APIS), the data used for the 5 km level source attribution section refers to the most recent source attribution run of FRAME, where estimates of N deposition are up-to 3 kg ha yr lower than CBED 2010-2012.*

1 km NH_3 concentration modelling: The 1 km grid resolution NH_3 dataset (FRAME model output) shows that the majority of the site has NH_3 concentration between 1-2 µg m^{-3}, with a small area below 1 µg m^{-3}. East/south-east of the site, towards an area with more intensive agriculture, NH_3 concentrations are elevated to 2 - 3 µg $m^{-3.}$

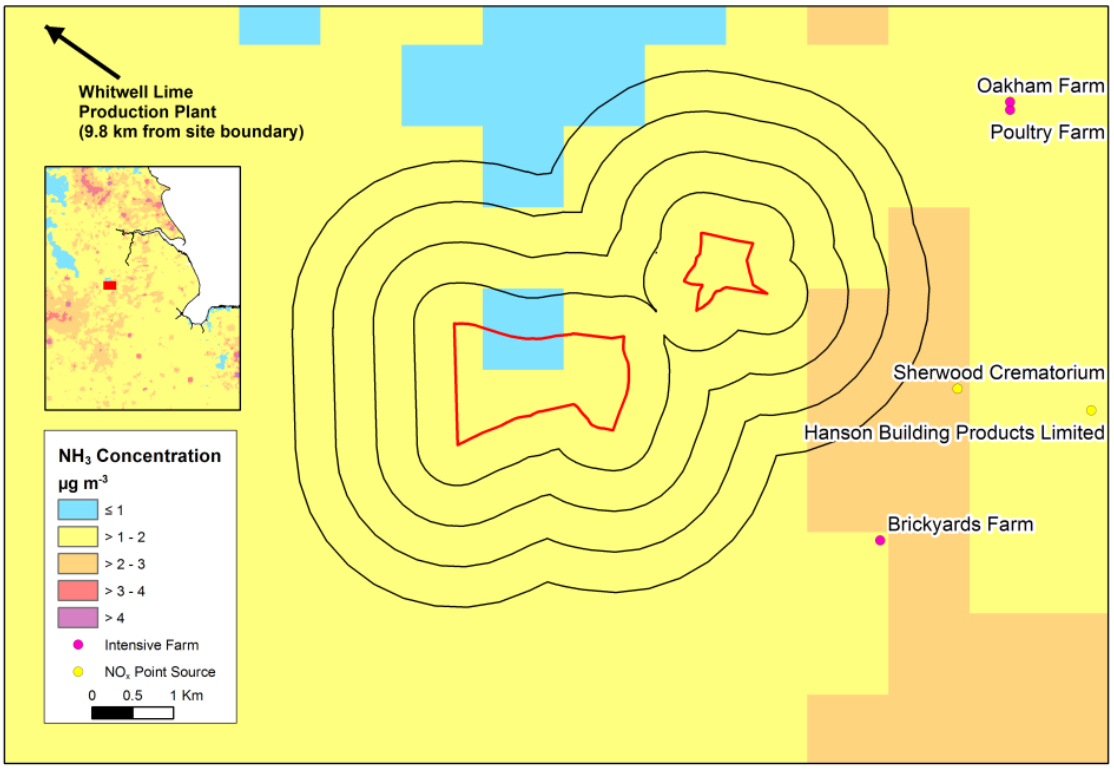

Figure 3 - Ammonia concentrations at Birklands and Bilhaugh (FRAME 1 km dataset for 2011), with locations of intensive farms and identified non-agricultural NO_x sources.

3. Source attribution calculations

***5 km Source attribution calculations*:** The initial scenario approach (using the source attribution dataset from 2005), indicates that non-agricultural (point) sources contribute 38 % of the total N deposition for the 5 km grid square containing the site. Roads contribute 17 % of the total N deposition. Roads are not allocated as a major threat under the initial assessment, as the nearest major road is > 200 m away from the site boundary. However, in this case road emissions were considered in more detail, as the road contribution is relatively high and there is a major road just beyond the 200 m threshold (see Section 4 below). The site also receives a significant proportion of N deposition derived from agricultural emissions (34 %), which may in part be due to the five intensive poultry farms (permitted under IED) located within 10 km of the site boundary.

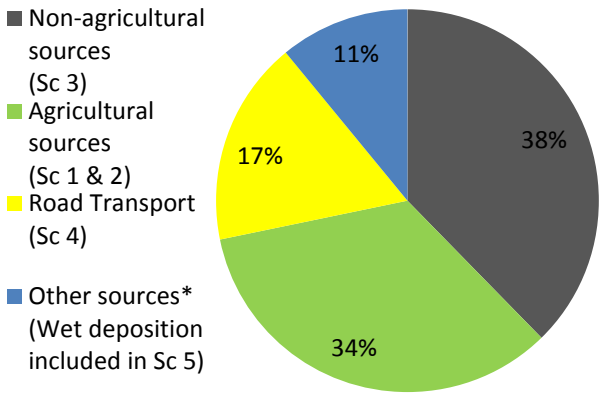

Figure 4 - Source attribution chart, showing the mean contributions to the N deposition across the 5 km grid square that contains Birklands and Bilhaugh

Table 1 - Birklands and Bilhaugh SAC: Scenario allocation - derived from the source attribution dataset (2005) using the initial scenario approach

Area (km^2)	Scenarios allocated (number, IDs)	Total N deposition (kg N ha^{-1} yr^{-1})	Scenario allocations for sub-site (in **bold**)					
			Source Attribution (% of total N deposition)			Total wet N deposition	Nearest Features (m)	
			Agriculture (fertiliser & livestock)	Non- Agricultural sources	Roads	Long Range N deposition	Intensive farm	Major road
2.7	2 (Sc1, Sc3)	34.4	34.1	37.7	17.3	34.5	3,345	235

Scenario totals will not add up to 100%, due to rounding and other small source categories, which are not included in the scenario definitions (e.g. dry deposition from imported emissions and offshore installations). The colour coding shows allocated scenarios in red, ambiguous allocations under the initial scenario approach in grey and scenarios below the threshold un-shaded.

***Scenario allocations* for site:**

1 - Lowland agriculture (many diffuse sources)
3 - Non-agricultural (point) source
4 - Roads
5 - Long range N-deposition

4. Inventory of most likely local emissions sources (desk based study)

Road transport emissions:

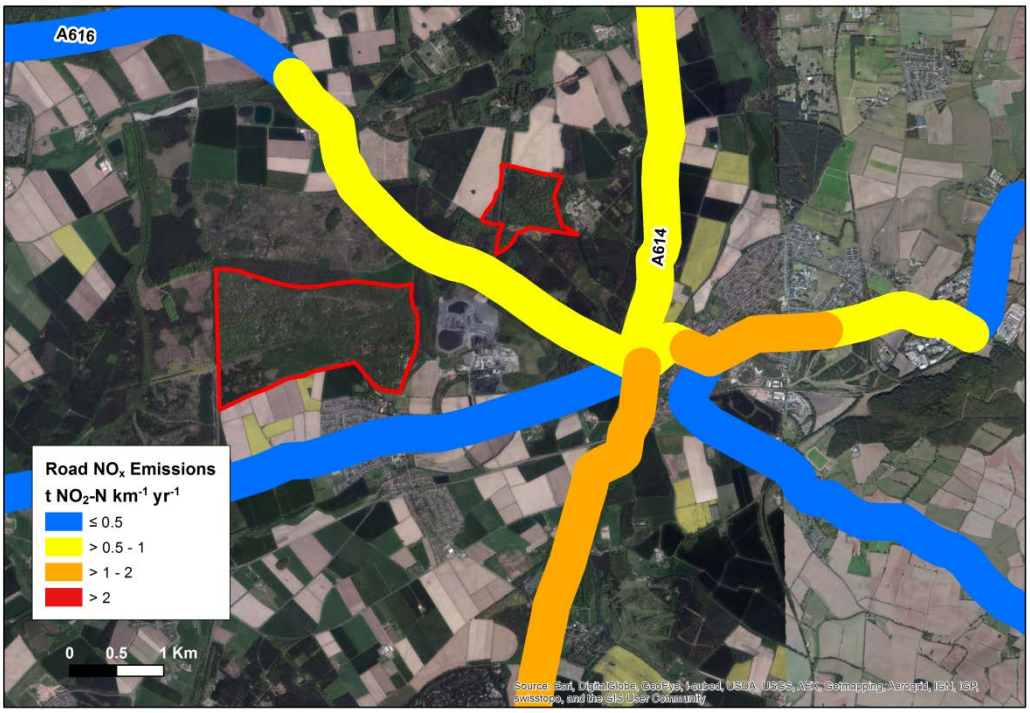

Figure 5 - Estimated annual NO_x emissions (t NO_x-N km^{-1} yr^{-1}, Defra EFT, 2014 and DfT AADF, 2012) from road links surrounding Birklands and Bilhaugh SAC. Roads buffered to 200 m (following work by Cape et al. 2004).

Estimated NO_x emissions from the road links surrounding Birklands and Bilhaugh are presented in Figure 5. Under the initial scenario approach, major roads > 200 m are not considered to pose a significant threat to N deposition. However as the northern part of the site is located just over 200 m (235 m) from the A616, which is estimated to emit > 0.5 t NO_x-N km^{-1} yr^{-1}, this may pose a threat to the site. In addition, the intersection with the A614 (~2 km from site) produces in excess of 1.2 t NO_x-N km^{-1} yr^{-1}, which may also contribute to the significant proportion (17 %) of N deposition the site is estimated to receive from road transport sources.

Agricultural emissions:

From the agricultural census analysis, it appears that there are very few agricultural holdings in close proximity to the site, with only five agricultural holdings identified within a 2 km zone of the site. The predominant NH_3 emissions for the holdings identified are derived from fertiliser application (grassland and arable, see Figure 6).

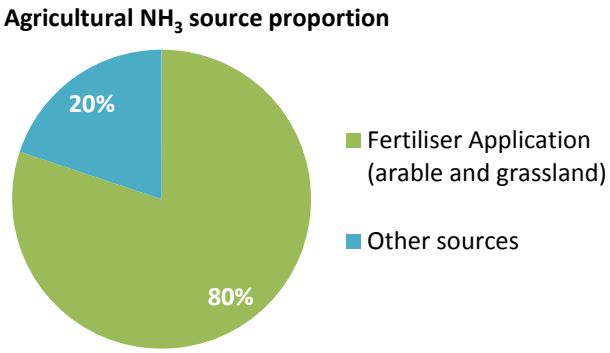

Figure 6 - Agricultural NH_3 emission sources in the 2km is surrounding Birklands and Bilhaugh SAC derived from 2012 agricultural census.

The agricultural emission density for the 2 km buffer zone surrounding the site is very low at 0.3 kg ha^{-1} yr^{-1}, indicating that local agricultural emissions are likely to be very minor. There are five intensive poultry farms within 10 km of the site boundary, with the closest at 3.3 km to the southeast of the site (see Figure 1). The other four intensive poultry farms are also located downwind of the site (considering the prevailing wind direction), and are therefore less likely to significantly contribute to the N deposited to the site.

Non-agricultural emissions:

There are no major NH_x or NO_x point emission sources within 2 km of the site, according to the NAEI database. The nearest larger emission source with NO_x emissions ~7 t N yr^{-1} is Kirton Brickworks, which is located ~ 4 km south east of the site. Within a 10 km zone of the site boundary, there is only one very large emission source in the NAEI, the Whitwell lime production plant, which is 9.7 km northwest of the site boundary.

Whitwell lime plant consists of two long rotary kilns that heat dolomitic limestones up to 2200°C. The kilns produce 1,610 t NO_2-N yr^{-1} and are powered using fossil fuels supplemented by solvent- and tyre-derived fuel. A recent report from the plant operators (Steetley Dolomite Ltd, 2011) shows that planning permission has been sought to fit a pre-heater to one of the kilns in order to reduce the NO_x emission from the kiln from >3,000 mg NO_2 m^{-3} to <800 mg NO_2 m^{-3}. This measure is only suitable for one of the kilns however and the other kiln can produce in excess of 5,000 mg NO_2 m^{-3}.

5. Selection of potential measures

Non-agricultural emissions are estimated to contribute significantly to the local N deposition of Birklands and Bilhaugh SAC, in addition to a high proportion of deposition from agricultural sources. As the Whitwell lime production plant is the only major non-agricultural N emission source identified in the area surrounding the site (< 10 km from the site boundary), measures should be considered to reduce N emitted from the site.

Measures targeting the use of mineral fertilisers to arable crops and grassland could also be relevant here, given that a substantial proportion of the site is bordered by arable fields and mineral fertiliser emissions are the dominant NH_3 source according to the 2012 agricultural census. It is also possible that livestock manures may be applied to these fields, but this would need to be confirmed through local knowledge.

Road transport emissions, with the A616 just 235 m from the site, and other major transport links passing close by may contribute to local N deposition to a greater degree than anticipated from the initial rough estimate using the initial scenario source attribution data. Road transport measures should therefore be considered at the site, to reduce the 17 % of N deposition produced by road transport emissions.

Table 3 summarises the local and national-scale measures that are likely to be most relevant to Birklands and Bilhaugh SAC. Although there are some livestock emission sources present in the wider area surrounding the site (from the agricultural census analysis and IED farm database), measures targeting livestock emissions do appear less relevant here, given that the agricultural land use in the immediate vicinity of the site is predominantly arable.

Table 3 - Potential local measures for decreasing local concentrations and deposition of nitrogen to Birklands and Bilhaugh SAC selected for the main local sources, selected from a list of potential measures

N source	Measure	Mitigation effect
Whitwell Lime plant	Installation of the proposed pre-heater to one of the kilns	~70 % reduction in NO_x emissions from the kiln
Fertiliser application to arable fields	Reduction of mineral fertiliser application rates	20%
Fertiliser application to arable fields	Conversion of intensive agricultural land (arable and grass) to unfertilised grassland or semi-natural land cover (inc. woodland) around Birklands to Bilhaugh SAC	90%
Road Transport	Installation of NO_{xer} barrier	≤ 75 %
Road Transport	Introduction of demand management technique (e.g. congestion charge or low emission zones (LEZs).	12%
Road Transport	Improve signage and access to real time traffic information	N/A
Road Transport	Promote greener technologies (alternative fuels and end of pipe technologies)	N/A
Road Transport	Realignment of roads	N/A

References:

Dragosits U., Carnell E.J., Misselbrook T. and Sutton M. (2014a) Site categorisation for nitrogen measures. Final report to Natural England for project IPENS049. 20 pp. http://publications.naturalengland.org.uk/publication/5802656649969664

Steetley Dolomite Ltd (2011) Whitwell Plant, PPC Permit BL3269 IH, Waste Incineration Directive Annual Report, available at http://www.whatdotheyknow.com/request/106192/response/271462/attach/9/WID%20Report%202011.pdf