# TOS PROTOCOL AND PROCEDURE: COARSE DOWNED WOOD

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See configuration management system for approval history.

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## Change Record

| REVISION | DATE | ECO # | DESCRIPTION OF CHANGE |
|---|---|---|---|
| A_DRAFT | 01/28/2015 | ECO-02135 | Initial draft release |
| B | 02/02/2015 | ECO-02673 | Migration to new protocol template, name change |
| C | 02/29/2016 | ECO-03584 | • Updated volume factor values for 5 domains (Appendix E)<br>• Additional guidance in chainsaw and fueling safety<br>• Updated time estimates for SOP B (Section 6.4)<br>• Added qualifying CDW characteristics to beginning of SOP B.1<br>• Changed scientificName to taxonID (Table 7); updated codes for `unknown hardwood` and `unknown softwood`<br>• Updated Branch Bark Cover percent categories and guidance for remarks(SOP B.1, Step 8)<br>• Table 9 modified to focus less on evergreen tree characteristics; table re-structured to enable faster decayClass assessment<br>• Added SOP B.2, devoted to tallying and measurement of forked CDW particles.<br>• Added additional scenarios to Table 10<br>• Updated sampling strategy priorities for SOP C.1 and C.2<br>• Added special instructions for SOP E - Data Entry<br>• Created 2-page quick reference sheet for field usage (Appendix B)<br>• Expanded limiting distances table (Appendix F - Table 20)<br>• Expanded minimum round diameters table (Appendix F - Table 21)<br>• Expanded Split CDW/Round Diameter Equivalents Table (Appendix F - Table 22) |
| D | 03/09/2017 | ECO-04422 | • Updated text to account for data collection using a mobile application.<br>• SOP B: Updated field names to be consistent with DPS ingest workbook.<br>• SOP B.1: Updated 'Unknown Hardwood' and 'Unknown Softwood' codes, and added guidance for downed logs with Vegetation Structure tags.<br>• SOP B.3 Troubleshooting: Added slash pile guidance |

| REVISION | DATE | ECO # | DESCRIPTION OF CHANGE |
|---|---|---|---|
| | | | • Equipment and SOP C: Replaced electronic scale with tare-able spring scales, based on technician feedback.<br>• Equipment and SOP C: Added Cant Hook and Log Stand to improve safety when cutting disks.<br>• SOP C.1: Reorganized, and added guidance for when bulk density sampling is considered complete.<br>• SOP C.2: Changed \`diskID\` to an incrementing number that will enable easy per site tracking of total number of disks sampled.<br>• SOP C.2: Diameter tape now used to record diameter of structurally sound disks with DBH ≥ 5 cm (was 10 cm).<br>• Appendix B: Consolidated all diameter / distance tables into this appendix, eliminated old Appendix E.<br>• Appendix D: Added transect length, F-values, for all sites to ensure repeatable, consistent tallying.<br>• Appendix E: Newly added quarantine compliance appendix.<br>• Appendix F: Newly added rank abundance of DSTs for targeted bulk density sampling completion. |
| E | 7/26/2018 | ECO-05680 | • Section 2.4: Added definitions of bole, branch, fork, and twig.<br>• Added Section 4.1 “Implementation Criteria”: Suspend sampling when tally is zero, consider suspending sampling when fewer than 10 particles tallied.<br>• Section 4.2: Added guidance to schedule CDW tally in different years in Distributed vs. Tower Plots, and to use a 5 y sampling interval.<br>• Section 6.1: Added ‘pig-tail’ stakes for tagging highly decayed logs.<br>• SOP A.2: Added optional barcode workflow for tracking bulk density samples, speeding Fulcrum data entry.<br>• SOPs B, C, D: Re-organized to integrate better with Fulcrum data collection steps.<br>• SOP B.1: Re-organized dense vegetation guidance into Box 1.<br>• SOP B.1: decayClass required for all tallied logs.<br>• SOP B.4: New SOP with re-tally guidance.<br>• SOP C.2: Added optional barcode workflow for tracking bulk density samples, speeding Fulcrum data entry. |

| REVISION | DATE | ECO # | DESCRIPTION OF CHANGE |
|---|---|---|---|
| | | | • SOP D.1: Changed dry criteria from ± 0.5 g or 0.5%, whichever is larger, to ± 0.5 g or 1%.<br>• SOP D.1: Clarified that oven drying data only recorded for initial drying event.<br>• SOP E.1: New section describing key parts of the digital data workflow. |

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# 1 OVERVIEW

## 1.1 Background

Monitoring stocks of coarse downed wood (CDW) is important because CDW uniquely influences ecosystem function. In terms of ecosystem services, CDW provides habitat for wildlife, stabilizes soil, increases microenvironment heterogeneity, stores C and nutrients over decades, and can enhance seedling germination for trees and other plants (Harmon and Sexton 1996). Because coarse downed wood particles can persist in the environment from decades to centuries, these particles have "afterlife" effects on ecosystem function of similar magnitude to those of live trees. In addition, knowledge about the quantity and size distribution of CDW pieces at the landscape scale can be used to model the probability of fire occurrence and severity because CDW can be an important fuel source (Brown 1974, Affleck 2008).

There are two components to the sampling design that are required to accurately estimate CDW mass: volume estimation, and calculation of bulk density. There are numerous tally-based methods for estimating CDW volume that have been developed over the past 50 years. A historically common method, line intercept sampling (LIS; Warren and Olsen 1964), requires searching fixed-length transects for logs that intersect the transect. However, because the LIS method tallies CDW pieces with probability according to length and length correlates imperfectly with volume, the most voluminous CDW pieces may be underrepresented, resulting in increased uncertainty in CDW volume estimates compared to frequency and length estimates (Affleck 2010). Other recently developed methods sample CDW with probability proportional to volume, and are designed specifically to estimate log volume directly from simple tallies, with reduced uncertainty compared to LIS (e.g. Affleck 2008, Gove et al. 2013). The tally-method NEON will employ, termed Line Intercept Distance Sampling (LIDS; Affleck 2008), tallies logs with probability proportional to volume and restricts the search for logs to a transect or group of radial transects at each sampling point (Affleck 2008, 2010). By using transects, detection errors in brushy or complex terrain are minimized compared to other techniques that require searching for logs over large areas (Jordan et al. 2004). Importantly, and in contrast to LIS, the length of the transect is not fixed with the LIDS method. Instead, the length of the transect increases for large-volume logs, ensuring that a representative sample of large logs is tallied across multiple field sites (Affleck 2008).

To convert estimates of CDW volume to mass and/or carbon (C) density, it is necessary to measure the bulk density of downed wood in a manner that quantitatively accounts for the proportion of the CDW particle that is void volume (i.e., internal hollows that reduce bulk density compared to a solid particle). Wood bulk density is typically measured by cutting cross-sectional disks from a statistically sufficient population of CDW particles, then determining the mass and volume of the disk samples (Harmon and Sexton 1996).

There are two additional factors that must be addressed if log volume and density estimates are to be accurately converted to CDW mass or C density per unit area at the stand scale. The first is that CDW density tends to change predictably as log decay progresses, and the second is that density changes with decay class are often dependent on species (Harmon and Sexton 1996). That is, different species that appear to be in the same stage of decay may have very different wood bulk density values, due to differences in the proportion of heartwood to sapwood, as well as other species-specific wood properties. In order to capture variation in density throughout the course of log decay, NEON will categorize sampled CDW particles within five standard decay classes defined by the U.S. Forest Service (Valentine et al. 2008), and all CDW particles will be identified to taxon according to a NEON-standard taxonomic identification method (for plants, this method relies heavily on the taxonomic ID system developed by the USDA; http://plants.usda.gov ).

## 1.2 Scope

This document provides a change-controlled version of Observatory protocols and procedures. Documentation of content changes (i.e. changes in particular tasks or safety practices) will occur via this change-controlled document, not through field manuals or training materials.

### 1.2.1 NEON Science Requirements and Data Products

This protocol fulfills Observatory science requirements that reside in NEON's Dynamic Object-Oriented Requirements System (DOORS). Copies of approved science requirements have been exported from DOORS and are available in NEON's document repository, or upon request.

Execution of this protocol procures samples and/or generates raw data satisfying NEON Observatory scientific requirements. These data and samples are used to create NEON data products, and are documented in the NEON Scientific Data Products Catalog (RD[03]).

## 1.3 Acknowledgments

Selection of the standard operating procedures described in this protocol was informed by Affleck (2008, 2010), Gove et al. (2013), Harmon and Sexton (1996), and Keller et al. (2004). Dr. Mark Harmon provided invaluable feedback throughout this document, but particularly for the bulk density sampling standard operating procedure.

## 2 RELATED DOCUMENTS AND ACRONYMS

### 2.1 Applicable Documents

Applicable documents contain higher-level information that is implemented in the current document. Examples include designs, plans, or standards.

| | | |
|---|---|---|
| AD[01] | NEON.DOC.004300 | EHSS Policy, Program and Management Plan |
| AD[02] | NEON.DOC.004316 | Operations Field Safety and Security Plan |
| AD[03] | NEON.DOC.000724 | Domain Chemical Hygiene Plan and Biosafety Manual |
| AD[04] | NEON.DOC.050005 | Field Operations Job Instruction Training Plan |
| AD[05] | NEON.DOC.000914 | NEON Science Design for Plant Biomass and Productivity |
| AD[06] | NEON.DOC.004104 | NEON Science Performance QA/QC Plan |

### 2.2 Reference Documents

Reference documents contain information that supports or complements the current document. Examples include related protocols, datasheets, or general-information references.

| | | |
|---|---|---|
| RD[01] | NEON.DOC.000008 | NEON Acronym List |
| RD[02] | NEON.DOC.000243 | NEON Glossary of Terms |
| RD[03] | NEON.DOC.002652 | NEON Level 1, Level 2 and Level 3 Data Products Catalog |
| RD[04] | NEON.DOC.001271 | AOS/TOS Protocol and Procedure: Data Management |
| RD[05] | NEON.DOC.002121 | Datasheets for TOS Protocol and Procedure: Coarse Downed Wood |
| RD[06] | NEON.DOC.001921 | NEON Raw Data Ingest Workbook for TOS Coarse Downed Wood: Field Tally Data |
| RD[07] | NEON.DOC.001922 | NEON Raw Data Ingest Workbook for TOS Coarse Downed Wood: Bulk Density Field and Lab Data |
| RD[08] | NEON.DOC.000987 | TOS Protocol and Procedure: Measurement of Vegetation Structure |
| RD[09] | NEON.DOC.001710 | TOS Protocol and Procedure: Litterfall and Fine Woody Debris |
| RD[10] | NEON.DOC.001717 | TOS Standard Operating Procedure: TruPulse Rangefinder Use and Calibration |
| RD[11] | NEON.DOC.000913 | TOS Science Design for Spatial Sampling |
| RD[12] | OSHDoc and Chainsaw Training | https://www.osha.gov/OshDoc/data_Hurricane_Facts/chainsaws.html ), USFS S-212, and the MTDC Chain Saw and Crosscut documentation |
| RD[13] | | Manual for Fulcrum Application: TOS Coarse Downed Wood [PROD] – All SOPs |

### 2.3 Acronyms

| Acronym | Definition |
|---|---|
| C | Carbon |
| CDW | Coarse Downed Wood |
| DST | 'Decay class x sizeCategory x taxonID' combination. The number of DSTs identified at a site informs the Bulk Density sampling effort. |

| Acronym | Definition |
|---|---|
| FWD | Fine Woody Debris |
| LIDS | Line Intercept Distance Sampling |
| LIS | Line Intercept Sampling |
| PPE | Personal Protective Equipment |
| VST | Vegetation Structure |

## 2.4 Definitions

Common terms used throughout this document are defined here, in alphabetical order.

| Term | Definition |
|---|---|
| bole | The trunk of a tree. A bole differs from a lateral branch in that it is a primary support structure for the individual and may support lateral branches. |
| branch | Woody structures ≥ 2 cm diameter that emerge from boles at an angle > 45˚, or that emerge from other branches at any angle. |
| Coarse downed wood (CDW) | Any fallen stem, and all of its connected branches, with diameter ≥ 2 cm at the point where the CDW particle intersects the LIDS transect. Qualifying particles are referred to as 'logs' in this protocol for convenience. Qualifying logs also include standing dead that are > 45˚ off the vertical (Harmon and Sexton 1996, Affleck 2010). |
| fork | A stem that is part of a multi-bole individual; forks emerge from another bole at an angle < 45˚. |
| twig | Woody structures < 2 cm diameter that emerge from boles or other branches. |

# 3 METHOD

Qualifying particles of CDW are divided into three different diameter size categories, as defined by Keller et al. (2004): 2–5 cm, 5–10 cm, and ≥ 10 cm. Furthermore, logs of all diameter must also be ≥ 1 m in length (Harmon and Sexton 1996). Dead trees (i.e. snags) that have not yet fallen to an angle > 45˚ from vertical are accounted for via the Vegetation Structure protocol (RD[08]), and logs that are suspended in the air > 2 m above the ground at the transect intersection point are ignored. Woody particles with diameter < 2 cm at the transect intersection point are considered fine woody debris and are sampled according to the Litterfall and Fine Woody Debris protocol (RD[09]).

The Standard Operating Procedures (SOPs) presented in this protocol describe tasks that, when taken together, allow estimation of CDW volume, length, frequency, mass, and projected cover at the stand scale. These SOPs are:

- **SOP A: Preparing for Sampling.** Preparatory steps for SOPs listed below, to be carried out prior to implementation.

- **SOP B: Tallying and Measuring CDW in the Field.** Includes performing CDW volume tallies in the field using the LIDS technique, measuring logs for additional variables required to convert volume tallies to length, frequency, and projected cover estimates, identifying logs to taxon, and categorizing logs into decay class.
- **B.4: Re-Talling Previously Surveyed LIDS Transects**
- **Re-tallying** previously surveyed transects generally follows the guidance in SOP B.1. Additional points pertinent to re-tally include:

1. The transect azimuth will be difficult to re-establish identically from bout to bout.
    a. Previously tagged logs can be used to guide transect re-establishment, but do not assume there is a 'true' transect. That is, do not attempt to perfectly re-create the previous transect.
    b. When the transect intersects a qualifying particle, DO check for a tag.
    c. If a tag cannot be found, DO use previously collected data to determine whether it is likely that a logID was previously assigned.
2. If it is known that a previous transect was incorrect due to azimuth inaccuracies, do NOT correct past data.
3. When illegible tags are encountered or a particle may have been tagged before but the tag cannot be found:
    a. If the previous **logID** can be determined with ≥ 90% confidence: Re-stamp a blank tag with the previous logID, and record **tagStatus** = 'replaced'.
    b. Else, re-tag the particle with a new **logID**, and record **tagStatus** = 'ok'.
4. When tags are attached from a previous bout:
    a. Previously collected **logID**, **logDistance**, **logDiameter**, **taxonID** and **decayClass** data may be used to help guide assessments in the current year.
    b. Previously collected data are *only* a guide. Current-year assessments should ultimately be made according to the protocol and current-year observations. That is, do not assume previous staff were correct 100% of the time.
    c. If the particle no longer qualifies, do not tally and do not create a record. The tag may be collected and removed from the plot.

- Bulk Density Sampling in the Field**.** Includes field-sampling log cross-sectional disks used for bulk density estimation, and for larger logs, sub-sampling disks to generate samples for wood moisture calculations.
- **SOP D: Processing Bulk Density Samples in the Laboratory.** Steps to dry and weigh wood bulk density samples in the laboratory.

***Overview of SOP B***

To implement SOP B, sampling locations are established at the center of each Tower Plot, and also at the center of 20 Distributed Plots that are used for co-located LAI, herbaceous biomass clip harvest, and vegetation structure measurements (RD[11]). Tower Plots are selected according to a spatially-balanced, random design, and Distributed Plots are selected according to a spatially-balanced, stratified random design, stratified by NLCD vegetation type (RD[11]). At each sampling location, three LIDS transects are established that radiate outward, with 120˚ separating each transect (**Figure 1**). The azimuthal orientation of each group of transects is chosen randomly for each of the sampling locations, in order to minimize effects of topography, directional blowdown, logging management, etc., on selection of CDW particles across all sampling locations. The per-plot random azimuths for LIDS transects are provided by Science and are available on the internal Sampling Support Library (SSL).

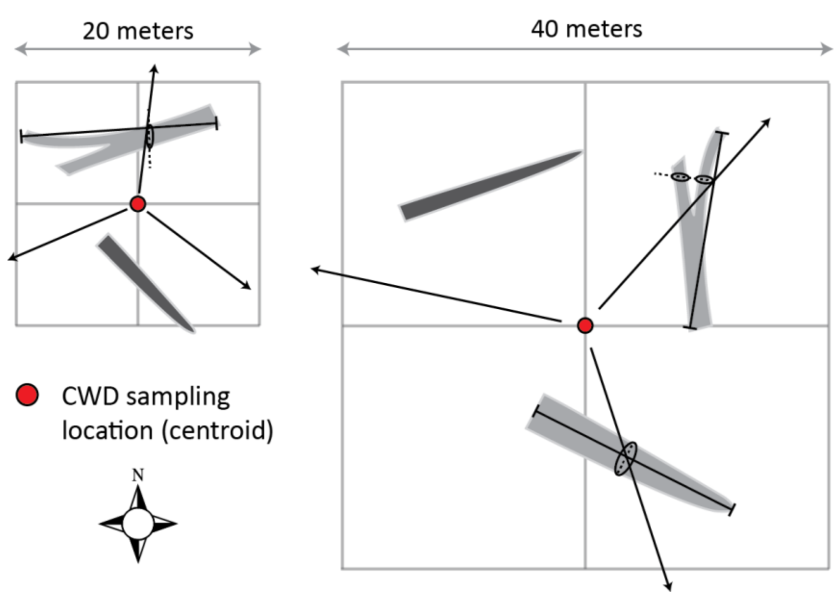


**Figure 1.** Illustration of three randomly oriented LIDS transects (arrow vectors) superimposed over a 20m x 20m plot (*left*), and a 40m x 40m plot (*right*). There is a 3m gap between the sampling location (i.e. the plot centroid), and the start of each transect which minimizes the chance that CDW particles close to the plot centroid get double- or triple-counted. Gray shapes represent CDW particles, dashed lines show the location and orientation of cross-sectional area measurement(s) (ovals) for those particles that intersect a LIDS transect, and capped black

lines imply the particles' central axes that should be measured for length. Darker gray CDW particles do not intersect LIDS transects and are suitable for bulk-density sampling. Note that CDW particles selected for tally and/or bulk density sampling may lie outside of the plot boundary.

Field staff search each of the 3 transects for qualifying pieces of CDW that intersect the transect, with the total transect distance searched being positively related to particle diameter. In other words, the LIDS technique dictates that the search for larger logs occurs over longer transect distances in order to adequately sample relatively rare large logs that contribute disproportionately to total CDW volume. Limiting distances that correspond to various log cross-sectional areas are provided in Appendix B, and Appendix B should be used in the field as a reference to help determine whether specific logs should be included or not in a given plot's tally. Once it is determined that a log should be tallied, its cross-sectional area and length are measured, as well as the distance from the sampling location. In addition, each qualifying log is assigned to a decay class, and is identified to the finest taxonomic resolution possible (i.e., species, genus, family or "unknown hardwood" or "unknown softwood"). The latter two designations are only to be used as a last resort.

***Overview of SOP C***

B.4 details the field procedure for sampling of CDW for bulk density. This SOP is implemented once within the first 3 years of a site going into Operations, and once more 5-6 years after the first implementation. Bulk density is sampled from three different diameter size categories (≥ 10 cm, 5-10 cm, and 2-5 cm), from logs that are not tallied in SOP B. A chainsaw, or less ideally a buck saw, is used to cut a narrow cross-sectional disk from each sampled CDW particle. The diameter and height of the disk are measured to enable calculating the volume of the disk, and the disk fresh mass is recorded in the field. For the two largest size categories, wedge-shaped pieces are sub-sampled from the disk, and these sub-samples are also weighed for fresh mass in the field. Subsamples are then transported back to the laboratory to calculate the disk's fresh mass to dry mass ratio. Disks sampled from the smallest size category are not sub-sampled, and are transported to the laboratory in their entirety.

Cross-sectional disks cannot be cut from extremely decayed logs, and instead of removing a disk, a decayed section of log is simply scooped into a plastic bag and the negative space is measured for volume with calipers. The sampled material is then transported back to the laboratory, dried, and weighed as above. Throughout the bulk density SOP, proper sample labeling and tracking of sample metadata is critical.

***Overview of SOP D***

SOP D describes the procedure for measuring, drying, and weighing cross-sectional disks in the laboratory (or wedge-shaped subsamples generated from these disks). Knowledge of the wood sample dry mass allows calculation of bulk density ($\rho$) as:

(1) $$\rho = \frac{disk\ dry\ mass\ (g)}{disk\ volume\ (cm^3)}$$

For larger disks from which wedges were generated, the fresh mass : dry mass ratio is calculated for the wedge subsample, and this ratio, along with the fresh mass of the entire disk that was measured in the field, is used to determine the dry mass of the disk. Proper sample labeling, and tracking of sample data and metadata, is extremely important to enable this calculation.

***Problem Reporting and Data Quality Assurance and Control***

Standard Operating Procedures (SOPs), in Section 7 of this document, provide detailed step-by-step directions, contingency plans, sampling tips, and best practices for implementing this sampling procedure. To properly collect and process samples, field staff **must** follow the protocol and associated SOPs. Use NEON's problem reporting system to resolve any field issues associated with implementing this protocol.

The value of NEON data hinges on consistent implementation of this protocol across all NEON domains, for the life of the project. It is therefore essential that field personnel carry out this protocol as outlined in this document. In the event that local conditions create uncertainty about carrying out these steps, it is critical that technicians document the problem and enter it in NEON's problem tracking system.

Quality Assurance and Quality Control (QA/QC) will be performed on data collected via these procedures according to the NEON Science Performance QA/QC Plan (AD[06]).

# 4 SAMPLING SCHEDULE

## 4.1 Implementation Criteria

- If CDW tally has not been implemented at a given site, an implementation decision is made via an analysis of VST data in consultation with Science. Implementation is based on the probability of detecting CDW particles ≥ 2 cm diameter.
- If CDW tally has been implemented and no particles were tallied at any plots:
    - Communicate with Science to determine whether sampling should be suspended until a state-changing event affects site-level CDW abundance (e.g., fire, brush-hogging, species invasion, etc.).
    - Do not implement or schedule CDW bulk density (SOP C, SOP D).
    - Keep CDW tally on the inter-annual schedule in the event a state-change occurs and sampling is required.
    - Science and Field Operations must communicate in the year prior to scheduled sampling to assess site conditions. If no state-change has occurred, continue to suspend CDW tally.
- If CDW tally has been implemented and < 10 particles were talled across all Distributed Plots or all Tower Plots:
    - Communicate with Science to determine whether CDW tally should be suspended.
    - Do not implement or schedule CDW bulk density (SOP C, SOP D).

### 4.2 Sampling Frequency and Timing

The frequency and timing of CDW sampling depends on the SOP being implemented (**Table 1**), and SOP B "Tallying and Measuring CDW in the Field" may be carried out independently from the bulk density SOPs (B.4 and SOP D). The bulk-density SOPs must always be performed together and may be carried out over more than one year in order to achieve the desired sample size (**Table 13**).

**Table 1.** Sampling frequency, sampling effort, and timing guidelines for coarse downed wood sampling on a per-SOP basis.

| SOP | Plot Type | Plot Number | Sampling Events | Yearly Interval | Remarks |
|---|---|---|---|---|---|
| SOP B: Tallying and Measuring CDW in the Field | Distributed | 20 max* | 1X per sampling year | Every 5 y | • Distributed and Tower Plot sampling should be staggered through time.<br>• Sampling should take no longer than 3 months.<br>• SOP B should be completed prior to SOP C in order to prepare a list of taxonIDs, size classes, and decay classes from SOP B data to prioritize collection in SOP C. |
| | Tower | 20-30† | | | |
| SOP C: Bulk Density Sampling in the Field | Distributed | 20 max* | Once within first 3 y of Operations; second time 5-6 y later | 5-6 y | • Sampling occurs twice per site.<br>• A given sampling event may occur over multiple years if target sample size cannot be achieved in one year; however, completing sampling in one season is ideal. |
| | Tower | 20-30† | | | |
| SOP D: Processing Bulk Density Samples in the Laboratory | Distributed | 20 max* | Once within first 3 y of Operations; second time 5-6 y later | 5-6 y | Sample processing in the laboratory should occur ASAP following field work. |
| | Tower | 20-30† | | | |

* CDW sampling occurs in the same subset of Distributed plots that are used for other plant biomass protocols; not all Distributed Plots will be sampled if CDW particles are absent from selected plots.

† The number of installed Tower plots vary by site; typically, forested sites that produce CDW receive twenty 40m x 40m plots; however, some sites with CDW may have thirty 20m x 20m Tower plots.

### 4.3 Criteria for Determining Onset and Cessation of Sampling

Because CDW is often produced during periods of seasonal storm activity, CDW sampling should be timed to occur *after* the period of maximal expected storm activity for a given site.

- Refer to Appendix C for sampling onset guidelines. Provided dates are guidelines only, and it is incumbent upon Field Operations to select sampling onset dates that are appropriate for each site and consistent with periods of storm activity.
- The temporal window in which CDW sampling in a given year must be completed is relatively long – it is only required that CDW field sampling be completed before the season of maximum storm activity resumes.

### 4.4 Timing for Laboratory Processing and Analysis

Because wood samples will continue to decay after collection and before drying, particularly when very moist, it is important to place wood samples into the drying oven as soon as possible following collection.

- Ideally, place samples in the drying oven within 24 hours of collection in the field.
- If drying within 24 h is not feasible:
    - Keep samples in muslin sample bags in a dry place. Keeping samples in a cloth bag is important (as opposed to plastic) because air-drying at room temperature can begin before the sample is placed in the drying oven.
    - Place samples in the drying oven within 5 days of collection in the field.

Once wood samples are dry, they may be placed in temporary storage prior to weighing. There are no scientific limits on the time oven-dried samples may be placed in temporary storage prior to processing (i.e., re-drying for 24 h, then weighing).

### 4.5 Sampling Timing Contingencies

**Table 2.** Guidance indicating how to respond to unanticipated delays in field tally work (SOP B), and the consequences of potential delays

| Delay/Situation | Action | Outcome for Data Products |
| --- | --- | --- |
| Hours to days | If delay prevents completion of any of three LIDS transects originating within a given plotID, record in a field notebook:<br>1. Document delay for the plotID in question.<br>2. Note distance along transect at which delay occurred.<br>3. Return to transect ASAP and continue sampling at distance recorded in notebook. | None anticipated |
| | If delay occurs between plots, resume CDW survey at next plotID ASAP. | None anticipated |

**Table 3.** Guidance indicating how to respond to unanticipated delays in bulk density sample collection (B.4), and the consequences of potential delays

| Delay/Situation | Action | Outcome for Data Products |
| --- | --- | --- |
| Hours to days | If delay prevents completion of bulk-density disk sampling:<br>1. Label cross-sectional disk, place any "wedges" into a labeled sample bag, and transport samples to an indoor work area.<br>2. Complete required disk measurements and record disk data on field datasheet.<br>3. Return to the field ASAP and continue sampling additional log cross-sectional disks. | None anticipated |
| | If delay occurs after sampling a log is complete but before the next log is begun, resume bulk density sampling ASAP. | None anticipated |

### 4.6 Criteria for Reallocation of Sampling Within a Site

Coarse Downed Wood sampling will occur on the schedule described above at up to 20 selected Distributed Plots (plot selection is determined by NEON Science), and all Tower Plots per site. Ideally, sampling will occur at these sampling locations for the lifetime of the Observatory (core sites) or the duration of the site's affiliation with the NEON project (relocatable sites). However, circumstances may arise that require that sampling within a site be shifted from one particular location to another. In general, sampling is considered to be compromised when sampling at a location becomes so limited that data quality is significantly reduced. If sampling at a given plot becomes compromised, an incident ticket should be submitted by Field Operations to Science.

There are two main pathways by which sampling can be compromised. Sampling locations can become inappropriately suited to answer meaningful biological questions (e.g., a terrestrial sampling plot becomes permanently flooded). Alternatively, sampling locations may be located in areas that are logistically impossible to sample on a schedule that that is biologically meaningful.

For Coarse Downed Wood tally sampling, criteria for considering a plot compromised are the same for both Distributed and Tower Plots:

- These plots are sampled every 5 y; if sampling cannot be completed for 2 consecutive bouts then the plot should be considered compromised.
    - Report compromised plots by submitting an incident ticket that contains the domainID, plotID, and 3-letter sampling module in the description.
        - ***Example***: 'D05 STEI_047 canceled for CDW'
    - When sampling cannot be completed at a plot, search the incident tracking database to determine whether cancellation has occurred over two consecutive bouts, and whether a request for a replacement plot is warranted due to a compromised plot.
- Report compromised plots to Science, and Science will provide a replacement plot for the current sampling bout.

# 5 SAFETY

This document identifies procedure-specific safety hazards and associated safety requirements. It does not describe general safety practices or site-specific safety practices.

Personnel working at a NEON site must be compliant with safe field work practices as outlined in the Operations Field Safety and Security Plan (AD[02]) and EHSS Policy, Program and Management Plan (AD[01]). Additional safety issues associated with these SOPs are outlined below. The Field Operations Manager and the Lead Field Technician have primary authority to stop work activities based on unsafe field conditions; however, all employees have the responsibility and right to stop their work in unsafe conditions.

## 5.1 Safety Considerations for SOP B: Tallying and Measuring CDW in the Field

### 5.1.1 Measuring Distances with the Laser Rangefinder

A laser rangefinder/hypsometer/compass instrument may be used to determine transect distances and measure log lengths. Safety considerations for this instrument include:

1. Avoid staring directly at the laser beam for prolonged periods. The rangefinder is classified as eye-safe to Class 1 limits, which means that virtually no hazard is associated with directly viewing the laser output under normal conditions. As with any laser device, however, reasonable precautions should be taken in its operation. It is recommended that you avoid staring into the transmit aperture while firing the laser.

- Never attempt to view the sun through the scope. Looking at the sun through the scope may permanently damage the eyes.

### 5.1.2 Measuring Log Length

When measuring logLength, or any other log attribute, it is recommended that personnel avoid standing, climbing, or working on logs, regardless of how high off the ground the log may be. Log surfaces may be slippery, resulting in a fall hazard, or logs may roll, introducing additional crushing risks.

## 5.2 Safety Considerations for SOP C: Bulk Density Sampling in the Field

### 5.2.1 Chainsaw Safety

B.4 requires that field staff cut cross-sectional disks from coarse downed wood particles for generation of bulk density data. The most efficient way to collect cross-sectional disks from downed logs is with a chainsaw, although a hand-powered buck saw is a less ideal option that can be employed should regulations or logistics prevent the use of a chainsaw. Should a chainsaw be chosen to complete the sampling task, there are multiple safety regulations provided by OSHA (https://www.osha.gov/OshDoc/data_Hurricane_Facts/chainsaws.html), USFS S-212, and the MTDC

Chain Saw and Crosscut documentation. In order to ensure safe operation of the chainsaw, NEON staff are required to complete USFS S-212 training (or equivalent) prior to operating a chainsaw. Training must be completed at least every 3 years.

**Personal Protective Equipment Requirements**

- Personal Protective Equipment (PPE) for the head, ears, eyes, face, hands, and legs must be worn when operating the saw to prevent or lessen the severity of injuries to workers.
- PPE must be inspected prior to use to ensure it is in serviceable condition.
- Do not wear loose-fitting clothing.

**Before Starting the Saw**

- Check controls, chain tension, and all bolts and handles to ensure they are functioning properly and adjusted according to the manufacturer's instructions.
- Make sure the lubrication (bar oil) reservoir is full.
- Start the saw on the ground or on another firm support. Drop starting is never allowed.
- Start the saw at least 10 feet from the fueling area, with the chain's brake engaged.

**While Running the Saw**

- Assure a solid, flat surface for foot placement, prior to operating the chainsaw.
- Clear the area of obstacles that might interfere with cutting the log. Clear away dirt, debris, small tree limbs, and rocks from the saw's path.
- Safety is paramount when operating the saw:
  - Preserve chain sharpness; operating a dull saw leads to fatigue.
  - To preserve sharpness, cut less decayed classes first, as more decayed pieces will require passing the saw into the duff / topsoil layer.
  - When cutting into the duff / topsoil layer, always use care and be ready for kickbacks.
  - If necessary and feasible, move the piece to be cut so the chain avoids contact with soil or rocks.
- Look for nails, spikes, or other metal in the tree before cutting.
- Keep hands on the handles, and maintain secure footing while operating the chainsaw.
- Be careful that the trunk or tree limbs will not bind against the saw. Watch for branches under tension, they may move suddenly when cut.
- Do not cut directly overhead or above shoulder height.
- Shut off the saw or release throttle prior to retreating.
- Shut off the saw or engage the chain brake whenever the saw is carried more than 3 steps, or across hazardous terrain.
- Be prepared for kickback; saws must be equipped with a mechanism that reduces kickback danger (chain brakes, low kickback chains, guide bars, etc.)

- Do not saw with the tip. If equipped, keep tip guard in place.

**Fueling the Saw**

Due to EPA requirements for non-venting fuel containers/systems, all fuel containers and saws manufactured after 2010 can become pressurized during normal use, and in some cases, can create fuel 'geysers' when fuel containers are opened. Such fuel geysers have been known to catch fire, and multiple severe burn injuries have been reported when this occurs. When re-fueling the chainsaw, pay attention to the following:

- Let the saw cool before opening the fuel cap. Never add fuel to a running or hot saw.
- Cover the cap with a rag while slowly opening any tank. This will slowly relieve any internal pressure, and prevent fine mists of any escaping fuel from finding an ignition source.
- Check the fuel container for the following requirements:
  - Must be metal or plastic
  - Must not exceed a 5 gallon capacity
  - Must be approved by the Underwriters Laboratory (UL), Factory Mutual (FM), the Department of Transportation (DOT), or other nationally recognized testing laboratory.
- Dispense fuel at least 10 feet from any source of ignition.
  - No smoking during fueling.
  - Fueling should ideally occur on the road or nearest approach to the plots.
  - Fueling should never take place within a designated NEON plot.
  - Refuel over a tarp, so small spills can evaporate before entering soil.
- Use a funnel or flexible hose when dispensing fuel into the saw.

# 6 PERSONNEL AND EQUIPMENT

## 6.1 Equipment

The following equipment is needed to implement the procedures in this document. Equipment lists are organized by task. They do not include standard field and laboratory supplies such as charging stations, first aid kits, drying ovens, ultra-low refrigerators, etc.

**Table 4.** Equipment list for SOP B. Item quantities are sufficient for a team of two technicians to perform CDW tallying and mensuration.

| Item No. | Supplier Number | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|---|
| **Durable items** | | | | | | |
| Compass Tools<br>Forestry Suppliers | 703512<br>90998 | R | Foliage filter | Allow laser rangefinder use in dense vegetation | 2 | N |
| | | R | *Handheld caliper, 20 cm | Measure CDW pieces up to 20cm diameter | 1 | N |
| Forestry Supplier | 59728 | R | *Handheld caliper, 50 cm | Measure CDW pieces up to 50cm diameter | 1 | N |
| Forestry Supplier | 59737 | R | *Handheld caliper, 95 cm | Measure CDW pieces up to 95 cm diameter | 1 | N |
| | | R | Hammer | Drive nails | 1 | N |
| Ben Meadows<br>Forestry Suppliers | 122732<br>39945 | R | Measuring tape, minimum 50 m | Delineate transect; determine whether logs central axes intersect transects | | N |

| Item No. | Supplier Number | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|---|
| Forestry Supplier | 91567 | R | Laser Rangefinder, 30 cm accuracy | Delineate transect; measure log distance to transect origin | 1 | N |
| Grainger | 5B317 | R | White reflector or reflective tape | Reflective target for laser rangefinder; aids in measuring distance to target accurately | 1 | N |
| | | R | Field guide, regional flora reference guide and/or key | Identify downed logs to functional group (hardwood vs. softwood) | 1 | N |
| Amazon | 0100078101 | S | GPS receiver, recreational accuracy | Navigate to sampling location | 1 | N |
| Ben Meadows<br>Forestry Suppliers | 100952<br>39167 | S | Chaining pins or other suitable anchor | Anchor measuring tapes | 1 set | N |
| | | S | Reflector pin-pole kit | Hold reflective target | 1 | N |
| Ben Meadows<br>Forestry Suppliers | 213379<br>37184<br>37036 | S | Compass with mirror and declination adjustment | Delineate transect | 1 | N |
| **Consumable items** | | | | | | |
| | | R | Per plot LIDS angle lists | Identify randomly assigned angles for LIDS transects in each plot | Varies | N |
| RD[05] | | R | Coarse downed wood field datasheet | Record sampling data | Varies | N |

| Item No. | Supplier Number | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|---|
| | | S | CR123A battery | Spare battery for laser rangefinder | 2 | N |
| | | S | AA battery | Spare battery for GPS receiver | | |
| | | R | Numbered aluminum tag, red | Tag downed logs ≥ 10 cm | As needed | N |
| | | R | Aluminum nail | Affix tags to logs ≥ 10 cm | As needed | N |
| | | S | Pig-tail stakes | Affix tags to highly decayed logs | As needed | N |

R/S=Required/Suggested; * The 20cm calipers are small, light, and suitable for measuring CDW in the 2-5cm and 5-10cm size classes, as well as larger pieces of CDW up to 20cm diameter; at sites with CDW ≤ 20cm diameter, this caliper is the only caliper required. At sites with larger diameter CDW, an additional caliper is required for the larger diameter pieces.

**Table 5.** Equipment list for SOP C. Quantities are sufficient for a team of two technicians to perform CDW bulk-density sampling.

| Item No. | | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|---|
| **Durable items** | | | | | | |
| Forestry Supplier | 91567 | R | Laser Rangefinder, 30 cm accuracy | Measure log distance to transect origin | 1 | N |
| Compass Tools<br>Forestry Suppliers | 703512<br>90998 | R | Foliage filter | Allow laser rangefinder use in dense vegetation | 2 | N |
| Grainger | 5B317 | R | White reflector or reflective tape | Reflective target for laser rangefinder; aids in measuring distance to target accurately | 1 | N |
| Ben Meadows<br>Forestry Suppliers | 122117<br>59505 | R | Diameter tape, 64 cm* | Measure cross-sectional disk diameter | 1 | N |
| Forestry Suppliers | 59422 | R | Diameter tape, 200 cm* | Measure cross-sectional disk diameter | 1 | N |
| | | R | Handheld caliper, 20 cm † | Measure cross-sectional disk height; measure log diameter for highly decayed CDW pieces | 1 | N |
| Forestry Supplier | 59728 | R | Handheld caliper, 50 cm † | Measure cross-sectional disk height; measure log diameter for highly decayed CDW pieces | 1 | N |

| Item No. | | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|---|
| Forestry Supplier | 59737 | R | Handheld caliper, 95 cm † | Measure cross-sectional disk height; measure log diameter for highly decayed CDW pieces | 1 | N |
| | | R | Hatchet | Collect subsamples from cross-sectional disks | 1 | Y |
| Forestry Supplier | 93750 | R | Spring scale, 20 kg capacity, tareable | Weigh fresh mass of large cross-sectional disks | 1 | N |
| Forestry Supplier | 93790<br>93709 | S | Spring scale, 5 kg capacity, tareable | Weigh fresh mass of medium cross-sectional disks | 1 | N |
| Forestry Supplier | 93053<br>93015 | R | Spring scale, 1000 g capacity, tareable | Weigh fresh mass of small cross-sectional disks, and disk subsamples larger than 300 g | 1 | N |
| Forestry Supplier | 93017 | R | Spring scale, 300 g capacity, tareable | Weigh fresh mass of disk subsamples | 1 | N |
| | | R | Heavy duty plastic bag | Contain cross-sectional disk for weighing with spring scale | 1 | N |
| | | R | Chainsaw, 18" bar minimum, tool-less chain adjustment | Collect log cross-section samples; check with local foresters to determine optimal bar length of saw | 1 | Y |
| | | R | Chainsaw carrying case, or Specialized chainsaw trail pack | Protect chainsaw during transport | 1 | N |
| Ben Meadows | 139541 | S | Cant Hook, 48" handle, LogRite brand or equivalent | Grip and maneuver CDW particles into cutting position, to enable safe cutting of bulk density disks | 1 | N |

| Item No. | | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|---|
| Ben Meadows | 139543 | S | Log Stand adapter for cant hook, LogRite brand or equivalent | Temporarily elevate CDW particle off ground to enable safe cutting of bulk density disks | 1 | N |
| | | R | Uniquely marked, muslin drawstring bags, minimum 10” x 12” (size will vary depending on log size) | Carry cross-sectional disk samples or wedge subsamples | As needed | N |
| | | R | Field guide, regional flora reference guide and/or key | Identify downed logs to functional group (hardwood vs. softwood) | 1 | N |
| | | S | Hammer | Drive nails | | |
| Amazon | 0100078101 | S | GPS receiver, recreational accuracy | Navigate to plots, or previously sampled CDW particles | 1 | N |
| Tiger Supplies | TS24700 | S | Reflector pin-pole kit; inexpensive alternative item: 361941 Plastic Diveway Marker Red 48” at Amazon | Hold reflective target | 1 | N |
| Ben Meadows<br>Forestry Supplier | 133732<br>39945 | S | Measuring tape, minimum 50 m | Map location of sampled logs | 1 | N |
| Ben Meadows<br>Forestry Suppliers | 213379<br>37184<br>37036 | S | Compass with mirror and declination adjustment | Map location of sampled logs | 1 | N |

| Item No. | | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|---|
| | | S | Crosscut saw | Collect log cross-section samples | 1 | Y |
| | | S | Crosscut saw leather scabbard | Protect crosscut saw during transport | 1 | N |
| **Consumable items** | | | | | | |
| | | R | Bags, 25# kraft, 8# kraft, or plastic | Contain highly decayed cross-sectional "disks" with no internal structure | As needed | N |
| | | R | Numbered, red aluminum tags | Tag downed logs ≥ 10 cm | As needed | N |
| | | R | Aluminum nail | Affix tags to logs ≥ 10 cm | As needed | N |
| | | R | Chainsaw bar and chain lubricant | Lubricate chainsaw during operation | 2 qts | Y |
| | | R | Chainsaw fuel, 1 gallon container | Fuel chainsaw during operation | 1 | Y |
| | | R | Permanent marker | Label sample | 2 | N |
| RD[05] | | R | Coarse Downed Wood field datasheet | Record sampling data and metadata | Varies | N |
| | | R | Per plot LIDS angle list | Ensure bulk-density sampling does not occur on LIDS transects | Varies | N |
| | | R | Waterproof paper, Rite-in-the-Rain or equivalent | Material for making labels to record bulk density disk metadata in the field | 10+ sheets | N |

| Item No. | | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|---|
| | | S | Adhesive barcode labels (Type I) | Label samples with barcode readable labels | 1 sheet | N |
| | | S | CR123A | Spare battery for laser rangefinder | 2 | N |

R/S=Required/Suggested; * Select a diameter tape size to bring to the field that will enable measuring all expected CDW sizes with one tape.
† Select the caliper size to bring to the field that will enable measuring all expected CDW sizes with one caliper.

**Table 6.** Equipment list for processing wood bulk-density samples in the lab (SOP D).

| Item No. | R/S | Description | Purpose | Quantity | Special Handling |
|---|---|---|---|---|---|
| **Durable items** | | | | | |
| MX100230 | R | Drying oven | Dry samples | 1-2 | N |
| MX100265 | R | Balance, 0.01 g accuracy | Weigh oven dried samples | 1 | N |
| **Consumable Items** | | | | | |
| RD[05] | R | Drying Datasheet | Record data | As needed | N |
| RD[05] | R | Lab Drymass Datasheet | Record data | As needed | N |
| MX100689 | S | Weigh boats, large | Contain dried sample while weighing; a metal bread pan will reduce static compared to plastic. | Varies | N |

R/S=Required/Suggested

## 6.2 Training Requirements

All technicians must complete required safety training as defined in the Field Operations Job Instruction Training Plan (AD[04]).

As per OSHA recommendations, training requirements for chain saw use include:

- Specific work procedures, practices, and requirements of the work site, including the recognition, prevention, and control of general safety and health hazards.
- Requirements of the OSHA Logging standard, Bloodborne Pathogens standard, First Aid, and CPR training.
- How to safely perform work tasks, including the specific hazards associated with each task, and the measures and work practices which will be used to control those hazards.
- How to safely use, operate, and maintain tools which the employee will be required to utilize in completing the assigned tasks.

In addition, for both the field and laboratory work, training must emphasize the importance of consistent, detailed labeling of all samples. ***Improper or inconsistent labeling is the most common and problematic error associated with this work!***

## 6.3 Specialized Skills

When performing field tallies and mensuration of CDW (SOP B), and when sampling CDW for bulk density (B.4), the lead plant technician must possess the demonstrated ability to identify most relatively undecayed logs to species based on bark and branch characteristics, and ideally, a subset of the relatively decayed logs to either genus or family.

## 6.4 Estimated Personnel Hours

The time required to implement a protocol will vary depending on a number of factors, such as skill level, system diversity, environmental conditions, and site-specific logistical constraints. The timeframe provided below is an estimate based on completion of a task by a skilled two-person team (i.e., not the time it takes at the beginning of the field season). Use this estimate as framework for assessing progress. If a task is taking significantly longer than the estimated time, an incident should be reported.

**Table 7**. Estimated staff and labor hours required for implementation of Coarse Downed Wood Sampling SOPs.

| SOP | Estimated time | Suggested staff | Total person hours |
|---|---|---|---|
| SOP A.1: Preparing for CDW field tally | 0.5 h | 1 | 0.5 h |
| SOP A.2: Preparing for CDW field bulk density | 2 h[1] | 1 | 2 h |
| SOP A.3: Preparing for CDW laboratory processing | 0.5 h | 1 | 0.5 h |
| SOP B: CDW field tally | 1 h – 1.5 h per plot (sparse)<br>2 h – 8 h per plot (dense)[2] | 2 | 2 h – 3 h per plot (sparse)<br>4 h – 16 h per plot (dense) |
| SOP C: CDW field bulk density | 2 h – 16 h per plot[3] | 2 | 4 h – 32 h per plot |
| SOP D: CDW bulk density laboratory processing | 1 – 3 min per sample | 1 | 1 h – 15 h[4] |

[1] Includes estimated time for chainsaw maintenance.

[2] Dense vegetation contributes to longer sampling times by impeding accurate placement of transect tapes and/or walking a transect.

[3] Wide range in estimated time due to variation in tree species richness across sites, variation in vegetation density.

[4] Expected sample number varies between 60 – 300 by site. Time estimate includes handling, drying, weighing, and recording data for each wood sample.

# 7 STANDARD OPERATING PROCEDURES

## SOP A Preparing for Sampling

### A.1 Preparing for Tallying and Measuring CDW in the Field (SOP B)

1. Charge GPS and load target plot locations.
2. Check/set correct compass declination. Note that declination changes with time and should be looked up annually per site: http://www.ngdc.noaa.gov/geomag-web/
3. Prepare laser rangefinder according to guidelines in RD[10].
4. Charge and sync mobile data collection tablets.
5. Print (on all-weather paper) CDW “Field Tally Datasheets” and site-specific LIDS angle list.
6. If not already known, obtain the volume factor (*F*) for CDW sampling from Science. The volume factor (*F*) is analogous to plot size, and along with the diameter of CDW present at a site, determines the sampling effort required at a given site. Site-specific volume factors (*F*) are provided in Appendix D. A single volume factor value should be used across a site, do not use multiple values. The per site determination of *F* is in accordance with these general guidelines:
   - Large *F* when CDW is plentiful and of relatively large diameter.
   - Small *F* when CDW is sparse and of relatively small diameter
7. Consult Appendix D or Science for the appropriate LIDS transect length.
   - For first-time sampling, transect lengths are informed by analysis of Vegetation Structure data.
   - Transect lengths may subsequently be revised after analysis of first-year CDW tally data.

## A.2 Preparing for Bulk-Density Sampling in the Field (B.4)

1. Charge GPS and load target plot locations.
2. Check/set correct compass declination. Note that declination changes with time and should be looked up annually per site: http://www.ngdc.noaa.gov/geomag-web/
3. Prepare chainsaw, when chainsaw use is permitted.
    a. Inspect chain and sharpen if necessary
    b. Inspect chain tension and adjust if necessary
    c. Prepare 2-cycle fuel in gallon fuel container
    d. Fill fuel and bar oil reservoirs (see Safety information in Section 5.2).
4. Cut waterproof "Rite-in-the-Rain" paper into 8 equally sized pieces per sheet for bulk density sample labels.
    a. ***Optional barcode workflow:*** Attach a Type I barcode to each sample label.
5. Mark unique **bagNumbers** on muslin bags with permanent ink (if no pre-marked bags exist). The same bags may be re-used for subsequent disk collections.
6. Charge and sync mobile data collection tablets.
7. Print CDW "Field Density Datasheets" and LIDS angle list.
8. Consult Appendix F for per site ranked lists of the most abundant 'decayClass x sizeCategory x taxonID' (DST) combinations at your site (based on analysis of SOP B data). Make sure to adequately sample the most abundant DSTs.
9. Prepare drying oven
    a. Clear sufficient space for wood bulk-density samples
    b. Set temperature to 105 °C.
10. Print Drying Datasheets.

## A.3 Preparing for Laboratory Processing of Bulk Density Samples (SOP D)

1. Print lab weighing datasheets
2. Check lab electronic scale accuracy with 100 g standard weight.

## SOP B Tallying and Measuring CDW in the Field

Qualifying CDW has the following characteristics:

- Diameter ≥ 2 cm AND length ≥ 1 m, with central axis that intersects the transect (**Figure 1**). Woody particles < 2 cm diameter are ignored for this protocol.
- Suspended logs should *not* be tallied if:
    - The angle from the ground exceeds 45˚ *or*
    - The particle is ≥ 2 m above the ground where it intersects the transect, *or*
    - It is unsafe to measure the particle.
- Is *not* a dead stems attached to a living plant.
- Is *not* a decumbent, but living, growth form.

### *Goals*

- Tally and measure qualifying CDW particles along 3 transects per plot in all Tower Plots and a subset of twenty Distributed Plots (list provided by Science).
    - Tally allows estimation of CDW volume, a critical metric for calculating CDW mass and carbon stocks.
    - Measurement of CDW particles allows estimation of frequency, length and other variables important for assessing ecosystem function.
- Identify qualifying CDW particles and assign to decay class, size category, and taxonID.
    - These three variables are very important to accurately convert volume estimates to mass and carbon stock estimates.
- Enter data into the ***TOS Coarse Downed Wood: Tally [PROD]*** mobile application. See the Coarse Downed Wood Fulcrum Manual (RD[13]) for data entry details.

### B.1 Procedure

1. Navigate to the plot to be sampled (using the GPS if necessary), and locate the plot centroid. Avoid trampling the nested subplots that flank the centroid (**Figure 1**).
2. Create a parent-level record in the *Coarse Downed Wood: Tally [PROD]* Fulcrum app for the **plotID**.
3. Assess the target plot for CDW potential:
    a. While standing at the plot centroid, use the “LIDS Angle List” to determine the azimuth relative to true north for the first LIDS transect. Azimuths for 3 LIDS transects per plot are provided by Science in the site-specific LIDS Azimuth Lists.

b. Sight along the desired azimuth using a declination-corrected mirror-site compass or the TruPulse 360 rangefinder. Select an object in the middle distance (e.g. unique looking tree, rock, or other feature), and use this object as a 'sight guide' for transect establishment along the desired azimuth.

c. For transects along which there is NO chance you will encounter qualifying CDW (e.g. transects that cross only grassland vegetation):

   i. Create a child-level record in the *Coarse Downed Wood: Tally [PROD]* Fulcrum app for the **plotID**,

   ii. Record **lidsAzimuth** and **targetTaxaPresent** = 'No'.

   iii. Save the child record.

d. If all three transects have NO chance of intersecting CDW:

   i. Save the plot-level parent record.

   ii. Proceed to the next plotID and continue sampling.

4. For all transects that may intersect CDW use the sight guide from step 3.b to establish the origin and direction of the LIDS transect relative to the plot centroid.

   a. Measure exactly 3 meters from the plot centroid toward the selected 'sight guide,' and anchor the end of the meter tape to the ground with a chaining pin. This point is the origin of the LIDS transect (as in **Figure 1**).

   b. The 3 meter gap is important to:

      - Minimize trampling around the centroid where diversity measurements may also occur, and
      - Reduce the chance that CDW close to the centroid will be tallied on > 1 transect.

5. Create a child-level record in the *Coarse Downed Wood: Tally [PROD]* app.

   a. Record **lidsAzimuth** and **targetTaxaPresent** = 'Yes'.

6. Walk toward the sight guide and begin extending the transect to the maximum transect length (see Appendix D for site-specific transect lengths).

   - Place a chaining pin or pin flag every 10 m to accurately mark the transect.
   - See **Box 1** for strategies to extend the transect in dense vegetation.

**Box 1**. Strategies to extend LIDS transects in dense understory vegetation.

In extremely dense understory it will be very difficult to navigate and to keep the tape straight. Do your best, and accept the fact that minor transect deviations are unavoidable. When line of sight is limited to several meters or less and severely limits accurately extending a tape along the transect, consider the strategies below.

A. Mark points along the transect for future reference, if allowed by site host.
    1. Mark logs or branches that indicate the beginning of the transect with marking that cannot be mistaken for CDW tags.
    2. Establish a marker at the end of the transect.
B. Work in shorter transect segments, rather than trying to establish the entire transect from beginning to end.
    1. Walk the tape along the transect until you come to an obstruction.
    2. Use a highly visible marker to indicate the end of a transect segment.
    3. If allowed by the site host, these markers should be kept in place to indicate intermediate points along the transect.
C. Extend the transect from the origin using a calibrated compass and/or rangefinder.
    1. Carefully maintain the **lidsAzimuth** and track the distance from the origin if a transect is paced out without the aid of a meter tape.
D. Triangulate around impenetrable obstacles (e.g., slash piles, 'vine hell', *Rubus* thickets, etc.).
    1. Re-align with the transect line and bearing as soon as possible.
    2. Record the distance at which triangulation began and ended in the **remarks**.

7. Survey the transect for potentially qualifying pieces of CDW ≥ 2 cm diameter AND ≥ 1 m length with central axes that intersect the transect (see examples in **Figure 1**).
    a. Assess qualifying diameter and length with respect to the point at which the central axis of the piece of CDW intersects the transect (**Figure 2**).
        - In **Figure 2**, the length of the central axis is measured from diameter 'breakpoints' because bulk density is calculated separately for different size categories, and thus length measurements must be assignable to these same diameter size categories:
            - 2 cm ≤ diameter < 5 cm
            - 5 cm ≤ diameter < 10 cm

- diameter ≥ 10 cm

- **logDiameter** is measured perpendicular to where the transect crosses the central axis of the particle; if the particle is bent, the measurement location will NOT be where the transect crosses the particle itself (**Figure 2**).

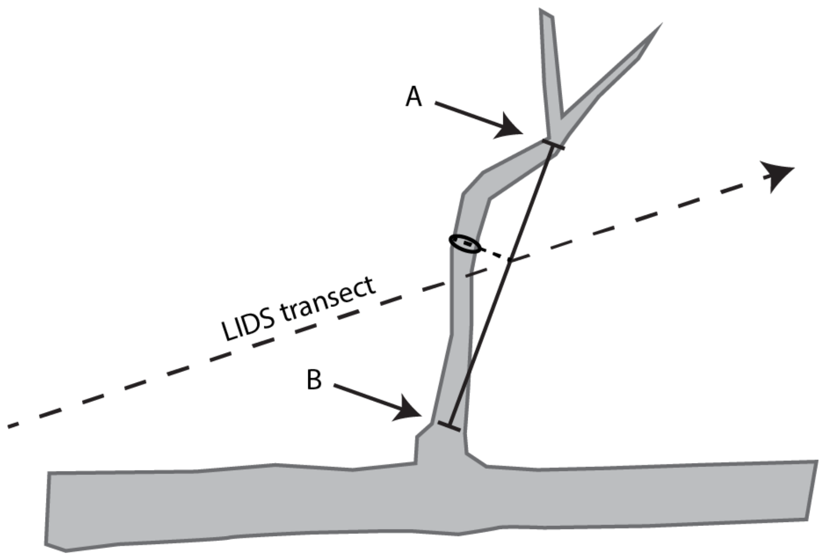


**Figure 2**. A LIDS transect (dashed line) intersecting a CDW particle that is tallied within the 5-10 cm diameter size class. The piece of CDW is attached to a larger piece of CDW ≥ 10 cm diameter, and the intersected piece is not tallied within the larger size class. Further along the branch from arrow A, the diameter is < 5 cm, and closer to the main bole from arrow B the diameter is ≥ 10 cm; the central axis (black line) is delineated along the portion of the CDW piece that is ≥ 5 cm diameter and < 10 cm diameter. Diameter is measured perpendicular to the central axis as shown by the oval in the figure. Diameter is *not* measured perpendicular to where the log intersects the transect, and diameter is *not* measured parallel with the transect where it intersects the log.

8. When a potentially qualifying piece of CDW intersects the transect, use information from step (7) to determine whether the log qualifies for tally and measurement:

   a. Use the mobile *Coarse Downed Wood: Tally [PROD]* application or Appendix B to determine whether the piece of CDW should be tallied. Particles of CDW are tallied in proportion to their cross-sectional area, for which diameter is an easy-to-measure proxy. Appendix B provides round diameter equivalents ($RD_E$) for elliptical and forked particles.

   *Example 1: Assuming a volume factor of F=8, pieces of CDW with D < 13.9 cm are NOT tallied if you have already walked 10 m along the transect.*

   *Example 2: Assuming a volume factor of F=8, do NOT tally pieces of CDW with D < 10 cm if you have already walked 5.14 m along the transect.*

b. Additional considerations:

   i. For logs that are elliptical in shape (e.g., highly decomposed logs that have begun to collapse under their own weight), assess the widest diameter to determine whether the log should be tallied.

   ii. Forked particles of CDW are tallied according to SOP B.2.

   iii. See SOP 0 'Troubleshooting' for other common issues and their resolution (e.g, irregular particles, slash piles, etc.)

   iv. In the event that the tablet fails, use either **Table 16** or **Table 17** in Appendix B to determine whether a log should be tallied. If you are not sure a log should be tallied, tally it; corrections to the data can be made during data entry.

9. For a qualifying log, create a child-level record in the *CDW: Tally [PROD]* app, and:

   a. Enter the **lidsAzimuth** and record **targetTaxaPresent** = 'Yes'.

   b. Record the **logID**:

      i. For logs ≥ 10 cm diameter, search for pre-existing tags if CDW tally has previously been implemented and record.

      ii. For untagged logs ≥ 10 cm diameter:

         a) If not already tagged, mark with a numbered, red aluminum tag.

         b) It is helpful to place the tag in a visible location near the intersecting point. Exceptions are if the wood is highly decayed at the intersect point; in this instance, use a pig-tail stake and place the tag where it is likely to stay in the log.

         c) For CDW particles with multiple qualifying branches, place the tag on the first branch that qualifies along the transect.

      iii. For logs ≥ 10 cm diameter previously tagged for VST:

         a) Add a red tag to the log; the number on the red tag is the logID.

         b) Leave the VST tag and record in the **vstTagID** field.

      iv. For logs < 10 cm diameter:

         a) **logID** = 'LXX', where 'XX' is sequentially assigned in the field, starting over at '01' at each new plot. Always use the 'L' prefix for these logs to enable separation from tagged logs in the NEON database.

         b) (If applicable) Record the **vstTagID**.

   c. Record required log attributes listed in **Table 8**.

**Table 8.** Log attributes recorded during CDW LIDS tallies.

| Field | Recorded Data | Method |
|---|---|---|
| **logDistance*** | Horizontal distance from transect intersect point to transect origin; nearest 0.1 m | TruPulse 360 (**HD** mode) or transect tape |
| **logDiameter** | • Maximum diameter of the CDW piece perpendicular to the log central axis at the point where the transect intersects the central axis (**Figure 2**); nearest 0.5 cm.<br>• For roughly circular logs, this is the only diameter measurement required.<br>• For elliptical logs, this the major axis of the ellipse. | Calipers |
| **logMinorDiameter** | For elliptical logs (often highly decomposed), this is the minor axis of the ellipse; nearest 0.5 cm. | For highly decomposed logs, push a chaining pin or the non-jaw end of the calipers into the wood until soil is reached. Measure and record this depth. |
| **logLength** (see **Figure 2**) | Length of the CDW piece central axis; nearest 0.1 m. | Meter tape or TruPulse 360 (**SD** mode) |
| **taxonID** | Species, genus, family or unknown, in that order. It is preferable to assign a family and use an identification qualifier code (idQ = CF or AF) than to use the unknown codes. For true unknowns you still must choose either:<br>• 'unknown hardwood' (code: '2Plant-H'), or<br>• 'unknown softwood' (code: '2Plant-S')<br>• If the log is very highly decayed, and distinguishing between hardwood and softwood is impossible, choose whichever is most likely based on the live trees in the plot, and the taxonIDs of other nearby downed logs that are less decayed. | • Visual inspection of remaining leaves, bark, surrounding live species, and other nearby downed logs; use field guide when helpful<br>• A digital photo that can be shared with an experienced botanist may also be helpful in assigning a **taxonID** |
| **identification Qualifier (idQ)** | See **Table 9** for idQ codes and descriptions. | Visual inspection |
| **decayClass** | Record for all qualifying logs. See **Table 10** for decayClass categories and descriptions. | Visual inspection |

* In extremely brushy conditions in which line of sight is obscured beyond a few meters, use the TruPulse with the brush filter in "FLt" mode, and establish waypoints along the transect at known distances from the transect origin. Measure distances from waypoints as needed.

**Table 9**. Identification qualifer codes (idQ) to designate unknown species, or those species with uncertain identification in the field.

| idQ Code | identificationQualifier | Description |
|---|---|---|
| CS | cf. species | Roughly equals but "not sure" about the species |
| AS | aff. species | "Similar to, but is not" the species |
| CG | cf. genus | Roughly equals but "not sure" about the genus |
| AG | aff. genus | "Similar to, but is not" the genus |
| CF | cf. family | Roughly equals but "not sure" about the family |
| AF | aff. family | "Similar to, but is not" the family |

**Table 10**. Decay classes for CDW pieces (modified from classes defined by the U.S. Forest Service).

| decay Class | Shape | Bark | Wood Texture | Twigs | Branches |
|---|---|---|---|---|---|
| 1 | Sound, freshly fallen, round. | Intact, fresh. | Intact, no rot. | Large and small diameter twigs present. Leaves/ needles may be present. | Present. Branches have most or all of their bark. |
| 2 | Sound, round. | Intact or partly missing; log has begun to lose bark. | Intact, sapwood partly soft. | Larger diameter twigs may be present. | Branches are present but have lost some bark. |
| 3 | Heartwood sound, log supports its own weight.<br>Still round. | Trace, log has little to no bark. | Sapwood can be pulled apart by hand, or is absent. | Absent. | Branches mostly absent; remaining are stubs with little bark; branch stubs are held firmly by heartwood and cannot be wiggled by hand. |
| 4 | Log does not support its own weight, but maintains shape; can be kicked apart, but breaking with hands is difficult | Absent. | Heartwood rotten, and may be made up of soft, small, blocky pieces; a chaining pin can be pushed easily into the log. | Absent. | Mostly stubs; intact branches absent. Branch stubs can be wiggled by hand. |
| 5 | No structural integrity; log does not retain shape, can be manually broken; majority of log still above litter layer. | Absent. | Soft, powdery when dry. | Absent. | Absent. |

10. Record the **tagStatus**; choose one of the following:
    a. **ok**; tag is new or existing tag present and value is consistent with previously entered value.
    b. **replaced**; log was tagged previously (> 90% probability) and tag is presently missing. It is known with > 90% probability what the previous tagID value was. A new tag with the previous tagID value has been attached.
11. Assess and record log decay characteristics. ***Note:*** The **decayClass** in step (9) is required for all logs; decay characteristics in this step are required for logs ≥ 10 cm diameter, and may also be recorded for logs < 10 cm diameter.
    - **leavesPresent** (or needles): 'Y' or 'N'
    - **twigsPresent**: 'Y' or 'N'. Twigs are < 2 cm diameter woody structures attached to the main log to be tallied.
    - **branchesPresent**: 'Y' or 'N'. Branches are ≥ 2 cm diameter woody structures attached to the main log to be tallied.
    - **branchBarkCover**: The % cover of bark on any branches; assign from the following categories: <5%, 5-10%, 11-25%, 26-50%, 51-75%, 76-95%, >95%.
    - **logBarkCover**: The % cover of bark on the main log to be tallied. Use the same % cover categories as above.
    - **logHandBreakable**: 'Y' or 'N'. Pieces of the log (not bark) can be broken apart by hand; focus on whether relatively large pieces can be removed using a full-handed grip rather than whether it is possible to break off small pieces with a prying finger or fingernail.
    - **logHoldsShape**: 'Y' or 'N'. The log holds its original shape, and does not slump or conform to the shape of the substrate upon which it lies. Breaks or indentations due to the impact of falling do not count.
    - **remarks**: Log-specific remarks. Typically not necessary, always be brief.
12. Save the child-level **logID** record.
13. Continue tallying logs that intersect the transect until the transect limit for the site is reached (see Appendix D for site-specific transect lengths).
14. Repeat steps (4) – (13) for any remaining transects.
15. Save the parent-level **plotID** record.
16. Proceed to the next plot and continue CDW tally.

## B.2 Tallying and Measuring Forked CDW Particles

When a transect intersects a particle of CDW that is forked, it is necessary to consider the summed cross-sectional area of qualifying forks to determine whether the particle should be tallied. The 'round diameter equivalent' calculator in the *CDW: Tally [PROD]* app is a valuable tool for making the necessary calculations. Additional required data for forked particles are listed in **Table 11**.

**Table 11**. Data required to determine whether forked CDW particles qualify for tally.

| Field | Recorded Data | Method |
|---|---|---|
| **majorAxisDiameter** | • Maximum diameter of fork at the measurement point specified by the protocol. Recorded as \`majorAxisDiameter1\`, \`majorAxisDiameter2\`, etc. to account for multiple forks.<br>• This is the only diameter necessary for roughly circular forks. | Calipers |
| **minorAxisDiameter** | For elliptical forks, this is the minor axis of the ellipse, measured at the point specified by the protocol. Recorded as \`minorAxisDiameter1\`, \`minorAxisDiameter2\`, etc. to account for multiple forks. | Calipers, or for highly decomposed logs, push a chaining pin or the non-jaw end of the calipers into the wood until soil is reached. |

There are multiple scenarios that are possible with forked CDW. Each requires a unique strategy to ensure that logs are tallied consistently.

### *SOP B.2.1 Transect intersects particle below fork, or on one fork only*

1. Similar to a single bole CDW particle, the decision to tally (or not) is based on the round diameter equivalent ($RD_E$) at the single point at which the particle intersects the transect.
   - The $RD_E$ is measured perpendicular to the particle's central axis at the point where the transect intersects the particle's central axis.
   - The length of the central axis is measured for the longest fork, regardless of whether the transect intersects that fork or not. That is, consider the entire particle – ***while paying attention to any diameter class breakpoints*** – when measuring log-level attributes.
2. Consult the *CDW: Tally [PROD]* app or Appendix B to determine whether the log should be tallied (**Table 16** or **Table 17**).
3. Record required diameter(s) and log-level attributes as specified in **Table 8**.

### *SOP B.2.2 Transect intersects multiple forks across different diameter classes*

*For a simple split with only two forks, and each intersected fork is in a different diameter class:*

1. Consider each fork as an independent CDW particle.
2. Measure the $RD_E$ for each fork to determine whether the fork should be tallied.
3. Record required diameter(s) and log-level attributes separately for each fork (one child-level record per fork).
   - Use the same **logID** for each fork.
   - Pay attention to diameter class breakpoints when determining **logLength** and the shape of the particle's central axis.

*For compound splits with > 2 forks:*

1. Consider groups of connected forks that are in the same diameter category separately from those forks, or groups of connected forks, that are in different diameter categories. Subsequent steps assume a CDW particle of this nature.
2. Determine whether to tally each group of connected forks within a given diameter size category one at a time. Use a single round diameter equivalent ($RD_E$) for each group of connected forks within the same diameter size category.
   - The diameter of each group of connected forks that intersects the transect can be combined into a single $RD_E$ using the *CDW: Tally [PROD]* app.
   - If the tablet fails, a single $RD_E$ can be estimated with Appendix B.2. If there are > 2 forks, combine forks two at a time using the table, using intermediate $RD_E$ values from each pair of forks until all forks have been combined into one $RD_E$.
3. Within a group of connected forks, for the largest fork record required diameter(s) as well as log-level attributes in one child-level logID record.
   - Pay attention to diameter class breakpoints when determining **logLength** and the shape of the particle's central axis.

*Example:*
*The transect crosses the main bole of a downed tree (main bole diameter = 25 cm @ intersect point), then crosses two forks of a connected branch (8 cm diameter and 5.5 cm diameter @ intersect points). The connected branch is 9.5 cm diameter where it emerges from the main bole.*

*Here, the main bole that is intersected is considered independently from the forked branch because it is in a different diameter class; the $RD_E$ = 25 is used with* **Table 16** *or* **Table 17** *to determine whether to tally and further measure the main bole.*

*For the two forks of the connected branch that also intersect the transect, given the input intersect diameters above, the $RD_E$ = 10 cm (from Appendix B.2). The $RD_E$ = 10 value is used with the CDW:*

*Tally [PROD] app (or* **Table 16** */* **Table 17***) to determine whether to tally and further measure the forked branch. If the branch is tallied, the* ***logLength*** *is measured from the origin of the branch (where it is 9.5 cm diameter) to either the branch tip, or the point at which diameter is < 5 cm, whichever comes first. Be mindful that* ***decayClass*** *may be more advanced for the forked branch than for the main bole, due to its smaller diameter.*

#### *SOP B.2.3 Transect intersects multiple forks within the same diameter class*

1. Consider connected forks originating from a common central axis AND that are in the same diameter class together as one CDW particle.
2. Determine whether to tally forked CDW particles based on a single round diameter equivalent ($RD_E$).
   - The diameter of each fork that intersects the transect can be combined into a single $RD_E$ using Appendix B.2.
3. If the CDW particle qualifies based on the combined $RD_E$, record required diameter(s) for the largest fork, as well as log-level attributes as specified in **Table 8** in one child-level **logID** record.
   - Pay attention to diameter class breakpoints when determining **logLength** and the shape of the particle's central axis.
   - Record diameter data for additional forks in additional child-level records using the same **logID**.

## B.3 Troubleshooting

**Table 12**. Troubleshooting common issues encountered when tallying and measuring CDW in the field.

| Issue | Description | Action |
|---|---|---|
| Too few CDW particles | < 5 pieces of CDW were tallied at > 20% of the sampled plotIDs | • Issue a problem ticket to procure a different volume factor (*F*) and transect length for sampling CDW at the site.<br>• Record the new F value at the top of each new datasheet. |
| Zero CDW particles | Zero pieces of CDW were tallied at > 1 of the sampled plotIDs | |
| Too many CDW particles | > 20 pieces of CDW were tallied at > 20% of the sampled plotIDs | |
| Transect intersects boundary | A LIDS transect encounters a boundary before the limiting distance is reached, and the boundary prevents further sampling (e.g. fence, poison oak thicket, impenetrably dense vegetation, property boundary, etc.).<br>*Note*: transitions between habitat/land cover (e.g. from forest to agricultural field) along a transect do not meet the definition of a physical barrier. | At the boundary, turn 180˚, reflect the transect back onto itself, and continue walking back toward the transect origin, tallying until the *total distance traveled* equals the distance originally desired for the transect (Gregoire and Monkevich 1994). |
| Uncertainty in **taxonID** | Cannot identify log to species, genus, or family rank. | • Determine whether log is "softwood spp." or "hardwood spp."<br>• In the taxonID field on the datasheet, record either '2plant-S' (unknown softwood) or '2plant-H' (unknown hardwood). Use nearby logs/trees to inform decision of Hardwood vs. Softwood.<br>• If possible, take a photo to enable an experienced botanist to help determine the **taxonID**. |
| Particle irregularity | Particle has an irregular base – e.g. a stem base that is wider than the rest of the trunk | • Move diameter measurement point to the nearest "regular" point on the log i.e. the first point at which the diameter stops changing |
| CDW intersects > 1 transect | Particle is tallied on more than one transect; that is, when plots are | • Only one tag is required |

| Issue | Description | Action |
|---|---|---|
| | relatively dense, a particle intersects two transects that originate from different plots. | • Tally the log on each transect it intersects; that is, the log will generate two data records.<br>• In **remarks** fields for each record of the log, note: 'also tallied in [plotID]' |
| Slash piles | The transect intersects a particle that is part of a 'slash pile.' Slash piles are heaped collections of waste CDW particles, created mechanically after logging or other clearing activities. | • The LIDS tally method cannot estimate the volume of slash piles: Do not tally or measure particles that are part of these piles.<br>• For each slash pile encountered, note in the **remarks**: "Slash pile @ X meters", and also record in the **remarks** the approximate diameter and height (in meters).<br>• Continue the transect straight through the slash pile; do NOT adjust transect length to accommodate interruption by a slash pile. |
| Rapidly tapering short particle | The distance between points A and B in **Figure 2** is < 1 m length. | • Do not tally. |

### B.4 Re-Talling Previously Surveyed LIDS Transects

Re-tallying previously surveyed transects generally follows the guidance in SOP B.1. Additional points pertinent to re-tally include:

5. The transect azimuth will be difficult to re-establish identically from bout to bout.
    a. Previously tagged logs can be used to guide transect re-establishment, but do not assume there is a 'true' transect. That is, do not attempt to perfectly re-create the previous transect.
    b. When the transect intersects a qualifying particle, DO check for a tag.
    c. If a tag cannot be found, DO use previously collected data to determine whether it is likely that a logID was previously assigned.
6. If it is known that a previous transect was incorrect due to azimuth inaccuracies, do NOT correct past data.
7. When illegible tags are encountered or a particle may have been tagged before but the tag cannot be found:
    a. If the previous **logID** can be determined with ≥ 90% confidence: Re-stamp a blank tag with the previous logID, and record **tagStatus** = 'replaced'.
    b. Else, re-tag the particle with a new **logID**, and record **tagStatus** = 'ok'.
8. When tags are attached from a previous bout:
    a. Previously collected **logID**, **logDistance**, **logDiameter**, **taxonID** and **decayClass** data may be used to help guide assessments in the current year.
    b. Previously collected data are *only* a guide. Current-year assessments should ultimately be made according to the protocol and current-year observations. That is, do not assume previous staff were correct 100% of the time.
    c. If the particle no longer qualifies, do not tally and do not create a record. The tag may be collected and removed from the plot.

# SOP C Bulk Density Sampling in the Field

## C.1 Sampling strategy overview

***Goals***

- Collect bulk density samples from logs that represent the most abundant **decayClass** x **sizeCategory** x **taxonID** (DST) combinations at the site.
- Enter data into the ***TOS Coarse Downed Wood: Field Bulk Density [PROD]*** mobile application. See the Coarse Downed Wood Fulcrum Manual (RD[13]) for data entry details.
- Do NOT collect bulk density samples from logs that intersect LIDS transects.
- Collect bulk density samples twice at each site: once within the first 3 y of site operations and the second time 5-6 y after the first sampling event.
- When paired with volume estimates by DST, bulk density allows calculation of CDW mass and carbon stocks.

***Sampling cross-sectional disks from downed logs***

For logs ≥ 10 cm diameter, it is ideal to:

- Cut cross-sectional disk samples with a chainsaw; however, if there are restrictions on chainsaw use, a buck or cross-cut type saw is an alternative.
- Cut cross-sectional disk samples at least 1 m in from the end of the log; and
- Repeat sample the same logs across both sampling bouts.
- Preferentially sample logs > 3 m length, due to the fact that two disks can be cut from the same log at a 5-6 y interval while still cutting each disk at least 1 m in from the end of the log at each sampling event.
- For logs ≥ 10 cm diameter and > 5 m length, cut two disks per log per bout: At each of the two sampling bouts, disks are cut at least 1 m in from either end of the log.
- Logs with diameter < 10 cm are not repeat sampled, and disks may be cut 50 cm from the end of the particle.

***Where to sample***

Cutting cross-sectional disk samples from CDW pieces for bulk-density estimation is carried out in and around Tower plots and Distributed plots. Because sampling involves cutting and removing a small section of downed log, individual site hosts may impose additional restrictions on where within a site it is allowed to perform the sampling. Be sure to check with the Field Operations Manager regarding potential sampling restrictions.

Additional restrictions

- Avoid sampling logs < 10 cm diameter within approximately 10 m of the plot centroid, as these logs are frequently tallied via SOP B.
- When sampling within Distributed plots, do not cut CDW particles where doing so would cause a change in plant diversity data collection from 1 $m^2$ nested subplots (e.g. a change in the percent abiotic cover).
- Be cognizant of trampling effects, and do not select logs for cross-sectional disk sampling that will require working within 10 $m^2$ nested subplots.
- To facilitate re-sampling logs during the second of the two prescribed bulk density sampling bouts, logs may be selected up to approximately 50 m from the plot centroid. Logs > 50 m from the centroid may be difficult to re-locate, and should be avoided. ***Be sure the site host has granted permission for sampling logs outside plot boundaries.***

***Prioritizing sampling effort***

For estimation of bulk-density, the goal is to sample logs for the most abundant DSTs, as identified by Science (see Appendix F for per site ranked lists of DSTs). An example of target sample sizes for different **sizeCategories** is provided in **Table 13**). When performing bulk density sampling:

- Target the most common CDW ‘decayClass x sizeCategory x taxonID’ combinations (DSTs) at a given site.
- Search all plots designated for CDW sampling, and opportunistically sample while traveling between plots (if allowed).
- Preferentially sample the largest diameter logs, as these logs are typically rarer, and also comprise the majority of CDW mass in an ecosystem (Keller et al. 2004) (**Table 13**).
- To enable repeat bulk density sampling of the same logs over the two bulk density sampling bouts, first try to find logs ≥ 3 m length for sampling. Search across all plots for logs meeting this criteria before sampling smaller length logs in any given plot.

**Table 13**. Example of desired CDW bulk-density sample size across multiple decay and diameter classes for an abundant species. Below, only the first two decayClasses for one taxon are shown for the sake of brevity.

| taxonID | decayClass | sizeCategory | sampleSize |
|---|---|---|---|
| *Acer rubrum* | 1 | 2-5 cm | 5 |
| | | 5-10 cm | 5 |
| | | ≥ 10 cm | 10 |
| | 2 | 2-5 cm | 5 |
| | | 5-10 cm | 5 |
| | | ≥ 10 cm | 10 |
| | etc… | etc… | etc… |

Guidelines and caveats for conducting bulk density sampling:

- Once the desired sample size is achieved for a given DST, stop searching for that combination in other plots.
- For widespread taxa that occur throughout the site, generate samples from as many pots as is feasible. For uncommon DSTs, it is acceptable to meet the desired sample size in only one plot.
- It may be difficult to achieve the desired sample size for DSTs associated with "unknown hardwood" and "unknown softwood" taxonIDs if most logs are identifiable to higher taxonomic resolution. Do your best given site conditions and the prescribed search area around the plot centroids.
- Sample sizes listed in **Table 13** may be achieved over up to two field seasons; however, completing sampling in one field season is preferred.

***Determining when sampling is complete***

The bulk density sampling effort is inherently variable from site to site, as it is driven by the number of DSTs, which is strongly dependent on site-level tree diversity. For each site, Science uses CDW tally data to create a list of DSTs ranked by tally abundance.

- Consider sampling complete once all rank-ordered DSTs that cumulatively make up 80% of the total tallies have been sampled (see Appendix F for per site lists of ranked DSTs).
- Desired sample sizes may not be achievable for all DSTs. Sampling can be considered complete for a given DST if all plots with applicableModule = 'cdw' have been searched within an approximately 50 m radius of the centroid, and the desired sample size has not been met.

## C.2 Initial bulk-density sampling in the field (Bout 1)

The field procedure described below enables calculation of both the volume and fresh mass of cross-sectional disks cut from pieces of CDW, both of which are required to determine CDW bulk density. To quantify uncertainty in bulk density measurements, QA must also be performed on these field measurements. Field QA consists of selecting 5% of sampled disks for re-measurement by a staff member who did not perform the original measurements. To record QA data:

- Create a child-level 'Disk Data' record and select **qaFreshMass** = 'Yes'.
- When not recording QA data, select **qaFreshMass** = 'No'.

Before performing any of the steps below:

- Be sure you are permitted to obtain CDW bulk-density samples from the intended sampling area, and determine whether chainsaw sampling is a permitted activity.
- Ascertain whether any wood quarantines affect your site (Appendix E). For example, sampling at Emerald Ash Borer (EAB) affected sites must occur during the non-flight season for EAB, and all samples must be double-bagged for transport back to the Domain Lab. See Appendix E for additional instructions.

***To Generate Bulk Density Samples:***

1. To help target the bulk density sampling effort, use the ranked list of DSTs in Appendix F. Tally each sampled log in the table to track sampling progress across DSTs.
2. Navigate to a desired plot that is suitable for CDW bulk-density sampling.
   - ***With site host permission***, logs may be selected up to approx. 50 m from the plot centroid.
3. Search for pieces of CDW that qualify for bulk density sampling. The most common CDW taxa for a site should be targeted first:
   - For CDW < 10 cm diameter: Pieces must be ≥ 1 m length, and only one bulk density sample per particle is allowed.
   - For CDW ≥ 10 cm diameter:
     - Pieces must be ≥ 2 m length, but ideally ≥ 3 m (to enable tagging and repeat sampling at two timepoints).
     - ***Sample as many logs as you can that are ≥ 3 m length during Bout 1***. Repeat sampling of the same logs in Bout 2 will be a major contribution to this field of ecology.
   - If you are sampling within an established NEON plot, use the LIDS Angle List to ensure that you do NOT select tagged CDW pieces for bulk-density sampling that were tallied on a LIDS transect. If you are unsure, be conservative and do NOT sample the piece in question.

4. When a log is encountered from which a bulk density disk will be collected, create a parent-level **plotID** record in the *CDW: Field Bulk Density [PROD]* app and enter required sampling meta-data:
    a. Select the **domainID**, **siteID** and **plotID**; if working outside established plot boundaries, choose the plotID of the nearest plot.
    b. **collectDate**; enter the date the sample was collected, *YYYY-MM-DD* format.
    c. **yearBoutBegan**; for bouts that span > 1 calendar year enter the earliest applicable year; *YYYY* format.
    d. **mappingMethod**; select 'Not Mapped' for logs that will NOT be repeat sampled. For logs ***≥ 10 cm diameter AND ≥ 3 m length*** that WILL be repeat sampled:
        i. Select a mappingMethod from the drop-down:
            a) 'Relative': Record **pointID** of nearest plot marker, **logAzimuth**, and **logDistance**. Mapping procedure is similar to VST (RD[08]). A suitable method when log is in sight of a plot marker.
            b) 'GPS': Record **sampleEasting** and **sampleNorthing**. A suitable method when logs are far from a plot marker and/or line of sight is obscured. Easting and northing allow easier re-location compared to decimal degrees.
5. Record required Log Data:
    a. **sizeCategory**; choose from: diameter ≥ 10 cm, 10 cm > diameter ≥ 5 cm, or 5 cm > diameter ≥ 2 cm.
    b. Enter the **logID**. This is an identifier used to link log-level data with field and lab data associated with cross-sectional disks sampled from the log.
        i. *For logs ≥ 10 cm diameter AND ≥ 3 m length* that will be repeat sampled: Affix a red, numbered tag to the middle of the log, and record the number in the **logID** field.
        ii. *For logs not meeting these criteria:* **logID** = 'LXX', where 'XX' are sequential numbers assigned in the field that start over at '01' at each new plot. Always use the 'L' prefix for these logs to enable separation from tagged logs in the NEON database.
        iii. For logs ≥ 10 cm diameter previously tagged for VST:
            a) Add a red tag next to the VST tag; the red tag is the **logID**.
            b) Leave the VST tag and record in the **vstTagID** field.

c. Record the **tagStatus**; choose 'ok' to indicate that a new tag was attached as part of bout1 sample collection.

d. **taxonID**; assign as described in SOP B.1 and identify to the finest taxonomic resolution possible.

- *Genus-species* or *Genus* should be possible for logs in decayClass 1-3; lower resolution taxonIDs are more likely for decayClasses 4 and 5.
- See **Table 8** for additional taxonID guidelines.

e. **identificationQualifier**; select from the available list if relevant (see **Table 9**).

f. **decayClass**; select from the available list (see **Table 10**).

g. Record decay class characteristics. Required for logs ≥ 10 cm diameter and may be relevant for smaller logs:

- **leavesPresent** (or needles); 'Yes' or 'No'
- **twigsPresent**; 'Yes' or 'No'. Twigs are defined as < 2 cm diameter woody structures attached to the main log or portion of log from which a disk will be cut.
- **branchesPresent**; 'Yes' or 'No'. Branches are defined as ≥ 2 cm diameter woody structures attached to the main log or portion of log from which a disk will be cut.
- **branchBarkCover**; The % cover of bark on any branches; assign from the following categories: <5%, 5-10%, 11-25%, 26-50%, 51-75%, 76-95%, >95%.
- **logBarkCover**; The % cover of bark on the main log or portion of log from which a disk will be cut. Use the same % cover categories as above.
- **logHandBreakable**; 'Yes' or 'No'. Pieces of the log can be broken apart by hand (bark does not count).
- **logHoldsShape**; 'Yes' or 'No'. The log holds its original shape, and does not slump or conform to the shape of the substrate upon which it lies. Breaks or indentations due to the impact of falling do not count.

6. Prepare a label and a muslin bag for the disk (or disks) that will be cut from the selected log. Use a pre-cut piece of 'Rite-in-the-Rain' type paper, and write with permanent marker.
   - **For logs ≥ 5 m in length**, two disks will be cut, one from either end of the log, and two labels are therefore required.
   - **For all logs**, record on the label:
     - **collectDate**: The date the bulk density sample is collected in the field, *YYYYMMDD* format.

- **plotID**: The unique identifier for the plot (or closest plot).
- **logID**: The logID previously recorded in step (5.b) above
- **diskID**: A technician assigned numeric identifier for the disk, either '1' or '2'.

7. Cut a cross-sectional disk (or disks) from the log using a method approved by the site host (if approved, chainsaws are always preferable). If only sampling from one end of the log – e.g., the log is < 5 m length – randomly choose an end to sample. Use the guidelines in **Table 14** below, and see **Figure 3**.
   - When feasible, use the Cant Hook and attached log stand to maneuver the CDW particle into safe cutting position, elevated off the ground with the log stand.
   - **For highly decayed logs that do not hold their shape**: It will be impossible to remove and measure a cross-sectional disk without it crumbling in the process. To deal with this situation, two cuts are made approximately 10 cm apart in the rotten log.
     - Keep the chain at the highest speed when cutting to make a clean cut and prevent rotten material from being thrown by the saw.
     - When both cuts are complete, simply scoop out the "disk" between the cuts by hand into a plastic garbage bag.
     - Thoroughly mix the sample by hand.

**Table 14.** Guidelines for cutting cross-sectional disks from CDW with different diameter and decayClass combinations.

| | **≥ 10 cm diameter log** | **< 10 cm diameter log** |
|---|---|---|
| **decayClasses 1-3** | • 5+ cm width disk<br>• ≥ 1 m buffer from log end | • 10 cm width disk<br>• ≥ 50 cm buffer from log end |
| **decayClasses 4-5** | • 10 cm width disk<br>• ≥ 1 m buffer from log end<br>• Chain at highest speed before initiating cuts | • 10 cm width disk<br>• ≥ 50 cm buffer from log end<br>• Chain at highest speed before initiating cuts |

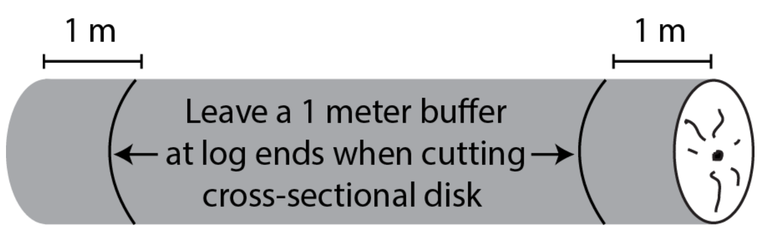


**Figure 3**. A minimum 1 m buffer should be left on either end of a ≥ 10 cm diameter CDW piece when cutting a cross-sectional disk for bulk-density sampling. The log depicted is > 5m length and is sampled from both ends at each of the two sampling timepoints. Qualifying logs < 5m length are only sampled at one end.

8. Create a child-level 'Disk Data' record in the *CDW: Field Bulk Density [PROD]* app, measure the required disk dimensions, and record:
   a. **bagNumber**; the permanent number labeled on each muslin bag. The bagNumber will be used to track the sample through drying and weighing.
   b. **diskID**; a technician assigned numeric identifier for the disk, either '1' or '2'.
   c. **(*Optional*) subsampleBarcode**; scan the sample barcode label to associate with the child-level disk record. The barcode will speed data entry in the laboratory.
   d. **For disks with structural integrity that hold their shape:**
      i. *For disks ≥ 5 cm diameter:*
         - Measure diameter with a diameter tape. Record to the nearest 0.1 cm:
            - **diameter**: The diameter of the cross-sectional disk
            - **ninetyDiameter**: Leave blank
         - Measure disk heights with calipers. Record to the nearest 0.1 cm:
            - **maxDiskHeight**: The maximum disk height
            - **minDiskHeight**: The minimum disk height
            - **aDiskHeight**: Technician selected representative intermediate disk height
            - **bDiskHeight**: Technician selected representative intermediate disk height
      ii. *For disks < 5 cm diameter:*
         - Measure diameter with calipers. Record to the nearest 0.1 cm:
            - **diameter**: The maximum disk diameter; i.e., the major ellipse axis
            - **ninetyDiameter**: The minimum disk diameter; i.e., the minor ellipse axis
         - Measure disk heights with calipers. Record to the nearest 0.1 cm:
            - **maxDiskHeight**: The maximum disk height
            - **minDiskHeight**: The minimum disk height
            - **aDiskHeight**: Leave blank
            - **bDiskHeight**: Leave blank

e. **For "disks" lacking structural integrity that do NOT hold their shape,** and have already been manually scooped into a plastic bag:

i. *For "disks" ≥ 10 cm diameter:*

- Measure diameters on both faces of the remaining cut log using calipers (**Figure 4**). For each field below, record the average of both cut faces, to the nearest 0.1 cm:
  - **diameter**: The maximum disk diameter; i.e., the major ellipse axis
  - **ninetyDiameter**: The minimum disk diameter; i.e., the minor ellipse axis
- Measure disk height with calipers (i.e., the width of the scooped out log area; "C" in **Figure 4**). Be sure to subtract 2X the width of the saw kerf from the measured height (i.e., 2X the width of the saw blade). Record to the nearest 0.1 cm:
  - **maxDiskHeight**: The maximum disk height
  - **minDiskHeight**: The minimum disk height
  - **aDiskHeight**: Technician selected representative intermediate disk height
  - **bDiskHeight**: Technician selected representative intermediate disk height

ii. *For "disks" < 10 cm diameter:*

- Measure diameters on both faces of the remaining cut log using calipers as above for ≥ 10 cm logs. Record to the nearest 0.1 cm.
  - **diameter**: The maximum disk diameter; i.e., the major ellipse axis
  - **ninetyDiameter**: The minimum disk diameter; i.e., the minor ellipse axis
- Measure disk height with calipers as above for ≥ 10 cm logs. Record to the nearest 0.1 cm:
  - **maxDiskHeight**: The maximum disk height
  - **minDiskHeight**: The minimum disk height
  - **aDiskHeight**: Leave blank
  - **bDiskHeight**: Leave blank

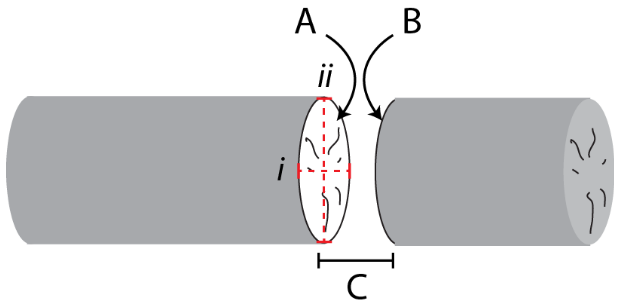


**Figure 4.** Measurements required for the space from which a crumbly "disk" was extracted by hand from a highly decayed log. Freshly cut surfaces are indicated by A and B, and C shows the height of the "disk." Highly decayed logs are often collapsed under their own weight, and show elliptical cross-sections (i.e., the red dashed lines *i* and *ii* where *i* > *ii*, which represent the major and minor ellipse axes, respectively). In the steps above, **diameter** is typically the average of A.*i* and B.*i* ; **ninetyDiameter** is typically the average of A.*ii* and B.*ii*

9. Measure the fresh mass of the entire cross-sectional disk sample using a spring scale.
   a. Choose an appropriately sized spring scale for the disk sample.
   b. Break up unwieldy pieces that do NOT exceed the spring scale limit with a hatchet, and weigh together, if feasible.
   c. Break up large pieces that DO exceed the spring-scale limit with a hatchet, and weigh pieces one at a time:
      i. Generate as few pieces as possible to prevent compounding mass measurement error.
      ii. Do NOT use a chainsaw for breaking the disk, as the saw will remove wood mass.
   d. Check the tare before each weighing.
   e. Record in the *CDW: Field Bulk Density [PROD]* app:
      i. **qaFreshMass**; defaults to 'No'; select 'Yes' if a child-level QA record is desired. 5% of disks should be selected for QA.
      ii. **diskFreshMass**; precision is determined by the spring scale that was used (not all scales are listed below).
         - 20 kg scale: Estimate to the nearest 100 g
         - 1000 g scale: Estimate to the nearest 5 g
         - 300 g scale: Estimate to the nearest 1 g

10. Cut an approximate 100 – 400 g subsample from the disk to take back to the laboratory and determine the fresh:dry mass ratio (see **Figure 5** below for subsampling guidelines).
    - Record 'Disk Subsample Created = No' and skip this step if the entire disk has a fresh mass < 400 grams.
    - When subsampling disks:
        - Larger masses, closer to 400 g, will be needed to generate a representative, wedge-shaped subsample from large-diameter disks (**Figure 5**A).
        - Smaller masses, closer to 100 g, will be sufficient for smaller-diameter disks (**Figure 5**B).
    - If decay throughout the disk appears non-uniform, i.e. a portion of the disk is more decayed than the rest:
        - Generate two subsamples that weigh approximately 100 – 400 g total, with volume of the two subsamples roughly proportional to the affected areas of the disk.
        - Both subsamples can be placed into the same, numbered muslin bag.
    - **For "disks" lacking structural integrity that do NOT hold their shape**:
        - Subsample approx. 100-200 g of well mixed sample by hand from the plastic bag.

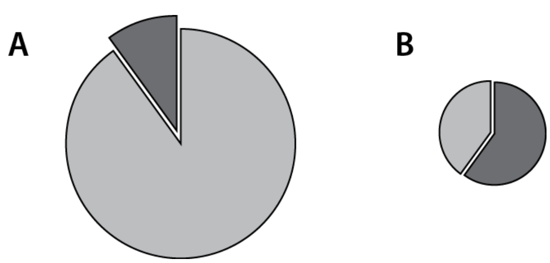


**Figure 5.** Creating wedge-shaped subsamples from cross-sectional disks from relatively large disks (A), and relatively small disks (B). In both A and B, the dark grey area is approx. 100 g, and the light grey is discarded.

11. Weigh the subsample created in step 10, and determine the fresh mass with an appropriately sized spring scale. Always tare the scale first. In the *CDW: Field Bulk Density [PROD]* app:
    a. Record the **sampleFreshMass**: Fresh mass of the disk subsample; nearest 1 g.
    b. Save the child-level disk record.
12. Place the sample into a numbered muslin bag, along with its associated label, and tie the bag.
13. Create another child-level disk record if a second disk can be collected from the log.
14. Return to step (3), above.

## C.3 Post-field sampling tasks

1. Place numbered muslin bags containing cross-sectional disks, or subsamples of disks, into the 105 ˚C drying oven(s).
   - Track drying progress with the general purpose Drying Datasheet (see SOP D.1 for details).
   - Bulk density samples can air-dry for up to 5 days before going into the oven if oven-space is not immediately available.

2. Perform routine chainsaw maintenance:
   - Sharpen chain if necessary. Keep in mind that during sampling of downed logs, the chain may come into frequent contact with the ground, and could dull quickly. However, the chain does not have to be particularly sharp to cut decayed logs, so only sharpen if you find you are having difficulty making straight(ish) cuts.
   - Check controls, chain tension, and all bolts and handles to ensure they are functioning properly and adjusted according to the manufacturer's instructions.
   - Make sure the lubrication (bar oil) reservoir is full. ALWAYS fill the bar oil reservoir when re-fueling to ensure it does not run dry.

## C.4 Repeat bulk-density sampling in the field (Bout 2)

The process of cutting, measuring, weighing, and subsampling cross-sectional disks from selected logs is identical to that described in SOP C.1 for Bout 1 sampling. However, the process of selecting logs for sampling is different: Only those logs ≥ 10 cm that were tagged with a red, aluminum tag in Bout 1 are re-sampled in Bout 2. For these logs that are re-sampled, cut cross-sectional disks per log according to the following strategy (see **Figure 6**):

- **For all logs:**
  - Use the disk sampling guidelines in **Table 14**.
  - Record the **tagStatus**; choose one of the following:
    - **ok**; existing tag present and value is consistent with previously entered value.
    - **replaced**; log was tagged previously (> 90% probability) and tag is presently missing. It is known with > 90% probability what the previous tagID value was. It is not necessary to attach a new tag because only two bouts of CDW Bulk Density are performed at a site.
- **For logs ≥ 3 m length** (that were ≥ 5 m length in Bout 1)(**Figure 6**A):
  - Cut two cross-sectional disk samples, 1 meter in from each end of the log.
- **For < 3 m length** (that were < 5 m length in Bout 1)(**Figure 6**B):
  - Cut one cross-sectional disk sample, 1 meter in from either end of the log.
  - For logs exactly 2 m long, cut the disk from the center of the log.

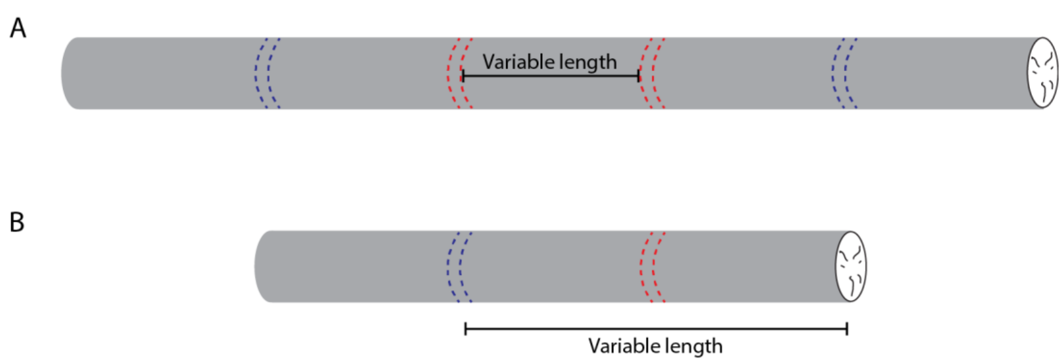


**Figure 6**. Strategy for generating cross-sectional disks from logs re-sampled for bulk density in Bout 2. (A) Logs ≥ 5 m length in Bout 1 and ≥ 3 m length in Bout 2; (B) Logs < 5 m length in Bout 1 and < 3 m length in Bout 2. Pairs of blue dashed lines represent Bout 1 disks, and pairs of red dashed lines indicate Bout 2 disks.

## SOP D Processing Bulk Density Samples in the Laboratory

### *Goals*

- Oven-dry bulk-density samples from B.4 to constant mass in the laboratory.
- Record dry-weight mass values in the ***TOS Coarse Downed Wood: Lab Bulk Density [PROD]*** application so that bulk-density can be calculated for abundant DSTs that occur at each site. See the Coarse Downed Wood Fulcrum Manual (RD[13]) for data entry details.
- Calculation of bulk density by DST allows accurate estimation CDW mass and carbon stocks when paired with volume estimates from SOP B.

### D.1 Drying and weighing samples

1. Record on the Drying Datasheet:
   a. **bagNumber**
   b. The **ovenStartDate** and **time** the samples are placed in the drying oven.
   c. ***Tip:*** Dry disk samples/subsamples from the same log at the same time to take advantage of 'batch' entry of oven drying data.

***Critical step:*** Recording the 'bagNumber' allows for easy tracking of drying progress for individual bags without having to open bags to see the label, and enables assessment of how long different batches of wood samples have been in the oven. Trackable, numbered bags are especially useful when samples from different days are in the same oven. The same bags may be re-used for subsequent disk collections.

2. Place marked muslin bags, with sample labels inside, into a 105 ˚C drying oven until samples are dried to a constant mass. Drying may take up to 5 days (120 h) or longer.
3. Check the drying progress using the Drying Datasheet.
   a. Choose 5 numbered muslin bags per **ovenStartDate** to monitor for drying time. If there are different size categories of sample (e.g. wedges from larger logs vs. cylinders of various sizes from smaller logs), choose 5 samples per size category and perform the steps below separately for each size category.
   b. Record the mass of the sample in these 5 bags through time to track drying progress. There is no need to remove samples from the bags: Simply record the mass of the bag + the sample inside.
   c. Each time drying progress is checked, calculate the difference in mass between the last two timepoints for each bag + sample(s).

d. Samples are dry when the average difference between the last two timepoints equals zero (i.e., the change in mass averaged across all 5 bags = 0, to within ± 0.5 g or ± 1% of the previous timepoint mass, whichever is larger).

   - The time difference between weight checks may need to be longer than 24 h, depending on wood water content and sample size.

4. Remove dried bulk-density samples from the drying ovens, let cool until safe to touch, and weigh as soon as possible.
   - Oven-dried wood will readily absorb water from the air, particularly in humid environments. Weigh samples one or two at a time soon after removal from the oven to prevent this problem.
   - ***If not weighing samples within 1 h after removing from the oven***, record **ovenOutDate/Time** on the label, and place in temporary storage. Samples not weighed within 1 h from when they are removed from the oven must be returned to a 105 ˚C drying-oven for 24 h prior to weighing.
5. Remove dried wood from the muslin bag, tare the balance + weigh boat, weigh each individual disk sample or subsample using a mass balance (0.01 g accuracy), and record data in the *CDW: Lab Bulk Density [PROD]* app.
   a. **logID**; for the logID linked to the disk sample, find an existing parent-level record in the *CDW: Lab Bulk Density [PROD]* app, or create one if none exists.

      ***Optional barcode workflow***: This workflow will avoid creating duplicates when a parent-level record for another disk cut from the same logID has already been created.

      i. In the main app, scan the barcode affixed to the sample label. If a parent-level record for another disk cut from same **logID** has already been created, it will be identified.
         a) Edit the record to create another child-level **diskID** record for the sample in hand.
      ii. If scanning the barcode in the main app does not bring up any existing records:
         a) Create a new parent-level **logID** record.
         b) In the **Select logID** field, scan the sample barcode to auto-populate sample meta-data previously entered in the *CDW: Field Bulk Density [PROD]* app.

   b. **Batch Oven Times**; batch oven times may be entered if there are 2 disks cut from the same log and both disks were dried identically (same dates, duration, etc.)
      - Oven Times are only recorded for initial drying. Do not record oven data for any subsequent drying events following storage.

c. Create a child-level **Disk Data** record for the sample in hand and record:
   i. **diskID**; select the diskID for the sample.
   ii. Enter **ovenStartDate/Time** and **ovenEndDate/Time** if 'batch' data were not previously entered.
   iii. **qaFreshMass**; select 'Yes' or 'No' depending on whether the record is for QA. A minimum of 5% of samples should be selected for QA weighing.
   iv. **diskFreshMass**; value is auto-populated from the *CDW: Field Bulk Density [PROD]* app when diskID is selected and may be changed here if necessary. Enter in grams (g).
   v. **Disk Subsample Created**; Indicate 'Yes' or 'No'. Value is auto-populated from the *CDW: Field Bulk Density [PROD]* app when diskID is selected and may be changed here if necessary.
   vi. **sampleFreshMass**; the fresh mass of the disk subsample created in the field, grams (g). Value is auto-populated from the *CDW: Field Bulk Density [PROD]* app when diskID is selected and may be changed here if necessary.
   vii. **qaDryMass**; select 'Yes' or 'No' depending on whether the record is for QA.
   viii. **dryMass**; the oven dry mass of the disk or disk subsample, nearest 0.01 grams.
   ix. Save the child-level disk record.

d. Save the parent-level **logID** record.

6. Repeat step (5) for additional dried samples.
7. Return dried wood samples to temporary storage in marked muslin bags once all data have been recorded.
   - Samples may be discarded after all data have been recorded, successfully ingested into the *CDW: Lab Bulk Density [PROD]* app, and QC checked.
   - Numbered muslin bags may be re-used for subsequent sampling events.

## D.2 Data Quality Assurance

To quantify uncertainty associated with weighing dried wood samples, a portion of dried samples are re-weighed by a different technician than the person who originally weighed the biomass.

1. Select 5% of dried, previously weighed samples for re-weighing by a different technician than he/she who performed the initial weighing.
    - If QA weighing does not take place within 1 hour of initially removing the sample from the oven, return samples targeted for QA to a 105 ˚C drying oven for 24 h prior to re-weighing.
2. For all QA records:
    a. Find the existing parent-level **logID** record in the CDW: Lab Bulk Density [PROD] app.
    b. Create a new child-level 'Disk Data' record.
    c. Select **qaDryMass** = 'Yes'
    - **qaDryMass**; enter to nearest 0.01 g
3. Return wood samples to temporary storage until all data have been successfully entered into the CDW: Lab Bulk Density [PROD] app and ingested successfully into the NEON database. Samples may be discarded once data have been QC checked according to RD[04] and successfully ingested into the NEON database.

## D.3 Equipment Maintenance

- Check balances before each use with a standard weight.
- Balances should be calibrated with a standard calibration weight set
    - After initial installation
    - Any time the balance is moved
    - Every 6 months, or
    - If the check above indicates the balance is reporting masses outside the manufacturer's specified tolerances.

## SOP E Data Entry and Verification

Mobile applications are the preferred mechanism for data entry. Data should be entered into the protocol-specific application as they are being collected, whenever possible, to minimize data transcription and improve data quality. For detailed instructions on protocol-specific data entry into mobile devices, see the internal NEON Sampling Support Library (SSL). Mobile devices should be synced at the end of each day, where possible; alternatively, devices should be synced immediately upon return to the Domain Support Facility.

Given the potential for mobile devices to fail under field conditions, it is imperative that paper datasheets are always available to record data. Paper datasheets should be carried along with the mobile devices to sampling locations at all times. As a best practice, field data collected on paper datasheets should be digitally transcribed within 7 days of collection or the end of a sampling bout (where applicable). However, given logistical constraints, the maximum timeline for entering data is within 14 days of collection or the end of a sampling bout (where applicable). See RD[04] for complete instructions regarding manual data transcription.

### E.1 Digital Data Workflow

**Data collected in the field: Tally**

1. The **domainID** and the **logID** are used to create the individualID in the NEON database. Make sure these input data are entered correctly before saving records.

**Data collected in the field: Bulk Density**

1. The **yearBoutBegan**, **plotID**, and **logID** are used to create the sampleID in the NEON database. Make sure these input data are entered correctly before saving records.
2. Saving *CDW: Field Bulk Density [PROD]* records and syncing will make **sampleIDs** available for further data entry in the downstream *CDW: Lab Bulk Density [PROD]* app.
    a. If corrections to any of the sampleID input variables are required after a sampleID has been selected in the downstream application:
        i. Make the correction(s) in the Field app and save.
        ii. Open, edit, and save each downstream parent- and child-level record in order to propagate the update.
    b. Consult the Coarse Downed Wood Fulcrum User Manual on the SSL for more detail.

**Data collected in the lab: Bulk Density**

1. The **sampleID** and the **diskID** are used to construct the **subsampleID**. Each subsampleID is associated with disk dimension, fresh weight, subsample fresh mass (if applicable) and dry mass values.
2. If **subsampleIDs** available in the 'Select diskID' drop-down are incorrect:
    a. Discard the *CDW: Lab Bulk Density [PROD]* record.
    b. Make corrections in the *CDW: Field Bulk Density [PROD]* app as described above, save and sync.
3. The child-level 'Disk Data' records in the *CDW: Lab Bulk Density [PROD]* app inherit **diskFreshMass** and **sampleFreshMass** data (when applicable) from the *Field Bulk Density* app. If either of these fields is incorrect and *Lab Bulk Density* records have already been created:
    a. Make updates only in the *Lab Bulk Density* app. Published values for these two fields are ingested from the *Lab Bulk Density* app only.

See the Data Management Protocol (RD[04]) for detailed, protocol-specific Data Management SOPs. See training materials on the SSL for detailed data ingest guidance via the NEON digital workflow.

## E.2 Field Data Sheets

Paper Field Data sheets for tally and bulk density sampling may be used if the mobile application ingest platform is unavailable or compromised.

- Transcribe data from the 'Coarse Downed Wood: Field Tally Datasheet' into the *Coarse Downed Wood: Tally [PROD]* app.
- Transcribe data from the 'Coarse Downed Wood: Field Bulk Density Log' and 'Coarse Downed Wood: Field Bulk Density Disk' data sheets into the *Coarse Downed Wood: Field Bulk Density [PROD]* app.
- Consult the Coarse Downed Wood Fulcrum Manual to determine appropriate values and formats for each field in the ingest table.

## E.3 Lab Data Sheets

Paper Lab Data sheets for bulk density sampling may be used if the mobile application ingest platform is unavailable or fails.

- Transcribe data from the 'Coarse Downed Wood: Lab Bulk Density' data sheet into the *Coarse Downed Wood: Lab Bulk Density [PROD]* app.

- Data from the Multi-Protocol Drying Data sheet are not transcribed for ingest into the NEON database.
- Consult the Coarse Downed Wood Fulcrum Manual to determine appropriate values and formats for each field in the ingest table.

## SOP F Sample Shipment

This protocol does not generate any samples that require shipment to external facilities for analysis or archive.

# 8 REFERENCES

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Keller, M., M. Palace, G. P. Asner, R. Pereira, and J. N. M. Silva. 2004. Coarse woody debris in undisturbed and logged forests in the eastern Brazilian Amazon. Global Change Biology **10**:784-795.

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Warren, W. G., and P. F. Olsen. 1964. A line intersect technique for assessing logging waste. Forest Science **10**:267-276.

## APPENDIX A DATASHEETS

The following datasheets and ingest documents are associated with this protocol:

**Table 15.** Datasheets associated with this protocol

| NEON Doc. # | Title |
|---|---|
| NEON.DOC.002121 | Datasheets for TOS Protocol and Procedure: Coarse Downed Wood |
| NEON.DOC.001921 | NEON Raw Data Ingest Workbook for TOS Coarse Downed Wood: Field Tally Data |
| NEON.DOC.001922 | NEON Raw Data Ingest Workbook for TOS Coarse Downed Wood: Bulk Density Field and Lab Data |

These datasheets can be found in Agile or the NEON Document Warehouse.

## APPENDIX B QUICK REFERENCES

### B.1 Minimum Round Diameters and Limiting Distance Tables

If it is unclear whether a log should be measured, err on the side of caution and measure it – i.e., RD rounds UP, $D_{lim}$ rounds DOWN.

**Table 16**. Limiting distances ($D_{lim}$) for round diameters (RD) across various LIDS volume factors (*F*). Double-lines indicate breaks between diameter sizeCategories.

| | $D_{lim}$ (m) | | | | |
|---|---|---|---|---|---|
| **RD (cm)** | **F=5** | **F=8** | **F=10** | **F=15** | **F=20** |
| **2** | 0.3 | 0.21 | 0.16 | 0.11 | 0.08 |
| **3** | 0.7 | 0.46 | 0.37 | 0.25 | 0.19 |
| **4** | 1.3 | 0.8 | 0.7 | 0.4 | 0.3 |
| **5** | 2.1 | 1.3 | 1.0 | 0.7 | 0.5 |
| **6** | 3.0 | 1.9 | 1.5 | 1.0 | 0.7 |
| **7** | 4.0 | 2.5 | 2.0 | 1.3 | 1.0 |
| **8** | 5.3 | 3.3 | 2.6 | 1.8 | 1.3 |
| **10** | 8.2 | 5.1 | 4.1 | 2.7 | 2.1 |
| **12** | 11.8 | 7.4 | 5.9 | 4.0 | 3.0 |
| **14** | 16.1 | 10 | 8.1 | 5.4 | 4.0 |
| **16** | 21.1 | 13 | 11 | 7.0 | 5.3 |
| **20** | 32.9 | 21 | 16 | 11 | 8.2 |
| **25** | 51.4 | 32 | 26 | 17 | 13 |
| **30** | 74 | 46 | 37 | 25 | 19 |
| **35** | 100 | 63 | 50 | 34 | 25 |
| **40** | 131 | 82 | 66 | 44 | 33 |
| **50** | 205 | 129 | 103 | 69 | 51 |
| **60** | 296 | 185 | 148 | 99 | 74 |
| **70** | | 252 | 202 | 134 | 101 |
| **80** | | 329 | 263 | 175 | 132 |
| **90** | | | 333 | 222 | 167 |
| **100** | | | | 274 | 206 |
| **110** | | | | 332 | 249 |
| **120** | | | | | 296 |

**Table 17**. Minimum round diameters ($RD_{min}$) for fixed distances (*D*) for various LIDS volume factors (*F*). Log diameters larger than those listed are tallied at any distance.

| | $RD_{min}$ (cm) | | | | |
|---|---|---|---|---|---|
| ***D (m)*** | **F=5** | **F=8** | **F=10** | **F=15** | **F=20** |
| **0.5** | 2.5 | 3.1 | 3.5 | 4.3 | 4.9 |
| **1** | 3.5 | 4.4 | 4.9 | 6.0 | 7.0 |
| **2** | 4.9 | 6.2 | 7.0 | 8.5 | 9.9 |
| **4** | 7 | 8.8 | 9.9 | 12.1 | 13.9 |
| **6** | 8.5 | 10.8 | 12.1 | 14.8 | 17.1 |
| **8** | 9.9 | 12.5 | 13.9 | 17.1 | 19.7 |
| **10** | 11 | 13.9 | 15.6 | 19.1 | 22.1 |
| **15** | 13.5 | 17.1 | 19.1 | 23.4 | 27.0 |
| **20** | 15.6 | 19.7 | 22.1 | 27.0 | 31.2 |
| **25** | 17.4 | 22.1 | 24.7 | 30.2 | 34.9 |
| **30** | 19.1 | 24.2 | 27.0 | 33.1 | 38.2 |
| **35** | 20.6 | 26.1 | 29.2 | 35.7 | 41.3 |
| **40** | 22.1 | 27.9 | 31.2 | 38.2 | 44.1 |
| **45** | 23.4 | 29.6 | 33.1 | 40.5 | 46.8 |
| **50** | 24.7 | 31.2 | 34.9 | 42.7 | 49.3 |
| **60** | 27 | 34.2 | 38.2 | 46.8 | 54.0 |
| **70** | 29.2 | 36.9 | 41.3 | 50.5 | 58.3 |
| **80** | 31.2 | 39.4 | 44.1 | 54.0 | 62.4 |
| **90** | 33.1 | 41.8 | 46.8 | 57.3 | 66.2 |
| **100** | 34.9 | 44.1 | 49.3 | 60.4 | 69.7 |
| **120** | 38.2 | 48.3 | 54.0 | 66.2 | 76.4 |
| **140** | 41.3 | 52.2 | 58.3 | 71.5 | 82.5 |
| **160** | 44.1 | 55.8 | 62.4 | 76.4 | 88.2 |
| **180** | 46.8 | 59.2 | 66.2 | 81.0 | 93.6 |
| **200** | 49.3 | 62.4 | 69.7 | 85.4 | 98.6 |
| **220** | 51.7 | 65.4 | 73.1 | 89.6 | 103.4 |
| **240** | 54.0 | 68.3 | 76.4 | 93.6 | 108.0 |
| **260** | 56.2 | 71.1 | 79.5 | 97.4 | 112.4 |
| **280** | 58.3 | 73.8 | 82.5 | 101.1 | 116.7 |

## B.2 Forked CDW and Single Round Diameter Equivalents

A CDW particle may be forked where it intersects the LIDS transect. Because tallying depends on total cross-sectional area for the piece, for forked pieces it is necessary to calculate the equivalent RD at the point of LIDS intersection as a function of the total cross-sectional area that is made up of each fork. Equivalent $RD_E$ values for CDW split into two forks are provided in (**Table 18**); for > 2 input forks, work in groups of two and calculate intermediate RDs until one equivalent RD is computed.

**Table 18**. The round diameters of split CDW pieces ($RD_{INPUTS}$), and corresponding calculated equivalent round diameters ($RD_E$).

| $RD_{INPUTS}$ | $RD_E$ | $RD_{INPUTS}$ | $RD_E$ | $RD_{INPUTS}$ | $RD_E$ | $RD_{INPUTS}$ | $RD_E$ |
|---|---|---|---|---|---|---|---|
| 1, 2 | 2.2 | 3, 14 | 14.3 | 7, 9 | 11.4 | 18, 22 | 28.4 |
| 1, 3 | 3.2 | 3, 16 | 16.3 | 7, 10 | 12.2 | 18, 24 | 30 |
| 1, 4 | 4.1 | 3, 18 | 18.2 | 7, 12 | 13.9 | 18, 26 | 31.6 |
| 1, 5 | 5.1 | 3, 20 | 20.2 | 7, 14 | 15.7 | 18, 28 | 33.3 |
| 1, 6 | 6.1 | 4, 5 | 6.4 | 7, 16 | 17.5 | 18, 30 | 35 |
| 1, 7 | 7.1 | 4, 6 | 7.2 | 7, 18 | 19.3 | 20, 22 | 29.7 |
| 1, 8 | 8.1 | 4, 7 | 8.1 | 7, 20 | 21.2 | 20, 24 | 31.2 |
| 1, 9 | 9.1 | 4, 8 | 8.9 | 8, 9 | 12.0 | 20, 26 | 32.8 |
| 1, 10 | 10.0 | 4, 9 | 9.8 | 8, 10 | 12.8 | 20, 28 | 34.4 |
| 1, 12 | 12.0 | 4, 10 | 10.8 | 8, 12 | 14.4 | 20, 30 | 36.1 |
| 1, 14 | 14.0 | 4, 12 | 12.6 | 8, 14 | 16.1 | 22, 24 | 32.6 |
| 1, 16 | 16.0 | 4, 14 | 14.6 | 8, 16 | 17.9 | 22, 26 | 34.1 |
| 1, 18 | 18.0 | 4, 16 | 16.5 | 8, 18 | 19.7 | 22, 28 | 35.6 |
| 1, 20 | 20.0 | 4, 18 | 18.4 | 8, 20 | 21.5 | 22, 30 | 37.2 |
| 2, 3 | 3.6 | 4, 20 | 20.4 | 9, 10 | 13.5 | 24, 26 | 35.4 |
| 2, 4 | 4.5 | 5, 6 | 7.8 | 9, 12 | 15.0 | 24, 28 | 36.9 |
| 2, 5 | 5.4 | 5, 7 | 8.6 | 9, 14 | 16.6 | 24, 30 | 38.4 |
| 2, 6 | 6.3 | 5, 8 | 9.4 | 9, 16 | 18.4 | 26, 28 | 38.2 |
| 2, 7 | 7.3 | 5, 9 | 10.3 | 9, 18 | 20.1 | 26, 30 | 39.7 |
| 2, 8 | 8.2 | 5, 10 | 11.2 | 9, 20 | 21.9 | 28, 30 | 41 |
| 2, 9 | 9.2 | 5, 12 | 13.0 | 10, 12 | 15.6 | 28, 32 | 42.5 |
| 2, 10 | 10.2 | 5, 14 | 14.9 | 10, 14 | 17.2 | 28, 34 | 44 |
| 2, 12 | 12.2 | 5, 16 | 16.8 | 10, 16 | 18.9 | 28, 36 | 45.6 |
| 2, 14 | 14.1 | 5, 18 | 18.7 | 10, 18 | 20.6 | 28, 38 | 47.2 |
| 2, 16 | 16.1 | 5, 20 | 20.6 | 10, 20 | 22.4 | 28, 40 | 48.8 |
| 2, 18 | 18.1 | 6, 7 | 9.2 | 12, 14 | 18.4 | 28, 42 | 50.5 |
| 2, 20 | 20.1 | 6, 8 | 10.0 | 12, 16 | 20.0 | 28, 44 | 52.2 |
| 3, 4 | 5.0 | 6, 9 | 10.8 | 12, 18 | 21.6 | 30, 32 | 43.9 |
| 3, 5 | 5.8 | 6, 10 | 11.7 | 12, 20 | 23.3 | 30, 34 | 45.3 |
| 3, 6 | 6.7 | 6, 12 | 13.4 | 14, 16 | 21.3 | 30, 36 | 46.9 |
| 3, 7 | 7.6 | 6, 14 | 15.2 | 14, 18 | 22.8 | 30, 38 | 48.4 |
| 3, 8 | 8.5 | 6, 16 | 17.1 | 14, 20 | 24.4 | 30, 40 | 50 |
| 3, 9 | 9.5 | 6, 18 | 19.0 | 16, 18 | 24.1 | 30, 42 | 51.6 |
| 3, 10 | 10.4 | 6, 20 | 20.9 | 16, 20 | 25.6 | 30, 44 | 53.3 |
| 3, 12 | 12.4 | 7, 8 | 10.6 | 18, 20 | 26.9 | 32, 34 | 46.7 |

## B.3 Limiting Distance and Log Diameter Examples

*Example 1:*

Walking down the first LIDS transect with a volume factor *F*=8, you encounter a CDW particle 32 cm in diameter, and you are 56 m from the transect origin: should the CDW particle be tallied? Looking at the left side of the table, 32 cm falls between 30 cm and 35 cm, so round up and use RD = 35 cm. For RD = 35 and F=8, the corresponding value of $D_{lim}$ = 63.0 meters. Because the distance along the transect of 56 meters is < $D_{lim}$, the CDW particle should be tallied.

*Example 2:*

You have walked 11 m from the origin of a LIDS transect with a volume factor *F*=15. Is it necessary to keep looking for and tallying CDW particles with diameter ≤ 20 cm? Looking at the right side of the table, a distance of 11 m falls between 10 m and 12 m, so round down to 10 m to be conservative. For $D_{lim}$ = 10 and F=15, the minimum diameter is 19.1 cm, meaning any CDW particles < 19.1 cm diameter can be ignored. However, logs ≥ 19.1 cm diameter should still be tallied.

## APPENDIX C ESTIMATED DATES FOR ONSET AND CESSATION OF SAMPLING

In general, the temporal strategy for sampling is outlined in Section 4, and the primary goal is to avoid sampling during periods of maximal seasonal storm activity that potentially create large fluxes of CDW. For most north-temperate sites, maximal seasonal storm activity occurs in the winter, and as such, CDW sampling should not occur in this time period. The dates below put coarse bounds on the northern hemisphere winter season, and are derived from MODIS-EVI phenology data, averaged from 2001-2009. The 'Approximate Start Date' field corresponds to the average date of greenup, and thus presumably, the end of winter and associated storm activity. The 'Approximate End Date' field corresponds to the average date by which greenness has returned to baseline 'winter' levels, and by which winter storms have presumably begun.

The dates below provide a coarse window only, and it is essential that domain staff monitor real-time conditions to determine when to start (and stop) sampling, as described in Section 4 of this protocol. For example, the hurricane season in the Southeastern U.S. and Puerto Rico is not meaningfully captured by this 'winter' window, and is therefore noted specially. Moreover, not all sites for which dates are listed below produce CDW; be sure to follow provided guidelines to determine whether the protocol should be implemented.

**Table 19**. Satellite-derived average dates of green-up and senescence that bound the CDW sampling window.

| Domain | Site | Approx. Start Date | Approx. End Date |
|---|---|---|---|
| 01 | BART | 04/30 | 10/27 |
| | HARV | 04/20 | 10/27 |
| 02 | BLAN | 03/16 | 11/06 |
| | SCBI | 03/26 | 11/16 |
| | SERC | 03/21 | 11/21 |
| 03 | DSNY | Hurricane season ends | Hurricane season begins |
| | JERC | Hurricane season ends | Hurricane season begins |
| | OSBS | Hurricane season ends | Hurricane season begins |
| 04 | GUAN | Hurricane season ends | Hurricane season begins |
| | LAJA | Hurricane season ends | Hurricane season begins |
| 05 | STEI | 04/30 | 09/07 |
| | TREE | 04/30 | 09/07 |
| | UNDE | 05/05 | 10/12 |
| 06 | KONA | 03/31 | 10/27 |
| | KONZ | 03/31 | 10/27 |
| | UKFS | 03/16 | 11/26 |
| 07 | GRSM | 03/31 | 11/06 |
| | MLBS | 04/20 | 11/06 |
| | ORNL | 03/31 | 11/11 |
| 08 | DELA | 03/01 | 11/26 |
| | LENO | 03/11 | 12/01 |

| Domain | Site | Approx. Start Date | Approx. End Date |
|---|---|---|---|
| | TALL | 03/16 | 11/26 |
| 09 | DCFS | 04/30 | 10/17 |
| | NOGP | 04/25 | 10/17 |
| | WOOD | 04/30 | 10/17 |
| 10 | CPER | 03/31 | 12/16 |
| | RMNP | 04/30 | 10/12 |
| | STER | 03/31 | 09/27 |
| 11 | CLBJ | 03/01 | 11/21 |
| | OAES | 03/16 | 11/06 |
| 12 | YELL | 04/30 | 10/07 |
| 13 | MOAB | 03/26 | 10/27 |
| | NIWO | 05/20 | 09/27 |
| 14 | JORN | 03/21 | 11/16 |
| | SRER | 05/31 | 11/26 |
| 15 | ONAQ | 03/16 | 10/07 |
| 16 | ABBY | 04/20 | 10/27 |
| | WREF | 04/25 | 10/17 |
| 17 | SJER | 09/27 | 06/04 (next calendar year) |
| | SOAP | 03/31 | 10/17 |
| | TEAK | 04/30 | 10/27 |
| 18 | BARR | 06/24 | 08/08 |
| | TOOL | 06/09 | 08/28 |
| 19 | BONA | 05/15 | 09/07 |
| | DEJU | 05/10 | 09/07 |
| | HEAL | 05/15 | 09/01 |
| 20 | PUUM | TBD | TBD |

## APPENDIX D SITE-SPECIFIC VOLUME FACTORS (F) AND TRANSECT LENGTHS FOR LIDS SAMPLING

Initial F-values and transect lengths come from analysis of Vegetation Characterization data collected from Tower Plots, and may be modified in subsequent years following analysis of site-specific tally data by Science.

- See SOP 0 'Troubleshooting' if you believe there is a problem with the F-value and transect length for your site.

**Table 20**. Site-specific volume factors and transect lenghts for coarse downed wood tally sampling with the LIDS method.

| Domain Number | siteID | Sampling by plotType | F-value | Transect Length (m) | Additional Information |
|---|---|---|---|---|---|
| 01 | BART | Dist: Yes Tower: Yes | 5 | 190 | |
| | HARV | Dist: Yes Tower: Yes | 5 | 170 | |
| 02 | BLAN | Dist: Yes Tower: Yes | 5 | 290 | Many Distributed and Tower Plots will have no CDW due to pasture, crop cover. |
| | SCBI | Dist: Yes Tower: Yes | 8 | 240 | Some Distributed Plots may have no CDW due to pasture cover. |
| | SERC | Dist: Yes Tower: Yes | 5 | 300 | Some Distributed Plots may have no CDW due to crop cover. |
| 03 | DSNY | Dist: Yes Tower: No | 5 | 210 | Some Distributed Plots may have no CDW due to pasture cover. |
| | JERC | Dist: Yes Tower: Yes | 5 | 260 | Some Distributed Plots may have no CDW due to crop cover. |
| | OSBS | Dist: Yes Tower: Yes | 5 | 130 | Some Distributed Plots may have no CDW due to wetland cover. |
| 04 | GUAN | Dist: Yes Tower: Yes | 5 | 90 | |
| | LAJA | Dist: Yes Tower: No | *TBD* | *TBD* | Most Distributed Plots will have no CDW due to pasture, crop cover. |
| 05 | STEI | Dist: Yes Tower: Yes | 5 | 110 | |
| | TREE | Dist: Yes Tower: Yes | 5 | 140 | |
| | UNDE | Dist: Yes Tower: Yes | 5 | 120 | |
| 06 | KONA | Dist: No Tower: No | *NA* | *NA* | Ag site, no qualifying CDW expected. |
| | KONZ | Dist: Yes Tower: No | 5 | 40 | Sampling suspended in 2018 until state-change occurs. |

| Domain Number | siteID | Sampling by plotType | F-value | Transect Length (m) | Additional Information |
|---|---|---|---|---|---|
| | UKFS | Dist: Yes<br>Tower: Yes | 5 | 180 | Some Distributed Plots may have no CDW due to grassland cover. |
| 07 | GRSM | Dist: Yes<br>Tower: Yes | 8 | 180 | |
| | MLBS | Dist: Yes<br>Tower: Yes | 5 | 170 | |
| | ORNL | Dist: Yes<br>Tower: Yes | 5 | 270 | Some Distributed Plots may have no CDW due to pasture cover. |
| 08 | DELA | Dist: Yes<br>Tower: Yes | 5 | 240 | |
| | LENO | Dist: Yes<br>Tower: Yes | 8 | 180 | |
| | TALL | Dist: Yes<br>Tower: Yes | 5 | 190 | |
| 09 | DCFS | Dist: No<br>Tower: No | *NA* | *NA* | Grassland site, no CDW anticipated. |
| | NOGP | Dist: No<br>Tower: No | *NA* | *NA* | Grassland site, no CDW anticipated. |
| | WOOD | Dist: No<br>Tower: No | *NA* | *NA* | Grassland site, no CDW anticipated. |
| 10 | CPER | Dist: No<br>Tower: No | *NA* | *NA* | Grassland site, no CDW anticipated. |
| | RMNP | Dist: Yes<br>Tower: Yes | Dist: TBD<br>Tower: 5 | Dist: TBD<br>Tower: 130 | Different forest types in Distributed vs. Tower Plots. |
| | STER | Dist: No<br>Tower: No | *NA* | *NA* | Agricultural site, no CDW anticipated. |
| 11 | CLBJ | Dist: Yes<br>Tower: Yes | 5 | 160 | Many Distributed Plots may have no CDW due to grassland cover. |
| | OAES | Dist: No<br>Tower: No | *NA* | *NA* | Grassland and shrub/scrub site, no CDW anticipated. |
| 12 | YELL | Dist: Yes<br>Tower: Yes | *TBD* | *TBD* | |
| 13 | MOAB | Dist: Yes<br>Tower: No | *TBD* | *TBD* | Most Distributed Plots may have no CDW due to shrub/scrub cover. |
| | NIWO | Dist: Yes<br>Tower: No | 5 | 110 | Some Distributed Plots may have no CDW due to tundra cover. |
| 14 | JORN | Dist: No<br>Tower: No | *NA* | *NA* | Sampling suspended in 2018 until state-change occurs. |
| | SRER | Dist: No<br>Tower: No | *NA* | *NA* | Sampling suspended in 2018 until state-change occurs. |
| 15 | ONAQ | Dist: Yes<br>Tower: No | 5 | 90 | Sampling suspended in 2018 until state-change occurs. |

| Domain Number | siteID | Sampling by plotType | F-value | Transect Length (m) | Additional Information |
|---|---|---|---|---|---|
| 16 | ABBY | Dist: Yes<br>Tower: Yes | 15 | 180 | |
| | WREF | Dist: Yes<br>Tower: Yes | *TBD* | *TBD* | |
| 17 | SJER | Dist: Yes<br>Tower: Yes | 5 | 280 | Most Distributed Plots may have no CDW due to grassland cover. |
| | SOAP | Dist: Yes<br>Tower: Yes | 8 | 170 | |
| | TEAK | Dist: Yes<br>Tower: Yes | 10 | 230 | |
| 18 | BARR | Dist: No<br>Tower: No | *NA* | *NA* | Tundra site, no CDW expected. |
| | TOOL | Dist: No<br>Tower: No | *NA* | *NA* | Tundra site, no CDW expected. |
| 19 | BONA | Dist: Yes<br>Tower: Yes | 5 | 50 | Some Distributed and Tower Plots may have no CDW due to shrub/scrub cover. |
| | DEJU | Dist: Yes<br>Tower: Yes | 5 | 30 | Some Distributed and Tower Plots may have no CDW due to shrub/scrub cover. |
| | HEAL | Dist: No<br>Tower: Yes | 5 | 20 | Sampling suspended in 2018 until state-change occurs. |
| 20 | PUUM | Dist: Yes<br>Tower: Yes | *TBD* | *TBD* | |

# APPENDIX E QUARANTINE COMPLIANCE

## E.1 Summary of Quarantines by Site Affecting CDW Sampling

A summary of quarantines that affect CDW sampling is provided on a per site basis in this subsection. Additional sub-sections below describe how each quarantine affects CDW sampling, and steps that must be taken to ensure that NEON complies with quarantine regulations. Quarantine status for a given site may change mid-season, and it is therefore imperative to monitor NEON's problem tracking system for mid-season updates.

**Table 21**. Summary of quarantines by site that affect Coarse Downed Wood sampling.

| Domain | Site | Quarantine List | Requirements |
|---|---|---|---|
| D06 | UKFS | Emerald Ash Borer (EAB) | • Compliance Agreement from Kansas PPQ prior to sampling. Check with Domain Manager to ensure necessary paperwork is complete prior to scheduling sampling.<br>• Schedule sampling during EAB non-flight period (1st Nov to 1st March).<br>• Follow all guidance in Appendix E.2 |

## E.2 Emerald Ash Borer Quarantine

The Emerald Ash Borer (EAB) quarantine applies to all NEON Coarse Downed Wood samples collected in a quarantined county that are then transported to a non-quarantined county, or that pass through non-quarantined counties, when samples are brought back to the Domain Lab.

***Required Steps to Comply with EAB Quarantine:***

1. Schedule sampling during the EAB non-flight season only (see **Table 21**).
2. Upon returning to the field vehicle after sampling, all muslin-bagged CDW bulk density samples must be double-bagged in large plastic trash bags.
   - Knot each trash bag independently.
3. Upon arriving at the Domain Lab, once the trash bags are opened, all muslin bagged samples must be placed directly into a 105 ˚C drying oven.
   - Once trash bags are opened, no temporary storage of the muslin bagged samples is allowed.
   - Unopened trash bags may be stored in the Domain Lab for up to 5 days.
4. Kill any beetles found inside the trash bags. Contact USDA if any dead specimens are thought to be EAB.

## APPENDIX F BULK DENSITY SAMPLING TARGETS PER SITE

Bulk Density sampling is considered complete when the specified number of disks have been sampled from each of the 'decayClass x sizeCategory x taxonID' (DST) combinations that cumulatively comprise 80% of the total number of logs counted during tally sampling. Per site rank abundance lists of DSTs are provided in each sub-section below.

### F.1 D01: Bartlett Experimental Forest (BART)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| BART | FAGR | 3 | >=10cm | 10.08 | 10.08 | 10 | 10 |
| BART | ACRU | 3 | >=10cm | 6.45 | 16.53 | 10 | 20 |
| BART | FAGR | 2 | >=10cm | 6.25 | 22.78 | 10 | 30 |
| BART | FAGR | 4 | >=10cm | 6.25 | 29.03 | 10 | 40 |
| BART | BEPAP | 3 | >=10cm | 5.65 | 34.68 | 10 | 50 |
| BART | ACRU | 2 | >=10cm | 5.24 | 39.92 | 10 | 60 |
| BART | BEPAP | 2 | >=10cm | 4.84 | 44.76 | 10 | 70 |
| BART | PIRU | 2 | >=10cm | 4.03 | 48.79 | 10 | 80 |
| BART | TSCA | 2 | >=10cm | 3.43 | 52.22 | 10 | 90 |
| BART | 2PLANT-H | 3 | >=10cm | 3.02 | 55.24 | 10 | 100 |
| BART | TSCA | 3 | >=10cm | 3.02 | 58.26 | 10 | 110 |
| BART | 2PLANT-H | 4 | >=10cm | 3.02 | 61.28 | 10 | 120 |
| BART | FAGR | | 5-10cm | 3.02 | 64.3 | 5 | 125 |
| BART | BEAL2 | 3 | >=10cm | 2.62 | 66.92 | 10 | 135 |
| BART | PIRU | 3 | >=10cm | 2.62 | 69.54 | 10 | 145 |
| BART | ACRU | 4 | >=10cm | 2.22 | 71.76 | 10 | 155 |
| BART | FAGR | | 2-5cm | 2.02 | 73.78 | 5 | 160 |
| BART | 2PLANT-S | 4 | >=10cm | 1.61 | 75.39 | 10 | 170 |
| BART | 2PLANT-H | 5 | >=10cm | 1.41 | 76.8 | 10 | 180 |
| BART | 2PLANT-H | | 5-10cm | 1.41 | 78.21 | 5 | 185 |
| BART | TSCA | | 5-10cm | 1.41 | 79.62 | 5 | 190 |
| BART | 2PLANT-H | 2 | >=10cm | 1.21 | 80.83 | 10 | 200 |

## F.2 D01: Harvard Forest (HARV)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| HARV | ACRU | 3 | >=10cm | 7.42 | 7.42 | 10 | 10 |
| HARV | PIRE | 2 | >=10cm | 4.8 | 12.22 | 10 | 20 |
| HARV | TSCA | 4 | >=10cm | 4.8 | 17.02 | 10 | 30 |
| HARV | TSCA | 2 | >=10cm | 4.37 | 21.39 | 10 | 40 |
| HARV | PIRE | 3 | >=10cm | 4.37 | 25.76 | 10 | 50 |
| HARV | PIRU | 3 | >=10cm | 3.93 | 29.69 | 10 | 60 |
| HARV | ACRU | 4 | >=10cm | 3.93 | 33.62 | 10 | 70 |
| HARV | TSCA | 5 | >=10cm | 3.49 | 37.11 | 10 | 80 |
| HARV | TSCA | 3 | 5-10cm | 3.49 | 40.6 | 5 | 85 |
| HARV | ACRU | 2 | >=10cm | 2.62 | 43.22 | 10 | 95 |
| HARV | QURU | 3 | >=10cm | 2.62 | 45.84 | 10 | 105 |
| HARV | BEPAP | 4 | >=10cm | 2.62 | 48.46 | 10 | 115 |
| HARV | ACRU | 5 | >=10cm | 2.62 | 51.08 | 10 | 125 |
| HARV | TSCA | 3 | >=10cm | 2.18 | 53.26 | 10 | 135 |
| HARV | ACRU | 3 | 5-10cm | 2.18 | 55.44 | 5 | 140 |
| HARV | BEPAP | 2 | >=10cm | 1.75 | 57.19 | 10 | 150 |
| HARV | BEPA | 3 | >=10cm | 1.75 | 58.94 | 10 | 160 |
| HARV | PIST | 3 | >=10cm | 1.75 | 60.69 | 10 | 170 |
| HARV | PIST | 5 | >=10cm | 1.75 | 62.44 | 10 | 180 |
| HARV | PIRU | 2 | >=10cm | 1.31 | 63.75 | 10 | 190 |
| HARV | PIST | 2 | >=10cm | 1.31 | 65.06 | 10 | 200 |
| HARV | FRAM2 | 3 | >=10cm | 1.31 | 66.37 | 10 | 210 |
| HARV | BEAL2 | 4 | >=10cm | 1.31 | 67.68 | 10 | 220 |
| HARV | 2PLANT-S | 5 | >=10cm | 1.31 | 68.99 | 10 | 230 |
| HARV | ACRU | 3 | 2-5cm | 1.31 | 70.3 | 5 | 235 |
| HARV | QURU | 1 | >=10cm | 0.87 | 71.17 | 10 | 245 |
| HARV | QURU | 2 | >=10cm | 0.87 | 72.04 | 10 | 255 |
| HARV | 2PLANT-H | 3 | >=10cm | 0.87 | 72.91 | 10 | 265 |
| HARV | BEAL2 | 3 | >=10cm | 0.87 | 73.78 | 10 | 275 |
| HARV | FAGR | 3 | >=10cm | 0.87 | 74.65 | 10 | 285 |
| HARV | BELE | 4 | >=10cm | 0.87 | 75.52 | 10 | 295 |
| HARV | PIST | 4 | >=10cm | 0.87 | 76.39 | 10 | 305 |
| HARV | ACRU | 2 | 5-10cm | 0.87 | 77.26 | 5 | 310 |
| HARV | TSCA | 2 | 5-10cm | 0.87 | 78.13 | 5 | 315 |
| HARV | ACRU | 4 | 5-10cm | 0.87 | 79 | 5 | 320 |
| HARV | BELE | 4 | 5-10cm | 0.87 | 79.87 | 5 | 325 |
| HARV | PIRE | 1 | >=10cm | 0.44 | 80.31 | 10 | 335 |

## F.3 D02: Blandy Experimental Farm (BLAN)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| BLAN | 2PLANT-H | 4 | >=10cm | 23.08 | 23.08 | 10 | 10 |
| BLAN | 2PLANT-H | 3 | >=10cm | 22.53 | 45.61 | 10 | 20 |
| BLAN | QUERC | 3 | >=10cm | 5.49 | 51.1 | 10 | 30 |
| BLAN | ROPS | 3 | >=10cm | 4.4 | 55.5 | 10 | 40 |
| BLAN | LITU | 3 | >=10cm | 3.3 | 58.8 | 10 | 50 |
| BLAN | QUVE | 3 | >=10cm | 3.3 | 62.1 | 10 | 60 |
| BLAN | QUAL | 3 | >=10cm | 2.75 | 64.85 | 10 | 70 |
| BLAN | QUERC | 4 | >=10cm | 2.75 | 67.6 | 10 | 80 |
| BLAN | FRAM2 | 3 | >=10cm | 2.2 | 69.8 | 10 | 90 |
| BLAN | JUNI | 3 | >=10cm | 2.2 | 72 | 10 | 100 |
| BLAN | QURU | 3 | >=10cm | 2.2 | 74.2 | 10 | 110 |
| BLAN | SAAL5 | 3 | >=10cm | 2.2 | 76.4 | 10 | 120 |
| BLAN | LITU | 4 | >=10cm | 2.2 | 78.6 | 10 | 130 |
| BLAN | 2PLANT-H | 5 | >=10cm | 1.65 | 80.25 | 10 | 140 |

### F.4 D02: Smithsonian Conservation Biology Institute (SCBI)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| SCBI | 2PLANT-H | 3 | >=10cm | 23.49 | 23.49 | 10 | 10 |
| SCBI | 2PLANT-H | 4 | >=10cm | 10.74 | 34.23 | 10 | 20 |
| SCBI | 2PLANT-H | 3 | 5-10cm | 5.37 | 39.6 | 5 | 25 |
| SCBI | ROPS | 3 | >=10cm | 4.7 | 44.3 | 10 | 35 |
| SCBI | QURUR | 3 | >=10cm | 4.36 | 48.66 | 10 | 45 |
| SCBI | FRAM2 | 3 | >=10cm | 4.03 | 52.69 | 10 | 55 |
| SCBI | SAAL5 | 3 | >=10cm | 4.03 | 56.72 | 10 | 65 |
| SCBI | JUNI | 2 | >=10cm | 3.02 | 59.74 | 10 | 75 |
| SCBI | FRAM2 | 2 | >=10cm | 2.68 | 62.42 | 10 | 85 |
| SCBI | LITU | 2 | >=10cm | 2.68 | 65.1 | 10 | 95 |
| SCBI | QUERC | 3 | >=10cm | 2.68 | 67.78 | 10 | 105 |
| SCBI | CATO6 | 3 | >=10cm | 2.35 | 70.13 | 10 | 115 |
| SCBI | PIVI2 | 3 | >=10cm | 2.01 | 72.14 | 10 | 125 |
| SCBI | ROPS | 2 | >=10cm | 1.68 | 73.82 | 10 | 135 |
| SCBI | SAAL5 | 2 | >=10cm | 1.68 | 75.5 | 10 | 145 |
| SCBI | JUNI | 3 | >=10cm | 1.68 | 77.18 | 10 | 155 |
| SCBI | QUERC | 4 | >=10cm | 1.68 | 78.86 | 10 | 165 |
| SCBI | QURUR | 4 | >=10cm | 1.68 | 80.54 | 10 | 175 |

## F.5 D02: Smithsonian Environmental Research Center (SERC)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| SERC | LITU | 3 | >=10cm | 14.25 | 14.25 | 10 | 10 |
| SERC | 2PLANT-H | 3 | >=10cm | 12.32 | 26.57 | 10 | 20 |
| SERC | 2PLANT-H | 4 | >=10cm | 12.32 | 38.89 | 10 | 30 |
| SERC | LITU | 4 | >=10cm | 4.83 | 43.72 | 10 | 40 |
| SERC | QUERC | 3 | >=10cm | 3.62 | 47.34 | 10 | 50 |
| SERC | LITU | 2 | >=10cm | 3.38 | 50.72 | 10 | 60 |
| SERC | LIST2 | 3 | >=10cm | 2.9 | 53.62 | 10 | 70 |
| SERC | QUAL | 3 | >=10cm | 2.66 | 56.28 | 10 | 80 |
| SERC | QUAL | 1 | >=10cm | 2.42 | 58.7 | 10 | 90 |
| SERC | 2PLANT-H | | 5-10cm | 2.42 | 61.12 | 5 | 95 |
| SERC | QUVE | 2 | >=10cm | 1.93 | 63.05 | 10 | 105 |
| SERC | PIVI2 | 3 | >=10cm | 1.93 | 64.98 | 10 | 115 |
| SERC | PIST | 3 | >=10cm | 1.69 | 66.67 | 10 | 125 |
| SERC | 2PLANT-H | 5 | >=10cm | 1.69 | 68.36 | 10 | 135 |
| SERC | LITU | | 5-10cm | 1.69 | 70.05 | 5 | 140 |
| SERC | FAGR | 2 | >=10cm | 1.45 | 71.5 | 10 | 150 |
| SERC | PRSE2 | 3 | >=10cm | 1.45 | 72.95 | 10 | 160 |
| SERC | 2PLANT-S | 4 | >=10cm | 1.45 | 74.4 | 10 | 170 |
| SERC | LIST2 | 2 | >=10cm | 1.21 | 75.61 | 10 | 180 |
| SERC | QURU | 2 | >=10cm | 1.21 | 76.82 | 10 | 190 |
| SERC | 2PLANT-S | 3 | >=10cm | 1.21 | 78.03 | 10 | 200 |
| SERC | LIST2 | | 5-10cm | 1.21 | 79.24 | 5 | 205 |
| SERC | CARYA | 3 | >=10cm | 0.97 | 80.21 | 10 | 215 |

## F.6 D03: Disney Wilderness Preserve (DSNY)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| DSNY | PINUS | 3 | >=10cm | 18.75 | 18.75 | 10 | 10 |
| DSNY | PIPA2 | 3 | >=10cm | 18.75 | 37.5 | 10 | 20 |
| DSNY | QUERC | 2 | 2-5cm | 12.5 | 50 | 5 | 25 |
| DSNY | QUNI | 2 | >=10cm | 6.25 | 56.25 | 10 | 35 |
| DSNY | NYSSA | 4 | >=10cm | 6.25 | 62.5 | 10 | 45 |
| DSNY | QUERC | 4 | >=10cm | 6.25 | 68.75 | 10 | 55 |
| DSNY | PIPA2 | 5 | >=10cm | 6.25 | 75 | 10 | 65 |
| DSNY | QUERC | 5 | >=10cm | 6.25 | 81.25 | 10 | 75 |

## F.7 D03: Jones Ecological Research Center (JERC)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| JERC | QUFA | 1 | >=10cm | 26.15 | 26.15 | 10 | 10 |
| JERC | PIPA2 | 3 | >=10cm | 9.23 | 35.38 | 10 | 20 |
| JERC | QUERC | 3 | >=10cm | 7.69 | 43.07 | 10 | 30 |
| JERC | PIPA2 | 1 | >=10cm | 4.62 | 47.69 | 10 | 40 |
| JERC | PINUS | 2 | >=10cm | 4.62 | 52.31 | 10 | 50 |
| JERC | QUERC | 2 | >=10cm | 4.62 | 56.93 | 10 | 60 |
| JERC | PINUS | 3 | >=10cm | 4.62 | 61.55 | 10 | 70 |
| JERC | PINUS | 4 | >=10cm | 4.62 | 66.17 | 10 | 80 |
| JERC | QUMA6 | 1 | >=10cm | 3.08 | 69.25 | 10 | 90 |
| JERC | QUFA | 2 | >=10cm | 3.08 | 72.33 | 10 | 100 |
| JERC | QUERC | 1 | >=10cm | 1.54 | 73.87 | 10 | 110 |
| JERC | QUHE2 | 1 | >=10cm | 1.54 | 75.41 | 10 | 120 |
| JERC | PIPA2 | 2 | >=10cm | 1.54 | 76.95 | 10 | 130 |
| JERC | PITA | 2 | >=10cm | 1.54 | 78.49 | 10 | 140 |
| JERC | QUMA6 | 2 | >=10cm | 1.54 | 80.03 | 10 | 150 |

## F.8 D03: Ordway-Swisher (OSBS)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| OSBS | PIPA2 | 3 | >=10cm | 9.23 | 9.23 | 10 | 10 |
| OSBS | PINUS | 3 | >=10cm | 6.15 | 15.38 | 10 | 20 |
| OSBS | QULA2 | 3 | >=10cm | 6.15 | 21.53 | 10 | 30 |
| OSBS | PIEL | 2 | >=10cm | 4.62 | 26.15 | 10 | 40 |
| OSBS | PIPA2 | 2 | >=10cm | 4.62 | 30.77 | 10 | 50 |
| OSBS | QULA2 | 2 | >=10cm | 4.62 | 35.39 | 10 | 60 |
| OSBS | PIPA2 | 5 | >=10cm | 4.62 | 40.01 | 10 | 70 |
| OSBS | 2PLANT-H | 2 | >=10cm | 3.08 | 43.09 | 10 | 80 |
| OSBS | PITA | 2 | >=10cm | 3.08 | 46.17 | 10 | 90 |
| OSBS | 2PLANT-H | 3 | >=10cm | 3.08 | 49.25 | 10 | 100 |
| OSBS | 2PLANT-H | 5 | >=10cm | 3.08 | 52.33 | 10 | 110 |
| OSBS | QUERC | 5 | >=10cm | 3.08 | 55.41 | 10 | 120 |
| OSBS | QULA2 | 5 | >=10cm | 3.08 | 58.49 | 10 | 130 |
| OSBS | QUVI | 5 | >=10cm | 3.08 | 61.57 | 10 | 140 |
| OSBS | QUHE2 | | 2-5cm | 3.08 | 64.65 | 5 | 145 |
| OSBS | PIPA2 | | 5-10cm | 3.08 | 67.73 | 5 | 150 |
| OSBS | QUHE2 | | 5-10cm | 3.08 | 70.81 | 5 | 155 |
| OSBS | QULA2 | | 5-10cm | 3.08 | 73.89 | 5 | 160 |
| OSBS | PIPA2 | 1 | >=10cm | 1.54 | 75.43 | 10 | 170 |
| OSBS | NYSSA | 2 | >=10cm | 1.54 | 76.97 | 10 | 180 |
| OSBS | QUHE2 | 2 | >=10cm | 1.54 | 78.51 | 10 | 190 |
| OSBS | QUNI | 2 | >=10cm | 1.54 | 80.05 | 10 | 200 |

### F.9 D05: Steigerwaldt (STEI)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| STEI | 2PLANT-H | | 5-10cm | 10.27 | 10.27 | 5 | 5 |
| STEI | 2PLANT-S | | 5-10cm | 9.19 | 19.46 | 5 | 10 |
| STEI | 2PLANT-H | | 2-5cm | 6.49 | 25.95 | 5 | 15 |
| STEI | 2PLANT-H | 3 | >=10cm | 5.95 | 31.9 | 10 | 25 |
| STEI | THOC2 | 3 | >=10cm | 4.86 | 36.76 | 10 | 35 |
| STEI | ACRU | | 5-10cm | 4.86 | 41.62 | 5 | 40 |
| STEI | 2PLANT-S | 4 | >=10cm | 4.32 | 45.94 | 10 | 50 |
| STEI | ACRU | 2 | >=10cm | 3.78 | 49.72 | 10 | 60 |
| STEI | 2PLANT-H | 4 | >=10cm | 3.78 | 53.5 | 10 | 70 |
| STEI | 2PLANT-H | 2 | >=10cm | 2.7 | 56.2 | 10 | 80 |
| STEI | 2PLANT-H | 5 | >=10cm | 2.7 | 58.9 | 10 | 90 |
| STEI | THOC2 | 4 | >=10cm | 2.16 | 61.06 | 10 | 100 |
| STEI | 2PLANT-S | 5 | >=10cm | 2.16 | 63.22 | 10 | 110 |
| STEI | 2PLANT-S | 3 | >=10cm | 1.62 | 64.84 | 10 | 120 |
| STEI | ACRU | 3 | >=10cm | 1.62 | 66.46 | 10 | 130 |
| STEI | POTR5 | 4 | >=10cm | 1.62 | 68.08 | 10 | 140 |
| STEI | ACRU | | 2-5cm | 1.62 | 69.7 | 5 | 145 |
| STEI | 2PLANT-S | 2 | >=10cm | 1.08 | 70.78 | 10 | 155 |
| STEI | ACER | 2 | >=10cm | 1.08 | 71.86 | 10 | 165 |
| STEI | ACSA3 | 2 | >=10cm | 1.08 | 72.94 | 10 | 175 |
| STEI | ACSA3 | 3 | >=10cm | 1.08 | 74.02 | 10 | 185 |
| STEI | ABBA | 4 | >=10cm | 1.08 | 75.1 | 10 | 195 |
| STEI | ACSA3 | 5 | >=10cm | 1.08 | 76.18 | 10 | 205 |
| STEI | ABBA | | 2-5cm | 1.08 | 77.26 | 5 | 210 |
| STEI | ACSA3 | | 2-5cm | 1.08 | 78.34 | 5 | 215 |
| STEI | 2PLANT | | 5-10cm | 1.08 | 79.42 | 5 | 220 |
| STEI | ABBA | | 5-10cm | 1.08 | 80.5 | 5 | 225 |

## F.10 D05: Treehaven (TREE)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| TREE | ABBA | 3 | >=10cm | 4.55 | 4.55 | 10 | 10 |
| TREE | ACRU | 2 | >=10cm | 3.79 | 8.34 | 10 | 20 |
| TREE | ABBA | 4 | >=10cm | 3.79 | 12.13 | 10 | 30 |
| TREE | ACRU | 3 | >=10cm | 3.03 | 15.16 | 10 | 40 |
| TREE | 2PLANT-S | 5 | >=10cm | 3.03 | 18.19 | 10 | 50 |
| TREE | BEPA | 2 | 2-5cm | 3.03 | 21.22 | 5 | 55 |
| TREE | ABBA | 3 | 5-10cm | 3.03 | 24.25 | 5 | 60 |
| TREE | PIRE | 2 | >=10cm | 2.27 | 26.52 | 10 | 70 |
| TREE | PICEA | 3 | >=10cm | 2.27 | 28.79 | 10 | 80 |
| TREE | PIST | 3 | >=10cm | 2.27 | 31.06 | 10 | 90 |
| TREE | BEPA | 4 | >=10cm | 2.27 | 33.33 | 10 | 100 |
| TREE | PIMA | 4 | >=10cm | 2.27 | 35.6 | 10 | 110 |
| TREE | ABBA | 3 | 2-5cm | 2.27 | 37.87 | 5 | 115 |
| TREE | PIGL | 1 | >=10cm | 1.52 | 39.39 | 10 | 125 |
| TREE | ABBA | 2 | >=10cm | 1.52 | 40.91 | 10 | 135 |
| TREE | BEPA | 2 | >=10cm | 1.52 | 42.43 | 10 | 145 |
| TREE | PIMA | 2 | >=10cm | 1.52 | 43.95 | 10 | 155 |
| TREE | PIST | 2 | >=10cm | 1.52 | 45.47 | 10 | 165 |
| TREE | 2PLANT-S | 3 | >=10cm | 1.52 | 46.99 | 10 | 175 |
| TREE | ACSA3 | 3 | >=10cm | 1.52 | 48.51 | 10 | 185 |
| TREE | BEPA | 3 | >=10cm | 1.52 | 50.03 | 10 | 195 |
| TREE | PIGL | 3 | >=10cm | 1.52 | 51.55 | 10 | 205 |
| TREE | ACSA3 | 4 | >=10cm | 1.52 | 53.07 | 10 | 215 |
| TREE | ACRU | 2 | 5-10cm | 1.52 | 54.59 | 5 | 220 |
| TREE | BEAL2 | 2 | 5-10cm | 1.52 | 56.11 | 5 | 225 |
| TREE | BEPA | 2 | 5-10cm | 1.52 | 57.63 | 5 | 230 |
| TREE | PIMA | 2 | 5-10cm | 1.52 | 59.15 | 5 | 235 |
| TREE | ACSA3 | 3 | 5-10cm | 1.52 | 60.67 | 5 | 240 |
| TREE | BEPA | 3 | 5-10cm | 1.52 | 62.19 | 5 | 245 |
| TREE | 2PLANT-S | 4 | 5-10cm | 1.52 | 63.71 | 5 | 250 |
| TREE | ACSA3 | 1 | >=10cm | 0.76 | 64.47 | 10 | 260 |
| TREE | PICEA | 1 | >=10cm | 0.76 | 65.23 | 10 | 270 |
| TREE | PIMA | 1 | >=10cm | 0.76 | 65.99 | 10 | 280 |
| TREE | THOC2 | 1 | >=10cm | 0.76 | 66.75 | 10 | 290 |
| TREE | 2PLANT-S | 2 | >=10cm | 0.76 | 67.51 | 10 | 300 |
| TREE | ACSA3 | 2 | >=10cm | 0.76 | 68.27 | 10 | 310 |
| TREE | LALA | 2 | >=10cm | 0.76 | 69.03 | 10 | 320 |
| TREE | PIGL | 2 | >=10cm | 0.76 | 69.79 | 10 | 330 |
| TREE | TSCA | 2 | >=10cm | 0.76 | 70.55 | 10 | 340 |
| TREE | LALA | 3 | >=10cm | 0.76 | 71.31 | 10 | 350 |

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| TREE | PIMA | 3 | >=10cm | 0.76 | 72.07 | 10 | 360 |
| TREE | PIRE | 3 | >=10cm | 0.76 | 72.83 | 10 | 370 |
| TREE | POTR5 | 3 | >=10cm | 0.76 | 73.59 | 10 | 380 |
| TREE | THOC2 | 3 | >=10cm | 0.76 | 74.35 | 10 | 390 |
| TREE | 2PLANT-H | 4 | >=10cm | 0.76 | 75.11 | 10 | 400 |
| TREE | 2PLANT-S | 4 | >=10cm | 0.76 | 75.87 | 10 | 410 |
| TREE | ACER | 4 | >=10cm | 0.76 | 76.63 | 10 | 420 |
| TREE | ACRU | 4 | >=10cm | 0.76 | 77.39 | 10 | 430 |
| TREE | BEAL2 | 4 | >=10cm | 0.76 | 78.15 | 10 | 440 |
| TREE | PICEA | 4 | >=10cm | 0.76 | 78.91 | 10 | 450 |
| TREE | PINUS | 4 | >=10cm | 0.76 | 79.67 | 10 | 460 |
| TREE | PIRE | 4 | >=10cm | 0.76 | 80.43 | 10 | 470 |

## F.11 D07: Great Smoky Mountain National Park (GRSM)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| GRSM | PINUS | 4 | >=10cm | 7.73 | 7.73 | 10 | 10 |
| GRSM | TSCA | 3 | >=10cm | 5.15 | 12.88 | 10 | 20 |
| GRSM | 2PLANT-H | 4 | >=10cm | 4.64 | 17.52 | 10 | 30 |
| GRSM | 2PLANT-H | 5 | >=10cm | 4.64 | 22.16 | 10 | 40 |
| GRSM | PIRU | 3 | >=10cm | 4.12 | 26.28 | 10 | 50 |
| GRSM | TSCA | 4 | >=10cm | 4.12 | 30.4 | 10 | 60 |
| GRSM | TSCA | 2 | >=10cm | 3.87 | 34.27 | 10 | 70 |
| GRSM | PINUS | 5 | >=10cm | 3.61 | 37.88 | 10 | 80 |
| GRSM | TSCA | 5 | >=10cm | 3.61 | 41.49 | 10 | 90 |
| GRSM | LITU | 3 | >=10cm | 3.09 | 44.58 | 10 | 100 |
| GRSM | 2PLANT-H | 3 | >=10cm | 2.84 | 47.42 | 10 | 110 |
| GRSM | LITU | 4 | >=10cm | 2.84 | 50.26 | 10 | 120 |
| GRSM | LITU | 2 | >=10cm | 2.58 | 52.84 | 10 | 130 |
| GRSM | PINUS | 3 | >=10cm | 2.32 | 55.16 | 10 | 140 |
| GRSM | ACRUR | 3 | >=10cm | 2.06 | 57.22 | 10 | 150 |
| GRSM | ACRUR | 4 | >=10cm | 2.06 | 59.28 | 10 | 160 |
| GRSM | 2PLANT-H | | 5-10cm | 2.06 | 61.34 | 5 | 165 |
| GRSM | ACRUR | 2 | >=10cm | 1.55 | 62.89 | 10 | 175 |
| GRSM | PIRU | 4 | >=10cm | 1.55 | 64.44 | 10 | 185 |
| GRSM | PIPU5 | 4 | >=10cm | 1.29 | 65.73 | 10 | 195 |
| GRSM | QUERC | 4 | >=10cm | 1.29 | 67.02 | 10 | 205 |
| GRSM | PIRU | 5 | >=10cm | 1.29 | 68.31 | 10 | 215 |
| GRSM | QUCO2 | | 5-10cm | 1.29 | 69.6 | 5 | 220 |
| GRSM | QUMO4 | 2 | >=10cm | 1.03 | 70.63 | 10 | 230 |
| GRSM | QUERC | 3 | >=10cm | 1.03 | 71.66 | 10 | 240 |
| GRSM | ABFR | 4 | >=10cm | 1.03 | 72.69 | 10 | 250 |
| GRSM | 2PLANT-H | 2 | >=10cm | 0.77 | 73.46 | 10 | 260 |
| GRSM | PINUS | 2 | >=10cm | 0.77 | 74.23 | 10 | 270 |
| GRSM | PIRI | 2 | >=10cm | 0.77 | 75 | 10 | 280 |
| GRSM | PIVI2 | 2 | >=10cm | 0.77 | 75.77 | 10 | 290 |
| GRSM | ROPS | 2 | >=10cm | 0.77 | 76.54 | 10 | 300 |
| GRSM | PIVI2 | 3 | >=10cm | 0.77 | 77.31 | 10 | 310 |
| GRSM | QURU | 3 | >=10cm | 0.77 | 78.08 | 10 | 320 |
| GRSM | QUMO4 | 4 | >=10cm | 0.77 | 78.85 | 10 | 330 |
| GRSM | 2PLANT-S | 5 | >=10cm | 0.77 | 79.62 | 10 | 340 |
| GRSM | ACRUR | 5 | >=10cm | 0.77 | 80.39 | 10 | 350 |

## F.12 D07: Oak Ridge (ORNL)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| ORNL | PINUS | 4 | >=10cm | 11.58 | 11.58 | 10 | 10 |
| ORNL | QUMO4 | 3 | >=10cm | 8.95 | 20.53 | 10 | 20 |
| ORNL | PINUS | 5 | >=10cm | 7.89 | 28.42 | 10 | 30 |
| ORNL | QUERC | 4 | >=10cm | 7.11 | 35.53 | 10 | 40 |
| ORNL | QUERC | 3 | >=10cm | 4.21 | 39.74 | 10 | 50 |
| ORNL | QURU | 3 | >=10cm | 3.68 | 43.42 | 10 | 60 |
| ORNL | PINUS | 3 | >=10cm | 3.42 | 46.84 | 10 | 70 |
| ORNL | PIEC2 | 4 | >=10cm | 3.16 | 50 | 10 | 80 |
| ORNL | QUAL | 3 | >=10cm | 2.63 | 52.63 | 10 | 90 |
| ORNL | JUVI | 4 | >=10cm | 2.63 | 55.26 | 10 | 100 |
| ORNL | QUMO4 | 1 | >=10cm | 2.11 | 57.37 | 10 | 110 |
| ORNL | ACRU | 3 | >=10cm | 1.84 | 59.21 | 10 | 120 |
| ORNL | QUMO4 | 2 | >=10cm | 1.58 | 60.79 | 10 | 130 |
| ORNL | LITU | 3 | >=10cm | 1.32 | 62.11 | 10 | 140 |
| ORNL | QUVE | 3 | >=10cm | 1.32 | 63.43 | 10 | 150 |
| ORNL | JUVI | 5 | >=10cm | 1.32 | 64.75 | 10 | 160 |
| ORNL | PIEC2 | 5 | >=10cm | 1.32 | 66.07 | 10 | 170 |
| ORNL | QUAL | 1 | >=10cm | 1.05 | 67.12 | 10 | 180 |
| ORNL | JUVI | 3 | >=10cm | 1.05 | 68.17 | 10 | 190 |
| ORNL | NYSY | 3 | >=10cm | 1.05 | 69.22 | 10 | 200 |
| ORNL | PIEC2 | 3 | >=10cm | 1.05 | 70.27 | 10 | 210 |
| ORNL | 2PLANT-H | 4 | >=10cm | 1.05 | 71.32 | 10 | 220 |
| ORNL | QUCO2 | 2 | >=10cm | 0.79 | 72.11 | 10 | 230 |
| ORNL | LITU | 4 | >=10cm | 0.79 | 72.9 | 10 | 240 |
| ORNL | QUMO4 | 4 | >=10cm | 0.79 | 73.69 | 10 | 250 |
| ORNL | QURU | 4 | >=10cm | 0.79 | 74.48 | 10 | 260 |
| ORNL | 2PLANT-H | 5 | >=10cm | 0.79 | 75.27 | 10 | 270 |
| ORNL | QUERC | 5 | >=10cm | 0.79 | 76.06 | 10 | 280 |
| ORNL | COFL2 | NA | 5-10cm | 0.79 | 76.85 | 5 | 285 |
| ORNL | QUMO4 | NA | 5-10cm | 0.79 | 77.64 | 5 | 290 |
| ORNL | QURU | 1 | >=10cm | 0.53 | 78.17 | 10 | 300 |
| ORNL | CATO6 | 2 | >=10cm | 0.53 | 78.7 | 10 | 310 |
| ORNL | PIVI2 | 2 | >=10cm | 0.53 | 79.23 | 10 | 320 |
| ORNL | QUAL | 2 | >=10cm | 0.53 | 79.76 | 10 | 330 |
| ORNL | QURU | 2 | >=10cm | 0.53 | 80.29 | 10 | 340 |
| ORNL | CARYA | 3 | >=10cm | 0.53 | 80.82 | 10 | 350 |

### F.13 D08: Dead Lake (DELA)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| DELA | 2PLANT-H | 4 | >=10cm | 30.7 | 30.7 | 10 | 10 |
| DELA | 2PLANT-H | 3 | >=10cm | 28.51 | 59.21 | 10 | 20 |
| DELA | 2PLANT-H | 2 | >=10cm | 5.7 | 64.91 | 10 | 30 |
| DELA | 2PLANT-H | 5 | >=10cm | 4.39 | 69.3 | 10 | 40 |
| DELA | QUERC | 3 | >=10cm | 3.07 | 72.37 | 10 | 50 |
| DELA | 2PLANT-H | | 5-10cm | 3.07 | 75.44 | 5 | 55 |
| DELA | QUERC | 2 | >=10cm | 2.19 | 77.63 | 10 | 65 |
| DELA | CELA | 1 | >=10cm | 1.32 | 78.95 | 10 | 75 |
| DELA | QUERC | 1 | >=10cm | 1.32 | 80.27 | 10 | 85 |

### F.14 D08: Lenoir Landing (LENO)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| LENO | QUERC | 4 | >=10cm | 18.75 | 18.75 | 10 | 10 |
| LENO | QUNI | 4 | >=10cm | 7.5 | 26.25 | 10 | 20 |
| LENO | QUNI | 2 | >=10cm | 6.25 | 32.5 | 10 | 30 |
| LENO | QUNI | 3 | >=10cm | 5.62 | 38.12 | 10 | 40 |
| LENO | 2PLANT-H | 4 | >=10cm | 5 | 43.12 | 10 | 50 |
| LENO | PINUS | 4 | >=10cm | 3.75 | 46.87 | 10 | 60 |
| LENO | PIGL2 | 4 | >=10cm | 3.12 | 49.99 | 10 | 70 |
| LENO | PITA | 4 | >=10cm | 3.12 | 53.11 | 10 | 80 |
| LENO | QUERC | 3 | >=10cm | 2.5 | 55.61 | 10 | 90 |
| LENO | LIST2 | 4 | >=10cm | 2.5 | 58.11 | 10 | 100 |
| LENO | CACA18 | 3 | >=10cm | 1.88 | 59.99 | 10 | 110 |
| LENO | PINUS | 3 | >=10cm | 1.88 | 61.87 | 10 | 120 |
| LENO | PITA | 3 | >=10cm | 1.88 | 63.75 | 10 | 130 |
| LENO | QUPA5 | 3 | >=10cm | 1.88 | 65.63 | 10 | 140 |
| LENO | QUPH | 3 | >=10cm | 1.88 | 67.51 | 10 | 150 |
| LENO | QUPA5 | 4 | >=10cm | 1.88 | 69.39 | 10 | 160 |
| LENO | 2PLANT-H | 5 | >=10cm | 1.88 | 71.27 | 10 | 170 |
| LENO | LIST2 | NA | 5-10cm | 1.88 | 73.15 | 5 | 175 |
| LENO | QUNI | 1 | >=10cm | 1.25 | 74.4 | 10 | 185 |
| LENO | CATO5 | 2 | >=10cm | 1.25 | 75.65 | 10 | 195 |
| LENO | LIST2 | 3 | >=10cm | 1.25 | 76.9 | 10 | 205 |
| LENO | CACA18 | 4 | >=10cm | 1.25 | 78.15 | 10 | 215 |
| LENO | CELA | 4 | >=10cm | 1.25 | 79.4 | 10 | 225 |
| LENO | QUPH | 4 | >=10cm | 1.25 | 80.65 | 10 | 235 |

## F.15 D11: Caddo / LBJ National Grassland (CLBJ)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| CLBJ | QUERC | 3 | >=10cm | 25 | 25 | 10 | 10 |
| CLBJ | QUST | 3 | >=10cm | 17.31 | 42.31 | 10 | 20 |
| CLBJ | QUST | 2 | >=10cm | 13.46 | 55.77 | 10 | 30 |
| CLBJ | ULMUS | 3 | >=10cm | 7.69 | 63.46 | 10 | 40 |
| CLBJ | 2PLANT-H | 3 | >=10cm | 5.77 | 69.23 | 10 | 50 |
| CLBJ | QUMA3 | 3 | >=10cm | 5.77 | 75 | 10 | 60 |
| CLBJ | QUERC | 4 | >=10cm | 3.85 | 78.85 | 10 | 70 |
| CLBJ | QUERC | 5 | >=10cm | 3.85 | 82.7 | 10 | 80 |

## F.16 D13: Niwot Ridge (NIWO)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| NIWO | 2PLANT-S | 5 | >=10cm | 20.53 | 20.53 | 10 | 10 |
| NIWO | 2PLANT-S | 4 | >=10cm | 17.88 | 38.41 | 10 | 20 |
| NIWO | 2PLANT-S | 3 | >=10cm | 8.28 | 46.69 | 10 | 30 |
| NIWO | PIEN | 3 | >=10cm | 6.95 | 53.64 | 10 | 40 |
| NIWO | ABLAL | 4 | >=10cm | 5.96 | 59.6 | 10 | 50 |
| NIWO | ABLAL | 3 | >=10cm | 5.3 | 64.9 | 10 | 60 |
| NIWO | PIEN | 2 | >=10cm | 4.97 | 69.87 | 10 | 70 |
| NIWO | ABLAL | | 5-10cm | 4.64 | 74.51 | 5 | 75 |
| NIWO | PIEN | 4 | >=10cm | 4.3 | 78.81 | 10 | 85 |
| NIWO | ABLAL | 2 | >=10cm | 3.64 | 82.45 | 10 | 95 |

### F.17 D16: Abby Road (ABBY)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| ABBY | PSMEM | 4 | >=10cm | 36.62 | 36.62 | 10 | 10 |
| ABBY | PSMEM | 3 | >=10cm | 20 | 56.62 | 10 | 20 |
| ABBY | 2PLANT-S | 5 | >=10cm | 7.04 | 63.66 | 10 | 30 |
| ABBY | PSMEM | 5 | >=10cm | 6.48 | 70.14 | 10 | 40 |
| ABBY | 2PLANT-S | 4 | >=10cm | 5.63 | 75.77 | 10 | 50 |
| ABBY | PSMEM | 2 | >=10cm | 5.07 | 80.84 | 10 | 60 |

### F.18 D17: San Joaquin Experimental Range (SJER)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SJER | PISA2 | 2 | >=10cm | 27.14 | 27.14 | 10 | 10 |
| SJER | PISA2 | 3 | >=10cm | 17.14 | 44.28 | 10 | 20 |
| SJER | PISA2 | 1 | >=10cm | 10 | 54.28 | 10 | 30 |
| SJER | PISA2 | 4 | >=10cm | 8.57 | 62.85 | 10 | 40 |
| SJER | QUWI2 | 2 | >=10cm | 4.29 | 67.14 | 10 | 50 |
| SJER | QUDO | 3 | >=10cm | 4.29 | 71.43 | 10 | 60 |
| SJER | QUDO | 4 | >=10cm | 4.29 | 75.72 | 10 | 70 |
| SJER | QUWI2 | 4 | >=10cm | 4.29 | 80.01 | 10 | 80 |

### F.19 D19: Bonanza Creek LTER (BONA)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| BONA | POTR5 | 3 | 5-10cm | 21.21 | 21.21 | 5 | 5 |
| BONA | POTR5 | 3 | >=10cm | 9.09 | 30.3 | 10 | 15 |
| BONA | POTR5 | 4 | >=10cm | 8.08 | 38.38 | 10 | 25 |
| BONA | BENE4 | 3 | >=10cm | 7.07 | 45.45 | 10 | 35 |
| BONA | POTR5 | 4 | 5-10cm | 7.07 | 52.52 | 5 | 40 |
| BONA | BENE4 | 4 | >=10cm | 6.06 | 58.58 | 10 | 50 |
| BONA | PIMA | 3 | >=10cm | 4.04 | 62.62 | 10 | 60 |
| BONA | BENE4 | 3 | 5-10cm | 4.04 | 66.66 | 5 | 65 |
| BONA | PIMA | 3 | 5-10cm | 4.04 | 70.7 | 5 | 70 |
| BONA | PICEA | 2 | >=10cm | 3.03 | 73.73 | 10 | 80 |
| BONA | PIMA | 2 | >=10cm | 3.03 | 76.76 | 10 | 90 |
| BONA | PIMA | 3 | 2-5cm | 3.03 | 79.79 | 5 | 95 |
| BONA | POTR5 | 2 | 2-5cm | 2.02 | 81.81 | 5 | 100 |

### F.20 D19: Delta Junction (DEJU)

| siteID | taxonID | decay Class | size Category | relative Abundance | cumulative Abundance | sampled DiskNum | cumulative DiskNum |
|---|---|---|---|---|---|---|---|
| DEJU | PIMA | 2 | 5-10cm | 40 | 40 | 5 | 5 |
| DEJU | PIMA | 2 | 2-5cm | 16 | 56 | 5 | 10 |
| DEJU | PIMA | 3 | 5-10cm | 16 | 72 | 5 | 15 |
| DEJU | POTR5 | 2 | 5-10cm | 12 | 84 | 5 | 20 |