

Terrestrial Field Data Collection Protocols

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SUMMARY

This report describes the terrestrial field data collection (methodology) presently being used by the Alberta Biodiversity Monitoring Institute (ABMI). This report is divided into 2 parts. Part 1 describes each of the terrestrial sampling protocols. Protocols are grouped into categories (Site Establishment, Spring Terrestrial, Summer Terrestrial) depending on the time of year they are to be conducted. Part 2 is composed of appendices and references that provide supplementary information.

BACKGROUND

Initial protocols for terrestrial data collection for the ABMI were developed between 1998 and 2001. A large group of scientific experts developed feasible, cost-effective methodologies capable of monitoring a diversity of biota over broad spatial scales and long time periods. The integrated terrestrial protocols were field tested during 2002. Based on that field test, revisions were implemented to make the protocols more cost-effective and to remove inconsistencies among the elements. Starting in 2003, most of the ABMI's terrestrial protocols were tested and revised as part of a 4-year prototype. Minor revisions have occurred since that time to articulate the methods more clearly.

PART 1. DATA COLLECTION PROTOCOLS

Protocols in this document are grouped based on the time of year they will be conducted.

- (1) **Managing Data Quality and Integrity** occurs throughout the field season.
- (2) **Establishing Terrestrial Sites** occurs during the month of May.
- (3) **Spring Terrestrial Protocols** are carried out from mid-May through to the end of June.
- (4) **Summer Terrestrial Protocols** are conducted immediately following the spring protocols – end of June through to the end of July.

MANAGING DATA COLLECTION QUALITY AND INTEGRITY

Personnel and Sampling

These data collection protocols are designed to be implemented by a field crew of 2 personnel working together, or at times semi-autonomously. At least one of the field crew members needs to have a strong background in identifying vascular plants.

These protocols are designed to collect data on thousands of species across Alberta. Many of these species can only be accurately identified by taxonomic experts. As a result, certain protocols rely heavily on the collection of specimens in the field that are later identified by qualified personnel in a laboratory setting. Vascular plants are the only taxonomic group that are subject to species-level identification in the field.

Crew Training Prior to Data Collection

All field staff receive training so they can operate vehicles and equipment safely. In addition, staff receive extensive training (in the classroom and field) prior to the beginning of each type of data collection. This protocol training includes learning what to do in a variety of field conditions that will be encountered, as well as conducting data collection at test sites. Crew members first become familiar with the protocol documents, field manuals, general field procedures, and field equipment (**Appendix 1: Equipment List**), then practice the data collection in a diversity of habitats. Questions that arise during

training are discussed with field supervisors. When necessary, training is delivered by experts (e.g., vascular plant identification, bryophyte and lichen collection).

To ensure data collection remains accurate through the season and that nothing is being missed, field crews review the protocols regularly. A detailed description of the training is outlined in the *ABMI's Terrestrial Field Training Manual*. Field supervisors visit each crew at a field site as early in the shift as possible to assist with problems, and to ensure that protocols are being followed and data are being collected properly. Supervisors conduct these quality control visits during each of the protocol phases (establishment, spring, and summer) and observe crew members performing all protocols. Note: multiple visits are required if there is concern over the quality of fieldwork being performed.

Entering Data into Tablets in the Field

Crews use tablets to record data. They also carry paper data sheets in case of electronic difficulties. Tablet entries must reflect exactly what was found/measured at the site. If options for a specific data field do not include an appropriate response, crews record the most appropriate descriptors and make extensive notes regarding their observations. Technicians do not create new categories or descriptors. All tablet data fields must have information recorded – even if it is a “zero”, “not applicable”, or “did not collect” (see below for descriptors of each). If data could not be collected for a specific element, then this must be noted in the tablet and the crew supervisor advised as soon as possible (end of the day at the latest).

None or 0 – None or “0” is applied to any variable that ***was examined*** by field crews and found to be absent. “None” is used for text entries and “0” is used for numerical entries. For example, when field crews examine the canopy and find no “Veteran” trees, this is to be recorded as “None”. When there is no slope at the site, this should be recorded as “0”. “0” can also be used as a code.

Variable Not Applicable (VNA) – Some ABMI data are collected in a nested manner. For example, for the variable “Tree Species”, a variety of nested conditions may describe the variable (e.g., Condition, DBH, Decay Stage, etc.). When a variable is recorded as “None”, nested conditions do not apply and are recorded as “VNA”. VNA is also used when the protocol calls for a modified sampling procedure based on site conditions, or the data cannot be collected due to the site being in open water. The use of VNA indicates that the cell cannot have data present.

Did Not Collect (DNC) – “DNC” is used to describe variables that should have been collected, but were not due to crew oversight, equipment failure, safety concerns, environmental conditions, or time constraints. The use of DNC highlights that the cell ordinarily would have contained data. If “DNC” is used, talk to your coordinator before leaving site and record an additional comment in the tablet explaining why the data were not collected.

In some cases, protocol data are collected in percentage brackets. Rounding may be required to determine what bracket best represents the characteristics found at site. The <1% category is reserved for describing features present on the landscape that occupy an area of less than 1 percent of a plot, ecosite, or other area of interest. In cases where the <1% option is present, the next bracket (5%) is used to describe features on the landscape occupying an area of 1% to less than 7.5% of the area. All other percentage brackets are subject to standard rounding rules.

Checking and Backing Up Field Data at Camp

Data entered in the tablet must be checked every evening for completeness. Missing fields should be immediately filled in, or an explanation provided in the comments section of the tablet as to why data are incomplete. Data should be exported from the tablet program and backed up nightly onto a USB flash drive. All additional data, including GPS coordinates, site photographs, and site samples, must be properly labelled and safely stored (see **Appendix 2: ABMI Naming Conventions** for a consolidated list of ABMI naming conventions). The data flash drive should remain in a secure area (e.g., in the trailer), and should not be taken into the field. When connectivity allows, crews are also expected to upload digital data to a secure FTP on a daily basis. Crews must recollect lost or missing data. If any data are collected on paper, these sheets need to be checked for accuracy and legibility. Datasheets should be stored in a secure location and handed in to a supervisor at the end of the shift.

Transferring Field Data

Data posted to the secure FTP are received by the crew supervisor throughout the shift. Tablet and/or USB flash drives containing data back-ups are transferred to the supervisor when the supervisor visits, or at the end of a shift. The completeness (e.g., all assigned sites present and all data fields filled in) of the data is confirmed during the transfer. Once field supervisors complete the initial data verification, they send all the data to the database programmer.

Shipping Specimens and Samples

Specimens and samples are shipped by bus or courier from field camps to the ABMI Processing Centre. The timing required for shipping and the packaging required for each type of specimen and sample are described in each of the protocol sections below. All specimens and samples that are shipped must be accompanied by a USB flash drive containing a document describing the shipment (type of sample, number of boxes/bags with specimens/samples, list of the sites where the samples were collected, number of samples, and name(s) of the person(s) that sent the samples).

Data Entry and Verification

Data are compiled and transferred into an electronic database by a database programmer. Electronic verification routines are performed on the database to ensure that data are complete and consistent with allowable codes.

ESTABLISHING TERRESTRIAL SITES

Establishment of terrestrial sites has three main components: mapmaking, route finding, and flagging the site. Individual maps are created in the office to assist field crews in their first visit to an ABMI site. Mapmaking requires use of satellite images to create base layers in GIS which are then overlaid with important access features such as roads, trails, seismic lines, pipelines, well sites, and water features. For private sites, an additional page with landowner/leaseholder phone numbers is included with the map and provided by the ABMI access manager/coordinator. This page will also include any prescribed access information from the landowner (e.g., whether crews should phone ahead, if specific gates or trails can be used, if quads or trucks are allowed in the fields). During the initial site visit, the most efficient route is found and described on the Access Data Sheet (**Appendix 3: Example of an Access and Revisit Data Sheet**) and on supplied maps. Any potential or existing hazards must also be described, and their location(s) marked on the map. Finally, additional maps and descriptions are prepared if required and access materials are compiled to facilitate data collection during subsequent visits.

Field Reconnaissance and Establishment of Terrestrial Sites

This protocol is designed to facilitate spring and summer sampling by having a predetermined route to site center recorded on an access sheet. Crews will have an estimated timeframe for getting to the site and have knowledge of potential access hazards. In addition, the 1ha site boundary, soil plots, downed woody material transects, plus 5x5m, 10x10m, 25x25m tree/snag plots are marked and flagged.

Field Equipment:

ABMI site maps

Folding handsaw/"Swede-saw"

GPS and compass

4 – 1.5m orange conduit per site

1 – 1.5m orange/blue conduit per site

5 – 12" magnetic survey spikes per site

32 – pigtails per site (8 with orange-painted tops)

2 – 100m tapes

Mallet

Orange, red, blue, and pink/blue flagging tape

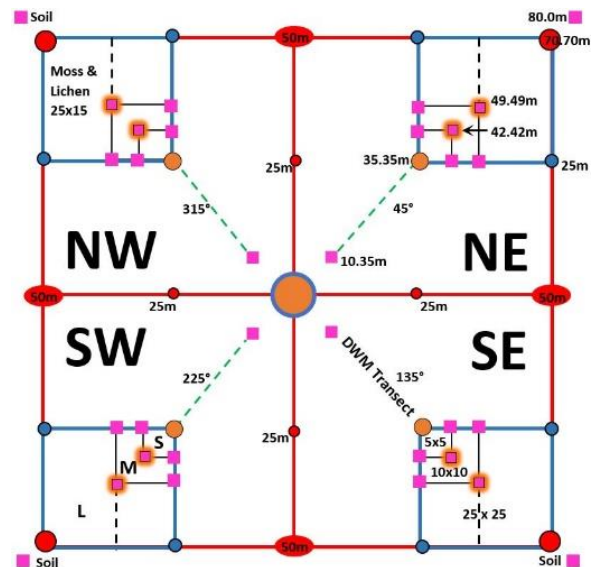


Figure 1. ABMI site layout

Ensure that compass declination is set appropriately for the location. Declinations for each site will be provided by the field supervisor. Record declination on the Access Sheet (**Appendix 3: Example of an Access and Revisit Data Sheet**) and on the front of the site package envelope. The accuracy of the GPS used during site establishment is also documented on the Access Sheet. Ensure that the GPS is configured to the NAD83/GRS80 settings.

Using orange flagging tape, mark corners and turn-offs while heading into the site on ATV, Argo, or on foot. Do not flag excessively. One strip at a corner will do. Flag on the RIGHT side of the trail or road (going into the site) for consistency and ease of removal in summer.

Record the GPS locations of corners, turn-offs, significant landmarks, and parking locations. Include detailed direction and distance measures to aid staff in relocating all access points and site center (**Appendix 3: Example of an Access and Revisit Data Sheet**).

Remove any impediments to travel if possible.

If it will take more than 2.0 hours to access a site, alert your supervisor.

Sites located in open water that are >200m from any vegetation are recorded as “Open Water” and are not visited for field data collection:

- Tablet data fields/data sheets are completed by recording zeros/none where appropriate and VNA for information that was not collected.
- It may be necessary to visit the site to confirm it is >200m from vegetation.
- Note that at some sites, the site center may be in open water, but camera/ARU stations will have been moved to shore; these stations will still be visited.

On public land

- Site center must be located as precisely as possible using a hand-held GPS with an accuracy of <7m. If, due to heavy forest cover or poor satellite coverage, accuracy values from the GPS are >7m, this is noted on the site establishment data sheet.
- At site center, drive a 1.5m steel conduit or bar (permanent marker) into the ground so that it protrudes 1m above the ground. Drive a magnetic survey spike below the ground surface, under the bar, a minimum of 30cm. In highly disturbed areas, dig the spike down to below 40cm. Steel conduit or rebar, as well as magnetic survey spike, should also be driven into the ground at the center of each quadrant (35.35m) to facilitate accurate re-establishment of plots during visits in later years. Be mindful of any ground disturbance restrictions at the site before installing conduit and spikes (e.g., be aware of pipeline locations and right of ways). Note that these permanent markers are not used on private land.
- Conduit and rebar should be painted with high visibility orange paint prior to being taken into the field. This allows them to be found much more easily in dense or shrubby site locations. Site center markers should be painted bright blue on the top 10cm to be easily distinguished from quadrant center markers. During establishment, site center and 35.35m markers are flagged with orange flagger to help crews locate them easily after leaf-out.
- Use a 100m tape to lay out the site. Start at site center and measure 80.0m down each ordinal direction (Northeast 45°, Southeast 135°, Southwest 225°, Northwest 315°). Take care to keep each line straight and on the correct bearing for the whole measured distance. As you go, place a 1.5m orange conduit and magnetic survey spike (permanent markers) at 35.35m and pigtailed at 10.35m (DWM), 42.42m (small tree plot – 5x5m corner), 49.49m (medium tree plot – 10x10m corner), and 80.0m (soil plot). When installing pigtailed, tie a long piece of pink striped flagger from the head of the pigtail up to a higher branch to aid in locating the pigtail after leaf-out. Mark the 70.70m corner of the site with a double red gate (**Figure 1**).

- Once the ordinal is laid out with appropriate markers and flagger, roll the tape back to the 35.35m marker and set up the edges of the nested tree plots (5x5m, 10x10m, 25x25m). Pigtailed are placed at 5m and 10m North or South, and East or West (depending on the quadrant) of the 35.35m marker, and a single blue gate is tied at the 25m mark on both sides. The lines between the 10m pigtailed and the 25m blue gates are flagged in blue, as are the lines from the 25m blue gates to the 70.70m red corner. These blue lines delineate the sides of the large tree plot boundary (e.g., if in the NE quadrant, measure east of the 35.35m marker and place pigtailed 5m and 10m away – these will be at 40.35m and 45.35m on the tape. Place a blue gate 15m further away – this will be at 60.35m on the tape and will be a total distance of 25m from the 35.35m marker. Flag the line between the 10m pigtailed and the 25m gate in blue. Flag the line from the 25m gate and the NE 70.70m corner in blue). Roll the tape back to the 35.35m marker and repeat the process along the remaining side of the nested plots (in the NE example above, run the tape north while installing the necessary markers). The nested tree plot pigtailed should be 5m and 10m perpendicular (within 20cm) of the 42.42m and 49.49m pigtailed. The blue gates should line up with the 70.70m red corner. Check accuracy with a compass.
- Once all ordinals and tree plots have been established, lay out the cardinal lines. From site center, measure and flag the North/South and East/West cardinals using a compass, a 100m tape, and red flagging tape. Flag at reasonable intervals to ensure lines will remain visible after leaf-out. Put a large single red gate at 25m and a large double red gate at 50m (the end of each line). Use red flagger to complete the boundaries of the 1ha site by compassing N/S or E/W of the 50m mark to meet the corners of the large tree plots (25m blue gates).
- In summary, at each site, red flagging tape is used for marking the 1ha boundary, blue flagging is used to mark the large tree plots, and pink striped flagging is used to mark pigtailed locations. Adhere to the colour scheme to ensure all technicians can easily identify their location within a site (**Figure 1**).
- All flagging and pigtailed, apart from the 42.42m and 49.49m pigtailed, must be removed during the final visit of the season. The 42.42m and 49.49m pigtailed are spray painted orange before being deployed in the field and are left in place to aid in re-establishing the tree plots during future visits. Unless otherwise specified, conduit/rebar and magnetic survey spikes should remain at the site. Averaged GPS waypoint locations are collected at each conduit (permanent marker) location.

On private property, National Parks, Provincial Parks, DND, and Reserve Lands

- Sites are routinely established (flagged out) during both spring and summer protocols.
- Use a GPS that is accurate to <30cm to locate site center. During a first-time visit, use compass and 100m tape to establish the site as described above using long pigtailed to mark the four 35.35m quadrant centers, four 70.70m corner points, four downed woody material (DWM) transect start points, four soil points, and tree plots as needed. Collect waypoints for site center and each 35.35m and 70.70m marker. These points will be used to re-establish the site during the summer visit and during future re-visits.
- All markers, flagging, and pigtailed **must** be removed after each visit unless otherwise specified by your supervisor.
- Care should be taken to minimize impact on crops/livestock at private sites. Refer to Land Access Manager notes for site-specific instructions (Access, impact on land, flagging allowances, etc.).

Terrestrial Site Re-visits

When visiting sites that have been previously surveyed, the goal is to re-establish the site as closely as possible to the original layout used. This is done by using previously collected coordinate information and by relocating permanent markers that were left during the previous site visit.

Finding permanent markers

- Use given GPS coordinates to navigate to site center and to the 35.35m marker locations.
- If necessary, use a metal detector to pinpoint conduit markers. Search in groups/pairs. Look for tree paint on trees near the expected 35.35m marker locations.
- Search for a minimum of 45 minutes before resorting to re-establishing a marker.
- If the site center conduit is found at a significant distance from the given GPS coordinate, ensure it is the site center conduit and not another of the site set-up markers (see **Appendix 4: Site Re-Visit Scenarios** for more information).
- If a confirmed site center conduit is found at a significant distance from a given GPS coordinate, consider projecting 35.35m points from the found site center conduit while in the field. This will help narrow down the likely search radius for additional markers.
- Once the confirmed site center marker has been located (or has been re-established), stand at the marker and record the distance shown by the GPS unit from this marker to the given site center coordinates. Enter this distance as the Distance from Historic parameter on the Revisit data sheet (see **Appendix 3: Example of an Access and Revisit Data Sheet**).
- Use waypoint averaging to mark all located and re-established markers. Record collected waypoint coordinates on the site Access Sheet.
- Complete the Revisit Data Sheet. Be sure to indicate which permanent markers were found at the site and which, if any, were not found and needed to be re-established.

Setting up a re-visit site

- If a 35.35m marker is not visible from site center, flag the marker more heavily or work as a team of two with one partner standing at the marker holding flagger higher up and one partner at site center sighting to the flagger with a compass. If the marker is still not visible, tie sight lines along the expected bearing between the marker and site center conduit until a line of sight is established between the two. Adjust the sight line if required so that site center and the 35.35m marker are connected by a straight line. Use a compass to determine the bearing of this line. This is the quadrant's actual bearing.
- Once the actual bearing is determined, lay out a 100m tape from site center to the 35.35m marker using the bearing. Make sure the tape is straight.
- Once at the 35.35m marker, change the compass declination so that the actual bearing matches the expected bearing for that quadrant. Use the following equation:
 - **Current declination + (expected bearing – actual bearing) = declination to use**
 - If the declination is more than 5° off from the expected value, call a field supervisor.
- Note the declination used for each quadrant on the Re-visit Data Sheet.
- Set up the remaining quadrants by repeating the above process. **Note:** declinations may vary between quadrants.
- If a conduit is found unearthed, do not move it. If it looks to be close to the original location, run out a tape and see if one end of the conduit looks more accurate than the other. If the conduit is

1.5m or more out of line and no magnetic survey spike can be found, re-establish the 35.35m marker.

- If the distance from site center to a 35.35m marker is off (i.e., if the distance is not actually 35.35m), adjust the distance of the 10.35m pigtail so that the resulting distance between the 35.35m marker and the 10.35m pigtail is exactly 25m. For example, if the 35.35m marker is really 35.25m away from site center, place the 10.35m pigtail at 10.25m from site center to allow for a full 25m downed woody material transect length.
- If declinations vary between quadrants, use the averaged declination of adjacent quadrants to determine the declination needed for each cardinal line.
- Before leaving the site, make sure to:
 - Place new, painted conduit beside any rebar or non-painted conduit
 - Place new, painted pigtails at the 42.42m and 49.49m locations

SPRING TERRESTRIAL PROTOCOLS

Spring terrestrial protocols require a single visit by a crew of two to each site. The crew collects site photos and data on trees/snags, downed woody material (DWM), soil arthropods, and moss/lichen. Crew members locate each quadrant's orange permanent marker (35.35m) and associated nested tree/snag plots. After laying out 100m tapes to provide a transect for DWM, a boundary for small, medium, and large tree/snag plots, and bryophyte/lichen plots, technicians collect soil cores and bryophyte and lichen samples, and measure DWM as well as trees/snags. Crews may work together and/or divide protocol data collection as is best suited to site conditions to maximize efficient use of time (e.g., one technician collects soil cores while the other measures DWM). One of the field staff collects lichen samples and the other collects bryophytes. Since the primary substrates differ between these two taxa, field staff must work separately. Technicians cannot switch between taxa throughout the season.

It is imperative that field crews preserve the integrity of the sampling area each time they visit a site. This is especially important directly around site center. Field crews should make every effort to “tread lightly” and minimize disturbance that will alter site characteristics in future surveys. To minimize the chances of transferring biota (invasive plants, crop pests, and pathogens) between sites, it is important that crews wash trucks, ATVs, and other equipment frequently. Field equipment is washed daily and bleached when moving between sites on private land. This includes personal equipment such as rain gear and boots. Trucks and off-road vehicles must also be washed when crews move between site block regions.

Ecological Site Classifications

This protocol classifies the dominant vegetative community at plots and transects. Ecological site types are named based on soil characteristics, soil nutrient status, moisture status, and vegetation structural stage.

Field Equipment:

ABMI Ecological Site Classification chart

Compass

Ecosite categories (**Table 1**) are broadly based on vegetation communities described in ecosite field guides for Alberta (see **Appendix 5: Ecological Site Classification Descriptions** for details). When determining ecosite type:

- First – determine whether the site is upland or lowland.
- Second – determine soil moisture status:
 - Upland sites -> dry [X], moist [M], or wet [G]
 - Lowland sites -> very wet [D] or open water [OW]
- Third – determine nutrient status based on types of shrub and understory vegetation present. Note that moisture status is often determined in combination with nutrient status since vegetation provides many clues about moisture presence.
- Fourth – determine tree species modifier based on the trees that are present and >1.3m tall (unless otherwise specified).
- Fifth – determine structural stage based on characteristics of the vegetation present. The goal is to describe the tallest layer of vegetation present with ≥10% cover.

Table 1. ABMI Ecological Site Classification - Simplified Chart

Dominant Shrub/Herb/Ground Cover		Nutr./ Moist. Code ¹	Tree Species Modifier	Tree Species Composition ² (In an area without human disturbance)	Structural Stage ³
Upland Vegetation Communities					A. Tree Dominated Ecosites <i>(Trees ≥ 1.3m tall & ≥10% cover)</i> – Add 4-letter code combining tree height, density, and arrangement. <u>Tree Height</u> (TS) Short – ≥50% of canopy cover <10 m tall. (TT) Tall – >50% of canopy cover ≥10 m tall. <u>Tree Density</u> (D) Dense – Trees ≥1.3 m tall are ≤2 m apart. (S) Sparse – Trees ≥1.3 m tall are >2 m apart. <u>Tree Arrangement</u> (C) Complex (Spatially) – Tallest trees ≥10 m apart, with smaller trees (~ ½ height) between that receive direct sunlight from above. (N) Non-complex (Spatially) – Tallest trees <10 m apart, with few or no smaller trees (~ ½ height) between, that receive direct light from above. B. Non-Tree Dominated Ecosites <i>(Trees <10% cover and/or <1.3m tall)</i> Shrubs Present <i>(Shrubs ≥10%; or Trees ≥10% but <1.3m tall)</i> – Add 3 letter code combining height and density. <u>Vegetation Height⁷</u> <i>Record the tallest layer with ≥10% cover.</i> (ST) Shrubs Tall – Shrubby vegetation >2 m tall (SL) Shrubs Low – Shrubby vegetation <2 m tall (TL) Trees Low – Trees <1.3 m tall <u>Vegetation Density</u> (D) Dense – Cover >75% (M) Moderate – Cover 25-75% (S) Sparse – Cover <25% Only Ground Vegetation Present <i>(Shrubs <10%; Trees <10%; Other Vasc. ≥10%)</i> – Add 3- letter code combining dominant vegetation type and density <u>Vegetation Type⁸</u> (GB) Bryoid/Lichen – Bryophyte and lichen (GF) Forb – Non-graminoid herbs and ferns (GG) Graminoid – grasses, sedges (GR) Marsh – reeds, rushes, and cattails <u>Vegetation Density</u> (D) Dense – Cover >75% (M) Moderate – Cover 25-75% (S) Sparse – Cover <25% Non-Vegetated <i>(<10% Vegetation Cover)</i> – Add 2-letter code describing dominant substrate type. (NR) – Bedrock, cliff, talus, bolder (NS) – Sand bar in river/stream (cobble, gravel, sand) (NB) – Beach at edge of a lake or wetland (NM) – Mineral soil, any other reason (NO) – Organic soil, any other reason Note: If standing water is present, refer to Open Water Communities
Poor – Xeric Bearberry, Lichen, Bog Cranberry, Juniper common at some sites	1 - PX	1a Pine	Pj + Fd > 80%		
Poor – Mesic Labrador Tea, Feather Moss, Bog Cranberry, Common Blueberry, Alder common at some sites	2 - PM	2a Pine	Pj + Pl > 50%		
		2b Other	Aw + Sw + Se +Fa +Pw > 50%		
		2c Sb	Sb > 50%		
Medium – Xeric Hairy Wild Rye, Bearberry, Canada Buffalo-berry, Feather Moss common at some sites	3 - MX	3a None	No Trees		
		3b Pine	Pj + Pl > 50%		
		3c AwMix	Aw > 20%		
		3d Spruce	Sw + Se + Fa >50%		
Medium – Mesic Low-bush Cranberry, Canada Buffalo-berry, Blueberry, Rose, Alder, Labrador Tea, Wild Sarsaparilla, Bog Cranberry, Feather Moss common at some sites	4 - MM	4a Pine	Pj + Pl + Fa >50%		
		4b PjMix	Aw + Bp + Sw >20%, AND Pj >20%		
		4c Aw	Aw > 50%		
		4d AwMix	Aw >20% AND Sw + Sb + Pl > 20%		
		4e Spruce	Sw > 50%		
Medium – Hygric Horsetail, Red-Osier Dogwood, Rose, Willow, Feather Moss common at some sites	5 - MG	5a Poplar	Pb + Aw > 50%		
		5b Spruce	Sw + Se > 50%		
		5c Sb	Sb > 50%		
Rich – Hygric Red-Osier Dogwood, Fern, Feather Moss, Rose, Alder, Bracted Honeysuckle common at some sites	6 - RG	6a Pine	Pl > 50%		
		6b Poplar	Pb + Aw > 50%		
		6c Spruce	Sw + Se + Fa > 50%		
Not Treed	7 - NT	7a Alpine	Elevation above tree line		
		7b Flood ⁴	Little to no vegetation present due to frequent flooding		
		7c Ice	Site disturbed frequently by ice or snow		
		7d Dry	Site in prairies/parkland and receives little precipitation		
		7e Geo	Geological features not suitable for tree growth		
		7f Human ⁵	Site disturbed recently by humans		
Aw – Trembling Aspen Pb – Balsam Poplar Pc – Plains Cottonwood Bp – Paper Birch	Ba – Alaska Birch Pl – Lodgepole Pine Pj – Jack Pine Pw – White Pine Sw – White Spruce	Sb – Black Spruce Se – Engelmann Spruce Fa – Subalpine Fir Fd – Douglas Fir	Fb – Balsam Fir Lt – Larch Mm – Manitoba Maple Am – Western Mountain Ash		

Dominant Shrub/Herb/Ground Cover	Nutr./ Moist. Code ¹	Tree Species Modifier	Tree Species Composition ² (In an area without human disturbance)	Structural Stage ³
Lowland/Wetland Vegetation Communities				C. Open Water Dominated Communities (Emergent Vegetation <10%) – Add 4-letter code combining dominant vegetation type, height and density
Bog: Poor – Hydric Labrador Tea, Peat Moss, Lichen, Bog Cranberry and Cloudberry may also be present (Soil saturated for part or all the year. Undecomposed organic soil substrate)	8 - PD	8a Sb ⁶	≥10% tree cover (can include trees <1.3m) Sb > 50%	Vegetation Type (OV) Vegetated – Floating or submerged plants ≥ 10% cover (ON) Non-Vegetated – Floating or submerged plants < 10% cover (note that only a 2-letter code is used for this category) Vegetation Height (S) Short Submerged – ≥50% of vegetation extending 0.0 – <0.3 m above the substrate (M) Medium Submerged – ≥50% of vegetation extending 0.3 – 1.3 m above the substrate (T) Tall Submerged – ≥50% of vegetation extending >1.3 m above the substrate (F) Floating – ≥50% of vegetation with floating leaves on the water surface. Vegetation Density (D) Dense – Aquatic vegetation covering >75% of the substrate. (M) Moderate – Aquatic vegetation covering 25-75% of the substrate. (S) Sparse – Aquatic vegetation covering ≥10- <25% of the substrate.
		8b Shrub	<10% tree cover	
Poor Fen⁶: Medium – Hydric Labrador Tea, Peat Moss, Sedge, Bog Cranberry, Dwarf Birch and Willow may also be present (Soil saturated for part or all the year. Undecomposed organic soil substrate)	9 - MD	9a SbLt	≥10% tree cover (can include trees <1.3m) Sb + Lt > 50%	
		9b Shrub	<10% tree cover	
Rich Fen: Rich – Hydric Dwarf Birch, Willow, Sedge, Grass, Moss (Soil saturated for part or all the year; undecomposed organic soil substrate; includes floating mats of vegetation)	10 - RDp	10a SbLt	≥10% tree cover (can include trees <1.3m) Sb + Lt > 50%	
		10b Shrub	<10% tree cover AND ≥10% shrub cover	
		10c None	<10% tree cover AND <10% shrub cover	
Wet Meadow: Rich – Hydric Dominated by sedge, grass, presence of shrub and trees (e.g. willow). Conductivity < 15 mS/cm (Soil, saturated for part or all of the year. Well decomposed, organic soil substrate.)	10.5 - RDm	10.5a Tree	≥10% tree cover (usually along wetland edge, may only be in shrub/ground stratum)	
		10.5b Shrub	<10% tree cover AND ≥10% shrub cover	
		10.5c None	<10% tree cover AND <10% shrub cover	
Marsh: Very Rich – Hydric Cattail, Rush, Reed, Conductivity < 15 mS/cm, sedge and grass may also be present (Water is above the rooting zone for most or all of the year)	11 - VD	11a None	Usually along a water body edge ≥10% emergent vegetation cover <10% tree cover	
Swamp Trees and shrubs present, poorly developed bryophytes, often with pools of water (Water is above the rooting zone for some of the year, mineral or humified organic soil rather than peaty)	12 - SD	12a Tree	>10% tree cover	
		12b Shrub	<10% tree cover	
Alkali Conductivity > 15 mS/cm, white salt flats at water's edge (Water is above the rooting zone for most or all of the year)	13 - AD	13a None	<10% shrub/tree cover	
Open Water	14 - OW	14a Lake	In standing water <10% emergent cover	
		14b River	In flowing water <10% emergent vegetation cover	

Classifications are based on Dominant Shrub/Herb/Ground Cover before determining the Tree Species Modifier and Structural Stage. Tree Species compositions in the tables are the “simplified categories” for the ABMI. These may not fit perfectly with what is seen at the site (see **Appendix 5: Ecological Site Classification Descriptions** for details).

1. Note that moisture nutrient category names are approximate and the category often also includes adjacent nutrient and moisture categories (Nutrient Status: P=Poor, M=Medium, R=Rich, V=Very Rich; Moisture Status: X=Xeric, M=Mesic, G=Hygric, D=Hydric, OW=Open Water. NT, SD, AD are exceptions).
2. Tree species composition is determined from both the dominant/co-dominant (canopy) and intermediate/suppressed (sub-canopy) trees, giving more weight to the dominant and co-dominant trees. Should the trees present not fall into the species listed, choose the category including the most closely related tree species or re-examine the nutrient moisture code.
3. Determine the structural stage by first determining if the site is tree dominated, non-tree dominated, or open water dominated after ecological site type is determined. Then choose the appropriate code combination paying careful attention to the descriptors.
4. Use 7b (NT-Flood) for sites at the edge of rivers, streams, lakes, and wetlands where vegetation is disturbed frequently by flooding. The area is either non-vegetated or dominated by grasses, sedges, and forbs, with trees/shrubs absent. Note that areas with water present seasonally, often with small permanent pools, but with trees/shrubs present, are classified as SD-Swamp.
5. Use category 7f (NT-Human) only when other ecosite classifications are not appropriate. Note that NT-Human CANNOT be used for historic conditions.
6. Poor Fens are often black spruce (Sb) dominated and do not always contain Larch/Tamarack (Lt). The absence of Larch does not indicate that the site is PD – it could still be MD. Differentiation between PD and MD must be determined based on the understory species (i.e., presence of cloudberry and lichen in PD, with the addition of sedge, dwarf/bog birch, and willow for MD).
7. Choose the tallest layer of vegetation with at least 10% cover of categories available (Order of height: Tall Shrub > Low Shrub > Trees Low). Use your discretion when choosing between Low Shrubs and Trees Low should they be roughly the same height and same coverage.
8. Use GR for tall, typically emergent vegetation including cattails, hardstem and softstem bulrush, giant reed grass (*Phragmites australis*), bur-reeds, and small-fruited bulrush.

Ecosite Classification for Soil Cores

- Determine the ecosite type for all four soil sampling locations (1m radius circle).
- Determine the primary, current ecosite type within the soil sampling area and record the proportion of the area (in 10% increments) occupied by that ecosite type. Include any other ecosite types, if present, in the comments section.
- For soil plots in forested areas, there may not be trees within the boundary of the sampling area. Record the tree species modifier and structural stage of the surrounding area if it is homogenous with the plot. The objective is to describe ecosite conditions under which the arthropods (in the soil samples) are living.

Ecosite Classification for Site Center

- Usually recorded during summer protocols
- Determine the ecosite type in a 50m radius circle around site center
- Classify the historical and current primary and (if applicable) current secondary ecosite types. Also record the percent coverage of each ecosite within the 50m radius circle. **Note:** a secondary ecosite should also be included if two different structural stages are present within the same Nutrient/Moisture/Tree Species combination (i.e., PX-Pine-TSDC dominates with a smaller component of PX-Pine-TTSN).
- It is possible to have >2 ecosites. If this occurs, please note in comments as described below.
- Primary ecosite types occupy a larger portion of the area than secondary ecosite types.
- Record ecosite types in 10% increments.
- Secondary ecosite types must occupy a minimum of 20% of the area, otherwise they are considered part of the primary ecosite.
- The total of the primary and secondary ecosite percentages must sum to 100% with the exception of cases where a third ecosite exists (i.e., a ratio of 60:20:20). Should a tertiary ecosite exist, a general description, including accurate nutrient/moisture regime and tree species modifier, must be included in the comments. If a third ecosite is found that occupies only 10% of the area, include it with the ecosite it most closely resembles.
- Ecosite data is collected over a large area. To more accurately estimate ecosite types and percentages, record data only after having fully explored the 50m radius circle surrounding site center. Aerial imagery can be used to inform percent cover estimates and to highlight areas on the ground that require more detailed investigation (i.e., areas of disturbance and areas of ecosite transition).

Determining Historical Ecosite

Generally, in undisturbed stands, the historical and current ecosite types will be the same.

If the area being described has been altered by some type of human disturbance (e.g., agriculture, well pad, road, cutline, etc.), it is important to determine the historical ecosite type based on pre-disturbance conditions. This may require looking at vegetation in adjacent areas to determine what would have been present originally.

Note: Regardless of region, NT-Human is not an acceptable historical ecosite type.

Determining Current Ecosite

For areas affected by fire or harvesting, record the Historical Ecosite type as best as possible. For current conditions, record the nutrient/moisture code which is applicable for the area (matches the historical in most cases as determined by surrounding vegetation), as well as the tree species modifier which would be present under non-disturbance conditions (e.g., PX-Pine in a burnt pine stand), Use a structural stage modifier which describes the current ground cover conditions (e.g., GFM in a cut block or NM in a severely burned stand).

Add comments to your classification whenever the results appear odd.

Physical Site Characteristics

This protocol provides a brief description of the vegetation at site center and is completed in the summer. Record all data based on how habitat looks at exact date/time of site visit.

Field Equipment:*Basic field supplies**Compass*

- At site center, record the historical and current ecosite classification (primary and secondary, if applicable)
- Physical site characteristics are recorded separately for the current primary and secondary (if applicable) ecosite types. Record all data based on what is present at the time of the site visit.
- Characteristics include physical and topographic conditions, characteristics of veteran, dominant/co-dominant (canopy), and intermediate/suppressed (sub-canopy) trees, dominant shrub species, and total shrub cover, herbaceous cover, ground cover, amount and type of human and natural disturbance, and any other distinguishing features.
- While standing at the site center conduit, determine slope using a compass. Turn the compass dial to E, and from a standing position with the compass parallel to the ground, sight to a reference point that is eye-level, 20m away in the direction of maximum slope. Record the slope and the aspect (direction of down-slope) in degrees.

For the Primary and Secondary Ecosite Types (separately), Record the Following:Trees

- Estimate tree species composition (in 10% increments), average distance between trees (in 1m increments), and average height of trees (to the nearest 5m category), for all trees (including trees <1.3m tall) within the ecosite type and within the following 3 stratification categories:
 1. *Veteran Trees* – Trees that are significantly older than the rest of the stand, usually remnants from a previous forest.
 2. *Dominant and Co-dominant Trees* (Canopy Trees) – Trees with well-developed crowns extending to the general level of surrounding trees. Dominant trees extend slightly above the surrounding trees and receive full light from above and partial light from the side. Co-dominant trees have crowns slightly smaller and lower than dominant trees and are crowded from the sides, thus receiving full light from above and little light from the side.

3. *Intermediate and Suppressed Trees (Sub-Canopy Trees)* – Trees with crowns that are usually smaller and below the canopy trees. These trees receive little or no direct light from above or from the sides.

- Stands may be missing one or more of the 3 stratification categories.
- Veteran and Intermediate/Suppressed Tree categories are determined relative to the Dominant/Co-dominant Tree category. This means you **MUST** have an entry in the Dominant/Codominant Tree category to have an entry in either the Veteran and/or Intermediate/Suppressed Tree categories.
- Dead trees (snags) are not included when determining tree density.

Shrubs

- Identify the most common shrub species (based on % cover) in two height categories (>1.3m and <1.3m) and record the species code.
- Estimate **total** shrub cover (not just the dominant species) for both height categories in one of four percent cover increments (1-25%, 26-50%, 51-75%, 76-100%), based on what would be obtained if a photograph had been taken from above all shrubs.

Ground Cover

- Identify the type of ground vegetation that is most common (grass, herb, shrub, sedge/rush/cattails, moss, lichen, weed, or if there is no vegetation present – record “NONE”) based on what would be obtained if a photograph had been taken from 0.5m above the ground.
- Record the % cover of bare ground and % cover of water (5% increments). Bare ground is defined as any substrate which is either not presently covered in vegetation (dead or live) or does not support the growth of vegetation.

Disturbance

- If present, record the type and proportion of the area affected by human disturbances (<1%, and 5% increments). If there is no human disturbance, record “NONE”. Multiple disturbance types can be recorded, if present, in order of abundance (**Table 2**).
- If present, record the type and proportion of the area affected by natural disturbance (<1%, and 5% increments). If there is no natural disturbance, record “NONE”. Multiple disturbance types can be recorded, if present, in order of abundance (**Table 3**).
- Total disturbance values (e.g., the sum of human and natural disturbance cover) cannot sum to >100% even in the event of multiple disturbance types (values may be <100%).
- In the event of overlapping disturbance types, record the disturbance of greatest impact and include additional comments. Represent additional disturbances as best as possible (i.e., in a pasture where a power line is also present, disturbance is recorded as 100% pasture and <1% powerline).

Table 2. List of human disturbance categories and associated codes

Code	Disturbance	Description
NONE	None	No human-caused disturbance observed
HARV	Harvest	Any type of forest harvesting (e.g., clear cut, partial cut, understory retention, etc. <30 years old)
PIPE	Pipeline	Any type of pipeline
POWER	Powerline	Any type of powerline
SEIS	Seismic	Any type of cutline or seismic line
RAIL	Railway	Any railway
WELL	Well Pad	Any type of area cleared for oil/gas/CBM pump jacks or well heads
ROADP	Road – Paved	Any type of road with paved surface
ROADG	Road – Gravel	Any type of road with an unpaved, but improved (e.g., gravel) surface
TRAIL	Trail	Any type of truck or ATV trail with an unimproved surface
CULT	Cultivated Crop/Field	Any type of cultivated field that is used to grow agriculture crops
PAST	Pasture	Any type of pasture (tame or native), grazing reserve, etc.
PUGG	Pugging/Hummocking	Livestock trails and pugging/hummocks from livestock
RES	Residential	Any type of human dwelling, farm building, or farmyard in a rural or acreage setting
URB	Urban	Any type of human dwelling, associated building, or yard/driveway/road in an urban setting
IND	Industrial	Any type of building, roadway, yard, etc. associated with industrial development
BARE	Bare Ground	Human-caused bare ground for which the cause cannot be determined
CAMP	Recreation/Parking	Any recreation facilities including improvised campsites
OTHER	Other	Specify other disturbance type in the comments

Table 3. List of natural disturbance categories and associated codes

Code	Disturbance	Description
NONE	None	No natural disturbance visible.
BEAV	Beaver Activity	Any evidence of beaver activity altering the landscape or vegetation.
DISEASE	Disease Outbreak	Any evidence of vegetation experiencing disease outbreak; it may be difficult to distinguish between disease and insect damage (see below).
EROS	Erosion	Any evidence of the wearing away of soil by precipitation or wind; potentially human induced (e.g., the side of a hill has eroded from rain (natural); culvert under logging road is plugged causing excessive run-off through low lying areas undercutting trees (human)).
FIRE	Fire Damage or Scarring	Any evidence of scarring or burning (may be human-caused); may coincide with salvage-harvesting.
FLOOD	Flooding	Any evidence of high-water mark, dead trees, etc.; potentially human-induced (e.g., a stream overflows its banks in spring and fills in forest depressions and/or “historic” flood plain (natural); evident by standing dead trees, grass and debris build-up; road built through spruce bog not allowing proper water transfer (human); evident by standing water and large stands of dead trees).
ICE	Ice/Snow	Any evidence of vegetation breakage caused by snow or ice.
INSECT	Insect Attack	Any evidence of vegetation experiencing an insect attack; it can take several years of defoliation to do permanent damage to the vegetation; identifying “notable” insect damage is difficult to the untrained eye (see below).
WIND	Wind Throw	Any evidence of wind throw (e.g., many trees up-rooted and laying on the ground and/or snapped along the bole); often occurring along canopy openings, cut-blocks, roads, etc.; potentially human-induced.
OTHER	Other Disturbance	Other type of disturbance; make notes in comments.
UNKN	Cause Unknown	Use if a crew member cannot decipher what type of disturbance has taken place and it is evident that something has changed the plot area in some way; ensure comments are filled out.

Insect:

- Any evidence of vegetation experiencing insect attack.
- **Note:** it can take several years of defoliation to do permanent damage to the vegetation. Identifying “notable” insect damage is difficult to the untrained eye.
- Conifer stand:
 - Examples: Budworms, Moths, Sawflies, Needle miners, Spider mites, Bark/Boring beetles, etc.
 - Symptoms: Tree die-off, brown/dead terminal ends and branches; frass at base of trees, larvae galleries on trunk and branches, evidence of woodpecker flaking
 - Confirmation: Larvae and/or adults on needles, branches, or bark depending on life cycle, evidence of silken webbing or cocoons
- Deciduous stand:
 - Examples: Tent caterpillars, Moths, Leaf miners, Spider mites, Aphids, etc.; significant damage to deciduous trees may not be noticeable at all times of the year
 - Symptoms: Complete defoliation, brown or yellow/dying leaves and trees, tree die-off
 - Confirmation: Larvae and/or adults on leaves and branches, silken webbing, cocoons, leaf deformity and/or galls

Disease:

- Any evidence of vegetation experiencing disease outbreak
- **Note:** it may sometimes be difficult to distinguish between disease and insect damage, especially depending on time of year
- Conifer stand:
 - Examples: Mistletoe, Witches-broom, Burls, Blister rust, Root rot, etc.
 - Symptoms: Erratic growth forms (bushy growth) on branches and/or stem (mistletoe/witches-broom), trunk deformities (burls), white/yellow/orange fungus growing on trunk/branches, brown needles and/or tree die-off (especially young trees; root rot).
 - Confirmation: Check for absence of insect damage and describe scenario in comments; tree die-off could be naturally caused by winter-kill and/or drought (especially in young trees)
- Deciduous stand:
 - Examples: Leaf spot, Leaf and Twig Blight, Leaf Rust, etc.
 - Symptoms: Coloured leaves; round or angular brown spots on leaves (leaf spot), blackening and wilting of young shoots; tips bending back (blight), powdery golden yellow pustules on leaves; yellow spots (rust)
 - Confirmation: Check for absence of insect damage and describe scenario in comments; can be difficult to assess according to season

Methods for Surveying Bryophytes and Lichens

Bryophytes and lichens are each surveyed by crew members that have undergone a minimum of 1.5 days of field and classroom training with an experienced bryologist and lichenologist.

Crew members choose (or are assigned) a taxon during training and may not switch taxa for the duration of the field season.

Field Equipment:

Mora knife
Hand lens
Squares of paper for small specimens
40 paper bags per site (labeled)
Cut proof gloves
Sharpie
Water
Watch with timer

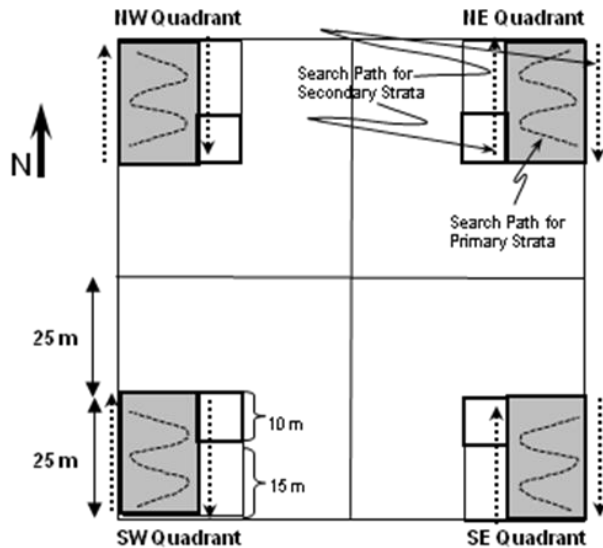


Figure 2. Bryophyte and lichen plot layout

Four 25x15m plots (total 0.15ha) are surveyed for bryophytes and lichens (**Figure 2**).

In each plot, record the proportion of the area (as 0, <1% or in 5% increments) affected by human caused disturbance (see human disturbance categories in **Table 2**)

Note for roads with accompanying ditches: if a road ditch affects the plot area, include the percent cover of the ditch in the applicable road disturbance category (i.e., Road – Paved (ROADP) or Road – Gravel (ROADG)). Describe in the comments what percentage of the total disturbed area is road surface and what percentage is ditch.

A single person spends up to 35 minutes in each of the 4 quadrants (maximum total: 140 minutes) collecting bryophytes. A second person independently completes the protocol for lichens.

Surveys always start in the NE quadrant and progress clockwise to the next quadrant (NE, SE, SW, NW).

In each quadrant, surveys are divided into two timed plots – Primary and Secondary (see below).

Primary Survey

- Strata (microhabitat types) present are sampled in the interior of the 25x15m plot.
 - For Bryophytes:
 - Search strata #1 logs/stumps, #3 wetlands/peatlands, and #4 rocks/cliffs (**Table 4**).

- For Lichens:
 - Search strata #1 logs/stumps, #2 trees/shrubs/other vertical structures, and #4 rocks/cliffs (**Table 4**)
- To help maximize the number of species detected, begin the timed search by surveying one example from each stratum that has the most diverse community of bryophytes/lichens. This must be completed within a maximum of 5-10 minutes. For example, large-diameter soft logs often have the highest diversity of both taxa. When present in the plot, these should be targeted early in the search.
- Then, continue searching for the three primary strata by zigzagging through the plot (**Figure 2**).
- Stop every 4 or 5 steps to examine the microhabitat types in the immediate area. When examples of any of the primary strata are found, take samples as you encounter them.
- Note that if there are no examples of any of the primary strata in the plot, then the search can be terminated after 5 minutes. A minimum of 5 minutes **must** be spent searching for examples of the primary strata in each plot as some microhabitats are small and dispersed (e.g., rocks). If surveying crop fields or other very recently disturbed areas and there is a single example of a microhabitat from the primary strata present and no specimens are found on this stratum after 5 minutes, the survey may be terminated.
- If there are multiple microhabitats (strata) found within the plot, then a minimum of 10 minutes must be spent searching. If all examples have been searched, then sampling may be terminated after 10 minutes (e.g., you are searching for lichens and there is a tree, a log, and no rocks/cliffs in the plot. If, after 10 minutes, all instances of logs and trees have been thoroughly searched, the search can be terminated).
- Plots that have all the primary strata require the full 25 minute search.

Secondary Survey

- Strata (microhabitat types) that have less diverse communities are searched in a belt transect following the 2 long sides of the 25x15m plot (**Figure 2**). Belt transect surveys are completed by walking along the plot boundary and sampling within 1m of either side of the transect. This results in two 25x2m transects in each of the 4 quadrants.
 - For Bryophytes:
 - Search strata #2 trees/shrubs/other vertical structures, and #5 upland soils (**Table 4**)
 - For Lichens:
 - Search strata #3 wetlands/peatlands, and #5 upland soils (**Table 4**)
- Ensure that examples of both secondary strata are searched if they occur on the transects.
- Search as many examples of the secondary strata as possible as you encounter them.
- If a variety of microhabitats are present in a stratum, then collect specimens from as many of these as possible (e.g., if many different tree species occur, then collect mosses from as many different tree species as possible).
- Use a time constrained search that is exactly 10 minutes long. Be sure to survey the entirety of both 25x2m transects during these 10 minutes.

Specimen Collection

- In each stratum and in each plot/transect, collect examples of all bryophytes or lichens that appear different from one another.
- Where possible, select homogenous samples that fit in the palm of your hand; if this would remove half or more of a single thallus or community, take a smaller sample to ensure the species diversity at the site is not depleted.
- If the specimen is **growing on mineral soil**, wrap the sample gently in a piece of paper so it doesn't break apart (disintegrate) once the soil dries.
- When collecting lichens, if the specimen is growing on a large boulder/rock/cliff, wet it thoroughly to help detach it from the substrate.
- Place small/fragile specimens in paper packets so they don't get lost or fragmented further.
- For each taxon (bryophytes/lichens), all specimens collected from a stratum are placed as a composite sample in a single bag.
- Use the adhesive labels provided to identify each bag (it may be easier to pre-label your paper bags with the ABMI site number and collection date before getting to site, especially if it's rainy).
- Be diligent not to collect the same species over and over again from a stratum. It takes considerable time to sort through duplicates in the lab. At the same time, be aware that some species can look very similar to one another in general appearance.

Collection codes

- If no specimens are found in a stratum of a plot/transect, but the stratum is present, circle "NONE" on the label of the empty paper bag and select "NONE" in the tablet.
- If no example of a stratum is found in a plot/transect (i.e., the stratum is absent), then circle "VNA" on the label of the empty paper bag and select "VNA" in the tablet.
- If samples are found and collected for a stratum of a plot/transect, circle "C" on the paper bag that contains the specimens and select "C" in the tablet.

At the end of each site

- Once the surveys are complete, ensure there are 20 paper bags for bryophytes and 20 paper bags for lichens.
- Take the collections to camp and dry them using the racks provided in trailers or any other well-ventilated space. Place the bags on their side and fluff out the sample for optimal surface area exposure. Be mindful to flip the bags daily and check the dryness of the samples. Most samples are dry within 3 days. Drying samples as quickly as possible is very important to prevent the development of mold. Once mold develops, a specimen is ruined.

At the end of each shift

- Once dry, place all bryophyte sample bags from a site into one large paper bag and label it with the site number, date collected, technician initials and "Bryophyte". Do the same for lichens.
- Fill a large cloth bag (referred to as a Santa Sac) with all the bryophyte samples and one with all the lichen samples. Transfer these to your field coordinator for delivery to the Processing Centre. Samples collected near the end of the shift will likely not have had time to dry completely. **Important:** Mark these samples conspicuously as being WET. Staff will attend to them at the ABMI Processing Centre.

- Place a flash drive with the collection information into a Ziploc bag and tie the bag to the inside of the cloth bag with flagging tape. Label the flagging tape with technician initials, sites included in the bag, and taxon.
- Specimens are sorted into species groups in the laboratory and then identified by experts.

Table 4. Strata and microhabitat types within strata used during searches for bryophytes and lichens

Stratum #1: Logs and Stumps (samples in 1 bag)
LS: Soft stumps and logs (decay classes 3-5) – sample roots and all sides
LH: Hard stumps and logs (decay classes 1-2) – sample roots and all sides
Stratum #2: Trees, Shrubs, and Other Vertical Structures (samples in 1 bag)
TD: Deciduous Trees – all sides of the roots, bases, trunks, and branches of both live and dead deciduous trees
TC: Coniferous Trees – all sides of the roots, bases, trunks, and branches of both live and dead coniferous trees
TS: Shrubs – all sides of the roots, bases, stems, and branches of live and dead shrubs (does not include trees <1.3m)
HB: Human Structures – vertical and horizontal parts of structures (survey from the ground)
Stratum #3: Wetlands and Peatlands (samples in 1 bag)
WMF: Wetlands, marshes, and fens – within the wetland, survey both under and away from trees
WSB: Shores/banks of wetlands, ponds, lakes, and streams – survey on organic or mineral soil adjacent to the water's edge
WDS: Moist depressions/seasonal wetlands dry at the time of survey – sample sides and bottom in the area influenced by water
WPW: Peatlands with or without standing water – survey both standing water and vegetation hummocks
Stratum #4: Rocks and Cliffs (samples in 1 bag)
BC: Boulders (>50cm diameter) – survey all surfaces (top, sides, and base), from soil upwards
RR: Rocks (<50cm diameter) – survey all surfaces (top, sides, and base), from soil upwards
CL: Cliffs (steep, high, rock face) – survey all faces, ledges, and crevices that can be accessed safely
Stratum #5: Upland Soils (samples in 1 bag)
UC: Humus soils under trees/shrubs (shaded by canopy) – survey as large a variety as possible
UO: Humus soils without trees/shrubs (open to sunlight) – survey as large a variety as possible
DC: Agriculturally cultivated soils
DM: Mineral soil in upland areas from any causes

Trees and Snags

This protocol is designed to measure tree and snag densities and sizes. Data are collected in three nested plots for three different size categories. The smallest plot is 5x5m and is anchored at the 35.35m quadrant center. The second plot is 10x10m and encompasses the small plot. The third plot is 25x25m and encompasses both the first and second plot (**Figure 3**).

Field Equipment:

- 50cm DBH calipers (1mm increments)*
- 5m DBH tape*
- 10m carpenter's tape*
- 100m measuring tape*
- Vertex hypsometer with transponder and batteries*
- Tree paint or chalk*
- Mora knife*

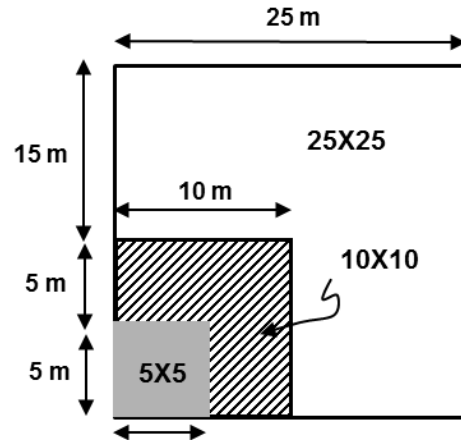


Figure 3. Trees and snags plot layout

For accurate and consistent data collection, treat the 5x5m plot as a square, and the 10x10m and 25x25m plots as L-shaped (**Figure 3**). Collect information in the 5x5m and then sequentially move to the 10x10m and then the 25x25m plots.

Protocol parameters

- Trees are defined as any tree species, with the exception of *Alnus* or *Salix*, that is $\geq 1.3\text{m}$ in height (**Table 5**). Any trees $< 1.3\text{m}$ in height are NOT measured.
- Snags are defined as dead trees $\geq 1.3\text{m}$ in height, leaning $\leq 45^\circ$ from vertical. Snags can be intact or broken below the canopy but must still be rooted (self-supporting).
- Stumps are defined as dead trees broken below the canopy with a top height of $< 1.3\text{m}$. Stumps are NOT measured.
- The diameter at breast height (DBH) is measured at 1.3m up the bole of the tree from the highest soil point (e.g., upslope when on an incline, top of a hummock, etc.). If the bole of the tree is at an angle, measure the 1.3m along the bole of the tree and then record the DBH.
- If DBH is $< 7\text{cm}$, measure diameter to the nearest 0.1cm.
- If DBH is $\geq 7\text{cm}$, measure diameter to the nearest 0.5cm.
- Tree diameter is measured using tree calipers if DBH is $\leq 10\text{cm}$.
- Tree diameter is measured using a DBH tape if DBH is $> 10\text{cm}$.
- Measured top and base heights are recorded to the nearest 0.1m.
- Estimated top and base heights are recorded to the nearest 0.5m.

Completing the plots

- Measure trees and snags on the boundary of the plot only if more than half of the bole is rooted within the plot. Note that flagging tape may not be an accurate determination of plot boundary. If in doubt, crews should lay out the measuring tape to confirm plot boundaries.
- Mark the trees with tree paint at breast height (e.g., at point of measurement), facing the 35.35m permanent marker once measurements have been taken and recorded.

- Tree height is measured using a vertex hypsometer, or in the case of small trees, can be measured using a carpenter's tape. Top height is measured to the highest living leaf on the tree and base height is the location on the stem where live branches occupy about three-quarters of the stem circumference. Personal judgement may be necessary to determine base height and it may be easier to estimate this when standing under the tree.
- Tree heights are measured along the length of the main stem. For leaning trees, heights must take into account the amount of lean.

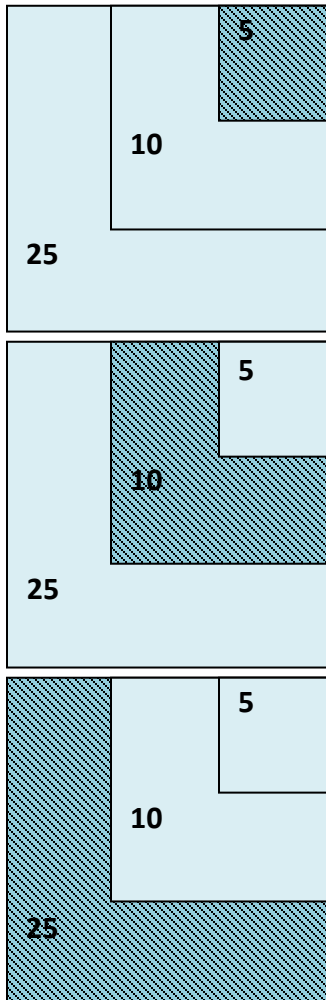


Figure 4. Trees and snags plot breakdown

5x5m Square Plot:

Record ALL trees and snags (Figure 4)

- For trees <7cm DBH: record Species, Condition, Decay Stage (as VNA), DBH, Top Height, and Measured or Estimated.
- For trees ≥7cm DBH: record Species, Condition, Decay Stage (as VNA), DBH, Top Height, Base Height, Measured or Estimated, and Crown Class.
- For snags <7cm DBH: record the same categories as live trees, including the appropriate decay stage.
- For snags ≥7cm DBH: record the same categories as live trees, including the appropriate decay stage, and excluding Base Height and Crown Class.

10x10m L-Shaped Plot:

Record for all trees and snags ≥7cm DBH (Figure 4)

- For all trees ≥7cm DBH: record Species, Condition, Decay Stage (as VNA), DBH, Top Height, Base Height, Measured or Estimated, and Crown Class.
- For all snags ≥7cm DBH: record the above categories, including the appropriate decay stage and excluding Base Height and Crown Class.

25x25m L-Shaped Plot:

Record for trees and snags ≥25cm DBH (Figure 4)

- For all trees ≥25cm DBH: record Species, Condition, Decay Stage (as VNA), and DBH
- For all snags ≥25cm DBH: record the above categories, including the appropriate decay stage

When to measure and when to estimate top and base height

- Tree top and base heights are measured using a vertex hypsometer for 3 trees (if possible) from each crown classification within the 10x10m plot (this includes the 5x5m plot due to the nested design). If fewer than 3 trees of a given crown classification exist in the combined 5x5m and 10x10m plots, each tree of that crown classification must be measured. If more than 3 trees of a given crown classification exist, estimate the heights of the remaining trees based on the top and base height values of the measured trees.

- A value for each tree height is recorded. A maximum of 15 trees' top and base heights are measured in each quadrant. All additional tree heights are estimated based on the heights of the measured trees.
- Indicate that the values were measured or estimated by placing an "M" or "E" in the Measured/Estimated column of the tablet for each individual tree.
- Every tree DBH **must** be measured using a DBH tape or calipers regardless of whether top and base height were measured or estimated.
- Measured trees should be spaced out as evenly as possible within the plot so they can be referenced to estimate the heights of surrounding trees. Avoid clumping measured trees together unless they are the only representatives from that crown classification in the plot (**Figure 5**).

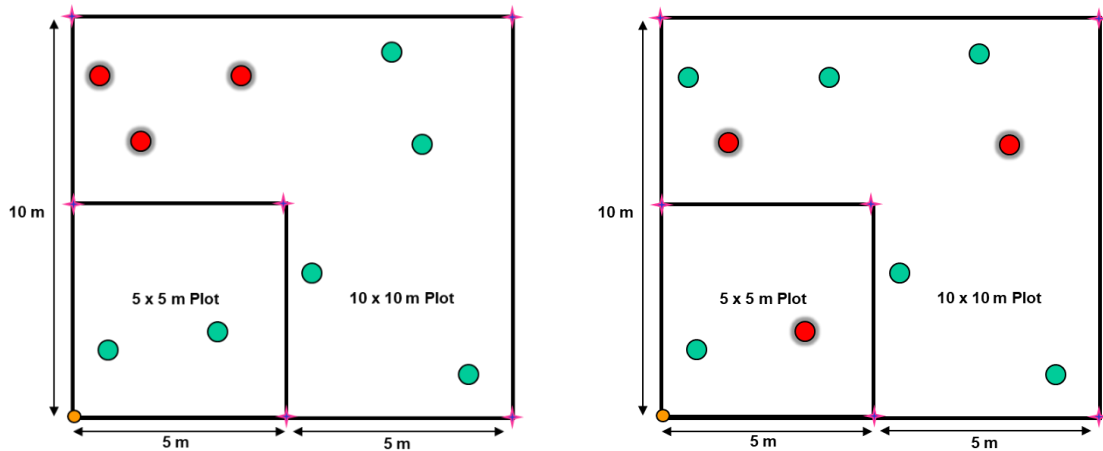


Figure 5. The red trees have **measured** heights and the green trees have **estimated** heights. Avoid clumping measured trees together (as on the left); instead, spread trees out evenly to assist with estimating heights of nearby trees (as on the right)

Determining decay stage

- Decay stages for snags with a complete bole are (**Figure 6**):
 - 1 = recently killed, all twigs/branches present, wood hard, bark (normally) intact
 - 2 = twigs and small branches missing (major branches remain), wood hard
 - 3 = no branches, bole mostly intact, wood starting to soften
- Decay stages for snags that are snapped along the bole so that the presence of twigs and branches cannot be evaluated are (**Figure 6**):
 - 1-2S = recently killed, wood hard, bark (normally) intact
 - 3S = wood starting to soften
 - 4S = wood soft throughout the snag

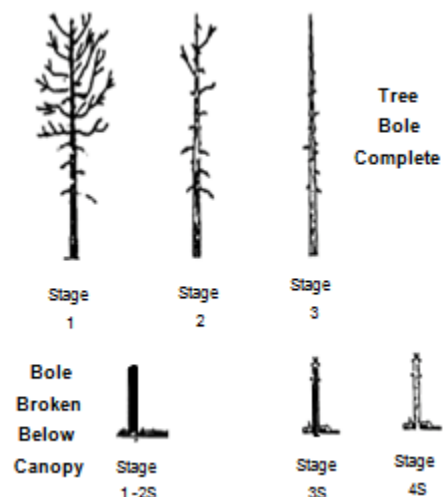


Figure 6. Snag decay stage classification

Determining crown classification

- Veteran = Trees that are considerably older/taller than the rest of the stand, usually remaining from a previous forest.
- Dominant = Trees with well-developed crowns extending slightly above the general level of surrounding trees; these receive full light from above and partial light from the side.
- Co-dominant = Trees with crowns that are slightly smaller than dominant and crowded from the sides; these form the general level of surrounding trees and receive full light from above with little light from the side
- Intermediate = Trees with crowns that are usually small and quite crowded below, but extending to the general level of surrounding trees; these receive little light from above and none from the side
- Suppressed = Trees with crowns entirely below the general level of the surrounding trees; these receive virtually no direct light from above or the side.

Note: Crown classification for trees on the edge of a forested area should be made by placing more weight on the tree's height than on its access to light.

Table 5. Tree species found in Alberta

Latin name and common name (native and non-native)*			
<i>Abies balsamea</i>	Balsam fir	<i>Pinus x murraybanksiana</i>	Murraybanks' pine
<i>Abies bifolia</i>	Rocky Mountain alpine fir	<i>Pinus albicaulis</i>	Whitebark pine
<i>Abies lasiocarpa</i>	Subalpine fir	<i>Pinus flexilis</i>	Limber pine
<i>Acer negundo</i>	Manitoba maple	<i>Pinus monticola</i>	Western white pine
<i>Acer glabrum</i>	Rocky Mountain maple	<i>Pinus sylvestris</i>	Scots' pine
<i>Betula papyrifera</i>	Paper birch	<i>Populus angustifolia</i>	Willow poplar
<i>Betula neoalaskana</i>	Alaska birch	<i>Populus balsamifera</i>	Balsam poplar
<i>Betula occidentalis</i>	Water birch	<i>Populus deltoides</i>	Plains cottonwood
<i>Fraxinus pennsylvanica</i>	Green ash	<i>Populus tremuloides</i>	Trembling aspen
<i>Larix laricina</i>	Tamarack	<i>Populus trichocarpa</i>	Black cottonwood
<i>Larix sibirica</i>	Siberian larch	<i>Pseudotsuga menziesii</i>	Douglas fir
<i>Picea engelmannii</i>	Engelmann spruce	<i>Quercus macrocarpa</i>	Bur oak
<i>Picea glauca</i>	White spruce	<i>Sorbus aucuparia</i>	European mountain ash
<i>Picea mariana</i>	Black spruce	<i>Sorbus scopulina</i>	Western mountain ash
<i>Picea pungens</i>	Colorado blue spruce	<i>Sorbus sitchensis</i>	Sitka mountain ash
<i>Pinus banksiana</i>	Jack pine	<i>Ulmus americana</i>	American elm
<i>Pinus contorta</i>	Lodgepole pine		

* includes all native species and a selection of more commonly found non-native species. If a tree species is found that is not on this list, it may be added manually to the tablet after positive identification is confirmed. Please include site comments denoting the unique species additions and ensure your supervisor is notified.

Downed Woody Material

This protocol measures all non-living woody debris along four forest floor transects.

Field Equipment:

50cm DBH calipers

Go-No-Go tool

Mora knife

50m Measuring tape

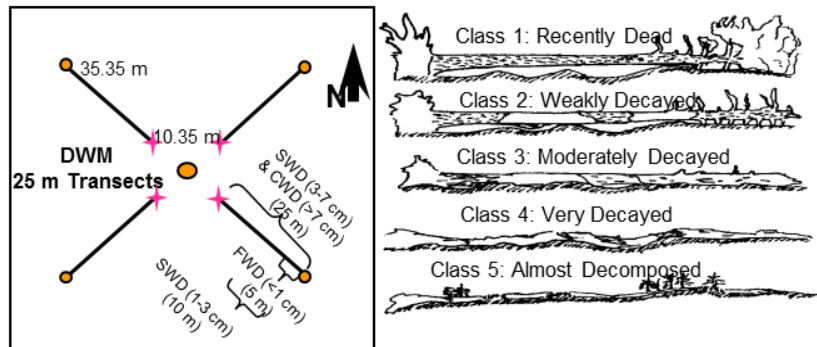


Figure 7. DWM layout and decay classification

Completing the transects

- DWM is measured on the four ordinal transects (**Figure 7**).
- Transects start at the 10.35m pigtail and extend for 25m to the 35.35m conduit in each quadrant.
- Dead wood must be on the forest floor, or rooted but leaning $>45^\circ$ from vertical, or suspended over the transect within technician reach to be recorded as DWM.
- DWM is divided into 3 categories (**Figure 8**):
 - Coarse Woody Debris (CWD; $\geq 7\text{cm}$)
 - Small Woody Debris (SWD; $1-6.99999\text{cm}$)
 - Fine Woody Debris (FWD; $<1\text{cm}$)
- SWD is further divided into 3 size classes:
 - 1.0-2.99999cm: the number of SWD pieces in this size class is tallied along the last 10m of each of the 4 DWM transects (e.g., 25.35-35.35m).
 - 3.0-4.99999cm: the number of SWD pieces in this size class is tallied along the entire 25m transect.
 - 5.0-6.99999cm: The number of SWD pieces in this size class is tallied along the entire 25m transect.
- To be included as SWD, the piece must intersect the transect and be above the litter layer (e.g., have $<50\%$ of its diameter buried).
- The number of FWM pieces that intersect the transect above the litter layer is tallied along the last 5m (e.g., 30.35m to 35.35m) of each of the 4 DWM transects. FWD only includes twigs, stems, and branches, and does not include cones, bark flakes, needles, or fragments of stems and branches $<10\text{cm}$ long. These pieces of FWD are often short; it is necessary to have the tape within a few centimeters of the forest floor for the last 5m to accurately determine whether or not the FWD pieces cross the transect.
- The “Go-No-Go” tool is used to determine which category each piece belongs to.

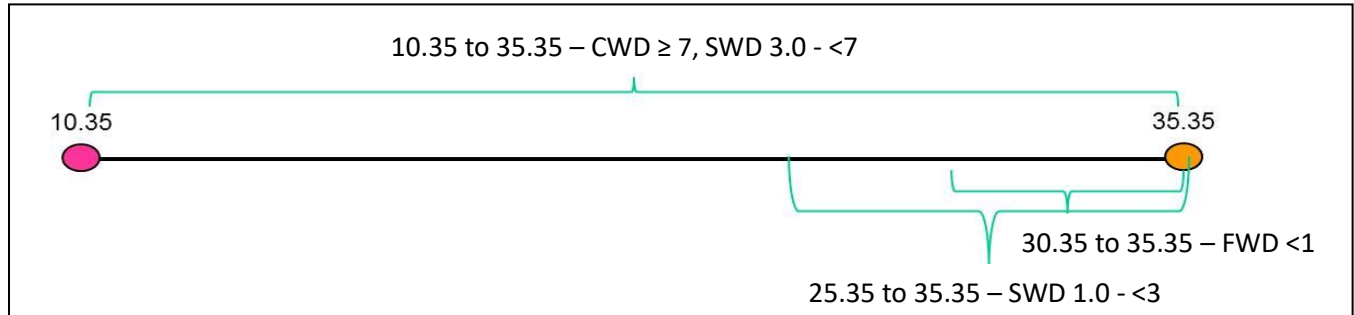


Figure 8. DWM transect layout

- CWD is recorded along the entire 25m of each of the 4 DWM transects. Measure each piece of CWD ≥ 7.0 cm diameter (in 0.5cm increments) where it intersects the transect. Record species, decay stage, and diameter at point of intersection with the measuring tape. Measure diameter using DBH calipers in a plane perpendicular to the long axis of the CWD.

Determining decay stage

For CWD, classify decay stage (at the point of intersection) into one of five decay classes (**Figure 7**):

1. Recently Dead = Bark (normally) attached to wood; little or no fungal mycelium developed under patches of loose bark (*100-95% of the initial dry density*)
 2. Weakly Decayed = Loose bark (intact or partly missing); well-developed fungal mycelium (normally) between bark and wood; rot extends < 3 cm radially into the wood (as measured by pushing a knife into the wood (*~95-75% of the initial dry density*))
 3. Moderately Decayed = Rot extends > 3 cm into the wood (as measured by pushing a knife into the wood), but core still hard; log may be sagging or broken, but still supported from forest floor by stones, humps, etc. (*~75-50% of the initial dry density*)
 4. Very Decayed = Rotten throughout (entire knife penetrates into wood); log shape conforms to forest floor; often elliptical in shape (*~50-25% of the initial dry density*)
 5. Almost Decomposed = Log completely decomposed in sections; outline of log discernible, but strongly fragmented and remaining parts often overgrown; wood disintegrates when lifted (*~25-50% of initial dry density*)
- When classifying the state of decay (1-5), careful attention should be given to all criteria listed.
 - Ensure that you look closely for logs in a decay class of 5 as some can be hidden by moss and litter covering the forest floor. Do your best to distinguish the edges of a class 5 log in order to obtain a diameter. If no clear log can be discerned, then it should be considered organic material and no longer woody debris.

Classifying DWM – What does and doesn't count

- Classified as DWM:
 - Twigs, stems, branches, and chunks of wood > 10 cm long with or without bark; alder and willow are included in DWM, along with other woody shrubs.
 - DWM **above** the litter layer or soil/water level; debris is considered no longer above when $> 50\%$ of its diameter is buried beneath a layer of surface organic matter (forest floor), mineral soil, or water where it crosses the tape.

- Odd-shaped pieces of wood; *estimate diameter at intersect as if it were round.*
- Fallen or suspended (not self-supporting) dead tree boles and branches, with or without roots attached, that intersect the plane of the transect line. Stems and branches may be suspended on nearby live or dead trees, other coarse woody debris, stumps, or other terrain features.
- Fallen trees/branches with green foliage that are no longer rooted in the ground (*decay stage 1*).
- Rooted, dead, woody material leaning $>45^\circ$ from vertical, that is not more than 50% buried.
- Recently cut logs.
- Uprooted (not self-supporting) stumps.
- Broken fencing material; *if fencing consists of flat boards, determine and record the average diameter of the piece as if it were round.*
- Exposed dead roots of snags/logs that have fallen and are crossing the transect.
- **NOT** classified as DWM:
 - Cones, bark flakes, needles, leaves, forbs, and pithy shrub species (such as rose and snowberry).
 - Live or dead trees (still rooted) which are self-supporting and leaning $\leq 45^\circ$ from vertical.
 - Dead branches still connected to standing live or dead trees.
 - Exposed roots of self-supporting trees.
 - Self-supporting stumps or their exposed roots.
 - A piece is no longer considered debris when the wood is decomposed to the point where it could be described as forest floor humus (no discernible shape or log left).
- It can be difficult to determine what to measure. Refer to **Figure 9** for additional information.

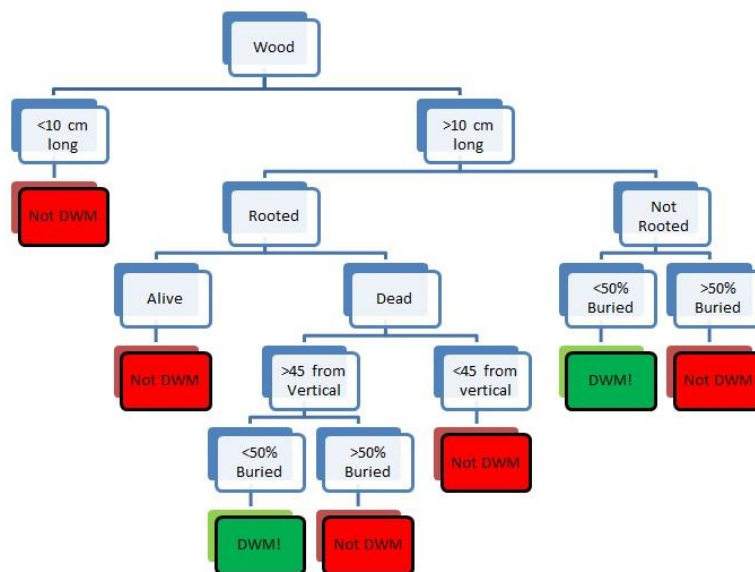


Figure 9. Reference for what is and is not considered DWM

Accumulation

- For piles of CWD, **measure if possible**. If the pile is too large, or if it is unsafe to measure each piece of CWD individually (e.g., a large slash pile), estimate the length of the pile and height of the pile at its highest point. Estimate what percentage of the area in the rectangle created by the height and length measurements is accumulated wood (**Figure 10**).
- Enter the estimated value (i.e., 40%) into the tablet program's Accumulation Calculator along with the estimated length and height. The tablet program will calculate a diameter for the accumulation as if it were a single log and auto-record the parameters used as part of the calculation in the entry's comment field.
- Assess the tablet's calculated output. If the calculated diameter value is far larger or far smaller than seems reasonable, reassess the estimated length, height, and wood cover values used; re-calculate if necessary.
- If recording data on a paper datasheet, manually calculate the CWD diameter using the formula below. Length and height are recorded in centimeters, while estimated cover is recorded as a decimal (i.e., an area of 40% cover is divided by 100 and entered as 0.40).

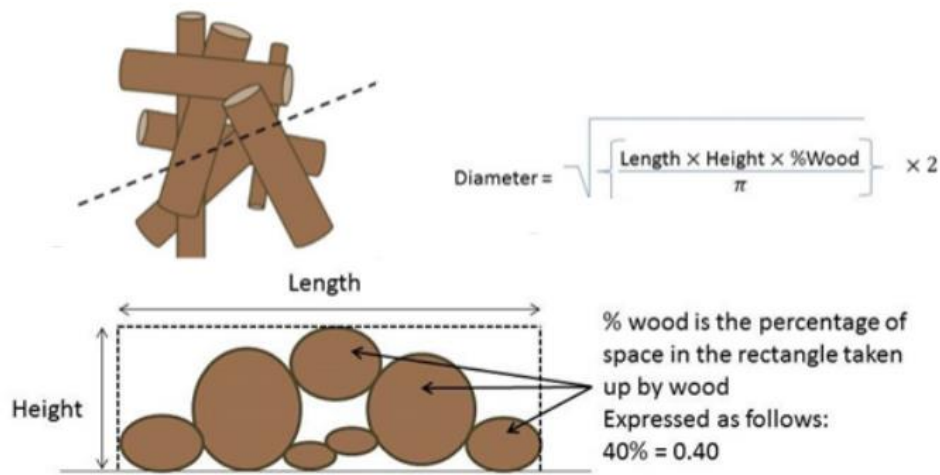


Figure 10. Calculating the diameter of an accumulation

- Identify and record the most common species in the accumulation and the most common decay stage.
- Record an "A" under the accumulation column on the data sheet or in the tablet. Note that if no accumulations were present, VNA is recorded in this column.

Partial tally

- When many pieces of FWD and SWD cross the transect (e.g., wind throw and broken off tree crowns containing many small branches), a partial tally approach can be used. For example, if a tree crown has fallen across the transect, a proportion of the branches/pieces are counted and the total number of FWD and SWD pieces is estimated.
- Measure the entire horizontal length of the debris field crossing the line (e.g., debris field is 5m long).
- Choose a representative sub-sample (not just the first portion of the transect) and tally the number of FWD and SWD pieces (e.g., 42 pieces of FWD, 22 pieces of SWD in the 1-2.999

category, 25 pieces of SWD in the 3-4.999 category, and 0 pieces of SWD in the 5-6.999 category tallied within a 50cm distance).

- To obtain an accurate estimate of DWM, the length of transect chosen for measurement must have at least 20 pieces of each DWM size class. Note that the length used for FWD may be different than the length used for SWD.
- Estimate the number of pieces in the total debris field (e.g., in the above scenario, multiply by 10 because 50cm is 1 tenth of 5m; 420 pieces of FWD, 220 pieces of SWD 1-2.999, 250 pieces of SWD 3-4.999, and 0 pieces of SWD 5-6.999).
- This is recorded in the partial tally section of the data sheet. For tablets, use the “partial” check box. Use “VNA” if you do not encounter a case which requires a partial tally.

Soil Cores: Soil Arthropods (Springtails and Mites) and Mineral Soil

This protocol is designed to measure presence and relative abundance of mites (*Orbatid*) within the organic layer of the soil and to collect mineral soil samples for determination of organic carbon and pH. These two samples are collected within the same core.

Soil arthropods and mineral soil are sampled at four locations at each site and must all be collected on the same day. To ensure that ecological conditions at the ABMI site are not disturbed, sampling is conducted outside the central 1ha area. Sample areas are located on the ordinal transects, 80.0m from site center (**Figure 11**) (approximately 10m outside the corners of the 1ha square).

Field Equipment:

Soil Corer (2" diameter)
 500ml measuring cup
 Cloth collection bags
 Mora knife
 Cut proof gloves
 Compass
 Piece of plastic sheet
 ABMI Ecological Site
 Classification Chart
 Dust pan and broom/large
 paintbrush
 Sharpie
 Cleaning kit (bleach spray
 and brush)

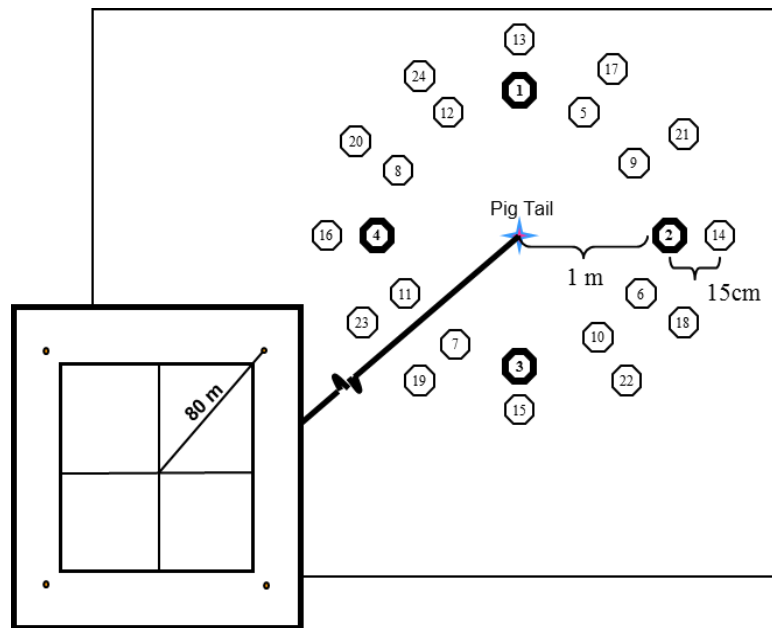


Figure 11. Soil core plot layout

Ecological characteristics of sample area

- Identify the current ecosite(s) that the 1m radius sample circle falls within in order to best classify the habitat in which the mites are living.

- Describe slope position for each of the four plots where soil cores will be extracted:
 - C = Crest, situated in a relatively level area on the top of a hill
 - S = Slope, situated on the side of a hill; include a modifier as 1 (e.g., S1) for slopes 2-5°, as 2 for slopes 6-10°, as 3 for slopes 11-30°, and as 4 for slopes >30°
 - T = Toe, situated at the bottom of a hill where the ground surface transitions from a slope to level
 - L = Level, situated in an area with <2° slope
 - D = Depression, situated in an area that accumulates water after rains
- If the plot is disturbed (either by humans or naturally), indicate the cause of the disturbance and the percent area affected (**Table 2; Table 3**).

Core collection and collection codes

- Collect soil cores that contain both the organic layer and approximately 10cm of mineral soil. This provides the sample for both the soil arthropods and the mineral soil (**Figure 12**).
- Cores are taken in sequential order (**Figure 11**) and each core location is given a descriptive code.
 - If a core is acquired and there is nothing unusual about it:
 - X = Core acquired, nothing unusual
 - If a core cannot be acquired:
 - SW = Standing Water
 - R = Rocks
 - SL = Stumps/Logs/Trees
 - RT = Root(s)
 - If a core can be acquired, but is unique:
 - AM = Animal Material
 - DWM = Downed Woody Material (e.g., decayed logs, roots, etc.)
 - HD = Human Disturbance (e.g., mineral soil, residence, private property, lawns)
 - WT = Water Table (e.g., water accumulated in hole after coring, permanently/presently frozen soil)
 - OT = Other (requires additional comment)
- Cores are divided into LFH and Mineral samples as described below.
- Sample bags are labeled with the following information:
 - Sample Type (LFH or Mineral)
 - Collector's Initials
 - Date
 - Site Number
 - Quadrant
- Double check each bag's label to ensure that the quadrant you are sampling is labelled accurately. Mislabeling quadrants (e.g., submitting two NW bags and no SW bag) is one of the most common reasons for expensive re-sampling. Pre-labelling sample bags before going in the field can help avoid mislabeling.
- If a sample is not taken for any reason, clearly note the reason in the tablet and **do not** send in an empty soil bag.
- To close the bags, simply pull the strings tight. Slip knots are appreciated. Please do not tie the soil sample bags together. Instead, transport them out of the field in a plastic grocery bag. For care and shipping instructions, see *Preserving and Packing Soil Samples* below.

Soil arthropods

- Only the organic component of the soil profile is collected for soil arthropods. This consists of the LFH horizon (litter, fermentation, and humus layers) and excludes the mineral soil.
- In each quadrant, a minimum of 4 cores is taken from each sample location. A minimum of 500ml of organic matter must be collected to create a complete composite sample.
- Determining the LFH horizon is usually straightforward based on the colour and texture of the soil and the resistance of the soil corer to penetrate far into the mineral layer.

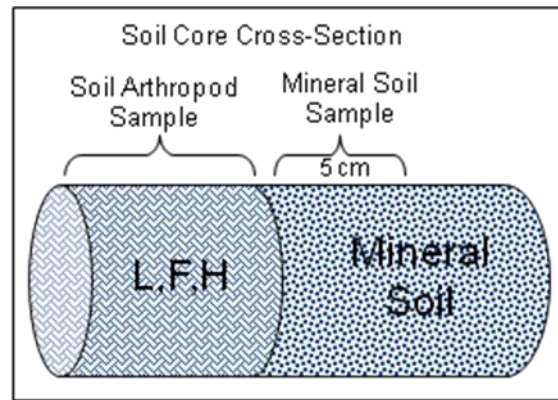


Figure 12. Soil core cross-section

The organic layer is typically dark in colour and coarse and fibrous (containing rooting systems), whereas the mineral soil is typically lighter in colour, finely particulate, and lacking most roots.

- Visually determine where the transition from LFH to mineral horizon appears. Grasp the LFH in one hand, the mineral soil in the other, and gently break these apart. If there are a few roots holding the two sections together, cut these with a knife. Place the LFH and the top 5cm of the mineral soil onto a plastic sheet (see description for mineral soil below).
- A minimum of 4 cores are taken from each sample location (quadrant). If more than 4 cores are required to accumulate 500ml of organic material, additional cores are taken in a clockwise fashion (**Figure 11**) until 500ml is attained or until 24 cores have been taken. The number of cores required to get 500ml of organic matter is recorded, along with the appropriate code for each core. Note: most commonly an "X = core acquired, nothing unusual" will be recorded.
- The LFH from all cores at each sampling location are mixed together on a plastic sheet and a random 500ml sample is placed into a cloth bag for processing. The volume of remaining LFH (if any) is measured, recorded, and returned to the site.
- Since organic material is collected from each quadrant, a total of 2L of organic material is sampled per site.
- For care and shipping instructions, see the *Preserving and Packing Soil Samples* section below.
- How to address different LFH Scenarios:
 - **If the LFH is indistinct (e.g., native grasslands, high alpine)**, collect the plant residue (litter) layer and top 2cm of soil. Based on the corer diameter, a minimum of 8 cores should be necessary to get 500ml of litter in these areas. In this scenario, the core code is recorded as "X = core acquired, nothing unusual" and the Modified LFH Collection code is recorded as "Top 2cm LFH Collected".
 - **If the LFH layer has been mixed artificially by mechanical equipment (e.g., cultivated agriculture fields)**, collect plant residue (litter) layer and top 2cm of soil. This core code is recorded as "X = core acquired, nothing unusual" and the Modified LFH Collection code is recorded as "Top 2cm LFH Collected".
 - **If the soil core location is on a road or if inorganic soil/other materials have been spread over the surface (e.g., paved surface)**, sweep the litter off the surface and include it as the LFH sample. Note: this may include only a few leaves, grass, gravel, or

other debris found on the top of the core locations and may need to be completed at all possible 24 coring sites to maximize the amount of material collected (i.e., to get as close to 500ml as possible). Do not core into any road surface where it will result in damage to public or private property. This core code is recorded as "X = core acquired, nothing unusual" and the Modified LFH Collection code is recorded as "Swept".

- **If a core location is on a slash pile that cannot be safely sampled**, no core is taken and the code "SL" is recorded. If all 24 of the quadrant's coring locations are within the slash pile, record all 24 locations in the tablet with the "SL" code and an additional comment describing the area.
- **If a core location is in standing water**, no core is taken and the code "SW" is recorded. If all 24 of the quadrant's coring locations are within the area of standing water, record all 24 locations in the tablet with the "SW" code and an additional comment describing the area.
- **If a core location falls on a vegetative mat that is present above the water table** (this is judged prior to a person standing on the mat), a core is taken, the code "WT" is recorded, and an additional comment describing the area is included.
- **If the full depth of the core cannot be collected due to frozen ground** (common in the spring in Northern Alberta), collect the cored soil in the corer and record the code "WT". Record an additional comment with the average depth of soil cored before hitting the frozen ground.
- **If the organic layer is deeper than the corer can penetrate** (e.g., corer is not long enough to reach the mineral soil), then the entire 40cm of organic material the corer extracts is collected from the core and used in the creation of the composite sample. This can be common in lowland areas such as black spruce/tamarack bogs.

Mineral soil

- The mineral soil sample is part of the same core that was collected to sample soil arthropods (**Figure 12**).
- Four 250ml composite samples of mineral soil are collected; one for each of the four quadrants at an ABMI site (a total of 1L of mineral soil sampled per site).
- When obtaining each core, ensure the corer enters as deep as possible so that sufficient mineral soil is collected.
- After removing the LFH layer from the core (see *Soil arthropods* above), collect maximum of 5cm of mineral soil and place this on a plastic sheet. Use a knife to cut the core of mineral soil 5cm below the LFH horizon (**Figure 12**). Return any additional mineral soil to the ground. Never collect mineral soil below a 5cm depth from the LFH horizon.
- Partial cores: If an obstruction (e.g., root) prevents you from reaching the required 5cm of mineral soil, temporarily keep the organic and mineral soil from the collected core and proceed as follows.
 - If cores with >5cm mineral soil are collected during the coring process, use these (a minimum of 4 required) to create the composite samples. Discard the cores with <5cm mineral soil (both the LFH and the mineral components) and do not include them in the final composite samples.
 - If you do not collect a core with >5cm mineral soil anywhere in the 24 coring locations, use the LFH and <5cm of mineral soil from the collected cores in your composite

samples. Include comments in the tablet describing the situation and include the average depth of the mineral soil achieved.

- Once at least 4 cores have been collected, mix the soil on the plastic sheet and subsample 250ml of mineral material.
- If there is <250ml of mineral soil after 4 cores, continue collecting mineral soil from core samples via the same sequence described above (in *Soil arthropods*) until a total of 250ml of mineral is collected per quadrant. Continue to mix LFH samples together in this scenario and take the 500ml subsample from the aggregate.
- Place the 250ml of collected mineral soil in a cloth bag and label as listed above. The mineral subsample must contain material from a minimum of 4 soil cores. If fewer than 4 cores contained mineral soil (confirmed after having sampled all 24 coring locations), mix together the available mineral soil and submit as the mineral sample. Include comments.
- For care and shipping instructions, see the *Preserving and Packing Soil Samples* section below.
- How to address different Mineral scenarios:
 - **If sampling in a fen/bog or similar habitat:** If no mineral soil is present at the sampling point or if mineral soil is too deep to reach with the soil corer, record “NONE” on the tablet and take the minimum of 4 cores. This information is relayed in the shipping document file that is exported to the Processing Centre. Note in comments the reason for the lack of sample (e.g., organic depth > 40cm).
 - **If frozen ground prevents the collection of >5cm of mineral soil:** Collect the number of cores needed to achieve the 250ml volume of mineral soil. Record each affected core with the “WT” code. Record an additional comment in the tablet with the average depth of soil cored before hitting the frozen ground. If every collected core hits frozen ground at approximately the same depth, it is acceptable to stop coring once the required mineral (and LFH) volume is achieved without continuing to core all 24 locations.
 - **If a partial core is collected:** See *Partial cores* bullet above

Preserving and packing soil samples

The following information is extracted from the *Soil Cooler Packing Checklist* provided by the Processing Centre:

- Extraction of mites from the LFH samples depends on the mites arriving at the Processing Centre alive. To do this, the LFH samples must be kept moist and cool. This can be accomplished by keeping the soil collection bags in an open plastic bag in the fridge. Ensure the plastic bag is not closed tightly to allow oxygen exchange.
- Mineral soil samples should be allowed to dry out and do not need to be kept cool.
- Both LFH and mineral samples are shipped within 3 days of collection. They must be shipped in a cooler with sufficient frozen water bottles to keep the LFH samples cool. Samples are separated from the frozen water bottles in the cooler by a wooden rack.
 - If you don't have frozen water bottles, frozen ice packs, frozen juice concentrate, or frozen food are alternative options. **Do not use bagged ice** as it melts and can saturate the soil samples. This has potential to drown the mites.

- If you don't have a wooden rack, use cardboard or newspaper to prevent contact between the samples and the frozen material.
- For shipping, each grocery bag should contain all the soil samples (up to 8 bags) for a single site. Grocery bags may be tied **loosely** at the top. Do not tie the soil sample bags together.
- For each site, fill out a soil ticket indicating what samples are present and which are absent in the shipment. Include this with your shipping document USB when shipping your soils.
- Place a flash drive with the shipping document and all the soil ticket slips into a Ziploc bag and tape the bag to the inside of the cooler lid. Secure the cooler lid with two strips of duct tape or packing tape for transport. Call the number provided on the *Soil Cooler Packing Checklist* and leave a message with the following information: when the cooler was shipped, your name, where the cooler was shipped from, the shipping company, what sites were shipped, and the waybill number.
- Once the cooler has been shipped, please provide the waybill number to your coordinator so that the shipment can be tracked.

Site Photographs

This protocol is designed to provide permanent pictures of the 1ha site.

Field Equipment:

Digital camera

Laminated photo sheet (Site#/Date/Direction)

Dry erase marker

Taking photos

- Ensure your field camera displays the correct date and time.
- Use the “landscape” orientation for all site photos.
- Take 6 photographs at each site:
 - 4 Transect Photos = Standing at site center, take a photograph at eye level in each of the four ordinal directions (NE, SE, SW, NW).
 - 1 Canopy Photo = Standing at site center, directly over the rebar, take a photograph of the canopy looking skyward.
 - 1 Representative Site Photo = From anywhere in the 1ha plot, take a single photograph that best represents the physical and vegetation characteristics of the area.
- Except for the canopy photo, include a filled in laminated photo sheet in each photo held at precisely 5m from the camera for scale. Use a compass to ensure the 4 transect photos are taken directly along the ordinal directions (NE, SE, SW, NE).
- Record the point-and-shoot camera ID and the photo numbers from the camera in the tablet.

- Check the resolution and quality of all photos while at the site; **re-take photos that are blurry or obstructed in any way.**

Managing photos

- Back-up photo files onto a tablet or laptop computer once back at camp. Photo files are re-labeled as follows during the back-up process:
 - Transect Photos = ABMI_[year]_[Site#]_[QUADRANT].jpg
 - Canopy = ABMI_[year]_[Site#]_[CANOPY].jpg
 - Representative site = ABMI_[year#]_[Site]_[SITE].jpg
- If a photo error is noticed while reviewing photos at the end of the day (i.e., there are 2 photos where the laminated sheet indicates the SW direction and there is no photo where the sheet indicates the NW direction), determine which image is correct and manually edit/correct the mislabeled image using an available tablet app. Save both the original and the edited versions of the corrected photo adding an _ORIGINAL and _EDITED suffix to the file name for each.
- All photos are copied daily to a folder on a tablet and to an external flash drive. If connectivity allows, photos are also loaded to FTP. At the end of each shift, or when visited by a field coordinator, site photos are transferred.

SUMMER TERRESTRIAL PROTOCOLS

Summer terrestrial protocols require a single visit by a crew of two to each site and can begin after June 15 in southern Alberta and after July 01 in northern Alberta. During this visit, the crew member with the best plant identification skills conducts the vascular plant survey while the other person conducts canopy cover measurements and tree core collection. Crews will also collect ecosite information at site center.

It is imperative that field crews ensure they preserve the integrity of the sampling area each time they visit a site. This is especially important directly around “high traffic” areas (e.g., site center). Make every effort to “tread lightly” in these areas to minimize disturbance that will alter site characteristics in future surveys. To minimize the chances of transferring biota (invasive plants, crop pests, and pathogens) between sites, it is important that crews wash trucks, ATVs, and other equipment frequently. Equipment needs to be washed daily when moving between sites on private land and must also be washed when crews move between site block regions.

Tree Cores

This protocol is designed to measure age and growth rate of trees. The protocol splits the site into two halves: the north half (combined NE and NW quadrants) and the south half (combined SE and SW quadrants) (**Figure 15**). Tree cores are obtained from a maximum of 5 trees at each site. These include the largest tree in the 1ha site, as well as the largest of the dominant and secondary species in each of the north and south halves of the site (if present). Trees are selected based on their relative abundance and DBH.

Field Equipment:

Straws

Scissors

Stapler and staples

Painter's tape for labels

Sharpie

Vertex hypsometer with transponder and batteries

Carpenter's tape

DBH calipers and tape

Folding saw

18" (5.5mm diameter) increment borer (minimum length)

PVC carrying case

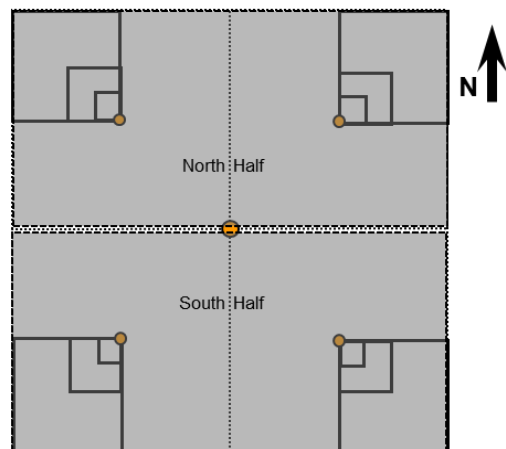


Figure 15. Site split into north and south halves for core/cookie collection

Tree species and tree selection

- Select the live tree with the largest DBH from the **leading** species (species with the highest stem density of dominant and/or co-dominant canopy trees), in both the North and South halves of the site. The tree selected as the largest for the 1ha (see below) cannot be selected again for the leading species. In this case, select the live tree with the second largest DBH from the leading species. Please note that a veteran or a residual tree from a former stand cannot be selected. Obtain tree cores (or cookies) and record species, DBH, tree height, and significant tree damage for the cored leading species trees.
- Select the live tree with the largest DBH from the **secondary** species (species with the second highest stem density of dominant and/or co-dominant canopy trees), if one occurs, in both the North and South halves of the site. To be classified as a secondary species, the species must comprise $\geq 20\%$ of the canopy stems in that half site. The tree selected as the largest for the 1ha (see below) cannot be selected again for the secondary species. In this case, select the live tree with the second largest DBH from the secondary species. Obtain tree cores (or cookies) and record species, DBH, tree height, and significant tree damage for the cored secondary species trees.
- Select the live tree with the **largest** DBH within the entire 1ha area regardless of species. Obtain a tree core (or cookie) and record species, DBH, tree height, and any significant tree damage. Veteran trees may be used for the largest tree.

Data collection

- Tree height is measured using a vertex hypsometer, or in the case of small trees, can be measured using a carpenter's tape. Top height is measured to the highest living leaf on the tree. Height is recorded to the nearest 0.1m.
- DBH is measured at 1.3m up the bole of the tree using calipers if $DBH \leq 10cm$, or DBH tape if $DBH > 10cm$. DBH is recorded to the nearest 0.5cm.
- Significant tree damage is defined as any damage or condition that could affect the normal height or growth rate of the tree. Record significant tree damage using the following categories:
 - BT = Broken Top
 - DT = Dead Top
 - FC = Fork/Crook
 - S = Scarring
 - O = Other (specify in comments)

*Use O = Other to indicate **damage from rot**, disease, mistletoe, insects, wild and/or domestic animals, abiotic natural factors, or anthropogenic factors. Be specific as to the type of damage in the recorded comment.

Core and cookie collection

- Use the increment borer to obtain the cores. Bore the tree at 1.3m on the side that faces site center (if possible). Be accurate when determining the height of the core. Core the tree at an upward angle to avoid the hole left in the tree filling up with rainwater. Be sure to hit the pith of the tree; the pith is required for accurate tree age analysis. If the tree is not round, obtain the core from the side with the narrowest width.

- If **cores are rotten or break** into more than 2 pieces while being extracted, attempt to re-collect from the same tree (core the tree again at 90° to the initial bore hole). If two attempts fail due to rot, collect a core from another similar tree. If similar difficulties are encountered after two attempts on the second tree, record the tree species, height, and DBH of the tree and record significant tree damage as “O = Other”. In the comments, explain that the core was not collected due to rot in both trees sampled for that core type.
- If any of the selected trees are **too large** for the increment borer, take as large a core as the corer will allow and estimate the additional length to the pith using the borer spoon as a guide. Use your carpenter’s tape to measure this. Record the estimated length in the comments along with the disclaimer that the tree was too large for the corer. Record all other information in the tablet as normal.
- If all trees in either the North or South half of the site for either the leading or secondary species are **<10cm DBH**, destructively sample a representative tree from **outside** the site by taking a cookie at a height of 1.3m. This makes it possible to core a leading species and take a cookie from a secondary species, or vice versa (**Figure 16**).

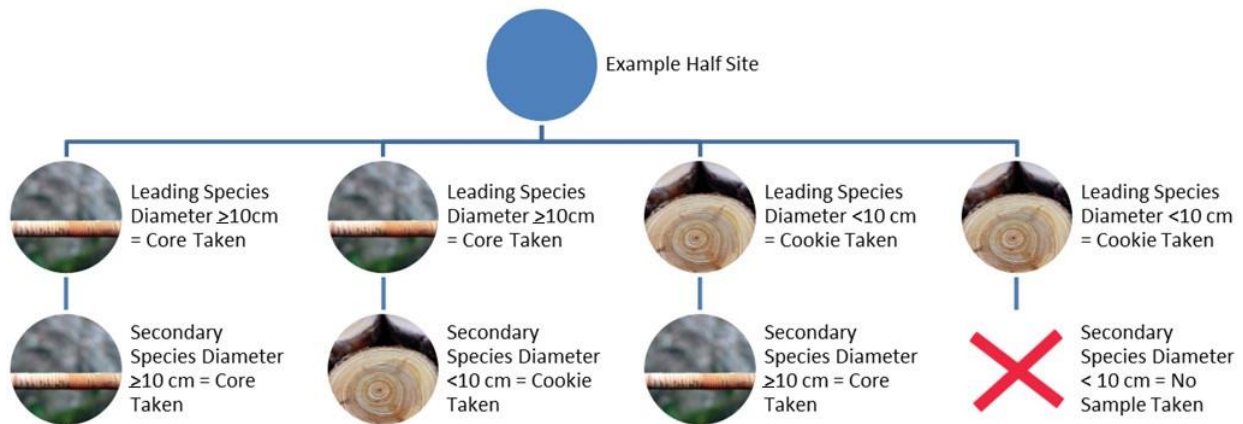


Figure 16. When to collect a core versus a cookie

- If all trees in the North or South half (excluding veterans) are <10cm DBH, only destructively sample the leading species from outside the 1ha area (e.g., a total of 2 trees per site). This means that if the largest tree has a DBH of <10cm, and cookies have already been taken for 2 samples at the site, no sample is collected for the largest tree (**Figure 17**).

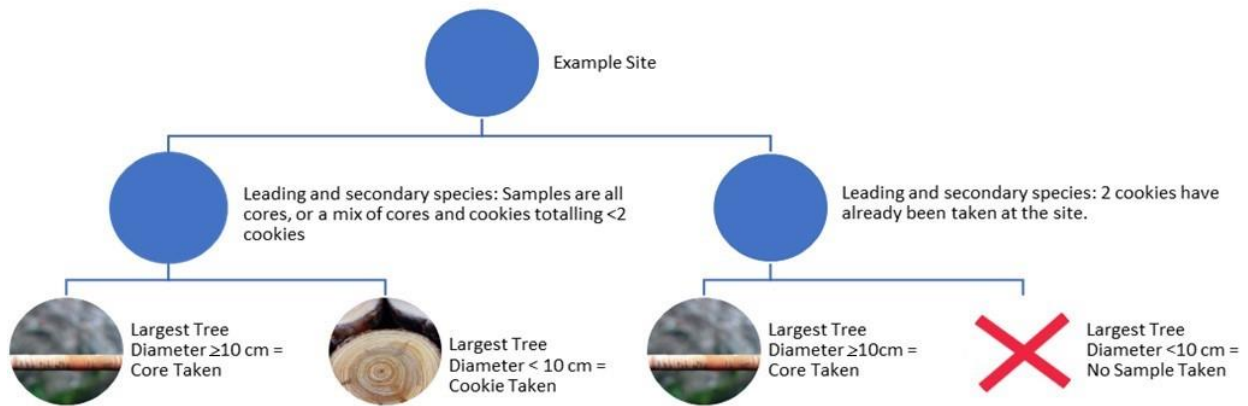


Figure 17. A maximum of two cookies can be taken per site

- When collecting a cookie, be sure to collect a sample **at least 2 inches** in length to allow for proper labelling and processing. Avoid cutting a cookie directly at branch intersections.
- In the **white zone/residential areas**, do not core/cookie any trees or tree-like ornamental shrubs when in a landowner's yard without express permission. Refer to land access notes for conditions that would *allow* you to take a sample. If sample collection is not permitted, record all other data for the species present and do not submit cores or cookies. Record the reason in the comments.

Core and cookie management

- Ensure you have at least 5 large, pre-punctured straws available for use at each site in case all 5 potential cores are collected.
- Straws are cut to allow air flow and to stop mold/rot from affecting the core samples. Slits should be cut halfway through the straw at a consistent angle from both sides (**Figure 18**). It is best to prepare these straws before heading into the field. See **Figure 19** for examples of how **NOT** to puncture a tree core straw.
- Once collected, preserve the core in the pre-punctured straw. Staple the straw ends (**do not tape**) to ensure the core can dry. The straw may be significantly longer than the collected core. Staple the straw close to the core on either end of the collected sample so that the core can't slide from one end of the straw to the other. This helps prevent the core from breaking during transport.



Figure 18. Straws are cut halfway through at a consistent angle from both sides to allow samples to dry and to avoid mold/rot

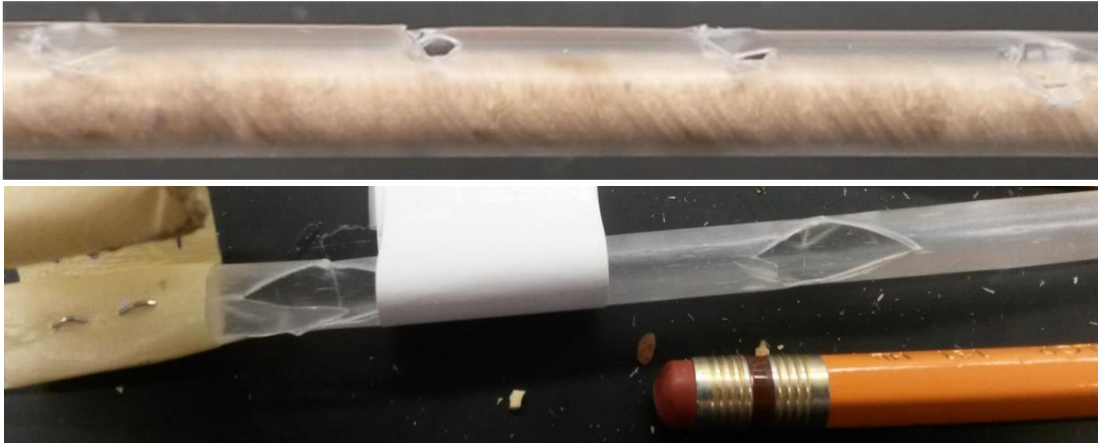


Figure 19. These are examples of **unacceptable** straw punctures. The top straw has punctures that are too small and are pointed inwards, potentially damaging the core; the bottom straw has punctures that are large enough for pieces of the core to break and escape the straw.

- Label each core/cookie with the following information:
 - Site #
 - N or S (for North or South half of the site)
 - Tree species
 - Sample type (i.e., Largest, Leading, or Secondary)
 - Collector initials
 - Date
- Cores should be labelled using a piece of painter's tape wrapped around the straw (**Figure 20**).
- Cookies can be labelled by writing on the cut face that was **not** at 1.3m if there is enough room for all the label components. If there is not enough room, wrap tape around the diameter of the cookie and write the label on the tape (**Figure 20**). Do not tape over either of the cut ends of the cookie. Ensure the tape is tight enough that it will not slip off the rough surface. Indicate on the cookie which end of the sample was measured at a height of 1.3m.



Figure 20. Appropriate core and cookie labels

- For transport in the field and back to camp, place all cores and cookies in a PVC carrying case. Be careful not to break the cores. **Note:** do not store the increment borer along with the collected cores in the PVC carrying case; the corer is rigid and can knock into the cores in the tube causing breakage.

- Once back at camp, set the cores and cookies out in a warm, dry environment and allow samples to dry.
- At the end of shift, place cookies in a paper bag. Cookies left in a plastic bag will rot. Place a label in the bag with the same information as on the label, or write the information on the bag itself.
- Group tree cores from the same site together by tying them together with flagging tape.
- Pack all cores and cookies into a cardboard box and submit to your field coordinator for further transport.

Canopy Cover

This protocol is designed to measure canopy cover within the site.

Field Equipment:

Spherical (concave) densiometer

Taking canopy cover

- Take readings at 35.35m and 49.49m (**Figure 21**) from site center along each ordinal transect (a total of 8 readings per site).
- Stand facing site center at 35.35m and stand with your back to site center at 49.49m.
- Hold the densiometer in the palm of your hand at elbow height (e.g., with your arm bent at right angles) and ensure that it is level.
- Using your dominant eye, imagine four dots equally spaced in each of the 24 squares on the densiometer (4 equal quarters) (**Figure 22**).
- Without moving your head, count the dots (quarters) that are in canopy opening (e.g., **NOT covered**) and record the number of open dots (quarters) in the tablet or on the data sheet.
- Only consider squares as covered if they are covered by shrubs or trees. Do not consider coverage of forbs or human-made structures when measuring canopy cover.

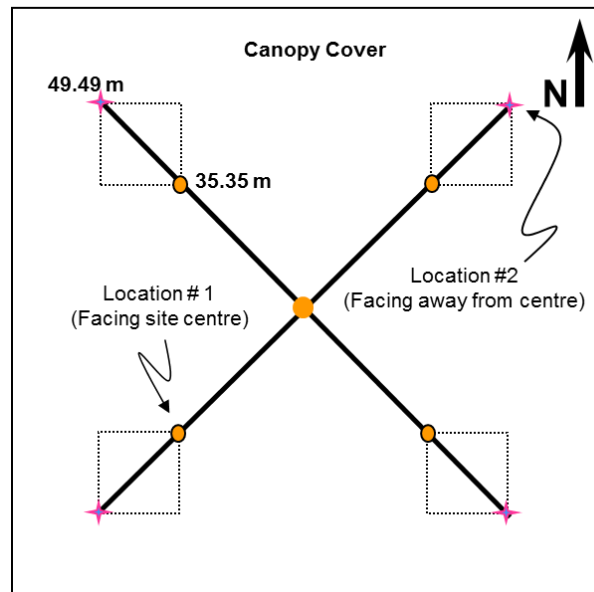


Figure 21. Canopy cover protocol layout

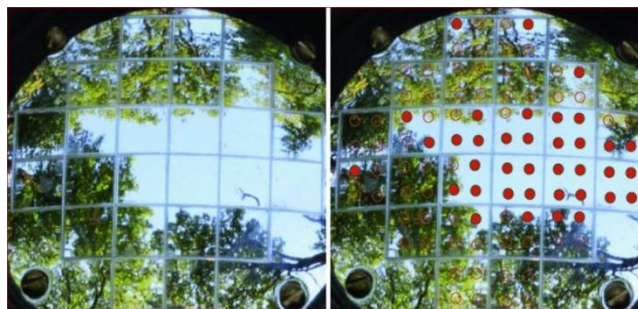


Figure 22. Densiometer open dot representation

Vascular Plants – Small Plot Survey

This protocol is designed to provide an acceptable level of repeatability for determining short-term trend in a set of species over time.

Plant surveys are completed over three 50m transects. Transects are spaced 20m apart. Plots are placed along each transect at 5m intervals (10 plots per transect, 30 plots total).

Each plot is circular and covers an area of 1m².

Plant technicians receive a minimum of 6 days of field and classroom training with a vascular plant expert prior to conducting small plot surveys.

Crews may work in teams of two to lay out the transects, but only the trained plant technician can complete the surveys.

ABMI sites are designated as Forest or Grassland Species List sites in advance of each field season. Plant technicians can only survey sites for which they have received applicable training (i.e., plant technicians trained on the forest species list can only survey Forest Species List sites and vice versa).

Field Equipment:

<i>Compass (declination set)</i>	<i>Species ID sheet binders</i>
<i>2 – 100m tapes</i>	<i>Plant storage binder</i>
<i>1 – 50m tape</i>	<i>More knife</i>
<i>Mallet</i>	<i>Hori-hori knife</i>
<i>1 – site center conduit</i>	<i>Ruler</i>
<i>5 – red-painted conduit</i>	<i>Camera</i>
<i>30 – flagged pigtails</i>	<i>Prepared plant press (incl. wax paper)</i>
<i>Flagger (any colour)</i>	<i>Plant tags</i>
<i>1m² circular hoop plot</i>	<i>Bleach cleaning kit</i>
<i>Extra hoop coupler</i>	<i>Trimble (for sites where permanent markers cannot be left)</i>
<i>Sample envelopes (for very dry plants)</i>	

Transect and plot layout

- Begin transect layout from site center. Ensure compass declination is set appropriately for the location.

Public land

- Transects span the NE and NW quadrants of an ABMI site and are established relative to site center (**Figure 23**).
- Lay out the western-most transect first, followed by the central and eastern-most transects. Stay as true to the indicated bearing as possible despite obstacles and vegetation. Allow the tape to

conform to the ground's topography and avoid any twists or folds that may affect measurement accuracy.

- Leave each transect tape in place until all plots along that transect have been completed. Tapes can be rolled up between transects.
- Transect layout – NE/NW:
 - Western-most transect (W) = Using a 100m tape and compass, measure 20m west of site center (bearing of 270°). Install a red-painted conduit at the 20m mark. Ensure conduit is securely in place before proceeding (use a mallet). Using the conduit as a corner, curve the tape around the conduit and run transect 50m north (bearing of 0°). Mark transect end-point with another red-painted conduit and check that it is securely in place.
 - Central transect (C) = Using a 50m tape and compass, measure 50m north of site center (bearing of 0°). Mark transect end-point with a red-painted conduit and check that it is securely in place.
 - Eastern-most transect (E) = Using a 100m tape and compass, measure 20m east of site center (bearing of 90°). Install a red-painted conduit at the 20m mark. Ensure conduit is securely in place before proceeding (use a mallet). Using the conduit as a corner, curve the tape around the conduit and run transect 50m north (bearing of 0°). Mark transect end-point with another red-painted conduit and check that it is securely in place.
- Plot layout – NE/NW:
 - Ten 1m² plots are completed along each North-South transect. The first plot of each transect is located 5m north of the placement line (**Figure 23**). Subsequent plots are spaced along each transect at 5m intervals.
 - Each 1m² plot is circular in shape. Place the plot on the west side of the transect with its outer edge just touching the tape at each 5m interval marker. For each plot, temporarily mark this intersection of plot edge and transect tape with a flagged pigtail. Placing the plots to the left of the transect tape (rather than directly on the line) avoids surveying the area most heavily trampled during transect layout.
 - Plots are surveyed sequentially as indicated in **Figure 23**.

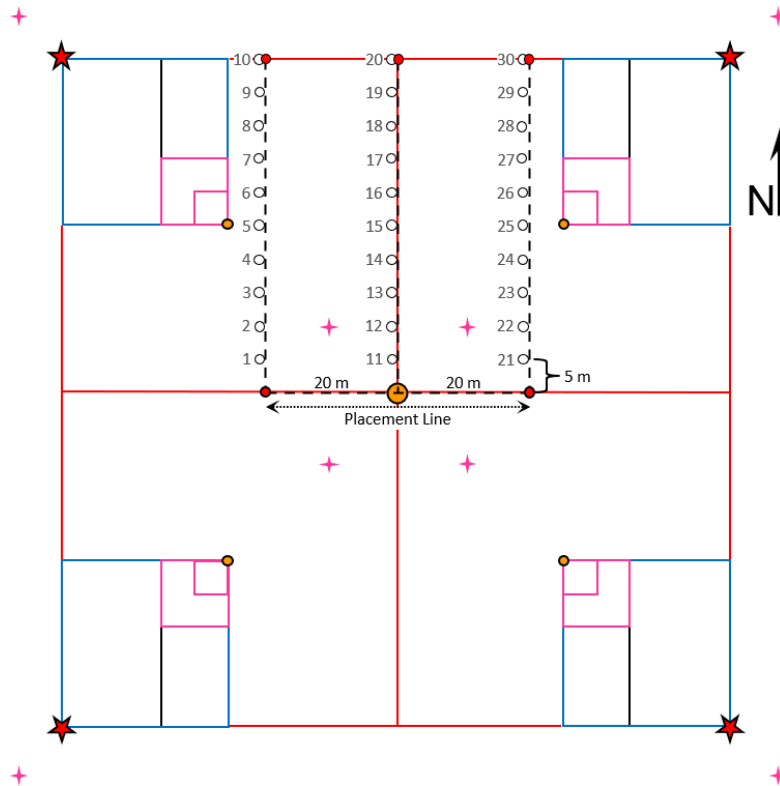


Figure 23. Standard small plot layout in the NE/NW quadrants

Private land

- On private land, where permanent markers cannot be left at site, a Trimble GPS is used to collect waypoints at the start- (0m), mid- (25m), and end-point (50m) of each transect. These points are collected before the 100m and 50m tapes used for transect establishment are rolled up.
- Label each point using the naming convention TSite#-TransectID-PositionID:
 - TSite# = prefix T for terrestrial followed by the site number of the site being surveyed
 - TransectID = the transect location (W for western-most, C for central, E for eastern-most)
 - PositionID = the waypoint location along each transect (0 for start-, 25 for mid-, 50 for end-point)

Contingencies

- If the protocol area within the NE and NW quadrants is inaccessible (i.e., at a cliff edge, on a busy road, occupied by a building or other structure, submerged in water deeper than the height of the technician's waders) and a minimum of 15 survey plots cannot be obtained, transects are relocated within the site. Alternate layout options are described in **Appendix 6: Small Plot Contingency Placements and Layouts**. Technicians must contact a field coordinator before implementing an alternate layout and must update the layout option used in the tablet.

- Note:
 - A determination of inaccessibility is based on whether the technician can safely lay out the transects and complete the surveys. A dense forest of shrubby transect line does not constitute inaccessibility.
 - If there are inaccessible areas within the layout, but a minimum of 15 plots can still be surveyed, the layout remains in the NE/NW quadrants. Plots deemed inaccessible are skipped. Data are recorded in the tablet as “DNC” for skipped plots and a comment is added to the “Plot Comments” field to provide context.
 - If a transect crosses a busy road where vehicular traffic is expected and it is unsafe to spend time on the road completing the survey, lay the transect tape out to the edge of the road and complete all survey plots up to that point. When safe to do so, pull the tape out to the far side of the road, mark the tape distance, and tie the tape off to a pigtail. Untie the tape from the site center conduit and pull it to the far side of the road. Establish the remaining transect distance and complete remaining plot surveys as normal. Unsafe plots are skipped and data are recorded in the tablet as “DNC” with comment.

Completing the survey

- Plot surveys are completed by trained plant technicians. All plots within a site must be surveyed by the same technician. Plot surveys may span multiple site visits if needed.
- Begin the survey in plot 1 and survey plots sequentially.
- For each plot:
 - Place the plot hoop on the west (NE/NW and SE/SW layouts) or north (NE/SE and NW/SW layouts) side of the tape. Ensure that the outer edge of the hoop is just touching the tape at the 5m increment marker. Mark each plot intersection point with a flagged pigtail as described above. Take care to minimize the disturbance caused while placing the hoop.
 - Hoops can be easily assembled and disassembled. This means a hoop can be pulled apart and reformed around trees and large shrubs present in the plot. Place the hoop as accurately as possible despite possible obstacles.
 - Survey the area within the plot and record all target species (see **Appendix 7: Small Plot Forest Species List** or **Appendix 8: Small Plot Grassland Species List** for applicable target species).
 - The hoop plot delineates the outer edge of a cylinder that reaches from the ground to the canopy. All plants intersecting this cylinder are included in the survey (i.e., plants rooted in the plot, as well as plants rooted outside the plot with branches, leaves, flowers, or fruits overhanging the plot boundary). Tall vegetation like trees may be easily forgotten; remember to look up.
 - Some target species are very small. Survey the plot from a variety of angles so that no target species is missed. Aim to look at the plot from a minimum of two angles.
 - Use species ID sheets if needed to confirm species identification in the field.
 - If unsure of whether a specimen found in a plot is a target species, use the Unidentified Species protocol outlined below.
 - If the tablet prompts for a voucher, use the Vouchering protocol outlined below.

- Record all presence/absence data in the tablet. Tablet species lists can be displayed by scientific or common name. Species can be searched for by scientific or common name.
- If the protocol cannot be completed in a single visit, technicians can return to the site and complete the remaining plots at a later date. Regardless of the date surveyed, all plots must be surveyed by the same technician. If surveys are split over multiple visits, record in the tablet the reason for the split (i.e., insufficient time), and indicate which plots were completed on which date (refer to the appropriate layout diagram – **Figure 23**, **Figure 26**, **Figure 27**, or **Figure 28** - for plot numbering). Notify a field coordinator of the incomplete protocol during end-of-day check-in.

Unidentified species

- If unsure whether a specimen found in a plot is a target species, search the area surrounding the plot for a comparable individual to collect (**do not** collect samples from within the plot).
- If a comparable specimen is found, collect the specimen.
 - Be sure to collect as many parts of the plant as possible – roots, stem, leaves, flowerheads, fruit, etc. If necessary, use a knife to cut out a small clump of soil containing the specimen's roots (this is necessary for grass specimens). Remove excess soil from the root ball to the extent possible.
 - Place the sample in a labelled plastic sleeve in a plant storage binder and transport to camp for pressing (see *Plant Pressing* below).
 - Record the collection in the tablet along with any pertinent specimen notes.
 - Keep the plant storage binder cool and out of the sun between the time of collection and the return to camp to preserve sample quality.
- If no comparable specimen is found, create a photo record.
 - **All photographs must show the plant along with a ruler for scale.**
 - Photographs must be taken for each of the following:
 1. Distinguishing key features as highlighted in the species ID sheets for the species you think it might be. Include macro shots where possible.
 2. Close-up photo showing entire plant.
 3. Zoomed-out photo showing the plant and its immediate surroundings (aim to capture an area of 0.25-1m²).
 4. Large-scale photo showing the ecosite where the plant is found.
 - Record the point-and-shoot camera ID in the tablet.
 - Record the in-camera photo numbers in the species-level comment section along with any pertinent specimen notes. This information will be used to re-label photos at the end of the day (see *Photo labelling* below for naming conventions).
 - Photographs will be used by a vascular plant expert to identify the plant. Photos must be clear and of good quality to meet this purpose. Check these photos in the field. **Poor quality photos must be re-taken.**
- Unidentified species collected via sample or photograph are collected only once per site. If the same unidentified species is encountered in multiple plots, reference the ID of the original collection in the tablet and do not recollect.

Voucher species

- The tablet prompts for voucher specimen collection for graminoids (grasses and sedges) and several forb species to confirm species identification (see **Appendix 9: Small Plot Forest Species Voucher List** or **Appendix 10: Small Plot Grassland Species Voucher List** for voucher species lists applicable to each site type).
- Voucher collection is required for the first surveyed occurrence of a voucher species at a site. Subsequent sightings of the same voucher species are recorded in the tablet in the same way as other target species (i.e., if *Ranunculus acris* is found in plot 4, the vouchering protocol is followed. If *Ranunculus acris* is later found in plots 6, 10, and 11 of the same site, no additional vouchers are required and the species is simply recorded as present in these plots).
- Vouchering:
 - If a voucher species is identified in a plot, search the area surrounding the plot for a comparable individual to collect (**do not** collect samples from within the plot).
 - If a comparable specimen is found, collect the specimen. Follow the same collection criteria as outlined above for collecting Unidentified Species.
 - If no comparable specimen is found, create a photo record. Follow the same photo-taking criteria as outlined above when photographing Unidentified Species.
- It is preferable to collect a physical sample rather than a photo for voucher species. If a photo record has been collected, keep an eye out for an example specimen while completing what remains of the site (remember to only collect samples from outside the plot survey areas). If found, collect the specimen as outlined above, discard the photo record, update the tablet data to reflect the new sample collection, and press and submit the voucher specimen along with any other samples.

Protocol clean-up

- Once all plots have been surveyed, roll up remaining measuring tapes and take down any flagger used during transect layout. At sites on public land, installed conduit remain in place to aid in plot relocation during re-visits. At sites on private land, remember to collect Trimble waypoints before rolling up the tapes.
- Pigtales that were used and removed from a site must be disinfected with a diluted bleach solution before being used at another site.

Plant Pressing

- If there is any uncertainty in the field about the identification of a potential target species, an example specimen must be collected (or photographed), pressed, and sent to the Processing Centre for formal identification. Similarly, all voucher specimens must be collected (or photographed), pressed, and submitted to the Processing Centre for ID confirmation.
- For sites where UIS or VS specimens are submitted, record the ID of the plant press used in the tablet's Press ID field for that site. If no pressed specimens are submitted, verify that the site's Press ID field is recorded as "VNA".
- Specimens should be placed in a plant press and labeled as soon as possible to prevent wilting.
- A species tag (**Figure 24**) is required for all UIS and VS samples. Tags must include the following:
 - Sample ID
 - For Unidentified species (UIS): Record sample ID as UIS-TSite#-Specimen#

- For voucher species (VS): Record as VS-TSite#-SPECIES CODE unless otherwise specified by the tablet*

* Species codes consist of the first 4 letters of the species' genus followed by the first 3 letters of the species-specific Latin name (e.g., Species code for *Agrostis scabra* is AGROSCA)

- Date of collection
- Initials of collector
- Plot number in which the species was initially found
- Additional notes related to the condition of the specimen or the habitat in which it was found that may assist a vascular plant expert with identification

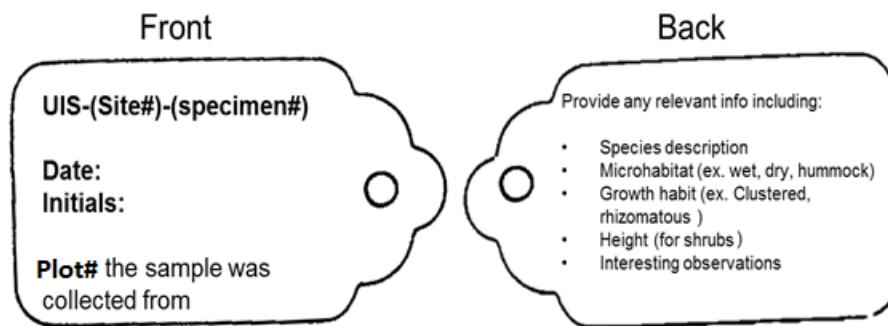


Figure 24. Example species tag

- Attach tags in a manner that is secure while ensuring that neither the tags nor strings will damage the specimen. Avoid wrapping the tag strings around delicate parts such as fibrous roots or very fine stems that will easily break when the specimen is dry.

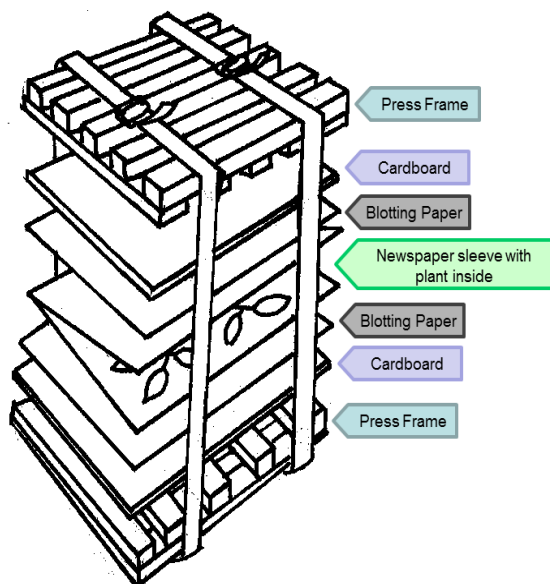


Figure 25. Plant press schematic

- Lay plants flat inside a sleeve of newspaper. Ideally only one to two specimens should be layered between each layer of blotting paper and cardboard (Figure 25).
- As specimens dry, some of the blotters and cardboard can be removed and used for fresher (more recently collected) specimens if needed.
- Avoid tightly scrunching specimen.
- Do not press sticky specimens, like shrub cuttings or bulky bunchgrasses, with delicate specimens. The delicate ones will not flatten properly.
- Bulky root balls can be left hanging out the edge of the press so long as the rest of the specimen is securely within its newspaper.
- Do not overload your newspaper sheets; too many specimens on a sheet can negatively impact how well each sample dries and flattens.

- Avoid overlapping specimens; they can stick together when dry.
- Excessively wet specimens, or specimens that have wet soil stuck to the roots, can become moldy in the press. Wet specimens should be given extra blotting papers and cardboard, or be pressed between sheets of wax paper. Samples should be checked periodically for mold. Replace blotters/cardboard with fresh ones if they are found to be damp.
- Excessively dry specimens (i.e., samples collected during a drought season that will crack if placed in a plant press) can be stored and submitted in sample envelopes. Place only 1 sample in each envelop used. Label each envelop with the species tag information before placing the sample inside.
- At the end of each field shift, plant technicians will label and submit a completed plant press. Presses are labeled with flagging tape. Each flagging tape label must include the following information:
 - Crew ID
 - Shift ID
 - Shift dates
 - Technician initials
 - Sites included in the press
 - The species list used (i.e., Small Plot – Forest List or Small Plot – Grassland List)
- A USB with the shipping document will also be attached to the plant press at the time of submission (see *Data Submission* below).

Photo Labeling

- Photo labelling follows the same naming pattern as UIS and VS species tags, but uses the prefix “PS” for photo specimen.
- Label photos as follows:
 - Photos showing distinguishing key features: PS_TSite#_Specimen#_FEATURES
 - Photos showing close-up of entire plant: PS_TSite#_Speciment#_FULL
 - Photos showing plant with 0.25-1m² area: PS_TSite#_Speciment#_HABITAT
 - Photos showing large area of ecosite where plant is found: PS_TSite#_Specimen#_LRG
- If there is more than one photo per category, simply add a (2), (3), etc. to the end of the label (i.e., PS_T123_1_FEATURES(4) for an unidentified species, or PS_T123_ELYMREP_FULL(2) for a voucher).

Data submission

- At the end of each field shift, review all pressed specimens and species tags, as well as all electronic data (tablet data, photo files, and waypoints if collected). Ensure data are complete, accurate, and properly formatted before submission to a field coordinator.

Plant press, specimen, and tag review

- Complete a final plant press review. Replace damp blotter paper if needed. If recently collected samples are still very wet, flag press as “WET” to alert Processing Centre staff.
- Check that each unidentified and voucher specimen in the press has a corresponding tablet record. Make edits within the tablet if necessary (e.g., if an expected sample is missing from the plant press, add a comment to the “Species comment” field in the tablet data explaining why it is not present and change the “Voucher” column from “Sample collected” to DNC).

- Ensure specimen tags are present and complete.
- Flag plant press with crew ID, shift ID, shift dates, technician initials, sites included in the press, and species list used. Use a long piece of flagger for this so that it can later be used to tie on a submission USB.

Tablet data review

- Complete a final tablet data check after having reviewed the contents of the plant press.
- Review data in tablet for overall completeness and accuracy. Ensure “DNC” entries are accompanied by an explanatory comment. Ensure Press ID and camera fields are correctly filled in for each site (see above). Ensure the protocol tab has greened out for each site.

Photo review

- Complete a final photo file review. Check that all expected photos are present and properly named.
- Create a folder called “Photo Specimens” and include all photographed specimens in the folder. Along with the photos, save to the USB an associated .txt file using WordPad on the tablet. In this text file, list all the species found in the folder in the following format: PS_TSite#_UIS# OR 7-letter Species Code.
- Save all photos to the same USB used to save the data and shipping document files. If possible, upload photos to FTP.

Waypoint review

- Complete a final waypoint review if private land waypoints were collected. Check that all site level records are present and correctly labeled. Review the paper data sheet; ensure waypoints are correctly transcribed and that all fields are complete. Leave data sheet in site package envelope.

Final submissions

- Submit USB to a Field Coordinator for review. Once shift-end QAQC is complete and requested updates have been made to the tablet and photo files, copy and paste the most up-to-date shipping document and Photo Specimens folder to a new USB. If necessary, re-upload these files to FTP. Attach updated USB to the plant press. Submit plant press and USB together for delivery to the Processing Centre. If applicable, return Trimble unit and accessories to a field coordinator.

PART 2. APPENDICES

Appendix 1: Equipment List

The equipment needed to implement the ABMI field data collection includes:

- Personal equipment provided to each crew
- Crew kits provided to each 2-person crew
- Optional field gear
- Equipment needed by each crew specific to spring terrestrial protocols
- Equipment needed by each crew specific to summer terrestrial protocols

Note: some equipment items are not specific to a particular protocol, but are required either for multiple protocols, are used to move around the site, or are used to address unforeseen circumstances.

Personal Equipment (Cloth bag)

GPS with AA batteries
Compass
Clipboard
Personal first aid kit (Alberta Type 1)
Mora knife
Bear spray
Safety whistle
No-cut work gloves
Safety glasses
Insect repellent
Sunscreen
Tablet(s)/chargers(s)/spare batteries
VHF radio
3 VHF batteries
VHF radio charger
VHF radio harness
100m tape

Recommended Field Gear (not provided)

Rubber boots
Hiking boots
Rain jacket
Rain pants
Daypack
Cruiser vest
Chest waders (\$100 stipend allotted)

Provided Gear (if required)

Nomex coveralls
Hardhat
ATV helmet

Crew Kit (Blue bin)

Aqua pac for radio
Satellite phone and batteries
Admin kit

- Pencils, pens, eraser, sharpener
- Envelopes
- Packing tape, painter's tape
- Stapler, staples, paperclips
- Scissors
- Sharpies, dry erase markers
- Lined paper
- USBs
- GPS cable
- Plant tweezers
- 2 Hand lenses
- ABMI forms (expense, incident, first aid, etc.)

ID Books (plant and animal)

Map books

Alberta Type 3 First Aid Kit

Duffle bag

2 Folding saws

AA batteries for GPS

2 Point-and-shoot camera kits

Found in Truck – Emergency kit containing:

- Alberta Type 2 First aid kit
- Safety triangles
- Fire extinguisher
- Shovel
- Bow saw
- Tool kit

Equipment for Spring Terrestrial Crews (Backpack)

Maps, air photos, satellite images
 Metal detector
 Pigtales
 Rebar/conduit/magnetic spikes
 Mallet
 Flagging tape (orange, blue, red, pink/blue striped)
 Large and small paper collection bags
 Santa sacs
 Soil corer
 Soil collection bags
 500ml measuring cup
 Plastic sheet
 Dustpan and brush
 Soil cleaning kit
 Coleman coolers
 Carpenter's tape
 Go-No-Go gauge
 DBH calipers (50cm)
 DBH tape
 Vertex hypsometer with transponder
 Pelican case (1050)
 Tree paint
 <30cm accurate GPS (given to crews as needed)

Equipment for Summer Terrestrial Crews – in addition to retained spring gear (Summer bin)

Plant press
 Plant tags
 Species ID binder
 Wax paper
 50cm folding ruler
 50m tape
 Increment borer
 Tree core straws
 PVC tree core carrying case
 Spherical (concave) densiometer
 Cam/ARU retrieval gear (drill kit, laptop cases, bubble wrap, coin envelopes)
 <30cm accurate GPS (given to crews as needed)
 Envelopes (for desiccated plants)

Appendix 5: Ecological Site Classification Descriptions

Simplification of Forest Ecosite Types To Be Used In The ABMI

For the ABMI, we have simplified the ecosite types from the “Field Guide to Ecosites of Northern Alberta” by Beckingham and Archibald (1996), “Field Guide to Ecosites of West-Central Alberta” by Beckingham *et al.* (1996), “Field Guide to Ecosites of Southwestern Alberta” by Archibald *et al.* (1996), “Range Plant Community Types and Carrying Capacity for the Upper Foothills Subregion of Alberta” by Willoughby (2005), “Range Plant Community Types for the Subalpine and Alpine Subregions” by Willoughby and Alexander (2006), “Range Plant Community Types and Carrying Capacity for the Montane Subregion of Alberta” by Willoughby *et al.* (2005), “Range Plant Community Types and Carrying Capacity for the Lower Foothills Region of Alberta” by Lawrence *et al.* (2005), “Guide to Range Plant Community Types and Carrying Capacity for the Dry and Central Mixedwood Subregions in Alberta” by Willoughby *et al.* (2006), and Range Plant Communities and Range Health Assessment Guidelines for the Foothills Fescue Natural Subregion of Alberta” by Adams *et al.* (2005).

Fifteen broad categories of vegetation types have been created – these are labeled based on the common moisture/nutrient level. The categories have then been subdivided based on composition of overstory trees. Note that the classifications of ecosites are based on vegetation communities and not soil information. The first letter in the moisture code indicates nutrient status (P=Poor, M=Medium, R=Rich, V=Very Rich), and the second letter indicates moisture conditions (X=Xeric, M=Mesic, G=Hygic, D=Hydric, OW=Open Water). Acronyms noted under the ecosite categories follow the literature that was summarized with the following additions: BM=Boreal Mixedwood, BH=Boreal Highlands, SB=Subarctic, CS=Canadian Shield, WC=Ecosites described for West-Central Alberta, SW= Ecosites described for Southwestern Alberta, LF=Lower Foothills, UF=Upper Foothills, MN=Montane, and SA=Subalpine.

Upland Vegetation Communities and Corresponding Ecosite Types Used by the ABMI

1. Bearberry/Lichen – PX

The shrub/ground stratum is usually dominated by bearberry and lichen, although bog cranberry and juniper sometimes are common at high elevations. This community is expected when soils are nutrient poor and moisture regime is xeric to subxeric.

1a) Pine – The shrub/ground stratum is usually dominated by bearberry and lichen, although bog cranberry is common at some sites. The overstory is dominated by pine.

Ecosites included:

- BM a1 (lichen Pj)
- BH a1 (bearberry Pj)
- SB a1 (bearberry PI)
- SB a2 (bearberry PIAw)
- SB a3 (bearberry Aw)
- CS a1 (bearberry Pj)
- WC_LF b1 (bearberry/lichen PI)
- SW_LF a1 (bearberry PI)
- WC_UF b1 (bearberry lichen PI)
- SW_UF a1 (bearberry PI)

- SW_MN a1 (limber pine/juniper FdPf)
- SW_MN b1 (bearberry PI)
- WC_SA b1 (bearberry/lichen PI)
- SW_SA a1 (lichen PI)

2. Labrador Tea/Feather Mos – PM

The shrub/ground stratum is usually dominated by Labrador tea and feather moss, although bog cranberry is common at some sites. At upper elevations in the mountains, bilberry and grouse-berry are common at some sites. This community is expected when soils are nutrient poor to medium and moisture regime is submesic to hygric.

2a) Pine – The shrub/ground stratum is usually dominated by Labrador tea and feather moss, although bog cranberry, blueberry, are common at some sites. At upper elevations in the mountains, bilberry and grouse-berry are common at some sites. The overstory is dominated by pine.

Ecosites included:

- BM c1 (Labrador tea – mesic PjSb)
- BH c1 (Labrador tea – mesic PjSb)
- SB c1 (Labrador tea – mesic PISb)
- CS c1 (Labrador tea – mesic PjSb)
- WC_LF d1 (Labrador tea-mesic PISb)
- SW_LF c1 (Labrador tea-mesic PI)
- SW_LF f1 (Labrador tea-hygric PI)
- WC_UF d1 (Labrador tea-mesic PISb)
- WC_UF e1 (tall bilberry/arnica PI)
- SW_UF c1 (tall bilberry/Labrador tea PI)
- WC_SA d1 (rhododendron-mesic PI)
- WC_SA f1 (rhododendron-subhygric PI)
- SW_SA e1 (false azalea-grouseberry PI)

2b) Other – The shrub/ground stratum is usually dominated by Labrador tea and feather moss, although bog cranberry is common at some sites. At upper elevations in the mountains, bilberry, heather, and grouse-berry are common at some sites. The overstory is dominated by a variety of species including spruce, fir, and trembling aspen.

Ecosites included:

- SW_LF c2 (Labrador tea-mesic AwSwPI)
- WC_UF e2 (tall bilberry/arnica AwSwPI)
- WC_UF e3 (tall bilberry/arnica Sw)
- WC_UF e4 (tall bilberry/arnica Fa)
- SW_UF c2 (tall bilberry/Labrador tea Sw)
- SW_UF c3 (tall bilberry/Labrador tea Fa)
- WC_SA d2 (rhododendron-mesic Se)
- WC_SA d3 (rhododendron-mesic Fa)
- WC_SA f2 (rhododendron-subhygric SeFa)

- SW_SA c1 (subalpine larch/heather LaFa)
- SW_SA d1 (spruce/heather Se)
- SW_SA e2 (false azalea-grouse-berry Pw)
- SW_SA e3 (false azalea-grouse-berry-Se)
- SW_SA e4 (false azalea-grouse-berry Fa)

2c) Sb – The shrub/ground stratum is dominated by Labrador tea and feather moss, although bog cranberry is sometimes common. The overstory is dominated by black spruce.

Ecosites included:

- BM g1 (Labrador tea – subhygric SbPj)
- BH g1 (Labrador tea – subhygric SbPj)
- SB e1 (Labrador tea – hygric SbPl)
- CS d1 (Labrador tea – subhygric SbPj)
- WC_LF h1 (Labrador tea subhygric SbPl)
- WC_UF h1 (Labrador tea subhygric SbPl)
- SW_UF c4 (tall bilberry/Labrador tea PlSb)
- SW_UF f1 (black spruce/Labrador tea SbPl)

3. Hairy Wild Rye – MX

The shrub/ground stratum is usually dominated by hairy wild rye, although bearberry is sometimes common. This community is expected when soils have medium nutrient levels and moisture regime is subxeric to mesic. These soil conditions are mainly found on south facing slopes in mountains.

3a) None – The shrub/ground stratum is usually dominated by hairy wild rye, other grasses, and bearberry. No trees are present.

Ecosites included:

- WC_LF a1 (Shrubby grassland)
- WC_UF a1 (Shrubby grassland)
- WC_MN a1 (shrubby grassland)
- WC_MN a2 (graminoid grassland)
- WC_SA a1 (shrubby grassland)
- WC_SA a2 (graminoid grassland)

3b) Pine – The shrub/ground stratum is usually dominated by hairy wild rye, although Canada buffalo-berry, bearberry, green alder, and feather moss are common at some sites. The overstory is usually dominated by lodgepole pine or Douglas fir.

Ecosites included:

- WC_LF c1 (hairy wild rye Pl)
- SW_LF b1 (bearberry/hairy wild rye Pl)
- WC_UF c1 (hairy wild rye Pl)
- SW_UF b1 (bearberry/hairy wild rye Pl)
- WC_MN b1 (bearberry Fd)

- WC_MN b2 (bearberry PI)
- WC_MN c1 (hairy wild rye Fd)
- WC_MN c2 (hairy wild rye PI)
- SW_MN c1 (Canada buffalo-berry/hairy wild rye Fd)
- SW_MN c2 (Canada buffalo-berry/hairy wild rye PI)
- WC_SA c1 (hairy wild rye PI)
- SW_SA b1 (bearberry/hairy wild rye PI)

3c) AwMix – The shrub/ground stratum is usually dominated by hairy wild rye, although Canada buffalo-berry and bearberry are common at some sites. The overstory is dominated by trembling aspen, with lesser amounts of lodgepole pine and white spruce.

Ecosites included:

- WC_LF c2 (hairy wild rye Aw)
- WC_LF c3 (hairy wild rye AwSwPI)
- SW_LF b2 (bearberry/hairy wild rye Aw)
- SW_LF b3 (bearberry/hairy wild rye AwSwPI)
- WC_UF c2 (hairy wild rye Aw)
- WC_UF c3 (hairy wild rye AwSwPI)
- SW_UF b2 (bearberry/hairy wild rye Aw)
- SW_UF b3 (bearberry/hairy wild rye AwSwPI)
- WC_MN b3 (bearberry Aw)
- WC_MN b4 (bearberry AwSwPI)
- WC_MN c3 (hairy wild rye Aw)
- WC_MN c4 (hairy wild rye AwSwPI)
- WC_MN b2 (bearberry Aw)
- WC_MN b3 (bearberry AwSwPI)
- SW_MN c3 (Canada buffalo-berry/hairy wild rye Aw)
- SW_MN c4 (Canada buffalo-berry/hairy wild rye AwSwPIFd)
- WC_SA c2 (hairy wild rye PIaw)

3d) Spruce – The shrub/ground stratum is usually dominated by hairy wild rye, although Canada buffalo-berry, bearberry and feather moss are common at some sites. The overstory is dominated by spruce.

Ecosites included:

- WC_LF c4 (hairy wild rye Sw)
- WC_UF c4 (hairy wild rye Sw)
- SW_UF b4 (bearberry/hairy wild rye Sw)
- WC_MN b5 (bearberry Sw)
- WC_MN c5 (hairy wild rye Sw)
- WC_MN_SA c3 (hairy wild rye Se)

4. Low-bush Cranberry/Canada Buffalo-berry – MM

The shrub/ground stratum is often dominated by low-bush cranberry and Canada buffalo-berry, although the vegetation community is variable and blueberry, alder, rose, Saskatoon, Labrador

tea, bearberry, thimbleberry, bog cranberry, willow, fir, and feather moss may be common. This community is expected when soils have medium to rich nutrient levels and moisture regime is submesic to mesic.

4a) PineMix – The shrub/ground stratum is often dominated by low-bush cranberry and Canada buffalo-berry, although bog cranberry, green alder, feather moss, and a variety of other shrubs are common at some sites. The overstory is dominated by pine with lesser amounts of trembling aspen, balsam poplar, paper birch, and spruce.

Ecosites included:

- BM b1 (blueberry PjAw)
- BH b1 (blueberry PjAw(Bp))
- SB b1 (Canada buffalo-berry PlAw)
- CS b1 (Canada buffalo-berry green alder PjAwBw)
- WC_LF e1 (Low-bush cranberry Pl)
- SW_LF d1 (low-bush cranberry/wild sarsaparilla Pl)
- SW_MN d1 (creeping mahonia-white meadowsweet Fd)
- SW_MN d2 (creeping mahonia-white meadowsweet Pl)
- SW_MN e1 (thimbleberry/pine grass Pl)

4b) Aw – The shrub/ground stratum is often dominated by low-bush cranberry and Canada buffalo-berry, although alder, rose, bog cranberry, and a variety of other shrubs are common at some sites. The overstory is dominated by trembling aspen.

Ecosites included:

- BM b2 (blueberry AwBp)
- BM d1 (low-bush cranberry Aw)
- BH b2 (blueberry Aw)
- BH d1 (low-bush cranberry Aw)
- SB b1 (Canada buffalo-berry Aw)
- CS b2 (Canada buffalo-berry green alder Aw)
- WC_LF e2 (low-bush Cranberry Aw)
- SW_LF d2 (low-bush cranberry/wild sarsaparilla Aw)
- SW_MN e2 (thimbleberry/pinegrass Aw)

4c) AwMix – The shrub/ground stratum is often dominated by low-bush cranberry and Canada buffalo-berry, although alder, rose, feather moss, and a variety of other shrubs are common at some sites. The overstory is dominated by trembling aspen and a mix of spruce and pine.

Ecosites included:

- BM b3 (blueberry AwSw)
- BM d2 (low-bush cranberry AwSw)
- BH d2 (low-bush cranberry AwSwSb)
- SB b1 (Canada buffalo-berry AwSwSb)
- CS b3 (Canada buffalo-berry green alder AwSwSb)
- WC_LF e3 (low-bush cranberry AwSwPl)

- SW_LF d3 (low-bush cranberry/wild sarsaparilla AwSwPI)

4d) Sw – The shrub/ground stratum is sometimes dominated by low-bush cranberry and Canada buffalo-berry, although rose, fir, feather moss, and a variety of other shrubs are common at some sites. The overstory is usually dominated by spruce.

Ecosites included:

- BM b4 (blueberry SwPj)
- BM d3 (low-bush cranberry Sw)
- BH b3 (blueberry SwPj)
- BH d3 (low-bush cranberry Sw)
- SB b1 (Canada buffaloberry Sw)
- WC_LF e4 (low-bush Cranberry Sw)
- SW_LF d4 (low-bush cranberry/wild sarsaparilla Sw)
- SW_UF d1 (silver-berry Sw)
- SW_MN e3 (thimbleberry/pinegrass Sw)

5. Horsetail – MG

The shrub/ground stratum contains horsetail, although dogwood, alder, rose, low-bush cranberry, Labrador tea, willow, and feather moss may be common at some sites. This community is expected when soils have medium to rich nutrient levels and a hygric moisture regime.

5a) PbMix – The shrub/ground stratum contains abundant horsetail, although alder, rose, low-bush cranberry, willow, and feather moss may be common at some sites. The overstory is dominated by balsam poplar and a mix of trembling aspen, paper birch, and white spruce.

Ecosites included:

- BM f1 (horsetail PbAw)
- BM f2 (horsetail PbSw)
- SB d1 (horsetail PbBw)
- SB d2 (horsetail AwSw)
- CS e1 (willow/horsetail AwBpPb)
- WC_LF i1 (horsetail PbAw)
- WC_LF i2 (horsetail PbSw)
- WC_MN f1 (horsetail PbAw)

5b) Spruce – The shrub/ground stratum contains abundant horsetail and feather moss, although Labrador tea and willow may be common at some sites. The overstory is dominated by white or Engelmann spruce.

Ecosites included:

- BM f3 (horsetail Sw)
- BH f1 (horsetail Sw)
- SB d3 (horsetail Sw)

- CS e2 (willow/horsetail AwSwSb)
- WC_LFi3 (horsetail Sw)
- SW_LF h1 (white spruce/horsetail Sw)
- WC_UF j1 (horsetail Sw)
- SW_UF h1 (white spruce/horsetail Sw)
- WC_MN f2 (horsetail Sw)
- SW_MN g1 (horsetail SwPb)
- SW_MN g2 (horsetail Sw)
- WC_SA g1 (horsetail Se)
- SW_SA h1 (horsetail Se)

5c) Sb – The shrub/ground stratum is dominated by Labrador tea and feather moss with horsetail present in lesser amounts. The overstory is usually dominated by black spruce.

Ecosites included:

- BM h1 (Labrador tea/horsetail SwSb)
- WC_LF j1 (Labrador tea/horsetail SbSw)
- SW_LF g1 (black spruce/ horsetail SwSb)
- SW_LF g2 (black spruce/horsetail Sb)
- WC_UF i1 (Labrador tea/horsetail SbSw)
- SW_UF g1 (black spruce/horsetail SbSw)

6. Dogwood/Fern/Feather Moss – RG

The shrub/ground stratum usually contains dogwood, fern, and abundant feather moss, although rose, alder, bracted honeysuckle, devil's club, and fir are common at some sites. This community is expected when soils have rich nutrient levels and a subhygric moisture regime.

6a) PI – The shrub/ground stratum usually contains dogwood, fern, and abundant feather moss, although bracted honeysuckle, alder, devil's club, and fir are sometimes common. The overstory is usually dominated by lodgepole pine.

Ecosites included:

- WC_LF f1 (bracted honeysuckle PI)
- SW_LF e1 (bracted honeysuckle fern PI)
- WC_UF f1 (bracted honeysuckle PI)
- SW_UF e1 (green alder/fern PI)
- SW_SA f1 (thimbleberry PI)

6b) PbMix – The shrub/ground stratum usually contains dogwood, fern, and abundant feather moss, although rose, alder, bracted honeysuckle and devil's club are common at some sites. The overstory is dominated by deciduous trees (usually balsam popular, but sometimes trembling aspen and paper birch), although spruce and pine may be common.

Ecosites included:

- BM e1 (dogwood PbAw)
- BM e2 (dogwood PbSw)

- WC_LF f2 (bracted honeysuckle AwPb)
- WC_LF f3 (bracted honeysuckle AwSwPI)
- SW_LF e2 (bracted honeysuckle fern AwPb)
- SW_LF e3 (bracted honeysuckle fern AwSwPI)
- WC_UF f2 (bracted honeysuckle Pb)
- WC_UF f3 (bracted honeysuckle PbSwPI)
- SW_UF e2 (green alder/fern Pb)
- WC_MN d1 (dogwood PbAw)
- WC_MN d2 (dogwood PbSw)
- SW_MN f1 (balsam poplar Pb)

6c) Spruce – The shrub/ground stratum usually contains dogwood, fern, and abundant feather moss, although rose, alder, bracted honeysuckle, devil's club and fir are common at some sites. The overstory is dominated by spruce and fir.

Ecosites included:

- BM e3 (dogwood Sw)
- BH e1 (fern Sw)
- WC_LF f4 (bracted honeysuckle Sw)
- SW_LF e4 (bracted honeysuckle fern Sw)
- WC_UF f4 (bracted honeysuckle Sw)
- WC_UF f5 (bracted honeysuckle Fa)
- SW_MN d3 (creeping mahonia-white meadowsweet Sw)
- SW_SA f2 (thimbleberry FaSe)

7. Not Treed – NT

The shrub/ground stratum is either non-vegetated or dominated by shrubs, grasses, sedges and forbs. A very wide variety of nutrient levels and moisture regimes can be present.

7a) Alpine – Sites occur at elevations above tree line. The shrub/ground stratum is either non-vegetated or dominated by heathers, grasses, sedges and forbs. Trees are absent due to climatic conditions.

7b) Flood – Sites are usually found at the edge of rivers, streams, lakes, and wetlands where vegetation is disturbed frequently by flooding. The shrub/ground stratum is either non-vegetated or dominated by shrubs (often willow), grasses, sedges and forbs. Trees are absent due to the frequent flooding.

Ecosites included:

- WC_LF g1 (shrubby meadow)
- WC_LF g2 (forb meadow)
- WC_UF f6 (bracted honeysuckle, willow)
- WC_UF g1 (shrubby meadow)
- WC_UF g2 (forb meadow)
- WC_MN e1 (meadow)
- WC_MN e2 (forb meadow)
- WC_SA e1 (shrubby meadow)

- WC_SA e2 (forb meadow)
- SW_SA g1 (dwarf birch/tufted hair grass)

7c) Ice – Sites are usually at higher elevations, where the vegetation is disturbed frequently by ice and snow. The shrub/ground stratum is either non-vegetated or dominated by shrubs, heathers, grasses, sedges and forbs. Trees are absent due to the action of ice and snow.

7d) Dry – Sites are usually in the grassland and parkland, where moisture stress limits establishment and growth of trees. The shrub/ground stratum is either non-vegetated or dominated by shrubs, grasses, sedges, and forbs.

7e) Geo – Geological features (e.g., rocky outcrops, sand dunes, etc) limit tree establishment and growth. The shrub/ground stratum is either non-vegetated or dominated by heathers, grasses, sedges, and forbs.

7f) Human – Human disturbance or activity limiting or preventing tree growth. The shrub/ground stratum is either non-vegetated or dominated by invasive species, grasses, sedges, or forbs.

Lowland Vegetation Communities and Corresponding Ecosite Types Used by the ABMI

8. Bog – Labrador Tea/Peat Moss/Lichen – PD

The shrub/ground stratum is dominated by Labrador tea, peat moss and lichen. This community is expected when soils are nutrient poor and have a hydric to subhygric moisture regime. The soil is saturated for part or all the year.

8a) Sb – The shrub/ground stratum is dominated by Labrador tea, peat moss and lichens, although bog cranberry and cloudberry are common at some sites. The overstory is dominated by black spruce.

Ecosites included:

- i. In J.D. Beckingham *et al.* (1996), J.D. Beckingham and J.H. Archibald (1996), and J.H. Archibald *et al.* (1996)
 - BM i1 (treed bog)
 - BH h1 (treed bog)
 - SB f1 (treed bog)
 - CS f1 (treed bog)
 - WC_LF k1 (treed bog)
 - SW_LF l1 (treed bog)
 - WC_UF k1 (treed bog)
 - SW_UF i1 (treed bog)
 - WC_SA h1 (treed bog)
- ii. In Willoughby (2005), Willoughby *et al.* (2005), and Willoughby *et al.* (2006)
 - DMD9 Sb-Lt/Labrador tea/Moss

8b) Shrub – The shrub/ground stratum is dominated by Labrador tea, peat moss and lichens, although bog cranberry and cloudberry are common at some sites. The overstory is dominated by black spruce but these trees cover <10% of the area.

Ecosites included:

- i. In J.D. Beckingham *et al.* (1996), J.D. Beckingham and J.H. Archibald (1996), and J.H. Archibald *et al.* (1996)
 - BM i2 (shrubby bog)
 - BH h2 (shrubby bog)
 - SB f2 (shrubby bog)
 - CS f2 (shrubby bog)
 - WC_LF k2 (shrubby bog)
 - WC_UF k2 (shrubby bog)
 - WC_SA h2 (shrubby bog)
- ii. In Willoughby (2005), Willoughby *et al.* (2005), and Willoughby *et al.* (2006)
 - UFE5 Sb/Willow
 - j19 Sb/Labrador tea/bog cranberry/cloudberry

9. Poor Fen – Labrador Tea/Peat Moss/Sedge – MD

The shrub/ground stratum is dominated by Labrador tea, peat moss and sedge. This community is expected when soils are nutrient poor and have a hydric to subhygric moisture regime. The soil is saturated for part or all the year.

9a) SbLt – The shrub/ground stratum is dominated by Labrador tea, peat moss and sedges, although bog cranberry, dwarf birch and willow are common at some sites. The overstory is dominated by black spruce and larch.

Ecosites included:

- i. In J.D. Beckingham *et al.* (1996), J.D. Beckingham and J.H. Archibald (1996), and J.H. Archibald *et al.* (1996)
 - BM j1 (treed poor fen)
 - BH i1 (treed poor fen)
 - SB g1 (treed poor fen)
 - CS g1 (treed poor fen)
 - WC_LF l1 (treed poor fen)
 - SW_LF j1 (treed poor fen)
 - WC_UF l1 (treed poor fen)
 - SW_UF j1 (treed poor fen)
 - WC_MN g1 (treed fen)
 - WC_SA i1 (treed fen)
- ii. In Lawrence *et al.* (2005), and Willoughby *et al.* (2006)
 - DMD8 Sb/Willow/Moss
 - j20 Sb-Lt/Sedge/Moss

9b) Shrub – The shrub/ground stratum is dominated by Labrador tea, peat moss and sedges, although bog cranberry, dwarf birch and willow are common at some sites. The overstory is dominated by black spruce and larch but these trees cover <10% of the area.

Ecosites included:

- i. In J.D. Beckingham *et al.* (1996), J.D. Beckingham and J.H. Archibald (1996), and J.H. Archibald *et al.* (1996)
 - BM j2 (shrubby poor fen)
 - BH i2 (shrubby poor fen)
 - SB g2 (shrubby poor fen)
 - CS g2 (shrubby poor fen)
 - WC_LF i2 (shrubby poor fen)
 - WC_UF i2 (shrubby poor fen)
 - SW_UF j2 (shrubby poor fen)
 - WC_MN g2 (shrubby fen)
 - WC_SA i2 (shrubby fen)
- ii. In Lawrence *et al.* (2005), and Willoughby *et al.* (2006)
 - DMA19 Bog willow
 - c11 Dwarf birch willow/Sedge/Peat moss

10. Rich Fen – Dwarf Birch/Willow/Sedge/Grass/Moss – RD

The shrub/ground stratum is dominated by dwarf birch, willow, sedge, and moss. This community is expected when soils are medium to rich and have a hydric to subhygric moisture regime. The soil is saturated for part or all the year.

10a) SbLt – The shrub/ground stratum is dominated by dwarf birch, willow, sedge, and moss. The overstory is dominated by black spruce and larch.

Ecosites included:

- i. In J.D. Beckingham *et al.* (1996), J.D. Beckingham and J.H. Archibald (1996), and J.H. Archibald *et al.* (1996)
 - BM k1 (treed rich fen)
 - BH j1 (treed rich fen)
 - SB h1 (treed rich fen)
 - CS h1 (treed rich fen)
 - WC_LF m1 (treed rich fen)
 - SW_LF k1 (treed rich fen)
 - WC_UF m1 (treed rich fen)
 - SW_UF k1 (treed rich fen)
- ii. In Willoughby (2005), Willoughby *et al.* (2005), and Willoughby *et al.* (2006)
 - DMC15 Pb/Reed grass
 - E17 Sb-Lt/Labrador tea
 - D12 Sb/Willow/Wire rush-Sedge/Moss
 - J21 Lt/Bog birch/Sedge/Moss

10b) Shrub – The shrub/ground stratum is dominated by dwarf birch, willow, sedge, and moss, and includes floating mats of vegetation. The overstory is dominated by black spruce and larch but these trees cover <10% of the area.

Ecosites included:

- i. In J.D. Beckingham *et al.* (1996), J.D. Beckingham and J.H. Archibald (1996), and J.H. Archibald *et al.* (1996)
 - BM k2 (shrubby rich fen)
 - BH j2 (shrubby rich fen)
 - SB h2 (shrubby rich fen)
 - CS h2 (shrubby rich fen)
 - WC_LF m2 (shrubby rich fen)
 - SW_LF k2 (shrubby rich fen)
 - WC_UF m2 (shrubby rich fen)
 - SW_UF k2 (shrubby rich fen)
- ii. In Willoughby (2005), Adams *et al.* (2005), Lawrence *et al.* (2005), Willoughby *et al.* (2005), Willoughby *et al.* (2006), and Willoughby and Alexander (2006)
 - DMA10 Willow/Sedge
 - DMA10a Willow/Marsh reed grass
 - c10 Willow-bog birch/Water sedge
 - D2a Drummond's willow
 - D3a Bebb willow/Beaked sedge
 - B8 Myrtle lv'd willow/Sedge
 - D9 Basket willow/Sedge
 - UFB1 Willow-bog birch/Water sedge
 - D11 Sw/Willow/Water sedge/Golden moss
 - SACFB1 Willow/Bog birch/Water sedge
 - SACFB2 Willow/Water sedge
 - FFC2 Beaked willow/Sedge/Tufted hair-grass

10c) None – The shrub/ground stratum is dominated by dwarf birch, willow, sedge, and moss, and includes floating mats of vegetation. Trees and shrubs cover <10% of the area.

Ecosites included:

- i. In J.D. Beckingham *et al.* (1996), J.D. Beckingham and J.H. Archibald (1996), and J.H. Archibald *et al.* (1996)
 - BM k3 (graminoid rich fen)
 - BH j3 (graminoid rich fen)
 - SB h3 (graminoid rich fen)
 - CS h3 (graminoid rich fen)
 - WC_LF m3 (graminoid rich fen)
 - SW_LF k3 (graminoid rich fen)

- WC_UF l3 (graminoid poor fen)
- WC_UF m3 (graminoid rich fen)
- SW_UF j3 (graminoid poor fen)
- SW_UF k3 (graminoid rich fen)
- WC_MN g3 (graminoid fen)
- WC_SA i3 (graminoid fen)
- ii. In Willoughby (2005), Lawrence *et al.* (2005), Willoughby *et al.* (2005), Willoughby *et al.* (2006), and Willoughby and Alexander (2006)
 - DMA1 Sedge meadow
 - DMA2 Marsh reed grass meadow
 - B12 Beaked/Water sedge
 - B12a Awned sedge
 - SACFA1 Water/Beaked sedge
 - UFA1 Water/Beaked sedge meadow
 - b8 Water sedge meadow

11. Marsh – Cattail/Rush/Reed – VD

The shrub/ground stratum is dominated by cattails, rushes or reed grass. This community is expected when soils are very rich and have a hydric moisture regime. Water is above the rooting zone for part or all of the year. Water salinity is less than 15mS/cm.

11a) None – There is no tree or shrub component to this vegetation community.

Ecosites included:

- i. In J.D. Beckingham *et al.* (1996), J.D. Beckingham and J.H. Archibald (1996), and J.H. Archibald *et al.* (1996)
 - BM l1 (marsh)
 - WC_LF n1 (marsh)
 - WC_MN h1 (marsh)
- ii. In Willoughby (2005), Lawrence *et al.* (2005), Willoughby *et al.* (2005), Willoughby *et al.* (2006), and Willoughby and Alexander (2006)
 - DMA1a Bulrush-Cattail
 - DMA21 Tall manna grass
 - DMA22 Common reed grass
 - DMA23 Reed canary grass
 - DMA26 Creeping spike rush
 - B17 Creeping spike rush
 - B18 Small fruited bulrush
 - B19 Great bulrush
 - B20 Cattail
 - b7 Marsh reed grass slough

12. Swamp – SD

Water salinity is less than 15mS/cm. Trees and/or shrubs are present. The shrub/ground stratum is dominated by river alder, willow spp., horsetail, mosses and grass/sedge. The soil organic horizon is relatively deep and comprised largely of humified organic matter. This community is expected when water is nutrient rich and present above the rooting zone for some of the year.

12a) Tree – >10% tree cover within an area of at least 30m in diameter.

12b) Shrub – <10% tree cover within an area of at least 30m in diameter.

13. Alkali – AD

Water salinity is greater than 15mS/cm. There is no emergent or rooted vegetation. The submergent vegetation is dominated by saltwater widgeon grass. This community is expected in wetlands with little “out-flow” of water, and where surface water is present above the rooting zone for part or all of the year.

13a) None – <10% tree plus shrub within an area of at least 30m in diameter.

14. Open Water – OW

Open water with <10% cover of emergent vegetation.

14a) Lake – Standing water with emergent vegetation present but covering <10%.

14b) River – Channel of flowing water with emergent vegetation present but covering <10%.

Appendix 6: Small Plot Contingency Placements and Layouts

Contingency 1: SE/SW

- If a minimum of 15 plots cannot be obtained using the standard NE/NW layout, move the survey to the SE and SW quadrants (**Figure 26**). Transect layout and plot placement in the SE/SW mimic those of the standard NE/NW setup. Bearings and directions are adjusted as described below.

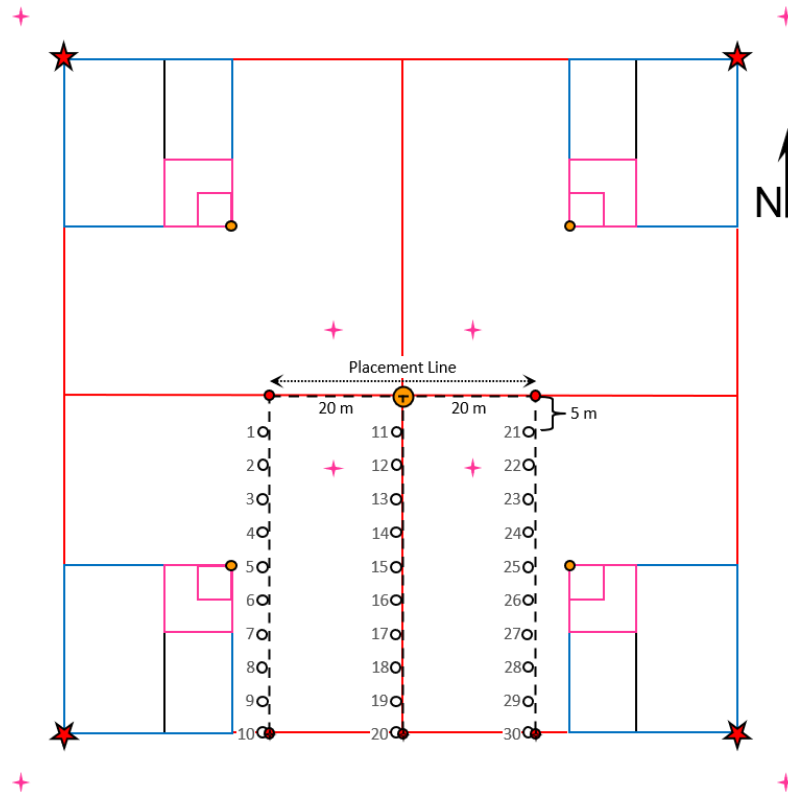


Figure 26. Small plot layout in the SE/SW quadrants (Contingency 1)

- Lay out the western-most transect first, followed by the central and the eastern-most transects. Stay as true to the indicated bearing as possible despite obstacles and vegetation.
- Transect layout – SE/SW:
 - Western-most transect (W) = using a 100m tape and compass, measure 20m west of site center (bearing of 270°). Install a red-painted conduit at the 20m mark. Ensure conduit is securely in place before proceeding (use a mallet). Using the conduit as a corner, curve the tape around the conduit and run transect 50m south (bearing of 180°). Mark transect end-point with another red-painted conduit and check that it is securely in place.
 - Central transect (C) = Using a 50m tape and compass, measure 50m south of site center (bearing of 180°). Mark transect end-point with a red-painted conduit and check that it is securely in place.
 - Eastern-most transect (E) = Using a 100m tape and compass, measure 20m east of site center (bearing of 90°). Install a red-painted conduit at the 20m mark. Ensure conduit is securely in place before proceeding (use a mallet). Using the conduit as a corner, curve the tape around the conduit and run transect 50m south (bearing of 180°). Mark

transect end-point with another red-painted conduit and check that it is securely in place.

- Plots are completed along each North-South transect. The first plot of each transect is located 5m south of the placement line. Subsequent plots are spaced along each transect at 5m intervals.
- A circular hoop is used to outline the survey area. The hoop is placed on the west side of the tape with its outer edge just touching the tape at each 5m interval marker. For each plot, temporarily mark this intersection of plot edge and transect tape with a flagged pigtail. Placing the plots slightly offset from the tape (rather than directly on the line) avoids surveying the area most heavily trampled during transect layout.
- Surveys are completed sequentially as indicated in **Figure 26**.
- Record the atypical protocol placement in the tablet and explain why the relocation was necessary.
- If on private land, navigate to site center using a handheld Trimble unit and provided coordinates. Ensure compass declination is set appropriately for the location before beginning transect layout. Complete the layout using compass and measuring tapes as described above and as shown in **Figure 26**. Before rolling up the tapes, use the Trimble to collect waypoints at the start- (0m), mid- (25m), and end-point (50m) of each transect.
- Label each point using the naming convention TSite#-TransectID-PositionID:
 - TSite# = prefix T for terrestrial followed by the site number of the site being surveyed
 - TransectID = the transect location (W for western-most, C for central, E for eastern-most)
 - PositionID = the waypoint location along each transect (0 for start-, 25 for mid-, or 50 for end-point)

Example: the start-point for the western-most transect at site 1329 is labeled T1329-W-0

Contingency 2: NE/SE

- If a minimum of 15 plots cannot be obtained using the standard NE/NW, or the SE/SW layout, move the survey to the NE and SE quadrants (**Figure 27**). In this case, the placement line runs north and south of site center and the transect lines run east and west.

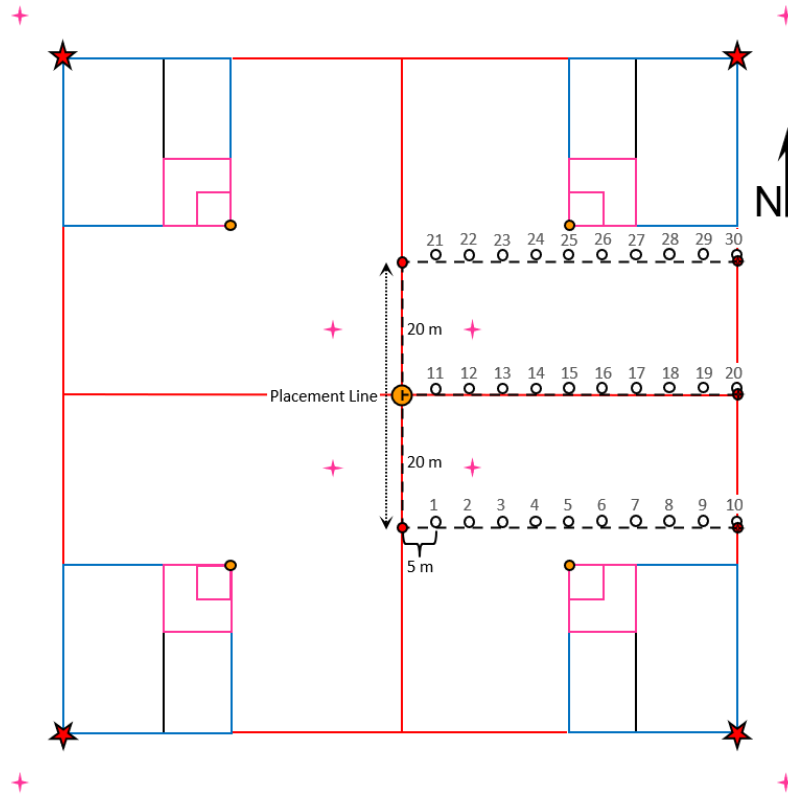


Figure 27. Small plot layout in the NE/SE quadrants (Contingency 2)

- Lay out the southern-most transect first, followed by the central and northern-most transects. Stay as true to the indicated bearing as possible despite obstacles and vegetation.
- Transect layout – NE/SE:
 - Southern-most transect (S) = Using a 100m tape and compass, measure 20m south of site center (bearing of 180°). Install a red-painted conduit at the 20m mark. Ensure conduit is securely in place before proceeding (use a mallet). Using the conduit as a corner, curve the tape around the conduit and run transect 50m east (bearing of 90°). Mark conduit end-point with another red-painted conduit and check that it is securely in place.
 - Central transect (C) = Using a 50m tape and compass, measure 50m east of site center (bearing of 90°). Mark transect end-point with a red-painted conduit and check that it is securely in place.
 - Northern-most transect (N) = Using a 100m tape and compass, measure 20m north of site center (bearing of 0°). Install a red-painted conduit at the 20m mark. Ensure conduit is securely in place before proceeding (use a mallet). Using the conduit as a corner, curve the tape around the conduit and run transect 50m east (bearing of 90°).

Mark transect end-point with another red-painted conduit and check that it is securely in place.

- Plots are completed along each East-West transect. The first plot of each transect is located 5m east of the placement line. Subsequent plots are spaced along each transect at 5m intervals.
- A circular hoop is used to outline the survey area. The hoop is placed on the north side of the tape with its outer edge just touching the tape at each 5m interval marker. For each plot, temporarily mark this intersection of plot edge and transect tape with a flagged pigtail. Placing the plots slightly offset from the tape (rather than directly on the line) avoids surveying the area most heavily trampled during transect layout.
- Surveys are completed sequentially as indicated in **Figure 27**.
- Record the atypical protocol placement in the tablet. Explain why the relocation was necessary and why the SE/SW quadrants could not be used.
- If on private land, navigate to site center using a handheld Trimble unit and provided coordinates. Ensure compass declination is set appropriately for the location before beginning transect layout. Complete the layout using compass and measuring tapes as described above and as shown in **Figure 27**. Before rolling up the tapes, use the Trimble to collect waypoints at the start- (0m), mid- (25m), and end-point (50m) of each transect.
- Label each point using the naming convention TSite#-TransectID-PositionID:
 - TSite# = prefix T for terrestrial followed by the site number of the site being surveyed
 - TransectID = the transect location (S for southern-most, C for central, or N for northern-most)
 - PositionID = the waypoint location along each transect (0 for start-, 25 for mid-, or 50 for end-point)

Example: the start-point for the southern transect at site 1329 is labeled T1329-S-0

Contingency 3: NW/SW

- If a minimum of 15 plots cannot be obtained using the standard NE/NW, or the SE/SW or NE/SE layout, move the survey to the NW and SW quadrants (**Figure 28**). As with the NE/SE layout, the placement line runs north and south of site center and the transect lines run east and west.

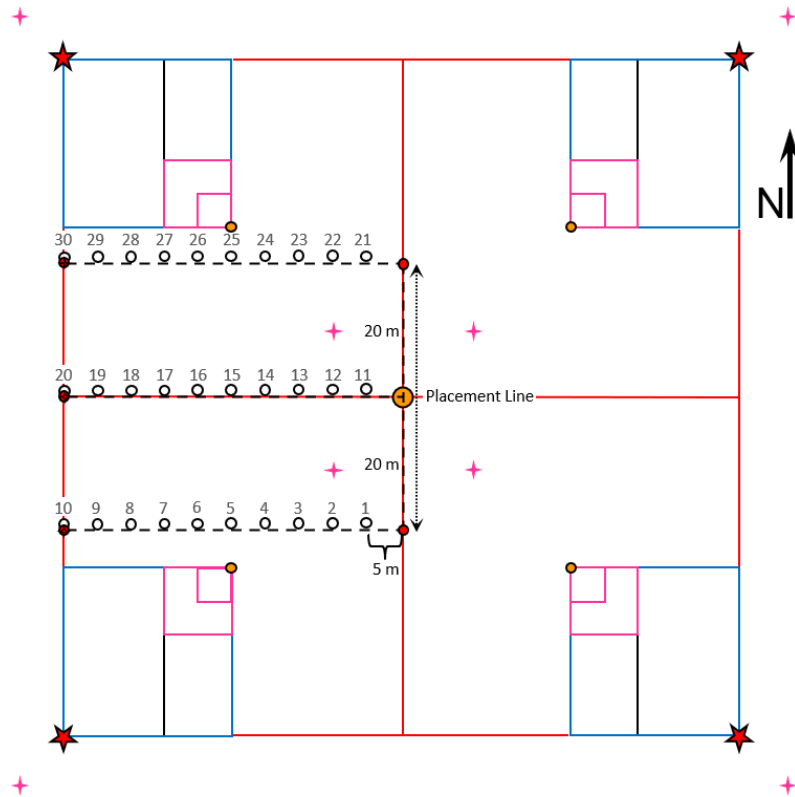


Figure 28. Small plot layout in the NW/SW quadrants (Contingency 3)

- Lay out the southern-most transect first, followed by the central and northern-most transects. Stay as true to the indicated bearing as possible despite obstacles and vegetation.
- Transect layout – NW/SW:
 - Southern-most transect (S) = Using a 100m tape and compass, measure 20m south of site center (bearing of 180°). Install a red-painted conduit at the 20m mark. Ensure conduit is securely in place before proceeding (use a mallet). Using the conduit as a corner, curve the tape around the conduit and run transect 50m west (bearing of 270°). Mark transect end-point with another red-painted conduit and check that it is securely in place.
 - Central transect (C) = Using a 50m tape and compass, measure 50m west of site center (bearing of 270°). Mark transect end-point with a red-painted conduit and check that it is securely in place.
 - Northern-most transect (N) = Using a 100m tape and compass, measure 20m north of site center (bearing of 0°). Install a red-painted conduit at the 20m mark. Ensure conduit is securely in place before proceeding (use a mallet). Using the conduit as a corner, curve the tape around the conduit and run transect 50m west (bearing of 270°). Mark transect end-point with another red-painted conduit and check that it is securely in place.

- Plots are completed along each East-West transect. The first plot of each transect is located 5m west of the placement line. Subsequent plots are spaced along each transect at 5m intervals.
- A circular hoop is used to outline the survey area. The hoop is placed on the north side of the tape with its outer edge just touching the tape at each 5m interval marker. For each plot, temporarily mark this intersection of plot edge and transect tape with a flagged pigtail. Placing the plots slightly offset from the tape (rather than directly on the line) avoids surveying the area most heavily trampled during transect layout.
- Surveys are completed sequentially as indicated in **Figure 28**.
- Record the atypical protocol placement in the tablet. Explain why the relocation was necessary and why neither the SE/SW nor NE/SE quadrants could be used.
- If on private land, navigate to site center using a handheld Trimble unit and provided coordinates. Ensure compass declination is set appropriately for the location before beginning transect layout. Complete the layout using compass and measuring tapes as described above and as shown in **Figure 28**. Before rolling up the tapes, use the Trimble to collect waypoints at the start- (0m), mid- (25m), and end-point (50m) of each transect.
- Label each point using the naming convention TSite#-TransectID-PositionID:
 - TSite# = prefix T for terrestrial followed by the site number of the site being surveyed
 - TransectID = the transect location (S for southern-most, C for central, or N for northern-most)
 - PositionID = the waypoint location along each transect (0 for start-, 25 for mid-, or 50 for end-point)

Example: the mid-point of the northern transect at site 1329 is labeled T1329-N-25

Appendix 7: Small Plot Forest Species List

<u>Species Name</u>	<u>Common Name</u>
<i>Abies</i> spp.	Firs
<i>Achillea borealis</i>	Common Yarrow
<i>Actaea rubra</i>	Red and White Baneberry
<i>Agrimonia striata</i>	Agrimony
<i>Agrostis scabra</i>	Rough Hair Grass
<i>Alnus alnobetula</i>	Green Alder
<i>Alnus incana</i>	Speckled Alder
<i>Amelanchier alnifolia</i>	Saskatoon
<i>Andromeda polifolia</i>	Bog Rosemary
<i>Anemonastrum canadense</i>	Canada Anemone
<i>Antennaria</i> spp.	Pussytoes
<i>Anthoxanthum hirtum</i>	Sweet Grass
<i>Aquilegia</i> spp.	Columbines
<i>Aralia nudicaulis</i>	Wild Sarsaparilla
<i>Arctium</i> spp.	Burdocks
<i>Arctostaphylos uva-ursi</i>	Common Bearberry
<i>Arctous rubra</i>	Alpine Bearberry
<i>Arnica</i> spp.	Arnicas
<i>Artemisia absinthium</i>	Absinthe Wormwood
<i>Artemisia campestris</i>	Plains Wormwood
<i>Astragalus cicer</i>	Cicer Milk Vetch
<i>Athyrium filix-femina</i>	Lady Fern
<i>Betula neoalaskana.papyrifera</i>	Alaska and Paper Birch
<i>Betula x sargentii</i>	Hybrid Dwarf Bog Birch
<i>Bromus ciliatus.porteri.pumpellianus.sitchensis</i>	Native Bromes (Fringed, Nodding, Pumpelly, Keeled Brome)
<i>Bromus inermis</i>	Smooth Brome
<i>Calamagrostis</i> spp.	Reed Grasses
<i>Calla palustris</i>	Water Arum
<i>Caltha palustris</i>	Marsh Marigold
<i>Campanula alaskana</i>	Harebell
<i>Capsella bursa-pastoris</i>	Shepherd's Purse
<i>Carex aquatilis</i>	Water Sedge
<i>Carex atherodes</i>	Awned Sedge
<i>Carex disperma</i>	Two Seeded Sedge
<i>Carex lasiocarpa</i>	Hairy Fruited Sedge
<i>Carex limosa</i>	Mud Sedge
<i>Carex magellanica</i>	Boreal Bog Sedge
<i>Carex</i> spp.	Sedges
<i>Carex sprengelii</i>	Sprengel's Sedge
<i>Castilleja</i> spp.	Paintbrushes
<i>Centaureinae</i>	Knapweeds Subtribe

<i>Chamaedaphne calyculata</i>	Leatherleaf
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	Common Fireweed
<i>Circaea alpina</i>	Small Enchanter's Nightshade
<i>Cirsium arvense</i>	Creeping Thistle
<i>Cladonia</i> spp.	Reindeer Lichen
<i>Comandra umbellata</i>	Bastard Toadflax
<i>Comarum palustre</i>	Marsh Cinquefoil
<i>Coptidium lapponicum</i>	Lapland Buttercup
<i>Cornus canadensis</i>	Bunchberry
<i>Cornus sericea</i>	Red Osier Dogwood
<i>Corydalis</i> . <i>Capnoides</i> spp.	Corydalis
<i>Corylus cornuta</i>	Beaked Hazelnut
Crop	Crop
<i>Danthonia</i> spp.	Oat Grasses
<i>Dasiphora fruticosa</i>	Shrubby Cinquefoil
<i>Delphinium glaucum</i>	Tall Larkspur
<i>Dendrolycopodium dendroideum</i>	Ground Pine
<i>Descurainia</i> spp.	Tansy Mustards
<i>Diphasiastrum complanatum</i>	Ground Cedar
<i>Drosera rotundifolia</i>	Round-leaved Sundew
<i>Dryopteris carthusiana</i> . <i>expansa</i>	Shield Ferns
<i>Elaeagnus commutata</i>	Silverberry
<i>Elymus repens</i>	Quack Grass
<i>Elymus trachycaulus</i>	Slender Wheat Grass
<i>Empetrum nigrum</i>	Crowberry
<i>Equisetum arvense</i>	Common Horsetail
<i>Equisetum fluviatile</i>	Swamp Horsetail
<i>Equisetum pratense</i>	Meadow Horsetail
<i>Equisetum sylvaticum</i>	Woodland Horsetail
<i>Eriophorum</i> spp.	Cotton Grasses
<i>Erodium cicutarium</i>	Stork's Bill
<i>Euphorbia virgata</i>	Leafy Spurge
<i>Fragaria</i> spp.	Strawberries
<i>Galeopsis bifida</i> . <i>tetrahit</i>	Bifid Hemp Nettle and Hemp Nettle
<i>Galium boreale</i>	Northern Bedstraw
<i>Galium trifidum</i>	Three-petaled Bedstraw
<i>Galium triflorum</i>	Sweet Scented Bedstraw
<i>Geocaulon lividum</i>	Northern Bastard Toadflax
<i>Geranium bicknellii</i>	Bicknell's Geranium
<i>Gymnocarpium dryopteris</i>	Oak Fern
<i>Heracleum maximum</i>	Cow Parsnip
<i>Hordeum jubatum</i>	Foxtail Barley
<i>Hudsonia tomentosa</i>	Sand Heather
<i>Juncus balticus</i>	Wire Rush
<i>Juniperus communis</i>	Ground Juniper

<i>Juniperus horizontalis</i>	Creeping Juniper
<i>Kalmia polifolia</i>	Northern Laurel
<i>Koeleria macrantha</i>	June Grass
<i>Larix laricina</i>	Tamarack
<i>Lathyrus ochroleucus</i>	Cream Colored Vetchling
<i>Lemna turionifera</i>	Common Duckweed
<i>Leucanthemum vulgare</i>	Ox Eye Daisy
<i>Leymus innovatus</i>	Hairy Wild Rye
<i>Lilium philadelphicum</i>	Western Wood Lily
<i>Linaria dalmatica.vulgaris</i>	Broad Leaved and Common Toadflax
<i>Linnaea borealis</i>	Twinflower
<i>Lonicera dioica</i>	Twining Honeysuckle
<i>Lonicera involucrata</i>	Bracted Honeysuckle
<i>Lonicera villosa</i>	Fly Honeysuckle
<i>Lotus corniculatus</i>	Bird's Foot Trefoil
<i>Lycopodium lagopus</i>	Running Club Moss
<i>Lysimachia latifolia</i>	Northern Starflower
<i>Maianthemum canadense</i>	Wild Lily Of The Valley
<i>Maianthemum trifolium</i>	Three Leaved Solomon
<i>Medicago lupulina</i>	Black Medick
<i>Medicago sativa</i>	Alfalfa
<i>Melilotus</i> spp.	Sweet Clovers
<i>Mentha canadensis</i>	Wild Mint
<i>Menyanthes trifoliata</i>	Buck Bean
<i>Mertensia paniculata</i>	Tall Lungwort
<i>Mitella nuda</i>	Bishop's Cap
<i>Moneses uniflora</i>	One Flowered Wintergreen
<i>Myrica gale</i>	Sweet Gale
<i>Ophioglossaceae</i> spp.	Grape Ferns and Moonworts Family
<i>Oplopanax horridus</i>	Devil's Club
<i>Oryzopsis asperifolia</i>	White Grained Mountain Rice Grass
<i>Parnassia</i> spp.	Grass Of Parnassus
<i>Peltigera</i> spp.	Pelt Lichen
<i>Petasites frigidus</i>	Arctic Sweet Coltsfoot
<i>Phalaris arundinacea</i>	Reed Canary Grass
<i>Phleum pratense</i>	Timothy
<i>Picea engelmannii</i>	Engelmann Spruce
<i>Picea glauca</i>	White Spruce
<i>Picea mariana</i>	Black Spruce
<i>Picea</i> spp.	Spruces (if not identifiable to species)
<i>Pilosella</i> spp.	Invasive Hawkweeds
<i>Pinus banksiana</i>	Jack Pine
<i>Pinus contorta</i>	Lodgepole Pine
<i>Plantago</i> spp.	Plantains and Allies

<i>Poa pratensis</i>	Kentucky Bluegrass
Poaceae spp.	Grass Family
<i>Populus balsamifera</i>	Balsam Poplar
<i>Populus tremuloides</i>	Trembling Aspen
<i>Potentilla</i> spp.	Cinquefoils
<i>Prosartes trachycarpa</i>	Fairybells
<i>Prunus pensylvanica</i>	Pin Cherry
<i>Prunus virginiana</i>	Choke Cherry
<i>Pseudotsuga menziesii</i>	Douglas Fir
<i>Ranunculus acris</i>	Tall Buttercup
<i>Rhododendron groenlandicum</i>	Common Labrador Tea
<i>Rhododendron tomentosum</i>	Marsh Labrador Tea
<i>Ribes</i> spp.	Currants
<i>Rosa</i> spp.	Roses
<i>Rubus arcticus</i> spp. <i>acaulis</i>	Dwarf Raspberry
<i>Rubus chamaemorus</i>	Cloudberry
<i>Rubus idaeus</i>	Wild Red Raspberry
<i>Rubus parviflorus</i>	Thimbleberry
<i>Rubus pubescens</i>	Dewberry
<i>Salix</i> spp.	Willows
<i>Schoenoplectus acutus.tabernaemontani</i>	Bulrush
<i>Shepherdia canadensis</i>	Canada Buffaloberry
<i>Sibbaldia tridentata</i>	Three Toothed Cinquefoil
<i>Silene latifolia</i>	White Campion
<i>Sonchus</i> spp.	Sow Thistles
<i>Sphagnum</i> spp.	Sphagnum
<i>Spinulum annotinum</i>	Stiff Club Moss
<i>Spiraea alba.lucida</i>	Narrow Leaved and White Meadowsweet
<i>Streptopus amplexifolius</i>	Clasping Leaved Twisted Stalk
<i>Symphoricarpos albus.occidentalis</i>	Snowberry and Buckbrush
<i>Tanacetum vulgare</i>	Common Tansy
<i>Taraxacum erythrospermum.officinale</i>	Dandelion
<i>Trifolium</i> spp.	Clovers
<i>Typha latifolia</i>	Common Cattail
<i>Vaccinium cespitosum</i>	Dwarf Bilberry
<i>Vaccinium microcarpum.oxycoccos</i>	Small Bog Cranberry
<i>Vaccinium myrtilloides</i>	Common Blueberry
<i>Vaccinium vitis-idaea</i>	Bog Cranberry
<i>Viburnum edule</i>	Low Bush Cranberry
<i>Vicia</i> spp.	Vetches
<i>Viola</i> spp.	Violets

Appendix 8: Small Plot Grassland Species List

<u>Species Name</u>	<u>Common Name</u>
<i>Achillea borealis</i>	Common Yarrow
<i>Actaea rubra</i>	Red and White Baneberry
<i>Agoseris glauca</i>	Yellow False Dandelion
<i>Agrimonia striata</i>	Agrimony
<i>Agropyron cristatum.fragile</i>	Crested and Siberian Wheatgrass
<i>Agrostis scabra</i>	Rough Hair Grass
<i>Allium cernuum.textile.schoenoprasum</i>	Nodding Onion, Prairie Onion, and Wild Chives
<i>Amelanchier alnifolia</i>	Saskatoon
<i>Androsace occidentalis.septentrionalis</i>	Western and Northern Fairy Candelabra
<i>Anemonastrum canadense</i>	Canada Anemone
<i>Antennaria spp.</i>	Pussytoes
<i>Anthoxanthum hirtum</i>	Sweet Grass
<i>Aphyllon spp.</i>	Aphyllons
<i>Aralia nudicaulis</i>	Wild Sarsaparilla
<i>Arctium spp.</i>	Burdocks
<i>Arctostaphylos uva-ursi</i>	Common Bearberry
<i>Arnica spp.</i>	Arnicas
<i>Artemisia absinthium</i>	Absinthe Wormwood
<i>Artemisia campestris</i>	Plains Wormwood
<i>Artemisia cana.longifolia</i>	Silver Sagebrush and Long Leaved Sagewort
<i>Artemisia frigida</i>	Pasture Sagewort
<i>Artemisia ludoviciana</i>	Prairie Sagewort
<i>Asclepias ovalifolia.speciosa</i>	Low and Showy Milkweed
<i>Astragalus cicer</i>	Cicer Milk Vetch
<i>Astragalus crassicaulus</i>	Ground Plum
<i>Astragalus pectinatus</i>	Narrow-leaved Milk Vetch
<i>Atriplex annual spp.</i>	Saltbushes (Annuals)
<i>Atriplex gardneri</i>	Gardner's Saltbush
<i>Betulaceae spp.</i>	Alders and Birches
<i>Bouteloua gracilis</i>	Blue Grama
<i>Bromus ciliatus.porteri.pumpellianus.sitchensis</i>	Native Bromes (Fringed, Nodding, Pumpelly, Keeled Brome)
<i>Bromus inermis</i>	Smooth Brome
<i>Bromus japonicus.squarrosus.tectorum</i>	Invasive Annual Bromes (Japanese Chess, Annual Brome, Cheatgrass)
<i>Calamagrostis spp.</i>	Reed Grasses
<i>Camassia quamash ssp. quamash</i>	Blue Camas
<i>Campanula alaskana</i>	Harebell
<i>Capsella bursa-pastoris</i>	Shepherd's Purse
<i>Carex aquatilis</i>	Water Sedge
<i>Carex atherodes</i>	Awned Sedge
<i>Carex duriuscula.obtusata</i>	Needleleaf and Blunt Sedge
<i>Carex filifolia</i>	Thread Leaved Sedge

<i>Carex pellita</i>	Woolly Sedge
<i>Carex</i> spp.	Sedges
<i>Carex sprengellii</i>	Sprengel's Sedge
<i>Castilleja</i> spp.	Paintbrushes
Centaureinae	Knapweeds Subtribe
<i>Chamerion angustifolium</i> ssp. <i>angustifolium</i>	Common Fireweed
<i>Chenopodium</i> spp.	Goosefoots
<i>Cirsium arvense</i>	Creeping Thistle
<i>Cirsium flodmanii.undulatum</i>	Flodman's and Wavy Leaved Thistle
<i>Cladonia</i> spp.	Reindeer Lichen
<i>Comandra umbellata</i>	Bastard Toadflax
<i>Cornus canadensis</i>	Bunchberry
<i>Cornus sericea</i>	Red Osier Dogwood
<i>Corylus cornuta</i>	Beaked Hazelnut
Crop	Crop
<i>Dalea purpurea</i> var. <i>purpurea</i>	Purple Prairie Clover
<i>Danthonia</i> spp.	Oat Grasses
<i>Dasiphora fruticosa</i>	Shrubby Cinquefoil
<i>Delphinium</i> spp.	Larkspurs
<i>Deschampsia cespitosa</i>	Tufted Hair Grass
<i>Descurainia</i> spp.	Tansy Mustards
<i>Distichlis spicata</i> ssp. <i>stricta</i>	Salt Grass
<i>Drymocallis arguta</i>	White Cinquefoil
<i>Elaeagnus commutata</i>	Silverberry
<i>Elymus repens</i>	Quack Grass
<i>Elymus trachycaulus</i>	Slender Wheat Grass
<i>Equisetum arvense</i>	Common Horsetail
<i>Eriocoma hymenoides</i>	Indian Ricegrass
<i>Erodium cicutarium</i>	Stork's Bill
<i>Escobaria vivipara</i>	Ball Cactus
<i>Euphorbia virgata</i>	Leafy Spurge
<i>Festuca campestris.hallii</i>	Foothills and Plains Rough Fescue
<i>Festuca idahoensis.saximontana</i>	Bluebunch and Rocky Mountain Fescue
<i>Fragaria</i> spp.	Strawberries
<i>Gaillardia aristata</i>	Gaillardia
<i>Galeopsis bifida.tetrahit</i>	Bifid Hemp Nettle and Hemp Nettle
<i>Galium boreale</i>	Northern Bedstraw
<i>Geranium viscosissimum</i>	Sticky Purple Geranium
<i>Geum triflorum</i>	Three Flowered Avens
<i>Glycyrrhiza lepidota</i>	Wild Licorice
<i>Grindelia squarrosa</i>	Gumweed
<i>Gutierrezia sarothrae</i>	Broomweed
<i>Gypsophila paniculata</i>	Common Baby's Breath
<i>Helictochloa hookeri</i>	Hooker's Oatgrass

<i>Heracleum maximum</i>	Cow Parsnip
<i>Hesperostipa comata</i>	Needle and Thread Grass
<i>Hesperostipa curtipendula</i>	Western Porcupinegrass and Porcupinegrass
<i>Heterotheca villosa</i>	Golden Aster
<i>Heuchera richardsonii</i>	Richardson's Alumroot
<i>Hordeum jubatum</i>	Foxtail Barley
<i>Hymenoxys richardsonii</i>	Colorado Rubber Plant
<i>Juncus balticus</i>	Wire Rush
<i>Juniperus communis</i>	Ground Juniper
<i>Juniperus horizontalis</i>	Creeping Juniper
<i>Koeleria macrantha</i>	June Grass
<i>Krascheninnikovia lanata</i>	Winter Fat
<i>Lactuca serriola</i>	Prickly Lettuce
<i>Lathyrus ochroleucus</i>	Cream Colored Vetchling
<i>Lemna turionifera</i>	Common Duckweed
<i>Leucanthemum vulgare</i>	Ox Eye Daisy
<i>Liatris ligulistylis punctata</i>	Meadow and Dotted Blazingstar
<i>Lilium philadelphicum</i>	Western Wood Lily
<i>Linaria dalmatica vulgaris</i>	Broad Leaved and Common Toadflax
<i>Linnaea borealis</i>	Twinflower
<i>Lithospermum</i> spp.	Puccoons
<i>Lomatium</i> spp.	Prairie Parsleys
<i>Lonicera dioica</i>	Twining Honeysuckle
<i>Lotus corniculatus</i>	Bird's Foot Trefoil
<i>Lupinus</i> spp.	Lupines
<i>Lygodesmia juncea</i>	Skeletonweed
<i>Medicago lupulina</i>	Black Medick
<i>Medicago sativa</i>	Alfalfa
<i>Melilotus</i> spp.	Sweet Clovers
<i>Mentha canadensis</i>	Wild Mint
<i>Mertensia paniculata</i>	Tall Lungwort
<i>Mitella nuda</i>	Bishop's Cap
<i>Monarda fistulosa</i>	Wild Bergamot
<i>Nassella viridula</i>	Green Needlegrass
<i>Oenothera biennis villosa</i>	Yellow Evening Primrose
<i>Opuntia fragilis polyacantha</i>	Brittle Prickly Pear and Prickly Pear Cactus
<i>Orthocarpus luteus</i>	Owl Clover
<i>Pascopyrum smithii</i>	Western Wheatgrass
<i>Peltigera</i> spp.	Pelt Lichen
<i>Penstemon</i> spp.	Beardtongues
<i>Petasites frigidus</i>	Arctic Sweet Coltsfoot
<i>Phalaris arundinacea</i>	Reed Canary Grass
<i>Phleum pratense</i>	Timothy
<i>Picea engelmannii</i>	Engelmann Spruce
<i>Picea glauca</i>	White Spruce

<i>Picea</i> spp.	Spruces (if not identifiable to species)
<i>Pilosella</i> spp.	Invasive Hawkweeds
<i>Pinus</i> spp.	Pines
<i>Plantago</i> spp.	Plantains and Allies
<i>Poa pratensis</i>	Kentucky Bluegrass
Poaceae spp.	Grass Family
<i>Populus balsamifera</i>	Balsam Poplar
<i>Populus deltoides</i> ssp. <i>monilifera</i>	Plains Cottonwood
<i>Populus tremuloides</i>	Trembling Aspen
<i>Potentilla anserina</i>	Silverweed
<i>Potentilla</i> spp.	Cinquefoils
<i>Prunus virginiana</i>	Choke Cherry
<i>Pseudotsuga menziesii</i>	Douglas Fir
<i>Puccinellia nuttalliana</i>	Nuttall's Alkali Grass
<i>Ranunculus acris</i>	Tall Buttercup
<i>Ratibida columnifera</i>	Prairie Coneflower
<i>Ribes</i> spp.	Currants
<i>Rosa</i> spp.	Roses
<i>Rubus idaeus</i>	Wild Red Raspberry
<i>Salix</i> spp.	Willows
<i>Salsola</i> spp.	Russian Thistles
<i>Schoenoplectus acutus</i> . <i>tabernaemontani</i>	Bulrush
<i>Selaginella densa</i>	Prairie Selaginella
<i>Shepherdia argentea</i>	Thorny Buffaloberry
<i>Shepherdia canadensis</i>	Canada Buffaloberry
<i>Silene latifolia</i>	White Campion
<i>Sonchus</i> spp.	Sow Thistles
<i>Sphaeralcea coccinea</i>	Scarlet Mallow
<i>Spiraea alba</i> . <i>lucida</i>	Narrow Leaved and White Meadowsweet
<i>Sporobolus hookerianus</i>	Alkali Cord Grass
<i>Sporobolus rigidus</i>	Sand Grass
<i>Symphoricarpos albus</i> . <i>occidentalis</i>	Snowberry and Buckbrush
<i>Syntrichia</i> cf. <i>ruralis</i>	Star Moss
<i>Tanacetum vulgare</i>	Common Tansy
<i>Taraxacum erythrospermum</i> . <i>officinale</i>	Dandelion
<i>Thermopsis rhombifolia</i>	Golden Bean
<i>Tragopogon dubius</i>	Common Goat's Beard
<i>Trifolium</i> spp.	Clovers
<i>Tripleurospermum inodorum</i>	Scentless Chamomile
<i>Typha latifolia</i>	Common Cattail
<i>Ventenata dubia</i>	North Africa Grass
<i>Vicia</i> spp.	Vetches
<i>Viola</i> spp.	Violets
<i>Zizia aptera</i>	Heart Leaved Alexanders

Appendix 9: Small Plot Forest Species Voucher List

<u>Species Name</u>	<u>Common Name</u>
Agrostis scabra	Rough Hair Grass
Antennaria spp.	Pussytoes
Anthoxanthum hirtum	Sweet Grass
Arctium spp.	Burdocks
Arnica spp.	Arnica
Astragalus cicer	Cicer Milk Vetch
Bromus ciliatus.porteri.pumpellianus.sitchensis	Native Bromes (Fringed, Nodding, Pumpelly, Keeled Brome)
Bromus inermis	Smooth Brome
Calamagrostis spp.	Reed Grasses
Carex aquatilis	Water Sedge
Carex atherodes	Awned Sedge
Carex disperma	Two Seeded Sedge
Carex lasiocarpa	Hairy Fruited Sedge
Carex limosa	Mud Sedge
Carex magellanica	Boreal Bog Sedge
Carex spengelii	Sprengel's Sedge
Castilleja spp.	Paintbrushes
Centaureinae	Knapweeds Subtribe
Danthonia spp.	Oat Grasses
Descurainia spp.	Tansy Mustards
Elymus repens	Quack Grass
Elymus trachycaulus	Slender Wheat Grass
Equisetum arvense	Common Horsetail
Equisetum fluviatile	Swamp Horsetail
Equisetum pratense	Meadow Horsetail
Eriophorum spp.	Cotton Grasses
Euphorbia virgata	Leafy Spurge
Gymnocarpium dryopteris	Oak Fern
Koeleria macrantha	June Grass
Leucanthemum vulgare	Ox Eye Daisy
Leymus innovatus	Hairy Wild Rye
Linaria dalmatica.vulgaris	Broad Leaved and Common Toadflax
Ophioglossaceae spp.	Grape Ferns and Moonworts Family
Oryzopsis asperifolia	White Grained Mountain Rice Grass
Phalaris arundinacea	Reed Canary Grass
Phleum pratense	Timothy
Picea spp.	Spruces
Pilosella spp.	Invasive Hawkweeds
Plantago spp.	Plantains and Allies
Poa pratensis	Kentucky Bluegrass
Potentilla spp.	Cinquefoils

Ranunculus acris

Silene latifolia

Sonchus spp.

Spiraea alba.lucida

Symphoricarpos albus.occidentalis

Tanacetum vulgare

Vicia spp.

Viola spp.

Tall Buttercup

White Campion

Sow Thistles

Narrow Leaved and White Meadowsweet

Snowberry and Buckbrush

Common Tansy

Vetches

Violets

Appendix 10: Small Plot Grassland Species Voucher List

<u>Species Name</u>	<u>Common Name</u>
Agropyron cristatum.fragile	Crested and Siberian Wheatgrass
Agrostis scabra	Rough Hair Grass
Allium cernuum.textile.schoenoprasum	Nodding and Prairie Onion, and Wild Chives
Antennaria spp.	Pussytoes
Anthoxanthum hirtum	Sweet Grass
Aphyllon spp.	Aphyllons
Arctium spp.	Burdocks
Arnica spp.	Arnicas
Artemisia cana.longifolia	Silver Sagebrush and Long Leaved Sagewort
Asclepias ovalifolia.speciosa	Low and Showy Milkweed
Astragalus cicer	Cicer Milk Vetch
Atriplex annual spp.	Saltbushes (Annuals)
Betulaceae spp.	Alders and Birches
Bromus ciliatus.porteri.pumpellianus.sitchensis	Native Bromes (Fringed, Nodding, Pumpelly, Keeled Brome)
Bromus inermis	Smooth Brome
Bromus japonicus.squarrosus.tectorum	Invasive Annual Bromes (Japanese Chess, Annual Brome, Cheatgrass)
Calamagrostis spp.	Reed Grasses
Carex aquatilis	Water Sedge
Carex atherodes	Awned Sedge
Carex duriuscula.obtusata	Needleleaf and Blunt Sedge
Carex filifolia	Thread Leaved Sedge
Carex pellita	Woolly Sedge
Carex sprengei	Sprengel's Sedge
Castilleja spp.	Paintbrushes
Centaureinae	Knapweeds Subtribe
Chenopodium spp.	Goosefoots
Cirsium flodmanii.undulatum	Flodman's and Wavy Leaved Thistle
Danthoniaspp.	Oat Grasses
Delphinium spp.	Larkspurs
Deschampsia cespitosa	Tufted Hair Grass
Descurainia spp.	Tansy Mustards
Elymus repens	Quack Grass
Elymus trachycaulus	Slender Wheat Grass
Equisetum arvense	Common Horsetail
Eriocoma hymenoides	Indian Ricegrass
Euphorbia virgata	Leafy Spurge
Festuca campestris.hallii	Foothills and Plains Rough Fescue
Festuca idahoensis.saximontana	Bluebunch and Rocky Mountain Fescue
Gypsophila paniculata	Common Baby's Breath
Helictochloa hookeri	Hooker's Oatgrass
Hesperostipa comata	Needle and Thread Grass

Hesperostipa curtiseta.spartea
Koeleria macrantha
Leucanthemum vulgare
Liatris ligulistylis.punctata
Linaria dalmatica.vulgaris
Lithospermum spp.
Lomatium spp.
Lupinus spp.
Nassella viridula
Pascopyrum smithii
Penstemon spp.
Phalaris arundinacea
Phleum pratense
Picea spp.
Pilosella spp.
Pinus spp.
Plantago spp.
Poa pratensis
Potentilla spp.
Puccinellia nuttalliana
Ranunculus acris
Salsola spp.
Silene latifolia
Sonchus spp.
Spiraea alba.lucida
Sporobolus hookerianus
Sporobolus rigidus
Symphoricarpos albus occidentalis
Tanacetum vulgare
Tripleurospermum inodorum
Ventenata dubia
Vicia spp.
Viola spp.

Western Porcupinegrass and Porcupinegrass
 June Grass
 Ox Eye Daisy
 Meadow and Dotted Blazingstar
 Broad Leaved and Common Toadflax
 Puccoons
 Prairie Parsleys
 Lupines
 Green Needlegrass
 Western Wheatgrass
 Beardtongues
 Reed Canary Grass
 Timothy
 Spruces
 Invasive Hawkweeds
 Pines
 Plantains and Allies
 Kentucky Bluegrass
 Cinquefoils
 Nuttall's Alkali Grass
 Tall Buttercup
 Russian Thistles
 White Campion
 Sow Thistles
 Narrow Leaved and White Meadowsweet
 Alkali Cord Grass
 Sand Grass
 Snowberry and Buckbrush
 Common Tansy
 Scentless Chamomile
 North Africa Grass
 Vetches
 Violets

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