

## Response to Referee Comments

We thank the Øystein Godoy and Johannes Peterseil for their thoughtful and helpful comments. Our responses (coloured red) are added next to the relevant comment – these have also been highlighted with comments in the revised manuscript.

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### Referee 1 - Oystein Godoy

“General comments This is a interesting dataset, in particular since standardised observations protocols have been used across a large geographical and multidisciplinary measurement network. More general questions that arises when reading the document include: 1. Given the time series approach of the dataset, has it been considered to homogenise the time series? That would increase the time series approach of the dataset. A comment on this would make sense since part of the justification for the combined dataset is to analyse the temporal evolution of features. 2. Documenting data using discipline specific standards (e.g. NetCDF Climate and Forecast convention or Global Biodiversity Information Facility standards) simplifies reuse since data are documented using controlled vocabularies to describe variables, their units, cell methods etc. Has application of standardised documentation been considered for the dataset and if not why?”

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**Referee 1 - Comment 1** - ECN’s policy has been to provide data as they are collected – which we have quality checked - and allow users to analyse the data in the way that suits them. The ECN protocols cover a number of domains (meteorology, biogeochemistry, biodiversity etc) and we do not have the resources to fine-tune the datasets in a way that a domain-specific data centre could do. We will however seek opportunities in the future to work with domain experts to ensure our data are useful to as many users as possible.

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We provided information on where to find information about the standard terms used in the supporting documentation in section 3.5. We primarily use the EnvThes controlled vocabulary – which was developed as part of our involvement in the LTER-Europe community - as the basis for the semantic harmonisation of data with our European and International partners. We have now expanded this section in the text to include this information.

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Since our data cover a number of domains, and our users tend to use several datasets together (e.g. to explore the effects of weather on species abundance), we made the choice to provide CSV files to users so they can use them together easily - rather than use a variety of discipline-specific documentation standards.

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“Specific comments Page 4, section 2.1: The text refers to full operating procedures in a separate document. Given the nature of some of the meteorological parameters that require more maintenance than standard meteorological observations (e.g. surface irradiance) it would be beneficial to have some more explanation of how these parameters are handled in this document.”

**Referee 1 – Comment 2** - The ECN AWS’ had regular, professional maintenance by external contractors on an annual or bi-annual basis. We’ve added this information to the manuscript.

“Page 4, section 2.1: It would also be natural to describe the sampling frequency in this document for consistency with other sections below although it is acknowledged that meteorological observations are slightly more complex to describe in a simple manner than the other observations due to the number of parameters.”

5 **Referee 1 – Comment 3** - The frequency of data collection for all the ECN protocols is provided in table 2 but we have also now made this clearer in the manuscript.

“Page 4, section 2.1: The AWS are located according to the handbook of 1982, but how are stations constructed, at which levels are sensors located etc and how are sensors maintained. Is that following any larger scale framework observation protocol like WMO?”

10 **Referee 1 – Comment 4** - We have added a diagram to the manuscript to show the layout of the meteorological enclosure and also added text which describes the height that the sensors are installed at and maintenance information. As noted in the manuscript the AWS was sited in accordance with British Meteorological Office requirements.

“Page 5, section 2.5: It would be beneficial to include frequency of dip samples similar to how this is indicated in section 2.4.”

**Referee 1 – Comment 5** - The frequency of data collection for all the ECN protocols is provided in table 2 but we have also now made this clearer in the manuscript.

15 “Page 8, section 2.16: It is commented that the methodology for bird observations changed during the time series, but it is not commented on how these two approaches compare and how that affects potential analysis of the time series.”

**Referee 1 – Comment 6** - The methodologies of the two surveys are different so it is unfortunately not possible to create a single time series from both datasets. We have made this clearer in the manuscript.

20 “Page 8, section 2.18: Reference for the Bats and Habitats survey methodology of the Joint Nature Conservation Committee is missing.”

**Referee 1 – Comment 7** - Thank you. We’ve added this reference to the text.

25 “Page 11, section 3.1: The text refers to the AWSNO field but doesn’t explain it in more detail (which type of information is provided, binary change – no change or id numbers, or something else). More information would be beneficial since this field is commented in the document, although it is acknowledged that full details are in the reference (which probably should be repeated here). The presence of the AWSNO and the text provided caused the general question on homogenisation of the time series.....

**Referee 1 – Comment 8** - We have added some information on how AWSNO are assigned to the manuscript.

.....There is also a comment that the dataset is so large, but what does that mean in this context? Numbers would be good.”

30 **Referee 1 – Comment 9** - We have provided information in section 3 to cover usage issues that our users have encountered in the past. Occasionally our users have been unable to open the data file – if they use a software package like Excel - because of the file size. We have therefore provided our normal advice in the manuscript to help users overcome this issue. This has been made clearer in the manuscript.

“Page 11, section 3.3: Again a comment on size of the dataset, but no explanation or justification is provided.”

**Referee 1 – Comment 10** - See comment above re file size.

“Page 11, sections 3.9 and 3.5 (wrong numbers): Did you consider using GBIF standards for these datasets?”

**Referee 1 – Comment 11** - We provided information on where to find information about the standard terms used in the supporting documentation in section 3.5. As mentioned above, we primarily use the EnvThes controlled vocabulary for the semantic harmonisation of our data with our partners. We have now expanded this section in the text.

5 “Page 12, section 4.2: It would be beneficial with some more information on the templates developed. It is not clear whether the templates were developed for simplifying the data entry process, quality assure the data or the entry process? How many templates were developed etc? This is an interesting element for reuse of the data and in particular if human errors are captured.”

**Referee 1 – Comment 12** - We have included a reference which provides more detailed information about the templates.

10 “Page 12, section 4.3: The relation between sections 4.2 and 4.3 could be further explained. Is data verification done in the templates mentioned in section 4.2 as well as in a separate step?”

**Referee 1 – Comment 13** - This verification is in addition to the checks made in the templates, this has been made clearer in the text.

15 “Page 12, section 4.3: Where are ranges for the ECN variables defined and where is the process leading up to these ranges documented? It is also commented that data out of range were treated in 3 different ways. On the second bullet point, what was the consequence for the data? Were data corrected and versioned?”

**Referee 1 – Comment 14** - The ranges are held in the database, this has been added to the manuscript. As the second bullet says the data were corrected and the changes flagged in the database.

“Page 12, section 4.3: Please consider referring to section 4.4 for explanation of quality flags.”

20 **Referee 1 – Comment 15** - Thank you. This has been added to the manuscript.

“Page 13, section 4.5: Again some further description of the processes around the meteorological data would be good, in particular irradiance which has issues concerning ventilation etc. And where sensors or AWS were run in parallel for periods, did they compare well?”

**Referee 1 – Comment 16** - Further information on this has been added to the manuscript.

25 “Page 13, section 5: Some more discussion on the temporal scales the dataset can be used for concerning non homogenised data would be beneficial. This would of course also depend on the types of analysis done and e.g. how sensitive the biosphere is to climate parameters.”

**Referee 1 – Comment 17** - A number of references have been provided to demonstrate the breadth of research which uses ECN data. The Data Centre does not have the resources to do these type of analyses itself so users are recommended to review the highlighted literature to explore how the data can be used.

30 “Technical corrections Page 11, section 3.9: Numbering must be wrong.”

**Referee 1 – Comment 18** - Thank you – we’ve corrected the numbering.

**Referee 2 – Johannes Peterseil**

The data paper provides a good overview on the data provided from the UK ECN Network. Method and dataset descriptions are clear. I checked several (not all) of the DOI and links are working providing the described content.

5 Observation sites - reference to the documentation of the observaiton sites (if existing) on DEIMS-SDR should be provided to provide a further description of the sites to the user. This also should be added to table 1.

**Referee 2 – Comment 1 – This information has been included in the introduction and added to table 1.**

Method description - temporal scale of observation is provided in table 2 but should also be mentioned in the textual description of the method. This would be a benefit to the reader. In addition table 2 should be mentioned in the '2. Methods'.

10 **Referee 2 – Comment 2 – The frequency of data collection for all the ECN protocols is provided in table 2 but we have also now made this clearer in the manuscript.**

**Comments provided in the supplement**

Page 2, line 20: reference to Mirtl et al. 2008 / Mirtl et al. 2019 STOTEN, refererring to the global network of LTER sites. ILTER and LTER Europe are important contributions to this effort.

**Referee 2 – Comment 3 – The Sci. Tot. Env. reference has been added to the manuscript**

15 Page 3, line 5: structure?

**Referee 2 – Comment 4 – We think that 'system' would be more appropriate**

Page 4, line 6: remove ":" as the following are sub-chapters

**Referee 2 – Comment 5 – this has been altered in the manuscript**

20 Page 4, line 7: General comment: for some of the datasets the temporal resolution is mentioned in the textual description, but not for all. This should bbe done for all, or mentioning in the paragraph above, that temporal resolution can be found in Table 2.

**Referee 2 – Comment 6 - The frequency of data collection for all the ECN protocols is provided in table 2 but we have also now made this clearer in the manuscript.**

Page 4, line 16: maybe a better term "control measure of blank tubes ..."

25 **Referee 2 – Comment 7 – this has been altered in the manuscript**

Page 5, line 22: see comment above. would be good to mention temporal resolution of the sample collection in order to allow to assess the data use.

**Referee 2 – Comment 8 - The frequency of data collection for all the ECN protocols is provided in table 2 but we have also now made this clearer in the manuscript.**

30 Page 7, line 16: was there a repetition of the baseline vegetation survey? should be mentioned also in the text.

**Referee 2 – Comment 9 – As stated in the manuscript, this was a one-off survey.**

Page 7, line 29: how was the number of random plots selected defined? was this by the share of ecosystem types? should be mentioned with one sentence.

**Referee 2 – Comment 10 – Additional information has been provided to make this clearer in the manuscript.**

Page 10, line 15: this sentence should be placed into the introduction section at the end.

**Referee 2 – Comment 11 – Reference to table 2 has been included in the introduction**

Page 10, line 16: would be good to start with a summary on the structure of the "data package" containing the data as well as the supporting documentaiton. The full package is referenced by a DOI. please consider to reorder the paragraphs a bit.

5 **Referee 2 – Comment 12 – This section has been reordered**

Page 10, line 16: as for meteorology it is specifically mentioned that the datasets were split into yearly time slices, the general rule for providing the data should be mentioned. I assume that in general the whole period is provided in one dataset file, correct?

**Referee 2 – Comment 13 – Yes this is correct, this has been clarified in the manuscript.**

10 Page 10, line 24: put this at the beginning of the paragraph "datasets"

**Referee 2 – Comment 14 - This section has been reordered**

Page 11, line 3: replace ":" by ","

**Referee 2 – Comment 15 – This has been altered.**

Page 11, line 5: see comment above

15 **Referee 2 – Comment 16 – This has been clarified in the manuscript**

Page 11, line 7: should also be mentioned in the method section on meteorology

**Referee 2 – Comment 17 – This has been added to the manuscript**

Page 11, line 9: is this mentioned in the "supporting documents" or in the metadata?

**Referee 2 – Comment 18 – Yes, this information is included in the supporting documentation**

20 Page 11, line 28: please put a short reference to the speices lists used - as a summary of the supporting documentation.

**Referee 2 – Comment 19 – This has been added as a new table (table 8).**

Page 11, line 29: is there also an online ressource the user can access?

**Referee 2 – Comment 20 – We do not make our species list available online but we primarily use the EnvThes controlled vocabulary for the semantic harmonisation of our data with our partners. We have now expanded this section in the text.**

25 Page 12, line 9: replace ":" by "a number of steps."

**Referee 2 – Comment 21 - This has been altered.**

Page 12, line 17: is there a reference describing this data processing steps? online reference to online description of the data reporting templates available?

**Referee 2 – Comment 22 – A reference has been added.**

30 Page 14, line 24: this could be already mentioned in the introduction. please consider to move this paragraph into the introduction.

**Referee 2 – Comment 23 - This section seeks to show the context in which the ECN datasets are collected and why they are useful to researchers. Therefore we think it is appropriate to include this information in this section. However we have included some additional information about this in the introduction.**

Page 14, line 30: could be moved after the chapter "4 . datasets" to put datasets relevant information together.

**Referee 2 – Comment 24** – Our reading of the ESSD manuscript preparation guidelines for authors is that the Data Availability section should appear just before the conclusions. We are happy to re-order if we have misunderstood.

Page 15, line 3: please mention, that registration is necessary to download the data!

5 **Referee 2 – Comment 25** – This has been added to the manuscript

Page 15, line 7: how will this be done? will there be an updated full period datasets or additional yearly data slices? if possible, please add information here.

**Referee 2 – Comment 26** - This has been added to the manuscript

10 Page 25, table 1: In order allow a better reference and access to online documentation of the observation sites reference to the documentation on DEIMS-SDR (<https://deims.org/>) is recommended. Please add the deims.id for the sites in the table.

**Referee 2 – Comment 27** – The DEIMS IDs for the ECN sites has been added to table 1.

Page 27, table 2: remove listing points

**Referee 2 – Comment 28** – This has been done

## 15 **The UK Environmental Change Network datasets - integrated and co-located data for long-term environmental research (1993-2015)**

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35 **Abstract.** Long-term datasets of integrated environmental variables, co-located together, are relatively rare. The UK Environmental Change Network (ECN) was launched in 1992 and provides the UK with its only long-term integrated environmental monitoring and research network for the assessment of the causes and consequences of environmental change.

Measurements, covering a wide range of physical, chemical and biological ‘driver’ and ‘response’ variables are made in close proximity at ECN terrestrial sites using protocols incorporating standard quality control procedures. This paper describes the datasets (there are nineteen published ECN datasets) for these co-located measurements, containing over twenty years of data (1993-2015). The data and supporting documentation are freely available from the NERC Environmental Information Data

5 Centre under the terms of the Open Government Licence using the following DOI’s:

#### *Meteorology*

Meteorology: <https://doi.org/10.5285/fc9bcd1c-e3fc-4c5a-b569-2fe62d40f2f5> (Rennie *et al.*, 2017a)

#### *Biogeochemistry*

Atmospheric nitrogen chemistry: <https://doi.org/10.5285/baf51776-c2d0-4e57-9cd3-30cd6336d9cf> (Rennie *et al.*, 2017b)

10 Precipitation chemistry: <https://doi.org/10.5285/18b7c387-037d-4949-98bc-e8db5ef4264c> (Rennie *et al.*, 2017c)

Soil solution chemistry: <https://doi.org/10.5285/b330d395-68f2-47f1-8d59-3291dc02923b> (Rennie *et al.*, 2017d)

Stream water chemistry: <https://doi.org/10.5285/fd7ca5ef-460a-463e-ad2b-5ad48bb4e22e> (Rennie *et al.*, 2017e)

Stream water discharge: <https://doi.org/10.5285/8b58c86b-0c2a-4d48-b25a-7a0141859004> (Rennie *et al.*, 2017f)

#### *Invertebrates*

15 Moths: <https://doi.org/10.5285/a2a49f47-49b3-46da-a434-bb22e524c5d2> (Rennie *et al.*, 2017g)

Butterflies: <https://doi.org/10.5285/5aeda581-b4f2-4e51-b1a6-890b6b3403a3> (Rennie *et al.*, 2017h)

Carabid beetle: <https://doi.org/10.5285/8385f864-dd41-410f-b248-028f923cb281> (Rennie *et al.*, 2017i)

Spittle bugs: <https://doi.org/10.5285/aff433be-0869-4393-b765-9e6faad2a12b> (Rennie *et al.*, 2018)

#### *Vegetation*

20 Baseline: <https://doi.org/10.5285/a7b49ac1-24f5-406e-ac8f-3d05fb583e3b> (Rennie *et al.*, 2016a)

Coarse grain: <https://doi.org/10.5285/d349babc-329a-4d6e-9eca-92e630e1be3f> (Rennie *et al.*, 2016b)

Woodland: <https://doi.org/10.5285/94aef007-634e-42db-bc52-9aae86adb33> (Rennie *et al.*, 2017j)

Fine grain: <https://doi.org/10.5285/b98efec8-6de0-4e0c-85dc-fe4cdf01f086> (Rennie *et al.*, 2017k)

#### *Vertebrates*

25 Frogs: <https://doi.org/10.5285/4d8c7dd9-8248-46ca-b988-c1fc38e51581> (Rennie *et al.*, 2017l)

Birds (Breeding bird survey): <https://doi.org/10.5285/5886c3ba-1fa5-49c0-8da8-40e69a10d2b5> (Rennie *et al.*, 2017m)

Birds (Common bird census): <https://doi.org/10.5285/8582a02c-b28c-45d2-afa1-c1e85fba023d> (Rennie *et al.*, 2017n)

Bats: <https://doi.org/10.5285/2588e91-6cbd-4888-86fc-81858d1bf085> (Rennie *et al.*, 2017o)

Rabbits and deer: <https://doi.org/10.5285/0be0aed3-f205-4f1f-a65d-84f8cf8d850f> (Rennie *et al.*, 2017p)

## 30 1 Introduction

The assessment of environmental change requires an understanding of how ecosystems function, how they respond to a range of pressures and how resilient they are to such changes. To make these assessments, precise and consistent measurements

repeated over long periods of time are needed (Sier and Monteith, 2016a). Ideally, these measurements should also be co-located to provide opportunities to directly link pressures and responses. This type of monitoring effort requires sustained funding (longer than usual research grants) and a clear long-term vision. Consequently, robust long-term environmental research networks are relatively rare.

5 The Environmental Change Network (ECN), launched in 1992, is the UK's long-term integrated environmental monitoring and research network (Environmental Change Network, 2019). ECN collects information on a broad baseline of integrated environmental information. The programme also provides more immediate information about trends and early warning of environmental extremes that may directly influence environmental policy. The ECN programme is sponsored by a consortium of fourteen UK Government departments and agencies (see acknowledgements), who contribute to the programme through  
10 funding either site monitoring or network co-ordination activities. [Internationally, ECN is formally recognised as the UK node of a global system of long term environmental research networks \(LTER-Europe \(Mirtl, 2010\) and ILTER \(Kim, 2006, Mirtl et al., 2018\)\).](#)

For the period covered by the published datasets, there were twelve terrestrial sites in the network (see figure 1), selected to cover the main range of environmental conditions present in the UK (see table 1). [Links to site descriptions on the ECN website and on DEIMS-SDR, an information management system that allows discovery of long-term ecosystem research sites around the globe \(Wohner, 2019\), are included in table 1.](#)  
15 The majority of these sites have been collecting data since at least 1993, meaning over twenty years of ECN data are now available. However many of the sites were chosen because they had a long history of environmental monitoring so have additional pre-ECN data available.

The monitoring programme includes a wide range of physical, chemical and biological 'driver' and 'response' variables, identified by experts in the field as being important for the assessment of environmental change (see table 2). A Statistical and Technical Advisory Group met regularly to review ECN monitoring activities. These measurements are made in close proximity at each site, using standard protocols incorporating standard quality control procedures (Sykes and Lane, 1996).

20 Data are managed by the ECN Data Centre, which has an integrated information [resource system](#) (Rennie, 2016) that stores all data and meta-data collected by the networks which supply data to it. These data are held in standardised structures in order to support the cross-disciplinary analyses necessary for environmental change research. An associated summary database consists of monthly, quarterly, and/or annual summaries of these data using summary statistics appropriate to each measurement, as advised by experts. These summary data can be explored through data visualisation interfaces available on the website (ECN Data Centre, 2019). The database uses the Oracle relational database management system with links to Arc GIS for spatial data handling. Data were regularly sent in from sites and were quality assured before being lodged in the  
25 database (information about quality control is in section 4).  
30

This paper describes the datasets for the high frequency, co-located ECN measurements. There are nineteen published datasets [table 2](#) containing over twenty years of data (1993-2015) covering biological, meteorological and biogeochemical measurements (Rennie *et al.*, 2016a,b; Rennie *et al.*, 2017a-p; Rennie *et al.*, 2018). They are hosted by the NERC Environmental Information Data Centre and are available to users under an Open Government Licence.

**Commented [RSC1]:** Response to Referee 2 – Comment 23

**Commented [RSC2]:** Response to Referee 2 – Comment 3

**Commented [RSC3]:** Response to Referee 2 – Comment 1

**Commented [RSC4]:** Response to Referee 2 – Comment 4

**Commented [RSC5]:** Response to Referee 2 – Comment 11



## 2. Methods

ECN measurements are co-ordinated and standardised across sites according to published protocols procedures (Sykes and Lane, 1996). The protocol documents are included in the supporting documentation provided alongside every data download. The protocols are designed to ensure consistency in methods and data handling over time and across ECN's sites. Sites were visited on the same day each week, preferably on a Wednesday, to synchronise sampling, within the site and across the network. The protocol documents detail quality control procedures e.g. correct handling of equipment and samples, maintenance schedules and calibration specifications; as well as unambiguous instructions for measurement and data handling. Data requirements are an integral part of these protocols and include specifications of variables, units, reporting precisions, dimensions, resolutions, reference systems and quality assurance procedures. These specifications, together with as much information as possible about likely user requirements, were used in design of the database, and the construction of standard formats for data transfer and standard field forms for each dataset. Where available, existing data capture methodologies were used (e.g. the Rothamsted light trap network (Rothamsted Insect Survey, 2019)) to maintain compatibility with other sectoral networks.

At each site, an area of one hectare was selected and permanently marked. This is called the Target Sampling Site (TSS) and destructive sampling within it kept to a minimum. Many of the measurements are co-located within the TSS. Dispersed monitoring protocols (e.g. vegetation) also include plots within the TSS. The TSS was chosen to be representative of the predominant vegetation, soil and management of the site.

Some protocols (sections 2.15 to 2.19) have not been measured at all sites or have had varied uptake at sites over time, limiting their use for cross-site comparison. In addition, some protocols are designed as national scale surveys so they have limited use for assessment of trends at individual sites. These limitations are discussed with each individual dataset. The methods for data collection for the nineteen published ECN datasets (1993-2015) are summarised below as follows:

### 2.1 Meteorology

Automatic weather stations (AWS) were installed at all ECN terrestrial sites, and situated in accordance with British Meteorological Office site requirements (Meteorological Office, 1982). The AWS was ideally located on, or within 500m of, the TSS. The layout of the meteorological enclosure is provided in figure 2. Full details for the procedure for installing an AWS are provided in the protocol document (Burt and Johnson, 1996) but the instruments were fixed to two cross-arms – one at 2m above ground level and oriented east/west and the other a 1m above ground level and oriented north/south. The wind vane and anemometer were located on the upper cross-arm and the air temperature and radiation sensors to the lower. A number of the sites also had either a manual meteorological station (referred to as MM in figure 2) or a second AWS to quality check the data. In addition, the majority of sites have operated more than one AWS in the same location e.g. when kit is replaced (see section 3.1 for details on how this is recorded in the dataset). All ECN AWS instruments were subject to regular (normally annual or biannual) professional calibration checks by external contractors. The data are hourly summaries

Commented [RSC6]: Response to Referee 2 – Comment 5

Commented [RSC7]: Response to Referee 1 – Comment 4

Commented [RSC8]: Response to Referee 2 – Comment 17

Commented [RSC9]: Response to Referee 1 – Comment 2

calculated from 5 second samplings and the variables recorded are listed in table 3. Full operating procedures are provided in the protocol document (Burt and Johnson, 1996) which is included in the supporting documentation provided alongside the data download (called MA.pdf).

**Commented [RSC10]:** Response to Referee 1 – Comment 3 and Comment 5  
Response to Referee 2 – Comment 2, Comment 6 and Comment 8

## 2.2 Atmospheric Nitrogen

5 Passive diffusion tubes were used to measure the concentration of nitrogen dioxide (NO<sub>2</sub>) at all ECN terrestrial sites. They were attached to a post at a height of 1.5m above ground level in the meteorological enclosure (figure 2), close to the AWS. As a quality check/control measure, blank tubes were also transported to the site but were not exposed on arrival. The blank tubes were returned to the laboratory the same day, stored in a refrigerator and analysed in the lab alongside the experimental tubes. In the early years of ECN, the diffusion tubes were assembled and analysed locally but these were replaced at some sites by commercially made tubes manufactured and analysed by Gradko Ltd. Comparability tests were conducted when this switch was made. The samples were collected fortnightly and the variables recorded are listed in table 4. Full operating procedures are provided in the protocol document (Bojanic, 1996) which is included in the supporting documentation provided alongside the data download (called AN.pdf).

**Commented [RSC11]:** Altered as a result of Referee 1 – Comment 4

**Commented [RSC12]:** Response to Referee 2 – Comment 7

**Commented [RSC13]:** Response to Referee 1 – Comment 3 and Comment 5  
Response to Referee 2 – Comment 2, Comment 6 and Comment 8

## 2.3 Precipitation Chemistry

15 Bulk (open funnel) precipitation collectors were used to measure the precipitation chemistry at all ECN terrestrial sites. These were situated in the meteorological enclosure (figure 2) close to the AWS, in an open location away from local sources of contamination (e.g. vehicle tracks or animal houses). Warren Spring Laboratory standard precipitation collectors were used, with the collecting bottle fixed 1.75m above the ground. The collectors were secured by guy ropes or bolted to a concrete base. The collector had a filter to prevent debris falling into the bottle and was kept dark and cool by a jacket. The collecting bottle was changed at the same time each week and the funnel replaced or cleaned with deionised water. The volume collected was recorded, and analysis of the samples were made by the analytical laboratories linked to each site. The cost of standardising methods of analysis across all ECN laboratories was prohibitive; instead the analytical guidelines (available in supporting documentation available with the data download) list approved techniques for each determinand with their corresponding limits of detection. The sponsoring Organisations were responsible for maintaining their own continuity in methods for existing long-term runs of data. Each laboratory practised its own internal quality control, and most participated in national quality assurance schemes. As a quality check, a standard quality control solution was sent to the laboratories that analyse the ECN water samples. This solution was analysed alongside the samples collected in the field. The samples were collected weekly and the variables recorded are listed in table 5. Full operating procedures are provided in the protocol document (Adamson and Sykes, 1996) which is included in the supporting documentation provided alongside the data download (called PC.pdf). Operating procedures for handling water samples (Adamson, 1996a) and analytical guidelines (Rowland, 1996) are also provided in the supporting information (called WH.pdf and WAG.pdf).

**Commented [RSC14]:** Altered as a result of Referee 1 – Comment 4

**Commented [RSC15]:** We added to clarify which organisations we are referring to

**Commented [RSC16]:** Response to Referee 1 – Comment 3 and Comment 5  
Response to Referee 2 – Comment 2, Comment 6 and Comment 8

#### 2.4 Soil Solution Chemistry

Water was collected from soils via suction lysimeters at the majority of ECN terrestrial sites. The lysimeters were installed at two depths within a 10m by 10m plot on the edge of, but outside, the TSS. Six samplers were installed in the A horizon and six others at the base of the B horizon (or at 10cm and 50cm if these soil horizons did not exist), ideally on a downslope to avoid debris from soil disturbance. Samplers were emptied and the water volumes collected on the same day each fortnight. One week after sample collection, the samplers were evacuated to 0.5 bar (or 0.7 bar for sites where insufficient soil solution could be collected), so the water only accumulated over the second week of the fortnightly period. The chemistry of the water collected was analysed by the analytical labs associated with each site. At some sites, particularly in drier months, the volume of water collected may have been very small; in these cases, the samples were discarded or, if possible, combined (only samples from the same horizon were combined) for analysis [\[see section 3.2. for details on how this is recorded in the dataset\]](#). The [samples were collected fortnightly and the](#) variables recorded are listed in table 5. Full operating procedures are provided in the protocol document (Adamson, 1996b) which is included in the supporting documentation provided alongside the data download (called SS.pdf). Operating procedures for handling water samples (Adamson, 1996a) and analytical guidelines (Rowland, 1996) are also provided in the supporting information (called WH.pdf and WAG.pdf).

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Response to Referee 2 – Comment 2, Comment 6 and Comment 8

#### 2.5 Surface Water Chemistry

Dip samples from rivers and streams were collected. This was only done at sites where flowing water was present. Samples were taken at a representative location above a weir; some sites collect samples at multiple locations on the site (indicated by the location code in the dataset). The collecting bottle is rinsed in river water and a 250ml sample of river water taken. The [samples were collected weekly and the](#) variables recorded are listed in table 5. Full operating procedures are provided in the protocol document (Johnson and Burt, 1996a) which is included in the supporting documentation provided alongside the data download (called WC.pdf). Operating procedures for handling water samples (Adamson, 1996a) and analytical guidelines (Rowland, 1996) are also provided in the supporting information (called WH.pdf and WAG.pdf).

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Response to Referee 2 – Comment 2, Comment 6 and Comment 8

#### 2.6 Surface Water Discharge

Hydrological data from rivers and streams were collected by logger at sites with a river or stream. Recording of river stage was by a permanently installed weir, the design of which was determined by the conditions at the site. Data were recorded by a logger. [The data are 15-minute averages calculated from ten second samplings of stage height and t](#)The variables recorded are listed in table 2. Full operating procedures are provided in the protocol document (Johnson and Burt, 1996b) which is included in the supporting documentation provided alongside the data download (called WD.pdf).

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Response to Referee 2 – Comment 2, Comment 6 and Comment 8

## 2.7 Moths

Light traps were used to sample moths (*Macrolepidoptera*) at the majority of the ECN terrestrial sites using the Rothamsted Insect Survey method (Rothamsted Insect Survey, 2019) at the majority of ECN terrestrial sites. Where possible, the light trap was sheltered by vegetation and placed away from artificial light sources, in a location that was convenient for daily emptying.

5 The traps require a continuous power supply so this often determined their location. Ideally, the traps were emptied daily throughout the year but when this was not possible (e.g. for more remote sites or at the weekend) samples could accumulate. Samples from the sites were identified by a single expert contracted by ECN. The data are stored within the Rothamsted Insect Survey database, as well as in the ECN database. A count of each species trapped was recorded. Full operating procedures are provided in the protocol document (Woiwod, 1996a) which is included in the supporting documentation provided alongside  
10 the data download (called IM.pdf).

## 2.8 Butterflies

Butterfly species were recorded on a fixed transect (which was divided into a maximum of 15 sections) at the majority of ECN terrestrial sites. The transect was chosen to be broadly representative of the site, and include areas under different management regimes. The length of the transect was dependant on the local conditions at the site. The national Butterfly Monitoring  
15 Scheme methodology was used (UK Butterfly Monitoring Scheme, 2019). The transect was walked at an even pace and the number of butterflies which were seen flying within or passing through an imaginary box (5m wide, 5m high and 5m in front of the observer) were recorded. Sampling took place when the temperature was between 13-17°C if sunshine was at least 60%; but if the temperature was above 17°C (15°C at more northerly sites) recording could be carried out in any conditions, providing it was not raining. Transects were walked weekly between the 1<sup>st</sup> April and 29<sup>th</sup> September providing the meteorological  
20 conditions were met. A count of each species observed was recorded. Full operating procedures are provided in the protocol document (Woiwod, 1996b) which is included in the supporting documentation provided alongside the data download (called IB.pdf).

## 2.9 Carabid Beetles

Pitfall traps were used to collect carabid beetles (Carabidae) at the majority of ECN terrestrial sites. Thirty traps were set  
25 divided between three transects, in or adjacent to the TSS; in areas representing different habitats where possible. The traps were polypropylene measuring 7.5cm diameter by 10cm deep and were filled with ethylene glycol preservative. They were buried with the top of the trap flush with the soil surface. The traps were set 10m apart along the transect. A wire netting cage made from chicken wire, was attached to the rim of the trap to reduce the number of small mammals inadvertently caught. Each trap also had a cover to help prevent rain flooding the traps and reduce bird interference. Samples were analysed by a  
30 local taxonomic expert. The samples were collected fortnightly (between May and end of October). A count of each species

trapped was recorded. Full operating procedures are provided in the protocol document (Woiwod and Coulston, 1996) which is included in the supporting documentation provided alongside the data download (called IG.pdf).

### 2.10 Spittle Bugs

Populations of *Philaenus spumaris* and *Neophilaenus lineatus* were monitored annually at the majority of ECN terrestrial sites.

5 In mid-June, counts of the spittle produced by nymphs made in 20 quadrats (0.25m<sup>2</sup>) randomly placed near the TSS. Also, in late August, the proportions of each colour morph of the adult *P. spumaris* were estimated using sweep netting on the TSS when the weather conditions were dry. Colour polymorphism is likely to be environmentally determined (Whittaker, 1965) and therefore an indicator of environmental change. The samples were collected annually (nymphs in June and adults in August). A count of each species/colour morph was recorded. Full operating procedures are provided in the protocol document  
10 (Whittaker, 1996) which is included in the supporting documentation provided alongside the data download (called IS.pdf).

### 2.11 Baseline Vegetation

This was a one-off survey at the start of ECN monitoring to establish a vegetation map at all sites. It allowed a vegetation map to be generated and the plots for continuous monitoring (see 2.12, 2.13, 2.14) to be selected. An approximately regular grid, coincident with the UK National Grid, was superimposed on the site map, scaled so as to provide approximately 400 sample  
15 grid positions. This ensured the plot locations were unbiased and relocatable. Additionally, no more than 100 points (infill points) were chosen to ensure all vegetation types were represented. A 2m x 2m plot was centred on each grid and infill point, oriented using magnetic bearings. These plots were permanently marked (the plot corners are marked with buried metal stakes). Species presence was recorded in the plots. Where the plots fell in woodland, the trees and shrubs were recorded in a 10m x 10m plot centred on the 2m x 2m plot to provide a more representative sample of the canopy and understory. Full  
20 operating procedures are provided in the protocol document (Rodwell *et al.*, 1996) which is included in the supporting documentation provided alongside the data download (called V.pdf).

### 2.12 Coarse-grain Vegetation

~~A random selection was made of forty of the 2m x 2m plots were randomly selected (from the plots from the regular grid set up for baseline survey vegetation recording (section 2.11) plots selected in the Baseline Survey) at the majority of ECN  
25 terrestrial sites at the onset of ECN monitoring. Where infill plots were included in the baseline survey up to ten of these plots was also randomly selected, providing a total of up to fifty of these plots for coarse-grain monitoring. The plots were permanently marked. The total number of plots selected varied in proportion to the total area of the site.~~ Where plots fell in woodland or scrub, the associated woodland protocol was also undertaken (see 2.13). The protocol was undertaken every nine years. Species presence was recorded in each of the twenty-five 40cm x 40cm cells within the plots. Full operating procedures are provided in the protocol document (Rodwell *et al.*, 1996) which is included in the supporting documentation provided  
30 alongside the data download (called V.pdf).

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### 2.13 Woodland Vegetation

Where grid and infill plots selected for coarse-grain sampling (section 2.12) fall in scrub or woodland, 10m x 10m plots (which were centred on the 2m x 2m plot used in the coarse-grain survey) were used to record trees and shrubs. Species dominance was assessed within the plots. Ten cells, each 40cm x 40cm, were selected at random within the plot and marked. Seedlings were counted by species in each cell. Additionally, an individual tree was chosen nearest the centre point of the cell and monitored for height and diameter at breast height (dbh). The protocol was undertaken every nine years, but dbh was measured every three years for sites where there was woodland. The variables recorded are listed in table 6. Full operating procedures are provided in the protocol document (Rodwell *et al.*, 1996) which is included in the supporting documentation provided alongside the data download (called V.pdf).

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### 2.14 Fine-grain Vegetation

At least two 10m x 10m plots from each vegetation type present at the site were randomly selected (from the plots selected in the Baseline Survey (see section 2.11)) within each vegetation type present on the majority of ECN sites. The plots were chosen to coincide with the original grid and infill plots where possible, but otherwise were selected using randomly selected pairs of co-ordinates. The plots did not coincide with the coarse-grain sampling plots (see section 2.12) to avoid repeated disturbance to the plots. Ten 40cm x 40cm cells were selected randomly within these plots. This survey was undertaken every three years but some sites chose to do this survey annually to provide a better temporal range. The same plots were visited on each occasion but often a smaller number of plots were chosen to do the annual survey. Species presence was recorded within the cells. Full operating procedures are provided in the protocol document (Rodwell *et al.*, 1996) which is included in the supporting documentation provided alongside the data download (called V.pdf).

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### 2.15 Frogs

It is difficult to monitor populations of adult frogs, therefore phenological observations were made of in selected pools and ditches and the number of egg masses were assessed as an indicator of the 'health' of frog populations at sites with standing water present. Additionally, a 250ml water sample was taken from the spawning area and analysed. The time at which frog breeding starts in the UK varies greatly, therefore observations of frog behaviour were made at the appropriate time for each site. The variables recorded are listed in table 7. Full operating procedures are provided in the protocol document (Beattie *et al.*, 1996) which is included in the supporting documentation provided alongside the data download (called BF.pdf).

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Response to Referee 2 – Comment 2, Comment 6 and Comment 8

### 2.16 Birds - Breeding Bird Survey

Bird species were recorded on two transect lines (within a 1km square) at the majority of ECN sites. Counts were made in the morning, ideally no later than 09:00. Transects were walked, at a slow and methodical pace, when the visibility was good and there was no strong wind or heavy rain. All birds which were seen or heard, as well as their distance (there are four distance

categories) from the transect were recorded. The methodology used was that of the Breeding Birds Survey (BBS, 2019) organised by the British Trust for Ornithology (BTO). The transect was walked twice each year (once between April and mid-May and the second between mid-May to late June). Full operating procedures are provided in the protocol document (Sykes, 1996a) which is included in the supporting documentation provided alongside the data download (called BB.pdf).

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5 This protocol replaced the Common Bird Census (see 2.17) in 1999. The methodologies of the two surveys are different so it is unfortunately not possible to create a single time series from both datasets. Please also note that the Breeding Birds Survey is designed to be a national-scale survey, therefore the site-based ECN data is limited in the amount of information which it can provide on the precise relationships between population levels and environmental change. It is recommended that the ECN data are used in conjunction with data from more widespread monitoring programmes (i.e. those of the BTO) so these  
10 limitations can be mitigated.

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### 2.17 Birds - Common Bird Census

Bird species were recording in a plot which should ideally be a minimum of 40 hectares in farmland and 10 hectares in woodland. The methodology used was that of the Common Birds Census (CBC, 2019) organised by the BTO. Ten visits were made between mid-March and late June, spaced evenly through the season. Cold, windy and wet days were avoided. The  
15 CBC uses a mapping method in which a series of visits were made to all parts of a defined plot during the breeding season and contacts with birds by sight or sound were recorded on large-scale maps. Information from the series of visits was combined to estimate the number of territories found. Within the CBC protocol, some species were also monitored by nest counts on the plot, or by a combination of nest counts and territory estimation. Full operating procedures are provided in the protocol document (Sykes, 1996b) which is included in the supporting documentation provided alongside the data download (called  
20 BC.pdf).

The CBC was the standard protocol at lowland ECN sites until 1999 when it was replaced by the BBS (see 2.16). The methodologies of the two surveys are different so it is unfortunately not possible to create a single time series from both datasets. A few sites continued the CBC alongside the BBS for a few years to allow comparison. Additionally, historical data (pre-ECN) was obtained for the Wytham site. Therefore the date ranges for individual sites in this dataset are not consistent.  
25 As with the BBS, the CBC was designed to be a national-scale survey so similar limitations apply to the site-based ECN data provided in this dataset.

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### 2.18 Bats

Bat species were mapped (using a bat detector) and their behaviour recorded at the majority of ECN sites. One or more kilometre squares were selected at the site. This selection did not need to be random as long as the square was reasonably  
30 typical of the site and that fieldwork at night could be conducted safely. The square was divided into two and a transect selected through each of these half-squares. The methodology was based on that used in the Bats and Habitats survey organised for the Joint Nature Conservation Committee (Walsh *et al.*, 1995). The transect was walked four times in each year (once in

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each three-week period between June and September). Bat detectors were used during the survey and the frequency the detector was tuned to could be altered during the survey if that helped ensure all species were recorded (in particular to distinguish between Pipistrelle species). Surveys were not carried out when rain was heavy or there were strong winds. A count of each species observed and their behaviour was recorded. Full operating procedures are provided in the protocol document (Walsh *et al.*, 1996) which is included in the supporting documentation provided alongside the data download (called BA.pdf).

The methodology is somewhat limited in the amount of information which it can provide on the precise relationships between population levels and environmental change; nevertheless by linking ECN results to those from more widespread monitoring programmes these limitations can be mitigated.

## 10 2.19 Rabbits and Deer

There were no practicable methods of making direct measures of the population size of the rabbit and deer populations; therefore an index method based on dropping counts was used to estimate relative abundance at the majority of ECN sites. The butterfly monitoring transect was used. A second transect that covered habitat types not present on the butterfly transect was also selected. Dropping counts were recorded on a transect twice a year (once in late March and again in late September). Droppings on the transect were cleared two weeks before sampling took place. At Moor House, the same methodology was also used to estimate the relative abundance of Grouse. Full operating procedures are provided in the protocol document (Coulson, 1996) which is included in the supporting documentation provided alongside the data download (called BU.pdf).

## 3. Datasets

The ECN datasets are listed in table 2, together with their citation information, the frequency of measurement and the variables collected. The NERC Environmental Information Data Centre (the repository that hosts the datasets) provides data and supporting information as separate packages – this allows improvements to be made to the supporting documentation over time if necessary while maintaining a persistent, citable dataset. The DOI for each dataset links to a landing page which contains separate links to download the data and the supporting information.

Each dataset follows the same basic structure:

- SITECODE - site code (see table 1)
- SDATE - date of sampling
- FIELDNAME - the variable being measured (these are described below and in the supporting information)
- VALUE - the value of the measured variable

All the datasets have this structure in common but some of the datasets may also contain some additional information, where necessary for the measurement. This is fully documented in the supporting information. For the majority of datasets, the

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entire time period is included in the data download – however, two large datasets are split into yearly time slices to make downloading easier for the user (see sections 3.1 and 3.3)

The supporting information, i.e. the protocol document, supplementary data and quality information, is provided with each dataset. It is important to refer to this information prior to analysing the data. The NERC Environmental Information Data Centre (the repository that hosts the datasets) provides data and supporting information as separate packages – this allows improvements to be made to the supporting documentation over time if necessary while maintaining a persistent, citable dataset. The DOI for each dataset links to a landing page which contains separate links to download the data and the supporting information. The supporting information is provided in a zip file using the ‘Supporting documentation’ link on the relevant page for each dataset (Rennie *et al.*, 2016a,b; Rennie *et al.*, 2017a-p; Rennie *et al.*, 2018). All the zip files contain a document called \*\*\*\_DATA\_STRUCTURE.doc (where \*\*\* is the ECN measurement code (see table 2)). This document contains detailed information about the structure of the dataset, location information for the sites, information about the variables measured, documents for any additional information needed to understand the dataset and provides any coding lists used.

Some usage notes are included below:

### 3.1 Meteorology

Given the size of this dataset, the data have been split into yearly csv files. Users are advised to open these files in a text editor or use statistical package to analyse these data as the file sizes remain too large for a software package like Excel to open. Over the period of data collection, the majority of ECN sites have operated more than one AWS in the same location – e.g. when kit is replaced. In many cases, these have been run concurrently to enable cross-checking of data. Replacement AWS’s are indicated by the ‘AWSNO’ field in the dataset – these are ID numbers assigned sequentially. Users should be aware of the AWSNO when analysing the data – particularly when two AWS’s have been run concurrently – to avoid misleading results by inadvertently combining data from two AWS’s.

### 3.2 Soil Solution Chemistry

Where samples were combined, this is indicated in the data with the replicate IDs XXS (combined shallow samplers) and XXD (combined deep samplers) in the datasets. Occasionally, the suction samplers were replaced, this is indicated in the data with a new replicate ID.

### 3.3 Surface Water Discharge

Given the size of this dataset, the data have been split into yearly csv files. Users are advised to open these files in a text editor or use statistical package to analyse these data as the file sizes remain too large for a software package like Excel to open. One site (Moor House – Upper Teesdale) uses an Environment Agency logger to record water discharge. The Environment Agency uses the WISKI format to record these data (the Hydrolog format was used prior to 2004). Both these formats include

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quality information which are available in this dataset (for Moor House only). An explanation for these quality codes is provided in the supporting information.

### 3.4 Carabid Beetles

There is an additional data column in this dataset which applies to only one species (*Pterostichus madidus*) where additional information was collected on gender (M or F) and leg colour (R (red) and B (black)). The ratio of leg colour is thought to depend on ecological factors (Terrell-Nield, 1992).

### 3.5 Standards and Coding Lists

ECN forms part of a global system of long-term, integrated environmental research networks – see section 5 for more details. Therefore it primarily uses the LTER-Europe controlled vocabulary, EnvThes (EnvThes, 2019), as the basis for the semantic harmonisation of data with its European and International partners. ECN uses a number of coding lists within its datasets. Where possible, existing coding systems were used to maintain compatibility with other related data resources. The coding lists used by ECN are listed in Table 8. These coding lists are fully documented in the supporting information.

### 3.6 Dataset Completeness

The majority of the ECN sites have been collecting the full suite of ECN measurements since 1993 but two sites joined the network later – Yr Wyddfa (Snowdon) in 1995 and Cairngorms in 1999. However, it should be noted that many of the sites are in remote locations which can mean that site managers are unable to attend the sites occasionally for health and safety reasons, causing gaps in the dataset. In particular, there was a Foot-and-mouth disease outbreak in the UK in 2001, which meant a number of the sites could not be visited for biosecurity reasons, and the data for that year are patchy. In addition, Rothamsted ceased biological monitoring in 2011 and Drayton left the network in 2014.

## 4 Data Quality

Quality control is central to all stages of ECN data collection and management and is handled through a number of steps.:

### 4.1 Standard Operating Procedures.

As described in the section 2, data collection procedures were co-ordinated and standardised across the sites through published protocols.

### 4.2 Data Transfer Templates

Data were checked and formatted by data providers prior to being submitted by email (in standardised, comma-separated files). Detailed data transfer documentation for each protocol guided the preparation of these files, to ensure comparability of data

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Response to Referee 2 – Comment 20

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across sites and over time. This documentation includes rules for handling missing values and data quality information. To aid site managers a bespoke set of data entry templates were developed for each protocol, using MS Access, to improve data handling efficiency (Rennie, 2016). These templates incorporate quality checking procedures, and help to ensure that quality checked, standardised and formatted data were submitted by site managers. The design of the templates takes into account ease of use, with the main emphasis being on minimising error. This type of data entry software is particularly useful where numeric coding systems for species are in use; numbers are less memorable and mistakes in one digit of a code can produce serious errors. For example, the software uses drop-down lists of codes (which are dynamically linked with a list of the species names) so that the codes can be cross-checked against the species name to ensure that the correct code is chosen.

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Response to Referee 2 – Comment 22

#### 4.3 Data Verification

In addition to the checks made in the templates, standard verification procedures were applied to all data before import into the database. The procedures performed numeric range checks (i.e. checking if a value falls within a specified range), categorical checks (e.g. checking that a species code appears on the standard code list), formatting (i.e. that the dataset conforms to the specified data format) and logical integrity checks (i.e. checking the data make sense e.g. that the dates in one dataset match those in a related dataset). Appropriate range settings for ECN variables were selected following discussion with specialists in each field. These ranges are held in a table in the database and the data are checked against this before being committed to the database. Where values fell outside these ranges, a cautious approach was adopted towards discarding data on the principle that apparent errors could be valid outliers. Data values identified by validation software as 'out of range' were treated in one of three ways:

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- where values were clearly meaningless due to a known cause, (e.g. an instrumentation fault, and could not be back-corrected), the data were discarded and database fields set to null (no data), and quality flags added to the database;
- where values were clearly in error, or out of range due to known calibration errors and could be back-corrected, the data were corrected. These changes were flagged in the database;
- where there was no straightforward explanation for outliers, the data were stored in the database, accompanied by quality flags (see section 4.4).

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#### 4.4 Quality Flagging

The ECN site managers assigned quality codes to indicate factors that may affect the quality of the data being collected, including deviations from the protocol, faulty instrumentation and common problems. They picked these from a standard list of ECN quality codes and these quality codes are included in the data download and an explanation for the codes provided in the supporting documentation. Site managers could pick as many quality codes as were applicable. Occasionally, an unusual event took place that was not covered by these codes. In that case, the site manager attached text explaining the circumstances. This is indicated by a quality code '999' in the data download. This quality text is available in a file called ECN\_\*\*\*\_qtext.csv (where \*\*\* is the measurement code; see table 2) which is provided in the supporting documentation.

#### 4.5 Quality Assessment Exercises

Samples were kept where possible (e.g. archived invertebrate samples) meaning the accuracy of identification can be assessed at a later date if necessary. Occasionally, quality assessment exercises have been run by appropriate experts to check, for example, consistency in species identification across sites (Scott and Hallam, 2003). The quality of more ephemeral measurements such as meteorology or water quality can only be similarly assessed by running duplicate or parallel systems. Duplicate systems are expensive, and in practice assessment normally involved regular checks for instrument drift and recorder error. Where possible, when new instrumentation or methods needed to be introduced, new and old systems were run in parallel to assess their relationship. This is assessed by the individual site manager who must satisfy themselves that the new systems compare well before proceeding with the switchover.

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#### 10 5. ECN datasets in context

ECN is nationally unique with its focus on high frequency and co-located measurements. It provides a rare opportunity to link pressures and responses to investigate relationships between environmental variables and explore environmental change over significant time scales. The data included within these datasets have been the focus of a number of peer-reviewed scientific publications over the past 20 years. For example, linking meteorological with invertebrate species data to explore the impact of drought (Morecroft *et al.*, 2002); exploring trends in the physical and biological environment (Morecroft *et al.*, 2009); determining that hydrochloric acid deposition was a driver of UK soil acidification (Evans, *et al.*, 2011); and to investigate declines in carabid beetle biodiversity (Brooks *et al.*, 2012). Many of the datasets were incorporated in papers forming a journal special issue marking the first 20 years of ECN (Sier and Monteith (*eds.*), 2016b). This special issue demonstrates how effective the datasets are in assessing and interpreting environmental change, covering a breadth of topics such as trends in weather and atmospheric deposition (Monteith, *et al.*, 2016); trends in dissolved organic carbon (Sawicka *et al.*, 2016; Moody *et al.*, 2016); various aspect of change in UK plant communities (Rose *et al.*, 2016; Morecroft *et al.*, 2016; Pallett *et al.*, 2016; Milligan *et al.*, 2016); ecosystem services (Dick *et al.*, 2016); carabid beetle communities (Eyre *et al.*, 2016; Pozsgai *et al.*, 2016); the use of digital imaging to assess vegetation cover (Baxendale *et al.*, 2016); and the response of Lepidoptera communities to warming (Martay *et al.*, 2016). A full catalogue of the peer-reviewed papers that have used ECN data are available on the website (ECN Publications Catalogue, 2019).

ECN sites cover a wide range of UK habitats but, given their focus on high frequency data, are costly to run and are relatively few in number. The representativeness of ECN sites was compared to data obtained by the UK Countryside Survey (CS - Countryside Survey, 2019). The survey is based on a stratified random sample of 1 km squares from the intersections of a regular 15 km grid superimposed on the rural areas of Great Britain. Analysis revealed that ECN sites effectively span the range of values for both temperature and rainfall and cover a similar range of vegetation types to the CS with the exception of arable, a land use category not assessed at ECN sites although present on several sites (Dick *et al.*, 2011).

ECN sites contribute to a number of national monitoring programmes e.g. Rothamsted Insect Survey (Rothamsted Insect Survey, 2019), Countryside Survey (Countryside Survey, 2019), the UK Butterfly Monitoring Scheme (UKBMS, 2019), the Breeding Bird Survey (BBS, 2019), the United Kingdom Eutrophying and Acidifying Network (UKEAP, 2019) and the Cosmic-ray Soil Moisture Monitoring Network (COSMOS-UK, 2019). ECN's focus on multidisciplinary, co-located measurements can help integrate these networks and provides temporal scale context for observations made by these networks, for example by providing information on year to year variation in vegetation communities to help inform how CS data can be influenced by weather variability (Scott *et al.*, 2010).

ECN is formally recognised as the UK's contribution to a global system of long-term, integrated environmental research networks and is a member of LTER-Europe (the European Long-Term Ecosystem Research Network – Mirtl, 2010) and ILTER (International Long Term Ecological Research – Kim, 2006). Individual ECN sites are also involved in other international networks, including INTERACT (International Network for Terrestrial Research and Monitoring in the Arctic - INTERACT, 2019), GLORIA (Global Observation Research Initiative in Alpine Environments - GLORIA, 2019), ICP Forest Level II (ICP Forests, 2019) and FLUXNET (FLUXNET, 2019).

## 6. Data Availability

Provision of easy access to data has always been central to ECN's strategy to provide a resource for environmental research, policy purposes and public information. The ECN datasets are hosted by the NERC Environmental Information Data Centre (EIDC, 2019) managed by the Centre for Ecology and Hydrology (CEH). The EIDC manages nationally important terrestrial and freshwater science datasets and is a CoreTrustSeal accredited data repository. EIDC has a registration system - users need a free account to download data. The ECN datasets can be discovered and downloaded through the EIDC's data catalogue (the Environmental Information Platform (EIP)). The datasets are listed in table 2, together with their citation information. They should be cited for every use using the information provided (Rennie *et al.*, 2016a,b; Rennie *et al.*, 2017a-p; Rennie *et al.*, 2018).

The ECN datasets are available under the Open Government Licence (Open Government Licence, 2019) and they are available as comma-separated files. Temporal extensions, provided as additional time slices, to the datasets will be created as additional further years of data become available.

## 7. Conclusions

The datasets collected by the UK Environmental Change Network are an invaluable and nationally unique resource, which, over the years, has proved useful to a range of users, including the scientific community and national policy makers. The co-location of high frequency meteorological, biological and biogeochemical measurements means the ECN datasets are ideally placed for the development of clearer process understanding and assessing the impact of shorter term events, such as droughts,

**Commented [RSC46]:** The Data Centre recently received this accreditation so we have added this information to help users feel confident that the data are from a trustworthy source.

**Commented [RSC47]:** Response to Referee 2 – Comment 26

on ecosystems. This two decade ECN data record provides a long-term baseline of environmental variability across a wide range of UK habitats against which environmental changes can be assessed.

#### **Team List**

The following people were ECN site managers during the period of data collection of these datasets: John Adamson, Roy  
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15 ECN and its Data Centre are co-ordinated by the Central Co-ordination Unit at CEH Lancaster. The following people have  
been involved in this during the period of data collection of these datasets: John Adamson, Chris Benefield, Deirdre Caffrey,  
Bill Heal, Pete Henrys, Lynne Irvine, Mandy Lane, Don Monteith, Mike Morecroft, Terry Parr, Susannah Rennie, Rob Rose,  
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#### **Author Contributions**

20 S.R. was responsible for the management of the ECN Data Centre, publication of the datasets and led the writing of this  
manuscript. C.A., S.A., D.B., S.B., V.B., J.D., B.D., C.M., D.P., R.R., S.S., T.S., C.T., H.W. are the current site managers and  
are responsible for site management, data collection and quality checking. All co-authors contributed to the writing, discussion  
and review of this manuscript.

#### **Competing Interests**

25 The authors declare that they have no conflict of interest.

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**Commented [RSC52]:** We have added this reference to provide more information to readers

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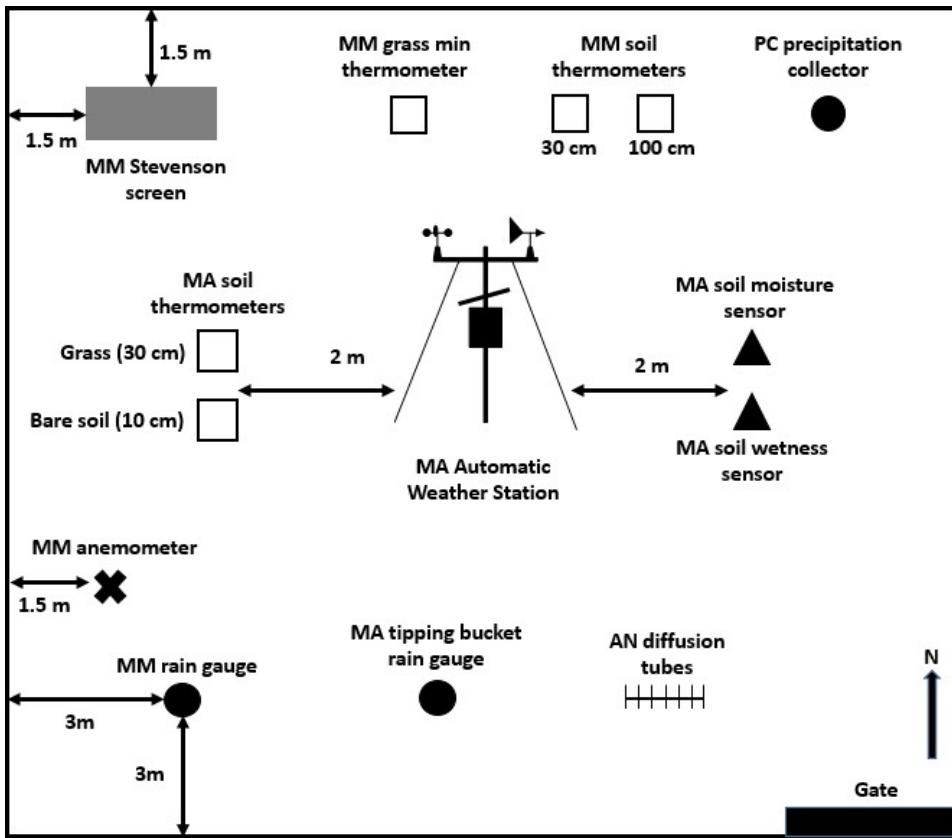
Figure 1: Locations of the ECN terrestrial sites



Figure 2: ECN Meteorological Enclosure (MA = Automatic Weather station; PC = Precipitation Chemistry; AN = Atmospheric Nitrogen; MM = Manual meteorology)

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Table 1: ECN terrestrial sites

Site (ECN Site code)	Site Description (links to the ECN website and DEIMS-SDR)	Location	Altitudinal Range (m above sea level)	Area (ha)	Site Type
Alice Holt (T09)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T09">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T09</a>	51° 9'16.46"N	110-125	850	Woodland

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	<a href="https://deims.org/d47ec839-5d20-4315-9f88-1e9edbab22e8">https://deims.org/d47ec839-5d20-4315-9f88-1e9edbab22e8</a>	0°51'47.58" W			
Drayton (T01)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T01">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T01</a> <a href="https://deims.org/00eb83ef-c965-462d-8022-7f7f75ccd14">https://deims.org/00eb83ef-c965-462d-8022-7f7f75ccd14</a>	52°11'37.95" N 1°45'51.95" W	320-1110	100	Lowland grassland/agricultural (data collection ceased at this site at the end of 2013)
Cairngorms (T12)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T12">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T12</a> <a href="https://deims.org/5a04fee1-42aa-47e9-abfc-043a3eda12ac">https://deims.org/5a04fee1-42aa-47e9-abfc-043a3eda12ac</a>	57° 6'58.84"N 3°49'46.98" W	40-80	190	Upland moor/mountain
Glensaugh (T02)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T02">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T02</a> <a href="https://deims.org/1c4d454d-0c00-49f9-a7fe-3a3e596c3648">https://deims.org/1c4d454d-0c00-49f9-a7fe-3a3e596c3648</a>	56°54'33.36" N 2°33'12.14" W	137-487	112	Upland moor/mountain with native mixed pine wood
Hillsborough (T03)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T03">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T03</a> <a href="https://deims.org/371c5259-6f38-4aa7-9517-c56f608c62cc">https://deims.org/371c5259-6f38-4aa7-9517-c56f608c62cc</a>	54°27'12.24" N 6°4'41.26"W	110-170	400	Lowland grassland/agricultural
Moor House – Upper Teesdale (T04)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T04">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T04</a> <a href="https://deims.org/bf78c96f-0763-4b31-b1a6-6eccef19edd1">https://deims.org/bf78c96f-0763-4b31-b1a6-6eccef19edd1</a>	54°41'42.15" N 2°23'16.26" W	290-848	750	Upland moor/mountain
North Wyke (T05)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T05">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T05</a> <a href="https://deims.org/4fbc4bf9-e342-4412-8f0c-c75aff08a8ca">https://deims.org/4fbc4bf9-e342-4412-8f0c-c75aff08a8ca</a>	50°46'54.96" N 3°55'4.10"W	120-180/	250	Lowland grassland/agricultural

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Porton Down (T10)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T10">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T10</a> <a href="https://deims.org/0f05a86f-0f7a-4b81-8268-6818a6064428">https://deims.org/0f05a86f-0f7a-4b81-8268-6818a6064428</a>	51° 7°37.83"N 1°38'23.46" W	100-172	122	7	Lowland grassland
Rothamsted (T06)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T06">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T06</a> <a href="https://deims.org/cb340d4c-e6e5-465a-b0cb-d6c613fa5541">https://deims.org/cb340d4c-e6e5-465a-b0cb-d6c613fa5541</a>	51°48'12.33" N 0°22'21.66" W	94-134	330		Lowland grassland/agricultural
Sourhope (T07)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T07">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T07</a> <a href="https://deims.org/125d4667-0fae-418d-88ff-7d9930809d12">https://deims.org/125d4667-0fae-418d-88ff-7d9930809d12</a>	55°29'23.47" N 2°12'43.32" W	200-601	111	9	Upland moor/mountain
Wytham (T08)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T08">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T08</a> <a href="https://deims.org/16dcd0c3-a114-412c-9f01-8c1af292ba69">https://deims.org/16dcd0c3-a114-412c-9f01-8c1af292ba69</a>	51°46'52.86" N 1°20'9.81"W	60-165	770		Woodland/agricultural
Yr Wyddfa (Snowdon) (T11)	<a href="http://data.ecn.ac.uk/sites/ecnsites.asp?site=T11">http://data.ecn.ac.uk/sites/ecnsites.asp?site=T11</a> <a href="https://deims.org/8b5da977-eed8-459f-b663-f3835aa0b356">https://deims.org/8b5da977-eed8-459f-b663-f3835aa0b356</a>	53° 4°28.38"N 4° 20.64"W	298-1085	700		Upland moor/mountain

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Table 2: ECN Datasets

Measurement (ECN measurement code)	Frequency of data collection	Variable/s recorded	DOI (Citation)
Meteorology (MA)	Hourly summaries calculated from 5 second samplings	See table 3	<a href="https://doi.org/10.5285/fc9bcd1c-e3fc-4c5a-b569-2fe62d40f2f5">https://doi.org/10.5285/fc9bcd1c-e3fc-4c5a-b569-2fe62d40f2f5</a> (Rennie <i>et al.</i> , 2017a)
Atmospheric nitrogen (AN)	Fortnightly	See table 4	<a href="https://doi.org/10.5285/baf51776-c2d0-4e57-9cd3-30cd6336d9ef">https://doi.org/10.5285/baf51776-c2d0-4e57-9cd3-30cd6336d9ef</a> (Rennie <i>et al.</i> , 2017b)

Precipitation chemistry (PC)	Weekly	See table 5	<a href="https://doi.org/10.5285/18b7c387-037d-4949-98bc-e8db5ef4264c">https://doi.org/10.5285/18b7c387-037d-4949-98bc-e8db5ef4264c</a> (Rennie <i>et al.</i> , 2017c)
Soil solution (SS)	Fortnightly	See table 5	<a href="https://doi.org/10.5285/b330d395-68f2-47f1-8d59-3291dc02923b">https://doi.org/10.5285/b330d395-68f2-47f1-8d59-3291dc02923b</a> (Rennie <i>et al.</i> , 2017d)
Surface water chemistry (WC)	Weekly	See table 5	<a href="https://doi.org/10.5285/fd7ca5ef-460a-463c-ad2b-5ad48bb4e22e">https://doi.org/10.5285/fd7ca5ef-460a-463c-ad2b-5ad48bb4e22e</a> (Rennie <i>et al.</i> , 2017e)
Surface water discharge (WD)	15-minute averages calculated from ten second samplings of stage height	<ul style="list-style-type: none"> <li>• Stage (m)</li> <li>• Discharge (cumecs)</li> </ul>	<ul style="list-style-type: none"> <li>• <a href="https://doi.org/10.5285/8b58c86b-0c2a-4d48-b25a-7a0141859004">https://doi.org/10.5285/8b58c86b-0c2a-4d48-b25a-7a0141859004</a> (Rennie <i>et al.</i>, 2017f)</li> </ul>
Moth (IM)	Nightly; weekly at remote sites	Count of each species trapped	<a href="https://doi.org/10.5285/a2a49f47-49b3-46da-a434-bb22e524c5d2">https://doi.org/10.5285/a2a49f47-49b3-46da-a434-bb22e524c5d2</a> (Rennie <i>et al.</i> , 2017g)
Butterfly (IB)	Weekly between April and September – dependant on weather conditions	Count of each species observed	<a href="https://doi.org/10.5285/5aeda581-b4f2-4e51-b1a6-890b6b3403a3">https://doi.org/10.5285/5aeda581-b4f2-4e51-b1a6-890b6b3403a3</a> (Rennie <i>et al.</i> , 2017h)
Carabid beetles (IG)	Fortnightly	Count of each species trapped	<a href="https://doi.org/10.5285/8385f864-dd41-410f-b248-028f923cb281">https://doi.org/10.5285/8385f864-dd41-410f-b248-028f923cb281</a> (Rennie <i>et al.</i> , 2017i)
Spittle bugs (IS)	Annual	Count of each species/colour morph	<a href="https://doi.org/10.5285/aff433be-0869-4393-b765-9e6faad2a12b">https://doi.org/10.5285/aff433be-0869-4393-b765-9e6faad2a12b</a> (Rennie <i>et al.</i> , 2018)
Baseline vegetation (VB)	One-off survey	Species presence	<a href="https://doi.org/10.5285/a7b49ac1-24f5-406e-ac8f-3d05fb583e3b">https://doi.org/10.5285/a7b49ac1-24f5-406e-ac8f-3d05fb583e3b</a> (Rennie <i>et al.</i> , 2016a)
Coarse-grain vegetation (VC)	Every nine years	Species presence	<a href="https://doi.org/10.5285/d349bab-329a-4d6e-9eca-92e630e1be3f">https://doi.org/10.5285/d349bab-329a-4d6e-9eca-92e630e1be3f</a> (Rennie <i>et al.</i> , 2016b)
Woodland vegetation (VW)	Every nine years - diameter at breast height (dbh) recorded every three years	See table 6	<a href="https://doi.org/10.5285/94aef007-634e-42db-bc52-9aae86adb33">https://doi.org/10.5285/94aef007-634e-42db-bc52-9aae86adb33</a> (Rennie <i>et al.</i> , 2017j)
Fine-grain vegetation (VF)	Every three years – some sites did it annually	Species presence	<a href="https://doi.org/10.5285/b98efec8-6de0-4e0c-85dc-fe4cdf01f086">https://doi.org/10.5285/b98efec8-6de0-4e0c-85dc-fe4cdf01f086</a> (Rennie <i>et al.</i> , 2017k)
Frog (BF)	Annual	See table 7	<a href="https://doi.org/10.5285/4d8c7dd9-8248-46ca-b988-c1fc38e51581">https://doi.org/10.5285/4d8c7dd9-8248-46ca-b988-c1fc38e51581</a> (Rennie <i>et al.</i> , 2017l)

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Breeding Bird Survey (BB)	Twice a year	Count of each species observed	<a href="https://doi.org/10.5285/5886c3ba-1fa5-49c0-8da8-40e69a10d2b5">https://doi.org/10.5285/5886c3ba-1fa5-49c0-8da8-40e69a10d2b5</a> (Rennie <i>et al.</i> , 2017m)
Common Bird Census (CBC)	Annual (variable date ranges for sites)	Count of each species observed and/or nests observed	<a href="https://doi.org/10.5285/8582a02c-b28c-45d2-afa1-c1e85fba023d">https://doi.org/10.5285/8582a02c-b28c-45d2-afa1-c1e85fba023d</a> (Rennie <i>et al.</i> , 2017n)
Bat (BA)	Four times a year	<ul style="list-style-type: none"> <li>Count of each species observed</li> <li>Behaviour</li> </ul>	<a href="https://doi.org/10.5285/2588ee91-6cbd-4888-86fc-81858d1bf085">https://doi.org/10.5285/2588ee91-6cbd-4888-86fc-81858d1bf085</a> (Rennie <i>et al.</i> , 2017o)
Rabbit and deer (BU)	Twice a year	Count of the dropping of each species	<a href="https://doi.org/10.5285/0be0aed3-f205-4fff-a65d-84f8cfd8d50f">https://doi.org/10.5285/0be0aed3-f205-4fff-a65d-84f8cfd8d50f</a> (Rennie <i>et al.</i> , 2017p)

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Table 3: Meteorological variables

Name in Dataset	Description	Units
ALBGRD	Albedo Ground (average)	Wm <sup>-2</sup>
ALBSKY	Albedo Sky (average)	Wm <sup>-2</sup>
DRYTMP	Dry bulb temperature (average)	°C
DRTYMP_RH	Dry bulb temperature within the relative humidity sensor (average)	°C
NETRAD	Net Radiation (average)	Wm <sup>-2</sup>
RAIN	Rainfall (total)	mm
RH	Relative humidity (average)	%
SOLAR	Solar Radiation (average)	Wm <sup>-2</sup>
STMP10	Soil temperature at 10 cm (average)	°C
STMP30	Soil temperature at 30 cm (average)	°C
SURWET	Surface wetness (number of minutes in the hour that surface is wet)	minutes
SWATER	Soil moisture – gypsum block (average)	bar
SWATER_T	Soil moisture – theta probe at 20 cm (average)	%
SWATER_T10	Soil moisture – theta probe at 10 cm (average)	%
SWATER_VWC	Soil moisture – volumetric water content at 20 cm (average)	m <sup>3</sup> /m <sup>3</sup>
WDIR	Wind direction (average)	degrees
WETTMP	Wet bulb temperature (average)	°C
WSPEED	Wind speed (average)	ms <sup>-1</sup>

Table 4: Atmospheric Chemistry variables

Name in Dataset	Description	Units
WEIGHTNO2	Weight of NO2 on the mesh	micrograms
NO2	NO2 concentration	micrograms/m3
NO2PPB	NO2 concentration	ppb
TDIFF	Exposure time	minutes
Q1-n	Quality code (see section 4)	integer

**Table 5: Chemical and associated variables (Precipitation chemistry, soil solution, surface water chemistry)**

Name in Dataset	Description	Units
ALKY	Alkalinity	mg/l
ALUMINIUM	Aluminium	mg/l
CALCIUM	Calcium	mg/l
CHLORIDE	Chloride	mg/l
COLOUR	Absorbance at 436nm	nM
CONDY	Conductivity	µS/cm
DOC	Dissolved organic carbon	mg/l
IRON	Iron	mg/l
MAGNESIUM	Magnesium	mg/l
NH4N	Ammonium	mg/l
NO3N	Nitrate nitrogen	mg/l
PH	pH	pH scale 1-14
PHAQCS	Aquacheck system pH stirred	pH scale 1-14
PHAQCU	Aquacheck system pH unstirred	pH scale 1-14
PO4P	Phosphate phosphorus	mg/l
POTASSIUM	Potassium	mg/l
SO4S	Sulphate sulphur	mg/l
SODIUM	Sodium	mg/l
TOTALN	Total nitrogen	mg/l
TOTALP	Total dissolved phosphorus	mg/l
VOLUME	Volume of sample collected (Precipitation and soil solution chemistry datasets only)	ml
VACUUM	Residual vacuum at time of sampling	bar

	(Soil solution chemistry dataset only)	
STAGE	Stage reading of water level (Surface water chemistry dataset only)	mm

**Table 6: Woodland Vegetation variables**

Name in dataset	DESCRIPTION	UNITS
A	Species recorded as sapling	species code
C	Species recorded as canopy dominant	species code
DIAMETER	Diameter at breast height (dbh)	cm
DISTANCE	Distance of stem from centre of random cell	m
E	Species recorded as seedling	species code
H	Species recorded as shrub layer	species code
HEIGHT	Height	m
I	Species recorded as intermediate	species code
NUM_STEMS	Number of stems	count
S	Species recorded as subdominant	species code
SEEDLING	Species recorded in seedling survey of cell	species code
U	Species recorded as suppressed	species code
Q1-n	Quality code (see section 4)	integer

5 **Table 7: Frog variables**

Name in dataset	Description	Units
ALKY	Alkalinity	mg/l
ALUMINIUM	Aluminium	mg/l
CALCIUM	Calcium	mg/l
CHLORIDE	Chloride	mg/l
CONDY	Conductivity	$\mu\text{S}/\text{cm}$
COLOUR	Absorbance at 436nm	nM
CONGDATE	Date frogs first seen congregating	date
DEPTH	Depth at centre of spawning area	cm
DOC	Dissolved organic carbon	mg/l
HATCHDATE	Date of first hatching observed	date
IRON	Iron	mg/l

LEAVEDATE	Date frogs first seen leaving	date
MAGNESIUM	Magnesium	mg/l
MAXTMP	Maximum temperature	°C
MINTMP	Minimum temperature	°C
NEWMASS	Number of new spawn masses	count
NH4N	Ammonium	mg/l
NO3N	Nitrate nitrogen	mg/l
PERCDEAD	Percentage dead or diseased eggs	%
PH	pH from water sample processed in laboratory	pH scale 1-14
PH1	First pH reading from daily sample	pH scale 1-14
PH2	Second pH reading from daily sample	pH scale 1-14
PH3	Third pH reading from daily sample	pH scale 1-14
PHAQCS	Aquacheck system pH stirred	pH scale 1-14
PHAQCU	Aquacheck system pH unstirred	pH scale 1-14
PO4P	Phosphate phosphorus	mg/l
POTASSIUM	Potassium	mg/l
SO4S	Sulphate sulphur	mg/l
SODIUM	Sodium	mg/l
SPAWNDATE	Date of first spawning observed	date
SURFAREA	Total surface area covered by spawn	m <sup>2</sup>
STAGE	Stage reading of water level	mm
TOTALN	Total nitrogen	mg/l
TOTALP	Total dissolved phosphorus	mg/l
VACUUM	Residual vacuum at time of sampling	bar
VOLUME	Volume of sample collected	ml
Q1-n	Quality code (see section 4)	integer

**Table 8: Species coding lists**

ECN Measurement	Coding List Used	Reference
Moths (IM)	Rothamsted Insect Survey	Rothamsted Insect Survey, 2019
Butterflies (IB)	Butterfly Monitoring Scheme	UKBMS, 2019
Carabid Beetles (IG)	Biological Records Centre	Biological Records Centre, 2019
Spittle Bugs (IS)	Biological Records Centre	Biological Records Centre, 2019

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<a href="#">Vegetation (VB, VC, VW, VF)</a>	<a href="#">National Vegetation Classification.</a> <a href="#">A look-up to the Biological Records Centre codes is also provided</a>	<a href="#">Rodwell, 1991</a> <a href="#">Biological Records Centre, 2019</a>
<a href="#">Birds (CBC)</a>	<a href="#">British Trust for Ornithology</a>	<a href="#">BBS, 2019</a>
<a href="#">Birds (CBC)</a>	<a href="#">British Trust for Ornithology</a>	<a href="#">CBC, 2019</a>
<a href="#">Bats (BA)</a>	<a href="#">ECN-developed code list</a>	<a href="#">Supporting information with the data download</a>
<a href="#">Rabbit and Deer (BU)</a>	<a href="#">ECN-developed code list</a>	<a href="#">Supporting information with the data download</a>

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