NEON USER GUIDE TO LITTERFALL AND FINE WOODY DEBRIS PRODUCTION AND CHEMISTRY (DP1.10033.001)

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CHANGE RECORD

REVISION	DATE	DESCRIPTION OF CHANGE
A	12/11/2017	Initial Release
B	09/01/2020	Included text regarding use of neonUtilities R package and statement about possible sampling location changes. Added text on reductions in trap numbers and publication of litter chemistry and stable isotope data along with mass fluxes as part of this data product.
C	04/25/2022	Updated section 4.3 Data Revision with latest information regarding data release.
D	1/25/2023	Section 3.1, minor clarification regarding plot numbers; Section 3.2, updated the timing for when data tables are expected to appear on the NEON data portal; Section 3.3.3, added new section for design change to measure all functional groups for chemistry and stable isotopes; Section 3.9, minor update to clarify data relationships between massdata and chemistrySubsamplng; Section 3.10, updated information on 2020 litter chemistry prototype including link to dataset.
D.1	11/13/2023	Described new ltr_vegetationCover table.
E	03/09/2024	Described new subplotID naming convention and change.
F	03/13/2025	Minor text editing throughout; Fixed AD[14] as it was referencing the wrong protocol; Section 3.6, updated spatial data link URL; Updated Section 3.8, updated the numbers for expected product instances as there were errors previously; Section 3.9, updated data relationship for field-data to massdata as there were errors previously; Section 4.4, added a dataQF value. Added information about the new neonUtilities Python package.

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1 DESCRIPTION

1.1 Purpose

This document provides an overview of the data included in this NEON Level 1 data product, the quality controlled product generated from raw Level 0 data, and associated metadata. In the NEON data products framework, the raw data collected in the field, for example, the dry weights of litter functional groups from a single collection event are considered the lowest level (Level 0). Raw data that have been quality checked via the steps detailed herein, as well as simple metrics that emerge from the raw data are considered Level 1 data products.

The text herein provides a discussion of measurement theory and implementation, data product provenance, quality assurance and control methods used, and approximations and/or assumptions made during L1 data creation.

1.2 Scope

This document describes the steps needed to generate the L1 data product, Litterfall and fine woody debris production and chemistry, which includes the dry weight of litterfall and fine woody debris collected from litter traps by plant functional type as well as chemistry and stable isotope values from select collection bouts. As of August 2020, the Litter chemical properties (DP1.10031.001) and Litter stable isotopes (DP1.10101.001) data products are being published as part of Litterfall and fine woody debris production and chemistry (DP1.10033.001). However, this User Guide is focused on the mass flux component, while a related Data Product User Guide details the chemistry and stable isotope measurements. This document also provides details relevant to the publication of the data product via the NEON data portal, with additional detail available in the file, NEON Data Variables for Litterfall and fine woody debris production and chemistry (DP1.10033.001) (AD[04]) and NEON Categorical Codes for Litterfall and fine woody debris production and chemistry (AD[05]), provided in the download package for this data product.

This document describes the process for ingesting and performing automated quality assurance and control procedures on the data collected in the field pertaining to TOS Protocol and Procedure: LTR – Litterfall and Fine Woody Debris (AD[08]). The raw data that are processed in this document are detailed in the file, NEON Raw Data Validation for Litterfall and Fine Woody Debris (DP0.10033.001) (AD[06]), provided in the download package for this data product. Please note that raw data products (denoted by 'DP0') may not always have the same numbers (e.g., '10033') as the corresponding L1 data product.

2   RELATED DOCUMENTS AND ACRONYMS

2.1   Associated Documents

AD[01]	NEON.DOC.000001	NEON Observatory Design (NOD) Requirements
AD[02]	NEON.DOC.000913	TOS Science Design for Spatial Sampling
AD[03]	NEON.DOC.002652	NEON Data Products Catalog
AD[04]	Available with data download	NEON Data Variables for Litterfall and fine woody debris production and chemistry (DP1.10033.001)
AD[05]	Available with data download	NEON Categorical Codes for Litterfall and fine woody debris production and chemistry
AD[06]	Available with data download	NEON Raw Data Validation for Litterfall and Fine Woody Debris (DP0.10033.001)
AD[07]	NEON.DOC.000914	TOS Science Design for Plant Biomass, Productivity, and Leaf Area Index
AD[08]	NEON.DOC.001710	TOS Protocol and Procedure: LTR – Litterfall and Fine Woody Debris
AD[09]	NEON.DOC.000913	TOS Science Design for Spatial Sampling
AD[10]	NEON.DOC.000913	TOS Science Design for Plant Diversity
AD[11]	NEON.DOC.000008	NEON Acronym List
AD[12]	NEON.DOC.000243	NEON Glossary of Terms
AD[13]	NEON.DOC.014037	TOS Protocol and Procedure: HBP – Measurement of Herbaceous Biomass
AD[14]	NEON.DOC.014038	TOS Protocol and Procedure: BBC – Plant Belowground Biomass Sampling
AD[15]	NEON.DOC.004825	NEON Algorithm Theoretical Basis Document (ATBD): OS Generic Transitions
AD[16]	Available on NEON data portal	NEON Ingest Conversion Language Function Library
AD[17]	Available on NEON data portal	NEON Ingest Conversion Language

2.2   Acronyms

Acronym	Definition
ANPP	Annual Net Primary Productivity
STRI/CTFS	Smithsonian Tropical Research Institute Center for Tropical Forest Science

3   DATA PRODUCT DESCRIPTION

The Litterfall and fine woody debris production and chemistry data product provides mass data for plant litter functional groups from individual sampling bouts, as well as chemistry and stable isotope data from select bouts (described in a related User Guide). Litter and fine woody debris are collected from elevated and ground traps, respectively. All masses reported following processing are reported at the spatial resolution of a single trap and the temporal resolution of a single collection event.

Mass data for each collection event are measured separately for the following functional groups, to an accuracy of 0.01 grams. Weights < 0.01g are reported and may indicate presence of a given functional group identified in the sorting process, but these masses are highly uncertain.

- Leaves
- Needles
- Twigs/branches
- Woody material (e.g. seed cones, bark, other lignified structures)
- Seeds (including fruits and other attached structures)
- Flowers (includes pollen cones and attached structures e.g., pedicels, peduncles…)
- Other (lichen, mosses, frass, unidentifiable material, etc.)
- Mixed (unsorted litter material)

In this protocol, litter is defined as material that is dropped from the forest canopy and has a butt end diameter <2cm and a length <50 cm; this material is collected in elevated 0.5m^2 PVC traps. Fine wood debris is defined as material that is dropped from the forest canopy and has a butt end diameter <2cm and a length >50 cm; this material is collected in ground traps as longer material is not reliably collected by the elevated traps. Elevated PVC litter trap design is consistent with that used by the Smithsonian Tropical Research Institute Center for Tropical Forest Science (STRI/CTFS) (Muller-Landau and Wright 2010). Each is a 0.5m^2 square with mesh 'basket' elevated ~80cm above the ground. Ground traps are 3 m x 0.5 m rectangular areas. Muller-Landau and Wright (2010) employ square elevated litter and ground traps that are both 0.5 m^2, for sampling litter and fine woody debris production in a tropical forest. However, due to the spatially heterogeneous production of fine woody debris, and particularly for larger pieces of fine woody debris, larger rectangular ground traps may be more appropriate (Muller-Landau, personal communication).

Litterfall and fine woody debris data may be used to estimate annual Aboveground Net Primary Productivity (ANPP) and aboveground biomass at plot, site, and continental scales. They also provide essential data for understanding vegetative carbon and nutrient fluxes over time.

3.1   Spatial Sampling Design

Litter and fine woody debris sampling is executed at terrestrial NEON sites that contain woody vegetation >2m tall in at least 10% of Tower plots. Along with most of NEON's plant productivity measurements, sampling for this product occurs only in Tower plots (AD[06]). Locations of Tower plots are selected randomly within the 90% flux footprint of the primary and secondary airsheds (and additional areas in close proximity to the airshed, as necessary to accommodate sufficient spacing between plots). In sites with forested tower airsheds, the litter sampling is targeted to take place in up to two randomly selected subplots in

each of 20 40m x 40m plots. In sites with low-statured vegetation in the tower airsheds, up to 30 20m x 20m plots. In some cases, available space, plot spacing requirements, and/or the tower airshed size restricts the number of Tower plots to below 20 (forested) or 30 (low-stature), which impacts the maximum plot numbers where litter could be sampled. See TOS Science Design for Plant Biomass, Productivity, and Leaf Area Index (AD[07]), TOS Protocol and Procedure: LTR – Litterfall and Fine Woody Debris (AD[08]), TOS Science Design for Plant Biomass, Productivity, and Leaf Area Index (AD[09]) and TOS Science Design for Plant Diversity (AD[10]) for further details.

One elevated trap and/or one ground trap is deployed for every selected 400 m^2 plot area (2 randomly selected 20x20 m subplots in 40 x 40 m Tower plots), resulting in 1-4 traps per plot. Trap placement within plots may be either targeted or randomized, depending on the vegetation. In sites with > 50% aerial cover of woody vegetation >2m in height, placement of litter traps is random and utilizes the randomized list of grid cell locations also used for herbaceous clip harvest and belowground biomass sampling (Figure 1) (AD[13], AD[14]). This is an ordered list of all available sampling locations within a given plot, from which a **clipCell** is removed after being utilized for sampling in any one of the three sampling protocols. Removal precludes consideration of a **clipCell** for future sampling under all protocols. In sites with < 50% cover of woody vegetation, sites with heterogeneously distributed, patchy, vegetation, trap placement is targeted such that only areas beneath qualifying vegetation are considered for trap placement. Woody vegetation cover, as measured by NEON's Airborne Observation Platform and/or vegetation structure protocols, may be be used to scale up litterfall production from the point measurements included here.

As much as possible, sampling occurs in the same locations over the lifetime of the Observatory. However, over time some sampling locations may become impossible to sample, due to disturbance or other local changes. When this occurs, the location and its location ID are retired. A location may also shift to slightly different coordinates. Refer to the locations endpoint of the NEON API for details about locations that have been moved or retired: https://data.neonscience.org/data-api/endpoints/locations/
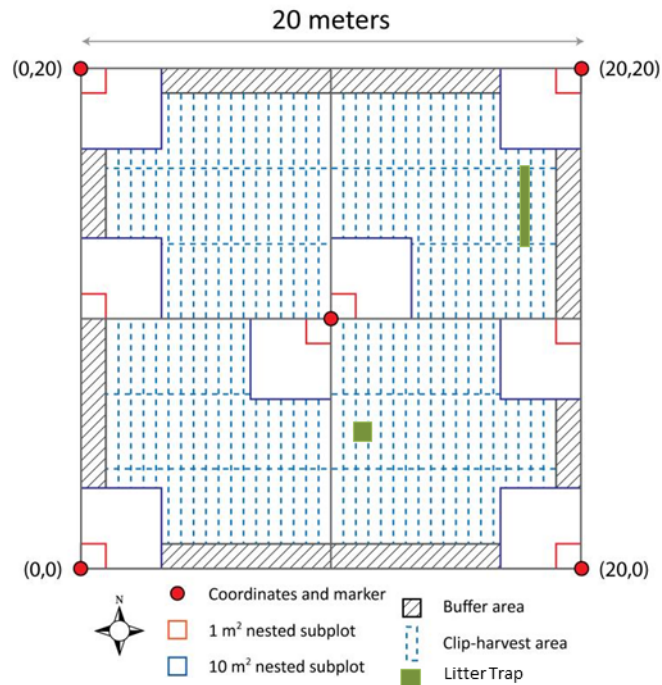
Figure 1: Arrangement of clip cells within a 20mx20m plot; a 1m buffer around the edge of the plot and all nested subplots are excluded from consideration for sampling to avoid interfering with plant diversity measurements, vegetation structure measurements and areas subject to high traffic around the edge of the plot. See AD[13] for details about clip cell design.

3.2 Temporal Sampling Design

Ground traps are sampled once per year. Target sampling frequency for elevated traps varies by vegetation present at the site, with frequent sampling (1x every 2weeks) in deciduous forest sites during senescence, and infrequent year-round sampling (1x every 1-2 months) at evergreen sites. A subset of collection bouts are chosen for chemistry and stable isotope measurements, once every five years. See TOS Science Design for Plant Biomass, Productivity, and Leaf Area Index (AD[07]), and the TOS Protocol and Procedure: LTR – Litterfall and Fine Woody Debris (AD[08]) for more details. At sites with deciduous vegetation or limited access during winter months, litter sampling of elevated traps may be discontinued for up to 6 months during the dormant season.

Trap deployment metadata is scheduled to appear on the NEON data portal 30 days after it is recorded, while field collection data, dry mass values, and chemistry subsampling metadata are scheduled to appear 60 days after data are collected for each activity. Note that chemistry subsampling records may appear on the data portal significantly later than the other tables for specific functional groups, see section 3.3.3 for more details.

3.3   Sampling Design Changes

3.3.1   2018-19 Sorting Reductions

Prior to the 2018 sampling season, all collections were sorted into the functional groups listed above prior to drying and measurement of dry mass. For the 2018 and 2019 sampling seasons, sorting of litterfall to functional group was reduced to traps from a spatially balanced subsample of five plots per bout. The reduced 2018-19 sorting effort corresponds to sorting either 5 traps (for 20m x 20m plots) or 10 traps (for 40m x 40m plots). All other traps were collected and measured as a mixed sample. This sampling reduction was reversed in the 2020 sampling season and all collected samples are sorted unless dictated by logistical constraints.

3.3.2   2020 Trap Number Reductions

Statistical analyses related to sampling effort identified a subset of sites where the number of elevated traps might be reduced from maximum tower plot numbers without impacting estimates of site level fine litter production. At the sites listed below, these reductions were implemented beginning in the 2020 sampling year. Analyses of ground trap litter production did not support dropping any ground traps; at the sites listed below (Table 1), litter traps are not deployed as elevated/ground pairs at all plots. As such we recommend that site level estimates are calculated for elevated and ground traps independently.

Table 1: Sampling reductions implemented 2020 sampling year

Domain	Site	Original Elevated Trap Count	Reduced Elevated Trap Count
D01	BART	40	20
D01	HARV	40	20
D02	SCBI	40	20
D02	SERC	40	20
D03	JERC	40	20
D05	TREE	40	30
D05	UNDE	40	20
D07	GRSM	40	20
D07	ORNL	40	20
D08	TALL	40	20

3.3.3   2022 Chemistry Measurements for All Functional Groups

In 2021 and earlier data, the chemistry of litter material was only measured for functional groups 'leaves' and 'needles'. This presented an issue for calculating mass-weighted fluxes of elements and stable isotopes because material from other functional groups can contribute a substantial amount to the litter mass flux in certain sites. Starting in the 2022 field season, all functional groups are analyzed for chemistry and stable isotopes. As before, leaf and needle materials are measured at the plot scale, whereas the other functional groups measure a site-level pooled sample, combining material across plots for the

bout where mass was highest for each group. This change brings with it a new sampleID construction for those functional groups. Moreover, chemistry subsampling data may appear significantly later than related field and mass records as it is sometimes necessary to wait until end of the sampling season to verify the highest-mass bout per group.

3.3.4   2023 Addition of Vegetation Cover Table

Litter traps are deployed at all sites with woody vegetation >2m tall in >=10% of Tower plots. Scaling litter production from material collected in litter traps to the plot or site requires data on total qualifying vegetation cover. To facilitate calculation of litter production at the subplot, plot and site scale, a new table ltr_vegetationCover has been added to the litter data product. Total areal cover (m^2) and percent cover of vegetation >2m for all subplots/plots where litter traps are deployed is calculated from the LiDAR derived canopy height model (CHM) in the Ecosystem Structure data product (DP3.30015.001) collected by NEON's Airborne Observation Platform. Those data are published alongside the Litterfall data for every year an AOP survey was/is completed at at given site.

3.3.5   2024 Subplot naming convention

The subplot naming convention was changed in all data; see section 3.6 Spatial Resolution and Extent for details.

3.4   Variables Reported

All variables reported from the field or laboratory technician (L0 data) are listed in the file, NEON Raw Data Validation for Litterfall and Fine Woody Debris (DP0.10033.001) (AD[06]). All variables reported in the published data (L1 data) are also provided separately in the file, NEON Data Variables for Litterfall and fine woody debris production and chemistry (DP1.10033.001) (AD[04]).

Field names have been standardized with Darwin Core terms (http://rs.tdwg.org/dwc/; accessed 16 February 2014), the Global Biodiversity Information Facility vocabularies (http://rs.gbif.org/vocabulary /gbif/; accessed 16 February 2014), the VegCore data dictionary (https://projects.nceas.ucsb.edu/ncea s/projects/bien/wiki/VegCore; accessed 16 February 2014), where applicable. NEON Terrestrial Observation System (TOS) spatial data employs the World Geodetic System 1984 (WGS84) for its fundamental reference datum and Geoid12A geoid model for its vertical reference surface. Latitudes and longitudes are denoted in decimal notation to six decimal places, with longitudes indicated as negative west of the Greenwich meridian.

Some variables described in this document may be for NEON internal use only and will not appear in downloaded data.

3.5   Temporal Resolution and Extent

The finest resolution at which temporal data are reported is the **daysOfTrapping**, the range between **setDate** and **collectDate** for a given **trapID**.

All traps collected as part of a single field collection effort may be grouped by the **eventID** field. The **eventID** for each sampling bout is a unique string. Individual traps within an **eventID** may have different

daysOfTrapping. Sampling bouts are numbered according to the numeric week of year. In the event that a sampling bout is canceled, traps will continue collecting litter material and **daysOfTrapping** field will capture the duration of any extended collection period resulting from a cancelled collection event.

collectDate (date an individual trap was collected) → **daysOfTrapping** → annual production

3.6 Spatial Resolution and Extent

The finest resolution at which spatial data for litter mass fluxes are reported is a single trap (Figure 2).

trapID (unique ID given to the individual trap, based on location within the plot) → **subplotID** (ID of one of four subplots within a plot) → **plotID** (ID of plot within site) → **siteID** (ID of NEON site) → **domainID** (ID of a NEON domain.
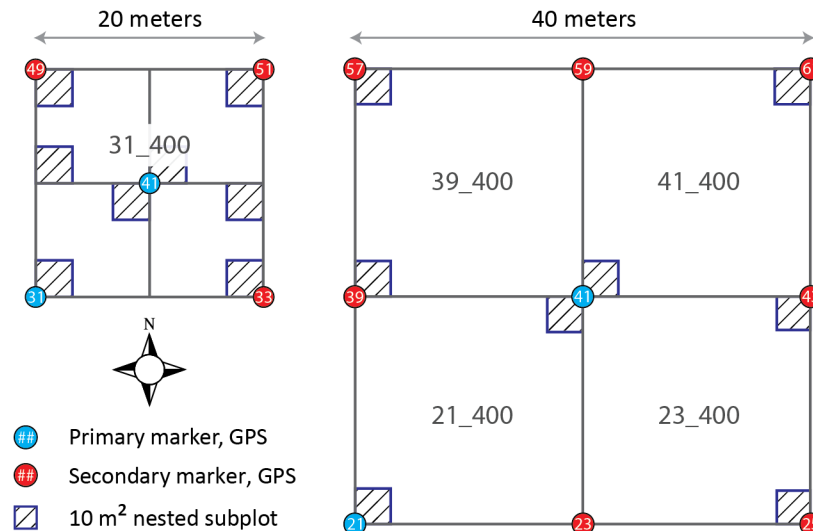

Figure 2: Plot, subplot and nested subplot layout in 20mx20m and 40mx40m Tower plots

The naming convention for subplots within Base plots consists of the identity of the plot point in the southwest corner of the subplot and the scale or size of the subplot. For example, subplot '21_400' is located with point 21 in the southwest corner and is 400m^2 (20m x 20m, Figure 2) and subplot '41_100' is located such that point 41 is in the southwest corner and is 100m^2 (10m x 10m, Figure 2).

Subplots within Base plots in data releases prior to the 2024 data release – Release 2024 – follow a slightly different naming convention. Previously, subplots of 100m^2 or 400m^2 were identified only by the identity of the point in the southwest corner of the subplot (e.g., '21' or '41'). The difference is that the updated subplotID contains the scale or area of the subplot in the string (e.g., '21_400' or '41_100').

The basic spatial data included in the data downloaded include the latitude, longitude, and elevation of the centroid of the plot where sampling occurred + associated uncertainty due to GPS error and plot width. Shapefiles of all NEON Terrestrial Observation System sampling locations can be found here: https://www.neonscience.org/data-samples/data/spatial-data-maps

To derive a more precise estimate of the location of each trap, there are two options:

- Use the getLocTOS function from the geoNEON package, available here: https://github.com/NEONScience/NEON-geolocation

- Or follow these steps to perform the same calculation:

  1. The namedLocation field in the data is the named location of the plot; more precise geographic data require the named location of the subplot. Construct the named location of the subplot of each record in ltr_pertrap by concatenating the fields for namedLocation and subplotID as: namedLocation + '.' + subplotID, e.g. subplotID '41' of namedLocation 'HARV_052.basePlot.ltr' has a complete named location of 'HARV_052.basePlot.ltr.41'.

  2. Use the API (http://data.neonscience.org/api; e.g. http://data.neonscience.org/api/v0/locations/HARV_052.basePlot.ltr.41) to query for elevation("locationElevation"), easting("locationUtmEasting"), northing("locationUtmNorthing"), coordinateUncertainty ("Value for Coordinate uncertainty"), elevationUncertainty ("Value for Elevation uncertainty"), and utmZone ("locationUtmZone") as inputs to the next step.

  3. Calculate the clipCellNumber of each trap (last 3 digits of trapID).

  4. Use the clip cell lookup table, available here: http://data.neonscience.org/api/v0/documents/clipCellNumber_lookup (clicking on link will initiate download), to find the offsets for each clipCellNumber and subplot (=pointID), and use the offsets to adjust the UTM values downloaded in step 2.

  5. Increase coordinateUncertainty by an appropriate amount to account for error introduced by navigating within plots. Technicians may shift elevated trap up to 1 meter to either the north or south within a selected clip cell to avoid obstacles. Additional error may be introduced due to tape stretching to navigate to locations within plots.

dryMass data from individual traps may be scaled to production per unit area using area or percent cover of qualifying vegetation from the ltr_vegetationCover table.

3.7 Associated Data Streams

massSampleMixtureID, **cnSampleID** and **ligninSampleID** are linking variables that tie specific, pooled samples and associated metadata to their chemistry and stable isotope measurements. Additional information about woody vegetation present in the plot, contributing to litter production, is available in the NEON Woody Plant Vegetation Structure data product (DP1.10098.001). Users are advised to leverage data from vegetation structure to provide context to litter data. Additional information about herbaceous vegetation present in the plot is available in the NEON Herbaceous Clip Harvest data product (DP1.10023.001). Four Tower plots have spatially coincident litter and soil data, the latter are available in the NEON Soil physical and chemical properties, periodic data product (DP1.10086.001).

3.8 Product Instances

There are no more than 13 litterfall collection bouts per year per site, with litter collected from no more than 40 elevated traps per bout. Each elevated litter trap will yield no more than 8 dry mass values (one

for each functional group or material category). There are a maximum of 40 ground traps per site. Each ground trap may have up to 5 functional groups and is sampled once per year, yielding no more than 200 dry mass values per year. Thus, no single site should ever exceed 4,360 litter mass data product instances in a given calendar year.

3.9 Data Relationships

The protocol dictates that each trap is established once (one expected record per **trapID** in ltr_pertrap). A record from ltr_pertrap may have zero or more child records in ltr_fielddata.trapID, depending on the date range of the data downloaded; a given ltr_fielddata.trapID is expected to be sampled zero or one times per **collectDate** (local time). A record from ltr_fielddata may have zero (if the trapCondition resulted in no litter collected) or more child records in ltr_massdata depending on the functional groups contained in the trap and whether reweighing occurred for QA purposes. A record from ltr_massdata may be pooled with one or more other ltr_massdata records into zero (if not sent for chemistry analyses) or one child record in ltr_chemistrySubsampling. These child records will appear in associated tables, described in the related Data Product User Guide for Litter chemical properties and Litter stable isotopes. Duplicates and/or missing data may exist where protocol and/or data entry aberrations have occurred; users should check data carefully for anomalies before joining tables.

ltr_pertrap.csv - > One record expected per **trapID** for all time

ltr_fielddata.csv - > One record expected per **trapID** per **collectDate** (day of year, local time) combination, generates a single **fieldSampleID** if litter is present in the trap

ltr_massdata.csv - > One record expected per **fieldSampleID** per **functionalGroup**, generates a single **massSampleID**. Duplicate instances of a single **massSampleID** are expected to exist where **qaDryMass** = 'Y'; these are samples that are reweighed for quality assurance purposes.

ltr_chemistrySubsampling.csv - > One record expected per **massSampleMixtureID**, which is a mixture of pooled massSampleID's (listed in **massSampleIDList**). Not all massSampleID's contribute to mixtures; some are discarded (consult the pooled list). Generates samples used to measure litter chemical properties and stable isotopes, and (sample size permitting) an archive sample for the NEON Biorepository.

ltr_vegetationCover.csv -> One record expected per **subplotID** per year in which an AOP survey is completed.

sampleIDs will be generated for each collection event and functional group within a sample. If the collection event has been selected for biogeochemical analyses and archive, subsamples are created, **sampleBarcodes** generated, and shipped to external labs or the NEON Biorepository. Otherwise, physical samples are discarded following measurement. See the related Data Product User Guide for more details on chemistry and stable isotope analyses and material archiving.

Data downloaded from the NEON Data Portal are provided in separate data files for each site and month requested. The neonUtilities package in R and the neonutilities package in Python contain functions to merge these files across sites and months into a single file for each table. The neonUtilities R package is available from the Comprehensive R Archive Network (CRAN; https://cran.r-project.org/web/packages/neonUtilities/index.html) and can be installed using the install.packages() function in R. The neonutilities package in Python is available on the Python Package Index (PyPi; https://pypi.org/project/neonutilities/)

and can be installed using pip. For instructions on using the package in either language to merge NEON data files, see the Download and Explore NEON Data tutorial on the NEON website: https://www.neonscience.org/download-explore-neon-data.

3.10 Special Considerations

3.10.1 2020 Chemistry Prototype

In 2020, two sites (D01 - Bartlett Experimental Forest and D05 - Treehaven) prototyped a revised method for litter sample pooling and chemical analysis. For the entire season, these sites pooled all functional groups at the level of the *site* (e.g., combining across plots), for all bouts in the year, and sent all functional groups for chemistry and stable isotope analyses. This was in addition to creating the plot-level samples for leaves and needles from a single fall bout as in the standard workflow. The results were used to inform the design change for litter chemistry that was adopted in 2022. The data along with a presentation compiling some of the results are available as a prototype dataset on the NEON data portal: https://data.neonscience.org/prototype-datasets/a6d42f4b-8d76-f192-9bbd-872b3e264437.

4 DATA QUALITY

4.1 Data Entry Constraint and Validation

Many quality control measures are implemented at the point of data entry within a mobile data entry application or web user interface (UI). For example, data formats are constrained and data values controlled through the provision of dropdown options, which reduces the number of processing steps necessary to prepare the raw data for publication. An additional set of constraints are implemented during the process of ingest into the NEON database. The product-specific data constraint and validation requirements built into data entry applications and database ingest are described in the document NEON Raw Data Validation for Litterfall and Fine Woody Debris (DP0.10033.001), provided with every download of this data product. Contained within this file is a field named 'entryValidationRulesForm', which describes syntactically the validation rules for each field built into the data entry application. Also included in this file is a field named 'entryValidationRulesParser', which describes syntactically the validation rules for each field that is performed upon ingest of the data into the NEON Cyberinfrastructure, based on a standardized data validation language (Nicl) internal to NEON. Please see AD[16] and AD[17] for more information about the Nicl language.

4.2 Automated Data Processing Steps

Following data entry into a mobile application or web user interface, the steps used to process the data through to publication on the NEON Data Portal are detailed in the NEON Algorithm Theoretical Basis Document: OS Generic Transitions (AD[15]).

4.3 Data Revision

All data are provisional until a numbered version is released. Annually, NEON releases a static version of all or almost all data products, annotated with digital object identifiers (DOIs). The first data Release

was made in 2021. During the provisional period, QA/QC is an active process, as opposed to a discrete activity performed once, and records are updated on a rolling basis as a result of scheduled tests or feedback from data users. The Issue Log section of the data product landing page contains a history of major known errors and revisions.

4.4 Quality Flagging

The **dataQF** field in each data record is a quality flag for known errors applying to the record.

Table 2: Descriptions of the dataQF codes for quality flagging

fieldName	value	definition
dataQF	legacyData	Data recorded using a paper-based workflow that did not implement the full suite of quality control features associated with the interactive digital workflow
dataQF	Non-standard trap construction	Traps constructed incorrectly, resulting in an area of 0.64m2 instead of standard 0.5m2

Records of land management activities, disturbances, and other incidents of ecological note that may have a potential impact are found in the Site Management and Event Reporting data product (DP1.10111.001).

5   REFERENCES

Muller-Landau, H. C., and S. J. Wright. 2010. Litterfall Monitoring Protocol. The Center for Tropical Forest Science Global Forest Carbon Research Initiative (http://www.forestgeo.si.edu/).