TOS PROTOCOL AND PROCEDURE: MEASUREMENT OF HERBACEOUS BIOMASS

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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	03/25/2011	ECO-00280	Initial Draft Release
B_DRAFT	01/13/2014	ECO-01140	Updates from 2013. Will be finalized in next rev.
C	03/24/2014	ECO-01664	Production release, template change, and other changes as detailed in Appendix C
D	04/10/2014	ECO-01792	Updated Appendix D with site-specific information
E	10/01/2014	ECO-02309	Migration to new protocol template
F	8/24/2015	ECO-02532	• New guidance for determining WST biomass to clip • Streamlined SOP C by removing information already provided in SOP B and improving reference to SOP B. • Created new SOP F 'Herbaceous Clip for Biogeochemistry' that includes grinding and subsampling for chemical analysis • Added timing information for SOP F to Section 4 • Added SOP H with shipping information for biogeochemistry samples; added Appendix F with supporting information for SOP F. • Updates from FOPS feedback: sorting WST, accounting for Toxicodendron mass, explanation of MODIS data in site-specific Appendix. • Section 4: Clarified intended temporal sampling strategy at agricultural sites with multiple crop rotations.
G	01/31/2017	ECO-04401	• Updated standardized text throughout document to match current TOS Protocol template. • Added 'Definitions' table to Section 2.4 • Removed Herbaceous Biomass for Biogeochemistry SOP. This SOP is now part of the Canopy Foliar Chemistry protocol. • Information for sampling agricultural sites removed, and is now referenced in NEON.DOC.001714 (Ag SOP). • Oven temperature standardized with other TOS protocols (65 ˚C). • Clarified that exclosures are not used in Tower Plots that support Plant Diversity and Biogeochemistry. • Added instructions when exclosure is placed in incorrect location in new troubleshooting table. • Added missing sampling dates to APPENDIX D, and clarified start date criteria in Section 4.2

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
H	12/04/2017	ECO-05225	• Section 4.2: Clarified guidance for sampling cessation in grazed Tower Plots. • Section 2.4 and SOP B: Added definition of woody-stem 'node' based on Field Operations feedback. • Section 6.4 Estimated Time: Updated with time estimates per SOP. • SOP A.2: Added standard 'Sample Labels and Identifiers' text • SOP D, sorting at grazed sites: Added subsampling instructions for sorting OSD for bouts not sorted to functional group. • SOP E: Added additional guidance for determining when drying is complete, and harmonized guidance for very light samples with BRY protocol. • SOP F, Data Entry: Added overview of required mobile data entry workflow from field to lab, and general cross-protocol Quality Assurance text. • Appendix D: Revised site-specific dates based on Field Operations feedback. • Appendix E: Added site-specific clipping guidance for D13 NIWO.
J	03/22/2018	ECO-05514	• Section 4, Timing: Updated to reflect sampling interval changes made in 2018 for grazed sites, and 5 y interval in Distributed Plots, rather than 3 y interval. • Section 6.1, Equipment: Updated to remove Maximo and provide Coupa specific purchasing details. • SOP B.1: Added code to Table 9 to account for rejected clip strip for exclosure due to obstacles, but still representative and useable for normal clip. • SOP C.1: Added subsampling instructions for approved grazed sites during bouts not sorted to functional group, and updated Appendix E with approved per site subsampling levels. • SOP E.1: Updated drying guidance from ± 0.5 g or ± 0.5% to ± 0.1 g or ± 1% of the previous timepoint mass, now consistent with LTR and CDW. • Multiple sections: Added optional barcode labeling workflow. • Multiple sections: Updated text to reflect digital data collection workflow.

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
			• Multiple sections: Updated text to reflect shift to 5 y sampling interval in Distributed Plots. • Appendix D: Updated with site-specific sampling intervals at grazed sites, and updated other dates based on Field Ops feedback.
K	04/17/2019	ECO-06075	• Section 3: Added overview of each SOP • Section 3.1: New section to make integration with Plant Belowground Biomass sampling visible in the TOC. • Section 4: Added scheduling information for synchronizing HBP in Distributed Plots with other TOS protocols. • Section 5: Added new standard warning text for *Toxicodendron*. • Section 6: Added *Toxicodendron* pictogram to equipment list. • Added 'Goals' section to Field and Lab SOPs to provide context to readers before detailed steps begin. • Changed 'clip cell' term to 'sampling cell' since cells support multiple protocols in addition to clip-harvest. • SOP A.3: Added preparatory work to identify all N-fixing plants that belong in the new N-fixer (NFX) group that replaces Leguminous Forbs (LFB). • SOP B: Updated Sampling Cell selection flow chart to include Clip List update. • SOP B: Bryophyte clips now generate stocks for all bryophyte species, rather than current-year growth increment for a subset of species. Added figure to support new guidance. • SOP B.3: Renamed section, and added guidance to not clip seedlings of tree species. • SOP C: Added guidance to avoid placing exclosures within 2 m of litter traps (elevated and ground). • SOP C: Added instructions to record grazing impacts to plots in Site Management app. • SOP E.2: Added guidance to let oven-dried biomass come to room temperature before weighing. • Appendix D: Added approved sampling interval and tower plot number optimizations.

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1 OVERVIEW

1.1 Background

Herbaceous vegetation is operationally defined in this protocol as non-woody plants (i.e. grasses, sedges, forbs, bryophytes, and non-woody vines such as *Convolvulus spp.* and certain *Rubus spp*.), as well as woody-stemmed plants with diameter at decimeter height (ddh) < 1 cm at the time of sampling. The net primary productivity (NPP) of this plant group dominates the total NPP of grassland sites, and can contribute significantly to NPP in savannahs and some forests, even though total herbaceous biomass is low relative to that of large woody stems.

Understanding long-term trends in herbaceous community structure and biomass is very important in grazed ecosystems where these plants constitute a critical food source for wildlife and livestock. In addition, members of the herbaceous plant community can respond relatively rapidly to various global change drivers. For example, it is predicted that cool-season C3 graminoids may decrease in abundance relative to warm-season C4 graminoids in more northern latitudes as global temperatures and CO_2 concentrations continue to rise, and water availability becomes more variable.

It is standard practice for herbaceous biomass and productivity to be assessed via clip harvests, followed by sorting clipped material into current-year and previous years' growth in order to estimate annual NPP for this plant growth form. Current-year growth is often sorted by species into additional categories based on plant functional traits – e.g. cool-season vs. warm-season graminoids, or leguminous vs. non-leguminous forbs. In order to engender cross-compatibility with existing research, NEON will sort clipped biomass into functional categories that are broadly similar to those employed by the global Nutrient Network research group (http://www.nutnet.umn.edu/exp_protocol).

In sites where grazing is an important part of the management practice, it is standard practice to use grazing exclosures to estimate the productivity that is consumed by grazing herbivores. NEON will employ a standard approach where clip-harvests are performed with paired grazed/exclosed areas per plot.

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

Thanks to Daniel Milchunas of Colorado State University and Mary Ashby of the Central Plains Experimental Range USDA-ARS for valuable advice and insight.

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.001574	Datasheets for TOS Protocol and Procedure: Measurement of Herbaceous Biomass
RD[06]	NEON.DOC.005005	Level 0 Data Products Catalog
RD[07]	NEON.DOC.000987	Measurement of Vegetation Structure
RD[08]	NEON.DOC.001788	Grazing Exclosure Assembly Instruction
RD[09]	NEON.DOC.001920	NEON Raw Data Ingest Workbook for TOS Herbaceous Plant Biomass
RD[10]	NEON.DOC.014038	TOS Protocol and Procedure: Plant Belowground Biomass Sampling

RD[11]	NEON.DOC.001024	TOS Protocol and Procedure: Canopy Foliage Chemistry and Leaf Mass per Area Sampling
RD[12]	NEON.DOC.001717	TOS Standard Operating Procedure: TruPulse Rangefinder Use and Calibration
RD[13]	NEON.DOC.001714	TOS Standard Operating Procedure: Measurement of Aboveground Productivity for Agricultural Crops
RD[14]	NEON.DOC.001716	TOS Standard Operating Procedure: Toxicodendron Biomass and Handling
RD[15]	NEON.DOC.001711	TOS Protocol and Procedure: Coarse Downed Wood

2.3 Acronyms

Acronym	Definition
ddh	Diameter at decimeter height
NPP	Net Primary Productivity

2.4 Definitions

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

Table 1. Definitions for common terms used throughout the Herbaceous Biomass protocol.

Term	Definition
clip list	A randomized list of sampling cells for each 20m x 20m plot or subplot, provided by NEON Science. Working down the list through time ensures that selected clip harvest locations will generate an unbiased estimate of herbaceous biomass every bout.
clip strip	A 2.0m x 0.1m rectangular area, typically centered within each sampling cell, in which the actual clip harvest takes place. Coordinates provided in clip lists correspond to the SW corners of clip strips.
exclosure	Portable structures made of wire mesh, and sometimes with a rigid support frame, that exclude herbivores from consuming herbaceous biomass in systems managed for grazing. Data from both exclosed and non-exclosed sampling cells allow estimates of herbaceous biomass consumption, needed to calculate net primary productivity in grazed systems.
node	Applied to woody-stemmed (wst) individuals with ddh < 1 cm, a node is the point furthest along the stem, away from the actively growing tissue, where current year's growth is attached to previous years' growth. This definition includes the point at which a leaf emerges directly from previous years' growth.
sampling cell	A 3.0m x 0.5m rectangular area within a plot that supports clip harvest sampling of herbaceous biomass; the long-edge of the cell is always oriented north/south. Sampling cells also support TOS Plant Belowground Biomass sampling in Tower Plots.

3 METHOD

The Standard Operating Procedures (SOPs) presented in this protocol describe tasks that, when taken together, allow estimation of aboveground herbaceous biomass (Distributed Plots) and productivity (Tower Plots) across important herbaceous functional groups. These SOPs are:

- **SOP A: Preparing for Sampling**. Instructions to prepare for sampling at standard and grazed sites.
- **SOP B: Field Sampling Sites Not Managed for Grazing**. Collecting herbaceous biomass from sampling cells in the field via clip-harvest, sorting to functional group, and recording required data and metadata.
- **SOP C: Field Sampling with Grazing Management**. Collecting herbaceous biomass from sampling cells via clip-harvest at sites managed for grazing.
- **SOP D: Post-Field Sampling Tasks**. Checking clipped biomass for sorting accuracy, refreshing the sampling kit, equipment maintenance and cleaning, and data management.
- **SOP E: Laboratory Processing of Herbaceous Biomass Samples**. Drying and weighing clipped herbaceous biomass, and performing dry mass QA for a subset of samples.

Herbaceous biomass clip-harvests occur within randomly located sampling cells located in 20m x 20m plots or subplots. The goal of the clip-harvesting procedure is to estimate the amount of herbaceous biomass produced within the delineated clip strip area within a cell. This means that only those herbaceous plants whose stems enter the ground within the clip strip are clipped (exceptions to this are woody-stemmed plants with diameter at decimeter height [ddh] < 1 cm; the SOPs describe in more detail how to deal with these plants). There will typically be one clip-harvest per plot or subplot per sampling event, although sites managed for grazing receive two clips per plot or subplot per bout; see SOP C.

There are two types of plots where clip-harvests will occur: Distributed Plots and Tower Plots. Clip-harvests in Distributed and Tower Plots are organized into 3.0m x 0.5m gridded, numbered 'sampling cells' that cover the available sampling area within the plot. Within a sampling cell, field staff perform clip-harvests in north/south-facing strips with dimensions of 2.0m x 0.1m (**Figure 1**). Those cells that overlap 1 m^2 and 10 m^2 nested subplots are omitted from clip-harvest sampling. Relative coordinates are assigned to the Southwest corner of each clip strip, which enable staff to find the desired clip strip location for a given sampling bout. For reference, the Southwest corner of each 20m x 20m plot or subplot is defined as (0,0), and the Northeast corner of the plot or subplot is (20,20) (**Figure 1**). Within Distributed Plots, the herbaceous biomass and productivity clip-harvest protocol is carried out only in non-forested plots with ≥ 50% herbaceous cover as seen from the air. Forested plots are considered to be those with NLCD Class = deciduous forest, mixed forest, or evergreen forest.

Clip harvests in 20m x 20m Tower Plots are carried out identically to those performed in Distributed Plots, with the exception that all plots are harvested regardless of NLCD vegetation type. For Tower

Plots 40m x 40m and larger, the herbaceous clip-harvest protocol is implemented in two randomly selected 20m x 20m subpots per plot (**Figure 2**). Again, similar to clip-harvesting in Distributed Plots, 1 m^2 and 10 m^2 nested subplots are not clip-harvested in Tower Plots, but larger sized nested subplots within 40m x 40m and larger Tower Plots may support clip-harvesting.

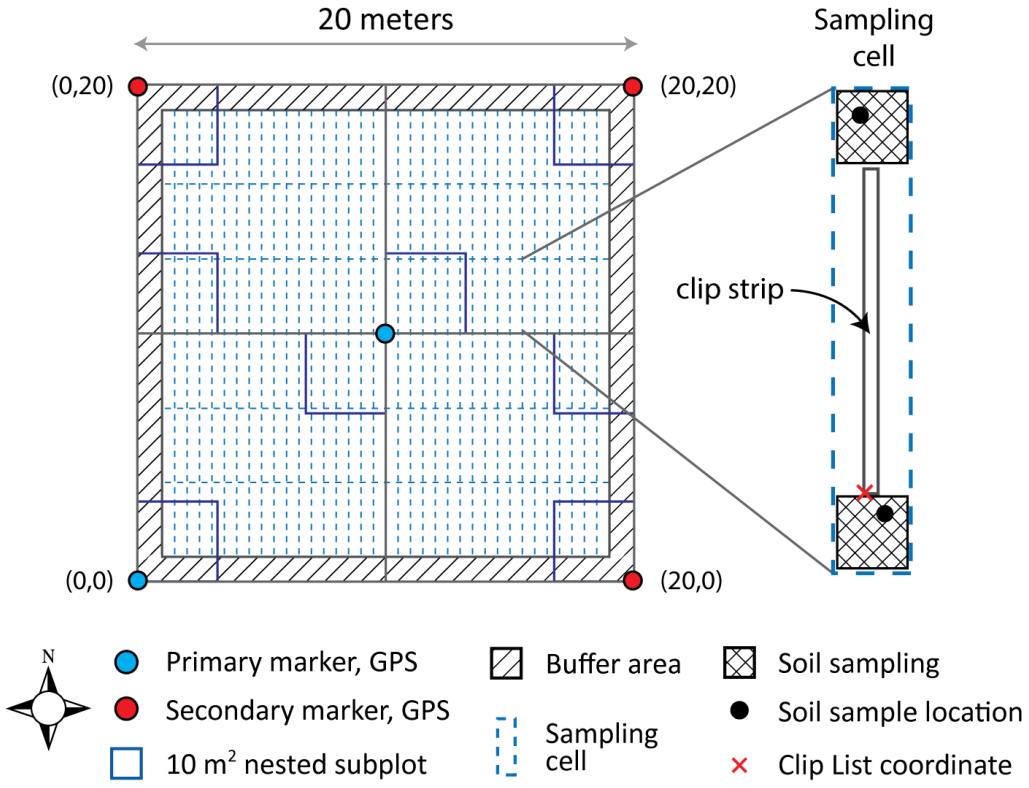

Figure 1. A Distributed Plot showing the locations of 3m x 0.5m sampling cells (dashed blue lines) that contain potential 2m x 0.1m clip strips. Coordinates corresponding to the SW corner of the clip strip (red 'X' in blowup) are provided to staff in plot-specific Clip Lists. Clip List coordinates are always relative to the SW corner of the plot (0,0). Sampling cells that overlap 10 m^2 nested subplots are omitted from Clip Lists.

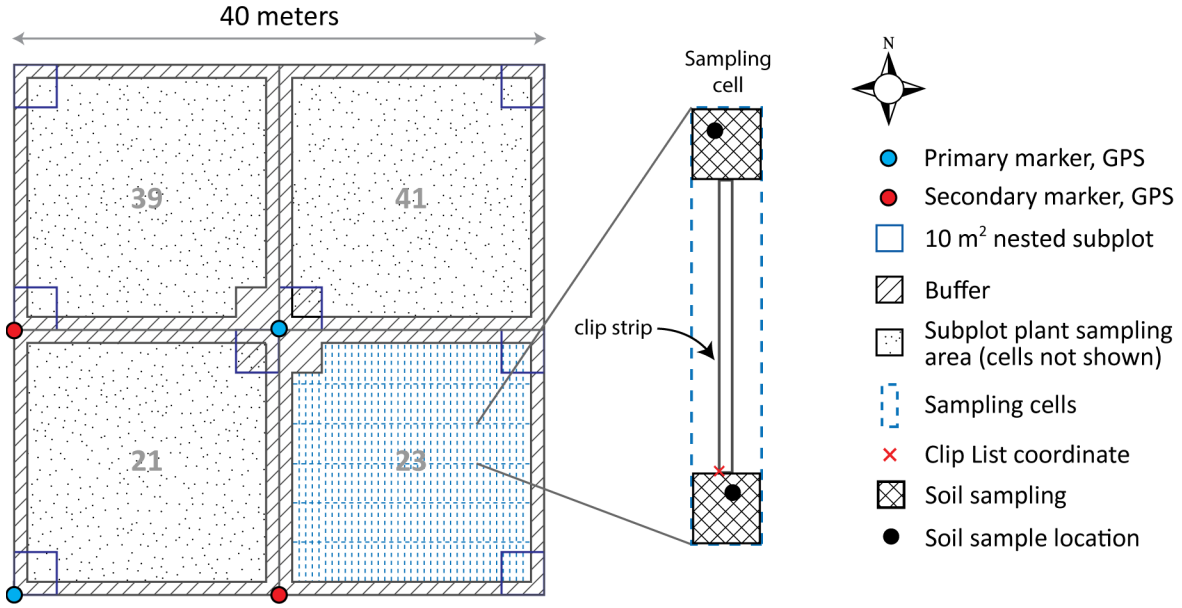

Figure 2. A 40m x 40m Tower Plot showing the location of 3m x 0.5m sampling cells (dashed blue lines) within the 20m x 20m subplot23. Cells from the other subplots have been omitted for clarity. The clip strip coordinates are supplied on a per subplot basis (red 'X'). Clip List coordinates are always relative to the SW corner of subplots (red and blue circles). Sampling cells that overlap 10 m^2 nested subplots are omitted from Clip Lists.

To determine a clip-harvest location within a given sampling bout, staff are provided with a randomized list of potential clip strip coordinates for each 20m x 20m plot or subplot (referred to as "Clip Lists" hereafter). An excess number of potential clip-harvest locations within a particular plot or subplot are randomly determined by NEON Science, with the knowledge that not all potential locations will be suitable for clip-harvesting. That is, there may be obstacles such as rocks, trees, ant nests, etc. at any given location that will prevent carrying out a clip-harvest. Staff should work down this list through time on a per plot or subplot basis, assigning the appropriate code to harvested and rejected strips on the list as work progresses from bout to bout, so that re-sampling of a given clip strip over the lifetime of the Observatory is minimized or eliminated. Clip strips are moved each year to minimize effects of harvest on subsequent biomass data.

Additional clip-harvest bouts are required if grazing exclosures are employed at the site. Instructions for utilizing exclosures are provided in SOP C.

Once field work is complete at the plot, harvested biomass is kept cold until sort checking is performed. Best practice is to place clipped biomass into a cooler containing cold packs immediately after clipping: keeping clipped biomass cold is critical to prevent wilting, so that species' diagnostic features are preserved. Within 24-h of harvest, the same staff who harvested and sorted the biomass in the field must then check each bag of clipped material to make sure that sorting was done properly, and in particular, that no previous years' biomass is mixed with current-year biomass. Sorted biomass is then

either returned to the cooler with fresh cold packs, or oven-dried as soon as possible in the laboratory and weighed.

Properly accounting for grazing, the contribution of different plant growth forms to overall aboveground biomass (sorting biomass to sub-shrubs, graminoid functional type, etc.), and determining whether biomass was produced in the current year or a previous year are the most important requirements for generating quality data from this field work.

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 clipped herbaceous biomass, 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 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 problems are documented and entered in NEON's problem tracking system.

Quality control is performed on data collected via these procedures according to the NEON AOS/TOS Data Management Protocol (RD[04]).

3.1 Integrating Herbaceous Biomass and Plant Belowground Biomass Sampling

- In Tower Plots, the Herbaceous Biomass and Plant Belowground Biomass sampling (RD[10]) protocols are spatially and temporally linked (**Table 3**), and Belowground Biomass sampling should co-occur in the same cell used for the peak aboveground biomass clip harvest.
- In an 'on' year for plant Belowground Biomass Sampling, the Clip List should indicate whether the Plant Belowground Biomass protocol was implemented prior to Herbaceous Biomass sampling. Always attempt to acquire Herbaceous Biomass samples from the same cell used for Plant Belowground Biomass sampling.
- When accepting/rejecting cells for potential sampling, be sure to consider suitability and representativeness with respect to ***both*** protocols.

4 SAMPLING SCHEDULE

4.1 Sampling Frequency and Scheduling

Sampling Frequency:

Herbaceous Biomass clip-harvest samples are collected according to the guidelines in **Table 2**. The frequency of Herbaceous Biomass clip-harvests depends on the type of site being sampled, as well as the type of plots sampled within the site.

Table 2. Sampling frequency and timing guidelines for herbaceous biomass clip-harvesting based on sampling type and plot type.

Sampling Type	Plot Type	Plot Number	# Events per Sampling Year	Yearly Interval[1]	Sampling Start	Sampling Stop
Agricultural	See the Agricultural Biomass SOP (RD[13])					
Ungrazed (SOP B)	Distributed, Gradient (non-forest NLCD types only)	n=20 (max)	1X per sampling year	Every 5 y	Peak biomass (APPENDIX D provides site-specific dates)	Within 14 d of sampling start
	Tower	Variable, see APPENDIX D	1X or 2X per sampling year	Annual	Peak biomass[3] (APPENDIX D provides site-specific dates)	Within 14 d of sampling start[4]
Grazed[5] (SOP C)	Distributed, Gradient (non-forest NLCD types only)	n=20 (max)	1X per sampling year	Every 5 y	Peak biomass (APPENDIX D provides site-specific dates)	Within 14 d of sampling start
	Tower	Variable, see APPENDIX D	Varies by site[6]: - Every 4 weeks, - Every 8 weeks, - 1X at peak biomass - See APPENDIX D	Annual	Deploy exclosures 10-14 d before animal stocking; first clip date = stocking date + sampling interval	See Section 4.2 (p.11)

[1] The schedule determining which years a protocol is implemented; all sites in a domain are sampled at the given interval, unless otherwise indicated; 'annual' means a protocol is implemented every year, 'every 5 y' means there are four 'off' years following every 'on' year. This field DOES NOT indicate the number of times within an 'on' year the protocol should be implemented; intra-year frequency is provided in the '# Events per Sampling Year' field.

[2] Plot number may be reduced following initial data collection at a given site.

[3] When two clip-harvests are performed per year, Sampling Start is per bout. For example, there would be one Sampling Start date for an early season peak in cool-season graminoid biomass (May), followed by another Sampling Start date for a late-season peak in warm-season graminoid biomass (August).
[4] When two clip-harvests are performed per year, "Sampling Stop" is per bout.
[5] Grazed ecosystems are defined as those actively managed for livestock grazing. The specified sampling intervals should only be applied when exclosures are present and livestock are present.
[6] Example: For a 4 week interval, a maximum of 4 weeks elapses between bout completion dates.

In Distributed Plots at a given site, this protocol is synchronized in an 'on' year with two other TOS plant biomass protocols:

- TOS Protocol and Procedure: Measurement of Vegetation Structure (RD[07])
- TOS Protocol and Procedure: Coarse Downed Wood (RD[15])

Scheduling of these three protocols is further coordinated according to **Table 3**. Staggering implementation of Herbaceous Biomass clip-harvest in Distributed Plots is important to prevent spikes in labor requirements from year-to-year.

Table 3. Coordination of Herbaceous Biomass clip-harvest with other TOS plant and soil sampling protocols through time. Years 1 through 7 are shown to illustrate the temporal grouping of protocols, and the pattern repeats beyond year 7. Grey cells indicate synchronized 'chemistry' and 'productivity' protocol groups; brown cells indicate protocols implemented annually in Tower Plots; orange cells are protocols implemented every 5 y in Tower Plots.

Protocol*	Interval (y)	Plot Type	Plot Number	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
BGB	5	tower	20 or 30†	X					X	
CFC	5	both	16-20	X					X	
LAI	5	distributed	20	X					X	
LTR-bgc	5	tower	20 or 30†	X					X	
NTR	5	both	10	X					X	
SLS-bgc	5	both	10	X					X	
SLS-mb	5	both	10	X					X	
CDW	5	distributed	20		X					X
HBP	5	distributed	20		X					X
VST	5	distributed	20		X					X
HBP	1	tower	5 to 30†	X	X	X	X	X	X	X
LAI	1	tower	3	X	X	X	X	X	X	X
LTR	1	tower	20 or 30†	X	X	X	X	X	X	X
VST	1	tower	5-10‡	X	X	X	X	X	X	X
CDW	5	tower	20 or 30†				X			
VST	5	tower	20 or 30†					X		

* Protocol codes and definitions: **BGB** = Belowground Biomass of fine root sampling; **CFC** = Canopy Foliar Chemistry sampling; **DIV** = Plant Diversity sampling; **LAI** = Leaf Area Index sampling; **LTR-bgc** = Litterfall biogeochemistry analysis; **NTR** = soil nitrogen mineralization incubation; **SLS-bgc** = Soil biogeochemistry analysis; **SLS-mb** = Soil microbial biomass analysis (PLFA); **CDW** = Coarse Downed Wood sampling; **HBP** = Herbaceous Biomass and Productivity sampling; **VST** = Vegetation Structure sampling; **LTR** = Litterfall sampling (no chemistry).

† The total number of Tower Plots sampled for Herbaceous Biomass varies by site; see APPENDIX D.

‡ A spatially-balanced subset of Tower Plots are selected for annual VST sampling at sites with relatively fast woody growth increment. See RD[12] for VST fast/slow growth increment classification by site.

Scheduling Considerations:

- ***Coordinating with Plant Belowground Biomass Sampling:*** In Tower Plots, Herbaceous Biomass clip-harvest is spatially and temporally linked with soil sample collection every 5 years (**Table 3**). See **SOP B.1** for protocol integration tips.
- ***Coordinating with Plant Diversity Sampling:*** Herbaceous Biomass clip-harvest is collocated with Plant Diversity sampling in all Distributed Plots every 5 years, and annually in 3 Tower Plots (**Table 3**). See **SOP B.1** for protocol integration tips.
- ***Plot Type Prioritization:*** Herbaceous biomass clip-harvests must be performed within Tower Plots on an annual basis, and sampling these plots is a priority.
- ***Bout Completion:*** A given sampling bout should be concluded within 14 days of initiation, so that the plant community does not change appreciably during the time that all target plots are sampled.
    - This guideline ensures that data collected across all plots within a given bout are comparable.
    - The number of personnel assigned to the clip-harvesting task should be optimized so that this goal is feasible.
- ***Field Work and Laboratory Processing:*** After herbaceous plants are clipped from a given clip strip, the following points are critical with respect to timing:
    - Place clipped biomass immediately into a cooler, and keep stored cool until it can be placed in a drying oven.
    - In the Field Sampling application, or “Field” datasheet, record the date and time that the samples were placed into cold storage after being clipped in the field.
    - Check field-sorted biomass for sorting accuracy within 24 h of harvest.
    - After sort-checking, place samples into the drying ovens as soon as possible.
        - In the Lab Mass application, or “Lab” datasheet, record the date and time that the samples were placed in the drying oven.
        - These data will enable automatic calculation of the number of hours that samples were kept in cold storage.

4.2 Criteria for Determining Onset and Cessation of Sampling

Sampling Onset

Sampling should be scheduled to occur once peak biomass production at a given site is complete. Conservatively, it is assumed this corresponds to the average date at which greenness begins to decrease at a site, according to the MODIS-EVI phenology product. Site-specific sampling start guidance, typically derived from MODIS-EVI, is provided in APPENDIX D. In general:

- Bouts should be scheduled to begin within a 2 week window that starts with the provided 'Start Date,' and
- It is incumbent upon Field Operations to schedule sampling onset dates in accordance with provided guidance.

Sampling Cessation – Grazed Tower Plots

At grazed sites, Tower Plot sampling should continue according to the site-specific interval (4 week, 8 week, etc.) while livestock are present AND plants are still growing. Sampling may be discontinued when:

- Senescence is complete for those functional groups grazed by livestock, and livestock are still present.
    - Assuming senescence occurs between bouts, carry out next scheduled bout after senescence is reported, then cease sampling.
- Livestock are removed, and growth continues.
    - If grazing is discontinued between bouts, carry out the next scheduled bout, then cease sampling.
        - Resume sampling at specified interval if livestock are returned to the plots at some later date. Because it can be difficult to predict when livestock grazing might resume, leave exclosures in place if possible and if approved by the site host.
    - If grazing is discontinued prior to the peak biomass bout that is sorted to functional group, the peak biomass bout is required for the sampling cell NOT under the exclosure, and should remain on the schedule.
- The stop date in APPENDIX D is reached.
    - Stop dates are derived from satellite greenness data. Contact NEON Science if plants are routinely still growing at the provided date(s) relevant to your sites.

4.3 Timing for Laboratory Processing and Analysis

Because herbaceous biomass continues to be biologically active after clipping and before drying (i.e. plant cells continue to respire and therefore lose mass), it is important to place clipped samples into the drying oven as soon as possible after clipping occurs. Ideally, samples will be placed in the drying oven within 24 h of clipping in the field, and must be kept in cold storage the entire time between clipping in the field and drying in the laboratory. Keeping samples in cold storage mitigates mass loss by slowing cellular activity. However, when it is not possible to dry samples in the laboratory within 24 h of clipping, it is acceptable to keep samples in cold storage for up to a maximum of 5 days following clipping.

Once samples are dry, they may be weighed immediately (SOP E.1), or 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 weighing and processing. However, samples should be stored temporarily for no more than 30 days to prevent backlogs from forming (SOP E.1).

4.4 Sampling Timing Contingencies

Table 4. Herbaceous Biomass sampling delay contingency decisions.

Delay/Situation	Action	Outcome for Data Products
Hours	If delay prevents completion of clip-harvest strip: 1. Ensure all small bags of sorted biomass are labeled, 2. Place small bags into a 25# bag and label, Resume harvest of same clip-harvest strip ASAP	No adverse outcome.
	If delay occurs between plots, resume harvest of next clip-harvest strip ASAP.	
1-7 days	If delay prevents completion of clip-harvest strip: 1. Ensure all small bags of sorted biomass are labeled, 2. Place small bags into a 25# bag and label, 3. Store already clipped biomass in a cooler/refrigerator (okay), or oven-dry as per protocol (best), 4. Resume harvest of same clip-harvest strip ASAP with new labeled bags, and 5. Combine dried biomass per functional group for weighing when all biomass is dry.	May create potential change in observed NPP, and may increase uncertainty in consumption estimates at grazed sites. May also be difficult to complete clip harvest of all plots in 10-14 day window if delay approaches 7 days.
	If delay occurs between clip-harvest strips, resume harvest of next strip ASAP.	

Delay/Situation	Action	Outcome for Data Products
8-13 days or longer	If delay prevents completion of clip-harvest strip: 1. Ensure all small bags of sorted biomass are labeled, 2. Place small bags into a 25# bag and label, 3. Store already clipped biomass in a cooler/refrigerator (okay), or oven-dry as per protocol (best), 4. Resume harvest of same clip-harvest strip ASAP with new labeled bags, and 5. Combine dried biomass per functional group for weighing when all biomass is dry.	More uncertainty in biomass and NPP estimates, especially in grazed systems. Aboveground biomass per unit area may change in the field over this length of time.
	If delay occurs between clip-harvest strips, resume harvest of next strip ASAP	

4.5 Criteria for Reallocation of Sampling Within a Site

Herbaceous Biomass 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, a problem ticket should be submitted.

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 Herbaceous Biomass clip-harvest sampling, criteria for considering a plot compromised depend on plot type:

- Distributed Plots: These plots are sampled every 5 y; if sampling cannot be completed for 2 consecutive bouts then the plot should be considered compromised.
- Tower Plots: If more than 50% of bouts over 3 consecutive years cannot be completed for a given plot, it may be considered compromised for this protocol.
- It is currently incumbent on Field Science to track which plots have been compromised for Herbaceous Biomass clip-harvest.

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 this field procedure 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. If stopping work compromises a bout or prevents completion of a bout, submit a ticket via NEON's issue tracking software.

For the field procedures, a laser rangefinder/hypsometer/compass instrument may be used to navigate to sampling cells within plots. Safety considerations for this instrument include:

- 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.

For samples that may contain tissue from Toxicodendron spp.: Additional safety issues associated with this field procedure include potential exposure to *Toxicodendron* oils (discussed in APPENDIX F, AD[02] and RD[14]).

- Throughout this document, the warning pictogram at left is used to identify steps relevant to collecting or processing samples that may contain *Toxicodendron* tissue.

6 PERSONNEL RESOURCES

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.

See also APPENDIX F, section F.1 for equipment related to minimizing exposure to toxic oils from *Toxicodendron spp.*

Table 5. Equipment list – durable items required for per-plot biomass clip harvesting and sorting (quantities are for two technicians)

Supplier	Supplier Number	R/S	Description	Purpose	Quantity	Special Handling
Durable Items						
Amazon Cabela's REI	IK270217 895022	S	GPS receiver, recreational accuracy, e.g. Garmin Etrex20x	Navigate to sampling location	1	N
Ben Meadows; Forestry Supplier	213379; 37184 37036	S	Compass with mirror and declination adjustment	Locate clip-harvest strips (with measuring tape)	1	N
Forestry Supplier	91567	R	Laser Rangefinder, 0.3 m accuracy	Locate clip-harvest strips within plots/subplots; use when plot slope > 20% or brushy	1	N

Supplier	Supplier Number	R/S	Description	Purpose	Quantity	Special Handling
Compass Tools Forestry Supplier	703512 90998	R	Foliage filter	Allow laser rangefinder use in dense vegetation	2	N
Grainger	5B317	R	Flat 3” reflector (reflective tape acceptable)	Reflective target for laser rangefinder; aids in measuring distance to target accurately	1	N
Constructed in-house	EG07570000 EG07570001 (Maximo)	R	Grazing exclosure, tall or short grass system (see NEON.DOC.001788 for assembly diagram)	Prevent herbivory at clip location in actively grazed sites		N
		S	Hammer	Install and remove grazing exclosure stakes	1	N
		R	Pruning shear	Clip plants		N
Forestry Supplier	61280	R	Magnifier hand-lens, 10X	Aid in species identification	1	N
Forestry Supplier	61260	R	Magnifier hand-lens, 20X	Aid in species identification	1	N
Fisher Grainger	19067113 3UZA9	R	Cold packs	Chill perishable samples in field		N
		R	Pre-marked string and stake sets	Delineate clip harvest strip; polyester cord recommended to minimize stretching with use.		N

Supplier	Supplier Number	R/S	Description	Purpose	Quantity	Special Handling
Ben Meadows Forestry Supplier	100952 39167	R	Chaining pins or other suitable anchor	Anchor measuring tapes	2	N
Ben Meadows Forestry Supplier	122731 40108 39943	R	Measuring tape, minimum 30 m	Locate clip-harvest strips within plots/subplots .Plot slope < 20%; grassland, savannah	1	N
Amazon Grainger	41N620	R	Ruler, 30 cm	Delineate clip-harvest strip	1	N
Forestry Suppliers	93710	S	Spring scale, 10 kg capacity, tareable	Weigh total fresh mass of high-volume clip strips at approved grazed sites for bouts not sorted to functional group.	1	N
Forestry Suppliers	93709	S	Spring scale, 5 kg capacity, tareable	Weigh total fresh mass or subsample fresh mass of high-volume clip strips at approved grazed sites for bouts not sorted to functional group.	1	N
Forestry Suppliers	93016	S	Spring scale, 2.5 kg capacity, tareable. Note: Unit has English and metric gradations. Data should be recorded in metric.	Weigh total fresh mass or subsample fresh mass at approved grazed sites for bouts not sorted to functional group (see APPENDIX E for list of approved sites).	1	N

Supplier	Supplier Number	R/S	Description	Purpose	Quantity	Special Handling
Forestry Suppliers	93019	S	Spring scale 1000 g capacity, tareable. Note: Unit has English and metric gradations. Data should be recorded in metric.	Weigh low mass fresh subsamples at approved grazed sites for bouts not sorted to functional group (see APPENDIX E for list of approved sites).	1	N
		R	Forceps	Identify and sort plants	2	N
		S	Work gloves	Protect hands	2	N
		R	Cooler	Chill perishable samples in field	1	N
Consumable Items						
		R	Survey marking flag, PVC or fiberglass stake	Delineate sampling area	4	N
		R	Adhesive barcode labels (Type I)	Label samples with barcode readable labels	1 sheet	N
ULINE	S-21339	R	Sample warning pictogram label	Identify samples that may contain *Toxicodendron* tissue	1 sheet	N
ULINE	S-7630	R	Paper bags, #8[1]	Contain clipped herbaceous biomass, sorted to functional group	50[2]	N
ULINE	S-7631	R	Paper bags, #25[1]	Organize smaller bags from a given clip strip	10[2]	N

Supplier	Supplier Number	R/S	Description	Purpose	Quantity	Special Handling
		R	Permanent marker	Label paper bags	2	N
		S	CR123A battery	Spare battery for laser rangefinder	2	N
		S	AA battery	Spare battery for GPS receiver	2	N
Resources						
		R	Mobile data collection device, table or equivalent	Record field sampling metadata	1	N
RD[05]		R	Herbaceous Biomass Field Datasheets	Record sampling metadata		N
		R	Per plot or subplot Clip Lists	Identify random clip strip locations	As needed	N
		R	Field guide, regional flora reference guide and/or key	Identify leguminous forbs and graminoids to species	1	N

R/S=Required/Suggested

[1] Bag size may be adjusted as necessary based on size/bulk of plants being clipped. For example, sites with tall grasses will require larger bags.
[2] Quantity may be adjusted as necessary based on field experience at a given site.

Table 6. Equipment list – Post-field sampling tasks

Supplier	Supplier Number	R/S	Description	Purpose	Quantity	Special Handling
Durable Items						
Forestry Supplier	61260	R	Magnifier hand-lens, 20X	Aid in species identification	1	N
Forestry Supplier	61280	R	Magnifier hand-lens, 10X	Aid in species identification	1	N
		R	Cooler	Chill perishable samples	1	N
		R	Cold packs	Chill perishable samples	Vari-able	
Resources						
RD[05]		R	Completed Herbaceous Biomass Field Datasheets	Contains field-collected sampling metadata	Vari-able	N
		R	Field guide, regional flora reference guide and/or key	Aid in distinguishing morphologically similar species to functional groups	1	N

R/S=Required/Suggested

Table 7. Equipment list – Processing herbaceous biomass clip-harvest samples in the laboratory

Supplier	Supplier Number	R/S	Description	Purpose	Quantity	Special Handling
Durable Items						
Fisher	01918307	R	Balance, 0.01 g accuracy	Weigh samples	1	N
Fisher	08732115	R	Weigh boats, large	Contain dried sample while weighing	Variable	N
Fisher	1523911	S	Plastic tray	Contain oversized samples while weighing	1	N
Consumable Items						
RD[05]		R	Datasheets: • Lab Drying QC Datasheet • Lab Weighing Datasheet	Recording dry weight of herbaceous biomass	As needed	N

R/S=Required/Suggested

6.2 Training Requirements

All technicians must complete required safety training and protocol-specific training for safety and implementation of this protocol as required in Field Operations Job Instruction Training Plan (AD[04]).

For the field component of this protocol, technicians must be trained in navigating to points in the field with a GPS and manual methods. Most critically, technicians must be trained to quickly identify common herbaceous species at the sites within the region of employment. Because different herbaceous functional groups can be sensitive indicators of ecosystem responses to global change (e.g. N deposition, warming, rising CO_2), it is very important that field technicians within a domain can accurately and quickly identify C3 and C4 graminoids as well as identify leguminous and non-leguminous forbs within that domain.

Training for both the field and laboratory work must emphasize the importance of consistent, detailed labeling of all samples, including proper use of barcodes if barcodes are used. ***Improper or inconsistent labeling and sample tracking is the most common and problematic error associated with this work!***

6.3 Specialized Skills

The lead plant technician must possess the demonstrated ability to identify required plants to functional group – either via visual inspection, or via visual inspection in combination with a dichotomous or polyclave key.

- Identification of all leguminous forbs to functional group, in the absence of flowers, is required.
- Identification to species is not required for non-leguminous forbs and woody stemmed plants.
- Identification to species is required for cool-season (C3) and warm-season (C4) graminoid functional groups. Lead field personnel should be able to identify graminoids vegetatively.

Ideally, each team member should know how to use diagnostic traits and a dichotomous or polyclave key to identify unknown species.

6.4 Estimated Time

The time required to implement a protocol will vary depending on a number of factors, such as skill level, system diversity, environmental conditions, and distance between sample plots. The timeframes provided below are estimates based on completion of a task by skilled technicians (i.e., not the time it takes at the beginning of the field season)(**Table 8**, below). Use this estimate as a framework for assessing progress. If a task is taking significantly longer than the estimated time, a problem ticket should be submitted.

Table 8. Estimated staff and labor hours required for implementation of Measurement of Herbaceous Biomass SOPs.

SOP	Estimated time	Suggested staff	Total person hours
SOP A.1: Preparing for Sampling (DSF)	0.5 h	1	0.5 h
SOP A.2: Grazing Exclosure Construction	8-16 h	2	16-32 h
SOP B: *Field Sampling (no grazing)	1-3 h per plot	2	2-6 h per plot
SOP C: *Field Sampling (grazing management)	2-6 h per plot	2	4-12 h per plot
SOP D: Post-Field tasks (sort checking, etc.)	0.5-2 h per plot	2	1-4 h per plot
SOP E: Laboratory Processing (drying, weighing, data entry)	0.5 h per plot	1	0.5 h per plot

* This time range includes identifying an acceptable clip-harvest location, delineating the clip strip, and clipping qualifying herbaceous biomass. The clip-harvest may take closer to 1 h per plot if herbaceous vegetation is sparse.

7 STANDARD OPERATING PROCEDURES

SOP A Preparing for Sampling

A.1 Sampling Equipment Preparation and Checklist

Table 9. Sampling equipment preparation checklist

Item	Action
GPS unit	Charge Load target locations
Compass, mirror-sight	Check/set correct declination[1]
Laser rangefinder / hypsometer	Item is only required if plot slope is > 20% or if obstacles in plot exist that prevent stretching a tape. To prepare: • Check battery, charge (if possible) • Clean lenses with lens cloth or lens tissue (if necessary) • Check/set correct declination[1]. See RD[12] for details. • Calibrate tilt-sensor (only necessary after severe drop-shock; see RD[12] for details).
Hand clippers	Clean and sharpen blades (if necessary)
Re-usable cold packs	Place in –20 ˚C freezer
Pre-marked string and stake sets[2]	Fabricate if necessary: Cut 2.5m of ⅛” diameter polyester cord Mark cord at each end with a permanent marker so that the center section of the cord measures exactly 2.0m between the markings. Tie each end to an 8” or longer tent stake.
Herbaceous Biomass Field Datasheets (RD[05])	Print on all-weather paper
Per plot or subplot Clip Lists[3]	Print on all-weather paper. Clip Lists are linked in the ‘Supporting Documents’ section of the online Sampling Support Library

[1] Declination changes with time and should be looked up annually per site: http://www.ngdc.noaa.gov/geomag-web/

[2] Pre-marked string and stake sets are used to temporarily delineate clip strip boundaries, and require fabrication prior to field work. Each set consists of two tent stakes connected by cord.

[3] Provided separately by Science Operations once plot establishment has been completed.

A.2 Sample Labels and Identifiers

- By default, this procedure considers each sampling cell harvested on a unique date to be a ***sample***, and each functional group or crop is a ***subsample*** ('functional group' and 'herbGroup' may be used interchangeably in this document).
- Subsamples are labeled with the location, date, and functional group of the collected subsample.
- In addition to labeling the subsample with human readable information, each subsample may also be associated with an optional scannable barcode.
- Subsample bags for the field may be pre-labeled with a template prior to beginning a bout. Label templates developed by Field Science may be available via the SSL.
- Ensure sufficient warning labels are available for identifying bags in the field that may contain *Toxicodendron*.

A.2.1 Barcode Workflow

Barcodes are optional at this time for Herbaceous Biomass clip-harvest samples. Until they are linked with a subsample, barcodes do not contain information specific to sample provenance.

- Barcodes may improve sample tracking, and reduce transcription errors associated with writing sample and subsample identifiers by hand.
- Barcodes may also speed entry of data into the Herbaceous Clip Harvest Lab Masses app if barcodes are first recorded in the Field Sampling app.

If using barcodes:

- Adhesive barcode labels should be applied to dry, room temperature bags or envelopes in advance of their use in the field (at least 30 minutes prior, but may be applied at the start of the season).
- See Section 6.1 for the appropriate barcode label type for this procedure. Note that a barcode label is applied *in addition to* labeling the subsample with human-readable information (hand-written or printed).

Barcodes are scanned into the mobile application when the subsample (i.e., herbGroup) is placed into the bag; only one barcode may be associated with a particular subsample. Do not reuse barcodes. If a barcode is associated with multiple subsamples the Parser will reject the records associated with the duplicate barcodes.

A.3 Early-season preparation

For all sites:

1. Create a list of common N-fixing plants at each site that should be sorted into the N-fixing functional group (NFX).
    a. Include all leguminous forbs.
    b. Include N-fixing woody-stemmed individuals with ddh < 1 cm.
    c. Consider species commonly encountered in plots, or species locally abundant in only 1-2 plots. Do not research species that are uncommon and never make up more than 10% of the clipped biomass from any plot.
2. Create a list of common cool-season graminoids and warm-season graminoids at each site that should be sorted into the CSG and WSG functional groups, respectively.
    a. Note key diagnostic features for species known to be difficult at a site.
    b. Consider species commonly encountered in plots, or species locally abundant in only 1-2 plots. Do not research species that are uncommon and never make up more than 10% of the clipped biomass from any plot.

For grazed sites:

Grazing exclosures are deployed only within Tower Plots. For 20m x 20m plots one exclosure per plot is constructed; for 40m x 40m plots, two exclosures per plot are constructed (one for each randomly selected 20m x 20m subplot).

1. Inspect existing grazing exclosures for wear and damage.
2. Construct additional grazing exclosures as needed according to plans outlined in RD[08].
    a. The drawings in RD[08] depict two different styles of grazing exclosure, with heights optimized for low-stature grassland vegetation (plants ~ 30cm height), and mid-stature grassland vegetation (plants ~ 1 m height).
    b. Choose the exclosure height so that the exclosure height is approximately equal to or just greater than the height of the vegetation.
    c. Provide feedback to Science if the assembly document requires updating to include an expanded range of exclosure heights.

3. Deploy exclosures within Tower Plots or subplots at least 14 days prior to the anticipated onset of grazing.
    a. The Domain Manager or lead Field Ecologist must communicate with the site host to ascertain when grazing begins in a given growing season.
    b. Follow steps in SOP B to locate clip-harvest strips and assess suitability.
    c. For each Tower Plot or subplot, place an exclosure over the first suitable clip strip, and stake the exclosure to the ground.
    d. The first sampling bout should be scheduled X weeks after the date the exclosures were actually deployed, where X is the site-specific sampling interval (see APPENDIX D for per site sampling intervals).
    e. If exclosures were put in place at the end of the previous growing season, schedule the first bout so that sampling is initiated X weeks after the actual date of animal stocking.

SOP B Field Sampling Sites Not Managed for Grazing

'Non-grazed' sites are defined as those sites not *actively* managed for grazing. Sites that experience grazing pressure from native animals, as opposed to livestock, are not considered grazed, and should be sampled according to this SOP.

Goals

- Identify one representative sampling cell per plot or subplot per bout.
    - Distributed Plots are harvested once per year at peak biomass (on a 5 y interval).
    - Tower Plots are harvested annually either once or twice per growing season, depending on whether a particular plant community shows seasonally distinct biomass peaks (e.g. C3 peak in spring, C4 peak in summer).
- From each sampling cell, collect herbaceous biomass samples from a 2.0m x 0.1m clip strip and sort clipped biomass to functional group.
    - If two harvests are performed in Tower Plots, both harvests must be sorted to functional group.
- Collect required field sampling metadata.
    - The preferred method for data collection is the *HBP: Field Sampling [PROD]* mobile application.
    - The 'Herbaceous Clip Harvest Fulcrum Manual' on the SSL contains detailed data entry instructions.

B.1 Spatially Linked Protocols

Plant Belowground Biomass Sampling

- In an 'on' year for the Plant Belowground Biomass Sampling protocol (RD[10]), accepting/rejecting sampling cells should be done with both protocols in mind (**Figure 3**).
    - *Example*: Reject the sampling cell if a large rock prevents soil sampling in the North sampling area, and clipping is otherwise possible.
- It is highly desirable for accepted sampling cells to support both protocols; be consistent across teams, and follow established accept/reject criteria when assessing whether a sampling cell is representative of the plot.
- To determine whether Plant Belowground Biomass Sampling is theoretically possible in a given sampling cell, briefly probe the North and South sampling areas within the cell with a chaining pin or equivalent (see **Figure 1** to locate N/S sampling areas within a cell).

Plant Diversity

- Plant Diversity sampling typically co-occurs with Herbaceous Clip-Harvest sampling in all Distributed Plots and in 3 randomly selected Tower Plots. In these plots, identify and demarcate a suitable sampling cell prior to performing Plant Diversity sampling. This will ensure that the cell is not trampled during Plant Diversity sampling.
- Should clip-harvest occur before Plant Diversity sampling:
    - Take care to avoid trampling 1 m^2 nested subplots used for Plant Diversity % cover measurements; and
    - Reject potential clip strips that contain rare or uncommon plants.

B.2 Herbaceous Biomass Sample Collection in the Field

1. Navigate to the plotID to be sampled (using the GPS if necessary).
2. Use the plot- or subplot-specific Clip List to identify the first potential clip strip location that has not already been sampled or rejected.
    - Permanent electronic versions of Clip Lists are linked via the Herbaceous Clip 'Supporting Documents' section of the SSL.
    - The Clip List provides:
        - A randomized list of potential clip strips per plot or subplot. Subplot number provided as a field in the spreadsheet.
        - A record of which clip strips have already been harvested or rejected.
    - For Tower plots 40m x 40m and larger, herbaceous biomass sampling is performed in a randomly selected subset of available subplots.
        - Clip Lists are only provided for these randomly selected subplots.
    - Paper versions of Clip Lists are used in the field by NEON staff to record clipping/rejection of clip strips for the current bout.
    - The permanent electronic Clip List *must* be updated with information recorded in the field when sampling a given plot is complete.
3. Locate the relative X,Y-coordinates of the clip strip SW corner within the plot or subplot. The procedure used to locate the X-coordinate depends on the value of the relative Y-coordinate and the different procedures are detailed below:

4. If the 'offsetNorthing' coordinate for the clipID is < 10:

a. Run a tape East/West along the south edge of the plot or subplot between the (0,0) → (20,0) plot markers (**Figure 1**), and stretch the tape taut.

b. Place a pin flag at the desired relative X-coordinate (offsetEasting).

c. Standing directly over the pin flag that was just placed at the X-coordinate, use either a compass and tape, or the TruPulse in **HD** mode with a reflective surface to locate the Y-coordinate (offsetNorthing) (see 'Best Practice Tips' below).
   - Make sure the azimuth is as close to 0˚ as possible (True North) when finding the Y-coordinate (see **Figure 1**).
   - Avoid trampling the potential clip-harvest strip as much as possible.

d. Place a pin flag at the clip strip (X,Y) location; this point corresponds to the SW corner of the clip strip.

5. If the 'offsetNorthing' coordinate for the clipID is > 10:

a. Run a tape East/West from the plot centroid (10,10) to either the (0,10) position or the (20,10) position (**Figure 1**):

offsetEasting	Tape Layout[1]
1 < offsetEasting < 10	From (10,10) to (0,10)[1]
10 < offsetEasting < 20	From (10,10) to (20,10)[1]

[1] Use a compass or the TruPulse in **AZ** mode to guide the tape along the correct azimuth. For plots < 20% slope and lacking brush, an additional tape can be run N/S connecting the SW/NW or SE/NE plot markers to help find the (0,10) and (20,10) points if desired.

b. Place a pin flag at the desired relative X-coordinate (offsetEasting).

c. Standing directly over the pin flag that was just placed at the X-coordinate, use either a compass and tape, or the TruPulse in **HD** mode with a reflective surface, to locate the Y-coordinate (offsetNorthing).
   - Make sure the azimuth is 0˚ (True North) when shooting the TruPulse to find the Y-coordinate.
   - Avoid trampling the potential clip strip as much as possible.

d. Place a pin flag at the clip strip (X,Y) location; this point corresponds to the SW corner of the clip strip.

BEST PRACTICE TIPS

- If the plot slope is > 20 %, or there is significant brush or obstacles that prevent accurately stretching a tape, the laser rangefinder should be used in **HD** mode to place the initial pin flags relative to the plot markers.
- Plot slope can be quickly estimated using the inclinometer in the rangefinder unit (**INC** mode).
- For plot slopes < 20%, either laser rangefinder or compass/tape are acceptable.

6. Assess whether the sampling cell is suitable and representative, and accept or reject the sampling cell (see **Figure 3** flow-chart).

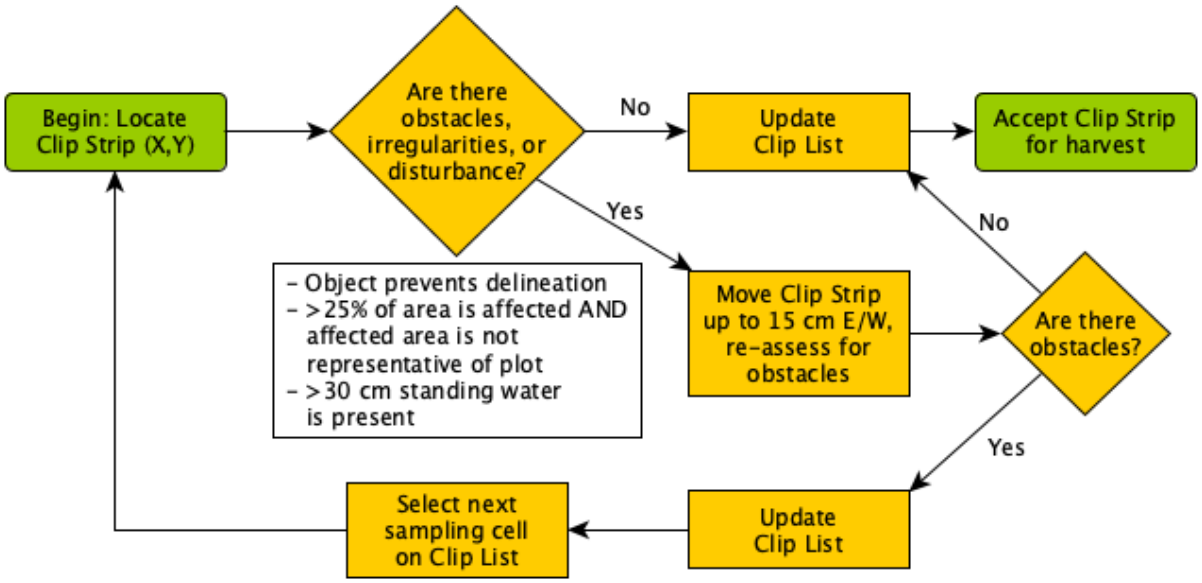

Figure 3. Flow chart to guide assessing potential sampling cells for clip-harvest suitability.

- Obstacles, disturbances, and/or irregularities may include trees, large rocks, ant nests, downed logs, etc.
- Strips should also be rejected if clipping a particular plant specimen in the strip would influence plot-level diversity. That is, the plant in question exists nowhere else in the plot or subplot.
    - If a rare or uncommon plant exists within the sampling cell, use code 4 to temporarily reject, and re-assess for clipping in a future year.
- If ≥ 3 consecutive potential sampling cells are rejected as 'unrepresentative,' it is necessary to consider recalibrating the working definition of 'representative.'

7. If the clipID is rejected, record why in the "status" column on the Clip List, select the next clipID on the list, and return to step (3) above. Otherwise, update the "status" column and proceed to step (8). Update the "status" column in the Clip List using codes in **Table 10**.

Table 10. Codes to document acceptance/rejection of clip strips on the list of clip strip coordinates.

Code	Definition
0	Rejected; disturbance, obstacle, and/or irregularity encountered within the Clip Strip
1	Accepted, no exclosure
2	Accepted, exclosure
3	Rejected temporarily, inundated
4	Rejected temporarily, uncommon plant
5	Co-located belowground biomass core sampling
~~6~~	~~Accepted for Bryophyte Productivity net harvest~~ (obsolete)
7	Rejected for exclosure due to obstacles, otherwise representative; use for non-exclosure clip

8. If there is no herbaceous biomass in a clip strip, AND the clip strip is deemed representative of the plot:
    a. Create a record for the **clipID**, and record 'targetTaxaPresent = N', save the record.
        i. If using paper data sheets, circle 'ttP = N' in the **remarks** field.
    b. Proceed to the next **clipID**, and return to step (1); otherwise continue to the next step.
9. Delineate the accepted clip strip for harvesting.
    a. Using one of the pre-marked string and stake sets, line up one of the marks with the pin flag, and push one stake into the ground.
    b. Stretch the string and second stake from the South to the North end of the clip strip, using the compass or the laser rangefinder to orient the string in a North/South direction.
    c. Keep the compass or laser rangefinder at least 50 cm from non-aluminum metal plot markers, eyeglasses, wristwatches, tent stakes, etc.
    d. Use a ruler or graduated chaining pin to place the second string-and-stake set 10 cm to the right (east) of the first set. Check that the distance between the two strings is exactly 10 cm at both ends of the clip strip.
    e. The two sets of marks on the two string-and-stake sets now clearly delineate a 2m x 0.1m area for clip-harvesting.

10. Using a permanent marker, label 8# kraft paper bags with the information below (use larger bags if vegetation is large-stature; if vegetation is wet, cloth bags may be used).

    Note: Bags may be optionally labeled with pre-affixed barcodes (SOP A.2).

    - **boutNumber**; use *XX* format, where XX is the bout number assigned by Field Operations, e.g. '01'. Values of **boutNumber** reset every year.
    - **date**; use *YYYYMMDD* format
    - **clipID**; as provided in Clip List; use "*plotID_samplingCellNumber*" format, e.g. CPER_001_126
    - **bagCount**; record after the clip is complete. The bagCount is the total # of bags per herbGroup from a given clipID; bagCount is not needed for OSD since OSD bags are discarded after the sort-check.

Table 11. Herbaceous clip-harvest functional groups with corresponding herbGroup codes, descriptions, and clipping guidelines.

herb Code	Description	Clipping Guidelines
ALL	Clipped herbaceous biomass is only sorted to remove OSD; use for non-peak-biomass harvests at sites managed for grazing with more than one sampling bout per growing season	Clip 1-2 cm above the ground; plants < 1-2 cm tall are ignored.
BRY	Bryophytes; lichens are not part of this group, and are ignored	Clip all live above-ground bryophyte biomass. Root presence can indicate beginning of soil when bryophytes form thick mats. Brown-colored bryophytes may still be alive; use site-specific knowledge to determine depth to which clipping is required (**Figure 4**)
CSG	Cool-season graminoids; includes all grasses, sedges, rushes, etc. with the C3 photosynthetic pathway	Clip 1-2 cm above the ground; plants < 1-2 cm tall are ignored. DO NOT clip the crowns of perennial graminoids, as this will damage or kill the plant (**Figure 5**)
WSG	Warm-season graminoids; includes all grasses, sedges, rushes, etc. with the C4 photosynthetic pathway	Clip 1-2 cm above the ground; plants < 1-2 cm tall are ignored. DO NOT clip the crowns of perennial graminoids, as this will damage or kill the plant (**Figure 5**)
NFX	Leguminous forbs, including all herbaceous annual and perennial members of the Fabaceae family; also includes other N-fixing herbaceous plants, and N-fixing WST with ddh < 1 cm.	Clip tissue produced in the current year; DO NOT clip any aboveground perennial parts. Plants < 1-2 cm tall are ignored.

herb Code	Description	Clipping Guidelines
FRB	Herbaceous annual and perennial forbs that do not fix nitrogen	Clip tissue produced in the current year; DO NOT clip any aboveground perennial parts. Plants < 1-2 cm tall are ignored.
WST	Woody-stemmed plants with ddh < 1 cm	Treat nodes where current-year woody growth emerges from previous years' woody growth as a "rooting point". Clip only leaves and twigs produced in the current year attached to nodes that lie within the clip strip. Harvested current-year material may leave the clip strip so long as the node lies within it. It is not necessary for the actual rooting point to lie within the clip strip. See training materials for example diagram.
OSD	Old standing dead material produced in a previous growing season	Make sure standing dead material produced in the *current* growing season is sorted into the correct group above.

11. If required to facilitate clipping, remove any cactus biomass lying within the clip strip. ***Only clip cactus plants of species listed in* Table 12 *AND that prevent access to herbaceous biomass that must be clipped.***
    - Dispose of the cactus biomass outside of the plot.
12. Clip and sort all herbaceous aboveground biomass rooted within the clip strip into the functional groups in **Table 11**. See SOP B.3 for common points of confusion and guidelines for problem plants, including *Toxicodendron*.
    - Do **NOT** clip herbaceous vegetation that passes through/leans over the clip strip but is not rooted in the strip (this includes non-woody vines; WST group is an exception, see third bullet below).
    - **DO** clip all herbaceous biomass of plants rooted within the strip > 1-2 cm in height. That is, include leaves in the harvest that exit the strip but originate from stems rooted within the strip.

- **DO** clip leaves and twigs of woody stemmed plants with ddh < 1cm that are produced in the current year AND originate from nodes that fall within the clip strip.
    - It is not necessary that the individuals are rooted in the clip strip; pay attention to nodes originating within the strip, not roots.
    - Nodes to look for are the furthest points along the stem, away from the actively growing tissue, where current year's growth is attached to previous years' growth.
    - Leaves produced in the current year that originate directly from previous years' growth should be clipped.
- Working in pairs, staff may split the clipping labor one of two ways:
    - Divide the 2 m clip strip into 1 m sections, label two bags for each herbGroup so that each technician has a set of bags, and then combine the biomass for each herbGroup when clipping is finished.
    - Divide the clipping labor among the herbGroups. For example, one person clips cool- and warm-season graminoids while a second person clips forbs and N-fixing plants.

BEST PRACTICE TIPS

- Target one **herbGroup** at a time.
- Clip slowly, and immediately sort clipped vegetation into labeled bags.
- Place full bags immediately into a cooler with cold packs.

13. When clipping is finished, group all bags from the current clipID into a larger 25# bag and return to the cooler.
14. Create a record in the Field Sampling app for the sampled **clipID**, and enter required plot-level sampling information:
    - **boutNumber**; for sites not managed for grazing:
        - boutNumber = 00 if sampling in Distributed Plots.
        - boutNumber = 01 if sampling in Tower Plots and there is only one bout scheduled for the site, or the current bout is the first of two scheduled bouts.
        - boutNumber = 02 if sampling in Tower Plots for the second of two scheduled bouts.
    - **plotID**; select from site-specific drop-down list, if using paper data sheets use SITE_### format.
    - **subplotID**; for all Distributed Plots and 20m x 20m Tower Plots, subplotID = 31. For 40m x 40m Tower Plots, subplotID = 21, 23, 39 or 41.

- **collectDate**; use *YYYYMMDD* format.
- **collectTime**; use HH:mm, 24-h time format. This is the ***local*** time the sample was placed in the cooler after clipping.
- **samplingCellNum**; ### format. This number is the last 3 digits of the clipID.
- **clipDimension**; the dimensions of the clip strip. Should be 2.0m x 0.1m; other dimensions are employed only during Agricultural Biomass sampling (RD[13]).
- **targetTaxaPresent**; record 'Y', as a 'N' answer would have been recorded in step (8).
- **samplingProtocolVersion**; select the version of the protocol used for sampling, typically the current released version.
- **hbpType**; select 'Non-agricultural'. hbpType = 'Agricultural' is only selected when implementing the Agricultural Biomass SOP (RD[13]).
- **Fresh Subsamples Created**; indicate 'N'. Fresh subsamples may only be created:
    - At grazed sites with herbGroup = ALL, following collaboration with Science to ensure subsampling generates representative data, or
    - When implementing the Agricultural Biomass SOP (RD[13]).
- **exclosure**; select 'N'. Exclosures are only present at grazed sites (SOP C).
- **sorted**; select 'Y'. Clip harvests at non-grazed sites are always sorted.
- **Herb Group Presence/Absence**; select the appropriate response for each herbGroup. When 'Present' is selected, a dryMass will be required in the Lab Mass app.
    - If using paper data sheets, circle the 3-letter codes in the **remarks** field for each herbGroup that is present.
- **remarks**; technician entered observations. E.g., 'Clip strip seasonally submerged in 10 cm water.'
- Scan **Herb Group Barcodes** if using optional barcode workflow. Link barcodes from each bag with subsamples in the Field Sampling app (each herbGroup is a subsample).
    - ***Note:*** Assigning barcodes to subsamples in the Field Sampling app allows you to scan a barcode and quickly find records in the Lab Mass app.
- **Finalize Record**; select 'N' when working in the field.
    - Records are only finalized when all fields have been populated, there is an internet connection, and you wish to sync and generate records in the downstream Lab Masses app for herbGroups from this **clipID**.

15. Save the record for the **clipID**, and proceed to the next plot or subplot.

16. **Finalize Records** when daily field work is complete, all fields have been populated with data, sample sorting has been quality checked by a botanist, and an internet connection is available.
    a. Open each record created in the field.
    b. **Finalize Record**; Select 'Y'.
    c. Save the record to auto-generate Lab Mass records for herbGroups from this **clipID**.
    d. Sync the tablet.

17. When sampling for a bout appears to be complete, cross-check with other teams and/or team-members to ensure that samples were collected from all scheduled **plotIDs/clipIDs**.

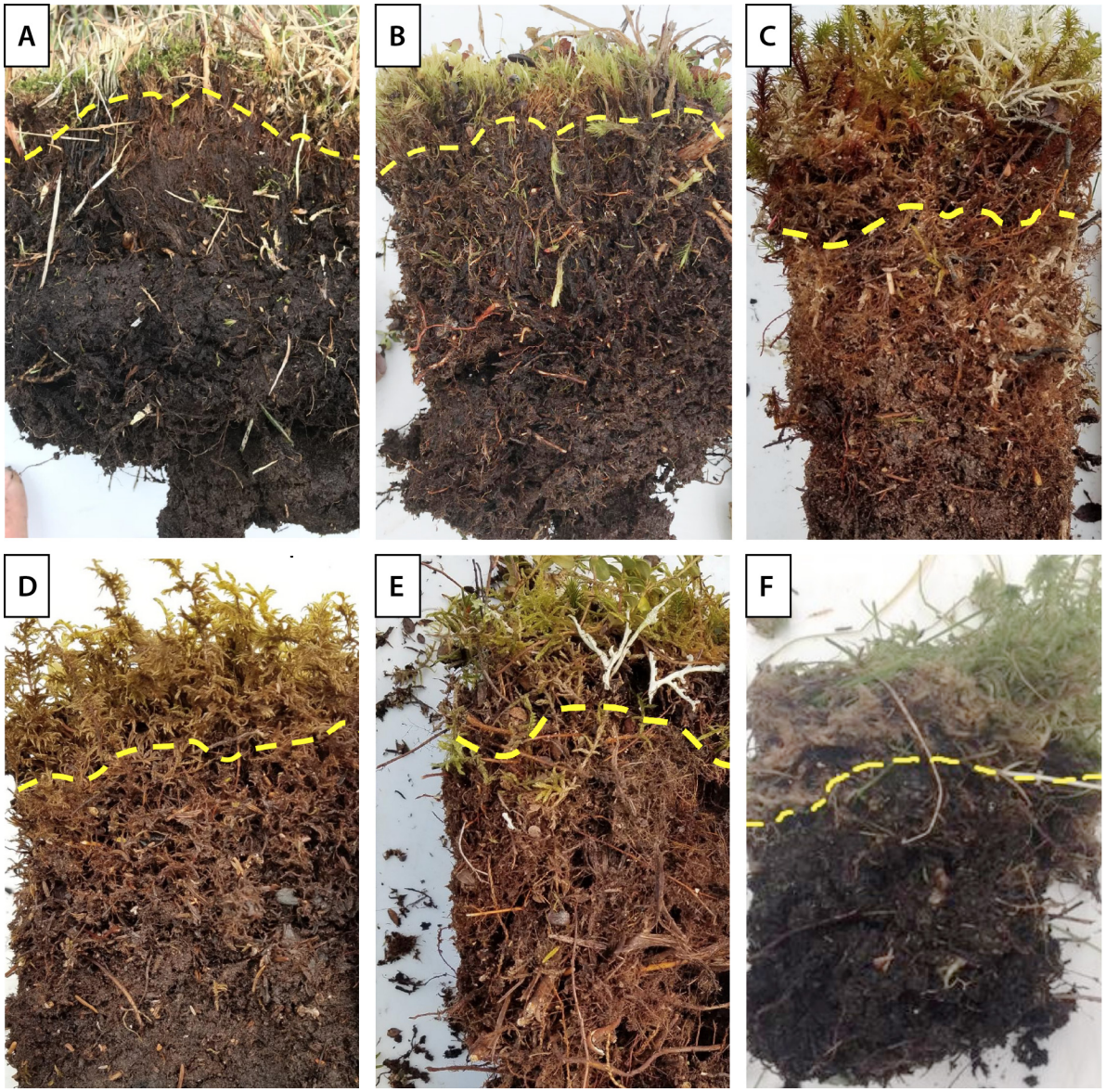

Figure 4. The start of the soil surface (dashed yellow line) at sites with ground cover dominated by bryophyte biomass. Bryophyte material above the yellow line should be clipped as part of this protocol. (A) BARR, (B) TOOL, (C) BONA, (D) DEJU, (E) HEAL, and (F) TREE. Soils collected by NEON during site characterization and in collaboration with NRCS.

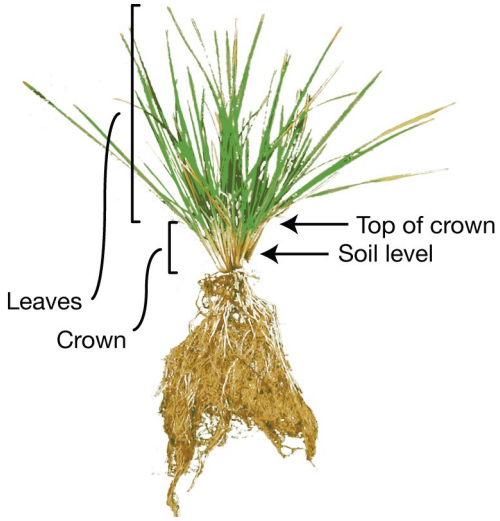

Figure 5. A perennial graminoid, showing the location of crown material relative to leaves and the soil surface.

B.3 Special Handling for Specific Plant Types

Table 12. Additional guidelines for plant growth forms that require special handling or consideration.

Growth Form	Guidelines
Barrel- and saguaro-type cactus species	DO NOT CLIP; clip around these plants.
Cholla- and pad-type cactus species	DO NOT CLIP for biomass; these plants are counted and measured with the Vegetation Structure protocol. Clip and remove pad cactus only if their presence hinders the removal of other herbaceous functional groups.
Toxicodendron spp.	• Follow the general guidelines established in TOS SOP: *Toxicodendron* Biomass and Handling (RD[14]) to minimize exposure to toxic oils. • Clip-harvest specific guidance is provided in APPENDIX F. • Label all bags that may contain *Toxicodendron* with the pictogram sticker shown at left.
Agave, Yucca, and related species	DO NOT CLIP; these plants are counted and measured with the Vegetation Structure protocol
Ferns	DO NOT CLIP; these plants are counted and measured with the Vegetation Structure protocol
Clumped plants (caespitose graminoids, large rosette forbs, tussock, etc.)	Clip only the part of the clump that is rooted within the clip strip. See training materials for examples.
Litter, prostrate on the ground	Ignore; prostrate litter material produced in a previous year is not sampled as part of this protocol.
Evergreen herbaceous plants for which distinguishing current-year from past-year growth is difficult	Do your best to distinguish current-year from past-year growth, and be conservative. Make sure all technicians make consistently similar decisions when clipping.
Epiphytes	DO NOT CLIP
Multiple rooting points, at least one of which is in the clip strip	Only clip biomass associated with rooting points located within the strip.
WST that are leguminous (N fixers)	Leguminous WST should be grouped in with the nitrogen-fixing functional group (NFX); the functional aspect of the grouping is more important than the morphological aspect.
Small sub-shrubs (e.g., Ericaceous plants) that are difficult to differentiate between WST or FRB	Use the USDA plants database as a consistent means of determining the growth form for a given species. If denoted a 'shrub' or 'sub-shrub' by USDA, classify as WST.
Tree seedlings	DO NOT CLIP; seedlings of species with the potential to become single- or multi-bole trees or small trees should not be clipped. (Optional) Create a site-specific list of common species and identifying traits.

B.4 Sample Preservation

- Keep paper bags with clipped vegetation in a cooler with cold packs to minimize wilting and to preserve diagnostic features for the post-harvest sort-check.
- Change cold packs for fresh ones every 12 h or transfer to a 4 ˚C refrigerator if a drying oven is not immediately available.
- Transfer bags to the drying oven as soon as possible after the post-harvest sort-check. Monitor drying progress with the “Lab Drying QC” datasheet.

IMPORTANT: Record the **collectDate** and **collectTime** in the Field Sampling app AND **ovenInDate** and time on both the sample bags and the Lab Masses app so that the number of hours the bags were stored cold can be automatically calculated.

SOP C Field Sampling with Grazing Management

Sites that are 'grazed' are actively managed for livestock grazing. This SOP should not be implemented at sites that experience grazing from native herbivores.

Goals

- Harvest two clip strips per plot or subplot per bout.
    - One clip strip per plot or subplot is protected from grazing with a grazing exclosure.
    - Another clip strip per plot or subplot is exposed to the managed level of grazing.
    - The Clip List provides the randomized list of potential clip-harvest strips per plot or subplot, and also indicates which clip strips have already been harvested or rejected.
- Use the Clip List to place exclosures at a random location prior to current-season grazing onset.
- After each clip-harvest sampling event, move the exclosure to the next random location, and clip according to the interval specified in APPENDIX D.
- Clip on the specified interval ONLY when livestock are present AND plants are actively growing.
- Sort all bouts to remove the 'OSD' functional group.
- Sort clipped biomass to additional functional groups for the bout scheduled closest to peak biomass (APPENDIX D). If there are multiple biomass peaks, the time point with the highest peak biomass is selected for functional group sorting.

EXCLOSURE DEPLOYMENT RESTRICTION:

- ***Exclosures must NOT be deployed in the 4 Tower Plots that support Plant Diversity and Biogeochemistry sampling (soil and canopy).*** Ferrous metals may interfere with soil biogeochemistry measurements.
- ***Maintain a distance of ≥ 2 m between exclosures and Litterfall traps (elevated and ground).*** Use sampling cell maps in Appendix G.1 to pre-emptively avoid cells within 2 m of litter traps. A remark may be added to the Clip List to identify sampling cells that are too close to traps.

Several common scenarios that affect grazing exclosure deployment are listed in

Table 13.

Table 13. Appropriate exclosure strategies for different grazing management scenarios.

Grazing Management Scenario	Required Actions
Animals are stocked after senescence has occurred, and removed before plants begin to grow again the next season	Not necessary to deploy exclosures
A portion, but not all, of the Tower Plots are managed for grazing	• Record plots affected by grazing in the Site Management app. • Place exclosures only over those Tower plots that are actively managed for grazing. • The peak biomass clip that is sorted to functional group is clipped at the same time as other Tower Plots.
A portion of the Tower Plots, or all of the Tower Plots, are grazed intermittently	• Record grazing periods in the Site Management app, to the best of your knowledge. • At the beginning of the season, deploy exclosures in all Tower Plots that may be grazed. If it is unclear which Tower Plots will be grazed, be conservative and install exclosures. • Actively monitor presence of livestock, and begin every clipping in a given plot the next bout after livestock arrive. • Clipping under exclosures is not required for a given plot if livestock have been absent from the plot for the entirety of the previous interval between bouts.
Animals are stocked year-round	• Record in the Site Management app • Deploy grazing exclosures year-round, even if sampling bouts cannot be performed in the absence of seasonal labor.

C.1 Sample Collection at Grazed Sites

1. Navigate to the plotID to be sampled (using the GPS if necessary).
2. Locate the desired clip strip for sampling.
    - For the clip strip without an exclosure, find the SW corner of the clip strip using the method described in SOP B.
    - For the clip strip under the exclosure, delineate a 2.0m x 0.1m area centered under the previously placed exclosure.
3. If there is no herbaceous biomass in a clip strip, AND the clip strip is deemed representative of the plot:
    - Create a record for the **clipID**, and record 'targetTaxaPresent = N'; save the record.

- If using paper data sheets, circle 'ttP = N' in the **remarks** field.
- Proceed to the next **clipID** within the plot, or if no additional **clipIDs** require sampling in this plot, return to step (1); if 'ttP = Y', continue to the next step.

4. Perform clip harvest as in SOP B.

   For bouts at grazed sites that are NOT sorted to functional group but still must be sorted to remove OSD, a subsampling approach may be employed to sort OSD from a representative portion of the total fresh sample. See APPENDIX E for the list of subsampling-approved sites, and approved subsampling levels.

   To subsample:

   a. When clipping is complete, thoroughly mix all biomass from the **clipID** to homogenize as completely as possible. For large amounts of biomass, or when there is more than one bag of biomass from the **clipID**, use a large bag, box, tray or equivalent vessel to mix the biomass.
   b. Tare a spring scale with a bag large enough to hold the entire fresh sample. Make sure the scale is rated to accommodate weighing the entire fresh sample+bag.
   c. Place the entire fresh sample into the bag (current year + OSD), weigh, and record the **Fresh Mass** in grams, to the highest precision possible. You may temporarily write on the bag, or create a record in the mobile application (see next step).
      i. ***Example***: If the finest gradations on the scale are 10 g intervals, estimate and record mass to the nearest 5 g.
   d. Determine the desired subsample percent (APPENDIX E), and estimate the mass of the fresh subsample to create.
      - If the subsample target is X%, the final subsample mass should be between X% and X+5%.
      - ***Example***: The target is a 25% subsample, so the actual subsample should be between 25% – 30 %. Assuming **Fresh Mass** = 50 g, the final subsample mass should be between 12.5 g – 15 g.
   e. Based on the estimated subsample weight, affix a labeled and optionally barcoded bag to an appropriately sized spring scale, and tare. The bag should be able to hold the entire subsample.
   f. Haphazardly grab mixed biomass from the mixed fresh sample and place in the subsample bag until the target mass is achieved (current year + OSD).
   g. Weigh and record the **Sub Sample Fresh Mass**, in grams, to the highest precision possible.
   h. Retain the labeled subsample bag and place in cold storage for further laboratory processing (SOP E). The remaining sample fresh mass may be discarded.

5. If not created above, create a record in the Field Sampling app for the sampled **clipID**, and enter required plot-level sampling information, as indicated below.
    - **boutNumber**; for sites managed for grazing:
        - **boutNumber** = 01, 02, 03, etc. and is assigned by Field Operations, incrementing with each bout.
        - Values of **boutNumber** reset every year.
    - **plotID**; select from site-specific drop-down list, for paper date sheets use SITE_### format.
    - **subplotID**; for 20m x 20m Tower Plots, subplotID = 31. For 40m x 40m Tower Plots, subplotID = 21, 23, 39 or 41.
    - **collectDate**; use HH:mm, 24-h time format. This is the ***local*** time the sample was placed in the cooler after clipping.
    - **samplingCellNum**; ### format. This number is the last 3 digits of the clipID from the Clip List.
    - **clipDimension**; the dimensions of the clip strip. Should be 2.0m x 0.1m; other dimensions are selected only during Agricultural Biomass sampling (RD[13]).
    - **targetTaxaPresent**; record 'Y', as a 'N' answer would have been recorded in step (3) above.
    - **samplingProtocolVersion**; select the version of the protocol used for sampling, typically the current released version.
    - **hbpType**; select 'Non-agricultural'. hbpType = 'Agricultural' is only selected when implementing the Agricultural Biomass SOP (RD[13]).
    - **Fresh Subsamples Created**; choose 'Y' or 'N'. Select 'Y' only if a site-specific subsampling modification is approved for the site AND **sorted** = 'N' (APPENDIX E).
    - **exclosure**; choose 'Y/N', depending on exclosure presence/absence over the clip strip.
    - **sorted**; choose 'Y/N'. Clip harvests at grazed sites are sorted during the peak biomass bout(s), otherwise select 'N'.
        - ***!!! Note*:** All bouts are sorted to remove OSD from current year biomass, and this sorting is not relevant to the choice made here.
    - **Fresh Mass**; the fresh mass of the entire sample, including OSD, in grams. Record to the highest precision possible; use tared spring scale of appropriate size.
        - Data are only recorded when **Fresh Subsamples Created** = 'Y', and **sorted** = 'N'.
    - **Sub Sample Fresh Mass**; the fresh mass of the subsample, including OSD, in grams. Record to the highest precision possible; use tared spring scale of appropriate size.
        - Data are only recorded when **Fresh Subsamples Created** = 'Y', and **sorted** = 'N'.
        - The size of the subsample is site-specific (see APPENDIX E).

- **Herb Group Presence/Absence**; select the appropriate response for each herbGroup.
    - Presence/Absence data for herbGroups are only recorded at grazed sites during the peak biomass bout(s) with **sorted** = 'Y'.
    - When 'Present' is selected for a herbGroup, a **dryMass** will be required in the Lab Mass app.
    - If using paper data sheets, circle the 3-letter codes in the **remarks** field for each herbGroup that is present.
- **remarks**; technician entered observations. E.g., 'Livestock manure in clip strip'.
- Scan **Herb Group Barcodes** if using optional barcode workflow.
    - ***Note:*** Assigning barcodes to subsamples in the Field Sampling app allows you to scan a barcode and quickly find records in the Lab Mass app.
- **Finalize Record**; select 'N' when working in the field.
    - Records are only finalized when all fields have been populated, there is an internet connection, and you wish to generate records in the downstream Lab Masses app for herbGroups from this **clipID**.

6. Save the record for the **clipID**.
7. If you have finished harvesting a clip strip that was protected by a grazing exclosure, move the exclosure to the next suitable clip strip location on the Clip List.
8. Stake the exclosure to the ground, and proceed to the next plot or **clipID** within the same plot.
9. **Finalize Records** when daily field work is complete, all fields have been populated with data, sample sorting has been quality checked by a botanist, and an internet connection is available.
    a. Open each record created in the field.
    b. **Finalize Record**; Select 'Y'.
    c. Save the record to auto-generate Lab Mass records for herbGroups from this **clipID**.
    d. Sync the tablet.
10. When sampling for a bout appears to be complete, cross-check with other teams and/or team-members to ensure that samples were collected from all scheduled **plotIDs/clipIDs**.

C.2 Troubleshooting

Table 14. Potential issues encountered during Herbaceous Biomass sampling at grazed sites, and issue resolution.

Issue	Resolution
Exclosure placed over > 1 sampling cell	• Clip herbaceous biomass from a clip strip centered under the exclosure. • Mark the affected cells as sampled on the Clip List.
Exclosure placed over incorrect sampling cell(s)	• Clip herbaceous biomass under the exclosure. • Mark the affected cell(s) as sampled on the Clip List.
Exclosure placed within buffer area	• Do not clip herbaceous biomass, as there is no clipID for this location. • Move exclosure to next suitable sampling cell on the Clip List.
Exclosure placed over 10 m^2 nested subplot	• If nestedSubplot supports Plant Diversity: Avoid trampling, do NOT clip, and move exclosure to next suitable sampling cell on the Clip List. • If nestedSubplot does NOT support Plant Diversity: Clip herbaceous biomass, and look up the samplingCellNumber from APPENDIX G.

C.3 Season Wrap-Up at Grazed Sites

At sites managed for seasonal grazing, there are several options when it comes to storing grazing exclosures for next season's use after grazing has ceased in the current season:

- **Offsite**:
  - The Domain Support Facility is always an acceptable location for storing exclosures provided there is outdoor space available that can be used within the bounds of the lease agreement, and that the storage location is reasonably secure.
  - A self-storage location may be used if sufficient budget is available.
- **Onsite, within plot**:
  - At sites with no winter snow accumulation, and with site host approval:
    - It is acceptable to move the exclosure to the next qualifying sampling cell location within the plot at the conclusion of the last bout managed for grazing for the season.
    - The exclosure will remain over the next targeted sampling cell until herbaceous biomass harvesting begins again the following season.
- **Onsite, outside plot**:
  - With site host approval, it is acceptable to store exclosures within the pasture, but outside the plot – e.g., stacked along a fence line.
  - With site host approval, exclosures may also be stored onsite, but away from the pasture – e.g., exclosures may be stacked near outbuildings, along the outside of fences near the plots, etc.
  - Care must be taken to ensure that exclosures are stacked and positioned such that any snow drifts that may accrue over winter do not influence plot vegetation or become problematic obstacles.

SOP D Post-Field Sampling Tasks

D.1 Check Sorting of Clipped Biomass

Goals

- ***Within 24-h of harvest,*** check bags of field-sorted biomass for sorting accuracy.
- Verify the growth habits of potentially problematic taxa using the USDA plants database – e.g., prostrate woody shrubs may initially appear to be forbs.
- Remove any litter produced in a previous year from material produced in the current year. The most common error, particularly for clip-harvests performed late in the growing season, is to confuse material that was produced in the current year and has already died with material that was produced in a previous year.
- Remove any material produced in the current year that belongs in another biomass group. For example, N-fixing forbs (NFX) should not be mixed with forbs (FRB).
- It is not necessary to check sorting accuracy for bags with herbGroup = OSD. The OSD material is used as a reference during the laboratory sort-check, and is then discarded.
- For bouts with herbGroup = ALL from grazed plots that are NOT sorted to functional group, a subsampling approach is approved for the sites listed in APPENDIX E.

To check clipped biomass sorted to functional group:

1. Select a 25# kraft bag (or bags) containing all of the biomass from a given clipID.
2. Make sure that all bags from a given clipID are collated in the correct 25# kraft bag(s).
3. Choose a smaller bag containing clipped biomass from one herbGroup only, and carefully check the biomass that was sorted in the field.
4. Set aside biomass that does not belong in the bag into separate piles (i.e. one pile for each herbGroup).
5. Place any previous years' litter into the 'OSD' bag.
6. Place sorted, checked biomass back into the original bags.
7. Clean the work area of any debris, and proceed to the next herbGroup from the same clipID, sorting again as in step (3).
8. Once all herbGroups have been checked for sorting accuracy, place piles of resorted biomass into the appropriately labeled herbGroup bags, and place all smaller bags back into the 25# bag(s).
    - Exception: Discard the OSD bag.
9. Label the 25# bag(s) with **ovenStartDate/Time** and place into the drying oven (SOP E), or return to the cooler for continued temporary storage.

10. Clean the workspace, and proceed to checking herbGroup bags from the next clipID.

To process clipped biomass NOT sorted to functional group for a grazing bout:

1. Select bags containing biomass samples or subsamples from a given **clipID**.
2. Sort current-year biomass from OSD. OSD may be discarded at this point.
3. Label the bag(s) of current-year biomass with **ovenStartDate/Time** and place into the drying oven (SOP E), or return to the cooler for continued temporary storage.
4. Clean the workspace, and proceed to checking bags from the next clipID.

BEST PRACTICE TIPS

- The lead plant technician or botanist should spot-check 10% of the re-sorted biomass piles before they are re-bagged.
- Spot-checks from a person skilled in plant species identification is particularly important early in the field season when seasonal field technicians may be less familiar with local flora.

D.2 Refreshing the Sampling Kit

- Make sure the following consumables are available in sufficient quantity for the next round of clip-harvests:
  - Paper bags, 8# and 25# kraft (or the necessary size given site vegetation stature)
  - Rite-in-the-Rain paper for printing field datasheets
  - Permanent markers for labeling bags in the field
- Return cold packs to the -20 ˚C freezer to refresh.

D.3 Equipment Maintenance and Cleaning

- Clean blades of hand clippers with an appropriate solvent (oil, ethanol, water), and dry thoroughly.
- Recharge batteries for the GPS unit (if necessary).
- Recharge batteries for the TruPulse (if applicable).

D.4 Data Management

- Sync all tablets upon return to the Domain Support Facility or Field House
- Tablets should be synced before any additional Lab Mass edits are made.
- See RD[04] for additional Data Management guidelines that pertain to this protocol.

SOP E Laboratory Processing of Herbaceous Biomass Samples

Goals

- Place clipped herbaceous biomass into the drying ovens as soon as possible following the post-field-sampling sort check.
- Verify that biomass is dry using the Multi-Protocol Drying Datasheet.
- Weigh dried biomass and record mass in the *HBP: Lab Masses [PROD]* app.
    - **SOP E.1:** Biomass sorted to functional group:
        - Fields for **Fresh Mass**, **Sub Sample Fresh Mass** and **Sub Sample Dry Mass** are left blank.
        - Record **Input Dry Mass** of entire clipped functional group.
    - **SOP E.2:** Biomass from grazed site not sorted to functional group:
        - Values for **Fresh Mass** and **Sub Sample Fresh Mass** are recorded in the field (SOP C).SOP C).
        - Record **Sub Sample Dry Mass** (current year only, no OSD).
        - Values of **Dry Mass** are calculated automatically.
- Obtain and record QA Dry Mass values for 10% of samples.

E.1 Drying and Weighing Herbaceous Biomass Sorted to Functional Group

1. Label each 25# bag (with smaller bags for each herbGroup inside) with the date and time it is placed in the drying oven.
    - These data are the **ovenInDate** and time required during data entry.
    - ***!!! Critical step***: Labeling or marking groups of bags allows assessment of how long different batches of bags have been in the oven, especially when harvests from multiple days occupy the same oven.
2. Place 25# bags into a **65 ˚C drying oven for 48h – 120h (2d – 5d)**.
3. After placing bags in the oven, check the drying progress of clipped biomass using a subset of 10 herbGroup samples, and the 'Multi-Protocol Drying Datasheet'.
4. Check the weight of the same selected subset of n=10 herbGroup sample bags per **ovenInDate** after day 1, 2, 3, etc. Record these weights each day on the 'Multi-Protocol Drying Datasheet'.
    - Plant material may be weighed WITH the bag for this part of the procedure.
    - Check the drying progress of the heaviest bags; these will likely take the longest to dry.
5. Calculate the difference in weight between the latest two time points for each bag.

6. Samples are dry when either of the following is true:
    - The average weight difference between the latest two timepoints = 0 (averaged across all n=10 bags, ± 0.1 g), or
    - The average weight difference is within ± 1% of the previous timepoint mass.

DRYING TIPS

- Organize bags in the oven by **ovenStartDate/Time** to facilitate monitoring. Keep bags selected for monitoring accessible in the oven.
- A spreadsheet calculator is useful for calculating the average weight difference. Ask your lead technician how to access the calculator already created by Field Science staff.
- If there are ≥ 10 25# bags from a single **ovenStartDate**, save time and weigh larger 25# bags from a given clipID that contain all of the smaller herbGroup bags for that clipID. It is not necessary to remove and weigh individual bags for a single herbGroup when there are ≥ 10 25# bags (write herbGroup = 'ALL' on the Multi-Protocol Drying Datasheet).
- ***Note:*** It may be more difficult to meet the definition of 'dry', above, when weighing larger 25# bags.

7. Remove bags of dried biomass from the drying oven, and label bags with **ovenEndDate**/Time.
    - After removing from the drying oven, dried plant material should be weighed as soon as it has cooled to room temperature; it will absorb moisture from the air if left in ambient room conditions (particularly in humid environments).
        - If using this method, it is helpful to remove bags from the oven and weigh one at a time.
        - Samples may also be cooled in a desiccator or sealed garbage type-bag or equivalent.
    - Dried samples may also be stored for up to 30 days in ambient room conditions prior to weighing. Samples treated in this manner must be returned to the drying oven for 24 h prior to weighing, and must be weighed as above after removal from the oven.
        - If samples were initially dried and kept in storage, it is not necessary to record any additional drying times.
8. Weigh biomass from each herbGroup from each clipID using a mass balance (0.01 g accuracy) and a large weigh boat, and enter required data for ingest.
    a. For large volumes of biomass that do not readily fit into a large weighboat, use the following strategies:
        i. Use a large plastic tray (or equivalent) instead of a weigh boat (see equipment list).

ii. Crush or chop the biomass to reduce volume so it will fit into a weigh boat.

iii. Avoid splitting the biomass into subgroups for weighing, as uncertainty values must be added each time a subgroup is created.

b. If using optional barcodes:
   i. Open the Herbaceous Clip Harvest Lab Masses app, and scan the barcode on the bag to bring up the record associated with the **sampleID**.
   ii. In the child record/list view of the application, scan the barcode again to bring up the **herbGroup** (child record/subsampleID), or manually select the correct **herbGroup**.
      - The application should now only show the record with the barcode value you scanned.

c. Otherwise, open the Herbaceous Biomass Lab Masses app, manually find and open the record for the **sampleID**, then open and edit the correct **herbGroup** (subsampleID).

d. Enter **Input Dry Mass** to the nearest 0.01 g, current-year plant material ONLY (without the bag).
   i. For very light samples < 0.01 g, record **Input Dry Mass** = 0.005 g.

9. Enter and/or check required metadata for each sample in the Herbaceous Biomass Lab Masses application:

- In the parent-level **clipID** record, check:
  - **collectDate**; date biomass was clipped in the field.
  - **Bout**; For Tower Plots, 01, 02, 03, etc. For Distributed Plots, Bout = 00.
  - **Sampling Cell Number**; last three digits of the **clipID**.
- In the child-level **herbGroup** record, check or enter:
  - **Oven Start Date/Time**; date and time (24-h format) the sample was initially placed in the drying oven.
    - Record only for initial drying event. Do not record additional dates/times for samples stored at room temperature, and then re-dried prior to weighing.
  - **Oven End Date/Time**; date and time the sample was initially removed from the drying oven.
  - **Weigh Date;** use *YYYYMMDD* format; date sample was weighed in the laboratory.

10. Save the child-level **herbGroup** record.

11. Once **Dry Mass** has been recorded for each 'Present' herbGroup, **QA Dry Mass** records may be created by a different staff member for a subset of samples (SOP E.3), or return biomass to temporary storage at ambient conditions. Samples in temporary storage can then be weighed for QA as time permits.

12. When all child-records have been updated with **Dry Mass** values and saved (including child-records for those herbGroups marked 'Not Present' in the field, save the parent-level **clipID** record.

E.2 Drying and Weighing Herbaceous Biomass Not Sorted to Functional Group at Grazed Sites

1. Weigh dried subsamples from each **clipID** using an electronic scale, and a weigh boat.
    a. If using optional barcodes:
        i. Open the Herbaceous Clip Harvest Lab Masses app, and scan the barcode on the bag to bring up the record associated with the **sampleID**.
        ii. Scan the barcode again to bring up the **herbGroup** = ALL record (child record/subsampleID), or manually select the **herbGroup =** ALL record.
    b. Otherwise, open the Herbaceous Biomass Lab Masses app, manually find and open the record for the **sampleID**, then open and edit the **herbGroup** = ALL child record (subsampleID).
    e. Enter **Sub Sample Dry Mass** to the nearest 0.01 g, current-year plant material ONLY (without the bag).
        i. For very light samples < 0.01 g, record **Sub Sample Dry Mass** = 0.005 g.
    f. **Dry Mass** values are automatically calculated by the Lab Masses app.
2. Enter and/or check required metadata for each sample, as above.
3. Save the child-level **herbGroup** = ALL record.
4. Do NOT create **QA Dry Mass** records when subsampling is performed. Return biomass to temporary storage at ambient conditions.
5. When all child-records have been updated with **Sub Sample Dry Mass** values (there should be only one), save the parent-level **clipID** record.

E.3 QA For Dry Mass Data

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

QA is not performed when subsampling is implemented at grazed sites not sorted to functional group. For all other bouts:

1. Per unique boutNumber for each site, select 10% of dried, previously weighed samples for re-weighing.
    - If QA weighing does not occur within one hour of the initial weighing, return the selected samples to the drying oven for 24 h prior to QA weighing. In humid environments, samples will pick up moisture from the atmosphere (especially bryophytes).
2. Within a randomly selected parent-level **clipID** record:
    a. *Create a **new** child-level **QA Dry Mass** record*, and randomly select an **herbGroup** for re-weighing.
        i. New child records will automatically default to **qaDryMass**=Yes
    b. Enter the re-weighed mass in the **Dry Mass** field to the nearest 0.01 g.
3. Return plant material to temporary storage.
    - Samples may be discarded only when data have been successfully ingested into the NEON CI database, and all errors reported by the ingest system have been resolved.

SOP F 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 field day, where possible; alternatively, devices should be synced immediately upon return to the Domain Support Facility.

However, 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.

F.1 Digital Data Workflow

Plot-level data collection in the field:

- The **clipID** and **collectDate** fields are used to construct the sampleID for the plot and the subsampleID for each **herbGroup**.
    - *Make SURE these are entered correctly before finalizing each field record.*
- Finalizing the field record for a **plotID** and syncing will automatically create records in the Lab Masses app for each **herbGroup**.
    - If corrections to either the **clipID** and/or the **collectDate** are required, and the Field app record has already been finalized and synced, you will need to open, edit, and save each child record in the Lab Mass app in order to update the automatically created **subsampleID**.
    - Consult the Herbaceous Biomass Fulcrum User Manual on the SSL for more detail.

Lab Mass data:

- The Herbaceous Biomass Field Sampling app automatically creates a Lab Masses record for each **herbGroup** per **clipID**.
- These auto-created records must be edited and saved to add **Dry Mass** data.
- Records for which **herbGroup** presence = ‘N’, as assigned in the Field Sampling app, automatically have **dryMass** = 0 g, and must simply be opened for editing and then saved in the Lab Masses app.

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.

F.2 Field Data

1. Update permanent digital versions of the Clip List with **date** and **status** data recorded in the field.
2. If using paper "Field" data sheets:
    a. If a representative clipID contained no herbaceous biomass, noted by circling 'ttP = N' in the **remarks** of the Field Data Sheet, enter in the Field ingest app:
        - **targetTaxaPresent** = 'N'
    b. If **targetTaxaPresent** = 'Y', additionally account for the presence/absence of each **herbGroup** in the Field ingest app, as noted in the **remarks** field on the paper data sheet.

F.3 Lab Data

1. Transcribe data from the "Lab Weighing" data sheet to the "Lab Mass" ingest app by editing automatically-created records for each **herbGroup** per **clipID**. Save each record once **dryMass** dta have been entered.

F.4 Quality Assurance

Data Quality Assurance (QA) is an important part of data collection and ensures that all data regarding observations and samples are accurate and complete. This protocol requires that certain QA checks be conducted in the field (i.e., before a field team leaves a plot or site), while others can be conducted at a later date in the office (typically within a week of collection).

Field QA procedures are designed to prevent the occurrence of invalid data values that cannot be corrected at a later time, and to ensure that data and/or sample sets are complete before a sampling window closes. Incomplete data and/or sample sets cannot be supplemented by subsequent sampling efforts if the sampling window has closed. Invalid meta-data(e.g. collection dates, plotIDs) are difficult to correct when field crews are no longer at a sampling location.

Office QA procedures are meant to ensure that sampling activities are ***consistent*** across bouts, that sampling has been carried out to ***completion***, and that activities are occurring in a ***timely*** manner. The Office QA will also assess duplicated data and transcription errors to maintain data ***validity*** and ***integrity***.

All QA measures needed for this protocol are described in the Data Management Protocol (RD[08]).

SOP G Sample Shipment

The Herbaceous Biomass protocol does not generate samples that require shipping.

8 REFERENCES

Didan, K. 2015. MOD13Q1 MODIS/Terra Vegetation Indices 16-Day L3 Global 250m SIN Grid V006. NASA EOSDIS Land Processes DAAC. https://doi.org/10.5067/MODIS/MOD13Q1.006.

The Nutrient Network Experimental Protocol page (http://www.nutnet.umn.edu/exp_protocol). Accessed 2013-09-19.

APPENDIX A DATASHEETS

Table 15. Datasheets associated with this protocol

NEON Doc. #	Title
NEON.DOC.001574	Datasheets for TOS Protocol and Procedure: Measurement of Herbaceous Biomass

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

APPENDIX B QUICK REFERENCES

B.1 Delineating the Clip Harvest Strip

LOCATE AND ASSESS POTENTIAL CLIP AREA

STEP 1 – Locate southwest corner of sample plot - plot coordinate (0,0)

STEP 2 – Select first available clip strip location from the Clip List. Be sure to check if Belowground Biomass Core sampling has already occurred in the current season, and choose clip strips accordingly.

STEP 3 – Locate the offsetEasting coordinate, anchor and stretch east-west tape, place pin flag.

offsetNorthing coordinate	East-West Tape Location
1.5, 4.5, or 7.5	(0,0) →(20,0)
10.5, 13.5, or 16.5	(0,10) →(20,10)

STEP 4 – Locate the offsetNorthing coordinate with TruPulse in HD mode (azimuth 0°), place pin flag.

STEP 5 – Assess suitability of clip strip. Relocate 15 cm west or east OR reject if not suitable.

STEP 6 – (If applicable) Record clip-strip 'status' on Clip List, and remove and relocate exclosure to next suitable random location.

DELINEATE 0.1 M X 2 M CLIP STRIP

STEP 1 – Place north-south oriented string-and-stake set on west side of clip strip. Use TruPulse to orient string.

STEP 2 – Place second string-and-stake set EXACTLY 10 cm to the east of first set.

STEP 3 – Check distance between strings at both ends with ruler.

PREPARATION

STEP 1 – If cactus are present, remove and discard only those cactus pads that would physically prevent clipping herbaceous biomass.

B.2 Clipping and Sorting

STEP 1 – Label 8# kraft paper bags (lunchbag size), use multiple bags as needed.

STEP 2 – Clip biomass ROOTED in clip strip area, sorting vegetation into coded bags as you go.

STEP 3 – Record on Field Datasheet the total number of bags harvested per clip strip.

Label Information

- boutNumber
- date
- clipID
- exclosure (Y or N)
- herbGroup (3 letter code)
- bagNumber (e.g. 2 of 3)

STEP 4 – Place all 8# bags from single clip strip into one labeled 25# bag.

STEP 5 – Store bag in cooler with cold packs (or sealed ice) for transport back to lab.

STEP 6 – Transfer clip bags to 4° C refrigerator in domain lab (if possible).

STEP 7 – Check sorting at end of day or next morning in lab.

STEP 8 – Confer with lead plant technician to check that all biomass is correctly sorted.

STEP 9 – Place clipped biomass in a drying oven as soon as possible after clipping and sorting.

STEP 10 – On the appropriate datasheets or on the bag, record the **collectDate** and time biomass was placed in the cooler in the field, as well as the **ovenStartDate**/Time that biomass was placed in the drying oven.

QUALITY DATA DEPEND ON PROPER:

- Sorting into groups.
- Separation of previous and current years' growth.
- Labeling of all samples.

CLIPPING GUIDELINES

- Only clip biomass ROOTED in the clip strip area (with the exception of WST).
- Sort clipped vegetation into appropriate bags as you go.
- Clip as close to the ground as possible (i.e., 1-2 cm above ground).
- DO NOT CLIP crowns of perennial grasses, as this will kill or damage the plant.
- Do not clip ANY cactus unless required to access herbaceous vegetation; see **Table 12** for cactus species that are NEVER clipped.
- Clip qualifying *Toxicodendron spp.* according to APPENDIX F.

APPENDIX C REMINDERS

Collecting Quality Biomass Data with the Clip Harvest Technique

At the plot: Be sure to…

- ☑ Avoid walking on targeted clip area, plant diversity subplots, and area surrounding plot centroid.
- ☑ Assess suitability of potential clip strip and accurately delineate.
- ☑ Relocate exclosure to next suitable location, if applicable.
- ☑ Fill out 'status' for sampled or rejected clip-harvest locations on Clip List

Clip harvesting: Be sure to…

- ☑ Clip and discard pad-forming cactus only if necessary.
- ☑ Fill in Field Datasheet and check that all bags are accounted for.
- ☑ Store bags in cooler or refrigerator at all times prior to oven drying.
- ☑ Check sorting in lab at end of field day or next morning.
- ☑ Confer with lead plant technician to check biomass functional group sorting.

Functional Group Name	Biomass Code
Bryophtyes (not lichens), see **Figure 4**	BRY
Cool-season graminoids (C3)	CSG
Warm-season graminoids (C4)	WSG
Nitrogen-fixing plants	NFX
Forbs (non N-fixing)	FRB
Woody-stemmed plants, ddh < 1.0 cm	WST
Previous years' old standing dead	OSD
Unsorted herbaceous biomass, potentially containing all functional groups	ALL

Using the Laser Rangefinder: Pay close attention to…

- ☑ Declination – Is it set for your current location?
- ☑ Selection choices in drop-down menu.
- ☑ Battery charge (replace when low-charge indicated).
- ☑ Transcription of measurements onto data sheet.
- ☑ Metal objects – Keep them at least 2 feet away from instrument when using internal compass.

APPENDIX D SITE-SPECIFIC SAMPLING DATES, BOUT NUMBERS, AND TOWER PLOT NUMBERS

The dates in the table below are estimated from satellite MODIS-EVI phenology data averaged from 2005-2014 (Didan 2015). For sites that are not grazed, dates correspond to the average date after which greenness begins to decrease at each site. By using the average greenness decrease date, we ensure that there is a high probability that all herbaceous biomass has been produced for the current season prior to clipping. For grazed sites, start dates correspond to green-up dates, and it is assumed that cows are present from this point forward. These dates are only a guide, 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.

At sites managed for grazing, Distributed Plots should be clip-harvested at approximately the same peak biomass date that functional groups are sorted in the Tower Plots (see "Additional Sampling Information" field in the table below).

Assessment of grazing management is accurate as of the publication date of this protocol; however, grazing management status may change, and must be assessed by the Domain Manager in consultation with the site host and/or grazing lessees.

Table 16. Site-specific grazing status, bout number, per bout sampling start dates, Tower Plot number, and additional site-specific sampling guidance for herbaceous clip-harvest.

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Tower Plot Number	Additional Sampling Information
01	BART	No	1	D: 07/17 T: 07/17	20	Timing reflects observed senescence dates for herbaceous understory, not MODIS-EVI data.
	HARV	No	1	D: 07/17 T: 07/17	20	Timing reflects observed senescence dates for herbaceous understory, not MODIS-EVI data.
02	BLAN	No	1	D: 07/13 T: 07/13	10‡	Dates are for peak biomass harvested in Dist Plots, and Tower Plots. Dates for agricultural Dist Plots in RD[13.]
	SCBI	No	1	D: 08/03 T: 08/03	20	
	SERC	No	1	D: 08/09 T: 08/09	5‡	Dates for Distributed Ag plots provided in RD[13].
03	DSNY	No	1	D: 07/19 T: 07/19	20‡	
	JERC	No	1	D: 08/10 T: 08/10	20	

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Tower Plot Number	Additional Sampling Information
	OSBS	No	1	D: 07/15 T: 07/15	20	
04	GUAN	No	2	D: 10/15 T: 10/15	20	Sampling dates based on precipitation data, not MODIS-EVI; very little change in EVI throughout the year.
	LAJA	Yes	D: 1 T: Every 4 weeks	D: 10/15 T: 01/01 – 12/31	10‡	Dates for Ag plots in RD[13]. Non-Ag Dist Plots: dates coincide with autumn wet season. Tower Plots: Peak biomass sort for grazed plots is bout scheduled closest to 10/15 (similar date as Dist Plot sort).
05	STEI	No	1	D: 08/08 T: 08/08	17	
	TREE	No	1	D: 08/07 T: 08/07	20	
	UNDE	No	1	D: 08/08 T: 08/08	20	
06	KONA	No	1	D: 07/31 T: see RD[13]	30	Dist Plots: date is for non-Ag plots; see RD[13] for Ag Dist and Tower Plot dates.
	KONZ	Yes	D: 1 T: Every 8 weeks	D: 07/30 T: 04/02 – 11/03	10‡	End sampling by senescence (estimate of 11/03), or when livestock removed. Tower Plots: Peak biomass sort for grazed plots is bout scheduled closest to 07/30.
	UKFS	No	1	D: 07/28 T: 07/28	20	
07	GRSM	No	1	D: 08/03 T: 08/03	20	
	MLBS	No	1	D: 08/08 T: 08/08	16	
	ORNL	No	1	D: 07/24 T: 07/24	20	
08	DELA	No	1	D: 07/17 T: 07/17	20	
	LENO	No	1	D: 07/17 T: 07/17	10	
	TALL	No	1	D: 07/14 T: 07/14	20	

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Tower Plot Number	Additional Sampling Information
09	DCFS	Yes	D: 1 T: Every 4 weeks	D: 7/28 T: 04/30 – 10/11	30	Tower Plots: Peak biomass sort for grazed plots is bout scheduled closest to 7/28 (similar date as Dist Plot sort).
	NOGP	Yes	D: 1 T: Every 4 weeks	D: 07/21 T: 04/18 – 10/12	10‡	Tower Plots: Peak biomass sort for grazed plots is bout scheduled closest to 7/21 (similar date as Dist Plot sort).
	WOOD	Yes	D: 1 T: Every 4 weeks	D: 08/02 T: 05/05 – 10/09	10‡	Tower Plots: Peak biomass sort for grazed plots is bout scheduled closest to 8/02 (similar date as Dist Plot sort).
10	CPER	Yes	D: 1 T: Every 8 weeks	D: 07/26 T: 03/29 – 11/08	10‡	Tower Plots: Peak biomass sort for grazed plots is bout scheduled closest to 07/26 (similar date as Dist Plot sort).
	RMNP	No	1	D: 08/02 T: 08/02	9	
	STER	No	1 bout per crop, per growing season	RD[13]	10	See RD[13]
11	CLBJ	Yes	2	D: 10/01 T b1: 06/13 T b2: 10/01	30	Clip harvests every 4 weeks in grazed Tower Plots; peak biomass sort is bout closest to 10/01.
	OAES	Yes	2	D: 11/11 T b1: 06/13 T b2: 11/11	10‡	Clip harvests every 4 weeks in grazed Tower Plots; peak biomass sort is bout closest to 11/11.
12	YELL	No	1	D: 07/12 T: 07/12	20	
13	MOAB	Yes	D: 1 T: 1	D: 08/13 T: 08/13	10‡	Tower Plots: Exclosures deployed before stocking in spring, one peak biomass clip sorted to functional group for all clipIDs.
	NIWO	No	1	D: 08/10 T: 08/10	30	

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Tower Plot Number	Additional Sampling Information
14	JORN	No	1	D: 09/12 T: 09/12	30	Grazing not anticipated in Tower plots, but may occur. Domain Mgr communicates with site host to determine if Tower plots grazed.
	SRER	Yes	D: 1 T: 2	D: 09/02 T b1: 03/20 T b2: 09/02	18	Grazing intermittent in Tower Plots; all Tower Plots get two sampling bouts (two biomass peaks); for grazed plots, exclosures deployed before stocking in spring, and sorted to functional group for second biomass peak (bout 2). Domain Mgr communicates with site host to determine when/which Tower plots are grazed, no dates provided here.
15	ONAQ	No	1	D: 06/15 T: 06/15	30	
16	ABBY	No	1	D: 07/23 T: 07/23	13	
	WREF	No	1	D: 07/27 T: 07/27	20	
17	SJER	Yes	D: 1 T: Every 4 weeks	D: 04/06 T: 10/07 – 06/03	10‡	Tower Plots: Peak biomass sort for grazed plots is bout closest to 04/06 (similar date as Dist Plots).
	SOAP	No	1	D: 07/08 T: 07/08	20	
	TEAK	Yes	D: 1 T: Every 4 weeks	D: 07/27 T: 05/04 – 10/09	20	Tower Plot start date corresponds to green-up; if livestock not present this early, requirement is for exclosures to be deployed in affected plots before stocking. Tower Plot peak biomass sort is bout closest to 07/27 (similar to Distributed Plots). If livestock removed prior to 10/09, implement 1 bout after livestock removal, then suspend.

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Tower Plot Number	Additional Sampling Information
18	BARR	No	1	D: 07/27 T: 07/27	30	
	TOOL	No	1	D: 07/26 T: 07/26	30	
19	BONA	No	1	D: 07/26 T: 07/26	20	
	DEJU	No	1	D: 07/27 T: 07/27	20	
	HEAL	No	1	D: 07/28 T: 07/28	5‡	
20	PUUM	No	1	D: 05/21 T: 05/21	20	

* 'D' denotes 'Distributed Plots,' and 'T' indicates Tower Plots.

† A single date indicates the earliest desired start date for a given bout, and it is assumed that the sampling stop date is 14 days after the start date (see Section 4 for more details). A date range is provided for sampling start/stop in grazed Tower Plots.

‡ The recommended number of Tower Plots is less than the established number of Tower Plots; select the lowest Morton Order plots not used for BGC for sampling.

APPENDIX E SITE-SPECIFIC MODIFICATIONS

Domain	Site(s)	Modification Type	Modification	Standard Rule	Rationale for Change
D09	DCFS NOGP WOOD	Subsampling	25% subsample for sorting current-year from OSD. Applies only to bouts not sorted to functional group.	100% of the sample is sorted for OSD.	Analysis indicates subsampling to remove OSD from current-year biomass allows calculation of correct total current-year mass, and saves labor.
13	NIWO	Clipping guidelines	Clip individuals that can be pinched between thumb and forefinger.	Do not clip individuals < 2 cm height.	Ignoring individuals < 2 cm length leads to loss of entire functional groups at NIWO, due to abundant, low-stature alpine plants.

APPENDIX F CLIP-HARVESTING *TOXICODENDRON* SPECIES

F.1 Equipment and Materials

Protocol-specific equipment for mitigating exposure to toxic oils from *Toxicodendron* species. General equipment and PPE is listed in RD[14].

Use the warning pictogram label '!' on all samples that may contain *Toxicodendron* (listed in Section 6.1 equipment list).

Table 17. Equipment and materials required for a team of two to minimize exposure to toxic oils from *Toxicodendron spp.* that should be clip-harvested.

Item Description	Qty	Example Item	Purpose
Small paper bags, pre-weighed, labeled with bag weight	Variable	8# or lunch sack type	*Toxicodendron* biomass never handled directly again after it is placed in pre-weighed bag.
Labeled hand clippers, dedicated to *Toxicodendron* clipping	1	Same item type as indicated in equipment lists	Minimize spread of oils to other equipment.

F.2 Minimizing Exposure to Toxic Oil in the Field and Lab

General guidelines for preventing and mitigating exposure to toxic oils from *Toxicodendron* species can be found in RD[14].

The following are protocol-specific best-practice techniques for minimizing exposure to toxic oil during clip-harvest of *Toxicodendron* species.

1. Prior to field work:
   a. Count out bags for storing and drying ONLY *Toxicodendron* biomass. Don't mix *Toxicodendron* biomass with any other biomass.
   b. Pre-weigh (to nearest 0.01 g) and label each paper bag that will be used for storing and drying clip-harvested *Toxicodendron* biomass. Once the weight of each empty bag is included on the bag label, the biomass inside the bag will never have to be touched after it is initially placed in the bag.
2. To process *Toxicodendron* biomass in the laboratory:
   - Minimize potential spread of toxic oil by putting *Toxicodendron* biomass bags into the same drying oven every time.
   - When drying is complete, clean drying oven shelves used for drying *Toxicodendron* biomass bags with hot water and Tecnu. Wear appropriate PPE when cleaning.

- Record weight of bag + dried biomass to nearest 0.01 g, and also record weight of individual empty bag (to 0.01 g) on data sheets. Dried *Toxicodendron* biomass should never leave the bag.
    - Use a spreadsheet to calculate the mass of *Toxicodendron* by difference. The Herbaceous Biomass webUI will only accept one 'dryMass' value, so you must subtract out the weight of the bag prior to data entry.
    - Use herbGroup = 'WST' for *Toxicodendron* biomass.
        - ***!!! Note***: If there are multiple WST bags – i.e., one with *Toxicodendron* biomass and others without – add all WST mass together manually then enter into Fulcrum.
- After weighing, dispose of all *Toxicodendron* biomass bags.
    - *Toxicodendron* tissue will not be specimen mounted, or processed for Herbaceous Biogeochemistry (i.e., archived and sent for external chemical analysis).

APPENDIX G SAMPLING CELL NUMBER COORDINATES AND MAPS

G.1 Maps of samplingCellNumber by subplotID

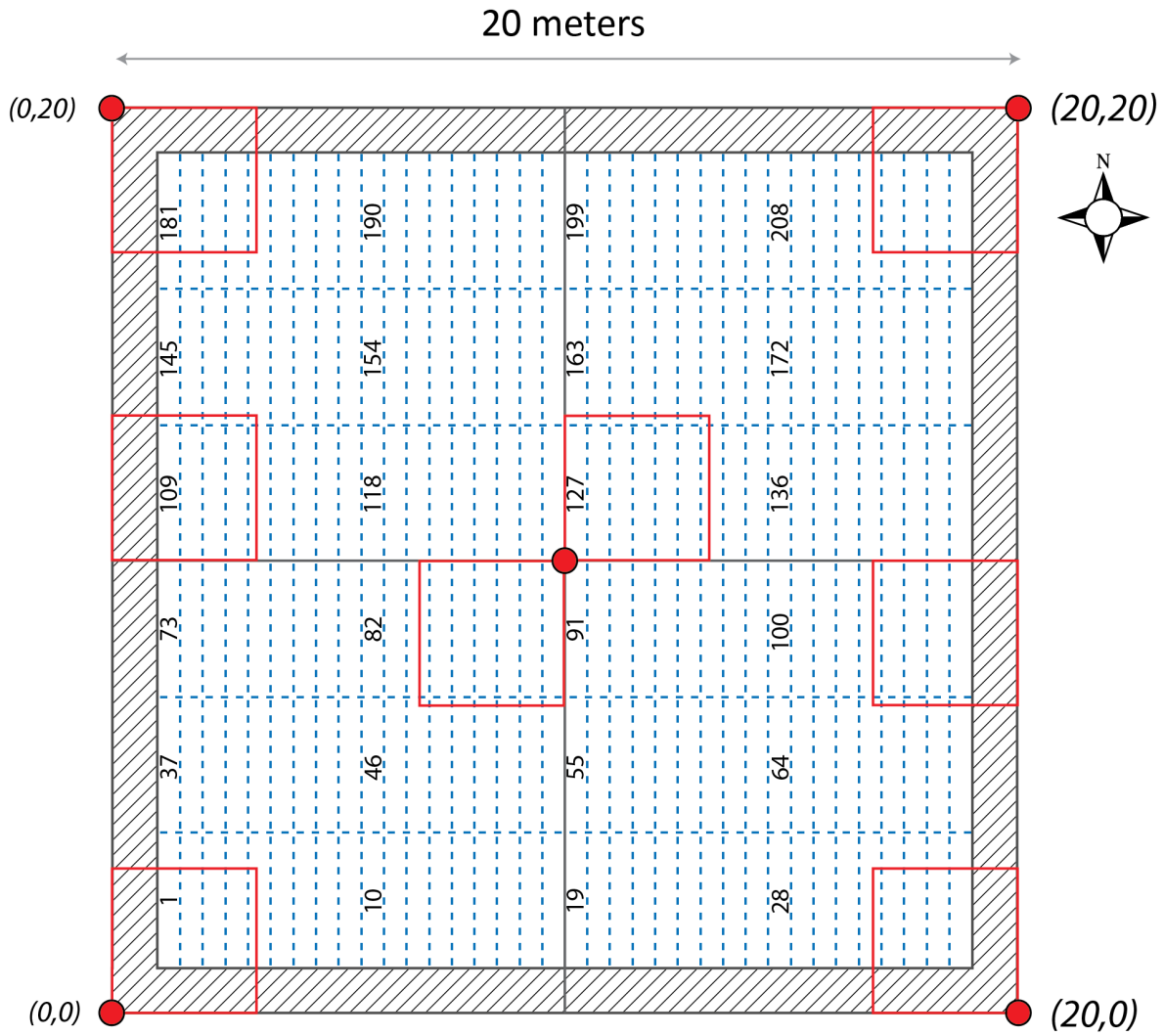

Figure 6. Map of samplingCellNumbers in a 20m x 20m base plot (subplotID = 31 in provided Clip Lists). Red squares indicate nested subplots used for diversity sampling; sampling cells that significantly overlap red squares are not used for clip sampling. However, cells with minimal overlap (e.g., 48-54, 68-72, 145-149) do support clip harvest sampling.

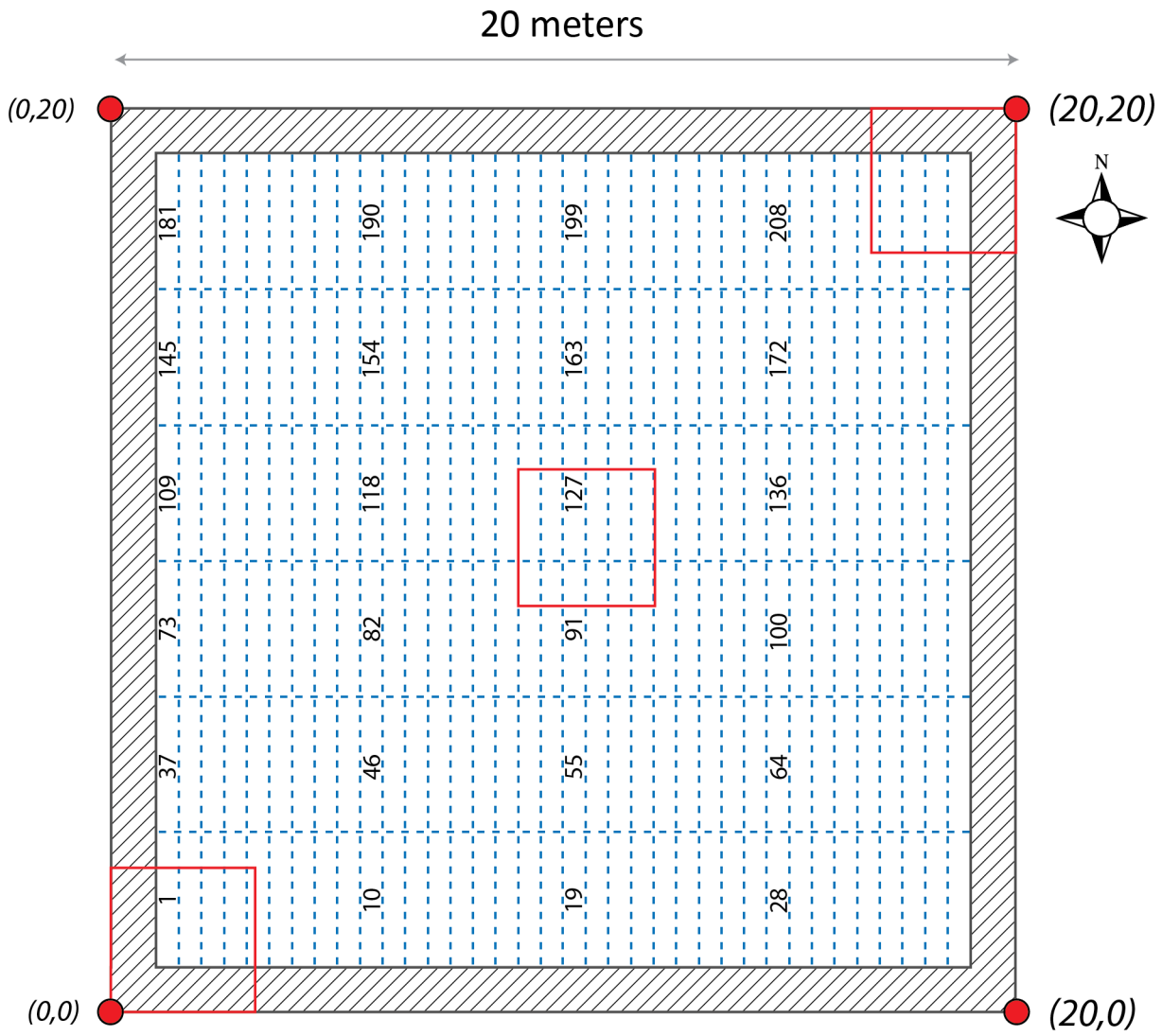

Figure 7. Map of samplingCellNumbers for **subplotID = 21** in a 40m x 40m Tower base plot. Cells that overlap nested subplots indicated by red squares are not used for clip sampling.

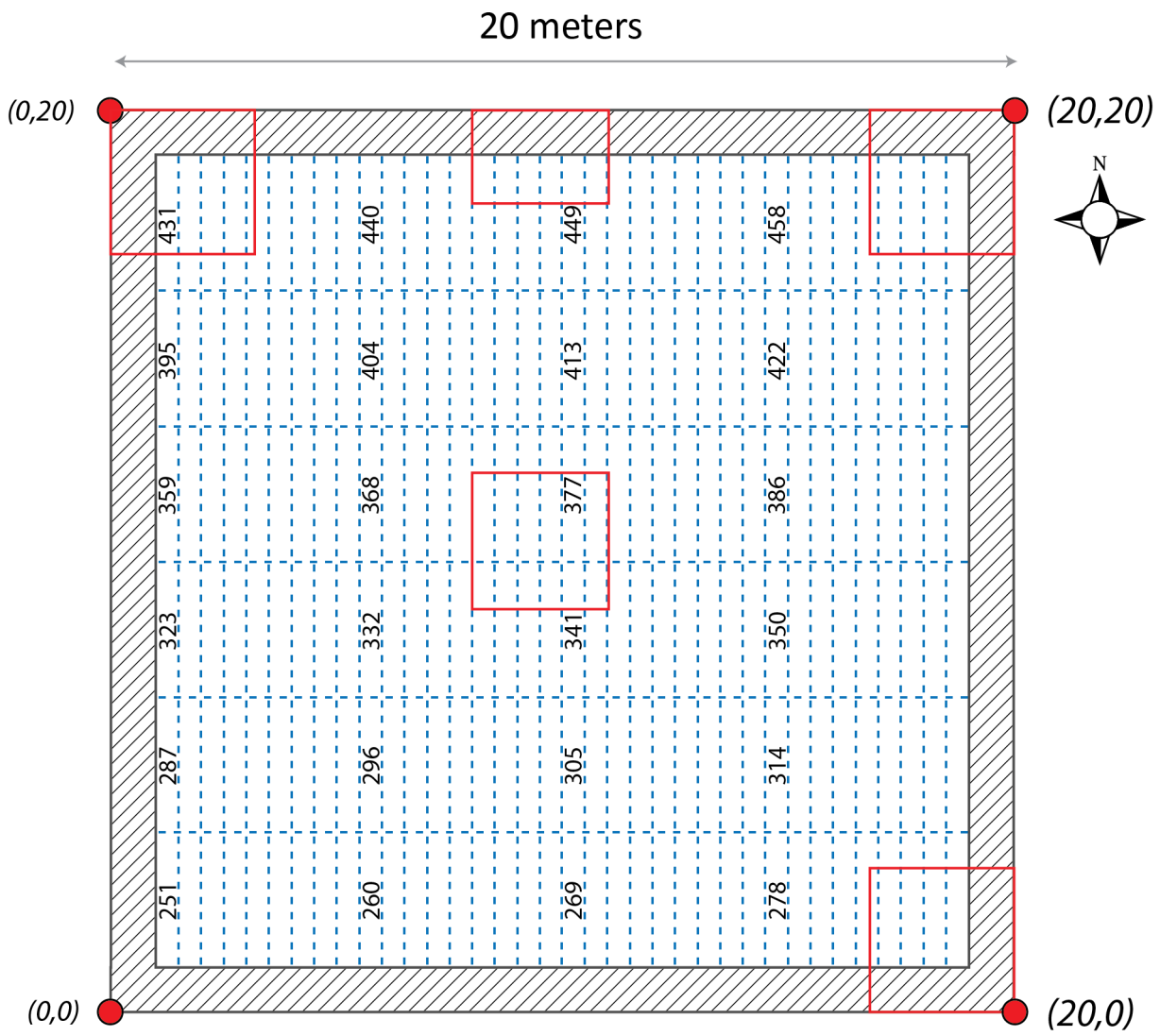

Figure 8. Map of samplingCellNumbers for **subplotID = 23** in a 40m x 40m Tower base plot. Cells that overlap nested subplots indicated by red squares are not used for clip sampling.

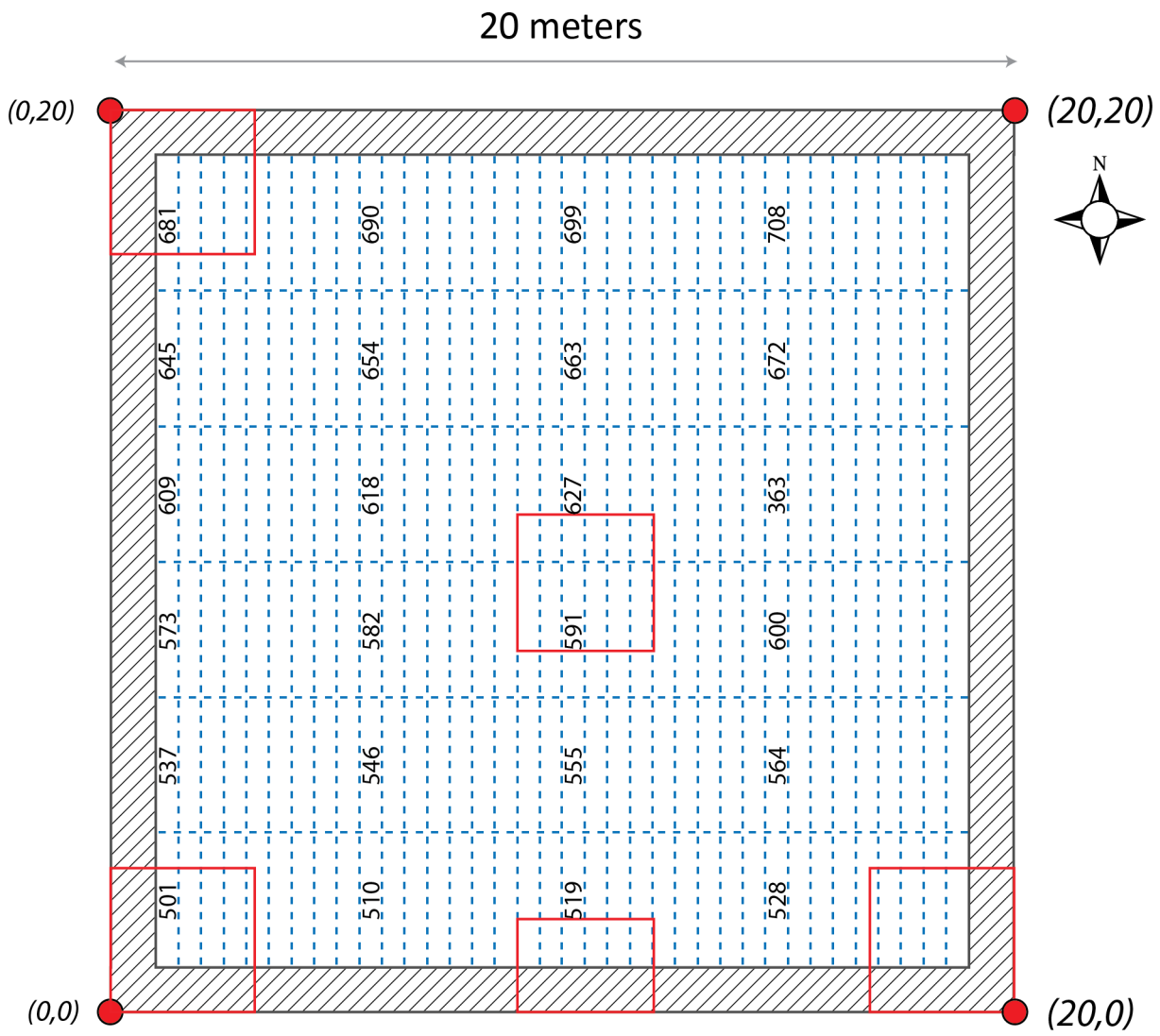

Figure 9. Map of samplingCellNumbers for **subplotID = 39** in a 40m x 40m Tower base plot. Cells that overlap nested subplots indicated by red squares are not used for clip sampling.

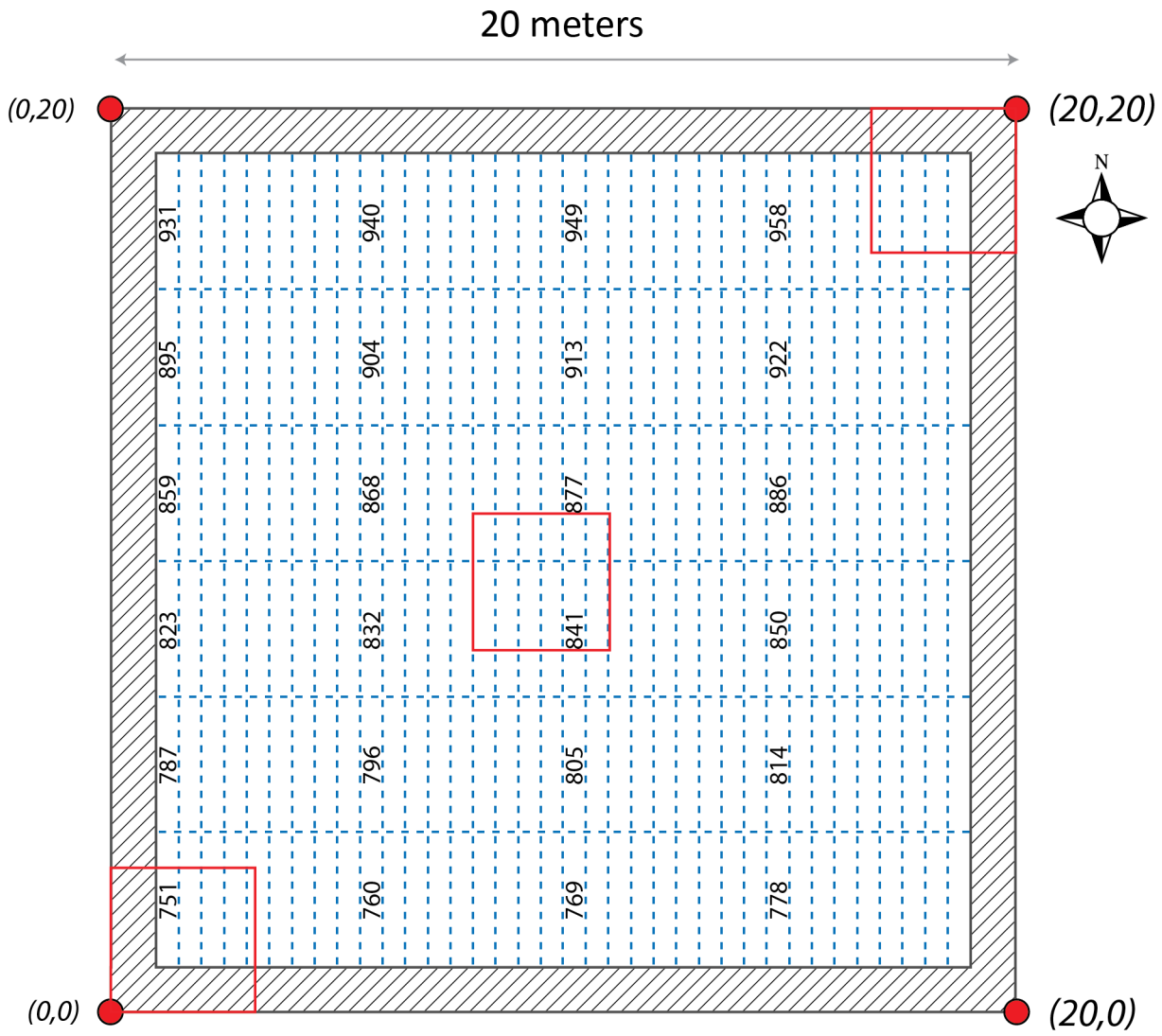

Figure 10. Map of samplingCellNumbers for **subplotID = 41** in a 40m x 40m Tower base plot. Cells that overlap nested subplots indicated by red squares are not used for clip sampling.

G.2 Coordinates for samplingCellNumbers by subplotID

Table 18. List of samplingCellNumbers by subplotID and associated easting and northing coordinates. Coordinates correspond to the SW corner of a 0.1m x 2m clip strip, and indicate the distance in meters relative to the SW corner of the plot (subplotID = 31) or subplot (subplotID = 21, 23, 39, 41).

cellNumber subplotID = 31	cellNumber subplotID = 21	cellNumber subplotID = 23	cellNumber subplotID = 39	cellNumber subplotID = 41	easting offset	northing offset
1	1	251	501	751	1.2	1.5
2	2	252	502	752	1.7	1.5
3	3	253	503	753	2.2	1.5
4	4	254	504	754	2.7	1.5
5	5	255	505	755	3.2	1.5
6	6	256	506	756	3.7	1.5
7	7	257	507	757	4.2	1.5
8	8	258	508	758	4.7	1.5
9	9	259	509	759	5.2	1.5
10	10	260	510	760	5.7	1.5
11	11	261	511	761	6.2	1.5
12	12	262	512	762	6.7	1.5
13	13	263	513	763	7.2	1.5
14	14	264	514	764	7.7	1.5
15	15	265	515	765	8.2	1.5
16	16	266	516	766	8.7	1.5
17	17	267	517	767	9.2	1.5
18	18	268	518	768	9.7	1.5
19	19	269	519	769	10.2	1.5
20	20	270	520	770	10.7	1.5
21	21	271	521	771	11.2	1.5
22	22	272	522	772	11.7	1.5
23	23	273	523	773	12.2	1.5
24	24	274	524	774	12.7	1.5
25	25	275	525	775	13.2	1.5
26	26	276	526	776	13.7	1.5
27	27	277	527	777	14.2	1.5
28	28	278	528	778	14.7	1.5
29	29	279	529	779	15.2	1.5
30	30	280	530	780	15.7	1.5
31	31	281	531	781	16.2	1.5
32	32	282	532	782	16.7	1.5
33	33	283	533	783	17.2	1.5
34	34	284	534	784	17.7	1.5
35	35	285	535	785	18.2	1.5
36	36	286	536	786	18.7	1.5
37	37	287	537	787	1.2	4.5

cellNumber subplotID = 31	cellNumber subplotID = 21	cellNumber subplotID = 23	cellNumber subplotID = 39	cellNumber subplotID = 41	easting offset	northing offset
38	38	288	538	788	1.7	4.5
39	39	289	539	789	2.2	4.5
40	40	290	540	790	2.7	4.5
41	41	291	541	791	3.2	4.5
42	42	292	542	792	3.7	4.5
43	43	293	543	793	4.2	4.5
44	44	294	544	794	4.7	4.5
45	45	295	545	795	5.2	4.5
46	46	296	546	796	5.7	4.5
47	47	297	547	797	6.2	4.5
48	48	298	548	798	6.7	4.5
49	49	299	549	799	7.2	4.5
50	50	300	550	800	7.7	4.5
51	51	301	551	801	8.2	4.5
52	52	302	552	802	8.7	4.5
53	53	303	553	803	9.2	4.5
54	54	304	554	804	9.7	4.5
55	55	305	555	805	10.2	4.5
56	56	306	556	806	10.7	4.5
57	57	307	557	807	11.2	4.5
58	58	308	558	808	11.7	4.5
59	59	309	559	809	12.2	4.5
60	60	310	560	810	12.7	4.5
61	61	311	561	811	13.2	4.5
62	62	312	562	812	13.7	4.5
63	63	313	563	813	14.2	4.5
64	64	314	564	814	14.7	4.5
65	65	315	565	815	15.2	4.5
66	66	316	566	816	15.7	4.5
67	67	317	567	817	16.2	4.5
68	68	318	568	818	16.7	4.5
69	69	319	569	819	17.2	4.5
70	70	320	570	820	17.7	4.5
71	71	321	571	821	18.2	4.5
72	72	322	572	822	18.7	4.5
73	73	323	573	823	1.2	7.5
74	74	324	574	824	1.7	7.5
75	75	325	575	825	2.2	7.5
76	76	326	576	826	2.7	7.5
77	77	327	577	827	3.2	7.5
78	78	328	578	828	3.7	7.5
79	79	329	579	829	4.2	7.5

cellNumber subplotID = 31	cellNumber subplotID = 21	cellNumber subplotID = 23	cellNumber subplotID = 39	cellNumber subplotID = 41	easting offset	northing offset
80	80	330	580	830	4.7	7.5
81	81	331	581	831	5.2	7.5
82	82	332	582	832	5.7	7.5
83	83	333	583	833	6.2	7.5
84	84	334	584	834	6.7	7.5
85	85	335	585	835	7.2	7.5
86	86	336	586	836	7.7	7.5
87	87	337	587	837	8.2	7.5
88	88	338	588	838	8.7	7.5
89	89	339	589	839	9.2	7.5
90	90	340	590	840	9.7	7.5
91	91	341	591	841	10.2	7.5
92	92	342	592	842	10.7	7.5
93	93	343	593	843	11.2	7.5
94	94	344	594	844	11.7	7.5
95	95	345	595	845	12.2	7.5
96	96	346	596	846	12.7	7.5
97	97	347	597	847	13.2	7.5
98	98	348	598	848	13.7	7.5
99	99	349	599	849	14.2	7.5
100	100	350	600	850	14.7	7.5
101	101	351	601	851	15.2	7.5
102	102	352	602	852	15.7	7.5
103	103	353	603	853	16.2	7.5
104	104	354	604	854	16.7	7.5
105	105	355	605	855	17.2	7.5
106	106	356	606	856	17.7	7.5
107	107	357	607	857	18.2	7.5
108	108	358	608	858	18.7	7.5
109	109	359	609	859	1.2	10.5
110	110	360	610	860	1.7	10.5
111	111	361	611	861	2.2	10.5
112	112	362	612	862	2.7	10.5
113	113	363	613	863	3.2	10.5
114	114	364	614	864	3.7	10.5
115	115	365	615	865	4.2	10.5
116	116	366	616	866	4.7	10.5
117	117	367	617	867	5.2	10.5
118	118	368	618	868	5.7	10.5
119	119	369	619	869	6.2	10.5
120	120	370	620	870	6.7	10.5
121	121	371	621	871	7.2	10.5

cellNumber subplotID = 31	cellNumber subplotID = 21	cellNumber subplotID = 23	cellNumber subplotID = 39	cellNumber subplotID = 41	easting offset	northing offset
122	122	372	622	872	7.7	10.5
123	123	373	623	873	8.2	10.5
124	124	374	624	874	8.7	10.5
125	125	375	625	875	9.2	10.5
126	126	376	626	876	9.7	10.5
127	127	377	627	877	10.2	10.5
128	128	378	628	878	10.7	10.5
129	129	379	629	879	11.2	10.5
130	130	380	630	880	11.7	10.5
131	131	381	631	881	12.2	10.5
132	132	382	632	882	12.7	10.5
133	133	383	633	883	13.2	10.5
134	134	384	634	884	13.7	10.5
135	135	385	635	885	14.2	10.5
136	136	386	636	886	14.7	10.5
137	137	387	637	887	15.2	10.5
138	138	388	638	888	15.7	10.5
139	139	389	639	889	16.2	10.5
140	140	390	640	890	16.7	10.5
141	141	391	641	891	17.2	10.5
142	142	392	642	892	17.7	10.5
143	143	393	643	893	18.2	10.5
144	144	394	644	894	18.7	10.5
145	145	395	645	895	1.2	13.5
146	146	396	646	896	1.7	13.5
147	147	397	647	897	2.2	13.5
148	148	398	648	898	2.7	13.5
149	149	399	649	899	3.2	13.5
150	150	400	650	900	3.7	13.5
151	151	401	651	901	4.2	13.5
152	152	402	652	902	4.7	13.5
153	153	403	653	903	5.2	13.5
154	154	404	654	904	5.7	13.5
155	155	405	655	905	6.2	13.5
156	156	406	656	906	6.7	13.5
157	157	407	657	907	7.2	13.5
158	158	408	658	908	7.7	13.5
159	159	409	659	909	8.2	13.5
160	160	410	660	910	8.7	13.5
161	161	411	661	911	9.2	13.5
162	162	412	662	912	9.7	13.5
163	163	413	663	913	10.2	13.5

cellNumber subplotID = 31	cellNumber subplotID = 21	cellNumber subplotID = 23	cellNumber subplotID = 39	cellNumber subplotID = 41	easting offset	northing offset
164	164	414	664	914	10.7	13.5
165	165	415	665	915	11.2	13.5
166	166	416	666	916	11.7	13.5
167	167	417	667	917	12.2	13.5
168	168	418	668	918	12.7	13.5
169	169	419	669	919	13.2	13.5
170	170	420	670	920	13.7	13.5
171	171	421	671	921	14.2	13.5
172	172	422	672	922	14.7	13.5
173	173	423	673	923	15.2	13.5
174	174	424	674	924	15.7	13.5
175	175	425	675	925	16.2	13.5
176	176	426	676	926	16.7	13.5
177	177	427	677	927	17.2	13.5
178	178	428	678	928	17.7	13.5
179	179	429	679	929	18.2	13.5
180	180	430	680	930	18.7	13.5
181	181	431	681	931	1.2	16.5
182	182	432	682	932	1.7	16.5
183	183	433	683	933	2.2	16.5
184	184	434	684	934	2.7	16.5
185	185	435	685	935	3.2	16.5
186	186	436	686	936	3.7	16.5
187	187	437	687	937	4.2	16.5
188	188	438	688	938	4.7	16.5
189	189	439	689	939	5.2	16.5
190	190	440	690	940	5.7	16.5
191	191	441	691	941	6.2	16.5
192	192	442	692	942	6.7	16.5
193	193	443	693	943	7.2	16.5
194	194	444	694	944	7.7	16.5
195	195	445	695	945	8.2	16.5
196	196	446	696	946	8.7	16.5
197	197	447	697	947	9.2	16.5
198	198	448	698	948	9.7	16.5
199	199	449	699	949	10.2	16.5
200	200	450	700	950	10.7	16.5
201	201	451	701	951	11.2	16.5
202	202	452	702	952	11.7	16.5
203	203	453	703	953	12.2	16.5
204	204	454	704	954	12.7	16.5
205	205	455	705	955	13.2	16.5

cellNumber subplotID = 31	cellNumber subplotID = 21	cellNumber subplotID = 23	cellNumber subplotID = 39	cellNumber subplotID = 41	easting offset	northing offset
206	206	456	706	956	13.7	16.5
207	207	457	707	957	14.2	16.5
208	208	458	708	958	14.7	16.5
209	209	459	709	959	15.2	16.5
210	210	460	710	960	15.7	16.5
211	211	461	711	961	16.2	16.5
212	212	462	712	962	16.7	16.5
213	213	463	713	963	17.2	16.5
214	214	464	714	964	17.7	16.5
215	215	465	715	965	18.2	16.5
216	216	466	716	966	18.7	16.5