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

Case Study A: Atmospheric nitrogen profile for Walton Moss SAC

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Atmospheric nitrogen profile for Walton Moss 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:

- Walton Moss SAC site is located in an intensive lowland agricultural landscape in N.W. England.
- The site's designated habitats, raised bogs, are very sensitive to atmospheric nitrogen (N).
- Current N deposition in the wider area is estimated to be 180% of the critical load of the most sensitive habitat. The level of exceedance may also be underestimated, for some areas of the site, given the proximity of likely local emission sources.
- Diffuse agricultural activities are the main source of atmospheric N for this site. Local agricultural sources, in particular cattle farming, contribute significantly to the deposition at Walton Moss, but a substantial proportion of the total N deposited is also estimated to originate from long-range N deposition.
- Mitigation measures targeting ammonia (NH_3) emissions from cattle farming would be particularly relevant here, given its dominance in the area. Potential activities to target are manure spreading and storage, and minimising emissions from cattle housing. Suitable measures include efficient application of slurries and manures to grassland, as well as following good agricultural practice by accounting for N in manures when calculating mineral fertiliser application rates.
- The south westerly edge of the site appears to have a significant proportion of potential N sources, in comparison to the rest of the site. Considering the prevailing south-westerly wind and elevated NH_3 concentrations in that area, this may be a priority area for implementing measures, especially considering that this portion of the boundary is not currently sheltered by a tree belt.
- Measures targeting sources > 10 km from the site boundary are also relevant here and should be considered, given the large proportion of N deposited to the site as wet deposition from medium- to long-range N sources.

1. Site characteristics

Site area: 2.9 km^2

Designated features:

Table 1 - Designated features and sensitivity at Walton Moss SAC

Interest Code	Interest Lay Name	Sensitivity to nitrogen deposition	Expected Exceedance Impact N
H7110	Active raised bogs	Very sensitive (Mapping CL ≤ 10 kg N ha^{-1} yr^{-1})	Leaching will cause a decrease in soil base saturation, increasing the availability of Al3+ ions, mobilisation of Al^{3+} may cause toxicity to plants and mycorrhiza, may have direct effect on lower plants (bryophytes and lichens).
H7120	Degraded raised bog	Very sensitive (Mapping CL ≤ 10 kg N ha^{-1} yr^{-1})	

N.B. All features for Walton Moss are classed as semi-natural features

Landscape context: intensive lowland agricultural landscape in NW England, with a south westerly prevailing wind (Figure 1). There are some existing tree belts following the site boundary for short distances at the north-eastern and western edges (widths 10-50 m, patchy in places), overall of a length of approx. 1 km. Given the direction of the prevailing wind, the existing tree belts are not well placed to capture deposition from sources upwind of the site.

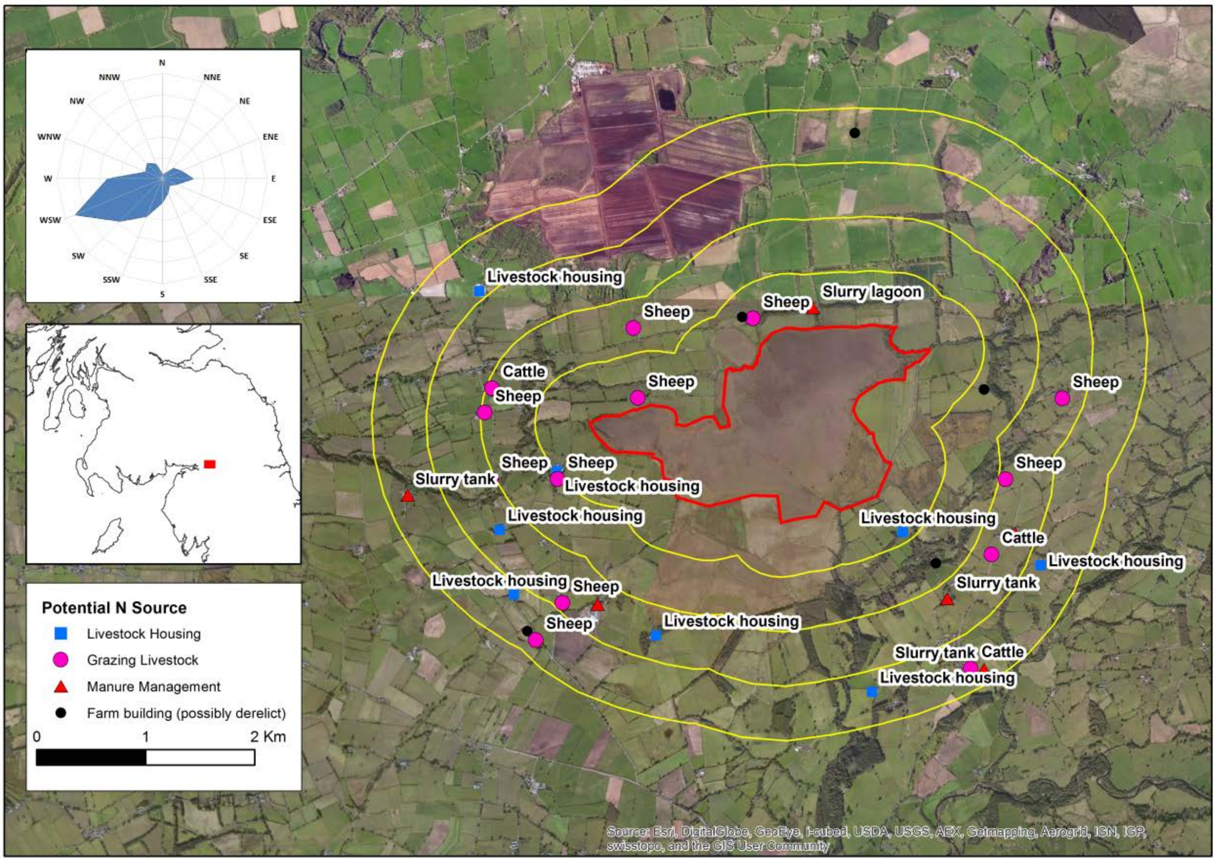


Figure1 - Walton Moss site map, showing N sources identified from Google Earth imagery, during a desk-based study carried out July 2014 (Google imagery date 30/05/2009). Wind rose shows the annual average (05/13 - 05/14) wind direction (%) in nearby Brampton (~5 km south of site), data from Windfinder.com (accessed 03/07/14).

2. Deposition and concentration estimates

***5 km grid deposition modelling*:** The most recent available model estimate of N deposition at the site exceeds the critical loads of the designated features by over 185 % (CBED model output for 2010-2012, from APIS), with higher N deposition estimated in the 5 km grid square containing the eastern edge of Walton Moss (Figure 2). The 2010-2012 estimates of N deposition are almost 3 kg N ha^{-1} yr^{-1} higher for parts of Walton Moss than those predicted for 2005, the most recent year with source attribution data for applying the initial scenario approach (FRAME model output, Table 2). Therefore the N deposition figures in Table 2 are presented only in reference to source attribution, and the 2010-2012 estimates should be used to estimate critical loads exceedance at the site. Given the large spatial variability of N at the landscape scale, the exceedance values presented in Figure 2 may be an underestimate in close proximity to N sources near the site boundary (such as animal housing and manure spreading).

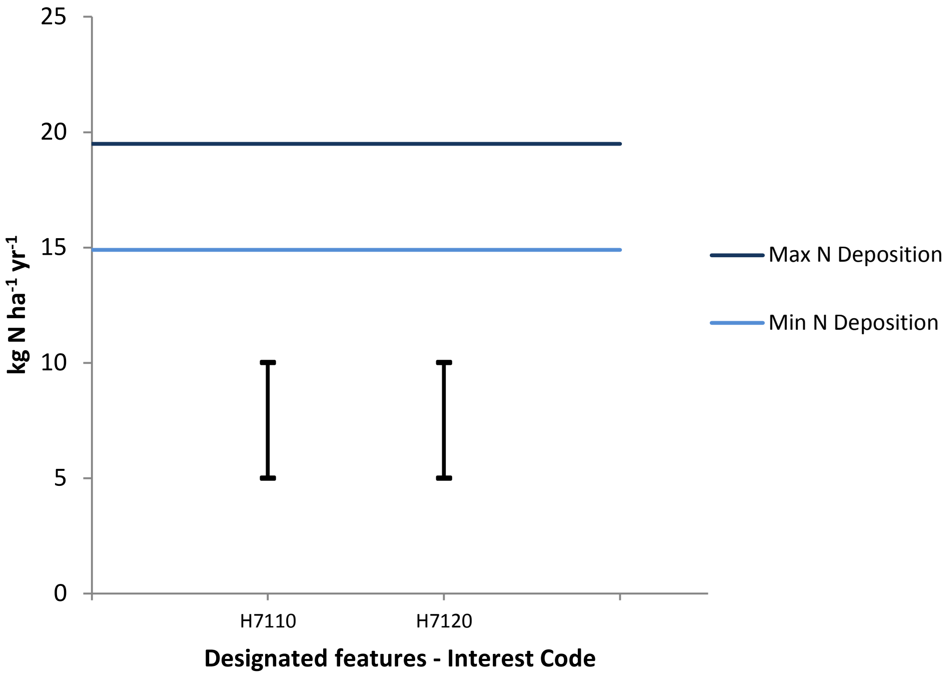


Figure 1 - Critical load exceedance for designated features at Walton Moss SAC, from APIS. Interests: H7110 - Active raised bogs; H7120 - degraded raised bogs.

1 km grid NH_3 concentration modelling: The 1 km grid resolution NH_3 dataset (FRAME model output) shows higher concentrations to the west of the site, which is consistent with the estimated N deposition datasets (CBED 2012, FRAME 2005). The south westerly edge of the site appears to have a substantial number of potential N sources, in comparison with the rest of the site. Considering the direction of the prevailing wind and elevated concentrations in that area, this may be a priority area for implementing measures, especially considering that this portion of the boundary is not currently sheltered by a tree belt.

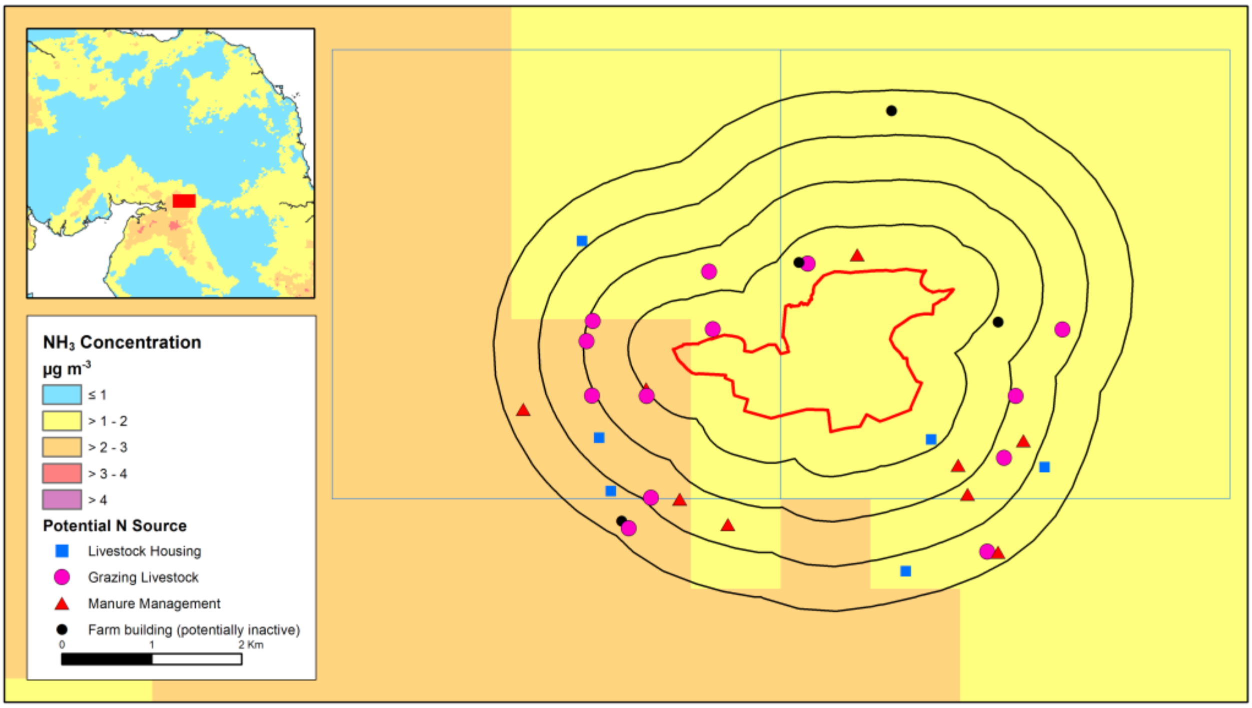
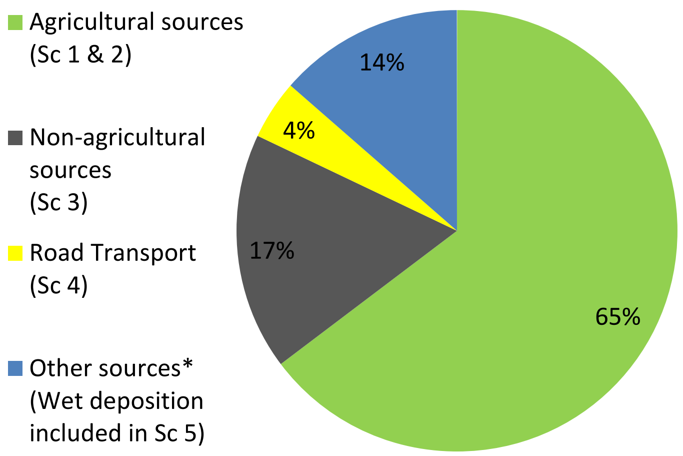


Figure 3 - Ammonia concentrations at Walton Moss SAC (FRAME 1 km dataset for 2011). The point symbols represent livestock houses (blue squares), manure/slurry storage facilities (red triangles), fields with grazing livestock pink circles) and farms which may or may not be active (black circles) – information from Google aerial images (images dated 30/05/2009). The outlines of the 5 km grid squares used in the deposition modelling and source attribution datasets are superimposed in blue.

3. Source attribution calculations

5 km grid source attribution: The initial scenario approach (using the source attribution dataset from 2005) indicates that diffuse agricultural activities are the main source of NH_3 emissions in the area and contribute approximately 65-70 % of the total N deposition, across the two 5 km grid squares containing the site. Only a relatively small proportion (<20 %) of the total N deposition at the site is attributed to non-agricultural NH_3 sources and road transport, with the site situated approximately 2.5 km from the nearest major road. Overall (i.e. including all N source types), a substantial proportion (> 40 %) of the total N deposited is estimated to originate from long-range transport.



* refers to sources such as offshore installations and imported emissions, which are included as wet deposition in screening Scenario 5

Figure 4 - source attribution chart, showing the mean contributions to the total N deposition across the two 5 km grid squares which contain Walton Moss SAC, using the initial scenario approach (2005 data).

Table 2 - Walton Moss Scenario allocation: derived from the source attribution dataset (2005) using the initial scenario approach

Deposition Type	Scenarios allocated (number, IDs)	Range in total N deposition for site (kg N ha yr^{-1})	Scenario allocations (in **bold)**			
			Total wet N deposition	Source Attribution (% of total N deposition)		
			Long Range N deposition (%)	Roads	Non-Agricultural (point) sources	Agriculture (fertiliser & livestock)
Semi-natural vegetation	2 (Sc1, Sc5)	17.1 - 19.8	**48.6 - 61.4**	3.9 - 4.8	15.7 - 19.1	**60.7 - 68.7**

N.B. ***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 and scenarios below the threshold un-shaded.***

Initial Scenario allocations:

1 - Lowland agriculture (many diffuse sources)
5 - Long range N deposition

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

Agriculture: A significant proportion of the farms in the area are cattle farms (mix of dairy and beef), which can be associated with high NH_3 emissions from activities such as animal housing, storage and land spreading of manures/slurry, livestock grazing and mineral fertiliser application (indicated by Figure 3). In addition to these diffuse agricultural activities surrounding the site, there are two large (IED) intensive broiler farms within 10 km of the site. One IED farm is situated approximately 8.5 km to the west of the site and houses ~250,000 broilers, and another unit (9 km SW) houses ~150,000 broilers. Using detailed information on housing and manure management from the IED database, the SCAIL screening tool was applied, which estimates that the two IED farms contribute approximately 6% (5% and 1%, respectively) to the total N deposition at Walton Moss.

Based on the 2012 Agricultural Census (and assuming farms are point sources), it is estimated that there are more than 1,000 cattle within a 1 km radius of the site boundary. Activities associated with cattle are estimated contribute to over 85% of the agricultural NH_3 emissions around the site (~11.5 t NH_3 N yr^{-1}, within a 1 km radius). Sheep farming is also prevalent in the area, with approximately 3,000 grazing sheep surrounding the site (< 1km), although NH_3 emissions from sheep are much smaller and only represent ~6 % of agricultural emissions around the site (Figure 3). The remaining agricultural NH_3 emissions near the site (< 1 km) derive from fertiliser application to permanent grassland (~6%) and minor sources such as arable crops, horses, goats and deer (~2%).

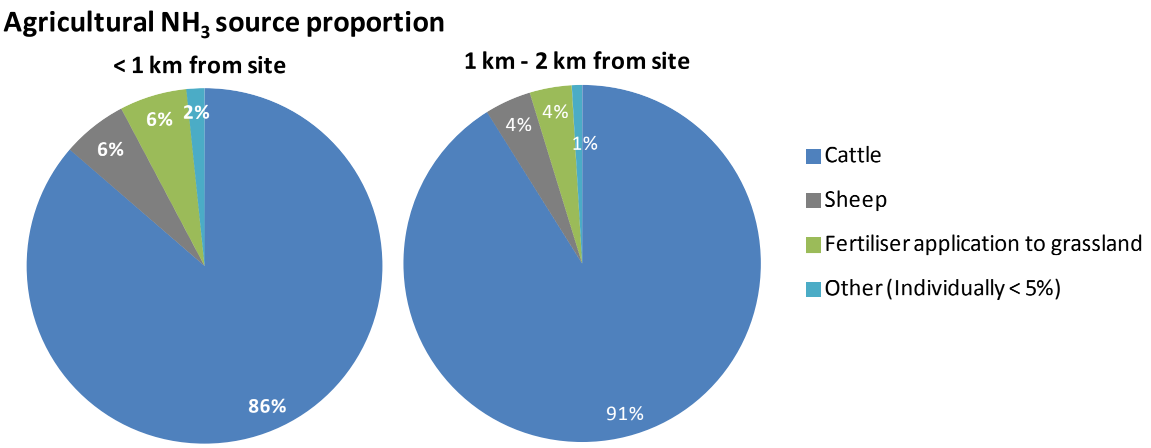


Figure 5 - Estimated proportion of agricultural activities contributing to agricultural emissions in the vicinity of Walton Moss (left: <1 km distance from the site boundary; right: 1-2 km from the site boundary). Emissions were estimated using standard emission factors from the UK agricultural NH_3 emission inventory (Misselbrook et al. 2013) and non-disclosive summaries of the 2012 Agricultural Census data.

***Other N sources*:** Walton Moss is situated approximately 2.5 km from the nearest major road, and therefore NO_x emissions from roads are less of an issue for the site (Table 2). Similarly, there are no large point sources of non-agricultural N emissions located in the near vicinity, with the nearest source identified in the National Atmospheric Emission Inventory (www.naei.org.uk, 2011 data) being a combustion source (~22 t NO_x-N yr) ~12.5 km away.

In addition to the local sources already identified, sources further afield are also thought to impact the site substantially, given that a large proportion (>40 %) of the N deposited to the site is as wet deposition.

5. Selection of potential mitigation measures

Local agricultural sources contribute significantly to the local N deposition at Walton Moss, therefore, agricultural measures are likely to be the most suitable for reducing N deposition through spatially targeted measures (Table 3). Measures targeting emissions from cattle farming are particularly relevant here, given its dominance in the area. Potential activities to target are manure/slurry spreading and storage, and minimising emissions from cattle housing. Suitable measures include efficient application of slurries and manures to grassland, as well as following good agricultural practice by accounting for N in manures when calculating mineral fertiliser application rates. In order to address the threat from long-range N deposition, measures for reducing emissions in a wider area should also be considered. Potential measures across a wider area could be delivered through a large-scale incentive scheme or regulatory approaches.

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

N source	Measure	Mitigation effect
Arable and grassland	Apply slurry to land via open-slot shallow injection instead of surface broadcast application	Open-slot injection -70 % Closed-slot injection 90 %
Arable and grassland	Surface applied slurry is incorporated into the soil shortly after application by either plough, disc or tine	< 4 hrs (Plough - 65%; Disc/tine - 50%) < 24 hrs - 30%
Arable and grassland	Surface applied FYM is incorporated into the soil shortly after application by either plough, disc or tine	< 4 hrs (Plough - 70%; Disc/tine - 45%) < 24 hrs - 30%
Cattle farms	Farm yard manure heaps are covered with an impermeable sheet for the duration of storage	60 %
Dairy farms	Formulating dairy cattle diets such that protein content does not greatly exceed requirement	10 %
Dairy farms	Increased frequency of removing manure from the floor of dairy cow cubicle housing	15 %
Dairy farms	Installation of grooved floors allowing faster drainage of urine to storage, thus lowering the potential for NH_3 emission from dairy house floors.	35 %
Dairy farms	Pressure washing (or hosing and brushing) of dairy cow collecting yards immediately following each milking event	70 %
Existing un-covered slurry lagoons and tanks	Use of slurry bags instead of existing un-covered slurry storage facilities	95 %
Manure heaps	Siting of temporary manure heaps in fields away from the vicinity of Designated Sites (at least 500m), also taking account of local topography and prevailing winds	Reduction in NH_3 concentration and deposition at the site, 0 % reduction in emissions
Manure heaps	Cover farm yard manure heaps with an impermeable sheet for the duration of storage	60%
Slurry lagoons	Addition of floating clay granules (or similar material) to reduce gaseous NH_3 transfer from slurry surface to the atmosphere	50 %

N source	Measure	Mitigation effect
Slurry lagoons	Tree belt shelters air flow across the lagoon and also re-captures ammonia downwind of the slurry store (note modelling included the increase in T associated with the sheltering of the slurry	20 %
Slurry tanks	Fitting a tent-like structure to above-ground slurry tanks to reduce gaseous transfer from the slurry to the atmosphere	80 %
Sources located to the SW of the site (upwind)	Consider suitable sites for planting tree belts downwind of NH_3 sources (e.g. livestock houses) close to the designated site, or upwind of the designated site (in relation to the prevailing wind direction)	20 %

It should be noted that Table 3 summarises potential measures to target only the most significant local sources. Therefore further measures which target minor sources, such as mineral fertiliser application to arable fields, are not listed here. In addition, as the majority of IED farms close to SACs are likely already implementing all or many of the most cost-effective measures, therefore these are not listed here. However, there may be the potential for further emission reductions from these sources.

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