UK Centre for Ecology & Hydrology

Atmospheric ammonia assessments on six designated sites in Northern Ireland. Year 1: June 2020 – May 2021

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1 Executive Summary

1.1 Objectives

- Atmospheric ammonia (NH_3) gas concentrations were monitored on six designated sites of international and national importance (Special Areas of Conservation, SAC and Areas of Special Scientific Interest (ASSI)) across Northern Ireland, to assess threats from atmospheric nitrogen inputs.
- The monitoring strategy at each designated site aims to capture the high spatial variability of NH_3 and any associated atmospheric concentration gradients away from sources, where the highest concentrations (and local sources) may be and where the largest ecosystem impacts are likely to occur.
- The sites are also part of the cross-border INTERREG Va funded Collaborative Action for the Natura Network (CANN) project (2017-2021), managed by the Special EU Programmes Body.
- The measurement data will provide supporting evidence to develop site-specific mitigation strategies, if necessary and appropriate.
- It is hypothesised that boundaries of a designated site that are closest to, and downwind of sources (e.g. intensive livestock units) will be exposed to the highest NH_3 concentrations and therefore most at risk from adverse effects on sensitive vegetation.
- This report presents monthly NH_3 measurements from the first year of monitoring, between June 2020 and May 2021.

1.2 Annual mean NH_3 concentrations

- A total of 37 NH_3 monitoring points were established, with between 4 and 9 monitoring points on each of the 6 designated sites depending on the size and complexity of each site.
- Monitoring was carried out at monthly intervals, with continuous time-integrated measurements made with passive UKCEH ALPHA® samplers. Since passive samplers do not require electricity, they are easily deployed without impacting on the site.
- Monthly measurements were aggregated to estimate annual average concentrations for the assessment of critical levels exceedance (annual thresholds). The monthly monitoring periods also enabled the construction of seasonal profiles across the sites, which helps in identifying peak emission periods, as well as likely source types (for example, slurry spreading activities during spring).

- The current "critical levels" (CLe), of 1 µg NH_3 m^{-3} and 3 µg NH_3 m^{-3} (annual mean concentrations) were adopted in 2007 for the protection of lichens-bryophytes and other vegetation (higher plants), respectively.

- Slieve Beagh was the cleanest site, with annual mean concentrations at all 7 monitoring points falling just below the 1 µg m^{-3} CLe for protection of lichens and bryophytes. Annual mean NH_3 concentrations at all other sites exceeded this threshold, with considerable exceedances noted at Curran Bog, Garry Bog, Peatlands Park and the most exposed parts of Turmennan. Average annual concentrations at Moneygal were slightly above the 1 µg NH_3 m^{-3} Cle, at 1.1 - 1.3 µg NH_3 m^{-3}.

- Only two monitoring points exceeded the CLe of annual mean NH_3 concentrations of 3 µg NH_3 m^{-3} for the protection of all other sensitive vegetation (higher plants). These were Curran Bog Site 1 (annual mean = 7.5 µg NH_3 m^{-3}) and Peatlands Park Site 7 (annual mean = 4.0 µg NH_3 m^{-3}). Both monitoring sites are in close proximity of livestock housing and related emitting activities.

1.3 Seasonal variability an NH_3 concentrations

- Seasonal trends at all sites show the lowest concentrations in winter and highest concentrations in spring and autumn, coinciding with the usual periods of livestock slurry/manure applications to fields in the area.

- A further large peak was observed at some sites in June 2020. This may be related to early-summer slurry spreading after silage cuts, likely in combination with warm weather. During June 2020, unusually high temperatures were recorded, with many days above 20°C (max 26°C on 25/06/2020)[1].

[1] https://www.timeanddate.com/weather/@2641364/historic?month=6&year=2020

2 Introduction

Monthly atmospheric ammonia (NH_3) gas measurements were conducted at six internationally important designated sites (Special Areas of Conservation, SAC) across Northern Ireland (Figure 1), to assess threats from atmospheric nitrogen input to sensitive habitats and protected features. The study sites and the number of ammonia monitoring points on each site are detailed below:

Study site	Number of NH_3 monitoring points
Curran Bog SAC	5
Garry Bog SAC	6
Moneygal Bog SAC	4
Peatlands Park SAC	9
Slieve Beagh SAC	7
Turmennan SAC	6

Full details on the rationale for site monitoring strategies have been provided in an earlier report by Thomas et al. (2019). The focus of this report is to present an analysis of the first full year of NH_3 concentration data over the period between June 2020 and May 2021.

Figure 1: Map showing the locations of the six Special Areas of Conservation (SAC) sites in Northern Ireland where local NH3 monitoring networks were installed in June 2020.

3 Method

3.1 Monitoring sites

The selection of the individual monitoring locations at each SAC was based on NH_3 concentration data from the most recent national atmospheric modelling available at the time (2017 data), at a 1 km by 1 km grid resolution. Aerial and satellite imagery from Google Earth were also extensively used to screen for potential local NH_3 emission sources and expected concentration gradients (Thomas et al., 2019).

3.1.1 Curran Bog

Curran Bog SAC is situated in an intensive agricultural area, dominated by cattle farming (dairy and beef). The SAC is in close proximity to many livestock houses and slurry/manure stores, primarily to the west of the site and at the south-eastern corner. The northern and north-eastern boundaries of the SAC are bordered by wooded areas which may provide buffer zones from agricultural emission sources to the north and north east.

Latitude	54.800
Longitude	-6.643
Area (ha)	183.5
Designation	Active raised bog (25.48 ha), Degraded raised bogs still capable of natural regeneration (126.86 ha)
Site character	Bogs, Marshes, Water fringed vegetation, Fens (82.6%) Humid grassland, Mesophile grassland (0.5%) Broad-leaved deciduous woodland (16.9%)
Notes	Several large farms and/or visible slurry stores/lagoons within 2km Three Industrial Emissions Directive (IED) farms within 5km
Links to previous/current monitoring	Ballynahone Bog (8 ALPHA sites since September 2014) is located close (1.5km) to Curran Bog, to the north/northeast. There is further landscape scale monitoring with 9 ALPHA sites within a 5 km radius of Ballynahone Bog and one DELTA site on the bog itself, since early 2019, which gives a wider understanding of concentrations in the wider area including Curran Bog.

3.1.2 Garry Bog

Garry Bog SAC is situated in a busy agricultural landscape with predominantly cattle farming (specifically dairy farming, but also beef farming), with the SAC in close proximity to many livestock houses and slurry/manure stores, especially to the west and south. The northern and eastern boundaries of the SAC are bordered by forested areas which are expected to provide a buffer zone from agricultural emission sources.

Latitude	55.108
Longitude	-6.530
Area (ha)	154.9
Designation	Active raised bog (142.7 ha)
Site character	Bogs, Marshes, Water fringed vegetation, Fens (100%)
Notes	Several large farms or visible slurry stores/lagoons within 2km; 1 IED farm within 2km, 2 further IED farms within 5km
Links to previous/current monitoring	Within 10km: AFBI27-D (NI-wide network of NH_3 concentration samplers, started Mar 2019, by AFBI & UKCEH); UKA00401 Coleraine (UK National Ammonia Monitoring Network site, https://uk-air.defra.gov.uk/networks/site-info?uka_id=UKA00401)

3.1.3 Moneygal Bog

Moneygal Bog SAC is situated in an agricultural landscape with predominantly mixed dairy and beef cattle farming, with the north-eastern boundary forming the border with the Republic of Ireland. There are several livestock farms in the vicinity of the site, with the closest farms being located to the south/southwest. The north-western boundary and smaller areas to the NE and SE are bordered by forested areas which provide buffer zones from agricultural emission sources.

Latitude	54.742
Longitude	-7. 630
Area (ha)	156.2
Designation	Active raised bog (142.7 ha)
Site character	Bogs, Marshes, Water fringed vegetation, Fens (89%) Humid grassland, Mesophile grassland (2%) Coniferous woodland (9%)
Notes	No IED farms within 5km Small farms within 2km
Links to previous/current monitoring	AFBI06-A within 10 km (new NI-wide network of NH_3 concentration samplers, set up Mar 2019, by AFBI & UKCEH)

3.1.4 Peatlands Park

Peatlands Park SAC is located in an intensive farming landscape (predominantly beef & dairy cattle, with one IED farm within 2 km of the western boundary). There are parts of the site that border farm land directly, while other areas of the site are more protected with woodland and bog features which provide a buffer against nearby emission sources.

Latitude	54.488
Longitude	-6.599
Area (ha)	207.5
Designation	Active raised bog (21.8 ha), Degraded raised bog (117.2 ha), Bog woodland (6.1 ha), Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles (42.5 ha)
Site character	Inland water bodies (Standing water, Running water) (4%) Bogs, Marshes, Water fringed vegetation, Fens (72%) Broad-leaved deciduous woodland (24%)
Notes	1 IED farm within 2km, 2 within 5km
Links to previous/current monitoring	Within 10km: AFBI11-A (new NI-wide network of NH_3 concentration samplers, set up Mar 2019, by AFBI & UKCEH). Peatlands Park ex-Sniffer site '03-'04 Model assessment undertaken under the EMIND project

3.1.5 Slieve Beagh

In contrast to the mainly lowland bog/fen type sites included in this study, Slieve Beagh SAC is a large upland site situated in an agricultural landscape dominated by mixed dairy and beef cattle farming nearby and with a cluster of IED farms to the north (4 - 6 km distance). There are not many farms close to the site boundary and most of the site is bordered by less intensively used land (including woodland), providing a buffer zone from agricultural emission sources. The south-western corner of the site forms the border with the Republic of Ireland (RoI), with much less detailed data availability for the purposes of this study, resulting in increased uncertainty in the model output data for this site. There are several known poultry farms in the RoI part of the wider landscape surrounding the site.

Latitude	54.348
Longitude	-7.194
Area (ha)	1,888.2
Designation	Active blanket bog (1112 ha), Natural dystrophic lakes and ponds (est. 15.3 ha), European dry heaths (80 ha)
Site character	Inland water bodies (Standing water, Running water) (1%) Bogs, Marshes, Water fringed vegetation, Fens (85%) Heath, Scrub, Maquis and Garrigue, Phygrana (14%)
Notes	1 IED farm within 2km, 1 further IED farm within 5km and several additional IED farms north east (within 10km) 3 small animal houses within 2km
Links to previous/current monitoring	AFBI04-A within 10 km (new NI-wide network of NH_3 concentration samplers, set up Mar 2019, by AFBI & UKCEH)

3.1.6 Turmennan

Turmennan SAC is located in a very intensive mixed farming landscape (with one IED farm less than 2 km to the NE). Parts of the site border farm land directly, especially to the east, whereas others (south-western side) are buffered by woodland and other semi-natural features.

Latitude	54.379
Longitude	-5.714
Area (ha)	14.8
Designation	Transition mires and quaking bogs (4.6 ha)
Site character	Inland water bodies (Standing water, Running water) (0.4%) Bogs, Marshes, Water fringed vegetation, Fens (50.1%) Dry grassland, Steppes (18.5%) Broad-leaved deciduous woodland (31%)
Notes	Few small farms evenly spread in 2km buffer. 1 IED Farm within 2km, 2 within 5km
Links to previous/current monitoring	Within 2km: AFBI21-A; within 10km: AFBI13-A (new NI-wide network of NH_3 concentration samplers, set up Mar 2019, by AFBI & UKCEH). Selected site for analysis in the EMIND project (Carnell and Dragosits, 2017).

3.2 Ammonia Monitoring Method

3.2.1 UKCEH ALPHA® Samplers

Atmospheric NH_3 gas concentrations were measured using the UKCEH high sensitivity ALPHA® passive sampler, shown in Figure 2 (Tang et al., 2001). Monitoring (ongoing for a second year) is carried out at a monthly frequency from June 2020, with continuous time-integrated sampling over each period. This is cost-efficient for providing annual mean concentrations for comparisons with the UNECE critical levels of NH_3 concentrations, with sufficient resolution to analyse seasonal patterns in the monthly data.

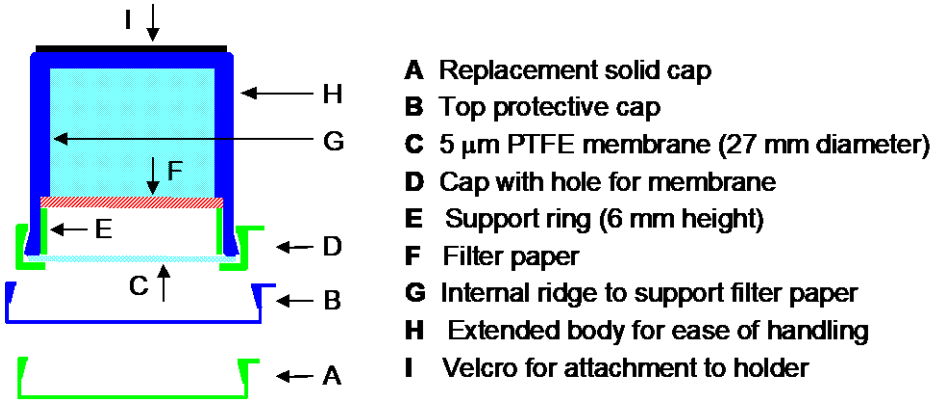

Figure 2: Outline diagram of a single UKCEH ALPHA® sampler.

3.2.2 Preparation of samplers

ALPHA® samplers are prepared in accordance with standard UKCEH protocols (Tang et al. 2019), using filter circles impregnated with 6 mg of citric acid. Replicate samplers (three) are prepared for each measurement and placed inside a sealed container, together with replacement solid caps that are used to replace the membrane and membrane caps at the end of sampling.

3.2.3 Exposure of samplers

ALPHA® samplers are attached with Velcro to an aerodynamically shaped support (upturned plant saucer) on a post at approx. 1.5 m height above ground or vegetation. The sampling height of 1.5 m above ground follows the standard protocol used in the UK national monitoring network, providing a representative NH_3 concentration in the atmosphere. Plastic bird spikes were mounted on the top of the support to deter birds from perching. Replicate (three) samples are used for each measurement in order to provide an estimate of measurement precision and uncertainty for the air concentration of NH_3.

ALPHA® sampling sites were set up by members of staff from Ulster Wildlife, NIEA and Monaghan County Council, under guidance from experienced personnel at UKCEH. Following site establishment and commencement of the first monitoring period, sites have been visited on a monthly basis by trained personnel to carry out the required monthly changeover of samples. A recording card is used by the site operator to record dates and times of the sample changes at each site, together with relevant local information (e.g. agricultural activities taking place in the vicinity, such as slurry spreading, during the month or at the time of visit).

3.2.4 Chemical analysis

Exposed samples are stored in a cold room at 4°C until analysis. Citric acid-impregnated filter circles from the exposed ALPHA® samplers are extracted into deionised water and analysed for aqueous ammonium (NH_4^+) on a SEAL Flow Injection Colorimetry system at the UKCEH Edinburgh analytical chemistry facility. The SEAL analytical method and SOP for determination of aqueous ammonium used at UKCEH Edinburgh is the same as that implemented by the UKAS accredited laboratory at UKCEH Lancaster for the UK National Ammonia Monitoring Network (Conolly et al., 2016) and an ALPHA® ammonia monitoring network in Northern Ireland funded by DAERA (Tang et al., 2021).

3.2.5 Calculation of air concentrations

The air concentration (χ_a) of NH_3 gas (µg NH_3 m^{-3}) is determined according to Eq. 1:

$$c_a = \frac{Q}{V} \quad (1)$$

The amount of NH_3 collected (*Q, µg*) on an ALPHA® sampler due to air sampling is given by Eq. 2:

$$Q = (Ce - Cb) * v * (\frac{17}{18}) \quad (2)$$

- *C_e is the liquid concentration of an exposed sample (µg NH_4^+ ml^{-1}),*
- *c_b is the liquid concentration of a blank sample (µg NH_4^+ ml^{-1}) and*
- *v is the liquid volume of the extraction solution (ml).*
- *multiplied by $\frac{17}{18}$ to convert from NH_4^+ (measured in liquid extract) to NH_3*

V is the estimated volume of air sampled by ALPHA® sampler over the exposure period (*V*, m^3), which may be determined by Eq. 3:

$$V = UR_{NH_3} * t \quad (3)$$

- *UR_{NH3} is the field calibrated uptake rate of ALPHA® sampler for UKCEH Edinburgh laboratory = 0.003241315 m^3 hr^{-1} (e.g. Martin et al., 2019)*
- *t is sampling duration (hours).*

3.2.6 QAQC

The accuracy of the SEAL analytical method for determination of ammonium (NH_4^+) in aqueous solution is assured by participation in international laboratory proficiency schemes (EMEP and GAW). The replicate ALPHA® samplers used for each measurement (triplicate samplers in this study) should, when performing well, agree to within 15 % (coefficient of variation, CV). Large discrepancies are most likely due to contamination of samples, or other factors that affect the performance of the samplers. The average reproducibility of replicate samples in the field has been better than 10 % (CV) and the detection limit (3 σ of blanks) was 0.03 µg m^3 for a monthly exposure period, indicating that the sites are operating very well.

4 Results and Discussion

4.1 Curran Bog

Four sites (CB1 – CB4) were established along a SW-NE transect from the western edge of the bog, where the closest farms with livestock houses and manure/slurry storage are located (Figure 3). A further sampling point (Site 5) was placed at a more easterly location. Modelled annual average NH_3 concentrations across the grid squares covering Curran Bog are in the range of 2.3 - 3.2 µg NH_3 m^{-3}, based on FRAME NH_3 concentration model output for the emission year 2017 (Figure 4, Table 3).

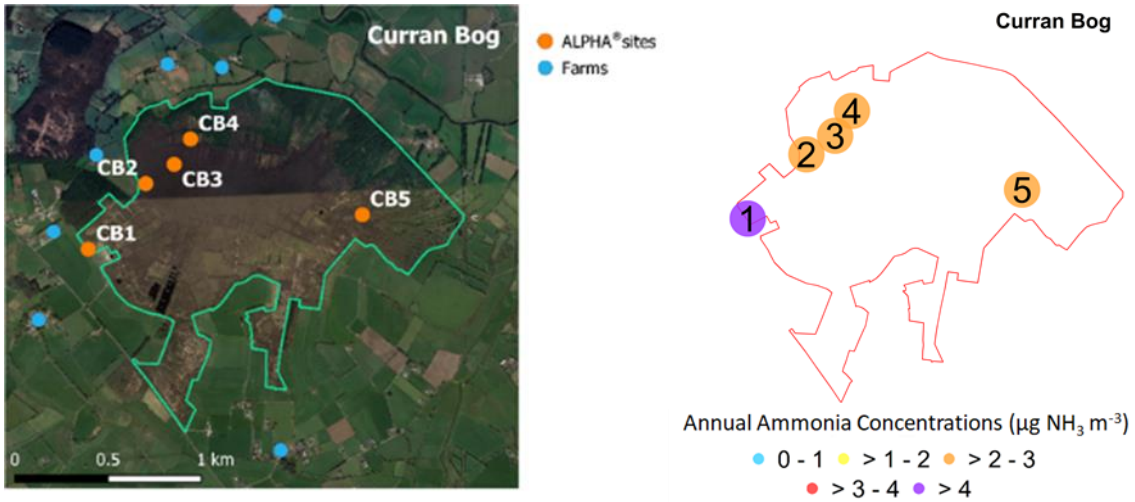

Figure 3: (LEFT) Map of Curran Bog, showing locations of the five monitoring points (CB1 – CB5) and proximity of farms (blue circles) as potential NH_3 sources. The farms are identified using satellite/aerial imagery and may or may not be active. (RIGHT) Map of annual average NH_3 concentrations at Curran Bog (June 2020 - May 2021).

The first year of NH_3 concentration measurements at Curran Bog shows the highest annual average NH_3 concentrations at Site 1 (CB1) (annual mean = 7.5 µg NH_3 m^{-3}, range = 2.5 – 24 µg NH_3 m^{-3}) (Figure 3, Figure 5, Table 2). This is consistent with its location on the western boundary of the SAC, in close proximity to agricultural emission sources identified in the landscape (Figure 3).

NH_3 concentrations along the SW-NE transect (Sites 1 – 4) decreased with distance from Site 1, with a near 4-fold decrease at Site 4 at the end of the transect (annual mean = 2.0 µg NH_3 m^{-3}, range = 1.3 – 2.9 µg NH_3 m^{-3}) (Figure 5, Table 2).The measurements therefore support model predictions (Figure 4) which suggest that there is likely a concentration gradient across the site, with the highest concentrations on the western boundary in closest proximity to emission sources.

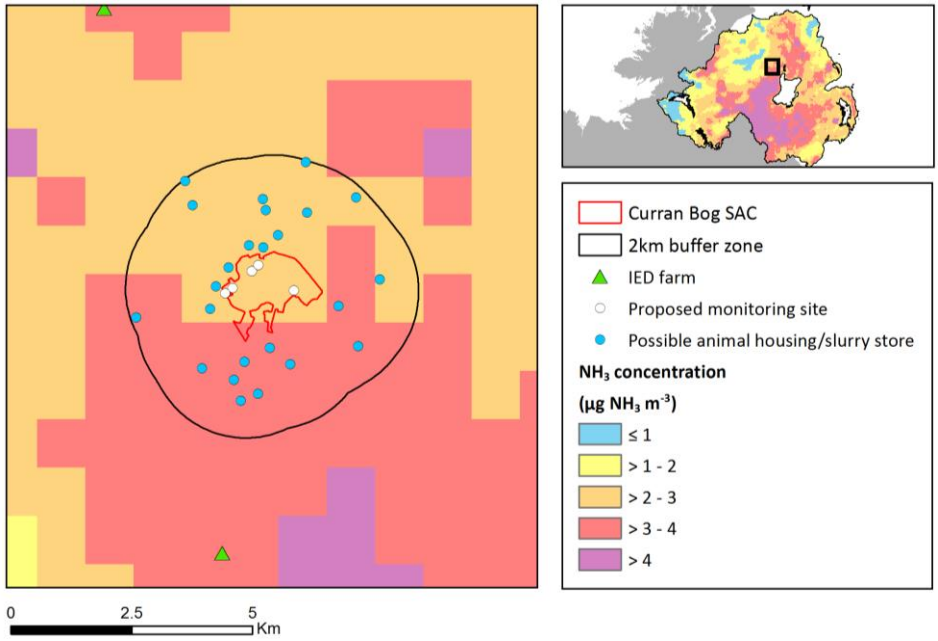

Figure 4: Modelled NH_3 concentrations at Curran Bog SAC (outlined in red) and the wider landscape at 1 km x 1km grid resolution (FRAME model output using 2017 emissions data).

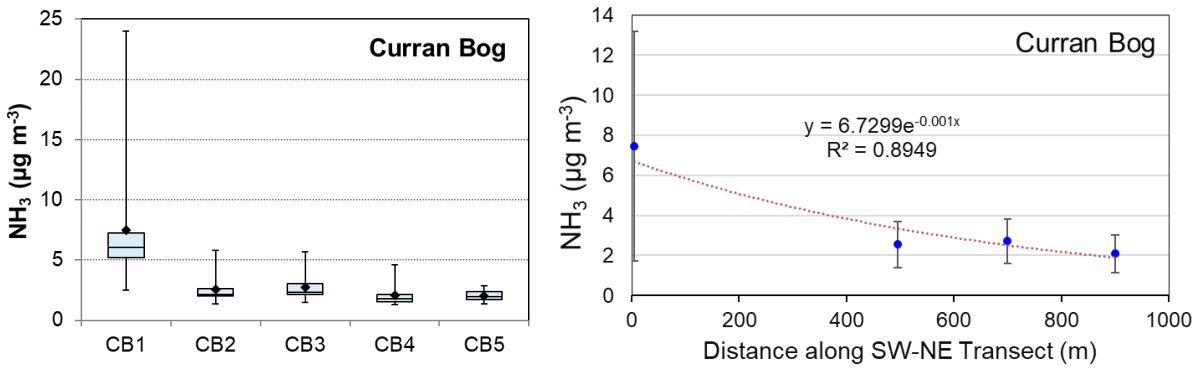

Figure 5: (LEFT) Boxplot comparing annual mean and median NH_3 concentrations measured at Curran Bog. Whiskers show the min and max of monitored monthly concentrations. (RIGHT) Changes in monitored mean concentrations at the 4 sites (CB1 – CB4: annual mean ± SD, *n* = 12) along the SW-NE transect across Curran Bog, showing an exponential decline in concentrations, with distance from the south-western edge of the reserve.

The annual mean measured concentration at Site 1 (7.5 µg NH_3 m^{-3}) is however much larger than modelled data, which estimate concentrations of between 2.3 – 3.2 µg NH_3 m^{-3} (Figure 4, Table 3). The modelled estimate is made at a 1 km x 1 km grid square resolution and represents an area-weighted average for the grid-squares containing Curran Bog. The modelled concentrations are likely an underestimate for this particular location. This is due to the methodology required for the emission inventory maps that underlie the modelled concentrations, where emissions associated with individual farm

holdings are distributed across suitable land cover in a wider area (for NI these are 5 x 5 km grid squares). Individual farm hotspots such as the enterprise located close to the site boundary are therefore being smoothed out across a wider local area. This is to satisfy data restrictions for the use of farm level data for the emission modelling, to preserve confidentiality, and results in a smoothed emission surface (i.e. data from at least 5 farms have to be aggregated).

By contrast, annual mean concentrations at Sites 2 to 5 (range = 2.1 – 2.8 µg NH_3 m^{-3} (Table 2) are within the range of modelled values (Table 3). Site 1 is therefore impacted by strong local emission sources that are smoothed out in the national modelled concentration maps. Observations from the field recorded manure spreading taking place within 10 m of the Site 1 in March 2021, which accounts for the very large spike in concentrations during that month (24 µg NH_3 m^{-3}) (Figure 6).

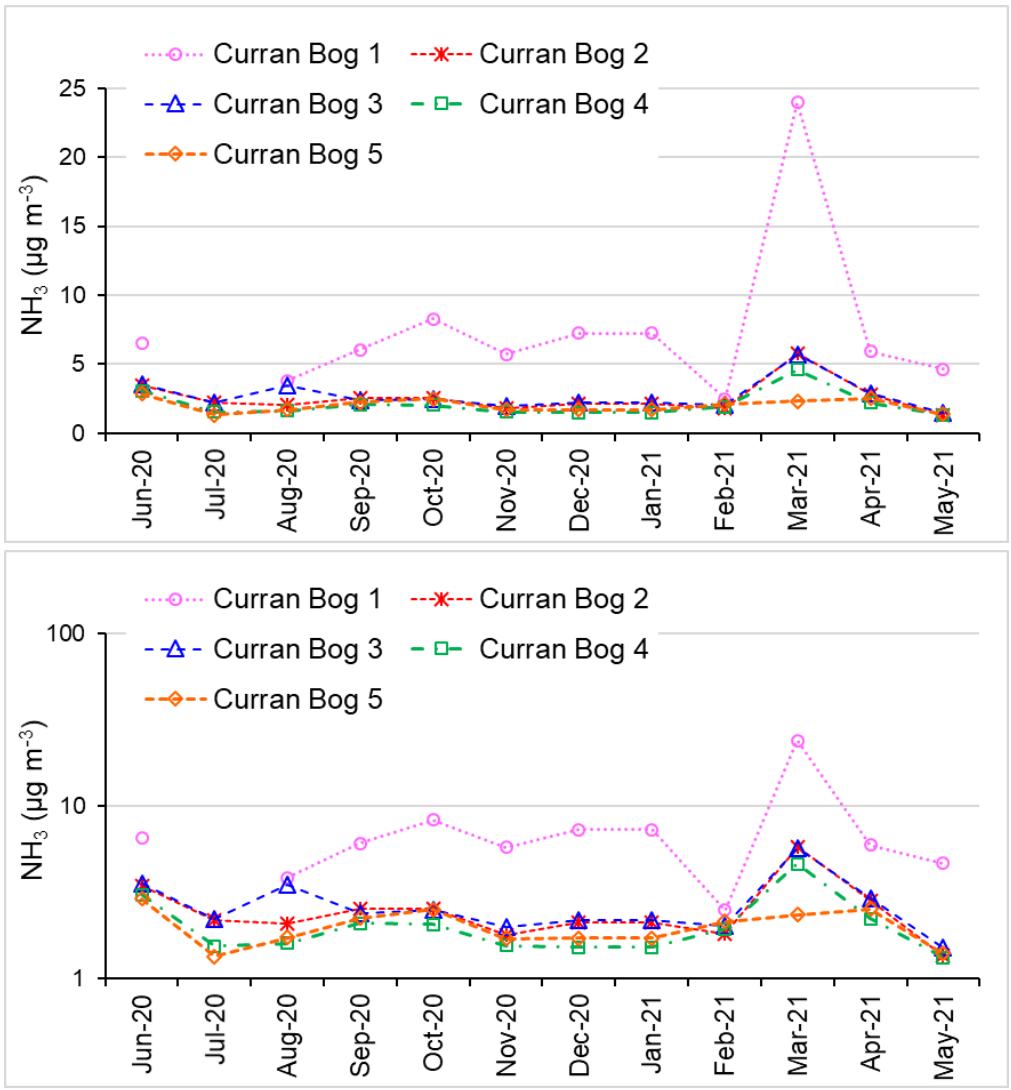

Figure 6: (TOP) Seasonal cycle in NH_3 concentrations at each of five monitoring points on Curran Bog, showing differences in the magnitude of concentrations. (BOTTOM) The same plot with Y-axis plotted on a log scale to show more clearly the seasonal profile at sites 2 to 5 with smaller concentrations than Site 1.

Site CB1 also showed much higher concentrations than the other measurement sites at Curran Bog for all months, apart from August 2020 and February 2021 when concentrations converged with the other sites, either due to absence of local sources affecting Site CB1 or changes in wind directions in those months (Figure 6). By contrast, Sites CB2 to CB5 were fairly similar both in their seasonal profile and magnitude of concentrations. Site CB5 is furthest from emission sources and is notable for the absence of a March peak, present at all other sites. This suggests that Site CB5 is perhaps not affected by local sources to the same extent as other sites on the west side of the bog.

There are also two months of interest from the first year of monthly measurements (Figure 6). These are the dip in concentrations in July 2020 (all sites) and in May 2021 (all sites except Site CB1). Ammonia concentrations in the summer months are usually larger than winter months, as ammonia volatilises from surfaces more rapidly during higher temperatures. Monthly averaged rainfall and temperature data for Northern Ireland showed cooler and wetter conditions than normal in those months (Figure 7), which may have contributed to the smaller concentrations observed.

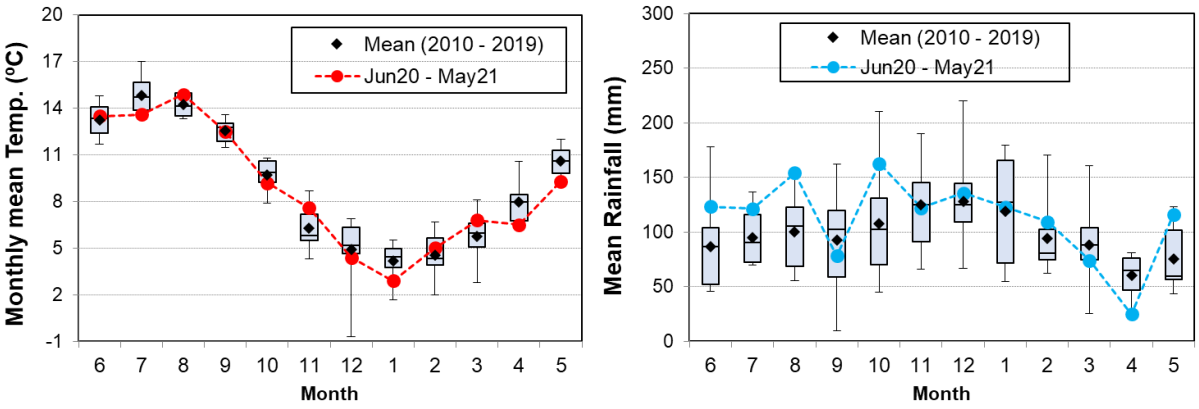

Figure 7: Comparison of mean (LEFT) monthly temperature and (RIGHT) rainfall during the study period (June 2020 – May 2021) with 10-year averaged monthly data (2010 to 2019) in Northern Ireland (https://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/, accessed 30/09/2021). The diamonds in the boxplots show the mean, with the grey boxes indicating the median and interquartile range, while the whiskers show the range (minimum and maximum). Please note this is national data, and not data from on-site met station.

4.2 Garry Bog

Six monitoring sites were established across Garry Bog to capture the expected concentration gradients (Figure 8, Figure 9). The three sites positioned on the southwestern edge of the bog (GB1, GB5, GB6) are in close proximity to agricultural fields and emission sources in the landscape. These are expected to be exposed to higher NH_3 concentrations than the other three sites (GB2 – GB4) that are further away from the sources (Figure 8).

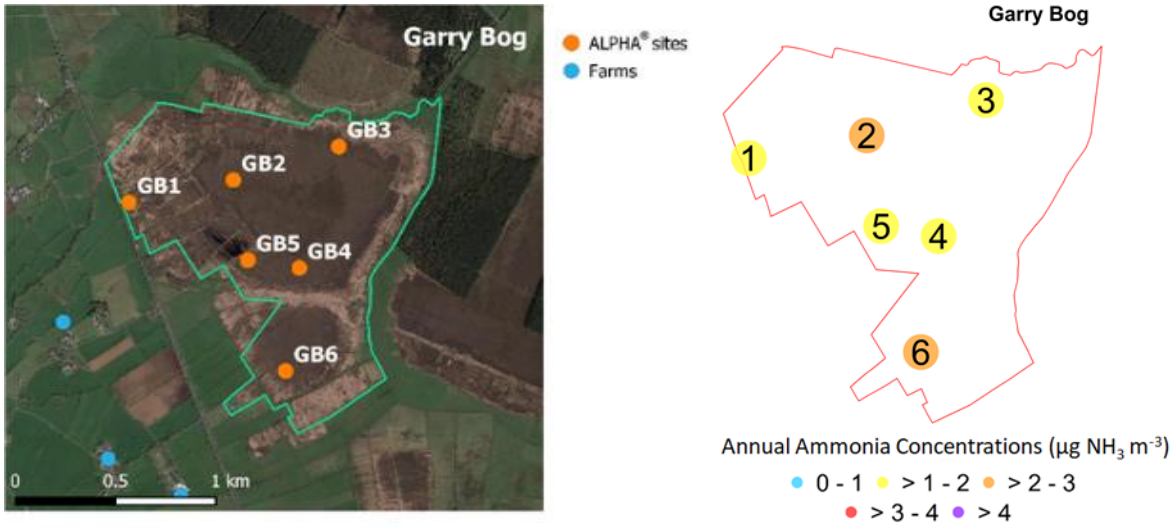

Figure 8: (LEFT) Map of Garry Bog SAC, showing locations of the six monitoring points (GB1 – GB6) and proximity of farms (blue circles) as potential NH_3 sources. The farms are identified using satellite/aerial imagery and may or may not be active. (RIGHT) Map of annual average NH_3 concentrations at Garry Bog (June 2020-May 2021).

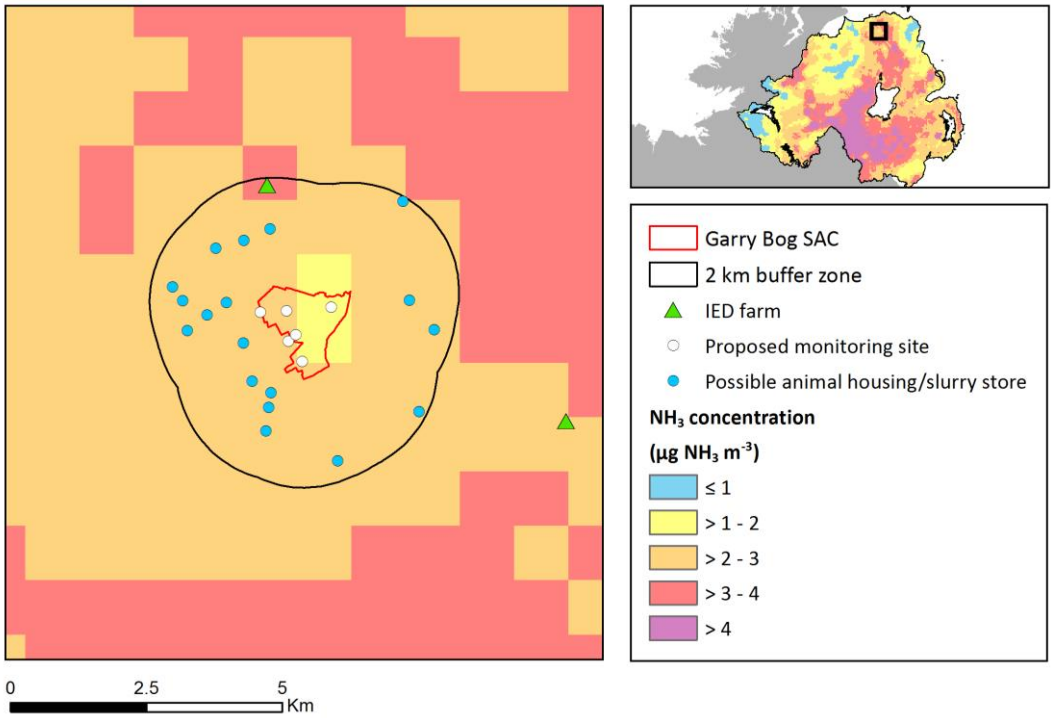

Figure 9: Modelled NH_3 concentrations for Garry Bog SAC (outlined in red) and the wider landscape at 1 km x 1 km grid resolution (FRAME model output).

Modelled concentrations of 1.9 – 2.4 µg NH_3 m^{-3} are estimated for the site, with the highest concentrations to the south and west of the bog (Figure 9, Table 3). The first year of monthly measurement data at Garry Bog shows relatively small concentration gradients across the site, with average annual concentrations of 1.6 - 2.4 µg NH_3 m^{-3} (Figure 10, Table 3), in good agreement with modelled concentrations. The lowest annual mean concentrations were measured at Site GB3 (Figure 10), located at the north eastern section of the bog and furthest from sources under prevailing winds. All site mean concentrations on Garry Bog are exceeding the critical level for its designated features of 1 µg NH_3 m^{-3}.

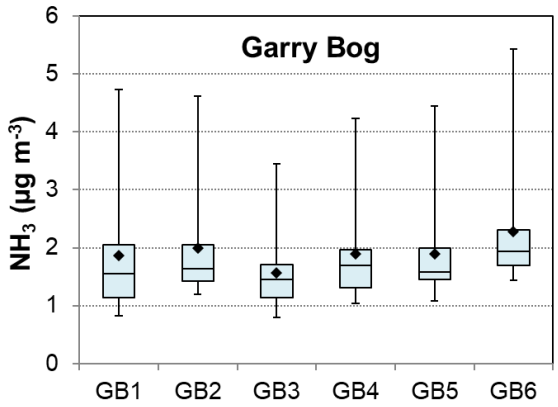

Figure 10: Boxplot comparing annual mean and median NH_3 concentrations. Whiskers show the min and max of monitored monthly concentrations.

In terms of seasonal patterns (Figure 11), the main peak around March 2021 (across all sites) coincides with the slurry spreading season. A secondary peak in June 2020 may have been due to early-summer slurry spreading after silage cuts in combination with warm weather (Figure 7). During June 2020, unusually high temperatures were recorded, with many days above 20°C (max 26°C on 25/06/2020)[2].

The highest NH_3 concentrations are consistently seen at Site GB6, with Site GB3 showing the lowest concentrations for most months. For most of the year, the trends in concentrations at all six sites are similar and within approx. 1 µg NH_3 m^{-3} of each other, apart from March 2021, when the range widens to approx. 2 µg NH_3 m^{-3} (Figure 11). This may imply that the same sources influence concentrations across the bog over the course of the year, i.e., the plumes of ammonia passing over the all monitoring site are the same, with the gradient depending on proximity of each monitoring site to the main sources, and the concentrations more dilute by the time they reach the further distant monitoring sites. The concentration gradients observed are consistent with the location of the main sources on the south-western edge of the SAC, in close proximity to Sites GB1, GB2, GB5 and GB6.

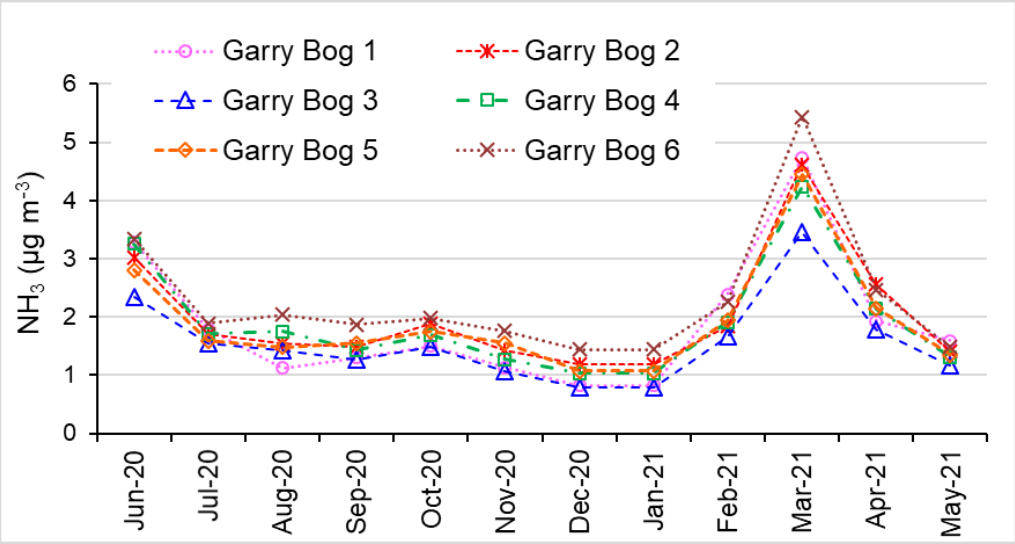

Figure 11: Seasonal cycle in NH_3 concentrations at each of six monitoring points on Garry Bog, showing similar trends between sites.

[2] https://www.timeanddate.com/weather/@2641364/historic?month=6&year=2020

4.3 Moneygal

The four monitoring locations on Moneygal Bog are located to cover the model-estimated W/SW to E/NE gradient across the site (Figure 12, Figure 13). The modelled concentrations are less certain for this site, due to its close proximity to the border with the Republic of Ireland (RoI). The reasons are that the emission input data for the RoI available at the time when the sampling strategy was developed were not as recent and RoI emission maps do not contain the same categorical resolution as the UK emission data.

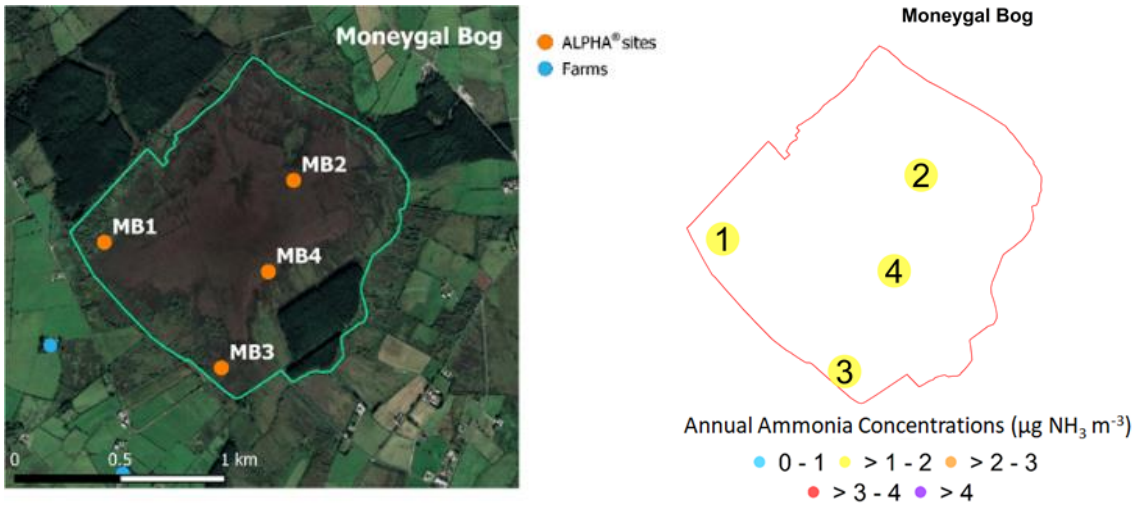

Figure 12: (LEFT) Map of Moneygal, showing locations of the four monitoring points (MB1 – MB4) and proximity of farms (blue circles) as potential NH_3 sources. The farms are identified using satellite/aerial imagery and may or may not be active. (RIGHT): Map of annual average NH_3 concentrations at Moneygal (June 2020-May 2021).

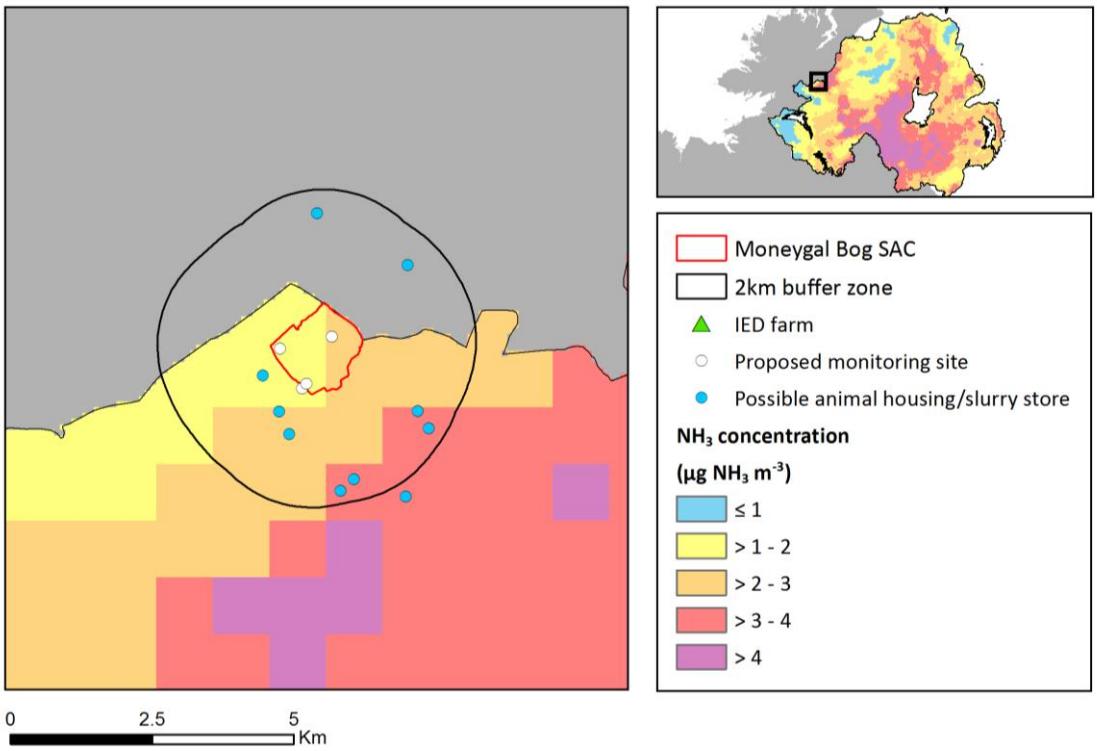

Figure 13: Modelled NH_3 concentrations for Moneygal Bog SAC (outlined in red) and the wider landscape at 1 km x 1 km grid resolution (FRAME model output).

The monitoring data for the first year show average annual concentrations in the range of 1.1 - 1.3 µg NH_3 m^{-3} across the four measurement sites (Figure 14, Table 3), exceeding the critical level of 1 µg NH_3 m^{-3} for its designated features, i.e. active raised bog. These are smaller than modelled NH_3 concentrations of 1.7- 2.5 µg NH_3 m^{-3} (2017). However, annual mean monitored concentrations at Sites M2 and M4 on the eastern side of the bog provided higher concentrations (mean = 1.3 µg NH_3 m^{-3}) than Sites M1 and M4 (mean = 1.1 µg m^{-3}), in agreement with model predictions of highest concentrations to the east (Figure 13). The small differences in concentrations (0.2 µg NH_3 m^{-3}) that was captured is also a testament to the high sensitivity and accuracy of the ALPHA® sampler approach.

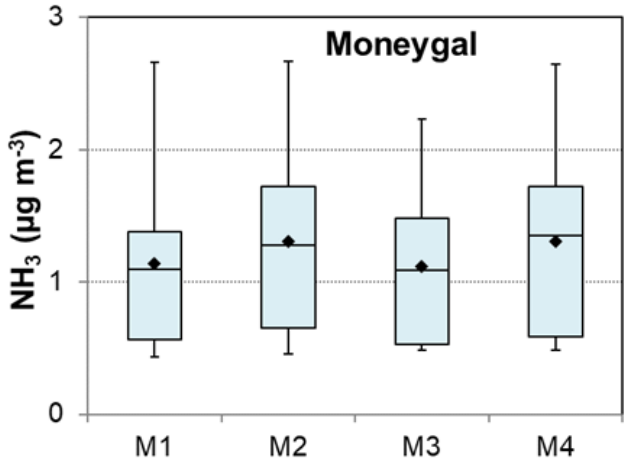

Figure 14: Boxplot comparing annual mean and median NH_3 concentrations. Whiskers show the min and max of monitored monthly concentrations.

In terms of seasonal patterns in measured monthly concentrations (Figure 15), the main peak of 2.2 - 2.7 µg NH_3 m^{-3} is in March 2021 (across all sites) and coincides with the slurry spreading season (February to April). A secondary peak in June 2020 on the other hand is likely to be related to early-summer slurry spreading after silage cuts in combination with warm weather (Figure 7), as seems to have been the case across Northern Ireland more widely[3]. The highest NH_3 concentrations are recorded at Sites M2 and M4 during most months, with lower measurements at Sites M1 and M3 (on western side of bog, further away from individual local sources, i.e. more due to the influence of a wider range of diffuse sources across the local landscape) for most months. The overall trends in NH_3 concentrations at all four sites are similar and within less than 0.5 µg NH_3 m^{-3} of each other, suggesting that there is no substantial concentration gradient across the site, with no hotspot sources located close to the site (Figure 12). This is consistent with the site location in relation to the surrounding farming landscape.

[3] During June 2020, unusually high temperatures were recorded, with many days above 20°C (max 26°C on 25/06/2020). In addition there is anecdotal evidence that movement restrictions during the early Covid-19 lockdown delayed some farming activities.
https://www.timeanddate.com/weather/@2641364/historic?month=6&year=2020

The trends in NH_3 measurements at Moneygal are similar to those measured on Curran Bog, with a dip in concentrations observed at all sites in Jul 2020, likely linked to cooler and wetter conditions. However, July is also a period when vegetation/crops are actively growing, and potentially actively taking up NH_3 from the atmosphere and reducing concentrations in the atmosphere.

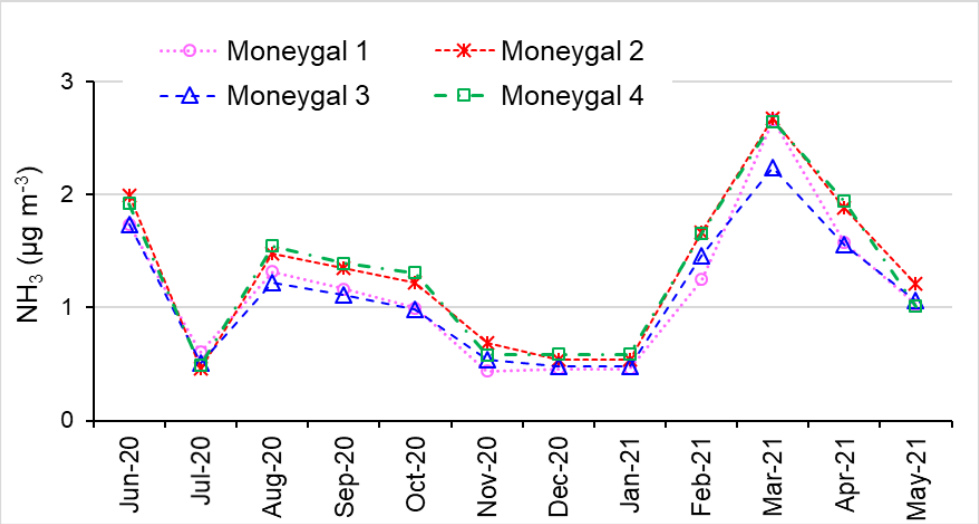

Figure 15: Seasonal cycle in NH_3 concentrations at each of four monitoring points on Moneygal, showing similar trends between sites.

4.4 Peatlands Park

Peatlands Park SAC is a larger, more complex site, and this is reflected in the larger number of monitoring sites required to enable the characterisation of NH_3 patterns and gradients across the site (9 sites PP1 – PP9) (A greater number of samplers than at other sites is important as there are several potential emission sources very close to the site boundary, whereas more central locations on the bog are expected to show lower concentrations (Figure 17). At this site, there is also a potential for buffering of NH_3 impacts by surrounding semi-natural areas, which adds to the complexity of the expected local concentration patterns.

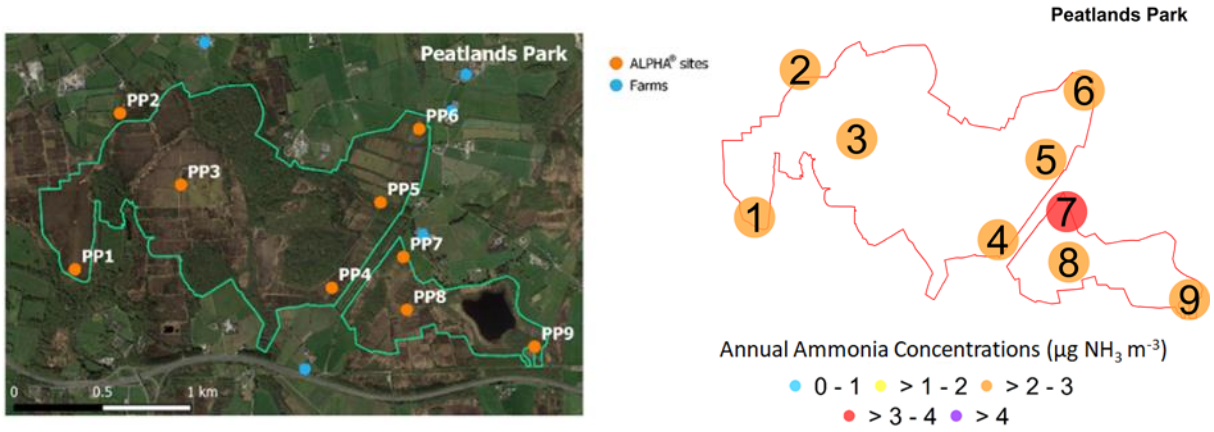

Figure 16: (LEFT) Map of Peatlands Park, showing locations of the five monitoring points (PP1 – PP9) and proximity of farms (blue circles) as potential NH_3 sources. The farms are identified using satellite/aerial imagery and may or may not be active. (RIGHT):Map of annual average NH_3 concentrations at Peatlands Park (June 2020 - May 2021).

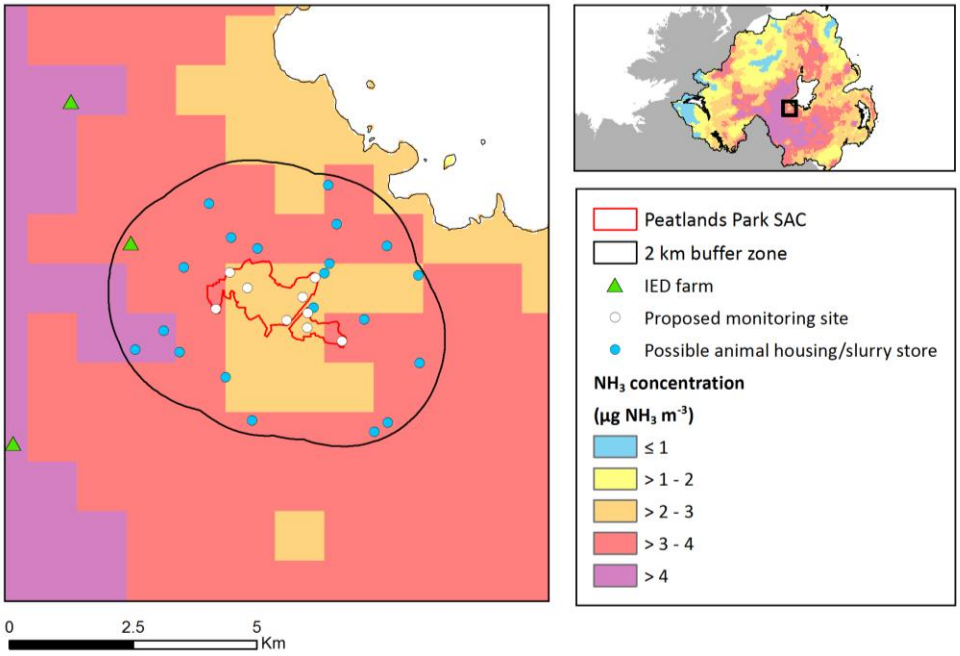

Figure 17: Modelled ground level NH_3 concentrations for Peatlands Park (outlined in red) and the wider landscape at 1 km x 1 km grid resolution (FRAME model output).

Modelled NH_3 concentrations of 2.7- 3.2 µg NH_3 m^{-3} (2017) are estimated for Peatlands Park (Table 3), with the highest concentrations to the west, north and east of the site (Figure 17), i.e. where the site boundaries overlap with the red-coloured grid squares, indicating concentrations >3 µg NH_3 m^{-3} , on average . The monitoring data for the first year show Site PP7 standing out with the highest annual average concentration of 3.8 µg NH_3 m^{-3} (range in monthly measurements of 1.9 - 6.2 µg NH_3 m^{-3}), likely due to its close proximity to livestock housing at the eastern site boundary. Annual average concentrations at the other 8 sites were smaller and between 2.0 - 2.6 µg NH_3 m^{-3} (range in monthly measurements of 1.2 - 7.2 µg NH_3 m^{-3}), but within the range of the modelled estimates. All sites at Peatlands Park are therefore substantially exceeding the critical level for its designated features of 1 µg m^{-3} (Figure 18).

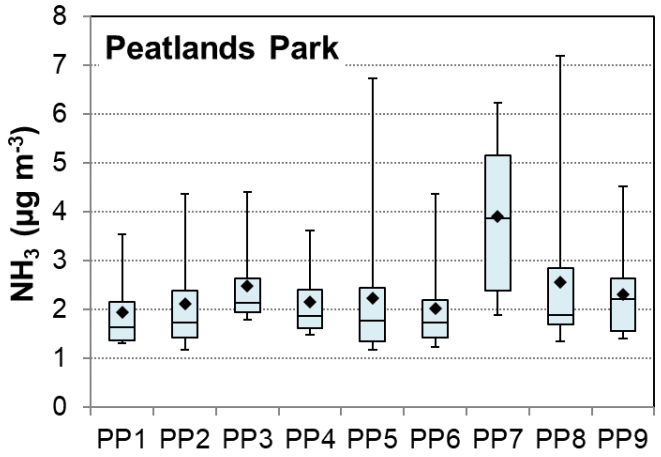

Figure 18: Boxplot comparing annual mean concentrations. Whiskers show the min and max of monitored monthly concentrations.

In terms of seasonal patterns (Figure 19), the main peak evident across all sites occurred again around March 2021 (February to April) and coincides with the slurry spreading season, with a secondary peak in June 2020 (again across all sites). This secondary peak in June 2020 is also visible at the other SACs and may be linked to warmer weather and/or late spring slurry spreading after silage cuts across the wider region. In addition, local peaks/events occurred at different sites in specific months, e.g. at Site PP8 in October 2020, or Site PP7 in August and September 2020. These may be related to slurry or manure spreading or other events/activities close to the monitoring sites. Monthly measured concentrations at most sites track each other closely (within 1 - 2 µg m-3), with the exception of the individual peaks at individual measurement sites as described. This suggests that there are common regional concentration patterns across the site, with the hotspot livestock housing source close to Site PP7 standing out most, and the individual occasional peaks at other sites as laid out above (Figure 19). Overall, the modelling and monitoring data complement

each other well, lending evidence that the modelled concentration data are fit for purpose across the wider area.

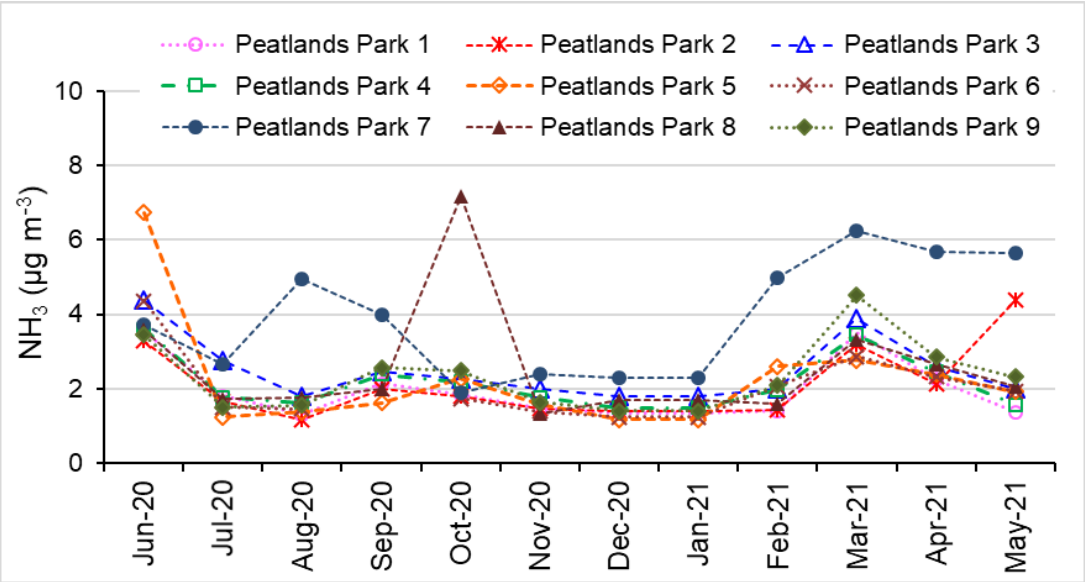

Figure 19: Seasonal cycle in NH_3 concentrations at each of nine monitoring points on Peatlands Park bog, showing similar trends between sites.

4.5 Slieve Beagh

The seven monitoring locations on Slieve Beagh are located to cover the boundaries of the site, across Northern Ireland and the Republic of Ireland. They have been located near access points to enable efficient sampler exchange. Modelled NH_3 concentrations of 1.4 – 2.2 µg NH_3 m^{-3} (2017) are estimated for the site, with the highest concentrations to the north, but with all areas exceeding the critical level for its designated features, of 1 µg NH_3 m^{-3} (Figure 21).

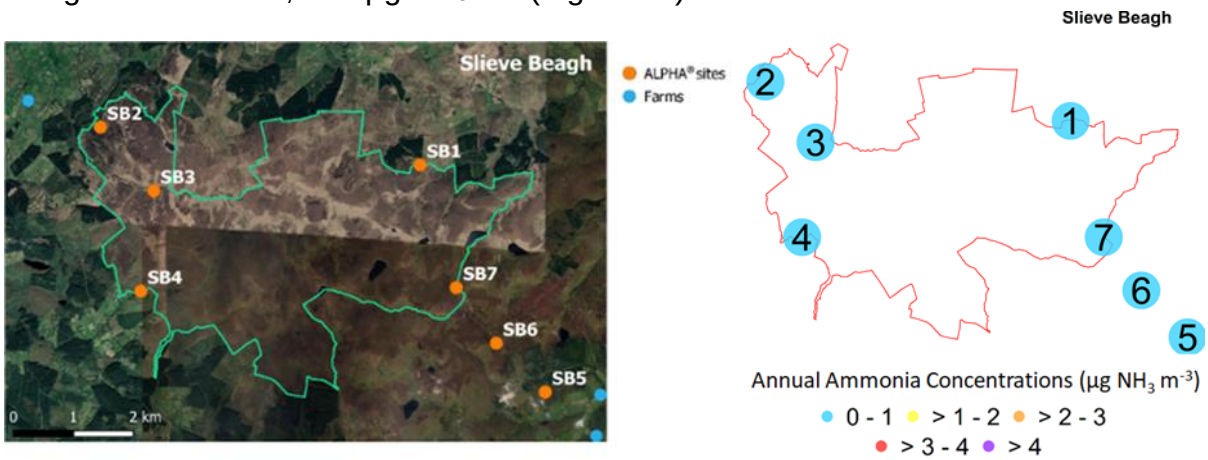

Figure 20: (LEFT) Map of Slieve Beagh, showing locations of the seven monitoring points (SB1 – SB7) and proximity of farms (blue circles) as potential NH3 sources. The farms are identified using satellite/aerial imagery and may or may not be active. (RIGHT) Map of annual average NH_3 concentrations at Slieve Beagh (June 2020 - May 2021).

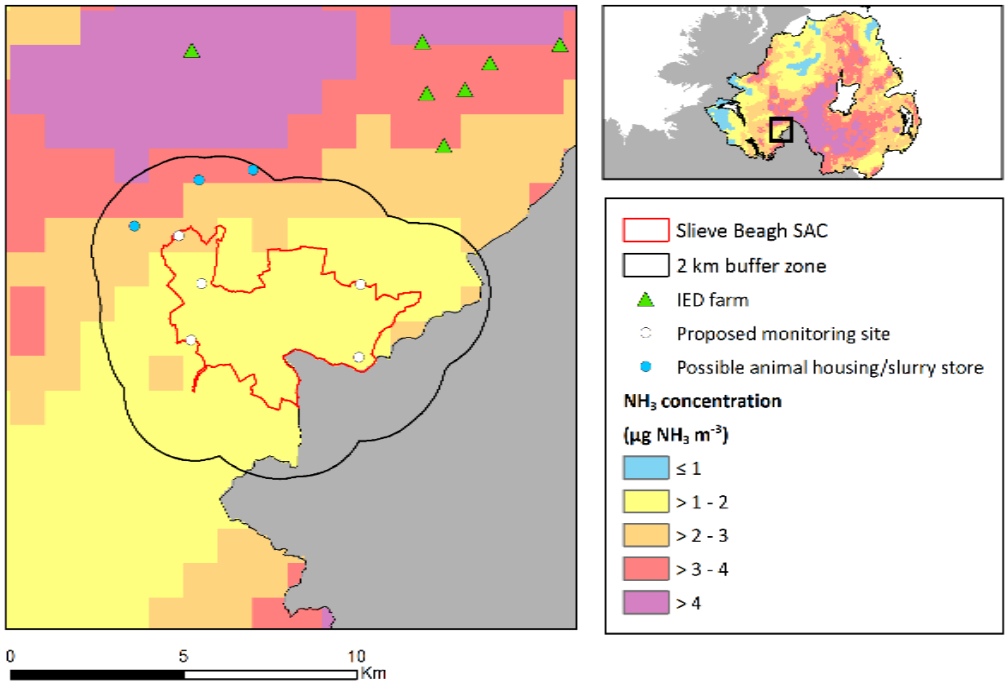

Figure 21: Modelled NH_3 concentrations for Slieve Beagh SAC (outlined in red) and the wider landscape at 1 km x 1 km grid resolution (FRAME model output for 2017).

During the early part of the first year, samples were exposed for a longer period (3 months, Jun - Aug 2020), and again for a 2-month period during Sep - Oct 2020, before normal monthly sampling was commenced in Nov 2020.These longer sampling periods disguise seasonal patterns somewhat, as measurements are averaged across a longer period of time. Despite the loss of monthly resolution at the beginning of the measurement period (Jun-Aug 2020, Sep-Oct 2020), the main spring peak around March 2021 is present, consistent with other sites, following strongly through to April. All sites can be seen to be tracking each other's peaks and troughs for the most part, within 0.5 µg NH_3 m^{-3} of each other. The main exception during the first year is Site SB4 which was recording the lowest concentrations during Jun - Aug 2020, but has since reported the second highest concentrations. However, it has to be noted that the June sample at SB4 was exposed for three months from June to August 2020, which presents some uncertainty on data over that period.

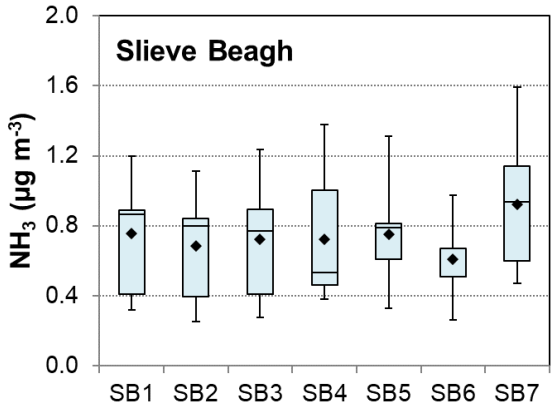

Figure 22: Boxplot comparing annual mean ammonia concentrations at Slieve Beagh. Whiskers show the min and max of monitored monthly concentrations.

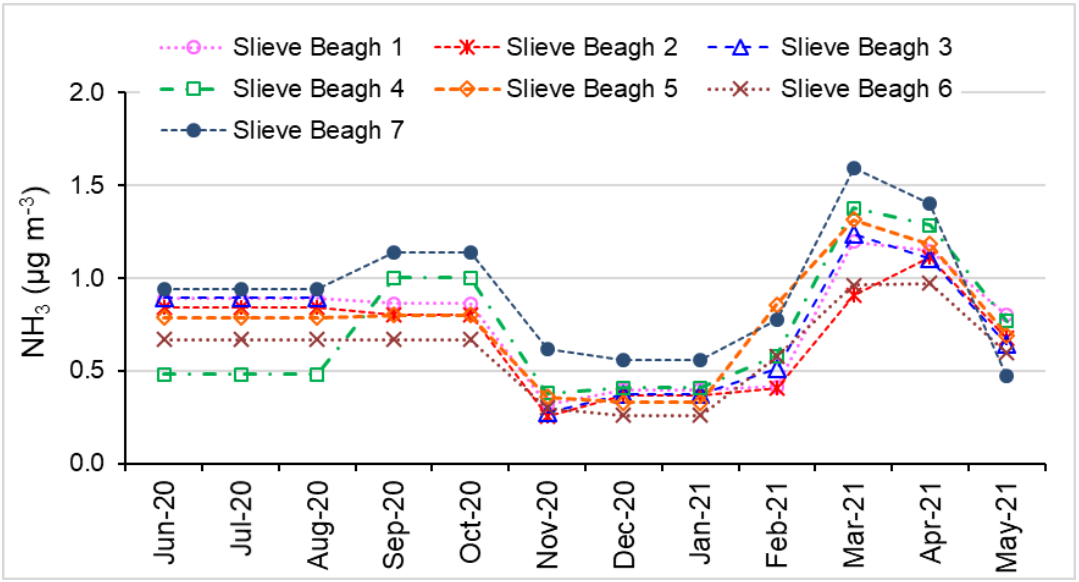

Figure 23: Seasonal cycle in NH_3 concentrations at each of seven monitoring points on Slieve Beagh, showing similar trends between sites.

The annual mean concentrations at the sites fall just below the UNECE Critical Levels threshold of 1 µg m^{-3}. These relatively low annual mean concentrations are 50 % lower than modelled values (Table 1). This is likely due to the large size of the reserve and also its remote location, with monitoring points located far from sources (> 1km). The exception is Site SB7 with the highest monitored concentrations at the centre of the reserve. Concentrations at Site SB7 (annual mean 0.92 µg m^{-3}) are higher than the other six sites (0.61 – 0.76 µg m^{-3}). Surprisingly, Site SB5 located at the southern end of the reserve and in closer proximity to agricultural sources provided smaller concentrations than Site SB7, but no further conclusions can be drawn at this point. It may be possible to gain a better understanding of local drivers of concentrations once the data for the second year of monitoring (in progress) become available.

Due to the upland character of this site (in contrast to the lowland SACs), with few local sources and smaller NH_3 concentrations, wet deposition is expected to be a significant influence here and to contribute to a larger fraction of the total nitrogen deposition. It is therefore recommended that wet deposition measurements are introduced here.

4.6 Turmennan

Six monitoring locations were established across Turmennan (Figure 24), to cover the expected concentration gradients across the site identified from modelling (Figure 25). Modelled NH_3 concentrations of 3.5 - 4.3 µg NH_3 m^{-3} (2017) are estimated for the site (Table 3), with the highest concentrations to the east, likely linked to local sources, substantially exceeding the critical level for its designated features of 1 µg NH_3 m^{-3} (Figure 25). To the north and west (1 - 4 km distance), there are indications of widespread annual average NH_3 concentrations > 4 µg NH_3 m^{-3}.

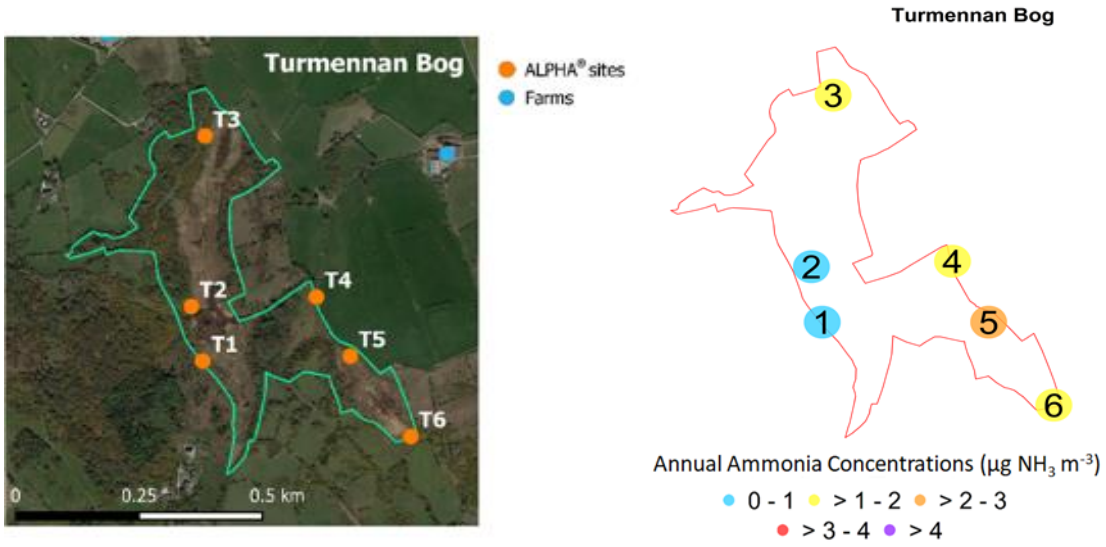

Figure 24: (LEFT) Map of Turmennan, showing locations of the six monitoring points (T1 – T6) and proximity of farms (blue circles) as potential NH_3 sources. The farms are identified using satellite/aerial imagery and may or may not be active. (RIGHT) Map of annual average NH_3 concentrations at Turmennan (June 2020 - May 2021).

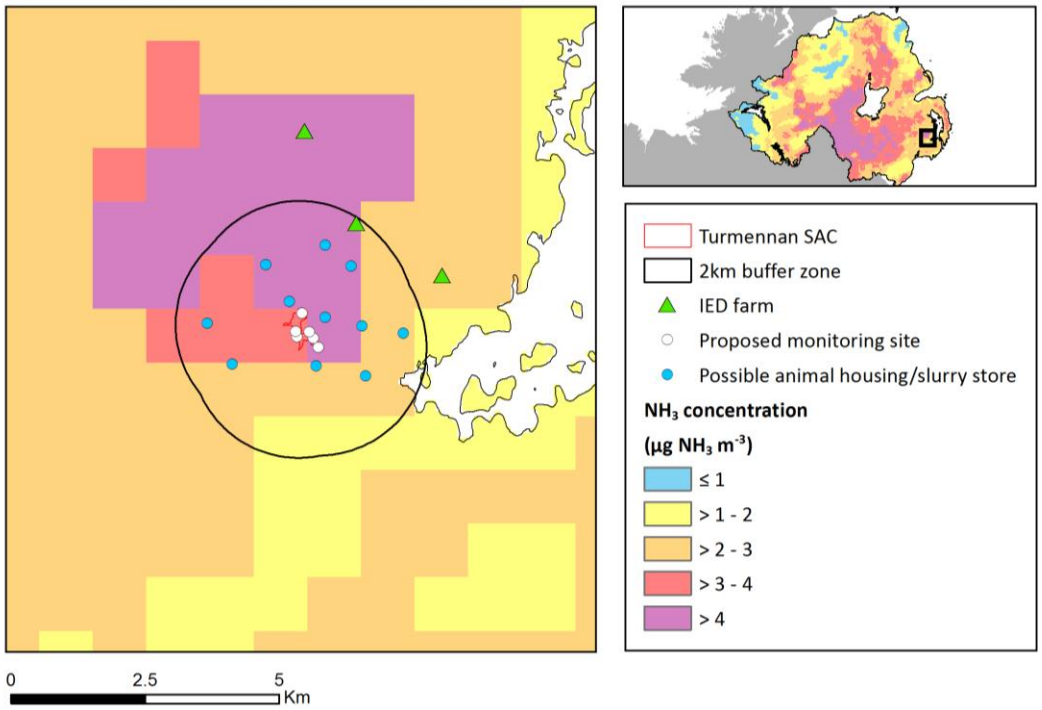

Figure 25: Modelled NH_3 concentrations for Turmennan SAC (outlined in red) and the wider landscape at 1 km x 1 km grid resolution (FRAME model output).

Annual mean monitored concentrations across the six sites (0.9 - 2.1 µg NH_3 m^{-3}) were lower than the modelled values for grid squares covering the site (range = 3.5 - 4.3 µg NH_3 m^{-3}, Table 3). Four of the measurement sites (T3 – T6) on the eastern side of Turmennan SAC, however, still exceeded the 1 µg m^{-3} critical level.

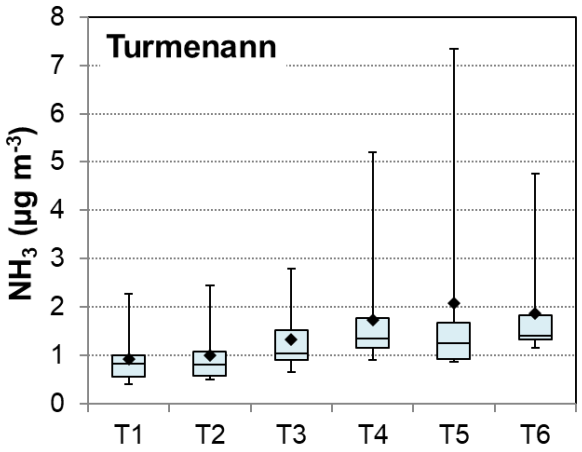

Figure 26: Boxplot comparing annual mean concentrations. Whiskers show the min and max of monitored monthly concentrations.

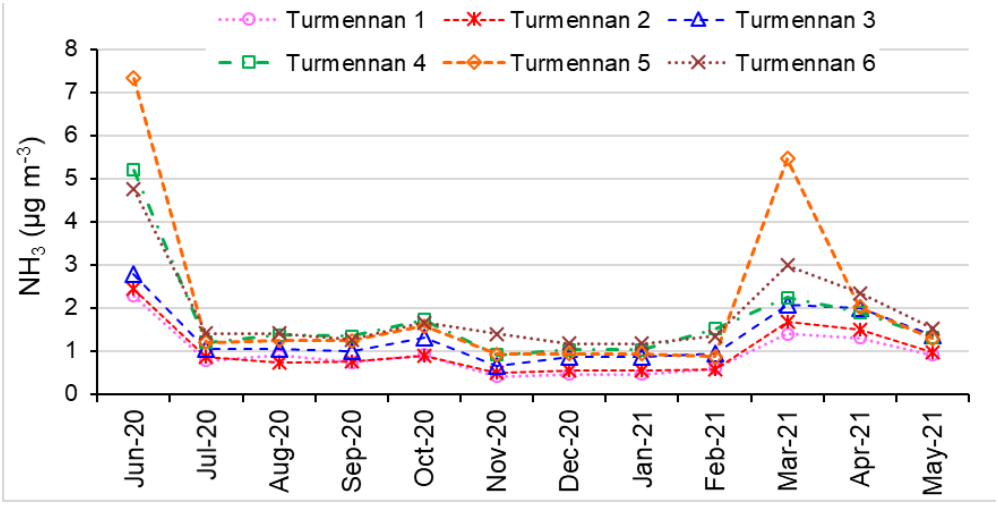

Figure 27: Seasonal cycle in NH_3 concentrations at each of six monitoring points on Turmennan, showing similar trends between sites.

While measured monthly concentrations are consistently between 0.4 and 1.7 m^{-3} during July 2020 to January 2021, there is a distinct slurry spreading peak around March, with measured concentrations as high as 5.5 µg m^{-3} at Site 5, which is immediately to the west of a field that receives slurry regularly (Figure 27). It is assumed that the high concentrations during June 2020 (2.3 - 7.3 µg m^{-3}) also represent slurry spreading activities in between silage cuts. This more unusual June peak in 2020 is visible across most of the sites and likely linked to warmer weather across the wider region[4].

Overall, annual average measured concentrations are lower than modelled concentrations, however seasonal peaks are substantial (>5 µg NH_3 m^{-3} at the most affected monitoring site). These are thought to be due to slurry spreading in the field immediately to the east of the site (large peaks in June 2020 and March 2021), and a smaller peak in October 2020, where the source is at a further distance from the site, i.e. enhanced concentrations are likely due to spreading on other nearby fields.

Turmennan is a very small site at 14.8 ha (i.e. just 14.8 % of a single 1km grid cell), and concentrations may be lower than would otherwise be expected due to a large area of semi-natural vegetation to the west, which provides a buffer from any sources located upwind of the prevailing westerly wind direction. The largest local source is an intensively managed field immediately to the east of the site boundary, and is therefore located downwind of the prevailing wind, with any emission plumes expected to be carried away from the site rather than across it. Therefore any measures to mitigate emissions from this field are likely to be very effective in reducing atmospheric N input from the main local source.

[4] https://www.timeanddate.com/weather/@2641364/historic?month=6&year=2020

5 Further ongoing work

The data presented in this report cover the first year of monitoring NH_3 concentrations at the six Special Areas of Conservation (SACs), from June 2020 to May 2021. The second year of monitoring is currently under way and a new report will be prepared once the sampling is complete (31 May 2022) and the samples have been processed by the laboratory and analysed.

In addition, moss samples have been collected for Moneygal in early spring 2022. These samples will be analysed for a) total foliar N (%N), and b) soluble NH_4-N, to complement the atmospheric NH_3 concentration measurements and this will be covered in a separate report. This ecosystem monitoring can be helpful in identifying NH_3 impacts to the plant communities in relation to changes in NH_3 concentrations and N deposition.

Nitrogen biomonitoring approaches such as foliar N (%N) are widely used to complement atmospheric measurements in the assessment of air pollution impacts of nitrogen on vegetation. Their use on a specific site of interest may be used to indicate either a level of exposure (N concentration or deposition) or ecosystem impact. Total foliar N (%N) is an established method, with extensive data on pleurocarpous mosses and some well-studied higher plants, e.g. *Calluna*. Foliar NH_4-N is another N biomonitoring method which provides an indication of plant soluble NH_4-N that is suitable as a sensitive indicator of the level of exposure to N deposition and NH_3 concentrations (JNCC, 2005) and which has been shown to be more sensitive than foliar total N method in some studies (JNCC, 2005).

6 Summary and Conclusions

Annual mean NH_3 concentrations derived from monthly measurements made at all 37 monitoring points across six designated sites are compared in Figure 28. Slieve Beagh is the cleanest of the six SACs monitored, with annual mean concentrations at all 7 of its monitoring points falling just below the UNECE Critical Levels threshold of 1 µg m^{-3} . The SAC with the next smallest NH_3 concentrations is Moneygal (range 1.11 – 1.31 µg m^{-3}). Moneygal is also located in a less intensively farmed part of the country and there are no local "hotspot" sources nearby, with no notable gradients across the site for most of the year, indicating wider diffuse sources such as landspreading away from the immediate vicinity of the site during the year.

By contrast, Curran Bog, Garry Bog, Peatlands Park and Turmennan all show much higher annual average concentrations, well above 1 µg m^{-3}. Of those four SACs, Turmennan has the lowest annual average concentrations at measurement sites furthest from the main local emission source (T1-T3), but with a clear concentration gradient into the site from the sampling locations closest to the source (T4-T6), i.e. the large field immediately to the east of the site boundary. Annual average concentrations across Garry Bog are less variable between sampling locations, and generally around 2 µg NH_3 m^{-3}, on average. The largest concentrations and largest gradients are seen at Curran Bog and Peatlands Park, and are linked to nearby livestock houses and associated activities.

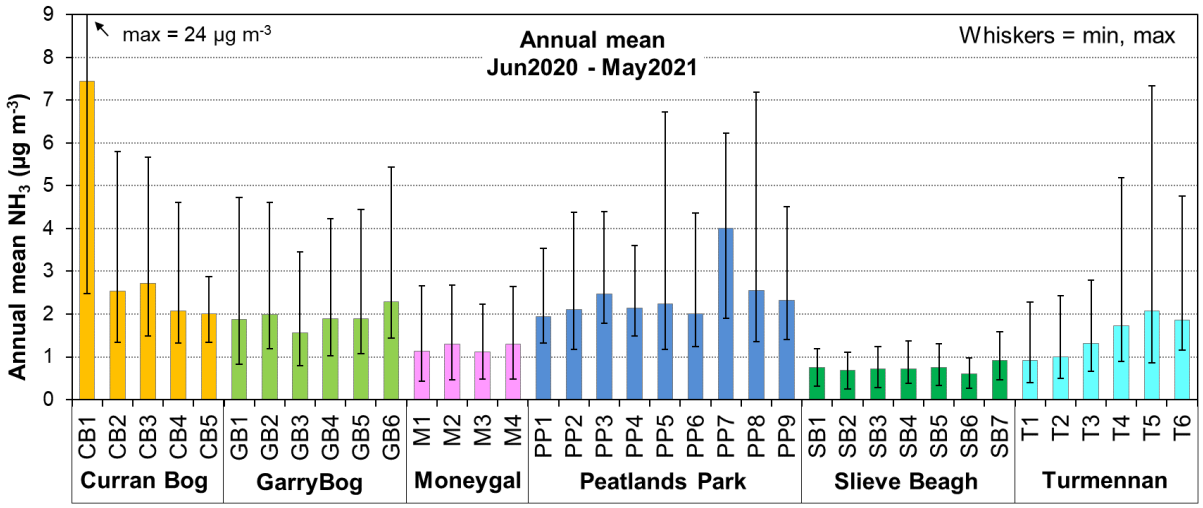

Figure 28: Summary graph comparing annual mean monitored NH_3 concentrations (June 2020 – May 2021) from all locations across the six designated SACs.

Table 1: Monthly monitored atmospheric NH3 concentrations at all six designated sites (37 sampling points in total) from June 2020 to May 2021.

	2020	2020	2020	2020	2020	2020	2020	2021	2021	2021	2021	2021
Site name	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**
Curran Bog 1	6.53	-	3.83	6.04	8.28	5.73	7.25	7.25	2.47	24.0	5.94	4.65
Curran Bog 2	3.42	2.18	2.06	2.54	2.53	1.78	2.10	2.10	1.82	5.79	2.83	1.34
Curran Bog 3	3.54	2.20	3.49	2.39	2.50	1.97	2.18	2.18	2.01	5.67	2.90	1.50
Curran Bog 4	3.06	1.54	1.60	2.09	2.04	1.54	1.51	1.51	1.92	4.62	2.21	1.32
Curran Bog 5	2.88	1.34	1.72	2.23	2.50	1.69	1.71	1.71	2.13	2.34	2.51	1.39
Garry Bog 1	3.29	1.79	1.12	1.30	1.50	1.14	0.83	0.83	2.39	4.73	1.93	1.59
Garry Bog 2	3.02	1.71	1.55	1.49	1.88	1.43	1.20	1.20	1.85	4.61	2.55	1.41
Garry Bog 3	2.35	1.54	1.43	1.27	1.48	1.06	0.80	0.80	1.67	3.45	1.79	1.14
Garry Bog 4	3.25	1.71	1.75	1.43	1.69	1.28	1.03	1.03	1.91	4.24	2.13	1.31
Garry Bog 5	2.81	1.59	1.48	1.55	1.75	1.56	1.08	1.08	1.94	4.45	2.14	1.35
Garry Bog 6	3.34	1.89	2.04	1.87	1.98	1.76	1.44	1.44	2.26	5.44	2.47	1.48
Moneygal 1	1.74	0.61	1.32	1.16	1.00	0.44	0.46	0.46	1.25	2.66	1.58	1.03
Moneygal 2	1.99	0.46	1.47	1.35	1.22	0.69	0.54	0.54	1.67	2.67	1.88	1.21
Moneygal 3	1.74	0.51	1.22	1.11	0.99	0.53	0.48	0.48	1.45	2.24	1.55	1.06
Moneygal 4	1.92	0.49	1.54	1.39	1.31	0.58	0.59	0.59	1.66	2.65	1.94	1.01
Peatlands Park 1	3.55	1.81	1.32	2.13	1.84	1.47	1.35	1.35	1.41	3.50	2.25	1.37
Peatlands Park 2	3.31	1.67	1.18	2.01	1.80	1.47	1.38	1.38	1.44	3.19	2.12	4.37
Peatlands Park 3	4.40	2.76	1.80	2.46	2.27	1.98	1.78	1.78	1.99	3.89	2.60	1.99
Peatlands Park 4	3.61	1.78	1.62	2.38	2.19	1.77	1.48	1.48	1.97	3.45	2.45	1.57
Peatlands Park 5	6.73	1.24	1.37	1.62	2.27	1.60	1.17	1.17	2.61	2.78	2.39	1.92
Peatlands Park 6	4.36	1.51	1.45	-	1.74	1.39	1.24	1.24	2.07	2.87	2.32	1.95
Peatlands Park 7	5.04	2.65	4.96	4.00	1.90	2.41	2.31	2.31	5.00	6.23	5.70	5.64
Peatlands Park 8	3.61	1.73	1.75	2.01	7.18	1.35	1.70	1.70	1.59	3.34	2.68	2.06
Peatlands Park 9	3.44	1.51	1.56	2.57	2.49	1.65	1.41	1.41	2.09	4.51	2.85	2.33
Slieve Beagh 1	0.89	0.89	0.89	0.86	0.86	0.32	0.40	0.40	0.41	1.20	1.15	0.80
Slieve Beagh 2	0.84	0.84	0.84	0.80	0.80	0.25	0.37	0.37	0.40	0.91	1.11	0.68
Slieve Beagh 3	0.90	0.90	0.90	-	-	0.28	0.37	0.37	0.51	1.24	1.10	0.65
Slieve Beagh 4	0.48	0.48	0.48	1.00	1.00	0.38	0.41	0.41	0.58	1.38	1.28	0.77
Slieve Beagh 5	0.79	0.79	0.79	0.80	0.80	0.36	0.33	0.33	0.86	1.31	1.18	0.69
Slieve Beagh 6	0.67	0.67	0.67	0.67	0.67	0.30	0.26	0.26	0.58	0.96	0.97	0.60
Slieve Beagh 7	0.94	0.94	0.94	1.14	1.14	0.62	0.56	0.56	0.78	1.59	1.40	0.47
Turmennan 1	2.27	0.78	0.89	0.73	0.91	0.40	0.46	0.46	0.59	1.39	1.30	0.90
Turmennan 2	2.44	0.85	0.72	0.76	0.89	0.49	0.54	0.54	0.58	1.68	1.49	0.95
Turmennan 3	2.79	1.03	1.04	1.00	1.30	0.66	0.85	0.85	0.93	2.08	1.99	1.36
Turmennan 4	5.19	1.19	1.37	1.34	1.73	0.90	1.02	1.02	1.51	2.24	1.89	1.31
Turmennan 5	7.33	1.20	1.25	1.24	1.57	0.91	0.92	0.92	0.86	5.46	2.01	1.29
Turmennan 6	4.75	1.41	1.40	1.26	1.65	1.39	1.16	1.16	1.34	2.98	2.35	1.52

Note: Samples that were exposed for > 1 month are shown in blue and underlined. The values are time-integrated averaged NH_3 concentrations over the extended exposure periods. Empty cells = no data (samples lost or other sampling issues)

Table 2: Summary statistics from year 1 of monitoring (June 2020 to May 2021).

	Annual mean ($\mu g\ NH_3\ m^{-3}$)		Annual mean ($\mu g\ NH_3\ m^{-3}$)					
Site name	**Method A: Time-weighted**	**Data capture**	**Method B: Mean of 12 months**	**Min**	**Max**	**N**	**%CV**	**Ratio: Mean A /Mean B**
Curran Bog 1	**7.48**	87%	**7.45**	2.47	24.0	11	77%	1.00
Curran Bog 2	**2.62**	96%	**2.54**	1.34	5.79	12	46%	1.03
Curran Bog 3	**2.78**	96%	**2.71**	1.50	5.67	12	41%	1.02
Curran Bog 4	**2.14**	96%	**2.08**	1.32	4.62	12	45%	1.03
Curran Bog 5	**2.07**	96%	**2.01**	1.34	2.88	12	24%	1.03
Garry Bog 1	**1.93**	100%	**1.87**	0.83	4.73	12	61%	1.03
Garry Bog 2	**2.06**	100%	**1.99**	1.20	4.61	12	50%	1.03
Garry Bog 3	**1.61**	100%	**1.57**	0.80	3.45	12	47%	1.03
Garry Bog 4	**1.97**	100%	**1.90**	1.03	4.24	12	50%	1.04
Garry Bog 5	**1.96**	100%	**1.90**	1.08	4.45	12	49%	1.03
Garry Bog 6	**2.35**	100%	**2.28**	1.44	5.44	12	49%	1.03
Moneygal 1	**1.15**	100%	**1.14**	0.44	2.66	12	57%	1.01
Moneygal 2	**1.33**	100%	**1.31**	0.46	2.67	12	52%	1.02
Moneygal 3	**1.13**	100%	**1.12**	0.48	2.24	12	50%	1.01
Moneygal 4	**1.33**	100%	**1.31**	0.49	2.65	12	52%	1.02
Peatlands Park 1	**2.01**	100%	**1.95**	1.32	3.55	12	41%	1.03
Peatlands Park 2	**2.02**	100%	**2.11**	1.18	4.37	12	47%	0.96
Peatlands Park 3	**2.56**	100%	**2.48**	1.78	4.40	12	34%	1.03
Peatlands Park 4	**2.20**	100%	**2.15**	1.48	3.61	12	34%	1.03
Peatlands Park 5	**2.37**	100%	**2.24**	1.17	6.73	12	68%	1.06
Peatlands Park 6	**2.08**	91%	**2.01**	1.24	4.36	11	46%	1.03
Peatlands Park 7	**3.78**	100%	**4.01**	1.90	6.23	12	40%	0.97
Peatlands Park 8	**2.54**	100%	**2.56**	1.35	7.18	12	63%	0.99
Peatlands Park 9	**2.32**	100%	**2.32**	1.41	4.51	12	41%	1.00
Slieve Beagh 1	**0.75**	100%	**0.76**	0.32	1.20	12	40%	0.99
Slieve Beagh 2	**0.68**	100%	**0.68**	0.25	1.11	12	39%	0.99
Slieve Beagh 3	**0.71**	84%	**0.72**	0.28	1.24	10	46%	0.98
Slieve Beagh 4	**0.72**	100%	**0.72**	0.38	1.38	12	50%	1.01
Slieve Beagh 5	**0.76**	100%	**0.75**	0.33	1.31	12	41%	1.01
Slieve Beagh 6	**0.61**	100%	**0.61**	0.26	0.97	12	39%	1.01
Slieve Beagh 7	**0.92**	100%	**0.92**	0.47	1.59	12	38%	1.00
Turmennan 1	**0.92**	100%	**0.92**	0.40	2.27	12	57%	1.00
Turmennan 2	**0.99**	100%	**0.99**	0.49	2.44	12	59%	1.00
Turmennan 3	**1.31**	100%	**1.32**	0.66	2.79	12	48%	0.99
Turmennan 4	**1.73**	100%	**1.73**	0.90	5.19	12	67%	1.00
Turmennan 5	**2.08**	100%	**2.08**	0.86	7.33	12	100%	1.00
Turmennan 6	**1.87**	100%	**1.87**	1.16	4.75	12	57%	1.00

Method A: Time-weighted annual mean takes into account the amount of time in each period. NH_3 concentrations (valid data) in each period are multiplied by its time weighting, i.e. [NH_3] x [days]. The sum of time-weighted NH_3 concentrations from all 12 periods, divided by the number of days in 2020/2021 (365.5 days) provided the time-weighted annual mean. Data capture is derived by the total number of days from the 12 periods with valid data, divided by the number of days (365.5).

Method B: Annual mean calculated from the mean of 12 monthly measurement periods between June 2020 and May 2021.

Table 3: Monitored vs modelled annual mean atmospheric NH_3 concentrations for the six designated sites.

Study Sites	Range in NH_3 concentrations (µg NH_3 m^{-3})	
	Monitored annual mean* (Jun20 – May21)	Modelled annual mean # (FRAME with 2017 emissions)
Turmennan (*n* = 6)	0.92 – 2.1	3.5 - 4.3
Curran Bog (*n* = 5)	2.1 – 7.5	2.3 - 3.2
Peatlands Park (*n* = 9)	2.0 – 3.8	2.7 - 3.2
Garry Bog (*n* = 6)	1.6 – 2.4	1.9 - 2.4
Moneygal Bog (*n* = 4)	1.1 – 1.3	1.7 - 2.5
Slieve Beagh (*n* = 7)	0.61 – 0.92	1.4 - 2.2

Note: *Time-weighted annual mean; # across the model grid squares overlapping each site

While this comparison (Table 3) is useful for cross-checking between modelled and measured concentration estimates, the following should be noted (as partly already referred to in this section and in the individual site profiles):

- Ammonia emissions are very highly variable across the landscape, and the modelled 1 km by 1 km grid estimates are based on coarser resolution datasets and assumptions in the underlying emission inventory maps that are used to calculate atmospheric concentrations. In particular, the range of concentrations across monitoring sites in close proximity to each other highlights these existing gradients across the landscape, compared with the much smoother patterns of the modelled data.
- Much seasonal variability is hidden behind the annual average concentrations at each monitoring site, with distinct peaks linked to local sources (such as slurry spreading in spring, early summer and to some degree in the autumn) or the presence of point sources such as livestock houses (see min/max columns in Table 2).

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8 References

Carnell E.J. and Dragosits U. (2017) EMIND - Evaluating and mitigating impacts of N deposition to Natura 2000 sites in Northern Ireland. CEH Report to the Northern Ireland Environment Agency (NIEA). Centre for Ecology & Hydrology, Edinburgh Research Station, Bush Estate, Penicuik. 17pp + appendices (5 site profiles, and tables for SAC assessments).

Conolly, C., Davies, M., Knight, D., Vincent, K., Sanocka, A., Lingard, J., Richie, S., Donovan, B., Collings, A., Braban, C., Tang, Y. S., Stephens, A., Twigg, M., Jones, M., Simmons, I., Coyle, C., Kentisbeer, J., Leeson, S., van Dijk, N., Nemitz, E., Langford, B., Bealey, W., Leaver, D., Poskitt, J., Carter, H., Thacker, S., Patel, M., Keenan, P., Pereira, G., Lawlor, A., Warwick, A., Farrand, P. and Sutton, M. A. UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) Annual Report 2015, 2016. https://nora.nerc.ac.uk/id/eprint/505858

JNCC (2005) Chapter 6 - Impacts of N on pleurocarpous mosses at the intensive sites. In: Biomonitoring Methods for assessing the impacts of nitrogen pollution: refinement and testing. JNCC Report No. 386. December 2005. http://jncc.defra.gov.uk/PDF/jncc386_web_ch06.pdf.

Martin, N. A., Ferracci, V., Cassidy, N., Hook, J., Battersby, R. M., di Meane, E. A., Tang, Y. S., Stephens, Amy C. M., Leeson, S. R., Jones, M.R., Braban, C. F., Gates, L., Hangartner, M., Stoll, J-M., Sacco, P., Pagani, D., Hoffnagle, J. A. and Seitler, E. Validation of ammonia diffusive and pumped samplers in a controlled atmosphere test facility using traceable Primary Standard Gas Mixtures. Atmospheric Environment, 199. 453-462. https://doi.org/10.1016/j.atmosenv.2018.11.038, 2019.

Tang, Y., Cape, J. and Sutton, M. 'Development and types of passive samplers for monitoring atmospheric NO_2 and NH_3 concentrations', *The Scientific World Journal,* 1, pp. 513-529, 2001.

Tang, Y.S, Stephens, A.C.M and Poskitt J: 'CEH ALPHA® Sampler User Instructions', Issue number 1.2, 2019.

Tang, Y.S. and Sutton, M. A.: Quality management in the UK national ammonia monitoring network. In: Proceedings of the International Conference: QA/QC in the field of emission and air quality measurements: harmonization, standardization and accreditation, held in Prague, 21-23 May 2003 (eds. Borowiak A., Hafkenscheid T., Saunders A. and Woods P.). European Commission, Ispra, Italy, 297-307, 2003.

Tang Y.S., Tomlinson S.J., Carnell E.J., Williams M. R., Thacker, S., Salisbury, E., Hunt, A., Guyatt H., Smith, H., Graham, C., Simmons I., Stephens A.C.M., Iwanicka A., Leaver D., Twigg M., Braban C.F., Keenan P.O., Pereira M.G., McIlroy J. and Dragosits U. Atmospheric ammonia, acid gas and aerosol measurements in Northern Ireland: Year 1 report for period: March 2019 – February 2020, 70 pp, February 2022, under review.

Thomas I.N., Tang Y.S, van Dijk N., Carnell E.J. and Dragosits U. Review and prioritisation of six proposed sites for wider NH_3 monitoring, Report to NI-EA, October 2019, 32 pp. https://nora.nerc.ac.uk/id/eprint/533521

9 Appendices

9.1 Appendix 1: Site locations

CURRAN

SITE_ID	X (installed)	Y (installed)	Comments
CB1	-6.655776 °W	54.797117°N	First samplers out 15 May 2019
CB2	-6.650816 °W	54.800199°N	First samplers out 15 May 2019
CB3	-6.648403 °W	54.801069°N	First samplers out 15 May 2019
CB4	-6.647016 °W	54.802332 °N	First samplers out 15 May 2019
CB5	-6.632764 °W	54.798460 °N	First samplers out 15 May 2019

GARRY BOG

SITE_ID	X (installed)	Y (installed)	Comments
GB1	-6.542908°W	55.109892 °N	First samplers out 12 May 2019
GB2A	-6.534729°W	55.110814 °N	First samplers out 12 May 2019
GB3A	-6.526396°W	55.112235 °N	First samplers out 12 May 2019
GB4A	-6.529662°W	55.106774 °N	First samplers out 12 May 2019
GB5A	-6.53369 °W	55.107213 °N	First samplers out 12 May 2019
GB6A	6.530935°W	55.102198 °N	First samplers out 12 May 2019

PEATLANDS PARK

SITE_ID	X (installed)	Y (installed)	Comments
PP1	-6.621619 °W	54.487387 °N	First samplers out 11 May 2019
PP2	-6.617950 °W	54.494310 °N	First samplers out 11 May 2019
PP3	-6.610634 °W	54.492140 °N	First samplers out 11 May 2019
PP4	-6.599220 °W	54.486350 °N	First samplers out 11 May 2019
PP5	-6.594760 °W	54.490710 °N	First samplers out 11 May 2019
PP6	-6.592352 °W	54.493966 °N	First samplers out 11 May 2019
PP7	-6.592850 °W	54.487940 °N	First samplers out 11 May 2019
PP8	-6.592710 °W	54.485230 °N	First samplers out 11 May 2019
PP9	-6.581924 °W	54.483213 °N	First samplers out 11 May 2019

TURMENNAN

SITE_ID	X (installed)	Y (installed)	Comments
T1A	-5.715649 °W	54.378410 °N	First samplers out 15 May 2019
T2A	-5.715936 °W	54.379357 °N	First samplers out 15 May 2019
T3A	-5.715262 °W	54.382505 °N	First samplers out 15 May 2019
T4	-5.711966 °W	54.379458 °N	First samplers out 15 May 2019
T5A	-5.710986 °W	54.378411 °N	First samplers out 15 May 2019
T6	-5.709248 °W	54.376939 °N	First samplers out 15 May 2019

MONEYGAL

SITE_ID	X (installed)	Y (installed)	Comments
MB1	-7.63995 °W	54.74081 °N	First samplers out end May 2019
MB2	-7.62600 °W	54.74341 °N	First samplers out end May 2019
MB3	-7.63211 °W	54.73557 °N	First samplers out end May 2019
MB4	-7.62785 °W	54.73946 °N	First samplers out end May 2019

SLIABH BEAGH

SITE_ID	Lat	Lon	Grid Ref	Comments
SB1	54.35827293	-7.158548679	H 5476 4583	First samplers out 05 June 2019
SB2	54.3644863	-7.240406906	H 4941 4648	First samplers out 05 June 2019
SB3	54.35489538	-7.226887465	H 5010 4373	First samplers out 05 June 2019
SB4	54.33988649	-7.230463799	H 5030 4541	First samplers out 05 June 2019
SB5	54.3240792	-7.127126015	H 5684 4205	First samplers out 05 June 2019
SB6	54.33150042	-7.139501697	H 5600 4287	First samplers out 05 June 2019
SB7	54.33994168	-7.149579518	H 5537 4380	First samplers out 05 June 2019

9.2 Appendix 2: Data tables

Curran Bog

Curran Bog			Date / Time			ppm NH_4^+ in 3 ml extract						NH_3 ($\mu g\ m^{-3}$)	
Year	Month	Site	OUT	IN	Time (Hrs)	ALPHA 1	ALPHA 2	ALPHA 3	mean	% CV	BLANK	Calibrated[1]	Comments
2020	Jun	CB1	2020/05/15 12:00:00	2020/06/26 15:05:00	1011.1	7.72	7.03	8.11	7.62	7.2%	0.068	**6.53**	15.05.20 strong smell from animal housing, no smell in June,
2020	Jun	CB2	2020/05/15 10:20:00	2020/06/26 13:34:00	1011.2	4.06	3.99	-	4.03	1.3%	0.068	**3.42**	Sample 3 = on the ground. rejected
2020	Jun	CB3	2020/05/15 10:30:00	2020/06/26 13:45:00	1011.3	3.96	4.36	-	4.16	6.9%	0.068	**3.54**	
2020	Jun	CB4	2020/05/15 10:45:00	2020/06/26 14:00:00	1011.2	3.57	3.66	3.57	3.60	1.5%	0.068	**3.06**	
2020	Jun	CB5	2020/05/15 09:15:00	2020/06/26 12:35:00	1011.3	3.53	3.37	3.31	3.40	3.3%	0.068	**2.88**	
2020	Jul	CB1	2020/06/26 15:05:00	2020/08/01 10:00:00	858.9	-	-	-	-	-	0.061	**-**	No samples returned
2020	Jul	CB2	2020/06/26 13:34:00	2020/08/01 17:20:00	867.8	2.38	2.03	2.27	2.23	8.0%	0.061	**2.18**	
2020	Jul	CB3	2020/06/26 13:45:00	2020/08/01 11:25:00	861.7	2.44	2.07	2.18	2.23	8.6%	0.061	**2.20**	
2020	Jul	CB4	2020/06/26 14:00:00	2020/08/01 11:05:00	861.1	1.57	1.26	1.89	1.57	20%	0.061	**1.54**	%CV > 15%
2020	Jul	CB5	2020/06/26 12:35:00	2020/08/01 10:30:00	861.9	1.32	1.47	1.35	1.38	5.7%	0.061	**1.34**	
2020	Aug	CB1	2020/08/01 10:00:00	2020/08/27 14:00:00	628.0	2.97	2.86	2.72	2.85	4.5%	0.097	**3.83**	
2020	Aug	CB2	2020/08/03 17:20:00	2020/08/27 12:30:00	571.2	1.45	1.47	1.41	1.44	2.2%	0.097	**2.06**	01.08.20 shoot ongoing, no cordite smell. No slurry smell. Installed 03.08.20.
2020	Aug	CB3	2020/08/01 11:25:00	2020/08/27 12:45:00	625.3	3.14	2.05	-	2.60	30%	0.097	**3.49**	%CV > 15%
2020	Aug	CB4	2020/08/01 11:05:00	2020/08/27 13:25:00	626.3	1.28	1.23	1.23	1.24	2.2%	0.097	**1.60**	
2020	Aug	CB5	2020/08/01 10:30:00	2020/08/27 12:15:00	625.8	1.32	1.38	1.29	1.33	3.4%	0.097	**1.72**	
2020	Sep	CB1	2020/08/27 14:00:00	2020/09/28 15:25:00	769.4	5.09	5.55	5.57	5.40	5.0%	0.091	**6.04**	
2020	Sep	CB2	2020/08/27 12:30:00	2020/09/28 13:50:00	769.3	2.33	2.12	2.52	2.32	8.4%	0.091	**2.54**	
2020	Sep	CB3	2020/08/27 12:45:00	2020/09/28 14:05:00	769.3	2.21	2.15	2.24	2.20	2.1%	0.091	**2.39**	
2020	Sep	CB4	2020/08/27 13:25:00	2020/09/28 14:25:00	769.0	1.85	1.95	1.97	1.93	3.3%	0.091	**2.09**	
2020	Sep	CB5	2020/08/27 12:15:00	2020/09/28 10:55:00	766.7	2.01	2.10	2.04	2.05	2.3%	0.091	**2.23**	
2020	Oct	CB1	2020/09/28 15:30:00	2020/10/26 14:30:00	672.0	6.73	6.12	6.40	6.42	4.8%	0.048	**8.28**	
2020	Oct	CB2	2020/09/28 14:00:00	2020/10/26 13:00:00	672.0	1.98	1.91	2.08	1.99	4.3%	0.048	**2.53**	
2020	Oct	CB3	2020/09/28 14:10:00	2020/10/26 13:30:00	672.3	1.95	1.94	2.00	1.97	1.7%	0.048	**2.49**	
2020	Oct	CB4	2020/09/28 14:30:00	2020/10/26 14:00:00	672.5	1.56	1.69	1.61	1.62	4.2%	0.048	**2.04**	
2020	Oct	CB5	2020/09/28 11:00:00	2020/10/26 11:00:00	673.0	2.08	1.86	-	1.97	7.8%	0.048	**2.49**	Sample 3 not returned from site

2020	Nov	CB1	2020/10/26 14:30:00	2020/11/28 15:00:00	792.5	8.05	3.64	4.11	5.27	46%	0.075	**5.73**	%CV > 15 %
2020	Nov	CB2	2020/10/26 13:00:00	2020/11/28 14:00:00	793.0	1.69	-	1.69	1.69	0.3%	0.075	**1.78**	
2020	Nov	CB3	2020/10/26 13:30:00	2020/11/28 13:20:00	791.8	1.91	2.08	1.59	1.86	13.4%	0.075	**1.97**	
2020	Nov	CB4	2020/10/26 14:00:00	2020/11/28 14:40:00	792.7	1.46	1.50	1.46	1.47	1.8%	0.075	**1.54**	
2020	Nov	CB5	2020/10/26 11:00:00	2020/11/28 13:00:00	794.0	-	1.62	1.61	1.61	0.3%	0.075	**1.69**	very wet
2020	Dec	CB1	2020/12/11 15:30:00	2021/01/29 15:45:00	1176.3	9.16	10.52	9.84	9.84	6.9%	0.089	**7.25**	Exposed for 2 months
2020	Dec	CB2	2020/12/11 12:00:00	2021/01/29 12:30:00	1176.5	2.99	2.85	2.90	2.91	2.4%	0.089	**2.10**	Exposed for 2 months
2020	Dec	CB3	2020/12/11 13:20:00	2021/01/29 13:15:00	1175.9	3.03	3.02	3.02	3.03	0.3%	0.089	**2.18**	Exposed for 2 months
2020	Dec	CB4	2020/12/11 13:20:00	2021/01/29 13:30:00	1176.2	2.15	2.15	2.07	2.12	2.3%	0.089	**1.51**	Exposed for 2 months
2020	Dec	CB5	2020/12/11 10:30:00	2021/01/29 10:30:00	1176.0	2.44	2.49	2.25	2.39	5.2%	0.089	**1.71**	Exposed for 2 months; filter wet
2021	Jan	CB1	See Dec 2020									**7.25**	See Dec 2020
2021	Jan	CB2	See Dec 2020									**2.10**	See Dec 2020
2021	Jan	CB3	See Dec 2020									**2.18**	See Dec 2020
2021	Jan	CB4	See Dec 2020									**1.51**	See Dec 2020
2021	Jan	CB5	See Dec 2020									**1.71**	See Dec 2020
2021	Feb	CB1	2021/01/29 15:45:00	2021/02/25 15:30:00	647.7	1.91	1.97	1.88	1.92	2.5%	0.087	**2.47**	
2021	Feb	CB2	2021/01/29 12:30:00	2021/02/25 13:00:00	648.5	1.36	1.45	1.50	1.44	4.8%	0.087	**1.82**	
2021	Feb	CB3	2021/01/29 13:15:00	2021/02/25 12:20:00	647.1	1.50	1.51	1.72	1.58	7.8%	0.087	**2.01**	
2021	Feb	CB4	2021/01/29 13:30:00	2021/02/25 11:15:00	645.8	1.60	1.48	1.44	1.51	5.5%	0.087	**1.92**	
2021	Feb	CB5	2021/01/29 10:30:00	2021/02/25 10:30:00	648.0	1.69	1.59	1.72	1.66	4.3%	0.087	**2.13**	
2021	Mar	CB1	2021/02/25 15:30:00	2021/03/25 15:45:00	672.3	18.56	18.36	18.62	18.51	0.7%	0.076	**24.0**	Manure spreading within 10 m
2021	Mar	CB2	2021/02/25 13:00:00	2021/03/25 13:00:00	672.0	-	4.66	4.40	4.53	4.0%	0.076	**5.79**	Gun club shooting
2021	Mar	CB3	2021/02/25 12:20:00	2021/03/25 12:30:00	672.2	4.48	4.50	4.33	4.44	2.1%	0.076	**5.67**	
2021	Mar	CB4	2021/02/25 11:15:00	2021/03/25 11:30:00	672.3	3.85	3.51	3.52	3.63	5.3%	0.076	**4.62**	
2021	Mar	CB5	2021/02/25 10:30:00	2021/03/25 10:00:00	671.5	1.93	1.86	1.83	1.87	2.8%	0.076	**2.34**	Gun club shooting
2021	Apr	CB1	2021/03/25 15:45:00	2021/04/30 09:30:00	856.7	5.64	6.36	5.64	5.88	7.1%	0.061	**5.94**	
2021	Apr	CB2	2021/03/25 13:05:00	2021/04/30 11:25:00	861.3	2.83	2.96	2.77	2.85	3.5%	0.061	**2.83**	Gun club shooting
2021	Apr	CB3	2021/03/25 12:30:00	2021/04/30 11:39:00	862.2	2.90	3.19	2.68	2.92	8.7%	0.061	**2.90**	
2021	Apr	CB4	2021/03/25 11:30:00	2021/04/30 11:50:00	863.3	2.16	2.25	2.33	2.25	3.8%	0.061	**2.21**	
2021	Apr	CB5	2021/03/25 10:30:00	2021/04/30 10:00:00	862.5	2.71	2.42	2.49	2.54	5.8%	0.061	**2.51**	Gun club shooting
2021	May	CB1	2021/04/30 09:34:00	2021/05/28 14:00:00	676.4	3.59	3.60	3.98	3.73	6.0%	0.130	**4.65**	
2021	May	CB2	2021/04/30 11:29:00	2021/05/28 12:00:00	672.5	1.18	1.14	1.17	1.16	1.7%	0.130	**1.34**	
2021	May	CB3	2021/04/30 11:44:00	2021/05/28 12:20:00	672.6	1.29	1.32	1.23	1.28	3.5%	0.130	**1.50**	
2021	May	CB4	2021/04/30 11:55:00	2021/05/28 12:25:00	672.5	1.10	1.09	1.25	1.15	8.0%	0.130	**1.32**	
2021	May	CB5	2021/04/30 10:04:00	2021/05/28 10:45:00	672.7	1.16	1.15	1.28	1.20	5.9%	0.130	**1.39**	bog extremely dry, gun club shooting

Garry Bog

Garry Bog			Date / Time			ppm NH_4^+ in 3 ml extract						NH_3 ($\mu g\ m^{-3}$)	
Year	Month	Site	OUT	IN	Time (Hrs)	ALPHA 1	ALPHA 2	ALPHA 3	mean	% CV	BLANK	Calibrated[1]	Comments
2020	Jun	GB1	2020/05/12 09:50:00	2020/06/24 10:00:00	1032.2	4.09	4.08	3.69	3.95	5.7%	0.068	**3.29**	
2020	Jun	GB2	2020/05/12 12:50:00	2020/06/24 14:10:00	1033.3	3.59	3.43	3.90	3.64	6.6%	0.068	**3.02**	
2020	Jun	GB3	2020/05/12 13:40:00	2020/06/24 13:25:00	1031.8	2.76	2.98	2.77	2.84	4.5%	0.068	**2.35**	
2020	Jun	GB4	2020/05/12 10:55:00	2020/06/24 11:30:00	1032.6	4.03	3.92	3.78	3.91	3.2%	0.068	**3.25**	more bird spikes needed
2020	Jun	GB5	2020/05/12 11:05:00	2020/06/24 11:15:00	1032.2	3.30	3.53	3.32	3.38	3.9%	0.068	**2.81**	birds using post, need more spikes
2020	Jun	GB6	2020/05/12 09:05:00	2020/06/24 09:00:00	1031.9	3.79	4.05	4.20	4.02	5.2%	0.068	**3.34**	
2020	Jul	GB1	2020/06/24 10:00:00	2020/07/28 09:40:00	815.7	1.91	1.68	1.60	1.73	9.2%	0.061	**1.79**	
2020	Jul	GB2	2020/06/24 14:10:00	2020/07/28 14:10:00	816.0	1.68	1.69	1.62	1.66	2.1%	0.061	**1.71**	
2020	Jul	GB3	2020/06/24 13:25:00	2020/07/28 13:20:00	815.9	1.54	1.52	1.44	1.50	3.6%	0.061	**1.54**	
2020	Jul	GB4	2020/06/24 11:30:00	2020/07/28 11:50:00	816.3	-	*3.74	1.66	1.66	-	0.061	**1.71**	Sampler 1 not returned, Sampler 2 rejected
2020	Jul	GB5	2020/06/24 11:15:00	2020/07/28 11:40:00	816.4	1.60	1.50	1.54	1.55	3.1%	0.061	**1.59**	
2020	Jul	GB6	2020/06/24 09:00:00	2020/07/28 10:00:00	817.0	1.78	1.75	1.94	1.82	5.5%	0.061	**1.89**	
2020	Aug	GB1	2020/07/28 09:40:00	2020/08/24 10:35:00	648.9	0.90	0.95	0.95	0.93	2.9%	0.097	**1.12**	
2020	Aug	GB2	2020/07/28 14:10:00	2020/08/24 15:45:00	649.6	1.23	1.25	1.27	1.25	1.7%	0.097	**1.55**	
2020	Aug	GB3	2020/07/28 13:20:00	2020/08/24 14:30:00	649.2	1.22	1.14	1.10	1.16	5.1%	0.097	**1.43**	
2020	Aug	GB4	2020/07/28 11:50:00	2020/08/24 13:03:00	649.2	1.44	1.35	1.39	1.39	3.3%	0.097	**1.75**	
2020	Aug	GB5	2020/07/28 11:40:00	2020/08/24 12:45:00	649.1	1.22	1.20	1.17	1.20	2.1%	0.097	**1.48**	
2020	Aug	GB6	2020/07/28 10:00:00	2020/08/24 09:45:00	647.7	-	1.74	1.48	1.61	11.8%	0.097	**2.04**	filter wet
2020	Sep	GB1	2020/08/24 10:58:00	2020/09/22 10:20:00	695.4	1.08	1.13	1.17	1.13	4.0%	0.091	**1.30**	
2020	Sep	GB2	2020/08/24 15:48:00	2020/09/22 15:00:00	695.2	1.27	1.26	1.31	1.28	1.9%	0.091	**1.49**	
2020	Sep	GB3	2020/08/24 14:30:00	2020/09/22 14:15:00	695.7	1.19	1.07	1.03	1.10	7.6%	0.091	**1.27**	
2020	Sep	GB4	2020/08/24 13:07:00	2020/09/22 12:05:00	695.0	1.22	1.23	1.24	1.23	0.7%	0.091	**1.43**	
2020	Sep	GB5	2020/08/24 12:48:00	2020/09/22 11:50:00	695.0	1.33	1.37	1.28	1.33	3.3%	0.091	**1.55**	
2020	Sep	GB6	2020/08/24 09:50:00	2020/09/22 09:24:00	695.6	1.50	1.64	1.59	1.58	4.6%	0.091	**1.87**	
2020	Oct	GB1	2020/09/22 10:25:00	2020/10/30 10:05:00	912.7	1.62	1.62	1.61	1.62	0.3%	0.048	**1.50**	
2020	Oct	GB2	2020/09/22 15:05:00	2020/10/30 14:30:00	912.4	2.09	2.02	1.92	2.01	4.3%	0.048	**1.88**	
2020	Oct	GB3	2020/09/22 14:20:00	2020/10/30 13:50:00	912.5	1.45	1.48	1.84	1.59	13.6%	0.048	**1.48**	
2020	Oct	GB4	2020/09/22 12:09:00	2020/10/30 11:50:00	912.7	1.75	1.74	1.93	1.81	5.7%	0.048	**1.69**	
2020	Oct	GB5	2020/09/22 11:55:00	2020/10/30 11:50:00	912.9	1.85	1.91	1.86	1.87	1.7%	0.048	**1.75**	

2020	Oct	GB6	2020/09/22 09:27:00	2020/10/30 09:05:00	912.6	2.03	2.11	2.18	2.11	3.7%	0.048	**1.97**	strong smell from opposite; animal housing near road
2020	Nov	GB1	2020/10/30 10:12:00	2020/12/04 09:45:00	839.5	1.21	1.17	1.13	1.17	3.4%	0.075	**1.14**	
2020	Nov	GB2	2020/10/30 14:35:00	2020/12/04 13:20:00	838.8	1.48	1.40	1.46	1.45	2.8%	0.075	**1.43**	
2020	Nov	GB3	2020/10/30 13:55:00	2020/12/04 13:50:00	839.9	1.01	1.16	1.12	1.09	7.0%	0.075	**1.06**	
2020	Nov	GB4	2020/10/30 11:55:00	2020/12/04 11:10:00	839.3	1.30	1.29	1.31	1.30	0.9%	0.075	**1.28**	
2020	Nov	GB5	2020/10/30 11:50:00	2020/12/04 10:45:00	838.9	1.55	1.53	1.62	1.57	2.7%	0.075	**1.56**	
2020	Nov	GB6	2020/10/30 09:13:00	2020/12/04 08:55:00	839.7	1.73	1.73	1.85	1.77	4.1%	0.075	**1.76**	
2020	Dec	GB1	2020/12/04 09:50:00	2021/01/31 10:40:00	1392.8	1.47	1.42	1.33	1.41	5.1%	0.089	**0.83**	Exposed for 2 months
2020	Dec	GB2	2020/12/04 13:25:00	2021/01/31 14:23:00	1393.0	1.90	1.98	2.10	2.00	5.0%	0.089	**1.20**	Exposed for 2 months
2020	Dec	GB3	2020/12/04 13:55:00	2021/01/31 13:38:00	1391.7	1.34	1.35	1.39	1.36	1.9%	0.089	**0.80**	Exposed for 2 months
2020	Dec	GB4	2020/12/04 11:15:00	2021/01/31 12:10:00	1392.9	1.78	1.66	1.76	1.73	3.8%	0.089	**1.03**	Exposed for 2 months
2020	Dec	GB5	2020/12/04 10:50:00	2021/01/31 10:48:00	1392.0	1.87	1.79	1.75	1.80	3.3%	0.089	**1.08**	Exposed for 2 months
2020	Dec	GB6	2020/12/04 09:00:00	2021/01/31 09:59:00	1393.0	2.40	2.52	2.22	2.38	6.3%	0.089	**1.44**	Exposed for 2 months
2021	Jan	GB1	See Dec 2020									**0.83**	See Dec 2020
2021	Jan	GB2	See Dec 2020									**1.20**	See Dec 2020
2021	Jan	GB3	See Dec 2020									**0.80**	See Dec 2020
2021	Jan	GB4	See Dec 2020									**1.03**	See Dec 2020
2021	Jan	GB5	See Dec 2020									**1.08**	See Dec 2020
2021	Jan	GB6	See Dec 2020									**1.44**	See Dec 2020
2021	Feb	GB1	2021/01/31 10:45:00	2021/02/26 10:30:00	623.7	1.69	2.37	1.30	1.79	30%	0.087	**2.39**	%CV > 15%
2021	Feb	GB2	2021/01/31 14:26:00	2021/02/26 13:55:00	623.5	1.40	1.48	1.34	1.41	4.7%	0.087	**1.85**	
2021	Feb	GB3	2021/01/31 13:42:00	2021/02/26 13:15:00	623.5	1.22	1.31	1.30	1.28	4.1%	0.087	**1.67**	
2021	Feb	GB4	2021/01/31 12:14:00	2021/02/26 11:40:00	623.4	1.46	1.46	1.43	1.45	1.2%	0.087	**1.91**	
2021	Feb	GB5	2021/01/31 10:58:00	2021/02/26 11:20:00	624.4	1.40	1.60	1.41	1.47	7.5%	0.087	**1.94**	
2021	Feb	GB6	2021/01/31 10:02:00	2021/02/26 09:45:00	623.7	1.53	1.85	1.71	1.70	9.4%	0.087	**2.26**	
2021	Mar	GB1	2021/02/26 10:35:00	2021/03/29 10:34:00	743.0	4.10	3.93	4.26	4.10	4.0%	0.076	**4.73**	
2021	Mar	GB2	2021/02/26 14:00:00	2021/03/29 11:35:00	740.6	3.89	3.88	4.18	3.99	4.3%	0.076	**4.61**	Lime being spread to the south around 700m away
2021	Mar	GB3	2021/02/26 13:20:00	2021/03/29 12:19:00	742.0	3.04	3.12	2.85	3.01	4.6%	0.076	**3.45**	smaller sampler body size? filter pierced. Very dry
2021	Mar	GB4	2021/02/26 11:45:00	2021/03/29 13:20:00	744.6	3.64	3.67	3.75	3.69	1.6%	0.076	**4.24**	
2021	Mar	GB5	2021/02/26 11:25:00	2021/03/29 13:45:00	745.3	3.66	3.82	4.14	3.87	6.2%	0.076	**4.45**	Extremely dry bog
2021	Mar	GB6	2021/02/26 09:50:00	2021/03/29 10:05:00	743.3	5.20	4.55	4.35	4.70	9.4%	0.076	**5.44**	
2021	Apr	GB1	2021/03/29 10:40:00	2021/04/27 10:18:00	695.6	1.60	1.62	1.58	1.60	1.2%	0.061	**1.93**	

2021	Apr	GB2	2021/03/29 11:39:00	2021/04/27 13:55:00	698.3	2.07	2.04	2.19	2.10	3.6%	0.061	**2.55**	Lime being spread to the south around 700m away
2021	Apr	GB3	2021/03/29 12:24:00	2021/04/27 13:04:00	696.7	1.52	1.48	1.48	1.49	1.7%	0.061	**1.79**	Very dry
2021	Apr	GB4	2021/03/29 13:24:00	2021/04/27 11:30:00	694.1	1.85	1.72	1.70	1.76	4.9%	0.061	**2.13**	
2021	Apr	GB5	2021/03/29 13:49:00	2021/04/27 11:20:00	693.5	1.87	1.62	1.80	1.76	7.5%	0.061	**2.14**	Extremely dry bog
2021	Apr	GB6	2021/03/29 10:09:00	2021/04/27 09:10:00	695.0	1.97	2.11	1.99	2.02	3.6%	0.061	**2.47**	
2021	May	GB1	2021/04/27 10:24:00	2021/05/24 09:45:00	647.4	1.28	1.31	1.34	1.31	2.1%	0.130	**1.59**	samples returned and analysed in August, (
2021	May	GB2	2021/04/27 14:00:00	2021/05/24 10:50:00	644.8	1.16	1.12	1.22	1.17	4.4%	0.130	**1.41**	As above
2021	May	GB3	2021/04/27 13:10:00	2021/05/24 11:16:00	634.8	0.94	0.89	1.09	0.98	10.5%	0.130	**1.14**	As above
2021	May	GB4	2021/04/27 11:34:00	2021/05/24 11:50:00	648.3	1.07	1.15	1.08	1.10	4.0%	0.130	**1.31**	As above
2021	May	GB5	2021/04/27 11:25:00	2021/05/24 12:00:00	648.6	1.09	1.13	1.18	1.13	4.2%	0.130	**1.35**	As above
2021	May	GB6	2021/04/27 09:14:00	2021/05/24 10:12:00	649.0	1.23	1.26	1.20	1.23	2.6%	0.130	**1.48**	As above

Moneygal

Moneygal			Date / Time			ppm NH_4^+ in 3 ml extract						NH_3 ($\mu g\ m^{-3}$)	
Year	Month	Site	OUT	IN	Time (Hrs)	ALPHA 1	ALPHA 2	ALPHA 3	mean	% CV	BLANK	Calibrated[1]	Comments
2020	Jun	M1	2020/05/29 16:09:00	2020/07/01 10:58:00	786.8	1.65	1.69	1.54	1.63	4.7%	0.068	**1.74**	
2020	Jun	M2	2020/05/29 14:44:00	2020/07/01 10:02:00	787.3	1.82	1.89	1.87	1.86	1.8%	0.068	**1.99**	
2020	Jun	M3	2020/05/29 15:47:00	2020/07/01 10:37:00	786.8	1.57	1.59	1.74	1.63	5.6%	0.068	**1.74**	
2020	Jun	M4	2020/05/29 14:31:00	2020/07/01 09:36:00	787.1	1.89	1.73	1.77	1.80	4.7%	0.068	**1.92**	
2020	Jul	M1	2020/07/01 11:00:00	2020/07/29 14:59:00	676.0	0.38	0.68	-	0.53	41%	0.061	**0.61**	3 not returned; %CV > 15%
2020	Jul	M2	2020/07/01 10:04:00	2020/07/29 14:18:00	676.2	-	0.41	0.42	0.41	1.5%	0.061	**0.46**	1 not returned
2020	Jul	M3	2020/07/01 10:39:00	2020/07/29 14:43:00	676.1	0.54	0.44	0.39	0.46	17%	0.061	**0.51**	%CV > 15%
2020	Jul	M4	2020/07/01 09:38:00	2020/07/29 14:06:00	676.5	0.40	0.48	-	0.44	13.7%	0.061	**0.49**	
2020	Aug	M1	2020/07/29 14:59:00	2020/08/28 18:22:00	723.4	1.11	1.21	1.24	1.19	5.8%	0.097	**1.32**	
2020	Aug	M2	2020/07/29 14:18:00	2020/08/27 16:57:00	698.7	1.24	1.30	1.28	1.27	2.3%	0.097	**1.47**	
2020	Aug	M3	2020/07/29 14:43:00	2020/08/27 18:02:00	699.3	1.09	1.07	1.06	1.08	1.4%	0.097	**1.22**	
2020	Aug	M4	2020/07/29 14:06:00	2020/08/27 17:47:00	699.7	1.30	1.38	1.31	1.33	3.3%	0.097	**1.54**	
2020	Sep	M1	2020/08/28 18:26:00	2020/09/25 09:50:00	663.4	1.11	0.91	0.90	0.97	12.4%	0.091	**1.16**	
2020	Sep	M2	2020/08/27 17:01:00	2020/09/25 08:53:00	687.9	1.12	1.20	1.14	1.15	3.8%	0.091	**1.35**	
2020	Sep	M3	2020/08/27 18:15:00	2020/09/25 09:34:00	687.3	0.95	1.01	0.94	0.97	4.3%	0.091	**1.11**	
2020	Sep	M4	2020/08/27 17:48:00	2020/09/25 08:28:00	686.7	1.22	1.19	1.15	1.18	2.8%	0.091	**1.39**	
2020	Oct	M1	2020/09/25 09:58:00	2020/10/27 14:48:00	773.8	0.85	0.89	1.05	0.93	11.4%	0.048	**1.00**	
2020	Oct	M2	2020/09/25 08:57:00	2020/10/27 13:08:00	773.2	1.10	1.17	1.10	1.12	3.3%	0.048	**1.22**	
2020	Oct	M3	2020/09/25 09:38:00	2020/10/27 14:32:00	773.9	0.90	0.89	0.97	0.92	4.9%	0.048	**0.99**	
2020	Oct	M4	2020/09/25 08:33:00	2020/10/27 14:09:00	774.6	1.22	1.24	1.15	1.20	3.8%	0.048	**1.30**	
2020	Nov	M1	2020/10/27 14:48:00	2020/11/27 12:25:00	741.6	0.45	0.45	0.45	0.45	0.1%	0.075	**0.44**	
2020	Nov	M2	2020/10/27 13:10:00	2020/11/27 10:25:00	741.3	0.65	0.54	0.79	0.66	20%	0.075	**0.69**	%CV > 15%
2020	Nov	M3	2020/10/27 14:32:00	2020/11/27 12:04:00	741.5	0.59	0.51	0.48	0.53	11.0%	0.075	**0.53**	
2020	Nov	M4	2020/10/27 14:09:00	2020/11/27 11:48:00	741.7	0.60	0.53	-	0.57	9.5%	0.075	**0.58**	
2020	Dec	M1	2020/11/27 12:25:00	2021/01/22 12:55:00	1344.5	0.76	0.80	0.81	0.79	3.4%	0.089	**0.46**	Exposed for 2 months
2020	Dec	M2	2020/11/27 10:25:00	2021/01/22 10:43:00	1344.3	0.89	0.94	0.92	0.91	2.9%	0.089	**0.54**	Exposed for 2 months
2020	Dec	M3	2020/11/27 12:04:00	2021/01/22 12:34:00	1344.5	0.86	0.84	0.80	0.83	3.9%	0.089	**0.48**	Exposed for 2 months
2020	Dec	M4	2020/11/27 11:48:00	2021/01/22 12:13:00	1344.4	0.99	0.99	-	0.99	0.5%	0.089	**0.59**	Exposed for 2 months

2021	Jan	M1	See Dec 2020								**0.46**	See Dec 2020
2021	Jan	M2	See Dec 2020								**0.54**	See Dec 2020
2021	Jan	M3	See Dec 2020								**0.48**	See Dec 2020
2021	Jan	M4	See Dec 2020								**0.59**	See Dec 2020
2021	Feb	M1	2021/01/22 12:57:00	2021/02/26 12:01:00	839.1	1.19	1.22	1.44	1.29	10.6%	0.087	**1.25**	
2021	Feb	M2	2021/01/22 10:46:00	2021/02/26 09:56:00	839.2	-	1.65	1.72	1.69	3.1%	0.087	**1.67**	Sampler 1 found on the ground , rejected
2021	Feb	M3	2021/01/22 12:36:00	2021/02/26 11:41:00	839.1	1.43	1.48	1.54	1.48	3.4%	0.087	**1.45**	
2021	Feb	M4	2021/01/22 12:15:00	2021/02/26 11:15:00	839.0	1.63	1.70	1.70	1.68	2.3%	0.087	**1.66**	
2021	Mar	M1	2021/02/26 12:04:00	2021/03/26 12:08:00	672.1	2.04	2.33	2.00	2.12	8.4%	0.076	**2.66**	
2021	Mar	M2	2021/02/26 09:59:00	2021/03/26 09:58:00	672.0	1.91	2.23	2.25	2.13	9.1%	0.076	**2.67**	
2021	Mar	M3	2021/02/26 11:44:00	2021/03/26 11:58:00	672.2	1.88	1.63	1.88	1.79	8.0%	0.076	**2.24**	
2021	Mar	M4	2021/02/26 11:18:00	2021/03/26 11:37:00	672.3	2.08	2.13	2.13	2.11	1.3%	0.076	**2.65**	
2021	Apr	M1	2021/03/26 12:08:00	2021/04/30 11:57:00	838.8	1.57	1.53	1.61	1.57	2.5%	0.061	**1.58**	
2021	Apr	M2	2021/03/26 09:58:00	2021/04/30 10:16:00	839.3	1.87	1.79	1.95	1.87	4.1%	0.061	**1.88**	
2021	Apr	M3	2021/03/26 11:58:00	2021/04/30 11:42:00	838.7	1.47	-	1.63	1.55	7.6%	0.061	**1.55**	
2021	Apr	M4	2021/03/26 11:37:00	2021/04/30 11:16:00	838.6	1.90	1.89	1.97	1.92	2.1%	0.061	**1.94**	
2021	May	M1	2021/04/30 12:00:00	2021/05/28 13:16:00	673.3	1.00	0.90	0.86	0.92	7.6%	0.130	**1.03**	
2021	May	M2	2021/04/30 10:18:00	2021/05/28 12:14:00	673.9	1.13	1.00	-	1.06	8.6%	0.130	**1.21**	one sampler missing
2021	May	M3	2021/04/30 11:45:00	2021/05/28 12:55:00	673.2	0.86	1.04	-	0.95	14.0%	0.130	**1.06**	one sampler missing
2021	May	M4	2021/04/30 11:19:00	2021/05/28 11:54:00	672.6	0.83	0.95	0.94	0.91	7.3%	0.130	**1.01**	

Peatlands Park

Peatlands Park			Date / Time			ppm NH_4^+ in 3 ml extract						NH_3 ($\mu g\ m^{-3}$)	
Year	Month	Site	OUT	IN	Time (Hrs)	ALPHA 1	ALPHA 2	ALPHA 3	mean	% CV	BLANK	Calibrated[1]	Comments
2020	Jun	PP1	2020/05/11 12:30:00	2020/06/22 12:30:00	1008.0	3.89	4.03	4.55	4.16	8.3%	0.068	**3.55**	
2020	Jun	PP2	2020/05/11 14:17:00	2020/06/22 13:30:00	1007.2	4.14	3.58	3.91	3.88	7.2%	0.068	**3.31**	
2020	Jun	PP3	2020/05/11 15:28:00	2020/06/22 14:30:00	1007.0	5.39	5.01	5.03	5.14	4.1%	0.068	**4.40**	
2020	Jun	PP4	2020/05/11 16:30:00	2020/06/22 15:45:00	1007.3	4.50	4.15	4.02	4.22	5.9%	0.068	**3.61**	
2020	Jun	PP5	2020/05/11 17:18:00	2020/06/22 16:40:00	1007.4	7.69	7.88	7.91	7.83	1.5%	0.068	**6.73**	
2020	Jun	PP6	2020/05/11 17:30:00	2020/06/22 16:55:00	1007.4	4.84	5.02	5.43	5.10	6.0%	0.068	**4.36**	
2020	Jun	PP7	2020/05/11 16:40:00	2020/06/22 16:30:00	1007.8	4.51	-	4.21	4.36	4.8%	0.068	**3.72**	
2020	Jun	PP8	2020/05/11 16:50:00	2020/06/22 16:35:00	1007.7	4.32	4.22	4.14	4.23	2.2%	0.068	**3.61**	
2020	Jun	PP9	2020/05/11 18:05:00	2020/06/22 17:10:00	1007.1	3.77	4.10	4.24	4.04	6.0%	0.068	**3.44**	
2020	Jul	PP1	2020/06/22 12:30:00	2020/07/31 12:35:00	936.1	1.93	2.06	-	1.99	4.8%	0.061	**1.81**	3 not returned
2020	Jul	PP2	2020/06/22 13:30:00	2020/07/31 13:25:00	935.9	1.85	1.83	1.88	1.85	1.4%	0.061	**1.67**	
2020	Jul	PP3	2020/06/22 14:30:00	2020/07/31 14:25:00	935.9	3.39	2.89	2.78	3.02	10.7%	0.061	**2.76**	
2020	Jul	PP4	2020/06/22 15:45:00	2020/07/31 10:05:00	930.3	1.85	1.93	2.08	1.95	6.0%	0.061	**1.78**	
2020	Jul	PP5	2020/06/22 16:40:00	2020/07/31 11:10:00	930.5	1.39	-	-	1.39	-	0.061	**1.24**	2 and 3 not returned
2020	Jul	PP6	2020/06/22 16:55:00	2020/07/31 11:30:00	930.6	1.51	1.59	1.90	1.67	12.4%	0.061	**1.51**	
2020	Jul	PP7	2020/06/22 16:30:00	2020/07/31 10:35:00	930.1	2.87	2.97	2.82	2.88	2.6%	0.061	**2.65**	
2020	Jul	PP8	2020/06/22 16:35:00	2020/07/31 10:50:00	930.3	1.95	1.81	1.94	1.90	4.0%	0.061	**1.73**	
2020	Jul	PP9	2020/06/22 17:10:00	2020/07/31 09:35:00	928.4	1.64	1.62	1.73	1.66	3.6%	0.061	**1.51**	
2020	Aug	PP1	2020/07/31 12:35:00	2020/08/28 15:30:00	674.9	1.07	1.10	1.17	1.11	4.7%	0.097	**1.32**	
2020	Aug	PP2	2020/07/31 13:25:00	2020/08/28 16:55:00	675.5	1.02	1.00	1.01	1.01	0.9%	0.097	**1.18**	
2020	Aug	PP3	2020/07/31 14:25:00	2020/08/28 17:55:00	675.5	1.51	1.51	1.45	1.49	2.2%	0.097	**1.80**	1 wrong lid, 2 wrong lid
2020	Aug	PP4	2020/07/31 10:05:00	2020/08/28 12:45:00	674.7	1.33	1.40	1.32	1.35	3.1%	0.097	**1.62**	
2020	Aug	PP5	2020/07/31 11:10:00	2020/08/28 14:05:00	674.9	-	1.17	1.14	1.16	1.9%	0.097	**1.37**	1 marked x
2020	Aug	PP6	2020/07/31 11:30:00	2020/08/28 14:25:00	674.9	-	1.22	-	1.22	-	0.097	**1.45**	1 wet, 3 not returned
2020	Aug	PP7	2020/07/31 10:35:00	2020/08/28 13:05:00	674.5	3.97	4.28	3.52	3.92	9.7%	0.097	**4.96**	1 marked x
2020	Aug	PP8	2020/07/31 10:50:00	2020/08/28 12:25:00	673.6	1.40	1.48	1.47	1.45	2.9%	0.097	**1.75**	
2020	Aug	PP9	2020/07/31 09:35:00	2020/08/28 12:20:00	674.7	1.24	1.35	1.33	1.30	4.4%	0.097	**1.56**	
2020	Sep	PP1	2020/08/28 15:35:00	2020/09/29 16:15:00	768.7	2.02	1.95	1.93	1.97	2.4%	0.091	**2.13**	people are coming over to look at sampler, 'path' developing in bog
2020	Sep	PP2	2020/08/28 17:00:00	2020/09/29 15:15:00	766.3	1.86	1.92	1.78	1.85	3.7%	0.091	**2.01**	

2020	Sep	PP3	2020/08/28 18:00:00	2020/09/29 13:00:00	763.0	2.23	2.13	2.36	2.24	5.1%	0.091	**2.46**	
2020	Sep	PP4	2020/08/28 12:45:00	2020/10/01 10:25:00	813.7	2.38	2.23	2.32	2.31	3.4%	0.091	**2.38**	
2020	Sep	PP5	2020/08/28 14:10:00	2020/10/01 11:50:00	813.7	1.57	1.58	1.65	1.60	2.6%	0.091	**1.62**	
2020	Sep	PP6	2020/08/28 14:25:00	2020/10/01 11:30:00	813.1	-	-	-	-	-	0.091	**-**	samples not analysed
2020	Sep	PP7	2020/08/28 13:10:00	2020/10/01 12:25:00	815.3	3.88	3.70	3.88	3.82	2.8%	0.091	**4.00**	
2020	Sep	PP8	2020/08/28 13:30:00	2020/10/01 13:00:00	815.5	2.04	2.00	1.85	1.96	5.1%	0.091	**2.01**	
2020	Sep	PP9	2020/08/28 12:25:00	2020/10/01 10:05:00	813.7	2.28	2.28	2.90	2.48	14.5%	0.091	**2.57**	Wet one sampler poked, a lot of dew on samplers
2020	Oct	PP1	2020/09/29 16:20:00	2020/10/28 16:18:00	697.0	1.52	1.56	1.46	1.51	3.3%	0.048	**1.84**	
2020	Oct	PP2	2020/09/29 15:20:00	2020/10/28 14:48:00	696.5	1.52	1.49	1.43	1.48	3.2%	0.048	**1.80**	
2020	Oct	PP3	2020/09/29 13:05:00	2020/10/28 13:34:00	697.5	1.83	1.74	2.01	1.86	7.3%	0.048	**2.27**	
2020	Oct	PP4	2020/10/01 10:30:00	2020/10/28 09:30:00	648.0	1.53	1.59	1.89	1.67	11.4%	0.048	**2.19**	dew on vials
2020	Oct	PP5	2020/10/01 11:55:00	2020/10/28 10:38:00	647.7	1.66	1.81	1.71	1.73	4.5%	0.048	**2.27**	
2020	Oct	PP6	2020/10/01 11:35:00	2020/10/28 11:00:00	648.4	1.20	1.45	1.35	1.34	9.5%	0.048	**1.74**	
2020	Oct	PP7	2020/10/01 12:25:00	2020/10/28 10:05:00	646.7	1.48	1.46	1.41	1.45	2.4%	0.048	**1.89**	
2020	Oct	PP8	2020/10/01 13:00:00	2020/10/28 10:22:00	646.4	5.09	5.66	5.34	5.36	5.3%	0.048	**7.18**	
2020	Oct	PP9	2020/10/01 10:10:00	2020/10/28 09:00:00	647.8	1.99	1.79	-	1.89	7.8%	0.048	**2.48**	Ba3 not returned from site
2020	Nov	PP1	2020/10/28 16:22:00	2020/12/01 13:55:00	813.6	1.43	1.56	1.35	1.44	7.5%	0.075	**1.47**	
2020	Nov	PP2	2020/10/28 14:52:00	2020/12/01 14:15:00	815.4	1.41	1.44	1.50	1.45	3.2%	0.075	**1.47**	
2020	Nov	PP3	2020/10/28 13:38:00	2020/12/01 00:00:00	802.4	1.93	1.83	1.92	1.89	2.9%	0.075	**1.98**	date/time in missing on record card, samples changed on 1.12.20
2020	Nov	PP4	2020/10/28 09:35:00	2020/12/01 11:43:00	818.1	1.73	1.71	1.76	1.73	1.3%	0.075	**1.77**	
2020	Nov	PP5	2020/10/28 10:46:00	2020/12/01 12:40:00	817.9	1.52	1.67	1.53	1.57	5.3%	0.075	**1.60**	
2020	Nov	PP6	2020/10/28 11:04:00	2020/12/01 13:00:00	817.9	1.34	1.41	1.38	1.37	2.6%	0.075	**1.39**	
2020	Nov	PP7	2020/10/28 10:10:00	2020/12/01 12:02:00	817.9	2.33	2.39	2.27	2.33	2.8%	0.075	**2.41**	
2020	Nov	PP8	2020/10/28 10:25:00	2020/12/01 12:20:00	817.9	1.29	1.30	1.42	1.34	5.5%	0.075	**1.35**	
2020	Nov	PP9	2020/10/28 09:05:00	2020/12/01 13:18:00	820.2	1.63	1.64	1.59	1.62	1.5%	0.075	**1.65**	
2020	Dec	PP1	2020/12/01 13:59:00	2021/01/29 14:28:00	1416.5	2.34	2.23	2.27	2.28	2.6%	0.089	**1.35**	Exposed for 2 months; filter wet
2020	Dec	PP2	2020/12/01 14:20:00	2021/01/29 14:50:00	1416.5	2.38	2.37	2.25	2.33	3.2%	0.089	**1.38**	Exposed for 2 months
2020	Dec	PP3	2020/12/01 15:00:00	2021/01/29 15:06:00	1416.1	2.94	2.97	3.03	2.98	1.5%	0.089	**1.78**	Exposed for 2 months
2020	Dec	PP4	2020/12/01 11:46:00	2021/01/29 13:30:00	1417.7	2.50	2.45	2.54	2.50	1.7%	0.089	**1.48**	Exposed for 2 months
2020	Dec	PP5	2020/12/01 12:44:00	2021/01/29 13:46:00	1417.0	1.93	2.00	2.01	1.98	2.3%	0.089	**1.17**	Exposed for 2 months; filter wet
2020	Dec	PP6	2020/12/01 13:05:00	2021/01/29 14:00:00	1416.9	2.01	2.09	2.19	2.10	4.4%	0.089	**1.24**	Exposed for 2 months; filter wet
2020	Dec	PP7	2020/12/01 12:05:00	2021/01/29 12:35:00	1416.5	3.92	4.01	3.55	3.83	6.3%	0.089	**2.31**	Exposed for 2 months; particle in vial
2020	Dec	PP8	2020/12/01 12:25:00	2021/01/29 12:50:00	1416.4	2.71	2.83	3.01	2.85	5.3%	0.089	**1.70**	Exposed for 2 months; pierced

2020	Dec	PP9	2020/12/01 13:22:00	2021/01/29 12:10:00	1414.8	-	2.39	2.34	2.37	1.6%	0.089	1.41	Exposed for 2 months; filter wet, pushed in together with membrane, wrong cap, filter wet
2021	Jan	PP1	See Dec 2020									1.35	See Dec 2020
2021	Jan	PP2	See Dec 2020									1.38	See Dec 2020
2021	Jan	PP3	See Dec 2020									1.78	See Dec 2020
2021	Jan	PP4	See Dec 2020									1.48	See Dec 2020
2021	Jan	PP5	See Dec 2020									1.17	See Dec 2020
2021	Jan	PP6	See Dec 2020									1.24	See Dec 2020
2021	Jan	PP7	See Dec 2020									2.31	See Dec 2020
2021	Jan	PP8	See Dec 2020									1.70	See Dec 2020
2021	Jan	PP9	See Dec 2020									1.41	See Dec 2020
2021	Feb	PP1	2021/01/29 14:34:00	2021/02/28 11:05:00	716.5	1.28	1.22	1.23	1.24	2.4%	0.087	**1.41**	
2021	Feb	PP2	2021/01/29 14:55:00	2021/02/28 11:25:00	716.5	1.27	1.23	1.32	1.27	3.5%	0.087	**1.44**	
2021	Feb	PP3	2021/01/29 15:08:00	2021/02/28 11:45:00	716.6	1.71	1.67	1.77	1.72	3.0%	0.087	**1.99**	
2021	Feb	PP4	2021/01/29 13:34:00	2021/02/28 09:35:00	716.0	1.65	1.80	1.65	1.70	5.0%	0.087	**1.97**	
2021	Feb	PP5	2021/01/29 13:50:00	2021/02/28 10:24:00	716.6	2.12	2.26	2.31	2.23	4.5%	0.087	**2.61**	
2021	Feb	PP6	2021/01/29 14:04:00	2021/02/28 10:40:00	716.6	1.96	1.72	1.68	1.78	8.5%	0.087	**2.07**	
2021	Feb	PP7	2021/01/29 12:39:00	2021/02/28 09:50:00	717.2	3.78	4.36	4.42	4.19	8.5%	0.087	**5.00**	
2021	Feb	PP8	2021/01/29 12:54:00	2021/02/28 10:00:00	717.1	1.55	1.31	1.32	1.39	9.8%	0.087	**1.59**	
2021	Feb	PP9	2021/01/29 12:15:00	2021/02/28 09:20:00	717.1	-	1.81	1.80	1.80	0.4%	0.087	**2.09**	28/02 smell of burning wood present. entire grassy area sprayed with glyphosate in the last two weeks and is dead!.
2021	Mar	PP1	2021/02/28 11:10:00	2021/03/26 12:10:00	625.0	2.62	2.62	2.50	2.58	2.7%	0.076	**3.50**	
2021	Mar	PP2	2021/02/28 11:29:00	2021/03/26 12:30:00	625.0	2.51	2.28	2.28	2.36	5.5%	0.076	**3.19**	
2021	Mar	PP3	2021/02/28 11:49:00	2021/03/26 12:58:00	625.2	2.94	2.80	2.83	2.86	2.6%	0.076	**3.89**	
2021	Mar	PP4	2021/02/28 09:40:00	2021/03/26 10:19:00	624.6	2.61	2.51	2.51	2.54	2.3%	0.076	**3.45**	
2021	Mar	PP5	2021/02/28 10:28:00	2021/03/26 11:20:00	624.9	2.16	2.03	2.00	2.06	4.1%	0.076	**2.78**	
2021	Mar	PP6	2021/02/28 10:44:00	2021/03/26 11:36:00	624.9	2.16	2.06	2.16	2.13	2.8%	0.076	**2.87**	
2021	Mar	PP7	2021/02/28 09:56:00	2021/03/26 10:50:00	624.9	4.39	4.61	4.60	4.53	2.8%	0.076	**6.23**	intense chicken manure smell - nearby shed possibly being cleaned out
2021	Mar	PP8	2021/02/28 10:05:00	2021/03/26 10:40:00	624.6	2.61	2.35	2.42	2.46	5.4%	0.076	**3.34**	
2021	Mar	PP9	2021/02/28 09:24:00	2021/03/26 10:00:00	624.6	3.26	3.23	3.40	3.30	2.8%	0.076	**4.51**	entire grassy area sprayed with glyphosphate in the last two weeks and is dead!.
2021	Apr	PP1	2021/03/26 12:15:00	2021/04/29 09:50:00	812.6	2.23	2.04	2.19	2.15	4.8%	0.061	**2.25**	filter pierced

2021	Apr	PP2	2021/03/26 12:34:00	2021/04/29 10:14:00	812.7	2.05	2.00	2.05	2.03	1.3%	0.061	**2.12**	
2021	Apr	PP3	2021/03/26 13:04:00	2021/04/29 10:30:00	812.4	2.51	2.47	2.44	2.47	1.5%	0.061	**2.60**	same 'sweet' smell in the air possibly chemical cleaner
2021	Apr	PP4	2021/03/26 10:25:00	2021/04/29 13:40:00	818.2	2.49	2.29	2.29	2.36	4.9%	0.061	**2.45**	
2021	Apr	PP5	2021/03/26 11:20:00	2021/04/29 12:05:00	815.8	2.41	2.25	2.22	2.29	4.4%	0.061	**2.39**	
2021	Apr	PP6	2021/03/26 11:40:00	2021/04/29 11:30:00	814.8	2.17	2.30	2.20	2.22	3.2%	0.061	**2.32**	
2021	Apr	PP7	2021/03/26 10:54:00	2021/04/29 12:40:00	816.8	6.01	5.12	5.03	5.38	10.1%	0.061	**5.70**	intense chicken manure smell - nearby shed posibly being cleaned out
2021	Apr	PP8	2021/03/26 10:44:00	2021/04/29 12:55:00	817.2	2.63	2.49	2.57	2.56	2.9%	0.061	**2.68**	
2021	Apr	PP9	2021/03/26 10:05:00	2021/04/29 13:20:00	818.3	2.61	2.76	2.81	2.73	3.7%	0.061	**2.85**	March : see Feb notes (glyphosate spraying) April :Even new lawn with wildflowers all grass dead.
2021	May	PP1	2021/04/29 09:55:00	2021/05/26 11:33:00	649.6	1.15	1.15	1.15	1.15	0.3%	0.130	**1.37**	No Gloves used when changing the samplers
2021	May	PP2	2021/04/29 10:22:00	2021/05/26 11:53:00	649.5	3.33	3.43	3.38	3.38	1.5%	0.130	**4.37**	
2021	May	PP3	2021/04/29 10:34:00	2021/05/26 12:08:00	649.6	1.60	1.59	1.65	1.61	2.1%	0.130	**1.99**	same 'sweet' smell in the air possibly chemical cleaner
2021	May	PP4	2021/04/29 13:44:00	2021/05/26 09:55:00	644.2	1.28	1.31	1.28	1.29	1.4%	0.130	**1.57**	
2021	May	PP5	2021/04/29 12:09:00	2021/05/26 10:38:00	646.5	1.48	1.63	1.54	1.55	4.8%	0.130	**1.92**	
2021	May	PP6	2021/04/29 11:44:00	2021/05/26 11:00:00	647.3	1.59	1.53	1.59	1.57	2.1%	0.130	**1.95**	
2021	May	PP7	2021/04/29 12:44:00	2021/05/26 10:11:00	645.5	4.79	4.06	4.04	4.29	9.9%	0.130	**5.64**	Strong chicken ammonia smell
2021	May	PP8	2021/04/29 12:59:00	2021/05/26 10:23:00	645.4	1.65	1.69	1.62	1.65	2.0%	0.130	**2.06**	
2021	May	PP9	2021/04/29 13:25:00	2021/05/26 09:38:00	644.2	1.80	1.89	1.84	1.84	2.3%	0.130	**2.33**	

Slieve Beagh

Slieve Beagh			Date / Time			ppm NH_4^+ in 3 ml extract						NH_3 ($\mu g\ m^{-3}$)	
Year	Month	Site	OUT	IN	Time (Hrs)	ALPHA 1	ALPHA 2	ALPHA 3	mean	% CV	BLANK	Calibrated[1]	Comments
2020	Jun	SB1	2020/06/05 00:00:00	2020/08/27 00:00:00	1992.0	2.07	2.17	2.04	2.09	3.4%	0.068	0.89	April samplers exposed in June. estimated date/ time cards missing
2020	Jun	SB2	2020/06/05 00:00:00	2020/08/27 00:00:00	1992.0	1.74	1.98	2.24	1.99	12.6%	0.068	0.84	wet, April samplers exposed in June. estimated date/ time cards missing
2020	Jun	SB3	2020/06/05 00:00:00	2020/08/27 00:00:00	1992.0	2.08	2.16	2.09	2.11	2.0%	0.068	0.90	April samplers exposed in June estimated date/ time cards missing
2020	Jun	SB4	2020/06/05 00:00:00	2020/08/27 00:00:00	1992.0	1.11	*4.023	1.21	1.16	6.5%	0.068	0.48	wet, April samplers exposed in June. estimated date/ time cards missing
2020	Jun	SB5	2020/06/05 00:00:00	2020/08/27 00:00:00	1992.0	1.88	1.85	1.86	1.86	0.7%	0.068	0.79	April samplers exposed in June. estimated date/ time cards missing
2020	Jun	SB6	2020/06/05 00:00:00	2020/08/27 00:00:00	1992.0	1.56	1.60	1.61	1.59	1.6%	0.068	0.67	April samplers exposed in June. estimated date/ time cards missing
2020	Jun	SB7	2020/06/05 00:00:00	2020/08/27 00:00:00	1992.0	2.62	1.80	-	2.21	26%	0.068	0.94	April samplers exposed in June. estimated date/ time cards missing, 3 not returned from site. %CV > 15%
2020	Jul	SB1	See June									0.89	See June
2020	Jul	SB2	See June									0.84	See June
2020	Jul	SB3	See June									0.90	See June
2020	Jul	SB4	See June									0.48	See June
2020	Jul	SB5	See June									0.79	See June
2020	Jul	SB6	See June									0.67	See June
2020	Jul	SB7	See June									0.94	See June
2020	Aug	SB1	See June									0.89	See June
2020	Aug	SB2	See June									0.84	See June
2020	Aug	SB3	See June									0.90	See June
2020	Aug	SB4	See June									0.48	See June
2020	Aug	SB5	See June									0.79	See June
2020	Aug	SB6	See June									0.67	See June
2020	Aug	SB7	See June									0.94	See June
2020	Sep	SB1	2020/08/27 11:00:00	2020/10/23 10:30:00	1367.5	1.46	1.43	1.45	1.44	1.1%	0.091	0.86	Exposed for 2 months
2020	Sep	SB2	2020/08/27 11:45:00	2020/10/23 11:35:00	1367.8	1.29	1.39	1.34	1.34	3.8%	0.091	0.80	Exposed for 2 months

2020	Sep	SB3	2020/08/27 12:15:00	2020/10/23 12:24:00	1368.1	-	0.56	0.53	0.55	3.6%	0.091	*(0.29)	Exposed for 2 months REJECTED: filter wet. pole was pulled out of ground, samplers lying on ground, wet.
2020	Sep	SB4	2020/08/27 12:45:00	2020/10/23 13:05:00	1368.3	1.84	1.46	1.68	1.66	11.6%	0.091	1.00	Exposed for 2 months
2020	Sep	SB5	2020/08/27 13:30:00	2020/10/23 13:40:00	1368.2	1.17	1.69	1.18	1.34	22%	0.091	0.80	Exposed for 2 months; %CV > 15%
2020	Sep	SB6	2020/08/27 14:00:00	2020/10/23 13:55:00	1367.9	1.11	1.10	1.19	1.14	4.3%	0.091	0.67	Exposed for 2 months
2020	Sep	SB7	2020/08/27 14:20:00	2020/10/23 14:25:00	1368.1	1.82	1.98	1.83	1.88	4.9%	0.091	1.14	Exposed for 2 months
2020	Oct	SB1	See Sep									0.86	See Sep
2020	Oct	SB2	See Sep									0.80	See Sep
2020	Oct	SB3	See Sep									*(0.29)	See Sep - rejected
2020	Oct	SB4	See Sep									1.00	See Sep
2020	Oct	SB5	See Sep									0.80	See Sep
2020	Oct	SB6	See Sep									0.67	See Sep
2020	Oct	SB7	See Sep									1.14	See Sep
2020	Nov	SB1	2020/10/23 10:50:00	2020/12/10 10:00:00	1152.2	0.43	0.51	0.54	0.50	11.5%	0.075	**0.32**	very wet, pierced, >1 month exposure
2020	Nov	SB2	2020/10/23 11:50:00	2020/12/10 11:20:00	1152.5	0.41	0.40	0.42	0.41	2.9%	0.075	**0.25**	very wet, >1 month exposure
2020	Nov	SB3	2020/10/23 12:24:00	2020/12/10 12:30:00	1153.1	0.44	0.46	0.41	0.44	6.7%	0.075	**0.27**	very wet, >1 month exposure
2020	Nov	SB4	2020/10/23 13:15:00	2020/12/10 13:30:00	1153.3	0.55	0.62	0.55	0.57	7.3%	0.075	**0.38**	very wet, >1 month exposure
2020	Nov	SB5	2020/10/23 14:00:00	2020/12/10 14:15:00	1153.3	0.60	0.50	0.53	0.55	9.0%	0.075	**0.36**	very wet, >1 month exposure
2020	Nov	SB6	2020/10/23 14:40:00	2020/12/10 14:35:00	1152.9	0.52	0.42	-	0.47	14.3%	0.075	**0.30**	very wet, pierced, >1 month exposure
2020	Nov	SB7	2020/10/23 15:20:00	2020/12/10 15:15:00	1152.9	-	0.89	-	0.89	-	0.075	**0.61**	very wet. one sample discarded as came back opened, >1 month exposure
2020	Dec	SB1	2020/12/10 10:00:00	2021/01/19 09:30:00	959.5	0.53	0.55	0.50	0.53	4.6%	0.089	0.40	samples wet. Exposed in Jan21 also
2020	Dec	SB2	2020/12/10 11:20:00	2021/01/19 10:30:00	959.2	0.49	0.51	0.46	0.49	5.5%	0.089	0.37	samples wet. Exposed in Jan21 also
2020	Dec	SB3	2020/12/10 12:30:00	2021/01/19 12:00:00	959.5	-	0.50	0.50	0.50	1.3%	0.089	0.37	samples wet. Exposed in Jan21 also
2020	Dec	SB4	2020/12/10 13:30:00	2021/01/19 13:30:30	960.0	-	0.56	0.52	0.54	5.5%	0.089	0.41	samples wet. Exposed in Jan21 also
2020	Dec	SB5	2020/12/10 14:15:00	2021/01/19 14:00:00	959.7	0.47	0.45	0.43	0.45	4.1%	0.089	0.33	samples wet. Exposed in Jan21 also
2020	Dec	SB6	2020/12/10 14:35:00	2021/01/19 14:30:00	959.9	0.27	0.47	0.39	0.37	27%	0.089	0.26	samples wet. Exposed in Jan21 also. %CV > 15 %
2020	Dec	SB7	2020/12/10 15:15:00	2021/01/19 15:00:00	959.7	0.85	0.55	0.69	0.70	21%	0.089	0.56	samples wet. Exposed in Jan21 also %CV > 15 %
2021	Jan	SB1	See Dec 2020										See Dec 2020
2021	Jan	SB2	See Dec 2020										See Dec 2020
2021	Jan	SB3	See Dec 2020										See Dec 2020
2021	Jan	SB4	See Dec 2020										See Dec 2020
2021	Jan	SB5	See Dec 2020										See Dec 2020

2021	Jan	SB6	See Dec 2020										See Dec 2020
2021	Jan	SB7	See Dec 2020										See Dec 2020
2021	Feb	SB1	2021/01/19 10:00:00	2021/02/23 09:30:00	839.5	-	0.57	0.40	0.48	24%	0.087	**0.41**	1 Sampler on the ground, High wind recently. %CV > 15 %
2021	Feb	SB2	2021/01/19 11:00:00	2021/02/23 10:30:00	839.5	0.47	0.50	0.45	0.47	6.0%	0.087	**0.40**	1 Sampler on the ground, High winds recently
2021	Feb	SB3	2021/01/19 12:00:00	2021/02/23 11:30:00	839.5	-	0.59	0.57	0.58	3.1%	0.087	**0.51**	1 Sampler on the groud, High winds recently
2021	Feb	SB4	2021/01/19 13:30:30	2021/02/23 12:30:00	839.0	0.67	0.62	-	0.64	5.1%	0.087	**0.58**	1 Sampler on the ground, High winds recently
2021	Feb	SB5	2021/01/19 14:00:00	2021/02/23 13:30:00	839.5	0.88	0.98	0.86	0.91	7.3%	0.087	**0.86**	
2021	Feb	SB6	2021/01/19 14:30:00	2021/02/23 14:00:00	839.5	0.62	0.63	0.66	0.64	3.0%	0.087	**0.58**	
2021	Feb	SB7	2021/01/19 15:00:00	2021/02/23 15:00:00	840.0	0.90	-	-	0.90	-	0.087	**0.85**	2 samplers on the ground, High winds recently
2021	Mar	SB1	2021/02/23 10:00:00	2021/03/23 09:30:00	671.5	0.98	1.01	-	0.99	2.3%	0.076	**1.20**	
2021	Mar	SB2	2021/02/23 10:45:00	2021/03/23 10:30:00	671.7	0.81	0.83	0.69	0.77	9.8%	0.076	**0.91**	
2021	Mar	SB3	2021/02/23 12:00:00	2021/03/23 11:30:00	671.5	1.00	1.15	0.94	1.03	10.4%	0.076	**1.24**	
2021	Mar	SB4	2021/02/23 13:00:00	2021/03/23 12:30:00	671.5	1.26	1.03	1.11	1.13	10.4%	0.076	**1.38**	
2021	Mar	SB5	2021/02/23 13:30:00	2021/03/23 14:00:00	672.5	1.10	1.05	1.11	1.09	3.3%	0.076	**1.31**	
2021	Mar	SB6	2021/02/23 14:00:00	2021/03/23 14:30:00	672.5	0.80	0.82	0.83	0.82	2.1%	0.076	**0.96**	
2021	Mar	SB7	2021/02/23 15:00:00	2021/03/23 15:30:00	672.5	-	1.31	1.30	1.30	0.5%	0.076	**1.59**	Wet; 1 Sampler on the ground
2021	Apr	SB1	2021/03/23 10:00:00	2021/04/26 09:30:00	814.5	1.20	1.14	1.05	1.13	6.9%	0.061	**1.15**	
2021	Apr	SB2	2021/03/23 10:40:00	2021/04/26 10:00:00	814.3	-	1.12	1.08	1.10	2.5%	0.061	**1.11**	
2021	Apr	SB3	2021/03/23 11:30:00	2021/04/26 11:00:00	814.5	1.03	1.15	1.08	1.09	5.3%	0.061	**1.10**	
2021	Apr	SB4	2021/03/23 12:40:00	2021/04/26 11:45:00	814.1	1.27	1.28	1.22	1.26	2.7%	0.061	**1.28**	
2021	Apr	SB5	2021/03/23 14:00:00	2021/04/26 13:00:00	814.0	1.09	1.32	1.07	1.16	12.1%	0.061	**1.18**	
2021	Apr	SB6	2021/03/23 14:30:00	2021/04/26 13:30:00	814.0	-	0.95	0.98	0.97	2.1%	0.061	**0.97**	
2021	Apr	SB7	2021/03/23 15:30:00	2021/04/26 14:15:00	813.8	1.30	1.44	-	1.37	7.4%	0.061	**1.40**	filter loose in the box, debris on 1 sample
2021	May	SB1	2021/04/26 09:30:00	2021/05/27 13:00:00	747.5	0.77	0.90	0.78	0.81	9.2%	0.130	**0.80**	
2021	May	SB2	2021/04/26 10:00:00	2021/05/27 13:45:00	747.8	0.70	0.72	0.71	0.71	1.9%	0.130	**0.68**	
2021	May	SB3	2021/04/26 11:30:00	2021/05/27 15:00:00	747.5	0.77	-	0.59	0.68	18%	0.130	**0.65**	1 sampler on the ground; %CV > 15%
2021	May	SB4	2021/04/26 12:30:00	2021/05/27 15:45:00	747.3	0.78	-	0.79	0.79	1.2%	0.130	**0.77**	
2021	May	SB5	2021/04/26 13:15:00	2021/05/27 08:00:00	738.8	0.69	0.72	0.73	0.71	3.2%	0.130	**0.69**	
2021	May	SB6	2021/04/26 13:30:00	2021/05/27 08:15:00	738.8	0.63	0.68	0.60	0.63	6.3%	0.130	**0.60**	1 sampler on the ground
2021	May	SB7	2021/04/26 14:15:00	2021/05/27 08:45:00	738.5	0.53	-	0.52	0.53	0.9%	0.130	**0.47**	1 sampler on the ground

Turmennan

Turmennan			Date / Time			ppm NH_4^+ in 3 ml extract						NH_3 ($\mu g\ m^{-3}$)	
Year	Month	Site	OUT	IN	Time (Hrs)	ALPHA 1	ALPHA 2	ALPHA 3	mean	% CV	BLANK	Calibrated[1]	Comments
2020	Jun	T1	2020/05/21 14:30:00	2020/06/22 13:30:00	767.0	2.05	2.10	2.04	2.06	1.6%	0.068	**2.27**	
2020	Jun	T2	2020/05/21 15:00:00	2020/06/22 13:15:00	766.2	2.23	2.32	2.06	2.20	5.8%	0.068	**2.44**	
2020	Jun	T3	2020/05/21 16:00:00	2020/06/22 13:40:00	765.7	2.50	2.48	2.56	2.51	1.7%	0.068	**2.79**	
2020	Jun	T4	2020/05/21 12:20:00	2020/06/22 15:15:00	770.9	4.70	4.72	4.53	4.65	2.2%	0.068	**5.19**	
2020	Jun	T5	2020/05/21 11:45:00	2020/06/22 15:30:00	771.8	6.30	6.39	6.94	6.54	5.4%	0.068	**7.33**	
2020	Jun	T6	2020/05/21 11:30:00	2020/06/22 15:45:00	772.2	4.22	4.31	4.27	4.27	1.0%	0.068	**4.75**	
2020	Jul	T1	2020/06/22 13:30:00	2020/07/31 12:00:00	934.5	0.87	0.90	0.91	0.89	2.4%	0.061	**0.78**	
2020	Jul	T2	2020/06/22 13:15:00	2020/07/31 12:10:00	934.9	0.95	0.96	0.99	0.97	2.2%	0.061	**0.85**	
2020	Jul	T3	2020/06/22 13:40:00	2020/07/31 12:30:00	934.8	1.14	1.15	1.20	1.16	2.5%	0.061	**1.03**	
2020	Jul	T4	2020/06/22 15:15:00	2020/07/31 11:15:00	932.0	1.33	1.32	1.35	1.33	1.2%	0.061	**1.19**	
2020	Jul	T5	2020/06/22 15:30:00	2020/07/31 10:50:00	931.3	1.31	1.28	1.42	1.33	5.5%	0.061	**1.20**	
2020	Jul	T6	2020/06/22 15:45:00	2020/07/31 10:20:00	930.6	1.51	1.53	1.64	1.56	4.6%	0.061	**1.41**	
2020	Aug	T1	2020/07/31 12:00:00	2020/08/26 11:45:00	623.7	0.72	0.72	0.75	0.73	2.7%	0.097	**0.89**	
2020	Aug	T2	2020/07/31 12:10:00	2020/08/26 12:00:00	623.8	0.63	0.61	0.59	0.61	2.9%	0.097	**0.72**	
2020	Aug	T3	2020/07/31 12:30:00	2020/08/26 12:30:00	624.0	0.86	0.86	0.81	0.84	3.3%	0.097	**1.04**	
2020	Aug	T4	2020/07/31 11:15:00	2020/08/26 15:15:00	628.0	1.07	1.09	1.08	1.08	1.0%	0.097	**1.37**	
2020	Aug	T5	2020/07/31 10:50:00	2020/08/26 15:00:00	628.2	1.01	1.02	0.96	1.00	3.4%	0.097	**1.25**	
2020	Aug	T6	2020/07/31 10:20:00	2020/08/26 14:30:00	628.2	1.13	1.08	1.11	1.10	2.3%	0.097	**1.40**	
2020	Sep	T1	2020/08/26 11:50:00	2020/09/25 16:20:00	724.5	0.66	0.74	0.69	0.70	5.8%	0.091	**0.73**	
2020	Sep	T2	2020/08/26 12:05:00	2020/09/25 16:30:00	724.4	0.68	0.81	0.67	0.72	10.7%	0.091	**0.76**	
2020	Sep	T3	2020/08/26 12:35:00	2020/09/25 17:15:00	724.7	0.92	0.89	0.94	0.92	3.1%	0.091	**1.00**	
2020	Sep	T4	2020/08/26 15:20:00	2020/09/25 14:30:00	719.2	1.09	1.26	1.23	1.19	7.5%	0.091	**1.34**	
2020	Sep	T5	2020/08/26 15:05:00	2020/09/25 14:15:00	719.2	1.14	1.08	1.11	1.11	2.9%	0.091	**1.24**	
2020	Sep	T6	2020/08/26 14:30:00	2020/09/25 14:00:00	719.5	1.11	1.15	1.13	1.13	1.6%	0.091	**1.26**	
2020	Oct	T1	2020/09/25 16:20:00	2020/10/30 12:15:00	836.9	0.92	0.89	0.94	0.92	2.8%	0.048	**0.91**	
2020	Oct	T2	2020/09/25 16:30:00	2020/10/30 12:30:00	837.0	0.93	0.87	0.88	0.89	3.6%	0.048	**0.88**	
2020	Oct	T3	2020/09/25 17:15:00	2020/10/30 13:00:00	836.8	1.29	1.35	1.23	1.29	4.6%	0.048	**1.30**	
2020	Oct	T4	2020/09/25 14:30:00	2020/10/30 11:15:00	837.7	1.77	1.66	1.67	1.70	3.7%	0.048	**1.72**	field is slurried 3x a year and fertilized + silage cut 3x. Ash dieback noted
2020	Oct	T5	2020/09/25 14:15:00	2020/10/30 11:00:00	837.7	1.61	1.50	-	1.55	4.6%	0.048	**1.57**	see Other Observations

2020	Oct	T6	2020/09/25 14:00:00	2020/10/30 10:30:00	837.5	1.73	1.61	1.55	1.63	5.7%	0.048	**1.65**	
2020	Nov	T1	2020/10/30 12:15:00	2020/12/02 15:40:00	795.4	0.46	0.43	0.43	0.44	3.7%	0.075	**0.40**	
2020	Nov	T2	2020/10/30 12:30:00	2020/12/02 15:55:00	795.4	0.51	0.50	0.55	0.52	5.2%	0.075	**0.49**	
2020	Nov	T3	2020/10/30 13:00:00	2020/12/02 16:20:00	795.3	0.71	0.66	0.65	0.67	4.2%	0.075	**0.66**	
2020	Nov	T4	2020/10/30 11:15:00	2020/12/06 12:15:00	889.0	1.02	1.00	0.95	0.99	3.7%	0.075	**0.90**	Wet; cattle prevented sample exchange on 2.12.20 hence later exchange date
2020	Nov	T5	2020/10/30 11:00:00	2020/12/06 12:05:00	889.1	1.03	1.00	0.99	1.00	2.1%	0.075	**0.91**	piercedcattle prevented sample exchange on 2.12.20 hence later exchange date
2020	Nov	T6	2020/10/30 10:30:00	2020/12/02 16:50:00	798.3	1.36	1.31	1.35	1.34	1.9%	0.075	**1.39**	
2020	Dec	T1	2020/12/02 15:45:00	2021/01/28 15:00:00	1367.3	0.86	0.77	0.79	0.81	6.0%	0.089	**0.46**	filter wet; exposed for 2 months
2020	Dec	T2	2020/12/02 15:59:00	2021/01/28 15:30:00	1367.5	0.97	0.94	0.90	0.93	3.7%	0.089	**0.54**	filter wet; exposed for 2 months
2020	Dec	T3	2020/12/02 16:24:00	2021/01/28 15:45:00	1367.4	1.34	1.42	1.48	1.41	5.2%	0.089	**0.85**	filter wet; exposed for 2 months
2020	Dec	T4	2020/12/06 12:19:00	2021/01/28 11:00:00	1270.7	1.57	1.61	1.54	1.57	2.0%	0.089	**1.02**	filter wet; exposed for 2 months
2020	Dec	T5	2020/12/06 12:09:00	2021/01/28 11:30:00	1271.4	1.49	1.44	1.38	1.43	3.8%	0.089	**0.92**	filter wet; pierced, exposed for 2 months
2020	Dec	T6	2020/12/02 16:55:00	2021/01/28 13:00:00	1364.1	2.01	1.87	1.83	1.90	5.1%	0.089	**1.16**	
2021	Jan	T1	See Dec 2020									**0.46**	See Dec 2020
2021	Jan	T2	See Dec 2020									**0.54**	See Dec 2020
2021	Jan	T3	See Dec 2020									**0.85**	See Dec 2020
2021	Jan	T4	See Dec 2020									**1.02**	See Dec 2020
2021	Jan	T5	See Dec 2020									**0.92**	See Dec 2020
2021	Jan	T6	See Dec 2020									**1.16**	See Dec 2020
2021	Feb	T1	2021/01/28 15:00:00	2021/02/26 12:30:00	693.5	0.61	0.55	0.50	0.55	10.2%	0.087	**0.59**	
2021	Feb	T2	2021/01/28 15:30:00	2021/02/26 13:00:00	693.5	0.54	-	0.55	0.54	2.3%	0.087	**0.58**	
2021	Feb	T3	2021/01/28 15:45:00	2021/02/26 14:00:00	694.2	0.73	0.85	0.90	0.82	10.3%	0.087	**0.93**	
2021	Feb	T4	2021/01/28 11:20:00	2021/02/26 11:30:00	696.2	1.26	1.31	1.30	1.29	1.9%	0.087	**1.51**	
2021	Feb	T5	2021/01/28 11:30:00	2021/02/26 11:00:00	695.5	0.80	0.69	0.83	0.77	9.1%	0.087	**0.86**	
2021	Feb	T6	2021/01/28 13:00:00	2021/02/26 10:45:00	693.8	1.23	1.08	1.15	1.15	6.7%	0.087	**1.34**	
2021	Mar	T1	2021/02/26 12:30:00	2021/03/26 12:45:00	672.3	1.20	1.09	1.13	1.14	4.9%	0.076	**1.39**	
2021	Mar	T2	2021/02/26 13:00:00	2021/03/26 13:15:00	672.2	1.35	1.42	1.34	1.37	3.0%	0.076	**1.68**	
2021	Mar	T3	2021/02/26 14:00:00	2021/03/27 14:45:00	696.8	1.74	1.72	1.74	1.73	0.9%	0.076	**2.08**	Reed cutting vehicle has poached ground beside the sample post (10m)
2021	Mar	T4	2021/02/26 11:30:00	2021/03/26 11:40:00	672.2	1.75	1.76	1.89	1.80	4.2%	0.076	**2.24**	
2021	Mar	T5	2021/02/26 11:00:00	2021/03/26 11:00:00	672.0	3.85	4.50	4.47	4.27	8.5%	0.076	**5.46**	
2021	Mar	T6	2021/02/26 10:45:00	2021/03/26 10:30:00	671.7	2.32	2.32	2.47	2.37	3.6%	0.076	**2.98**	Cattle poaching ground close to the sample point,

2021	Apr	T1	2021/03/26 12:45:00	2021/04/22 12:15:00	646.5	0.98	1.06	1.03	1.03	4.0%	0.061	**1.30**	
2021	Apr	T2	2021/03/26 13:15:00	2021/04/22 12:30:00	646.3	1.16	1.08	1.24	1.16	6.8%	0.061	**1.49**	large amount of weed cutting - 40m but all cut material stacked on far side of farm - 100m,
2021	Apr	T3	2021/03/27 14:50:00	2021/04/22 13:45:00	621.9	1.59	1.45	1.38	1.47	7.3%	0.061	**1.99**	Reed cutting vehicle has poached ground beside the sample post (10m), time 'out' updated based on overlaps
2021	Apr	T4	2021/03/26 11:40:00	2021/04/22 11:10:00	646.5	1.40	-	1.53	1.46	6.3%	0.061		
2021	Apr	T5	2021/03/26 11:00:00	2021/04/22 10:20:00	646.3	1.45	1.64	-	1.54	8.7%	0.061	**2.01**	1 sampler missing for deployment,
2021	Apr	T6	2021/03/26 10:30:00	2021/04/22 10:00:00	646.5	1.81	1.73	1.85	1.80	3.3%	0.061	**2.35**	Cattle poaching ground close to the sample point, no stock in field, lush grass,
2021	May	T1	2021/04/22 12:15:00	2021/05/27 16:45:00	844.5	1.03	0.98	1.00	1.00	2.5%	0.130	**0.90**	owner has cut grass in a narrow path (1mx50m long) and left cuttings where they fell. Grass cut on 21/06/2021
2021	May	T2	2021/04/22 12:30:00	2021/05/27 16:54:00	844.4	0.99	0.97	1.18	1.05	11.2%	0.130	**0.95**	large amount of weed cutting - 40m but all cut material stacked on far side of farm - 100m,
2021	May	T3	2021/04/22 13:45:00	2021/05/27 17:10:00	843.4	1.42	1.57	1.34	1.44	8.0%	0.130	**1.36**	
2021	May	T4	2021/04/22 11:15:00	2021/05/27 15:29:00	844.2	1.40	1.39	1.40	1.39	0.5%	0.130	**1.31**	May - No stock in field. June- No stock in field
2021	May	T5	2021/04/22 10:50:00	2021/05/27 15:13:00	844.4	1.35	1.33	1.43	1.37	3.8%	0.130	**1.29**	
2021	May	T6	2021/04/22 10:30:00	2021/05/27 14:55:00	844.4	1.62	1.59	1.58	1.60	1.4%	0.130	**1.52**	no stock in field, lush grass, Evidence of much stock poaching around wall that sampler is on but no stock currently there.

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