TOS PROTOCOL AND PROCEDURE: HBP – MEASUREMENT OF HERBACEOUS BIOMASS

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	03/25/2011	ECO-00280	Initial release
B	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	08/24/2015	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 C, and clarified start date criteria in Section 4.2
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 C: Revised site-specific dates based on Field Operations feedback. • Appendix D: 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 D 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. • Multiple sections: Updated text to reflect shift to 5 y sampling interval in Distributed Plots.

			• Appendix C: 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 C: Added approved sampling interval and tower plot number optimizations.
L	03/16/2021	ECO-06538	• Updated to new template (NEON.DOC.050006vL). • SOP B and SOP C: Changed boutNumber to weekBoutBegan to simplify bout naming convention. • Section 4: Added NEON-wide convention for documenting missed sampling and a field data quality flag to indicate when sampling conditions were not optimal with samplingImpractical and biophysicalCriteria respectively.

			• SOP B.2: Added a new code to the clip cell status to indicate when a clipID was temporarily rejected. • SOP B.2: Added specific directions that when plotTyple is Distributed and nlcdClass = forest, plot should not be clipped but a record should be created. • SOP B.2: Added specific directions that when plotTyple is Distributed and plot cover < 50% herbaceous, plot should not be clipped but record should be created. • SOP B.2: Added directive that clipID should be rejected if sampling in 10 m2 subplot is likely to impact plant diversity or vegetation structure data products. • Tables 10 and 13: Indicated that byophytes should be clipped at select sites. • SOP D: Removed text, "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." These bags should be checked. • SOP E.3: Clarified that samples returned to drying oven prior to QA of dry mass data should be dried to similar threshold used for primary drying of samples. • Appendix D: Added several site-specific modifications to the site-specific appendix. • Appendix C: Removed the number of Tower plots from Table 14 as the plot list is maintained in an alternative location.
M	03/16/2022	ECO-06781	• Update to reflect change in terminology from relocatable to gradient sites
N	02/08/2024	ECO-07062	• Migrated to protocol template rev L • Updated NEON logo • Section 4.1: Updated sample size directives to account for Optimization; see SSL for plot sampling lists. • Section 4.6: Added values for sampling impractical and biophysical criteria • SOP A.4: Added new guidance on determining the need to sample Distributed Plots based on herbaceous cover not NLCD type. • SOP B and SOP C: Reiterated that samples should not be stored longer than five days between collectDate and weighDate • SOP E.1: Clarified that samples except for *Toxicodendron sp.* should be removed from the paper bag prior to calculating masses • SOP E.1: Increased the suggested maximum time samples are left in the drying oven to 10 days

			• SOP E.1: Added field sampleCondition to enable documentation of the sample condition • Appendix C: Updated sampling start dates based on new MODIS EVI data and information from observations at site. • Appendix D: adding subsampling for D11 OAES and CLBJ. • Appendix G: New appendix that clarifies bryophyte clipping requirements and subsampling routine.

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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 CO2 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 (http://www.nutnet.umn.edu/exp_protocol). 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. 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	EHS Safety Policy and Program Manual
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.004104	NEON Science Data Quality Plan
AD[06]	NEON.DOC.000914	NEON Science Design for Plant Biomass and Productivity

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 Data Products Catalog
RD[04]	NEON.DOC.001271	AOS/TOS Protocol and Procedure: DMP – Data Management
RD[05]	NEON.DOC.001574	Datasheets for TOS Protocol and Procedure: Measurement of Herbaceous Biomass
RD[06]	NEON.DOC.003282	NEON Protocol and Procedure: SIM – Site Management and Disturbance Data Collection
RD[07]	NEON.DOC.005247	AOS/TOS Standard Operating Procedure: NEON Aquatic and Terrestrial Site Navigation
RD[08]	NEON.DOC.000987	TOS Protocol and Procedure: VST – Measurement of Vegetation Structure
RD[09]	NEON.DOC.001788	Grazing Exclosure Assembly Instruction
RD[10]	NEON.DOC.001920	NEON Raw Data Ingest Workbook for TOS Herbaceous Plant Biomass
RD[11]	NEON.DOC.014038	TOS Protocol and Procedure: BBC – Plant Belowground Biomass Sampling
RD[12]	NEON.DOC.001024	TOS Protocol and Procedure: CFC – Canopy Foliage Chemistry and Leaf Mass per Area Sampling
RD[13]	NEON.DOC.001717	TOS Standard Operating Procedure: TruPulse Rangefinder Use and Calibration
RD[14]	NEON.DOC.001714	TOS Standard Operating Procedure: ABP – Measurement of Aboveground Productivity for Agricultural Crops
RD[15]	NEON.DOC.001716	TOS Standard Operating Procedure: Toxicodendron Biomass and Handling
RD[16]	NEON.DOC.001711	TOS Protocol and Procedure: CDW – Coarse Downed Wood
RD[17]	NEON.DOC.005023	TOS Standard Operating Procedure: SVY – Survey Method for Assessing Vegetation Cover

2.3 Acronyms

Acronym	Definition
ddh	Diameter at decimeter height
NPP	Net Primary Productivity
ISO	International Organization for Standardization
SSL	Sampling Support Library

2.4 Definitions

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.

Fulcrum: Software platform used to create NEON electronic data entry applications.

Herbaceous (for the purposes of this protocol): Herbaceous vegetation and woody-stemmed plants with diameter at decimeter height [ddh] < 1 cm

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.

Sampling Support Library: A NEON and protocol specific space with links to the documentation required to implement field and lab collections and observations.

ServiceNow: Software tool used for problem/incident tracking and resolution.

3 METHOD

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 (**Figure 1**). 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 2**). 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 2**). Within Distributed Plots, the herbaceous biomass and productivity clip-harvest protocol is carried out at plots with herbaceous vegetation ≥ 50% cover (≤ 50% forest canopy cover) as seen from the air (i.e., from the perspective of a remote-sensing instrument). Herbaceous cover in Distributed plots is assessed every five years at each site.

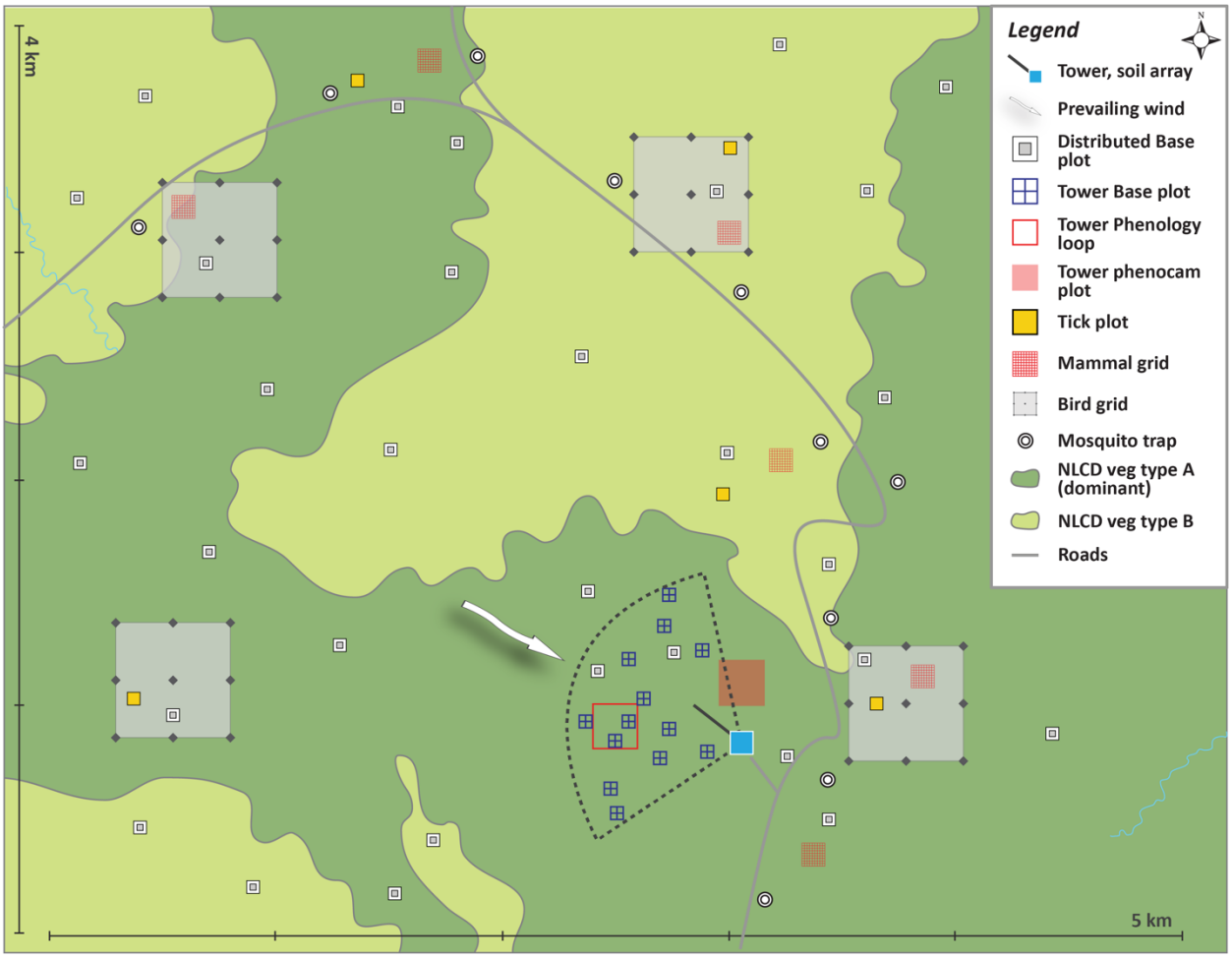

Figure 1. A schematic of sampling locations at a NEON site demonstrating the location of Distributed Plots and Tower Plots at which the protocol is implemented.

Clip harvests in 20m x 20m Tower Plots are carried out identically to those performed in Distributed Plots, with the exception that all plots identified for sampling are harvested regardless of the percentage of herbaceous cover. For Tower Plots 40m x 40m, the herbaceous clip-harvest protocol is implemented in two randomly selected 20m x 20m subplots per plot (**Figure 3**). Again, similar to clip-harvesting in Distributed Plots, 1 m2 and 10 m2 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.

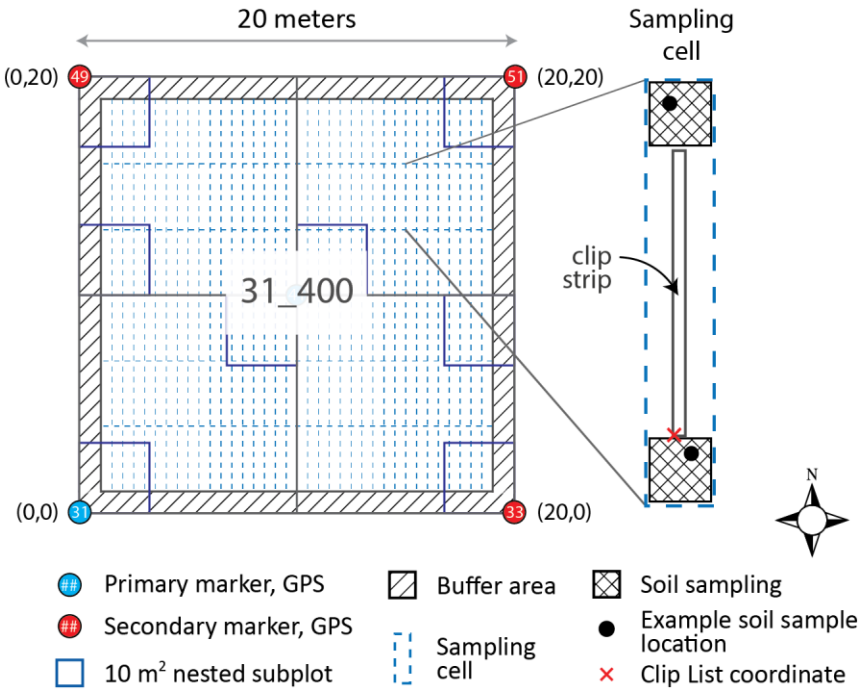

Figure 2. A Distributed Plot showing the locations of 3m x 0.5m sampling cells (dashed blue lines) that contain potential 2m x 0.1m clip strips. Coordinates corresponding to the SW corner of the clip strip (red 'X' in blowup) are provided to staff in plot-specific Clip Lists. Clip List coordinates are always relative to the SW corner of the plot (0,0). Sampling cells that overlap 10 m2 nested subplots are omitted from Clip Lists.

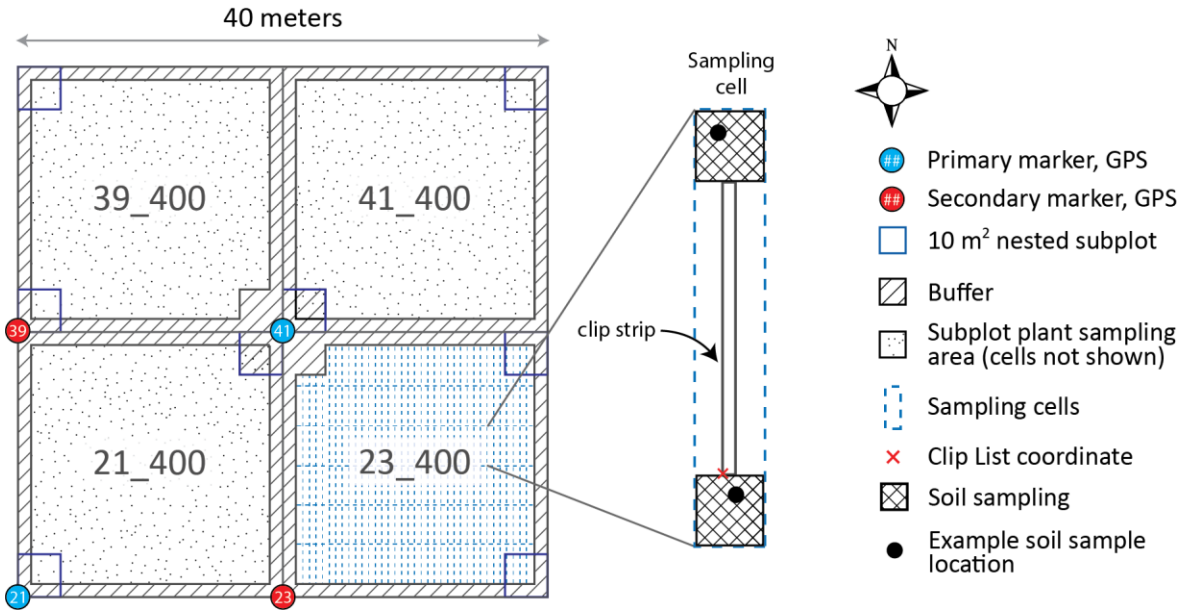

Figure 3. A 40m x 40m Tower Plot showing the location of 3m x 0.5m sampling cells (dashed blue lines) within the 20m x 20m subplot 23_400. Cells from the other subplots have been omitted for clarity. The clip strip coordinates

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 samples, field technicians **must** follow the protocol and associated SOPs. Use NEON's problem reporting system to resolve any field issues associated with implementing this protocol.

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

Quality assurance is performed on data collected via these procedures according to the NEON Science Data Quality Plan (AD[05]).

3.1 Integrating Herbaceous Biomass and Plant Belowground Biomass Sampling

- In Tower Plots, the Herbaceous Biomass and Plant Belowground Biomass sampling (RD[11]) protocols are spatially and temporally linked (**Table 2**), 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 Timing

Herbaceous Biomass clip-harvest samples are collected according to the guidelines in **Table 1**. 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 1. Sampling frequency for Herbaceous Biomass procedures on a per SOP per plot type basis.

Sampling Type	Plot Type	Plot Number	# Events per Sampling Year	Yearly Interval[1]	Sampling Start	Sampling Stop
Agricultural	See the Agricultural Biomass SOP (RD[14])					
Ungrazed (**SOP B**)	Distributed	n=20 (max)	1X per sampling year	Every 5 y	Peak biomass (**Appendix C** provides site-specific dates)	Within 14 d of sampling start
	Tower	Variable, see site-specific lists on the SSL[2]	1X or 2X per sampling year	Annual	Peak biomass[3] (**Appendix C** provides site-specific dates)	Within 14 d of sampling start[4]
Grazed[5] (**SOP C**)	Distributed	NA	NA	NA	NA	NA
	Tower	Variable, see site-specific lists on the SSL[2]	Varies by site[6]: - Every 4 weeks, - Every 8 weeks, - 1X at peak biomass that replaces the scheduled grazing bouts - See **Appendix C**	Annual	Deploy exclosures 10-14 d before animal stocking; first clip date = stocking date + sampling interval	See Section **4.2** (pg. 13)

[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] Site-specific sampling and plot prioritization lists are linked from the SSL. 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.

Scheduling of these three protocols is further coordinated according to **Table 2**. Staggering implementation of Herbaceous Biomass clip-harvest in Distributed Plots is important to prevent spikes in labor requirements from year-to-year.

Table 2. 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	5-20		X					X
VST	5	distributed	20		X					X
HBP	1	tower	0 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 site-specific plot sampling and prioritization lists linked from the SSL.

‡ A spatially-balanced subset of Tower Plots are selected for annual VST sampling at sites with relatively fast woody growth increment. See RD[08] 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 belowground root biomass sampling every 5 years (**Table 2**). See **SOP B.1** for protocol integration tips.
    - Date of peak biomass herbaceous clip harvest: Schedule plant belowground biomass soil sampling such that it is completed within ≤ 7 d of the start of herbaceous clip harvest, or such that plant belowground biomass sampling begins within ≤ 7 d of herbaceous clip harvest completion. If there are two herbaceous biomass peaks, schedule plant belowground biomass sampling relative to the clip harvest with the greatest biomass peak.
    - Site-specific sampling start dates are provided in **Appendix C**.
- ***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 2**). 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 (**SOP D.3**).
    - 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 and adjusted with input from observations at the site, is provided in **Appendix C**. 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.
- Livestock are removed prior to the grazing interval and the scheduled bout is not the peak green bout. Create sampling impractical (see section 4.5) for both:
    - The 'ambient' clip strip that would have been exposed to grazing (**samplingImpractial** = 'cell not clipped, livestock absent')
    - The clip strip under the exclosure (**samplingImpractial** = 'cell not clipped, livestock absent') and add a **setDate** with the companion grazing Fulcrum application.

- 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 C** 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 site.

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 3. 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,	May create potential change in observed NPP, and may increase uncertainty in consumption estimates at grazed sites.

Delay/Situation	Action	Outcome for Data Products
	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 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.	
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 Missed or Incomplete Sampling

Sampling according to the schedule is not always possible, and multiple factors may impede work in the field at one or more plots or sampling locations in a given bout. For example:

- Logistics – e.g., insufficient staff or equipment
- Environment – e.g., deep snow, flooding, inclement weather, or
- Management activities – e.g., controlled burns, pesticide application

Instances such as those listed above must be documented for scheduling, tracking long-term plot suitability, and informing end users of NEON data availability. Some types of missed sampling are due to events that should be recorded in the Site Management App; refer to the Site Management and Event Reporting Protocol for more detail (RD[06]).

Missed or Incomplete Sampling Terms

Terms that inform Missed or Incomplete Sampling include:

- **Protocol Sampling Dates**: Bout-specific sampling dates (**Appendix C**).

- **Scheduled Sampling Dates**: Bout-specific sampling dates scheduled by Field Science and approved by Science. These dates coincide with or are a subset of the Protocol Sampling Dates.
- **Missed Sampling**: Incidence of *scheduled sampling* that did not occur. Missed Sampling is recorded at the same resolution as data that are ordinarily recorded.
- **Sampling Impractical**: The field name associated with a controlled list of values that is included in the data product to explain a Missed Sampling event – i.e., why sampling did not occur.
- **Rescheduled**: Missed Sampling is rescheduled for another time according to one of the scenarios documented in **Figure 4** resulting in no change to the total number of sampling events per year.

The documentation that must accompany missed sampling depends on the timing, subsequent action, and the audience appropriate for numerous scenarios (**Figure 4**).

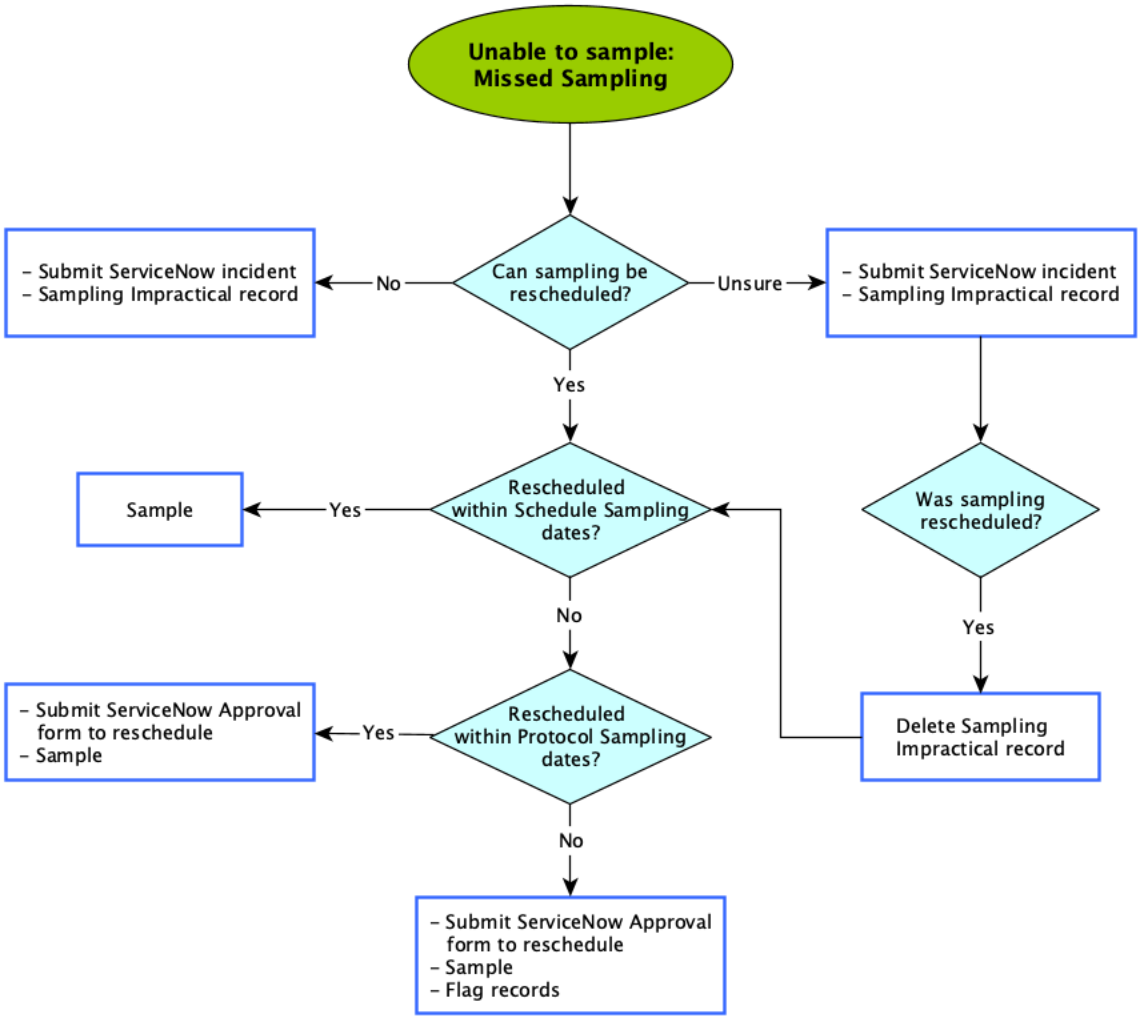

Figure 4. The documentation to account for a Missed Sampling event depends on the situation for each sampling unit not sampled per bout that is not sampled. Diamonds represent decision points and boxes describe the

required action. Required actions may include: a) Submitting a ServiceNow incident, b) creating a Sampling Impractical record, c) creating a data Flag, d) creating a Site Management record, or e) some combination of (a) – (d).

To Report Missed or Incomplete Sampling:

1. Missed or Incomplete Sampling that cannot be rescheduled within the Schedule sampling dates must be communicated to Science by a ServiceNow Incident.
    a. For Missed Sampling that is Rescheduled, there are some cases that require approval by Science and Operations (**Figure 4**).
    b. Consult **Table 4** below to determine required actions if scheduled activities are delayed or canceled. Guidance for this and other NEON protocols is summarized for ease of use in a table posted to a Field Science Sharepoint library. However, this protocol is the ultimate source of information should any discrepancy exist.

Table 4. Guidance for responding to delays and cancellations encountered during implementation of Measurement of Herbaceous Biomass protocol.

Activity Name	Days Delayed from Schedule	Delay Action	Cancellation Action
Measurement of herbaceous biomass (TOS Herbaceous Clip) -Distributed and Tower	> 7 days out of Scheduled Sampling Dates	OS Schedule Change Request	Submit incident ticket
	> 7 days out of Protocol Sampling Dates	OS Schedule Change Request and incident ticket	
Measurement of herbaceous biomass (TOS Herbaceous Clip) – Grazing	> 7 days out of Scheduled Sampling Dates at sites with 4- or 8-week frequency	OS Schedule Change Request	Submit incident ticket
	> 7 days out of Protocol Sampling Dates at sites with 4- or 8-week frequency	OS Schedule Change Request and incident ticket	
Measurement of herbaceous biomass (TOS Herbaceous Clip) – Agriculture	> 60 days out of Scheduled Sampling Dates if crop not present/not mature	OS Schedule Change Request	Submit incident ticket
	> 60 days out of Protocol Sampling Dates if crop not present/not mature	OS Schedule Change Request and incident ticket	

2. Create a Fulcrum record for each Missed Sampling event in the field that cannot be rescheduled. That is, if data are recorded in the field at the plot level, a record must be made for each plot missed.
    a. Create a record for each clip strip that would have been harvested. If two clip lists were to be sampled in a single plot, create two records.

b. Missing data in downstream applications (e.g., Lab apps) are not recorded if no samples were collected in the field. However, if field sampling was successfully completed but could not be processed in the lab, a record should be created. For example, if a sample was collected in the field but was not dried within required time and the sample is destroyed, a record for each destroyed subsample should be created.

3. For each Missed Sampling record, the **Sampling Impractical** field must be populated in Fulcrum (**Table 5**).

    a. For Rescheduled sampling events that occur outside of the defined Protocol Sampling Dates, a protocol-specific Flag must also be recorded (**Figure 4**).

Table 5. Protocol-specific Sampling Impractical reasons entered in the Fulcrum application. In the event that more than one is applicable, choose the dominant reason sampling was missed.

Sampling Impractical reason	Description
Other	Sampling location inaccessible due to other ecological reason described in the remarks
Location flooded	Standing or flowing water too deep to complete sampling
Logistical	Site or plot access compromised, staffing issues, errors (e.g., equipment not available in the field)
Location snow covered	Sampling location covered in snow
Management	Management activities such as controlled burn, pesticide applications, etc.
Exclosure cell not clipped, livestock absent	Cattle were removed from the area for the entirety of the previous grazing period and no sample was harvested from beneath the exclosure.
Ambient cell not clipped, livestock absent	Cattle were removed from the area for the entirety of the previous grazing period and no sample was harvested.

4.6 Biophysical Criteria

Sampling schedules are based on historical data. While schedules can and should be refined to optimize the criteria for sample timing (i.e., during peak herbaceous biomass), it may not always be possible to optimize sample timing. Staff may not be available if biomass peaks early in a hot and dry year. Conversely, sampling outside the Protocol sampling dates might actually satisfy the peak biomass or biophysical criteria for sampling. The Biophysical Criteria field is intended to communicate such instances to users of the data. If sampling takes place according to schedule and sampling criteria, the default 'OK – no known exceptions' value is entered. If criteria are not met, enter one of the pre-defined sampling values (**Table 6**).

Please use these data quality flags only when truly appropriate as any remark might cause users of the data to remove the data from consideration when working with the data.

Table 6. Protocol-specific Biophysical Criteria indicators entered in the HBP: Lab Masses [PROD] application.

Biophysical Criteria	Description
OK – no known exceptions	Samples collected according to protocol
OK – schedule change but conditions met	Sampling not within the Protocol sampling dates, but the peak biomass sampling criteria was met
Conditions not met: most plants not yet flowering	Sampling occurred prior to the peak biomass target date
Conditions not met: most plants senesced	Sampling occurred after the peak biomass target date
Qualifying material < 50% of plot area, sampling criteria not met	Herbaceous vegetation is < 50% of aerial cover of the plot
Recent burn – herbaceous cover impacted	A recent fire has impacted the amount of standing herbaceous biomass at the plot and in the resulting clip sample.

4.7 Estimated Time

Table 7. 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 A.4: Assessing Distributed Plots for Sampling	0.1-2 h	2	0.1-4 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

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 EHS Safety Policy and Program Manual (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.

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[15]).

Sharp Blades Sharp-bladed pruners and/or loppers may be used to clip and subsample crop plants. Safety considerations for these tools include:

- Select the correct tool for the job.
- Use personal protective equipment, to include gloves, safety glasses, and work boots to minimize injuries in the field.
- Assure all personnel working in the area are aware of the use of the sharp tools, and keep all sharp blades safely away from others.
- Maintain good posture and do not twist or stretch body awkwardly while making cuts with a pruner or lopper.

- 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

6.1 Training Requirements

All technicians must complete protocol-specific training as required in the Field Operations Job Instruction Training Plan (AD[04]). Additional protocol-specific required skills and safety training are described here.

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!***

6.2 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.

7 STANDARD OPERATING PROCEDURES

SOP Overview

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 (**Figure 5**). 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.

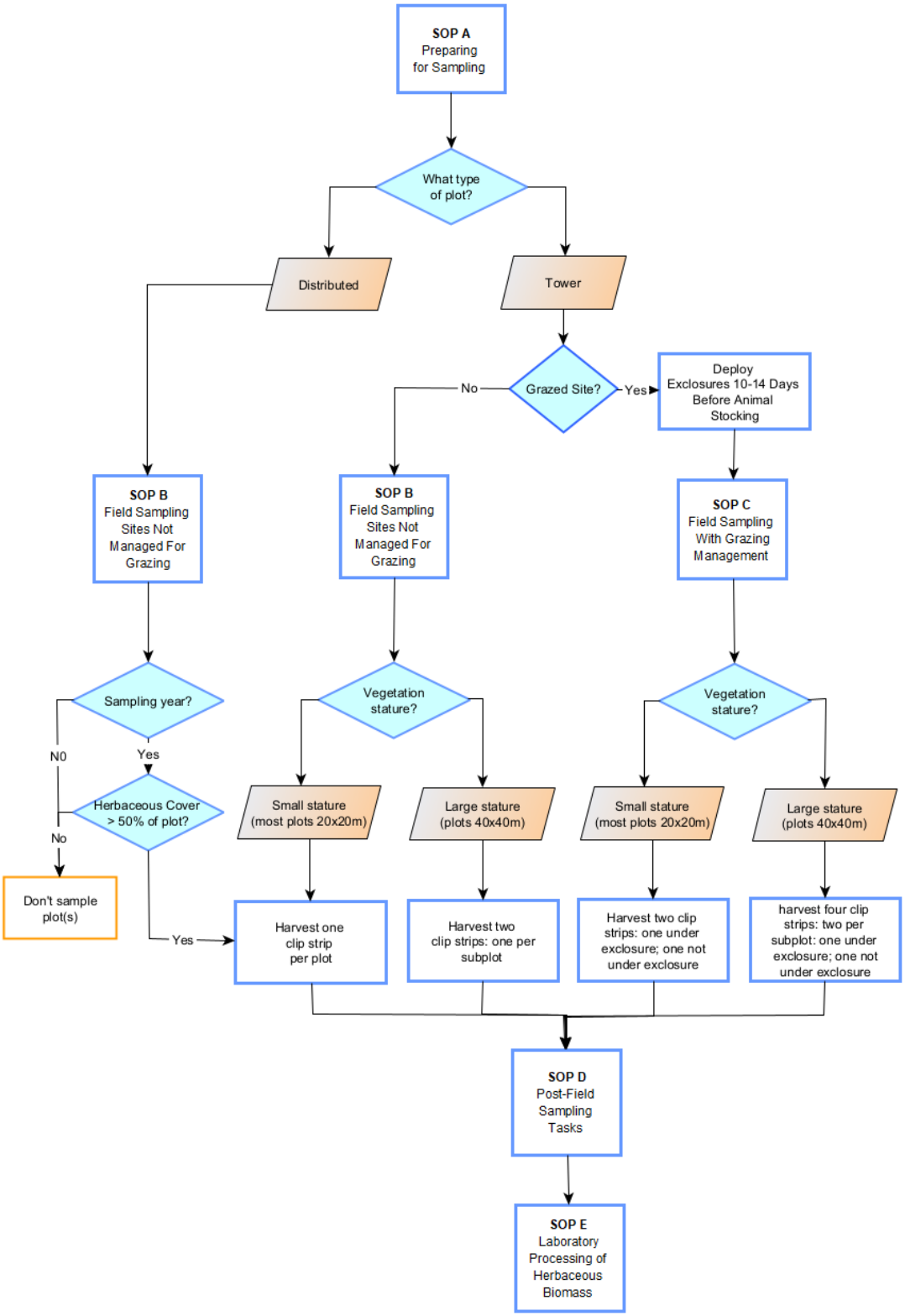

Figure 5. A high level workflow diagram that visually shows how the separate SOPs are sequentially connected.

SOP A Preparing for Sampling

A.1 Preparing for Data Capture

Mobile applications are the preferred mechanism for data entry. Mobile devices should be fully charged at the beginning of each field day, whenever possible.

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.

A.2 Preparing for Field Sampling

1. Plan and save sampling routes for field teams using standard site navigation procedures (RD[07]). Route planning enhances sampling efficiency and helps avoid accidental foot traffic within NEON plots.
2. 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.
3. 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[09].

a. The drawings in RD[09] 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 C** 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.

    f. Document the date and time the exclosure was set with the Fulcrum application *HBP: Exclosure Setting*.

A.3 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.
- For sites with BRY subsampling: Create pre-cut rite-in-the-rain labels that minimally includes plotID, sampling cell, and date for each clip cell that will be sampled for bryophytes).

- Ensure sufficient warning labels are available for identifying bags in the field that may contain *Toxicodendron*.

A.3.1 Barcode Workflow

Barcodes are strongly recommended 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.

When using barcodes:

- Adhesive Type I 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 **Appendix E** 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. Although it is always acceptable to use barcodes, in some cases barcodes are absolutely required.

Figure 6. An example of a Type I barcode. These large-size, field-tolerant barcodes have a prefix of 'A' followed by 11 numbers.

Table 8. Barcode requirements for sample types generated by the Measurement of Herbaceous Biomass protocol.

Sample Type	Description	Example Identifier	Fulcrum App	Container Type	Barcode Used	Barcode Required?	Barcode Qty
Field subsamples	Improve sample tracking, and reduce transcription errors associated with writing sample and subsample identifiers by hand.	CPER.052.157 20190805 (plotID.sampling cellNumber. collectDate)	HBP: Field Sampling AND HBP: Lab Masses	Paper Bag, #8 or #25 BRY: Heavy-duty freezer bag (3-4 mil)	Type I	Optional	1 per sub sample (functional group/ herbGroup)

A.4 Assessing Distributed Plots for Sampling

The HBP protocol quantifies the herbaceous contribution to total plant biomass stocks at the site scale by sampling at Distributed Base Plots every five years. In plots dominated by large stature, woody vegetation, the herbaceous layer contributes minimally to total standing biomass. To account for this, Distributed Base Plots are only sampled if herbaceous cover (i.e., qualifying vegetation including woody plant material with basal diameter < 1cm) is ≥ 50% of the aerial cover of the plot. In other words, plots dominated by forest are not sampled. Prior to each herbaceous biomass sampling bout at Distributed Base Plots, aerial cover of herbaceous biomass must be evaluated to determine whether

qualifying vegetation exists, and if the herbaceous samples should be collected (

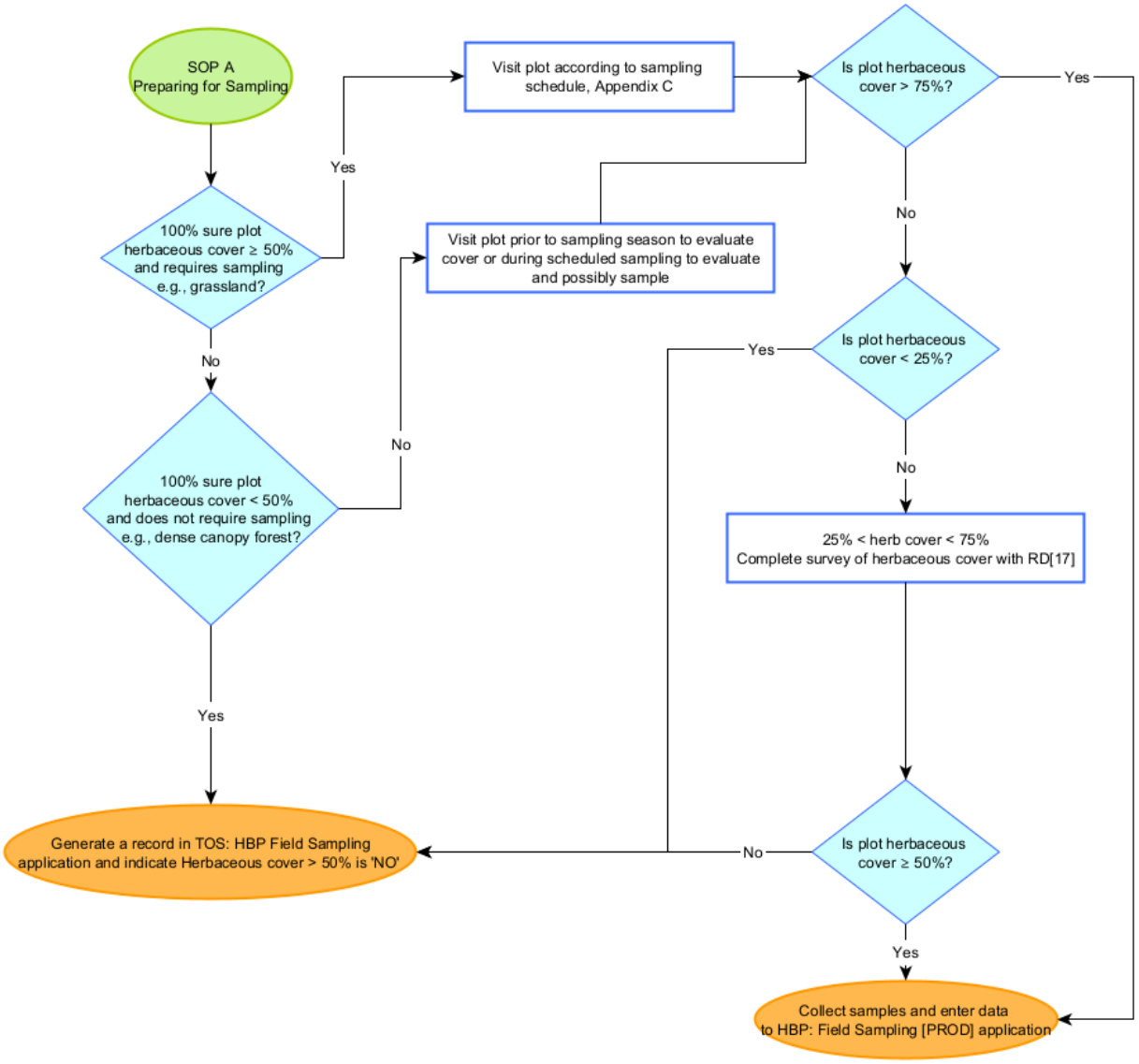

Figure 7). Below are directions for assessing qualifying vegetation and directions for when to make assessments:

1. Regardless of the NLCD type, if certainty about the presence of qualifying herbaceous cover and the need to sample the plot (i.e., ≥ 50% herbaceous vegetation as viewed from above the canopy) is not 100%, schedule the plot for an evaluation visit prior to sampling or visit the plot according to the sampling schedule (**Appendix C**) and be prepared to sample the plot after a field assessment:
    a. If qualifying herbaceous cover is > 75%, sample the plot.
    b. If qualifying herbaceous cover is < 25%:

i. Select the plot from the *HBP: Field Sampling* Fulcrum application.

ii. Leave **Sampling Impractical** = 'OK' and complete required fields including the date of plot evaluation.

iii. Set the field **Herbaceous cover > 50%** to 'NO'. This auto populates **biophysicalCriteria** to 'Qualifying material < 50% of plot area, sampling criteria not met.'

c. If herbaceous cover is > 25% and < 75%, complete a survey of vegetation cover (RD[17]).

i. If qualifying herbaceous cover is ≥ 50%, sample the plot

ii. If qualifying herbaceous cover is < 50%, create a Fulcrum record where **Herbaceous cover > 50%** is 'NO' as in **A.4.1.b** above.

2. If the NLCD type **is not** forest and it is > 99% certain that the plot is dominated by qualifying herbaceous vegetation (i.e., the plot has ≥ 50% cover of qualifying herbaceous vegetation as viewed from above the canopy), there is no need to visit and evaluate the plot prior to sampling; visit the plot according to the sampling schedule (**Appendix C**) and assess herbaceous cover.

a. If qualifying herbaceous cover is > 75%, sample the plot.

b. If qualifying herbaceous cover is < 25%:

i. Select the plot from the *HBP: Field Sampling* Fulcrum application.

ii. Leave **Sampling Impractical** = 'OK', and complete required fields including the date of plot evaluation.

iii. Set the field **Herbaceous cover > 50%** to 'NO'. This auto populates **biophysicalCriteria** to 'Qualifying material < 50% of plot area, sampling criteria not met.'

c. If qualifying herbaceous cover is > 25% and < 75%, complete a survey of vegetation cover (RD[17]).

i. If qualifying herbaceous cover is ≥ 50%, sample the plot.

ii. If qualifying herbaceous cover is < 50%, create a Fulcrum record where **Herbaceous cover > 50%** is 'NO' as in **A.4.2.b** above.

3. If the NLCD type **is** forest and it is > 99% certain that the plot is dominated by dense forest canopy and would not qualify for sampling (i.e., the plot has < 50% qualifying herbaceous vegetation as viewed from above the canopy) there is no need to visit and evaluate the plot. In this scenario, assessment of the plot may be informed by visits within the past year.

a. Create a record for the plot in the *HBP: Field Sampling* Fulcrum application.

b. Leave **Sampling Impractical** 'OK', and complete required fields including the date of plot evaluation.

c. For the field **Herbaceous cover > 50%** select 'NO'. This auto populates **biophysicalCriteria** to 'Qualifying material < 50% of plot area, sampling criteria not met.'

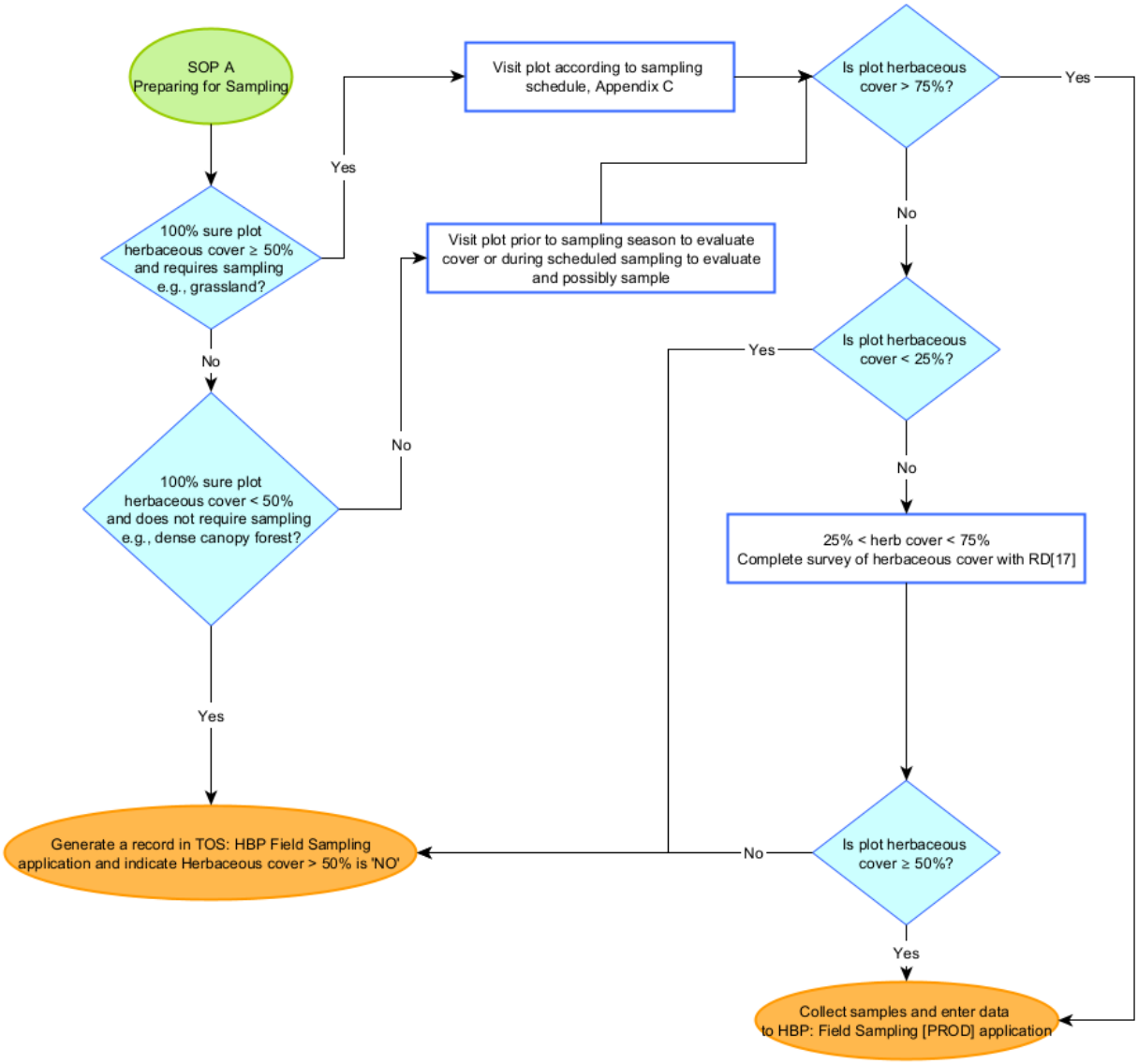

Figure 7. Workflow for determining if herbaceous biomass samples should be clipped at Distributed Plots as determined by the plot-scale herbaceous cover; see text in **A.4** for more information.

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 (**Figure 8**).

Goals

- Sample plots in accordance with the site-specific plot prioritization lists linked from the SSL.
- Identify one representative sampling cell per 400 m^2 plot or 400 m^2 subplot per bout.
    - Distributed Plots are harvested once per year at peak biomass (on a 5 year interval).
    - Tower Plots are harvested annually either once or twice per growing season, depending on whether vegetation at the site 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.

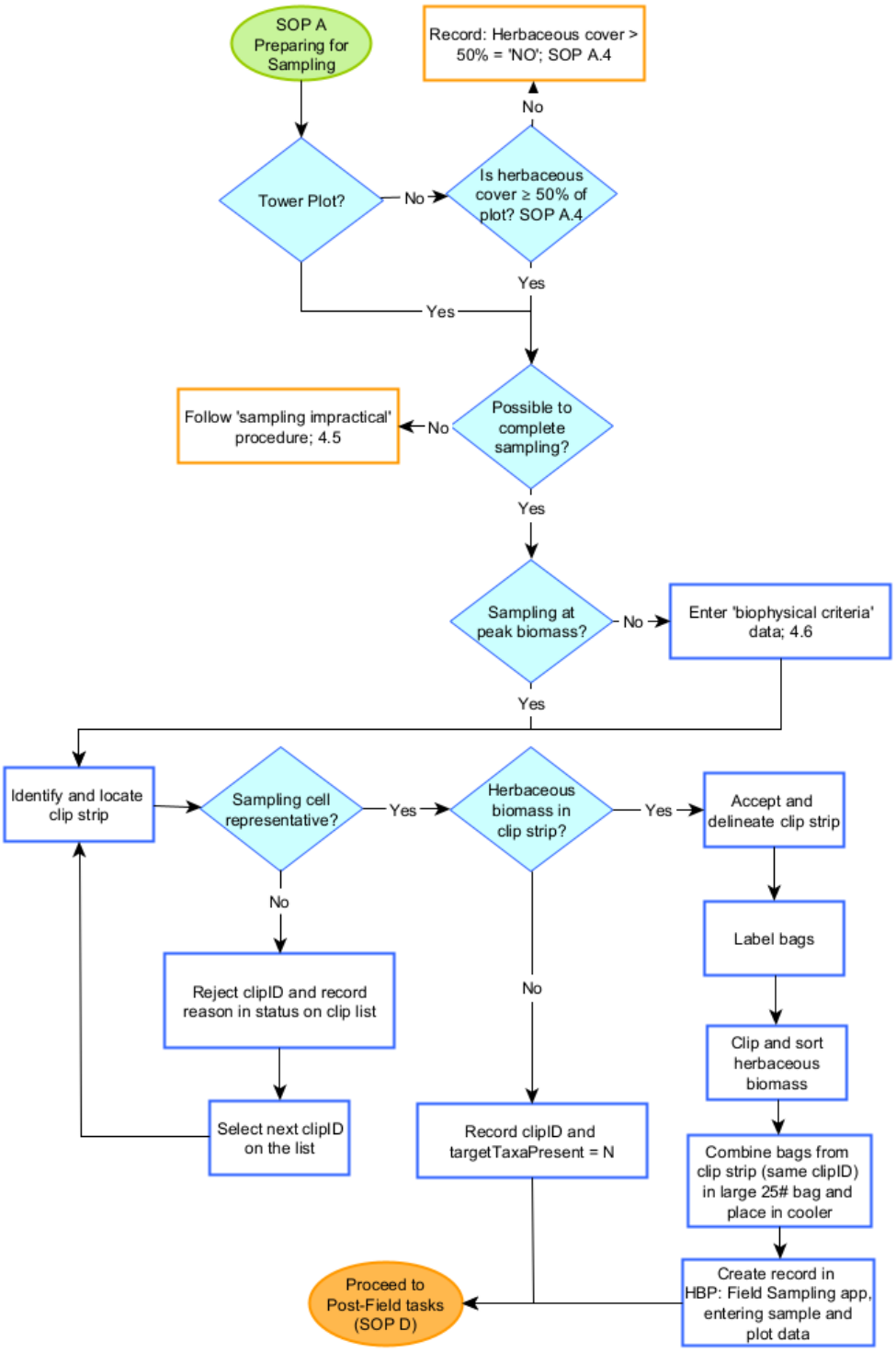

Figure 8. Workflow diagram for a sorted peak biomass bout at sites not managed for grazing (SOP B).

B.1 Spatially and Temporally Linked Protocols

Plant Belowground Biomass Sampling

- In an 'on' year for the Plant Belowground Biomass Sampling protocol (RD[11]), accepting/rejecting sampling cells should be done with both protocols in mind (**Figure 8**).
    - *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 3** to locate N/S sampling areas within a cell).
- Coordinating the timing of plant belowground biomass sampling with the date of peak biomass herbaceous clip harvest:
    - Schedule plant belowground biomass soil sampling such that it is completed within ≤ 7 d of the start of herbaceous clip harvest, or such that plant belowground biomass sampling begins within ≤ 7 d of herbaceous clip harvest completion.
    - If there are two herbaceous biomass peaks, schedule plant belowground biomass sampling relative to the clip harvest with the greatest biomass peak.
- Site-specific sampling start dates are provided in **Appendix C**.

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 1cell 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. Sample plots according to the site-specific sampling and prioritization lists linked from the SSL to ensure the correct plots are sampled and to adhere to the spatial sampling design should sampling be unexpectedly interrupted.
2. If the qualifying herbaceous cover of Distributed Plots is not ≥ 50% as seen from the air above the canopy, see **SOP D.1**. Otherwise, sample the plot as described below.
3. Navigate to the plotID to be sampled (using the GPS if necessary).

BEST PRACTICE TIPS

- It is useful to track those Distributed Plots with non-herbaceous cover >50% of the plot such that sampling criteria are not met.
- Plot status can now be tracked in the data; targetTaxaPresent = 'No', and biophysicalCriteria = 'Qualifying material <50% of plot area, sampling criteria not met'.
- Alternatively, a list can be created in a new tab of the clip list file that is accessed by the SSL.

4. 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.
5. 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:
6. **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 2**), 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 2**).
- 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.

7. ***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 2**):

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.

8. Assess whether the sampling cell is suitable and representative, and accept or reject the sampling cell (**Figure 9**).
    - 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.'

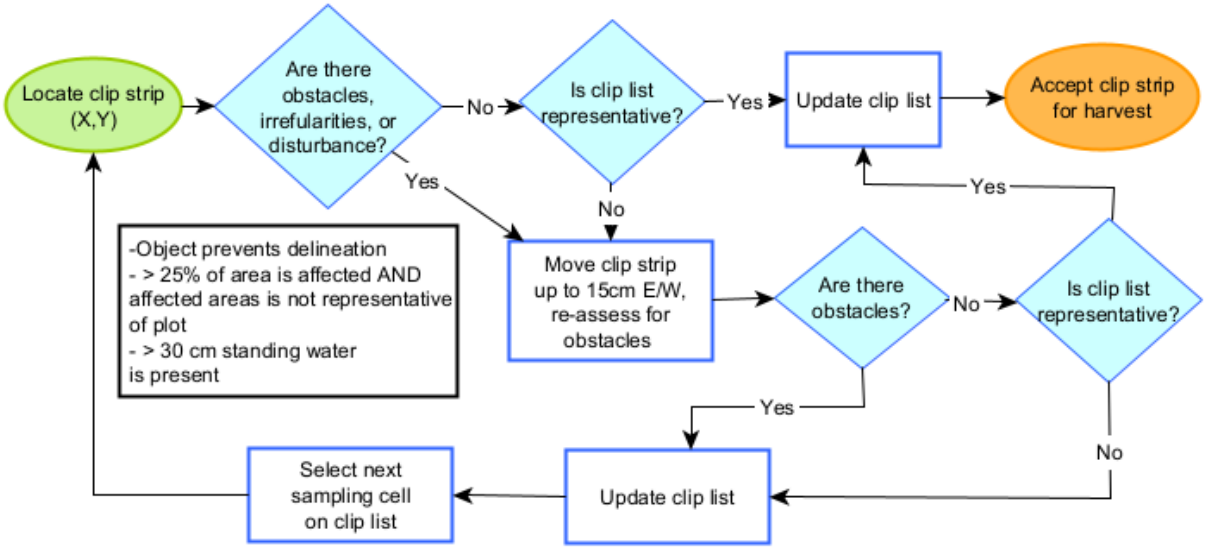

Figure 9. Flow chart to guide assessing potential sampling cells for clip-harvest suitability.

9. 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 9**.

Table 9. 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	Rejected temporarily, unrepresentative lack of growth in current season from drought

10. 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.
11. 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.
12. 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.3**).

- **weekBoutBegan**; use *XX* format, where XX is the ISO week the bout began.
- **date**; use *YYYYMMDD* format
- **clipID**; as provided in Clip List; use "*plotID_samplingCellNumber*" format, e.g. CPER_001_126.
- **herbGroup**; the functional group of the sorted herbaceous biomass (**Table 10**).
- **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.

Table 10. 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	Only at sites listed in the Site-specific appendix (Appendix D) table, 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 14**).
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 10**)
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 10**)
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.

† Bryophytes clipped only at sites specific sites described in **Table 15**.

13. If required to facilitate clipping, remove any cactus biomass lying within the clip strip. **Only clip cactus plants of the types listed in Table 11 AND that prevent access to herbaceous biomass that must be clipped.**
    - Dispose of the cactus biomass outside of the plot.
14. Clip and sort all herbaceous aboveground biomass rooted within the clip strip into the functional groups in **Table 10**. Herbaceous clip-harvest functional groups with corresponding herbGroup codes, descriptions, and clipping guidelines. 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.

15. When clipping is finished, group all bags from the current clipID into a larger 25# bag and return to the cooler.
16. Create a record in the Field Sampling app for the sampled clipID, and enter required plot-level sampling information:
    - **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_400. For 40m x 40m Tower Plots, subplotID = 21_400, 23_400, 39_400 or 41_400.
    - **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.
    - **weekBoutBegan**; the ISO week number in which the sampling bout began. If bout duration exceeds a single week, enter the ISO number of the week the bout began.
    - **samplingCellNum**; ### format. This number is the last 3 digits of the clipID.
    - **samplingCellDimension**; the dimensions of the clip strip. Should be 2.0m x 0.1m; other dimensions are employed only during Agricultural Biomass sampling (RD[14]).

- **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[14]).
- **exclosure**; select 'N'. Exclosures are only present at grazed sites (SOP C).
- **sorted**; select 'Y'. Clip harvests at non-grazed sites are always sorted.
- **Toxicodendron clipped;** indicate if there is Toxicodendron in the clip cell, if yes follow *Toxicodendron* guidance (RD[15)] and **Appendix F**.
- **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**.

17. Save the record for the **clipID**, and proceed to the next plot or subplot.
18. **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.
19. 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**.

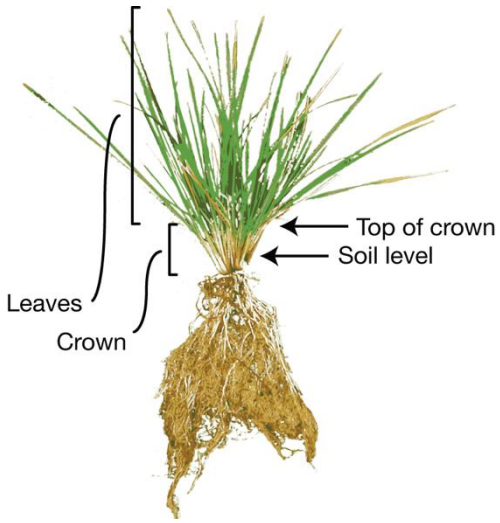

Figure 10. A perennial graminoid, showing the location of crown material relative to leaves and the soil surface.

B.3 Special Handling for Specific Plant Types

Table 11. 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[15]) 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.

Growth Form	Guidelines
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.
Bryophytes	See **Appendix G**.

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.
- Do not store samples for more than five days in the refrigerator before beginning the oven-drying process to prevent degradation of samples and mass loss (see Section 4.3).
- 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 (**Figure 11**).

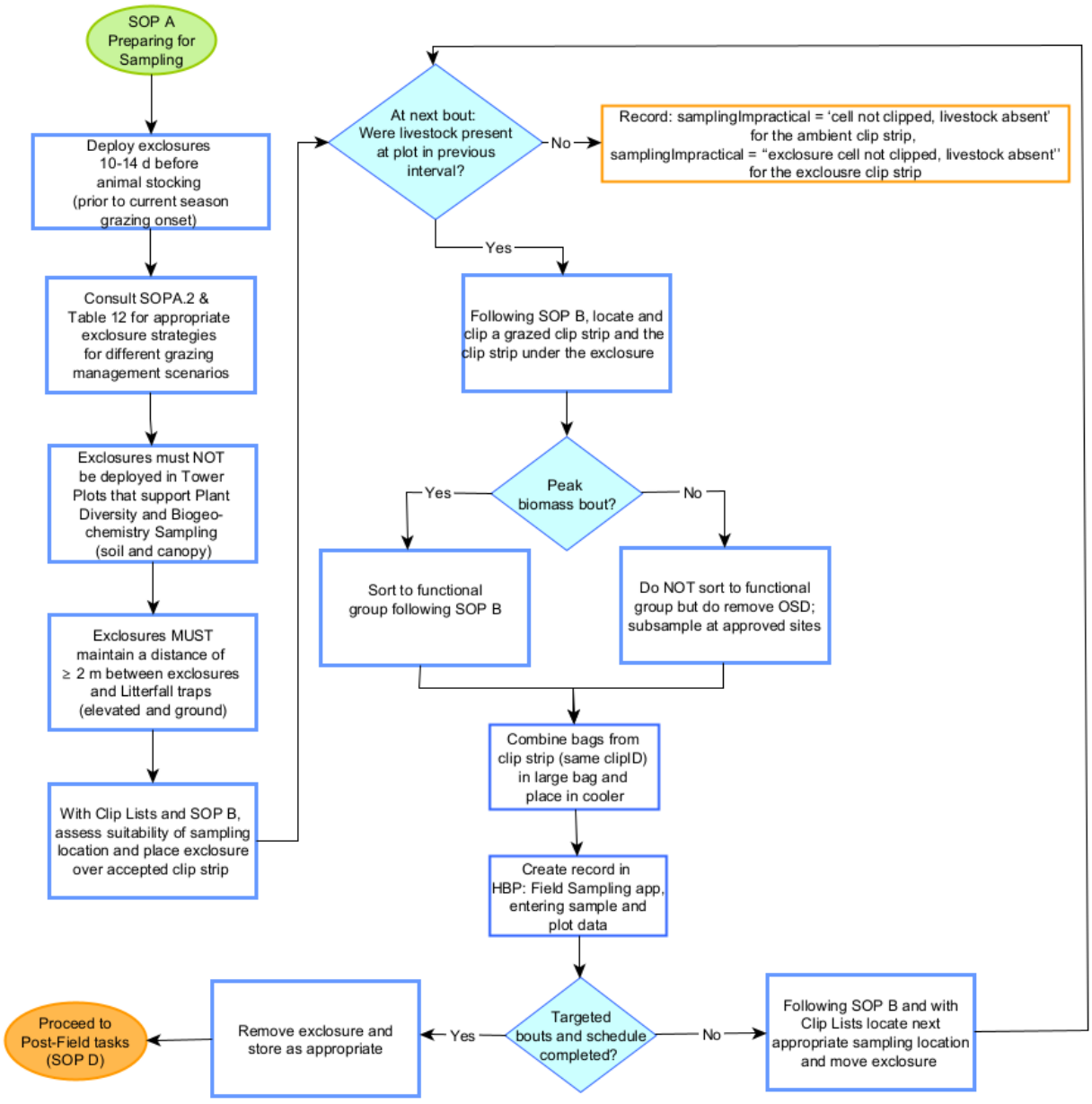

Figure 11. High-level workflow diagram for clipping herbaceous biomass in a system managed for grazing (SOP C).

Goals

- Sample plots in accordance with the site-specific plot prioritization lists linked from the SSL.

- 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 C.**
- 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 C**) If there are multiple biomass peaks, the time point with the highest peak biomass is selected for functional group sorting. The peak biomass bout that is sorted to functional group takes the place of the grazing bout scheduled for that interval.

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 H.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 12**.

Table 12. 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

Grazing Management Scenario	Required Actions
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. • If livestock have been absent from the plot for the entirety of the previous interval between bouts, clipping – both under the exlosure and the non-exclosed clip strip - is not required for the given plot.
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. Sample plots according to the site-specific sampling and prioritization lists linked from the SSL to ensure correct plots are sampled and to adhere to sampling design should sampling be unexpectedly interrupted.
2. Navigate to the plotID to be sampled (using the GPS if necessary).
3. 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.
4. 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.

5. Perform clip harvest as in SOP B.

Bouts at grazed sites that are NOT sorted to functional group must be sorted to remove OSD. The OSD can be sorted in the field or can be done in the lab if completed within 24hrs of the harvest, as with the sorting check (SOP D).

A subsampling approach may be employed to sort OSD from a representative portion of the total fresh sample. The subsampling can take place in the field with spring scale or in the lab using the mass balance. See **Appendix D** 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 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 *HBP: Lab Masses* Fulcrum application (see next step).

d. Determine the desired subsample percent **(Appendix D**), 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, 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 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.

6. 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.

- **plotID**; select from site-specific drop-down list, for paper date sheets use SITE_### format.
- **subplotID**; for 20m x 20m Tower Plots, subplotID = 31_400. For 40m x 40m Tower Plots, subplotID = 21_400, 23_400, 39_400 or 41_400.
- **collectDate**; use HH:mm, 24-h time format. This is the ***local*** time the sample was placed in the cooler after clipping.
- **weekBoutBegan**; the ISO week number in which the sampling bout began. If bout duration exceeds a single week, enter the ISO number of the week the bout began.
- **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[14]).
- **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.
- **exclosure**; choose 'Y/N', depending on exclosure presence/absence over the clip strip.
    - If exclosure is 'Y', select the exclosure set record previously created in the *HBP: Exclosure Setting* Fulcrum application or create a new record that reflects the date and time the exclosure was placed prior to the grazing interval.
- **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.
- **Toxicodendron clipped;** indicate if there is Toxicodendron in the clip cell, if yes follow *Toxicodendron* guidance (RD[15)] and **Appendix F**.
- **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**.

7. Save the record for the **clipID**.
8. 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 and use the *HBP: Exclosure Setting* Fulcrum application to document the **setDate** and **setTime**.
9. Stake the exclosure to the ground, and proceed to the next plot or **clipID** within the same plot.
10. **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.
11. 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**.

Troubleshooting

Table 13. 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 H**.

C.2 Grazed Site 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.
- Do not store samples for more than five days in the refrigerator before beginning the oven-drying process to prevent degradation of samples and mass loss (see Section 4.3).
- 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.

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 Document Plots Not Qualifying for Sampling Due to Forest Cover

Generating data for all plots that could be sampled enables better accounting and understanding of which plots were sampled, which were not, and why.

- All Tower Plots identified for sampling should be sampled regardless of vegetation cover; sample size depends on the site and analyses of data.
- Data must be entered for all Distributed Plots targeted for sampling. When the qualifying herbaceous cover in a Distributed Plot is < 50%, sampling does not take place.
    - Generate a record for the each forested Distributed plot that does not qualify for sampling, entering **domainID, siteID, plotID**, **recordedBy**, and setting **Herbaeous cover > 50% of plot area** to 'NO' (this will set **targetTaxaPresent** = 'No' and biophysicalCriteria to 'Qualifying material <50% of plot area, sampling criteria not met'). Be sure to record **collectDate**, **collectTime**, **weekBoutBegan**, and **samplingProtocolVersion**.

D.2 Document Incomplete Sampling Within a Site

Herbaceous Biomass sampling will occur on the schedule at up to 20 selected Distributed and Tower Plots (plot selection is determined by NEON Science) at each 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 (gradient 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.
- Plots that were not sampled should be documented for each plot and each bout with the sampling impractical field. Plots It is currently incumbent on Field Science to track which plots have been compromised for Herbaceous Biomass clip-harvest.

To document locations not sampled during the current bout:

1. Review Fulcrum records to determine which locations were scheduled for sampling but were not sampled.
2. Create an incident with the following naming convention to document the missed sampling: 'TOS Sampling Incomplete: MOD – [Root Cause Description]'
    a. Example: 'TOS Sampling Incomplete: HBP – Could not access plot due to permanently closed road'.

Staff scientists review incident tickets periodically to determine whether a sampling location is compromised.

D.3 Check Sorting of Clipped Biomass

The workflow for handling herbaceous biomass samples after collection in the field requires checking field work and in some cases further sorting to ensure accurate estimates of herbaceous biomass production (**Figure 12**).

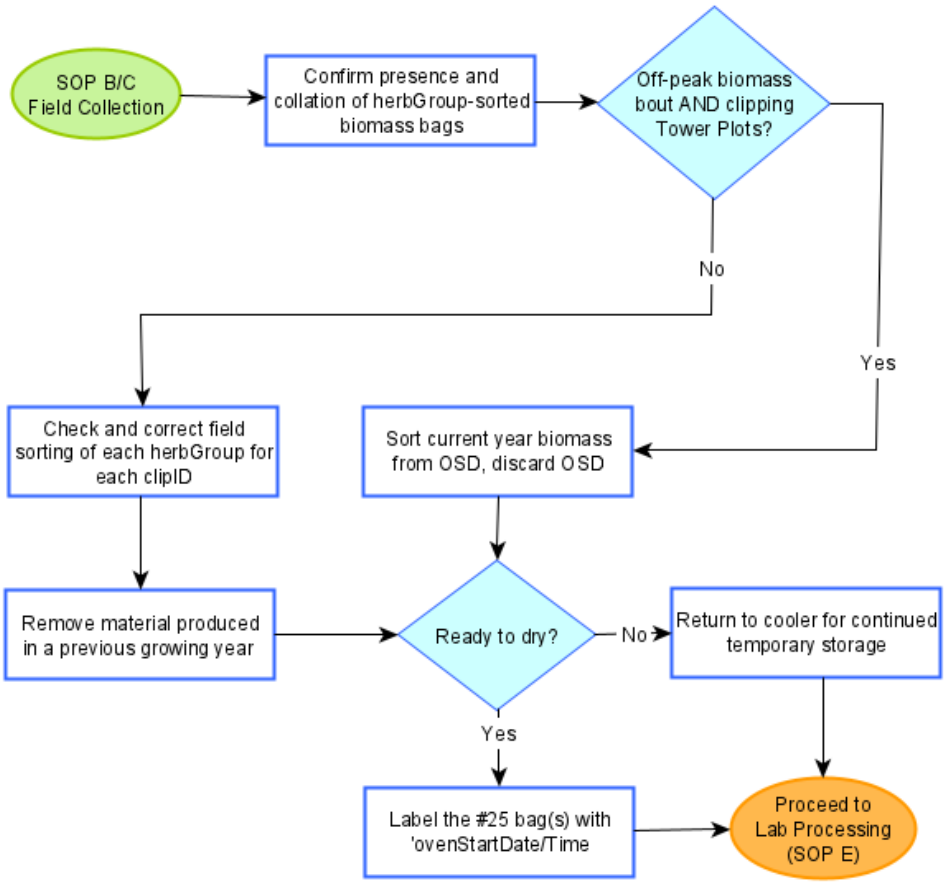

Figure 12. High-level workflow diagram for sort-checking clipped herbaceous biomass prior to oven-drying (**SOP E**).

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).

For bouts with herbGroup = ALL from grazed plots that are NOT sorted to functional groups' subsampling approach is approved for the sites listed in **Appendix D.**

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.4 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.5 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.6 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

Generating dry mass data from the samples requires the drying of clipped material, weighing biomass, and quality assessment (**Figure 13**).

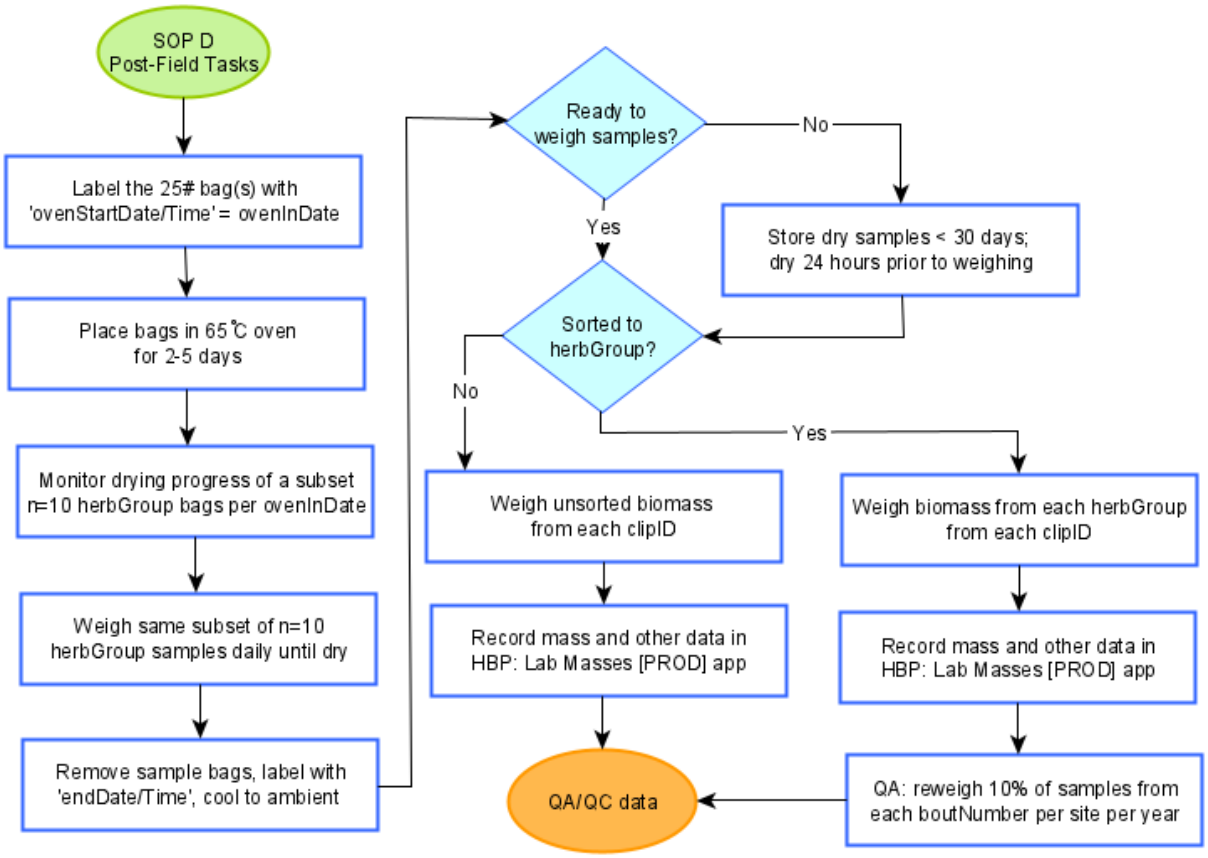

Figure 13. High-level workflow diagram for oven-drying and weighing clipped herbaceous biomass and recording dry mass data (SOP E).

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 (i.e., not the peak biomass bout where herbGroup sorting is done):
  - Values for **Fresh Mass** and **Sub Sample Fresh Mass** (for those sites approved for subsampling) are recorded in the field or in the lab (**SOP C**).
  - Record **Sub Sample Dry Mass** (for those sites approved for subsampling; 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 Groups

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)**.
   - *Note*: Samples may stay in the drying oven for > 120 h (5 d) without issue. The max time is based on the assumption that drying ovens should not be monopolized unnecessarily.
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 ± 1% of the previous timepoint mass, whichever is larger).

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 immediately as it will absorb moisture from the air if left in ambient room conditions (particularly in humid environments).
        - It is helpful to remove bags from the oven and weigh one at a time.
    - 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. Do not update or change the oven times from the original drying times.
8. Remove dried plant material from the bag and weigh biomass from each herbGroup from each clipID using a mass balance (0.01 g accuracy) and a large weigh boat. Enter all required data.
    a. For large volumes of biomass that do not readily fit into a large weigh boat, 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 this increases uncertainty associated with the final dry mass.
    b. For cases when *Toxicodendron* is present in the woody stemmed plants **herbGroup**, follow guidance in RD[15], **Appendix F**, and helper fields in the Fulcrum application to account for mass of *Toxicodendron*.

c. 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.

d. Otherwise, open the *HBP: Lab Masses* app, manually find and open the record for the **sampleID**, then open and edit the correct **herbGroup** (subsampleID).

e. 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 *HBP: Lab Masses* application:

- In the parent-level **clipID** record, check:
  - **collectDate**; date biomass was clipped in the field
  - **weekBoutBegan**; ISO week number (range = 1-52).
  - **Sampling Cell Number**; last three digits of the **clipID**.
- In the child-level **herbGroup** record, check or enter:
  - **OvenStartDate/Time**; date and time (24-h format)the sample was initially placed in the drying oven.
  - **SampleCondition**; the condition of the **herbGroup**-specific sample (**Table 14**).

Table 14. Herbaceous biomass sampleCondition values.

Code	Description	Sample handling	Field sample fate
OK	OK	No changes	Processed
Sample not refrigerated before oven drying	Sample not kept cool after harvest and before oven drying in the lab	No changes	Processed
Sample stored > 5 days prior to drying	Sample storage duration exceeded guidelines and resulting mass values may be compromised	No changes	Processed
Lost	Sample lost after collection and before measurement of **dryMass**	None, sample lost	Lost
Other	Notes about the condition of the same	No changes	Processed

10. Record dates and times for the initial drying event only. Do not record additional dates or change 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.
11. Save the child-level **herbGroup** record.
12. 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.

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).
    c. Weigh the samples as in section **E.1.8** above.

d. For cases when *Toxicodendron* is present in the woody stemmed plants **herbGroup**, follow guidance in RD[15], **Appendix F**, and helper fields in the Fulcrum application to account for mass of *Toxicodendron*.

2. If the site is not approved for subsampling, for the herbGroup = ALL sample:
    a. Record the required metadata as in **E.1.9**.
    b. Record the mass in the **inputDryMass** and confirm **finalDryMass** is populated in the *HBP: Lab Masses* application.
3. If the site is approved for subsampling AND a subsample was not created in the field, for the herbGroup = ALL sample:
    a. Enter the weight of the total sample in the **freshMass** field, and the weight of the subsample in the **subsampleFreshMass** field as described in the directions for creating the subsample (**SOP C.1**).
    b. Sort the subsample removing OSD from the current year plant material.
    c. Weigh the target plant material (as in **E.1.8**), and enter **subSampleDryMass** to the nearest 0.01 g.
        i. For very light samples < 0.01 g, record **subSampleDryMass** = 0.005g.
        ii. **finalDryMass** values are automatically calculated by the Lab Masses app.
4. Enter and/or check required metadata, as above.
5. Save the child-level **herbGroup** = ALL record.
6. Do NOT create **QA Dry Mass** records when subsampling is performed. Return biomass to temporary storage at ambient conditions.
    a. Biomass in temporary storage may be discarded once QC is complete AND Fulcrum records have successfully loaded.
7. Save the sample and 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 **weekBoutBegan** 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).
- Determine that samples are sufficiently dry as described for assessing samples (E.1): samples are dry when the weight difference between timepoints is <0.05 g or 1%, whichever is greater.

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. 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. Data collected on paper data sheets must be transcribed 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:
        i. **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** data have been entered.

F.4 Quality Assurance

Data Quality Assurance and Quality Control (QAQC) is an important part of data collection and ensures that all data regarding observations and samples are accurate and complete. ***Use the QC Checklist linked via the Herbaceous Biomass page in the SSL to perform QC***.

This protocol requires that certain QC 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.

Other QA measures needed for this protocol are described in the Data Management Protocol (RD[04]).

SOP G Sample Shipment

Not applicable for the Herbaceous Biomass protocol.

8 REFERENCES

Didan, K. 2023. *MODIS/Terra Vegetation Indices 16-Day L3 Global 250m SIN Grid V061*. 2021, distributed by NASA EOSDIS Land Processes Distributed Active Archive Center, https://doi.org/10.5067/MODIS/MOD13Q1.061.

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

APPENDIX A QUICK REFERENCES

A.1 Delineating the Clip Harvest Strip

LOCATE AND ASSESSES 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.

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.

A.2 Clipping and Sorting

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

Label Information

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

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.

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 11** for cactus species that are NEVER clipped.
- Clip qualifying *Toxicodendron spp.* according to Appendix F.

APPENDIX B 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.

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 Appendix G	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 C ESTIMATED DATES FOR ONSET AND CESSATION OF SAMPLING

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

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Additional Sampling Information
01	BART	No	1	D: 07/17 T: 07/17	Timing reflects observed senescence dates for herbaceous understory, not MODIS-EVI data.
	HARV	No	1	D: 07/17 T: 07/17	Timing reflects observed senescence dates for herbaceous understory, not MODIS-EVI data.
02	BLAN	No	1	D: 08/05 T: 08/05	Date based on Field Science observations. Dates are for peak biomass harvested in Dist Plots, and Tower Plots. Dates for agricultural Dist Plots in RD[13.]
	SCBI	No	1	D: 08/04 T: 08/04	
	SERC	No	1	D: 08/11 T: 08/11	Dates for Distributed Ag plots provided in RD[14].
03	DSNY	No	1	D: 07/28 T: 07/28	

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Additional Sampling Information
	JERC	No	1	D: 08/18 T: 08/18	
	OSBS	No	1	D: 07/25 T: 07/25	
04	GUAN	No	2	D: 10/15 T: 10/15	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	Dates for Ag plots in RD[14]. 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). Reduce the agricultural clip in the subset of Distributed plots in pastureHay to 1x per year.
05	STEI	No	1	D: 08/12 T: 08/12	
	TREE	No	1	D: 08/12 T: 08/12	
	UNDE	No	1	D: 08/13 T: 08/13	Clip and sort bryophyte functional group (herbGroup).
06	KONA	No	1	D: 08/11 T: see RD[14]	Dist Plots: date is for non-Ag plots; see RD[14] for Ag Dist and Tower Plot dates.
	KONZ	Yes	D: 1 T: Every 8 weeks	D: 08/11 T: 04/14 – 11/07	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: 08/11 T: 08/11	
07	GRSM	No	1	D: 08/09 T: 08/09	
	MLBS	No	1	D: 08/11 T: 08/11	
	ORNL	No	1	D: 07/23 T: 07/23	
08	DELA	No	1	D: 07/22 T: 07/22	

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Additional Sampling Information
	LENO	No	1	D: 07/25 T: 07/25	
	TALL	No	1	D: 07/20 T: 07/20	
09	DCFS	Yes	D: 1 T: Every 4 weeks	D: 8/05 T: 04/30 – 10/31	Modified start date based on Field Science feedback. 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: 07/31 T: 04/18 – 10/31	Modified start date based on Field Science feedback. 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: 08/10 T: 05/05 – 10/31	Modified start date based on Field Science feedback. 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: 06/12T: 03/29 – 11/08	The peak biomass bout diverges from MODIS EVI as requested per ecologist observations of peak biomass. Tower Plots: Peak biomass sort for grazed plots is bout scheduled closest to 07/10 (similar date as Dist Plot sort).
	RMNP	No	1	D: 08/06 T: 08/06	
	STER	No	1 bout per crop, per growing season	RD[14]	See RD[14]

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Additional Sampling Information
11	CLBJ	Yes	2	D: 10/01 T b1: 06/13 T b2: 10/01	MODIS-EVI data difficult to interpret; start date based on Field Science feedback. Clip harvests every 4 weeks in grazed Tower Plots; peak biomass sort is bout closest to 10/01. Tower plots that are not grazed should be clipped during bout 1 but not sorted, grazed tower plots will capture that peak with repeated grazing sampling.
	OAES	Yes	2	D: 06/13 T b2: 11/11	MODIS-EVI data difficult to interpret; start date based on Field Science feedback. Clip harvests every 4 weeks in grazed Tower Plots; peak biomass sort is bout closest to 11/11.
12	YELL	No	1	D: 07/23 T: 07/23	
13	MOAB	Yes	D: 1 T: 1	D: 08/13 T: 08/13	MODIS-EVI data difficult to interpret; start date based on Field Science feedback. Tower Plots: Exclosures deployed before stocking in spring, one peak biomass clip sorted to functional group for all clipIDs.
	NIWO	No	1	D: 08/01 T: 08/01	Earlier start date than MODIS date based on Field Science feedback.
14	JORN	No	1	D: 09/07 T: 09/07	Visual estimate from MODIS timecourse data. Grazing not anticipated in Tower plots, but may occur. Domain Mgr communicates with site host to determine if Tower Plots grazed.

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Additional Sampling Information
	SRER	Yes	2	D: 09/02 T b1: 4/01 T b2: 09/02	MODIS-EVI data variable; start date based on Field Science feedback.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: 06/10 T: 06/10	
16	ABBY	No	1	D: 06/27 T: 06/27	The peak biomass bout diverges from MODIS EVI as requested per ecologist observations of peak biomass.
	WREF	No	1	D: 6/26 T: 06/26	Date adjusted earlier than MODIS-EVI based on Field Science assessment of understory peak biomass for GASH, MANE2.
17	SJER	Yes	D: 1 T: Every 4 weeks	D: 04/10 T: 09/05 – 06/11	Tower Plots: Peak biomass sort for grazed plots is bout closest to 04/06 (similar date as Dist Plots).
	SOAP	No	1	D: 06/26 T: 06/26	Date earlier than MODIS-EVI date due to shift in vegetation following fire that is not captured by MODIS time series.
	TEAK	Yes	1	D: 07/27 T: 07/27	Date earlier than MODIS-EVI due to effect of more frequent dry years.
18	BARR	No	1	D: 07/27 T: 07/27	Earlier start date than MODIS date based on Field Science feedback. Clip and sort bryophyte functional group (herbGroup).

Domain Number	Site ID	Grazing Mgmt	Bouts per Growing Season*	Sampling Dates*† (MM/dd)	Additional Sampling Information
	TOOL	No	1	D: 07/26 T: 07/26	Earlier start date than MODIS date based on Field Science feedback. Clip and sort bryophyte functional group (herbGroup).
19	BONA	No	1	D: 07/26 T: 07/26	Earlier start date than MODIS date based on Field Science feedback. Clip and sort bryophyte functional group (herbGroup).
	DEJU	No	1	D: 07/27 T: 07/27	Earlier start date than MODIS date based on Field Science feedback. Clip and sort bryophyte functional group (herbGroup).
	HEAL	No	1	D: 07/28 T: 07/28	Earlier start date than MODIS date based on Field Science feedback. Clip and sort bryophyte functional group (herbGroup).
20	PUUM	No	1	D: 05/21 T: 05/21	Start date based on precipitation data and targets end of wet season for logistical reasons.

* '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.

APPENDIX D SITE-SPECIFIC INFORMATION

D.1 D04 – LAJA – Laja Experimental Station

Reduce the agricultural clip in the subset of Distributed Plots in pastureHay to 1x per year.

D.2 D09 – All Sites

25% subsample for sorting current-year from OSD. Applies only to grazed Tower Plot bouts not sorted to functional group. Analysis indicates subsampling to remove OSD from current-year biomass allows calculation of correct total current-year mass, and saves labor.

D.3 D11 – CLBJ – LBJ National Grassland

It is acceptable to avoid clipping (i.e., reject clipID) of sampling locations that fall in the most dense areas of vegetation.

15% subsample for sorting current-year from OSD may be employed. Applies only to grazed Tower Plot bouts not sorted to functional group. Analysis indicates subsampling to remove OSD from current-year biomass allows calculation of correct total current-year mass and saves labor.

D.4 D11 – OAES Klemme Range Research Station

15% subsample for sorting current-year from OSD may be employed. Applies only to grazed Tower Plot bouts not sorted to functional group. Analysis indicates subsampling to remove OSD from current-year biomass allows calculation of correct total current-year mass and saves labor.

D.5 D13 - NIWO – Niwot Ridge Mountain Research Station

Clip individuals that can be pinched between thumb and forefinger. Ignoring individuals < 2 cm length leads to loss of entire functional groups at NIWO, due to abundant, low-stature alpine plants.

D.6 D17 – SJER – San Joaquin Experimental Range

25% subsample for sorting current-year from OSD. Applies only to grazed Tower Plot bouts not sorted to functional group. Analysis indicates subsampling to remove OSD from current-year biomass allows calculation of correct total current-year mass, and saves labor.

D.7 D18 and D19 – All Sites

25% subsampling in the lab for obtaining dry mass of BRY functional group. Sorting live bryophyte (BRY) material from dead BRY, lichens, and other organic material is extremely time consuming, and experimental analysis has confirmed that BRY subsampling can significantly reduce the time required to sort BRY samples while maintaining data quality.

APPENDIX E 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 16. Equipment list – durable items required for per-plot biomass clip harvesting and sorting (quantities are for two technicians).

Supplier/Item No.	Exact Brand	Description	Purpose	Quantity
Durable Items				
	N	GPS receiver, recreational accuracy, e.g. Garmin Etrex20x	Navigate to sampling location	1
	N	Compass with mirror and declination adjustment	Locate clip-harvest strips (with measuring tape)	1
Forestry Supplier 91567	Y	TruPulse 360R Laser Rangefinder, 0.3 m accuracy	Locate clip-harvest strips within plots/subplots; use when plot slope > 20% or brushy	1
Compass Tools; 703512 Forestry Supplier; 90998	Y	TruPulse Foliage filter	Allow laser rangefinder use in dense vegetation	2
	N	Flat 3” reflector (reflective tape acceptable)	Reflective target for laser rangefinder; aids in measuring distance to target accurately	1
Constructed in-house (Maximo) EG07570000 EG0757000	*NA*	Grazing exclosure, tall or short grass system (see NEON.DOC.001788 for assembly diagram)	Prevent herbivory at clip location in actively grazed sites	
	N	Hammer	Install and remove grazing exclosure stakes	1
	N	Pruning shear	Clip plants	

Supplier/Item No.	Exact Brand	Description	Purpose	Quantity
	N	Magnifier hand-lens, 10X	Aid in species identification	1
	N	Magnifier hand-lens, 20X	Aid in species identification	1
	N	Cold packs	Chill perishable samples in field	
	NA	Pre-marked string and stake sets	Delineate clip harvest strip; polyester cord recommended to minimize stretching with use.	
	N	Chaining pins or other suitable anchor	Anchor measuring tapes	2
	N	Measuring stick, minimum 2 m length, folding; or equivalent such as tent pole frames or similar	Delineate clip harvest strip for crops (may be easier to push through thick vegetation than using string sets)	1
	N	Measuring tape, minimum 30 m	Locate clip-harvest strips within plots/subplots. Plot slope < 20%; grassland, savannah	1
	N	Ruler, 30 cm	Delineate clip-harvest strip	1
	N	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	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	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 D for list of approved sites).	1
	N	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 D for list of approved sites).	1
	N	Forceps	Identify and sort plants	2
	N	Work Gloves	Protect hands	2

Supplier/Item No.	Exact Brand	Description	Purpose	Quantity
	N	Coolers	Chill perishable samples in field	1
Consumable Items				
	N	Survey marking flag, PVC or fiberglass stake	Delineate sampling area	4
	Y	Adhesive barcode labels (Type I)	Label samples with barcode readable labels	1 sheet
	N	Sample warning pictogram label	Identify samples that may contain *Toxicodendron* tissue	1 sheet
	N	Paper bags, #8[1]	Contain clipped herbaceous biomass, sorted to functional group	50[2]
	N	Paper bags, #25[1]	Organize smaller bags from a given clip strip	10[2]
	N	Heavy-duty freezer bags, 3-4 mil; e.g., 18" x 21" Large Thick 4 Mil Clear Zip Storage Bags, Heavy-Duty Plastic Reclosable Zip Seal Poly Lock Bag, Durable Zipper Bags	Bryophyte sample collection	
	N	Permanent marker	Label paper bags	2
	N	CR123A battery	Spare battery for laser rangefinder	2
	N	AA battery	Spare battery for GPS receiver	2
Resources				
	N	Mobile data collection device, table or equivalent	Record field sampling metadata	1
RD[05]	*NA*	Herbaceous Biomass Field Datasheets	Record sampling metadata	
	NA	Per plot or subplot Clip Lists	Identify random clip strip locations	As needed
	NA	Field guide, regional flora reference guide and/or key	Identify leguminous forbs and graminoids to species	1

Table 17. Equipment list – Post-field sampling tasks.

Supplier/Item No.	Exact Brand	Description	Purpose	Quantity
Durable Items				
	N	Magnifier hand-lens, 10X	Aid in species identification	1
	N	Magnifier hand-lens, 20X	Aid in species identification	1
	N	Coolers	Chill perishable samples in field	1
	N	Cold packs	Chill perishable samples in field	Variable
Resources				
RD[05]	*NA*	Completed Herbaceous Biomass Field Datasheets	Contains field-collected sampling metadata	Variable
	NA	Field guide, regional flora reference guide and/or key	Identify leguminous forbs and graminoids to species	1

Table 18. Equipment list – Processing herbaceous biomass clip-harvest samples in the laboratory.

Supplier/Item No.	Exact Brand	Description	Purpose	Quantity
Durable Items				
	N	Balance, 0.01 g accuracy	Weigh samples	1
	N	Weigh boats, large	Contain dried sample while weighing	Variable
	N	Plastic tray	Contain oversized samples while weighing	*1*
Consumable Items				
RD[05]	*NA*	Datasheets: Lab Drying QC Datasheet Lab Weighing Datasheet	Recording dry weight or herbaceous biomass	As needed

APPENDIX F CLIP HARVESTING TOXICODENDRON SPECIES

F.1 Equiment and Materials

Protocol-specific equipment for mitigating exposure to toxic oils from *Toxicodendron* species. General equipment and PPE is listed in RD[15].

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

Table 19. 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[15].

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:
    a. Minimize potential spread of toxic oil by putting *Toxicodendron* biomass bags into the same drying oven every time.
    b. When drying is complete, clean drying oven shelves used for drying *Toxicodendron* biomass bags with hot water and Tecnu. Wear appropriate PPE when cleaning.

c. 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.

    i. 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.

    ii. 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.

d. After weighing, dispose of all *Toxicodendron* biomass bags.

    i. *Toxicodendron* tissue will not be specimen mounted, or processed for Herbaceous Biogeochemistry (i.e., archived and sent for external chemical analysis).

APPENDIX G BRYOPHYTE COLLECTION AND PROCESSING

G.1 Preparing for Sampling

1. Create pre-cut rite-in-the-rain labels using a template for each clip cell that will be sampled for bryophytes. At a minimum, the template must allow recording: **plotID, sampling cell,** and **date**.
    a. Labeling information written directly on plastic bags can easily rub off; in addition, not writing directly on heavy-duty bags means they can be re-used.

G.2 Field Sampling

BRYOPHYTE SAMPLING TIPS

The goal of the protocol is to efficiently quantify the bryophyte contribution to total herbaceous biomass. As such, only those bryophyte morphologies that substantially contribute to the total herbaceous biomass should be harvested. Target taxa/morphologies include sphagnum, boreal feather, and cushion mosses; when clipping, collect material that can be pinched and harvested with clippers or a razor. Do not collect bryophyte taxa that don't represent an appreciable amount of herbaceous biomass. Growth forms that are diminutive, sparse, or tightly appressed to the ground, rocks, or other substrates – i.e., those materials that can't be pinched – should not be collected. Do collect bryophytes growing on downed logs that intersect the clip strip, but do not include epiphytic bryophytes in the sample.

In many cases, bryophyte sampling will remove the clip-strip sized patch of material that is part of a continuous mat. Other functional groups are often removed in this process and can be sorted as appropriate.

1. Collect BRY along with other herb groups as directed in **SOP B.**
2. Clip 'mat-forming' bryophytes that grow in sometimes relatively deep layers on the ground. It is helpful to develop site-specific expertise and training materials to determine a depth that more or less corresponds to the transition from "live" to "dead" bryophytes, and to clip to that depth to get total bryophyte stocks (**Figure 14**).
    a. Mat-forming, feather, and cushion bryophytes growing on downed logs and branches of downed logs that intersect the clip strip should be included in the sample.
    b. Bryophytes growing on living trees are not the intended target of the HBP protocol and should not be collected for inclusion in the sample.
3. Place all BRY from an entire clip strip into a single, labeled bag to ensure BRY samples are processed and subsampled as one unit.
4. Sample bag should be larger 1 gallon plastic freezer bag (at least 3 mil). These bags are more durable in a freezer and can hold more compressed BRY material than paper bags.

5. Large samples that don't fit in 1 gallon bags can go in larger, heavy-duty 4 mil bags.
6. *Example bags*: 18" x 21" Large Thick 4 Mil Clear Zip Storage Bags, Heavy-Duty Plastic Re-closable Zip Seal Poly Lock Bag, Durable Zipper Bags.
7. Fill out premade, precut rite-in-the-rain sample label template (from SOP A). Place the label inside the plastic bag, oriented so the writing is visible through the bag from the outside.
8. Once collected, store BRY sample in a cooler with ice packs for transport to field housing or DSF refrigerators.

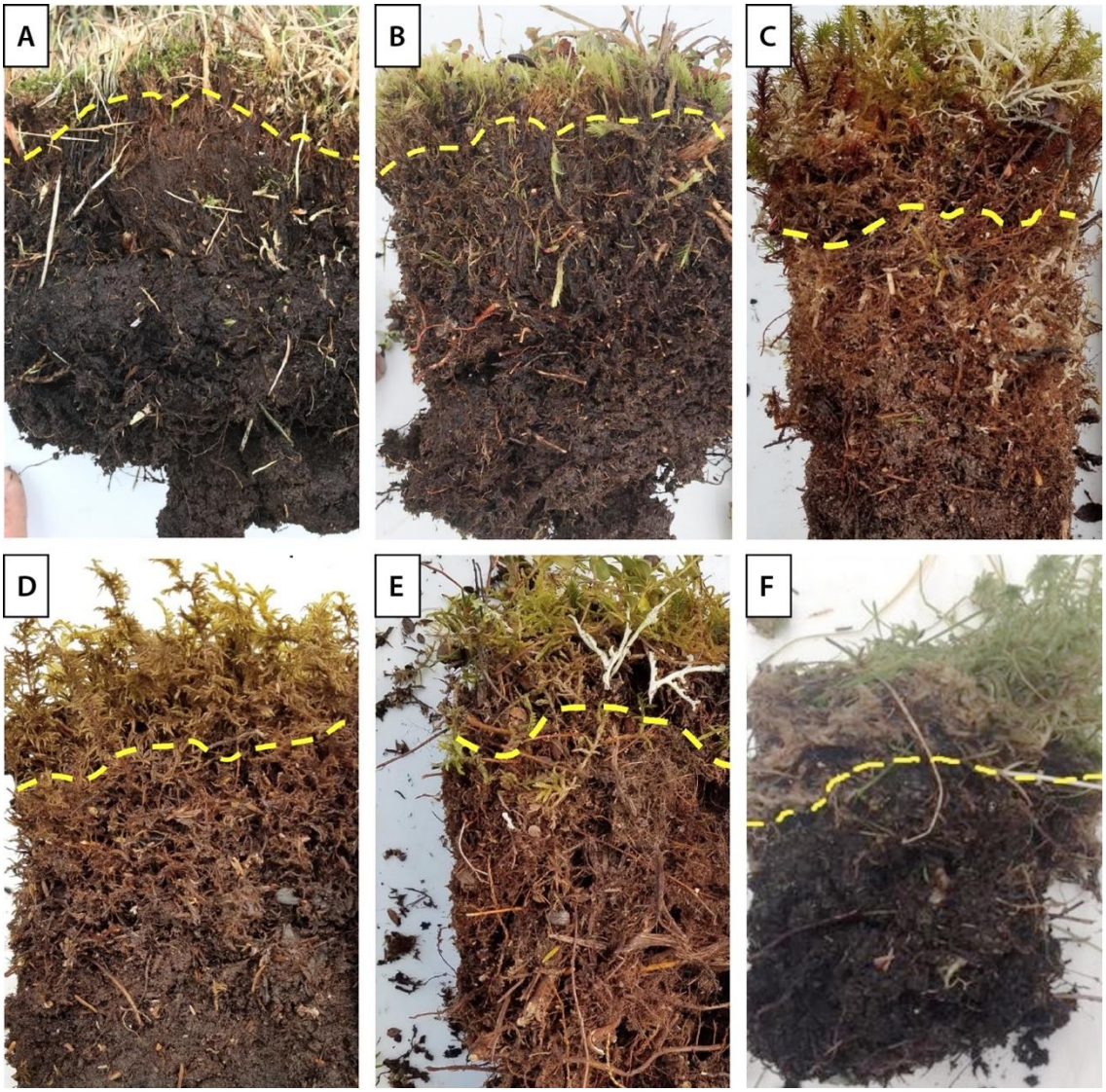

Figure 14. The start of the soil surface (dashed yellow line) at sites with ground cover dominated by bryophyte biomass. Bryophyte material above the yellow line should be clipped as part of this protocol. (A) BARR, (B) TOOL, (C) BONA, (D) DEJU, (E) HEAL, and (F) TREE. Soils collected by NEON during site characterization and in collaboration with NRCS.

G.3 Post Field Sampling

BRYOPHYTE SAMPLING HANDLING TIPS

- Water will continuously evaporate from the homogenized BRY material. Water loss means that the fresh mass of the whole sample will decrease over time as the sample is exposed to open air.
- Be organized and focused with subsampling once a fresh mass of the whole sample is acquired. The longer it takes to create the BRY subsample, the less meaningful the subsample proportion becomes compared to the fresh mass of the whole homogenized sample. The less time subsampling takes after the original fresh mass is recorded, the better the subsampling results will be.
- As with other HBP functional groups, it is preferable to subsample and sort BRY samples immediately. However, if BRY samples cannot be homogenized, subsampled, and sorted within 5 days from collection, samples can be frozen AFTER removal of excess water (step 2 below). Freezing extends the sorting deadline; however, samples should be fully processed within the sampling year that they were collected.
- Do NOT subsample if the bryophyte sample is < 100 g fresh mass.

1. BRY samples can be stored in a 4 ˚C refrigerator for up to five days.
2. Remove excess water from the BRY sample before subsampling occurs in the lab. Drier samples lead to better and more consistent results from the homogenizing and subsampling process.
    a. Gently roll the sample in the plastic bag with the bag slightly open and allow excess water to pour out of the bag without losing any plant tissue.
    b. BRY samples that are properly labeled and from which excess water has been removed may be stored in a –20 ˚C freezer.
3. Remove collected BRY samples from refrigerator/freezer and homogenize. The intention is that the homogeneous sample can be split into smaller subsamples and that each subsample will be representative of the BRY material in the clip strip.
    a. If frozen, samples will usually thaw overnight in a 4 ˚C refrigerator. Larger samples weighing over 1000 grams will take longer to thaw.
    b. Empty the sample bag into a container that can easily hold the entire BRY sample.
    c. Mix the sample well by hand, splitting apart clumps of moss and removing any large obvious incorrectly sorted material like soil or twigs (no more than 5 minutes, this is not a sort).
4. Weigh the fresh mass of the whole homogenized sample (nearest 0.01 g).
    a. Tare a container (e.g., a 2000 mL glass beaker), and add the entire homogenized sample.

b. In the ***HBP: Lab Mass [PROD]*** fulcrum application record sample information as with other functional groups.

c. If subsampling:

   i. Set **Subsamples created in lab?** to 'YES'

   ii. For the BRY child record, enter the **freshMass** (nearest 0.01 g). Note the value that populates in the **targetSubsampleFreshMass** calculator: This calculated value is based on the site-specific subsampling target (**Appendix D.7**).

   iii. Subsample the homogenized BRY material. The subsample should be within ± 10% of the **targetSubsampleFreshMass** calculator target value displayed in the *HBP: Lab Masses [PROD]* app.

      1) Label a paper bag of suitable size. In addition to all the information needed on standard HBP functional group bags, subsample bags should be labeled with the **Subsample Fresh Mass.**

      2) Tare the labeled paper bag.

      3) Add homogenized BRY to the tared subsample bag on the scale to within ± 10% of the target mass.

      4) Record the **subsampleFreshMass** (0.01 g) on the labeled subsample bag.

      5) Record the **subsampleFreshMass** (0.01 g) in the corresponding *HBP: Lab Masses [PROD]* BRY child record and save the record.

      6) Discard the unused BRY sample material.

BRYOPHYTE SAMPLING HANDLING TIPS

- To save time during subsampling, pre-label the subsampling bags to minimize time spent writing during subsampling.

d. If not subsampling:

   i. Set **Subsamples created in lab?** to 'No'

e. Process and sort the BRY subsample or sample according to SOP E or place the sample in cold storage.

   i. Paper bags can be stored directly in a 4 ˚C refrigerator if they will be sorted within 5 days of initial collection.

ii. If the BRY subsample or sample will not be sorted within 5 days of collection, deposit the paper bag containing the subsample or sample into a plastic bag and place in a –20 ˚C freezer to await sorting and drying.

iii. If samples will be refrozen before sorting, it is important that subsample or sample paper bags are stored inside plastic bags. This will prevent bags from sticking to the freezer shelves and becoming torn. Multiple subsamples or samples may be stored in plastic bags in the freezer, though no more than might be sorted in a week (10 bags maximum).

G.4 Laboratory Processing

1. Prepare and pre-weigh empty paper bags for oven-drying sorted BRY subsamples or samples. Oven-dried BRY are strongly affected by static electricity. It is highly preferable to weigh dry sorted BRY in the bag. Recording and subtracting the empty bag weight from the final dry mass is critical for accurate subsample or sample dry mass weights.

    a. Dry empty bags for 24 h in a 65 ˚C oven, then weigh and record the empty bag mass clearly on the bag (nearest 0.01 g). Oven-drying is required because bags will absorb humidity from the atmosphere.

2. Thaw frozen BRY subsamples or samples in a 4 ˚C refrigerator for 24 hours prior to sorting. Subsamples or samples < 1000 g are likely small enough to thaw overnight.

    a. Do not thaw more subsamples or samples than can be sorted in 3 days.

3. Place thawed BRY subsample or sample on a sorting tray.

    TIP: Only have one sample outside of the refrigerator at a time to avoid accidental mixing of samples.

4. Sort living BRY material from dead bryophytes, lichens, and other materials according to existing protocol guidelines.

    a. Place sorted BRY material into a pre-weighed paper bag (see Step 1).

5. Oven-dry sorted BRY subsamples or samples at 65 ˚C for a minimum of 48 h and track weights to confirm dryness according to standard protocol procedure.

6. When samples are dry, if subsampling record **subsampleDryMass** (nearest 0.01 g) or if not subsampling record mass values directly to the **finalDryMass** in the *HBP: Lab Masses [PROD]* Fulcrum application.

    a. Make sure the **subsampleDryMass** and **finalDryMass** do not include the mass of the bag.

APPENDIX H SAMPLING CELL NUMBER COORDINATES AND MAPS

H.1 Maps of samplingCellNumber by subplotID

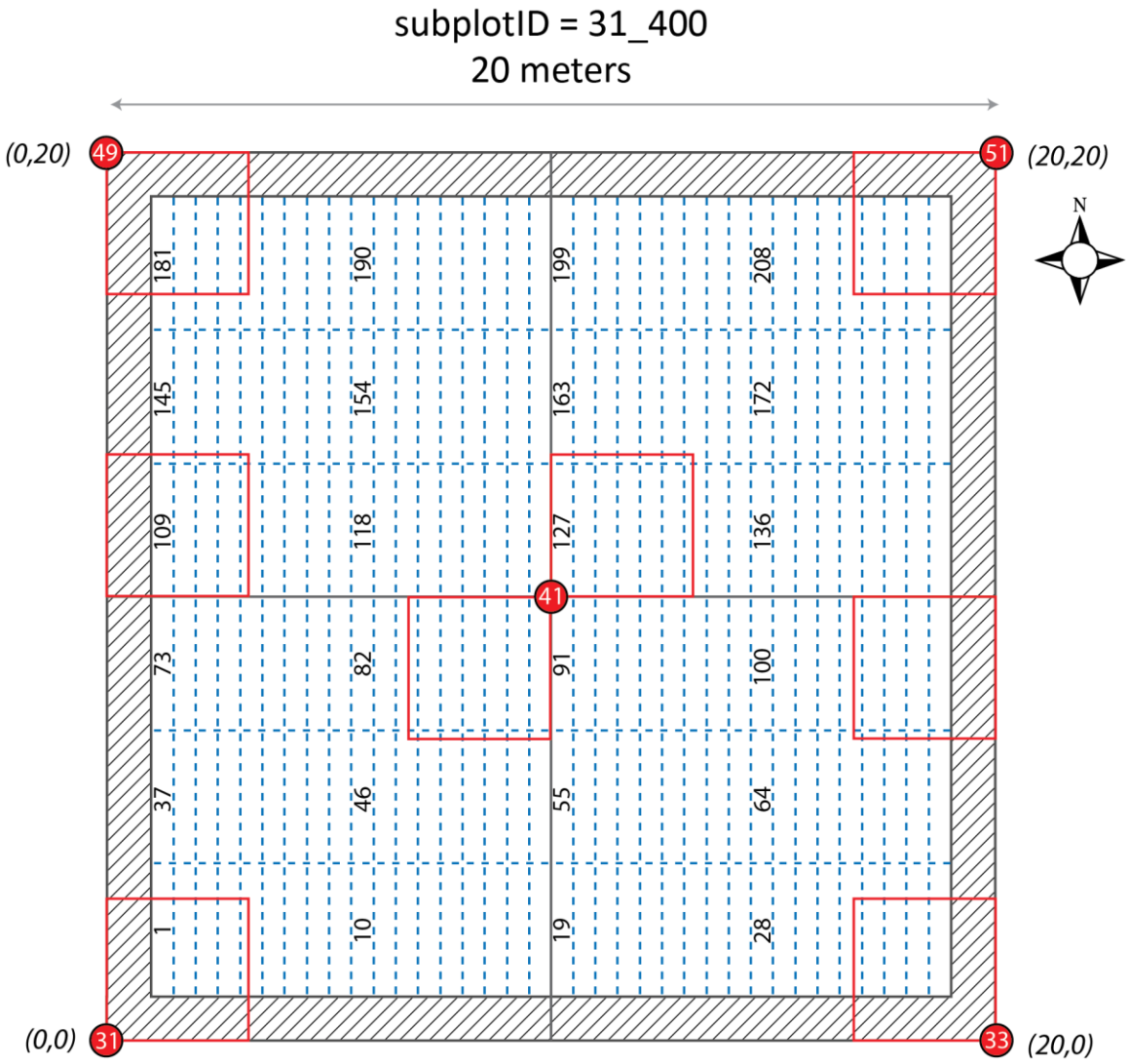

Figure 15. Map of Sampling Cells and numerical identifiers in a 20m x 20m base plot (subplotID = 31_400). Red squares indicate nested subplots used for diversity sampling; sampling cells that significantly overlap red squares are not used for fine root soil sampling or clip sampling. However, cells with minimal overlap (e.g., 48-54, 68-72, 145-149) do support these sampling activities. Red circles with white numbers represent plot markers with associated pointIDs.

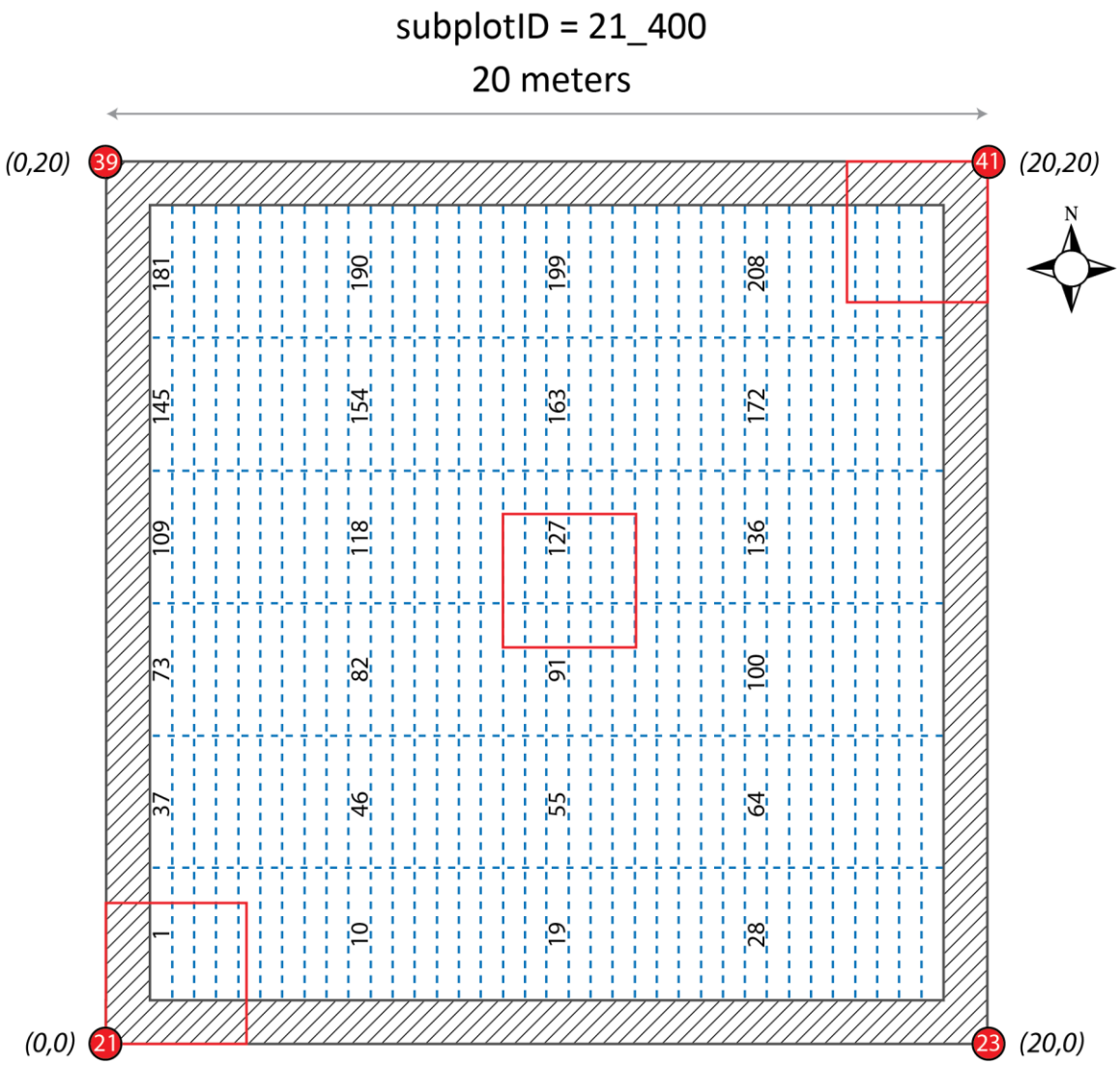

Figure 16. Map of Sampling Cells and numerical identifiers for **subplotID = 21_400** in a 40m x 40m Tower base plot. Cells that overlap nested subplots indicated by red squares are not used for fine root soil sampling or clip sampling. Red circles with white numbers represent plot markers with associated pointIDs.

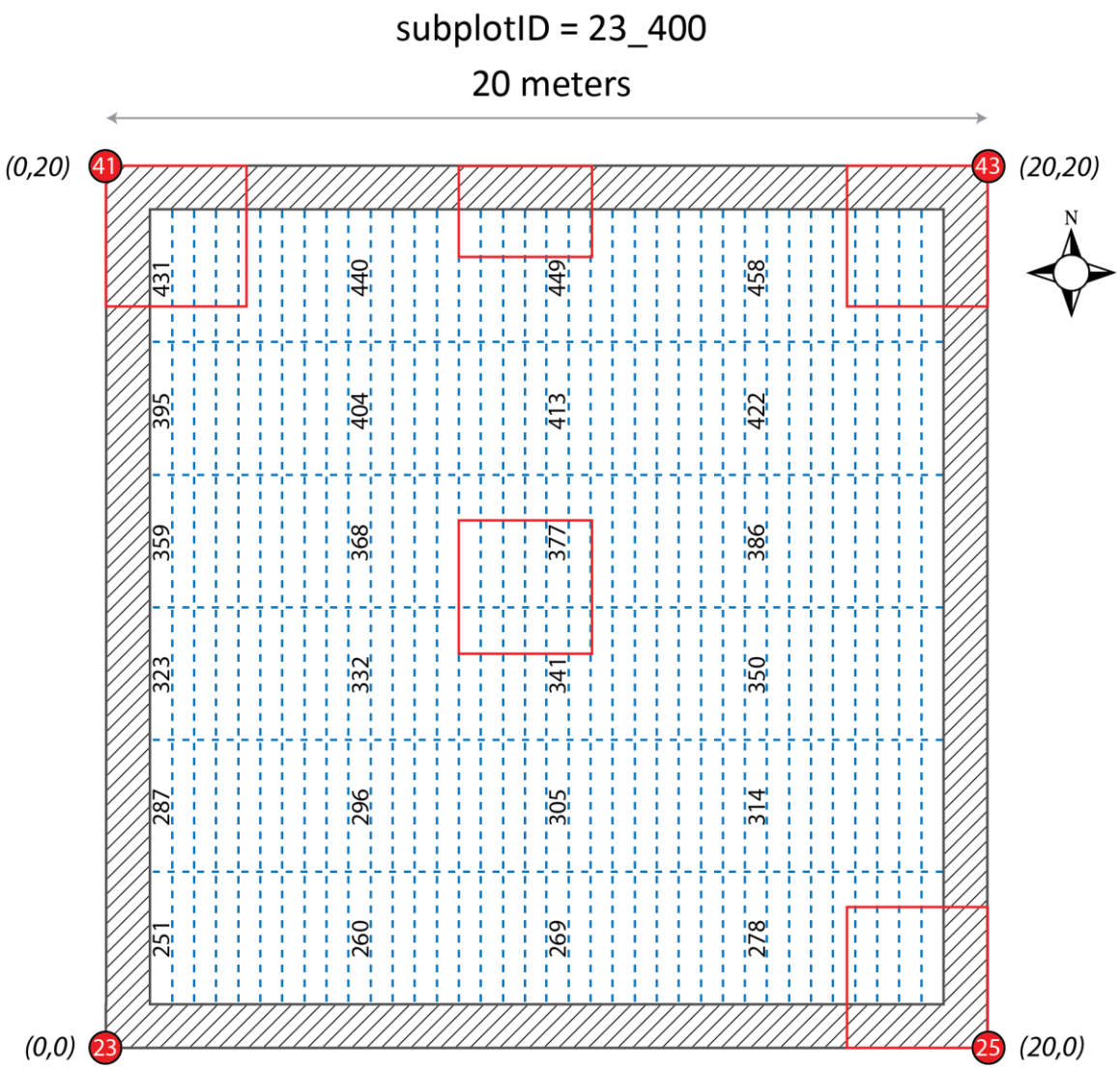

Figure 17. Map of Sampling Cells and numerical identifiers for **subplotID = 23_400** in a 40m x 40m Tower base plot. Cells that overlap nested subplots indicated by red squares are not used for fine root soil sampling or clip sampling. Red circles with white numbers represent plot markers with associated pointIDs.

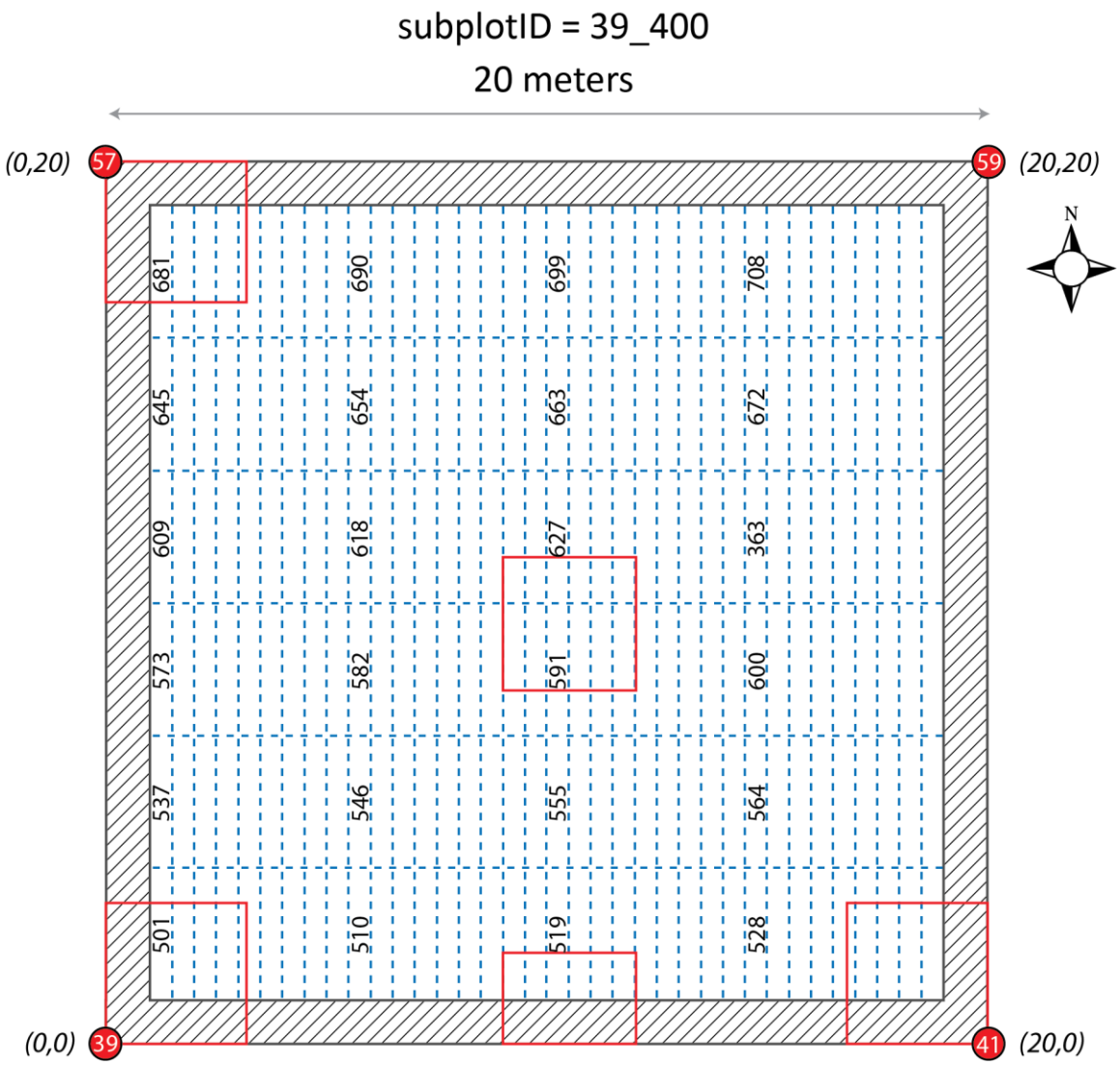

Figure 18. Map of Sampling Cells and numerical identifiers for **subplotID = 39_400** in a 40m x 40m Tower base plot. Cells that overlap nested subplots indicated by red squares are not used for fine root soil sampling or clip sampling. Red circles with white numbers represent plot markers with associated pointIDs.

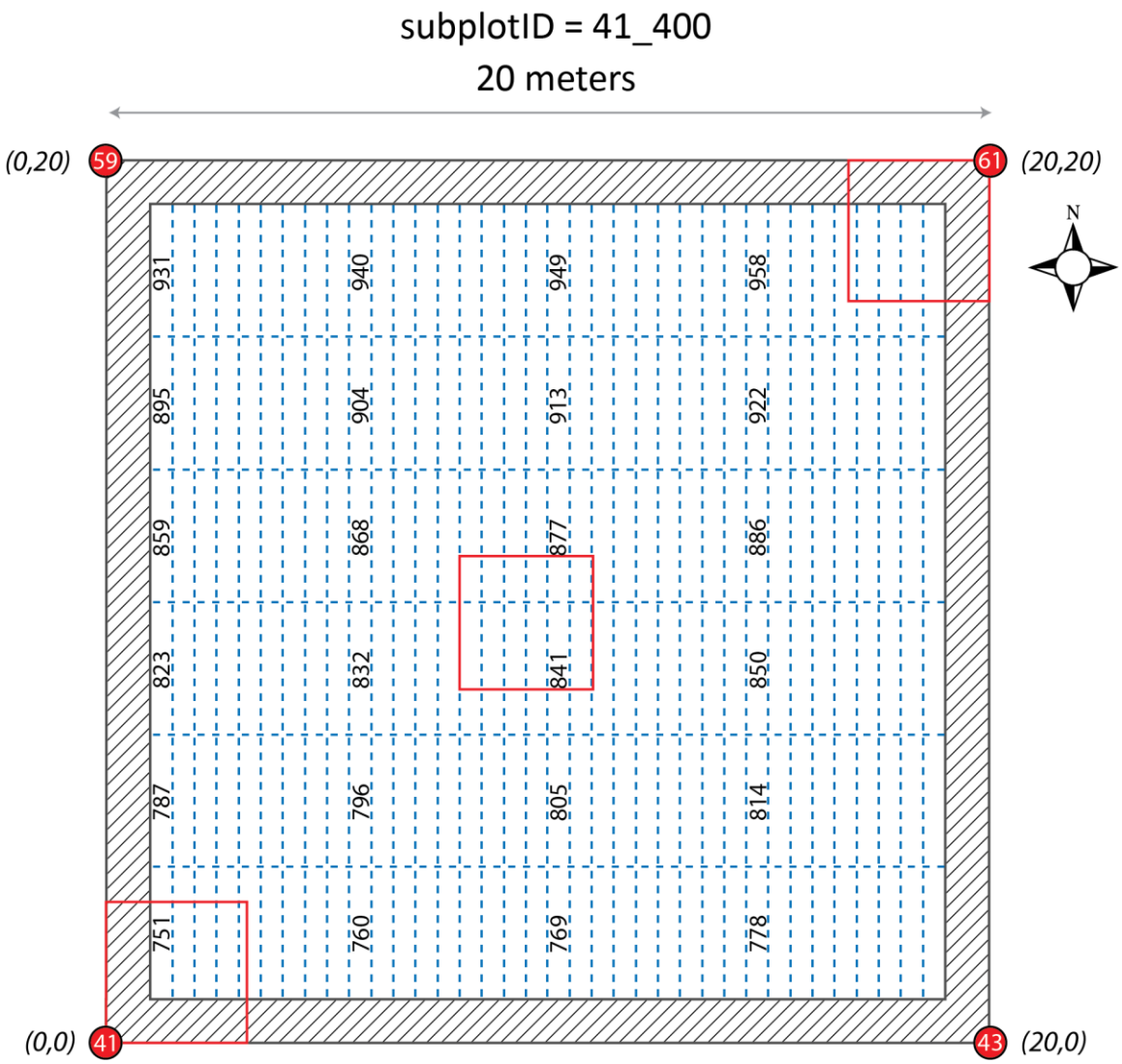

Figure 19. Map of Sampling Cells and numerical identifiers for **subplotID = 41_400** in a 40m x 40m Tower base plot. Cells that overlap nested subplots indicated by red squares are not used for fine root soil sampling or clip sampling. Red circles with white numbers represent plot markers with associated pointIDs.

H.2 Coordinates for samplingCellNumbers by subplotID

Table 20. List of Sampling Cells and numerical identifiers by subplotID and associated easting and northing coordinates. Coordinates correspond to the SW corner of a 2m x 0.1m Clip Strip, and indicate the distance in meters relative to the SW corner of the plot (subplotID = 31_400) or subplot (subplotID = 21_400, 23_400, 39_400, and 41_400).

Cell Numbers subplotID = 31_400	Cell Numbers subplotID = 21_400	Cell Numbers subplotID = 23_400	Cell Numbers subplotID = 39_400	Cell Numbers subplotID = 41_400	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

Cell Numbers subplotID = 31_400	Cell Numbers subplotID = 21_400	Cell Numbers subplotID = 23_400	Cell Numbers subplotID = 39_400	Cell Numbers subplotID = 41_400	easting offset	northing offset
37	37	287	537	787	1.2	4.5
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

Cell Numbers subplotID = 31_400	Cell Numbers subplotID = 21_400	Cell Numbers subplotID = 23_400	Cell Numbers subplotID = 39_400	Cell Numbers subplotID = 41_400	easting offset	northing offset
79	79	329	579	829	4.2	7.5
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

Cell Numbers subplotID = 31_400	Cell Numbers subplotID = 21_400	Cell Numbers subplotID = 23_400	Cell Numbers subplotID = 39_400	Cell Numbers subplotID = 41_400	easting offset	northing offset
121	121	371	621	871	7.2	10.5
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

Cell Numbers subplotID = 31_400	Cell Numbers subplotID = 21_400	Cell Numbers subplotID = 23_400	Cell Numbers subplotID = 39_400	Cell Numbers subplotID = 41_400	easting offset	northing offset
163	163	413	663	913	10.2	13.5
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

Cell Numbers subplotID = 31_400	Cell Numbers subplotID = 21_400	Cell Numbers subplotID = 23_400	Cell Numbers subplotID = 39_400	Cell Numbers subplotID = 41_400	easting offset	northing offset
205	205	455	705	955	13.2	16.5
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