Alberta Biodiversity
Monitoring Institute

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Terrestrial Field Data Collection Protocols

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A diverse group of scientists [Dan Farr, Chris Shank, Rich Moses, Stan Boutin, Erin Bayne (vertebrates), Phil Lee, Steve Hanus (forest structure and vascular plants), Jennifer Doubt, Rene Belland, Diane Haughland (bryophytes and lichens), Anona-Liisa Sippola, Jogeir Stokland (fungi), Neville Winchester, Bert Finnamore, Jeff Battigelli, Heather Proctor (arthropods)] and others have reviewed the literature and helped to develop protocols for sampling terrestrial biota and habitat structures. These protocols were combined into an integrated suite by Jim Schieck, Chris Shank, and Dan Farr. The present document incorporates changes suggested during peer review. Numerous technicians and managers also provided feedback during development and testing of the protocols. Updates to this document were incorporated by Curtis Stambaugh, Jim Schieck, Christina Sobol, Chris Kolaczan, Greg Brooke, Martin Lankau, Stephanie Ball, Jacqueline Dennett, Mike Boucher, Nina Veselka, Dan Greenacre, Chris O'Sullivan, David Evans, Amanda Schmidt, Rachel Humphrey, Anne Willis, James Holland, and Nik Kozakevich.

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SUMMARY

This report describes the terrestrial field data collection protocols (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 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.

(5) **Protocol Differences Between Forest/Mountain and Parkland/Grassland** are regionally specific protocol variations.

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 the 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***)**,** then practice the data collection in a diversity of habitats. Questions that arise during the 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 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 the field site as early in the shift as possible to assist with problems and to ensure that protocols are being followed and data is 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 field work 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 descriptions 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) – Use "DNC" 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, 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*** for a consolidated list of ABMI naming conventions). The flash drive should remain in a secure area (e.g., in the trailer), and should not be taken into the field. Crews must recollect lost or missing data. If any data are collected on paper, these sheets need to be checked for accuracy and legibility. If not transferred to a tablet, datasheets should be stored in a secure location and handed in to a supervisor at the end of the shift.

TRANSFERRING FIELD DATA

Tablets and/or USB flash drives containing data back-ups are transferred to the crew 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 Royal Alberta Museum (RAM). 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 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, finding a route, and flagging the site. Individual maps are created in the office to assist field crews in their first visit to the ABMI site. Map making 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 land owner (e.g., whether crews should phone ahead, if specific gates or trails can be use, if quads or trucks are allowed in fields). During the initial visit to the site, the most efficient route is found and described on the Access Datasheets (***Appendix 3***) and 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 knowledge of potential access hazards. In addition, the 1 ha site boundary plus 5X5 m, 10X10 m, and 25X25 m tree/snag plots are marked and flagged.

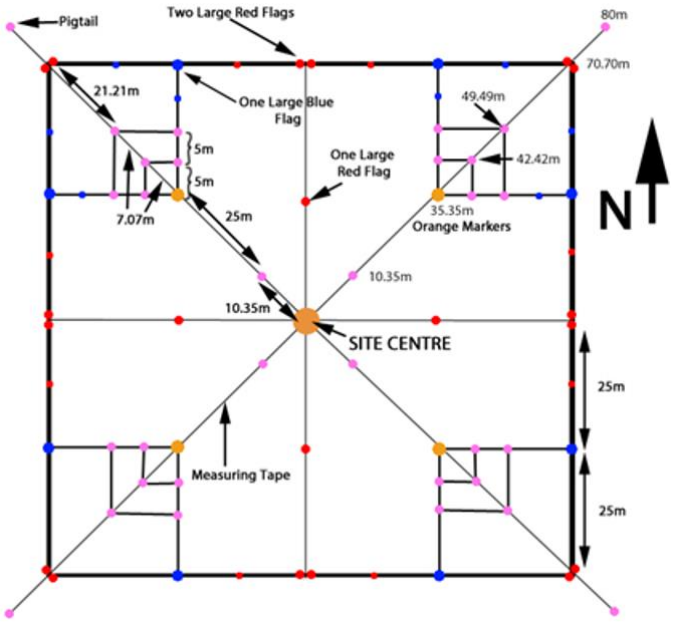

Figure 1. ABMI site layout

Field Equipment:

ABMI site maps

Folding handsaw/"Swede-saw"

GPS and compass

5 – 1.5 m orange steel or aluminum bars/site

5 – 12" nails or magnetic survery spikes/site

32 – pigtails/site

2 – 100 m tapes

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

Orange and blue spray paint

- Ensure that compass declination is set appropriately for the location. Declinations for each specific site will be provided by the field supervisor. If the crew is using a GPS that can accurately determine declination they can double check against the provided data (see the field manual for how to determine declination). Record

declination on the Access Sheet (***Appendix 3***) and the front of the map folder. The accuracy of the GPS used during site establishment is also documented on the Access Sheet.

- Using orange flagging tape, mark corners and turn-offs while heading into the site on ATV or 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 turnoffs, corners, significant landmarks, and parking locations. Include detailed direction and distance measures to aid staff in relocating all access points and site center (***Appendix 3***).
- 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, and >200 m from any vegetation, are recorded as "Open Water" and are not visited to collect field data.
    - 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 >200 m 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 will still be visited.
- On public land:
    - Site center and quadrant centres (35.35 m) must be located as precisely as possible using a hand-held GPS with an accuracy of < 7 m. If, due to heavy forest cover or poor satellite coverage, accuracy values from the GPS are > 7 m, this is noted on the site establishment datasheet.
    - At site center drive a 1.5 m steel conduit or bar (permanent marker) into the ground so it protrudes 1 m above ground. Also, drive a magnetic survey spike below the ground surface, under the bar, a minimum of 30 cm. In highly disturbed areas, dig the spike down to below 40 cm. Steel conduit or rebar, as well as a magenetic survey spike, should also be driven into the ground at the centre of each quadrant (35.35 m) in order to facilitate accurate re-establishment of plots during visits in later years. 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 as this allows them to be found much more easily in dense or shrubby site locations. Site centre markers should be painted bright blue on the top 10 cm in order to be easily distinguished from quadrant centre markers. To facilitate protocol collection, lay out 5X5 m, 10X10 m, and 25X25 m nested tree/snag plots, insert the downed woody material (DWM) and soil plot pigtails, and flag the boundary of the 1 ha site, including North, South, East, and West lines.
    - Red flagging tape is used for marking the 1 ha boundary, blue tape for the large tree plots, and pink/blue tape for marking pigtail locations. Adhere to the color scheme to assist crews in identifying their location within the site (***Figure 1***).
    - Lay out each ordinal transect (northeast 45°, southeast 135°, southwest 225°, northwest 315°) using a 100 m tape measure, placing the 1.5 m bar (permanent marker) at 35.35 m and pigtails at 10.35, 42.42, 49.49, and 80 m (***Figure 1***). Ensure pigtails are marked with pink/blue flagging and place pink flagging above the pigtail (on a branch or shrub) to aid locating the pigtails after leaf out. Mark each plot corner at 70.70 m using red flagging tape (Double Red Flag). Roll the tape back to the 35.35 m permanent marker and insert pigtails for the remaining sides of the small and medium tree/snag plots

by measuring 5 m and 10 m N or S and E or W (depending on the quadrant). These pigtails should also be 5 m and 10 m perpendicular (within 20 cm) to the 42.42 m and 49.49 m pigtails. Continue on the N/S and E/W bearing (depending on quadrant) 25 m from the permanent marker (e.g., 60.35 m) to reach the 1 ha boundary and corner of the large tree/snag plots. Mark this corner with a large single blue flag. Using your compass, locate the double red flagged corner, and flag the boundary towards it using blue tape. Flag in blue as you roll the tape back along the lines just laid out, towards the 35.35 meter marker conduit. Flag the North/South and East/West cardinal lines using red flagging tape at reasonable intervals to ensure it will be visible after leaf out. Put a double red flag at the end of each line (50 m), and a large single flag at 25 m. Use red flagging tape to complete the boundaries of the 1 ha site by compassing N/S or E/W to meet the corners of the large tree plots.

  - All flagging and pigtails must be removed during the final visit of the season with the exception of all 42.42 m and 49.49 m pigtails. The 42.42 m and 49.49 m pigtails are spray painted orange and remain to aid in re-establishing the tree plots in future visits. Unless otherwise specified, conduit/rebar should remain at the site.

- 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 < 30 cm, to locate site center and establish the four 35.35 m quadrant-centers, the four 70.70 m corner points, and DWM transect start points.
  - All flagging and pigtails **must** be removed after each visit.
  - 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.).

SITE RE-VISITS: FULL PROTOCOL COLLECTION

When visiting sites that have been previously sampled, our goal is to establish sites to match the original layout as closely as possible using permanent markers left from previous visits and/or using coordinates provided.

Protocols

- Use given GPS coordinates to navigate to site centre and 35.35 m marker locations.
- If necessary, use metal detector to pinpoint marker locations.
- While standing at the Site Centre permanent marker record the distance your GPS says you are from the Site Centre waypoint that was provided to you.
- Use waypoint averaging to mark all located markers and record these new waypoints on the Access Sheet.
- Navigate from site centre to located 35.35 m markers using a compass
- Lay out transect tape as you go and make sure the tape is straight!
- Stand at site centre.
- Sight along the transect tape towards the 35.35 m marker.
- Figure out the bearing of your line.

- Change the compass declination so that your current bearing matches the expected bearing for that quadrant.
    - Use the following equation: Current declination + (expected bearing – actual bearing) = declination to use.
- Note the declination used for each quadrant .
- Set up remainder of quadrant with the acquired declination. Note: declinations may vary between quadrants.
- Before leaving the site make sure to:
    - Re-paint all conduit, 42.42 m, and 49.49 m pigtails with orange paint
    - In addition – spray the top 10 cm of the site centre conduit with blue paint

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 (35.35 m) and associated nested tree/snag plots. After laying out the 100 m tape to provide a transect for DWM and a boundary for small, medium, and large tree/snag plots, technicians collect soil cores, 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 so as to maximizes 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 raingear and boots.

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

Ecosite categories (***Table 1***) are broadly based on vegetation communities described in ecosite field guides for Alberta (see ***Appendix 4*** 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 often is determined in combination with nutrient status because vegetation provides many clues about moisture status).
- Fourth: Determine tree species modifier based on the trees that are present and above 1.3 m 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** *(Trees ≥ 1.3m tall & ≥10% cover)* – Add 4-letter code combining tree height, density, and arrangement. Tree Height **(TS) Short** – ≥50% of canopy cover <10 m tall. **(TT) Tall** – >50% of canopy cover ≥10 m tall. Tree Density **(D) Dense** – Trees ≥1.3 m tall are ≤2 m apart. **(S) Sparse** – Trees ≥1.3 m tall are >2 m apart. Tree Arrangement **(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** *(Trees <10% cover and/or <1.3m tall)* **Shrubs Present** *(Shrubs ≥10%; or Trees ≥10% but <1.3m tall)* – Add 3 letter code combining height and density. Vegetation Height[7] *Record the **tallest** layer with ≥10% cover.* **(ST) Shrubs Tall** – Shrubby vegetation >2 m tall **(SL) Shrubs Low** – Shrubby vegetation <2 m tall **(TL) Trees Low** – Trees <1.3 m tall Vegetation Density **(D) Dense** – Cover >75% **(M) Moderate** – Cover 25-75% **(S) Sparse** – Cover <25% **Only Ground Vegetation Present** *(Shrubs <10%; Trees <10%; Other Vasc. ≥10%)* – Add 3-letter code combining dominant vegetation type and density Vegetation Type[8] **(GB) Bryoid/Lichen** – Bryophyte and lichen **(GF) Forb** – Non-graminoid herbs and ferns **(GG) Graminoid** – grasses, sedges **(GR) Marsh** – reeds, rushes, and cattails Vegetation Density **(D) Dense** – Cover >75% **(M) Moderate** – Cover 25-75% **(S) Sparse** – Cover <25% **Non-Vegetated** *(<10% Vegetation Cover)* – 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, 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 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 **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 <25% of the substrate.
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%	
		8b **Shrub**	<10% tree cover	
Poor Fen: 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)	
		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 (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 strata)	
		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 4*** 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 reexamine 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 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 (ie.,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 the Low Shrubs and Trees Low should they be roughly the same height and the 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 (1 m radius circle).
- For these plots, determine the primary current ecosite type within the area sampled, and record the proportion of area (in 10% increments) occupied by that 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 Centre

- Usually recorded during summer protocols
- Determine the ecosite type in a 50 meter radius circle for site centre
- Classify the historical and current primary and (if applicable) current secondary ecosite types. Also record the percent coverage of each ecosite within the 50 m radius circle.

  Note: a secondary ecosite should also be included if two different structural stages are present (e.g., 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.
- Primary ecosite types occupy a larger proportion 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 primary and secondary ecosite percentages must sum to 100 with the exception of cases where a third ecosite exists (ex: 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 3rd 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 50 m radius circle surrounding site centre. Areal 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 – for example GFD in a cutblock 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 centre and is completed in the summer. Record all data based on how habitats look at exact date/time of site visit.

Field Equipment:

Basic field supplies

Compass

- At site centre, 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 time of 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 centre conduit, determine slope using a compass. Turn the compass dial to E, and from a standing position with compass parallel to the ground, sight to a reference point that is eye-level above the ground 20 m 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:

- Estimate tree species composition (in 10% increments), average distance between trees (in 1 m increments), and average height of trees (to the nearest 5 m category), for all trees (including trees <1.3 m 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 and Co-dominant Tree* category. This means you **MUST** have an entry in the *Dominant and Co-dominant 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.

- Identify the most common shrub species (based on % cover) in two height categories (>1.3 m, and <1.3 m) and record the species codes.
- Estimate total shrub cover (not just the dominant species) in categories (1-25%, 26-50%, 51-75%, 76-100%), based on what would be obtained if a photograph had been taken from above all shrubs.
- Identify the type of ground vegetation that is most common (grass, herbs, shrub, sedge/rush, 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 0.5 m 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.
- 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***).

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	Power Line	Any type of power line
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 from livestock	Livestock trails and pugging/hummocks
RES	Residential	Any type of human dwelling, farm building, or farm yard 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 distrubance type

- 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***).

Table 3. List of natural disturbance categories and associated codes

Code	Disturbance	Description
Beaver	Beaver Activity	Any evidence of beaver activity altering the landscape or vegetation.
Disease	Disease Outbreak	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. See chart below.
Erosion	Erosion	Evidence of the wearing away of soil by precipitation or wind; potentially human induced. E.g. Side of a hill has eroded from rain (natural); culvert under logging haul road is plugged causing excessive run-off through low lying areas undercutting trees.
Fire	Fire Damage or Scarring	Any evidence of scarring or burning (may be human caused); may coincide with salvage-harvesting.
Flood	Flooding	Evidence of high water mark, dead trees, etc.; potentially human induced. E.g. Stream overflows its banks in spring and fills in forest depressions and/or "historic" flood plain (natural) - evident by standing dead tree, 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	Evidence of vegetation breakage caused by snow or ice.
Insect	Insect Attack	Any evidence of vegetation experiencing an 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.
Wind	Wind Throw	Evidence of wind throw (e.g., many trees up-rooted and laying on the ground and/or snapped along the bole); often occuring along canopy openings, cutblocks, roads, etc. Potentially human induced.
Other	Other Disturbance (Specify)	Other type of disturbance. Make notes in comments.
None	No Natural Disturbance Observed	No natural disturbance visible
Unknown	Cause Unknown (Specify in Comments)	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. This heading can be replaced with any "other" type of disturbance agent if something has been identified that is not on the list.

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: Budworms, Moths, Sawflies, Needleminers, 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: Tent caterpillars, Moths, Leafminers, 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: 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: 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.

- Disturbance values must not sum to >100%, even in the event of multiple disturbance types (values may be <100%).

METHODS FOR SURVEYING BRYOPHYTES & LICHENS

Equipment:

Mora knife

Hand lens

Toilet paper for fragile specimens

Squares of paper for small specimens

40 paper bags per site

Sharpie

Water

Watch

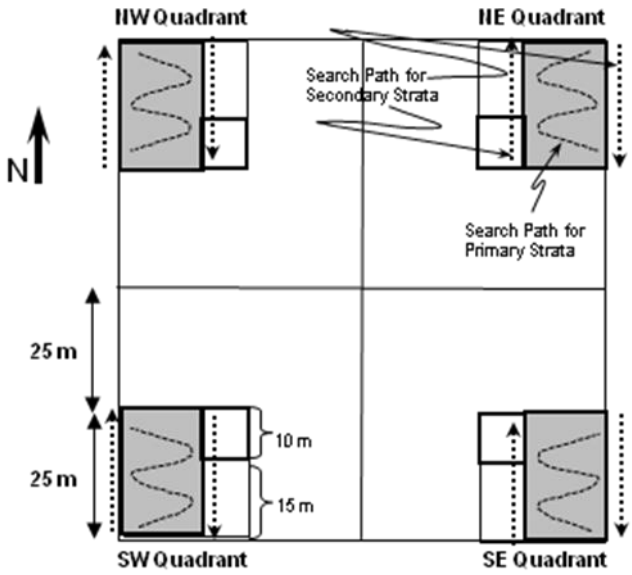

Figure 2. Bryophyte and lichen plot layout

- 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.
- Four 25 x 15 m plots (total 0.15 ha) 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 disturbances (see disturbance categories table above).
- A single person spends 35 minutes in each of the 4 quadrants (maximum total: 140 minutes) collecting bryophytes. A second person independently completes the protocol for lichens.
- Always start surveys 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**: strata (microhabitat types) present are sampled in the interior of the 25 x 15 m plot.
        - **For bryophytes:** Search strata #1 logs/stumps, strata #3 wetlands/peatlands and strata #4 rocks and cliffs (***Table 4***).
        - **For lichens:** Search the strata #1 logs/stumps, strata #2 trees, shrubs and other vertical structures and strata #4 rocks and 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, and when present in the plot, should be targeted early in the search.
        - Then search 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 stratum in each plot as some microhabitats are small and dispersed in space (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 strata 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 which have all of the primary strata should take the full 25 minutes to search.
    - **SECONDARY:** the strata (microhabitat types) that have less diverse communities are searched in a belt transect following the 2 long sides of the 25 x 15 m plot (***Figure 2***). Walk along the plot boundary and sample within 1 m of either side of the transect. This results in two 25 x 2 m transects in each of the 4 quadrants.
        - **For bryophytes:** Search the strata #2 trees, shrubs and other vertical structures and strata #5 upland soils (***Table 4***).
        - **For lichens:** Search the strata #3 wetlands/peatlands and strata #5 upland soils (***Table 4***).
        - Ensure that examples of both secondary strata are searched if they occur on the transect.
        - Search as many examples (or as much area) 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.
- In each stratum in each plot/transect, collect examples of all the bryophytes or lichens that appear different from one another.
- When collecting specimens:
    - 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 with toilet paper so it does not 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 or wrap them in toilet paper so they don't get lost or fragment further

  - If the sample is very wet (e.g., a moss specimen from a wetland stratum) carefully squeeze out the sample before placing it in the bag. Be mindful to fluff the specimen back out after squeezing.
  - When in doubt about whether a specimen is unique or has been collected already, collect it again.
  - We do not sample crustose lichen; however, when in doubt about whether a specimen is crustose, collect it.

- 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).
  - Be diligent to not collect the same species over and over again from a stratum as 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.
- If no specimens are found in a stratum of a plot/transect, but the stratum is present, then circle "None" on the label of the empty paper bag and select “None” on the tablet. If no example of a stratum is found in a plot/transect (the microhabitat is absent), then circle “VNA” on the label of the empty paper bag and select “VNA” on the tablet – e.g., variable not applicable. Circle “C” on bags that contain specimens and select “C” on the tablet.
- Once the surveys are completed, 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. 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 mould. Once mould develops a specimen is ruined.
- Once dry, place all bryophyte sample bags into one large paper bag and label it with the site number and “Bryophyte”. Do the same for lichens.
- At the end of each shift, 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 the laboratory. Samples collected near the end of the shift will have likely not had time to dry completely. **Important**: Mark these samples conspicuously as being wet and staff will attend to them at the Royal Alberta Museum (RAM).
- 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.
- 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 & logs (decay classes 3-5) - sample roots and all sides
LH: Hard stumps & 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 & dead shrubs (does not include trees below 1.3 m)
HB: Human Structures - vertical and horizontal parts of the structures (survey from the ground)
Stratum #3: Wetlands and Peatlands (samples in 1 bag)
WMF: Wetlands, marshes, & fens - within the wetland survey both under and away from trees
WSB: Shores/banks of wetlands, ponds, lakes, & streams - survey on organic or mineral soil adjacent the water's edge
WDS: Moist depressions/seasonal wetlands dry at 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 (>50 cm diam.) - survey all surfaces (top, sides, and base) from the soil upwards
RR: Rocks (<50 cm diam.) - survey all surfaces (top, sides, and base) from the soil upwards
CL: Cliffs (steep high rock face) - survey all of the 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 5 x 5 m and is anchored at the 35.35 m quadrant center. The second plot is 10 x 10 m, and encompasses the small plot (***Figure 3***). The third plot is 25 x 25 m and encompasses both the first and second plots.

Field Equipment:

50 cm DBH calipers (1 mm increments)

5 m DBH tape

10 m carpenter's tape

100 m measuring tape

Vertex hypsometer with transponder

Tree paint

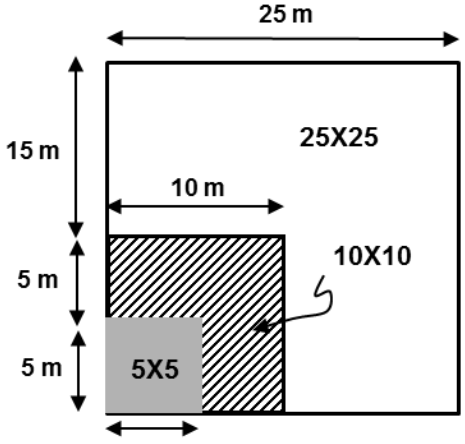

Figure 3. Trees and snags plot layout.

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

For the purposes of this protocol:

- Trees are defined as any tree species, with the exception of Alnus or Salix, that is ≥ 1.3 m in height (***Table 5***). Any trees < 1.3 m in height are NOT measured.
- Snags are defined as dead trees ≥ 1.3 m in height, leaning ≤ 45° 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 m. Stumps are not recorded.
- The diameter at breast height (DBH) is measured at 1.3 m up the bole of the tree from the highest soil point (e.g., upslope side when on an incline, top of a hummock, etc.). If the bole of the tree is at an angle, measure the 1.3 m along the bole of the tree and then record the DBH.
- If DBH is < 7 cm, measure diameter to the nearest 0.1 cm
- If DBH is ≥ 7 cm, measure diameter to the nearest 0.5 cm
- Tree diameter is measured using tree calipers, or in the case of trees with DBH > 10 cm, DBH tape.
- 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., point of measurement) facing the 35.35 m permanent marker once measurements have been taken and recorded.
- Top height and base height are measured to the nearest 0.1 m unless this value is estimated, in which case height is measured to the nearest 0.5 m.
- 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 judgment 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, and for leaning trees, heights must be corrected based on the amount of lean.

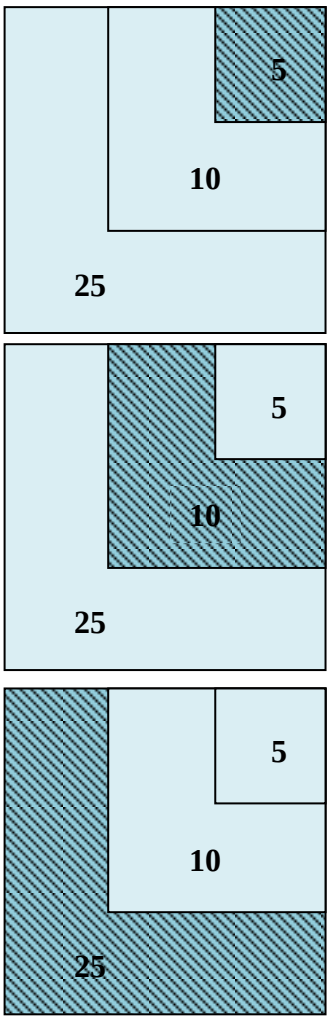

Figure 4. Trees and snags plot breakdown.

5 x 5 Square Plot

- **Record for ALL trees and snags.**
- For trees < 7 cm DBH, record Species, Condition, Decay Stage (as VNA), DBH, Top Height, and Measured or Estimated.
- For trees ≥ 7 cm DBH, record Species, Condition, Decay Stage (as VNA), DBH, Top Height, Base Height, Measured or Estimated, and Crown Class.
- For snags < 7 cm DBH, record the same categories as live trees, including the appropriate decay stage.
- For snags ≥ 7 cm DBH, record the same categories as live trees, including the appropriate decay stage, and excluding Base Height and Crown Class **(*Figure 4*)**.

10 x 10 L-Shaped Plot

- **Record for ALL trees and snags ≥ 7 cm DBH.**
- For all trees, record Species, Condition, Decay Stage (as VNA), DBH, Top Height, Base Height, Measured or Estimated, and Crown Class.
- For all snags, record the above categories, including the appropriate decay stage, and excluding Base Height and Crown Class **(*Figure 4*)**.

25 x 25 L-Shaped Plot

- **Record for ALL trees and snags ≥25 cm DBH.**
- For all trees and snags record Species, Condition, Decay Stage (as applicable), and DBH **(*Figure 4*)**.

When to Measure or Estimate Top and Base Height

- Tree top and base heights are measured using a vertex hypsometer for a maximum of 3 trees from each crown classification within the 10x10 m plot (this includes your 5x5 m plot due to the nested design). If fewer than 3 trees of a given crown classification exist in the 5x5 m and 10 x 10 m plots combined, 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 will be recorded. A maximum of 15 trees' top and base heights will be measured in each quadrant. All additional tree heights will be estimated based on the heights of the measured trees.
- Indicate that the measurements were measured or estimated by placing an "M" or "E" in the Measured/Estimated column on the tablet for each individual tree.
- Every tree DBH will be measured using a DBH tape or calipers.

- 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***).

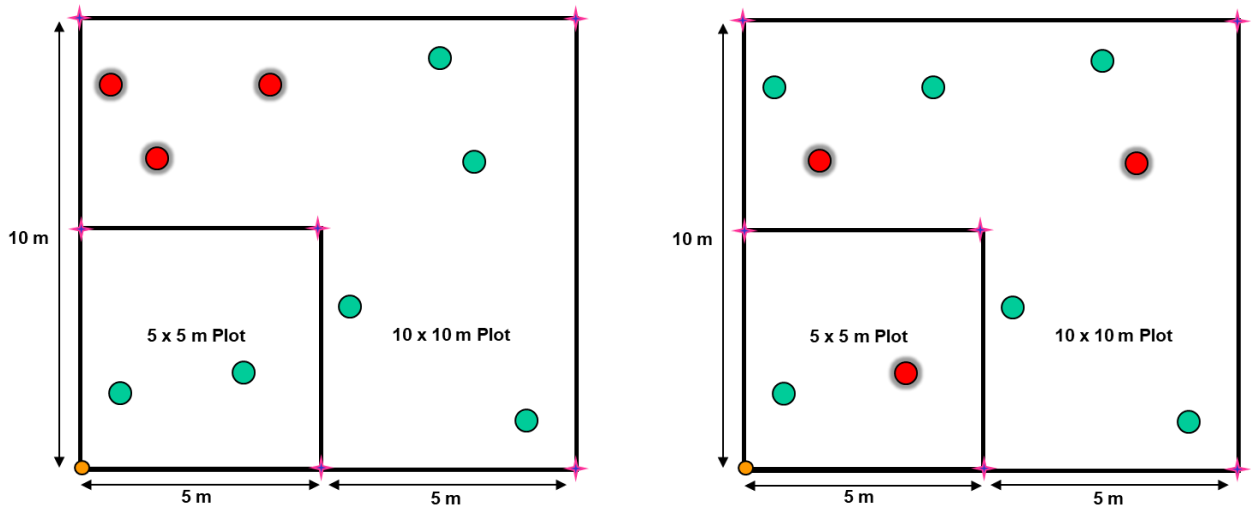

Figure 5. In this crown classification the red trees have **measured** top and base heights and the green trees have **estimated** top and base heights. Avoid clumping all measured trees together and instead, spread them out evenly to assist with estimating heights of nearby trees.

Determining Decay Stage

- Decay stage for snags is described as:
  - 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 (***Figure 6***).

- If the tree is snapped along the bole so that the presence of twigs and branches cannot be evaluated, then decay is classified based on the snag condition as:
  - 1-2S = recently killed, wood hard, bark (normally) intact
  - 3S = wood starting to soften
  - 4S = wood soft throughout the snag (***Figure 6***).

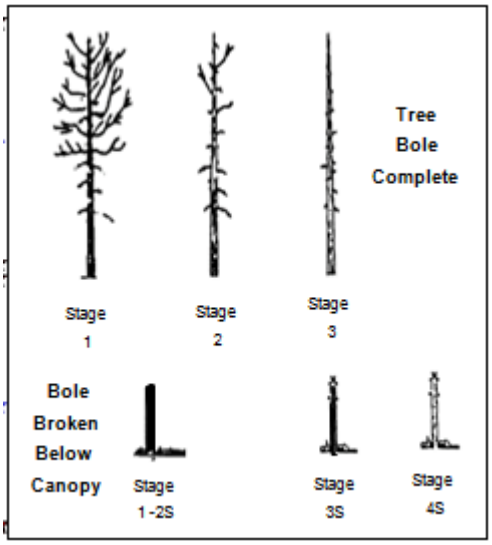

Figure 6. Snag decay stage

Determining Crown Classification

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

Table 5. Tree species found in Alberta

Tree species found in Alberta (native & non-native)*	
Abies balsamea	Balsam fir
Abies bifolia	Rocky Mountain alpine fir
Abies lasiocarpa	Subalpine fir
Acer negundo	Manitoba maple
Acer glabrum	Rocky Mountain maple
Betula papyrifera	Paper Birch
Betula neoalaskana	Alaska birch
Betula occidentalis	Water birch
Fraxinus pennsylvanica	Green ash
Larix laricina	Tamarack
Larix sibirca	Siberian Larch
Picea engelmannii	Engelmann spruce
Picea glauca	White spruce
Picea mariana	Black Spruce
Picea pungens	Blue/Colorado spruce
Pinus banksiana	Jack pine
Pinus contorta	Lodgepole pine
Pinus ˣmurraybanksiana	Murraybanks' pine
Pinus albicaulis	Whitebark pine
Pinus flexilis	Limber pine
Pinus monticola	Western white pine
Pinus sylvestris	Scots' pine
Populus tremuloides	Trembling aspen
Populus balsamiferea	Balsam poplar
Populus angustifolia	Willow poplar
Populus deltoids	Plains cottonwood
Populus trichocarpa	Black cottonwood
Pesudotsuga menziesii	Douglas fir
Quercus macrocarpa	Bur oak
Sorbus aucuparia	European mountain ash
Sorbus scopulina	Western mountain ash
Sorbus sitchensis	Sitka mountain ash
Ulmus americana	American elm

*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 that your supervisor is notified.

DOWNED WOODY MATERIAL

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

Field Equipment:

50 cm DBH calipers

Go-No-Go Tool

Mora Knife

50-m Measuring Tape

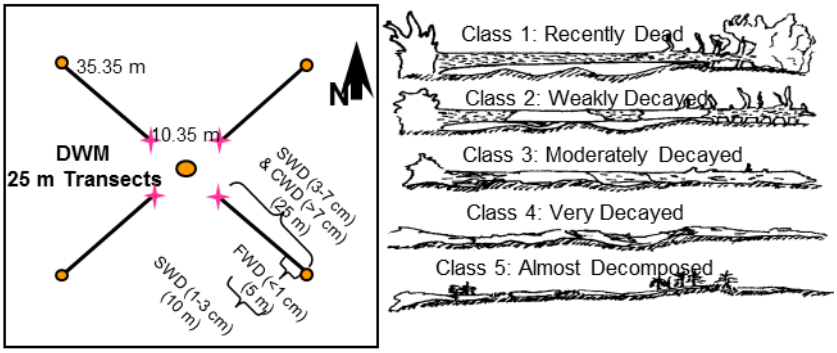

Figure 7. DWM layout and decay class

- DWM is measured on the four ordinal transects (***Figure 7***).
- Transects start at the 10.35 m pigtail and extend for 25 m to the 35.35 m rebar in each quadrant.
- Dead wood must be on the forest floor, or rooted but leaning > 45° from vertical, or suspended over the transect (within technician reach) to be recorded as DWM.
- DWM is divided into Coarse Woody Debris (CWD; ≥ 7 cm), Small Woody Debris (SWD; 1-6.99999 cm) and Fine Woody Debris (FWD; < 1 cm) (***Figure 8***). The "go-no-go" tool is used to determine which category each piece belongs to.
- SWD is placed into 3 size classes (1.0-2.99999, 3.0-4.99999 and 5.0-6.99999 cm). Tally the number of SWD 1.0-2.99999 cm along the last 10 m (e.g., 25.35 to 35.35 m) of each of the 4 DWM transects. SWD 3.0-4.99999 cm and 5.0-6.99999 cm are tallied along the entire 25 m transect. To be included as SWD, the piece must intersect the transect and be above the litter layer (e.g., < 50% buried).
- Tally the number of pieces of FWD that intersect the transect above the litter layer, along the last 5 m (e.g., 30.35 to 35.35 m) of each of the 4 DWM transects. Fine woody debris only includes twigs, stems, and branches, and does not include cones, bark flakes, needles, or fragments of stems and branches < 10 cm long. These pieces of FWD are often short; thus, it is necessary to have the tape measure within a few centimeters of the forest floor for the last 5 m to accurately determine whether or not the FWD piece crosses the transect.

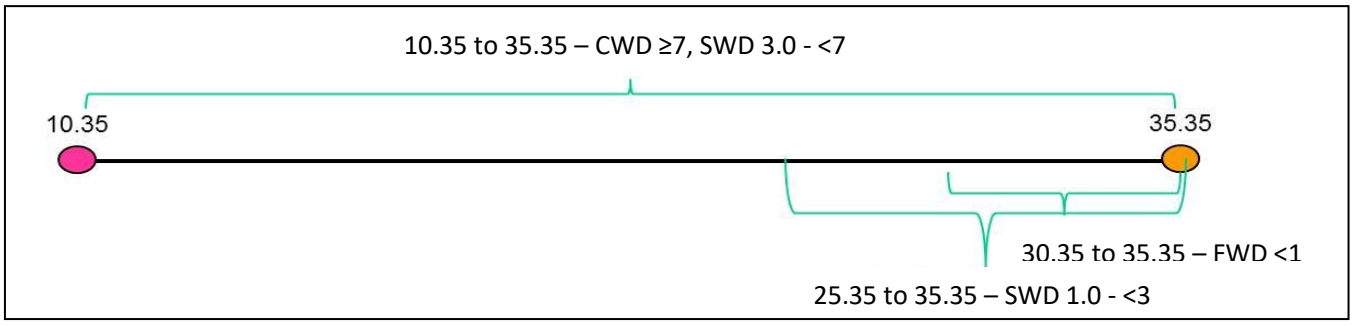

Figure 8. DWM transect layout

- Measure each piece of CWD ≥ 7.0 cm diameter (in 0.5 cm increments) where it intersects the transect along the entire 25 m of each DWM transect.
- For CWD (≥ 7.0 cm diameter), 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.
- Classify decay stage (at the point of intersection) into one of five decay classes (***Figure 7***):

  1) Recently Dead - Bark (normally) attached to the 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. *(25-5 % of the 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.

In some cases it is difficult to determine what to measure. The following provides some details:

- **Classified as Downed Woody Material**
  - 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 <u>above</u> the litter layer or soil; debris is considered no longer above when it is >50% buried beneath a layer of surface organic matter (forest floor) or mineral soil.
  - 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° from vertical, that is not more than 50% buried.
  - Recently cut logs.
  - Uprooted (not self-supporting) stumps.
  - Exposed dead roots of snags/logs that have fallen and are crossing the transect (***Figure 9***).

- **Things <u>NOT</u> classified as Downed Woody Material**
  - 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 ≤45° from the 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 of log left) (***Figure 9***).

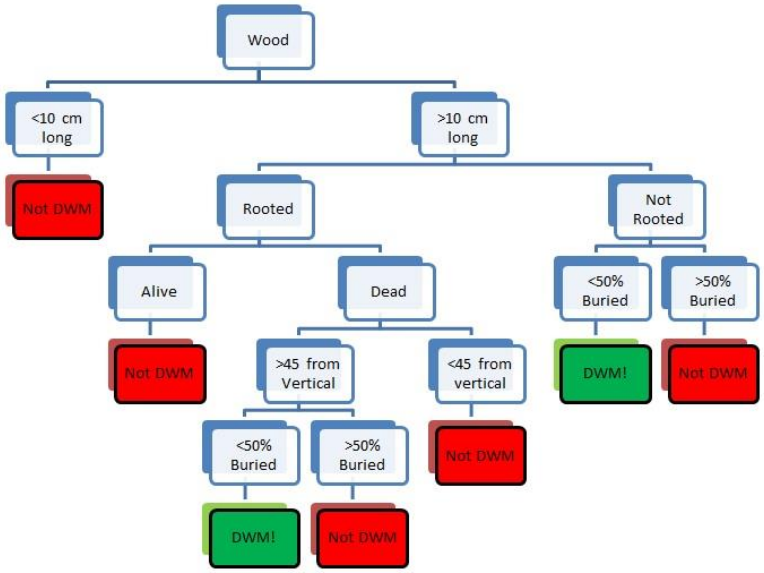

Figure 9. Use this flow chart as a reference to help determine what is and what is not considered DWM.

- **Accumulations** of large DWM (e.g., logging debris or slash piles):
  - For piles of CWD - **Measure if possible,** otherwise estimate the length of the pile and the 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***). This estimated value, for example 40%, is entered into the tablet program's Accumulation Calculator along with measured accumulation length and height. The tablet program will calculate a diameter for the accumulation and auto-record the parameters used as part of the calculation in the entry's comment field.
  - 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.).

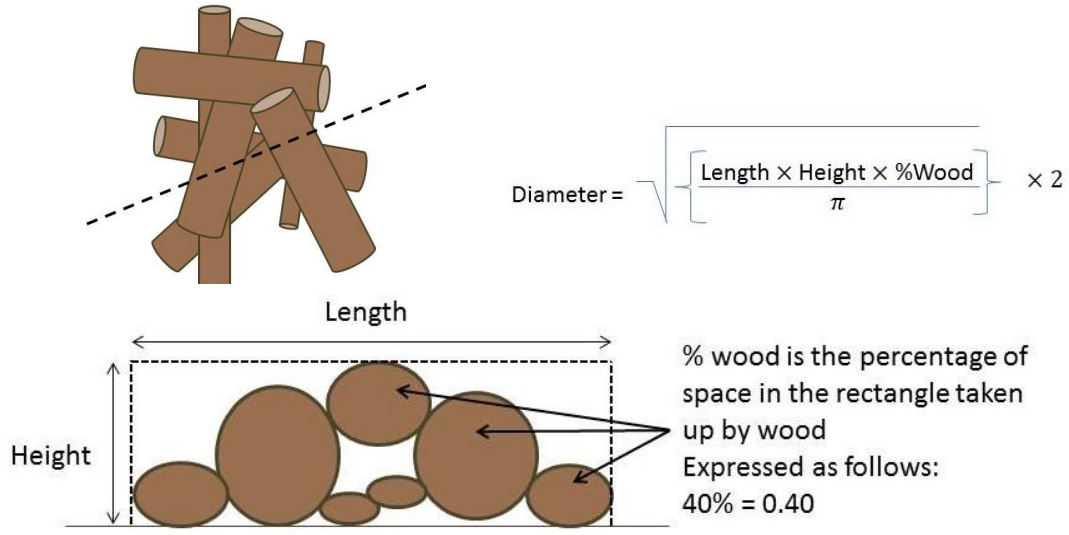

Figure 10. Example of how to calculate the diameter of accumulations.

- 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 datasheet or tablet. Note that if no accumulations were present, VNA is recorded.

- **Partial Tally** is used when many pieces of FWD and SWD cross the transect (e.g., wind throw and broken-off tree crowns containing many small branches). If a tree crown has fallen across the transect, a proportion of the branches/pieces are counted and the total number is estimated.
  - Measure the entire horizontal length of the debris field crossing the line (e.g., debris field is 5 m long).
  - Choose a representative sub-sample (not just the first portion of transect) and tally the number of FWD and SWD pieces (e.g., 42 pieces of FWD and 25 pieces of SWD tallied within a 50 cm distance).
  - To obtain an accurate estimate of DWM, the length of transect chosen for measurement must have at least 20 pieces for each type. 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 50 cm is 1 tenth of 5 m; 420 pieces FWD and 250 pieces of SWD).
  - This is recorded in the partial tally section of the data sheet. Use VNA if you do not encounter a case which requires a partial tally. For tablets, use the "partial" check box.

SOIL CORES: SOIL ARTHROPODS (SPRINGTAILS AND MITES) & MINERAL SOIL

This protocol is designed to measure presence and relative abundance of mites (*Oribatid*) 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.

Field Equipment:

Soil Corer (2" diameter)

500 mL measuring cup

Cloth collection bags

Piece of plastic sheet

ABMI Ecological Site Classification Chart

Dust Broom or Large Paintbrush

Sharpie

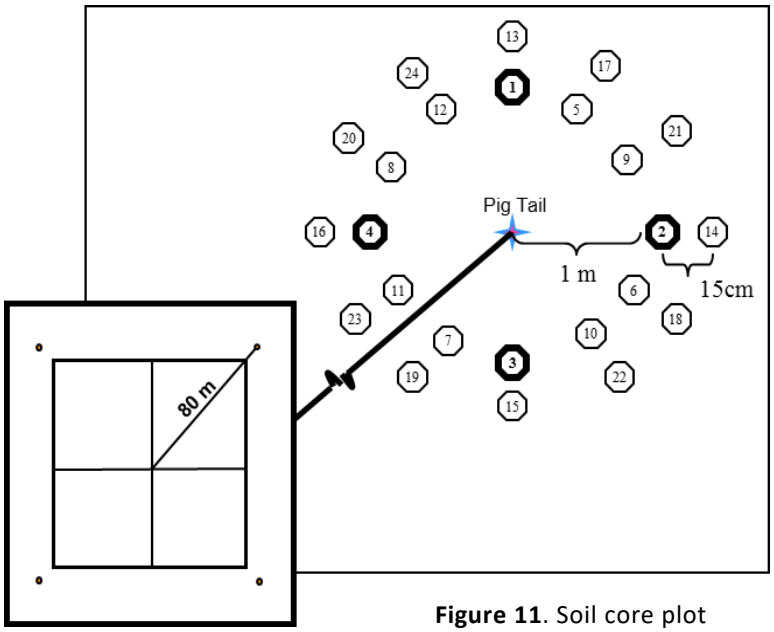

Figure 11. Soil core plot lavout

Ecological Characteristics of Sample Area

- 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 1 ha area.
- Sample areas are located on the ordinal transects 80 m from site center (***Figure 11***) – approximately 10 m outside the corners of the 1 ha square.
- Identify the current ecosite(s) that the 1 m 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 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 on 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***).

Soil Collection and Codes

- Collect soil cores that contain both the organic layer and approximately 10 cm of mineral soil – this provides the sample for both the soil arthropods and the mineral soil (***Figure 12***).
- Do not collect partial cores. If an obstruction (e.g., root) prevents you from reaching the mineral soil, discard the core, enter the reason in the tablet, and move to the next coring location.
- 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 taken:

  - SW = Standing Water
  - R = Rocks
  - SL = Stumps/Logs
  - RT = Root(s)

  If core can be taken, 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 accumulates after coring, or permanently/presently frozen soil)
  - OT = Other (requires additional comment)
- Cores are divided into LFH and Mineral samples (see below for further instruction)
- Samples are labeled with the Sample Type (LFH/Mineral), Collector's Initials, Date, Site Number, and Quadrant.
- Double-check each bag's label to ensure that the quadrant you are sampling is labelled accurately – mislabelling quadrants (e.g., submitting two NW bags and no SW bag) is one of the most common reasons for expensive resampling. Pre-labelling your 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 the *Preserving and Packing Soil Samples* section 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.
- Determining the LFH horizon is usually straight forward based on the color and texture of the soil and

resistance of the soil corer to penetrate far into the mineral layer. The organic layer is typically dark in color, coarse and fibrous (containing rooting systems), whereas the mineral soil is typically lighter in color, 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 hand, and gently break these apart. If there are a few roots holding the two sections together, then cut these with a knife. Place the LFH and the top 5 cm of the mineral soil onto a plastic sheet (see description for mineral soil below).
- If the LFH is indistinct (e.g., native grasslands, high alpine), collect the plant residue (litter) layer and the top 2 cm of the soil. Based on the corer diameter, a minimum of 8 cores should be necessary to get 500 mL of litter in these areas. This core code is recorded as "X=core acquired, nothing unusual" and the Modified LFH Collection is recorded as "Top 2cms LFH Collected".

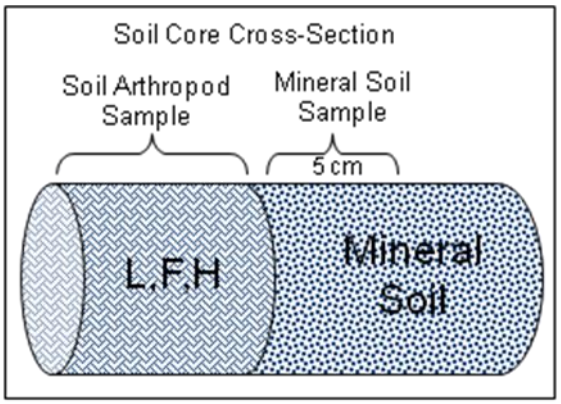

Figure 12. Soil core cross-section

- Where LFH layer has been mixed artificially by mechanical equipment (e.g., cultivated agriculture fields), collect the plant residue (litter) layer and top 2 cms of the soil. This core code is recorded as "X=core acquired, nothing unusual" and the Modified LFH Collection is recorded as "Top 2 cms LFH Collected".
- When the soil core location is on a road or if inorganic soil and 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 that this may include only a few leaves, grass, gravel, or other debris on the top of the core location. Do not core into any road or 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 is recorded as "Swept".
- If a core location is in standing water, no core is taken and the code SW is recorded. However, if a vegetative mat 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 a comment is left.
- 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 40 cm of organic material the corer extracts is collected from the core. This can be common in lowland areas such as black spruce/tamarack bogs.
- A minimum of 4 cores are taken (***Figure 11***) from each sample location (quadrant). If more than 4 cores are required to accumulate 500 mL of organic material, additional cores are taken in a clockwise fashion (***Figure 11***) until 500 mL is attained or until 24 cores have been taken. The number of cores required to get 500 mL of soil is recorded along with the appropriate code for each core. Note: most commonly an X will be recorded for "core acquired, nothing unusual."
- The LFH from all cores at each sampling location are mixed together on a plastic sheet and a random 500 mL 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 2 L of organic material is sampled per site.
- For care and shipping instructions, see the *Preserving and Packing Soil Samples* section below.

Mineral Soil

- The mineral soil sample is part of the same core that was collected to sample soil arthropods (***Figure 12***).
- Four 250 mL composite samples of mineral soil are collected – one for each of the four quadrants at each ABMI site.
- When obtaining each core, ensure the corer enters as deep as possible to ensure that mineral soil is collected.
- After removing the LFH layer from the core (see soil arthropod protocol above), collect 5 cm of mineral soil and place this on a plastic sheet. Use a knife to cut the core of mineral soil 5 cm below the LFH horizon (***Figure 12***). Return any additional mineral soil to the ground.
- While 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 supervisors. Note in comments reason for lack of sample, e.g.,: “organic depth > 40cm.”
- If after 4 cores more than 250 mL of mineral soil is collected, then mix the soil on the plastic sheet and sub-sample 250 mL.
- If there is < 250 mL of mineral soil after 4 cores, then continue collecting the mineral soil from core samples, via the same sequence as described in soil arthropods, until a total of 250 mL of soil is collected per quadrant. Continue to mix LFH samples together in this scenario and take the 500 mL sample from the aggregate.
- Place the 250 mL of collected mineral soil in a cloth bag and label as listed above.
- Mineral soil samples should be allowed to dry out and do not need to be kept cool.
- Pack samples in the cooler with soil arthropod samples (see above) and courier them to the laboratory for processing (see Preserving and Packing Soil Samples section below).

Preserving and Packing Soil Samples

- The following information is extracted from the Soil Cooler Packing Checklist provided by the Royal Alberta Museum.
- Extraction of mites from the LFH samples depends on the mites arriving at the Royal Alberta Museum alive. To do so, 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 to allow oxygen exchange.
- Mineral soil samples should be allowed to dry out and do not need to be kept cool.
- Both samples are shipped within 3 days of collection. They must be shipped in a cooler with sufficient frozen water bottles in order 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, then frozen ice packs, frozen juice concentrate or frozen food are preferable. Do not use bagged ice, as it melts and saturates the soil samples, potentially drowning 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) 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 (***Figure 13***). Include this with your shipping document when shipping your soils.
- Place a flash drive with the shipping document and all of the 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 package has been shipped please provide the waybill number to your coordinator so we have the ability to track the shipment.

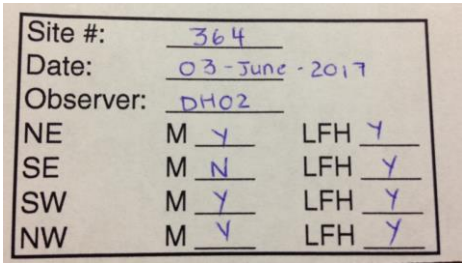

Figure 13. Complete a soil ticket for each entire site. Include one for each site shipped in that cooler with the flashdrive.

SITE PHOTOGRAPHS

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

Field Equipment:

Digital camera

Laminated Photo Sheet (Site#/Date/Direction)

Dry Erase Marker

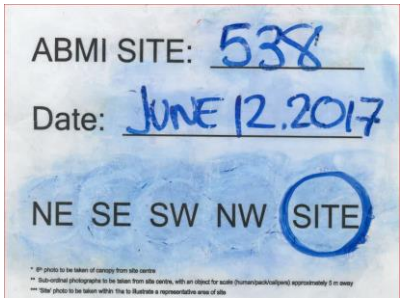

Figure 14. Laminated photo sheet

- Use "landscape" orientation for all site photos.
- Ensure your field camera displays the correct date and time.
- Take six 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 within the 1 ha plot; take a single photograph that best represents the physical and vegetation characteristics of the area.
- Except for in the canopy photo, include a filled out laminated photo sheet (***Figure 14***) in each photo, held at precisely 5 m from the camera for scale. Use a compass to ensure the 4 transect photos are taken directly along the ordinal directions (NE, SW, SE, NW).

- Record the photo number from the camera in the tablet.
- Check the resolution and quality of all photos at the site; **re-take if the photo is blurry or obstructed**.
- Back-up photo files onto a tablet or laptop computer once back at camp. Transect photos are labeled ABMI_[year]_[site]_[quadrant].jpg (e.g., ABMI_2021_546_NW.jpg). Canopy and representative site photos are labeled with [CANOPY] and [SITE] at the end of the label name instead of the quadrant.
- All photos are copied daily to a folder on a tablet and an external hard drive/flash key for backup. At the end of each field 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 centre.

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.

TREE CORES

This protocol is designed to measure age and growth rate of trees.

Field Equipment:

18 inch (5.5 mm diameter) increment borer

Straws

Stapler & staples

Ziploc bags

Labels

Vertex hypsometer

Folding Saw

DBH calipers and tape

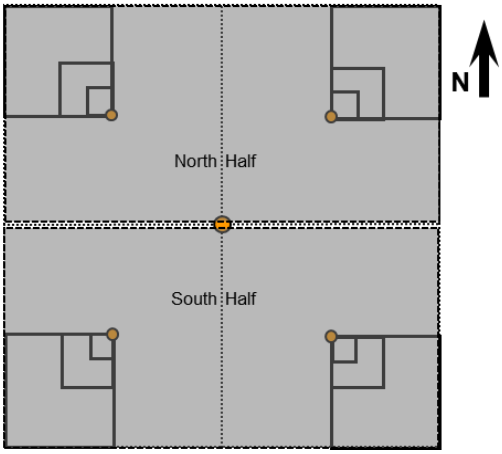

Figure 15. The site is split to form a North and South half.

- Tree cores are obtained from a maximum of 5 trees at each site.
- Trees are selected based on their relative abundance and DBH.
- For this protocol split the site into two halves the North half (the combined NE and NW quadrants) and the South half (the combined SE and SW quadrants) (***Figure 15***).
- 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. The tree selected as the largest for the 1 ha cannot be selected again. In this case select the live tree with the second largest DBH from the leading species. Please note a veteran or a residual tree from a former stand can not be selected. Obtain tree cores (or cookies) and record species, DBH, tree height, and significant tree damage for the cored trees.

- Select the live tree with the largest DBH from the **secondary** species (species with the 2nd highest stem density of dominant and/or co-dominant canopy trees), if one occurs, in both the North and South halves. To be classified as the second species, the species must comprise >20% of the canopy stems in that half site. The tree selected as the largest for the 1 ha cannot be selected again. In this case select the live tree with the second largest DBH from the second species. Please note a veteran or a residual tree from a former stand can not be selected. Obtain tree cores (or cookies) and record species, DBH, tree height, and significant tree damage for the cored second species trees.
- Select the live tree with the **largest** DBH within the entire 1 ha 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 largest trees.
- 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. Enter height to the nearest 0.1 m.
- At 1.3 m, use calipers or DBH tape to record DBH to the nearest 0.5 cm.
- Significant tree damage is defined as any damage or condition that could affect the normal height or growth rate of the tree: broken tops, dead tops, forks, crooks, and/or abnormal scarring or other damage (e.g., mistletoe). Record significant damage as:
    - BT = Broken Top
    - DT = Dead Top
    - FC = Fork/Crook
    - S = Scarring,
    - O = Other (indicate damage from diseases, insects, wild and/or domestic animals, abiotic natural factors, and anthropogenic factors)
- Use the increment borer to obtain the cores. Bore the tree at 1.3 m, on the side that faces site centre if possible (be accurate when determining the height of the core). 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, recollect. 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, then record significant tree damage as "Other". In the comments, explain that the core was not collected due to rot in both trees sampled for that core type.
- If all trees in either the North or South half of **either** the leading or secondary species are <10 cm DBH, destructively sample a representative tree from **outside** of the quadrant by taking a cookie at a height of 1.3 m. This makes it possible to core a leading species and take a cookie from a secondary species, or vice versa (***Figure 16***) .

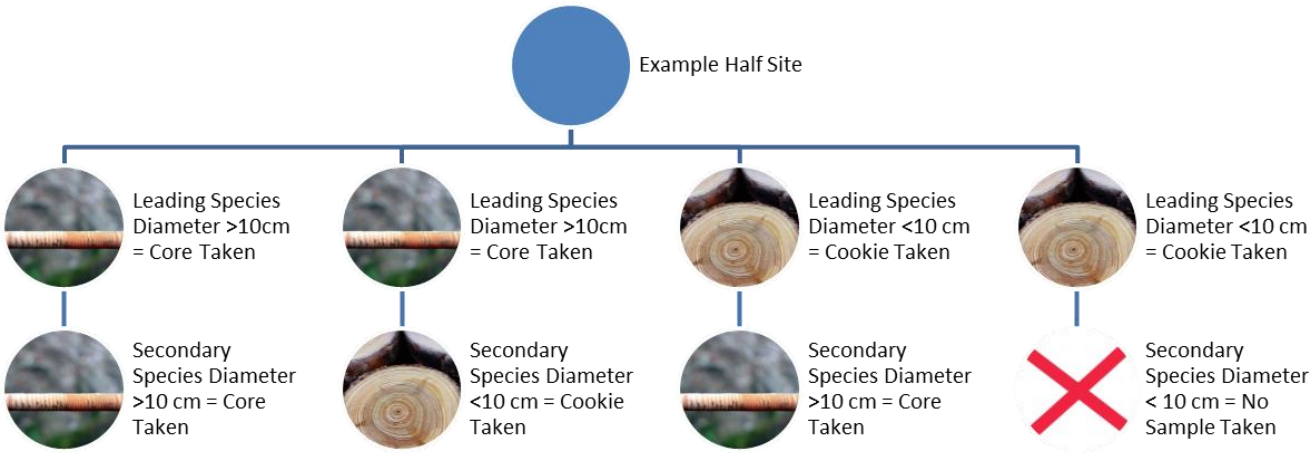

Figure 16. Flowchart showing when to take a core and when to take a cookie.

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

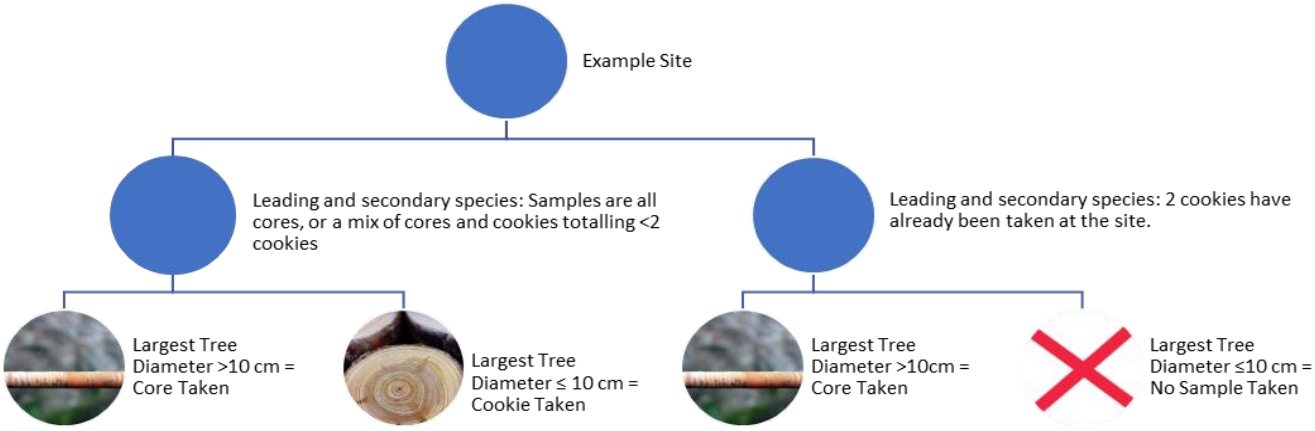

Figure 17. A maximum of two cookies can be taken at a site.

- When collecting a cookie be sure to collect a sample 2 inches in length to allow for proper labelling and processing. Avoid cutting a cookie directly at branch intersections.
- Note: In the white zone/residential areas, if you are in a landowner's yard, do not core/cookie any trees or tree-like ornamental shrubs. Refer to land access notes for conditions that would *allow* you to take a sample or take all other measurements for species present and do not submit cores noting reasons in comments.

Tree Core/Cookie Sample Management

- Ensure you bring at least 5 large prepunctured straws to each site in case you need to take all 5 potential cores.
- Straws are cut to allow air flow and stop mold/rot from affecting tree cores. Slits should be cut halfway through the straw at a consistent angle (*Error! Reference source not found.*). See ***Figure 19*** for examples of how **not** to puncture the straw.
- Preserve the core in a 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 closed on either end of the collected core so that the core can't slide from one end of the straw to the other. This will help prevent the core from breaking during transport.

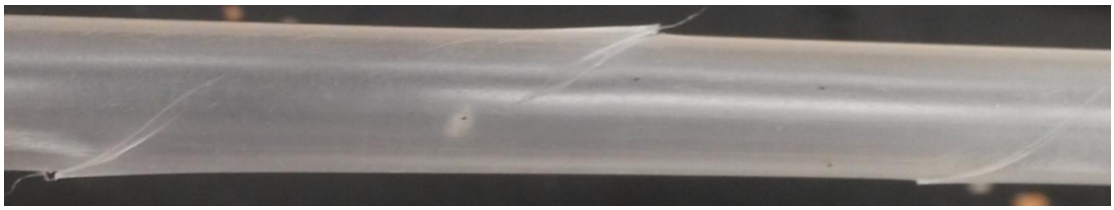

Figure 18. Straws are to be cut halfway through at a consistent angle from both sides to allow collected samples to dry and avoid mold/rot.

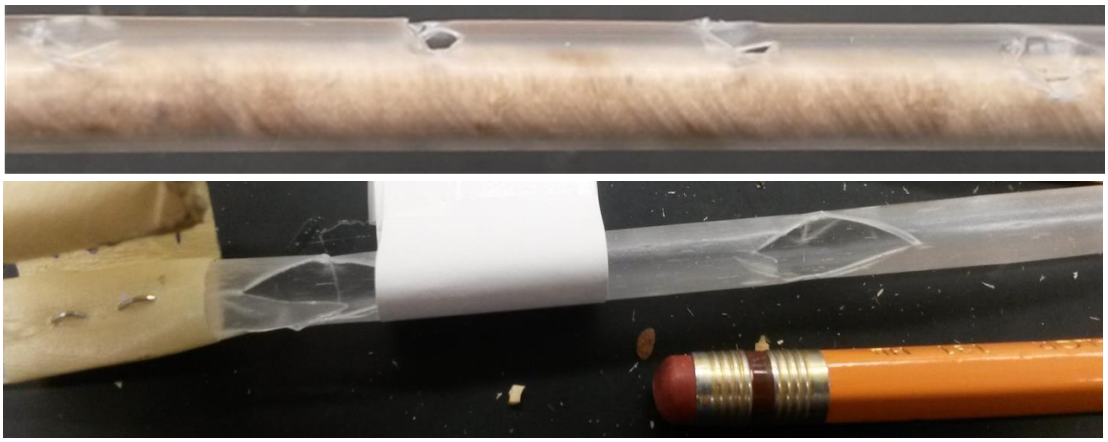

Figure 19. The two images above are examples of **unacceptable** punctured straws. The top straw has punctures that are too small and are pointing inwards potentially damaging the core. The bottom straw has punctures that are large enough for pieces of the core to break and escape the straw.

- Label each core/cookie with the following information: site #, N or S, tree species, sample type (largest, leading, secondary), initials, and date (***Figure 20***).
- Cookies can be labelled by writing on one of the cut faces if there is enough room to fit all of the label. If there is not enough room then wrap tape around the

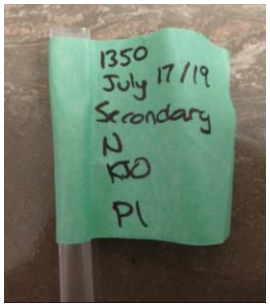

Figure 20. Straws should be labelled on a piece of tape wrapped around the straw.

diameter of the cookie and write the label on the tape **(Figure 21**). Do not tape over either of the cut ends of the cookie, and ensure the tape is tight enough that it will not slip off the rough surface.

- For transport in the field place all cores and cookies in the PVC case to transport from site to camp; be especially careful not to break the cores.
- When back at camp, set the cores and cookies out in a in a warm and dry environment to avoid rot.
- Place cookies in a paper bag. Cookies left in plastic bags will rot. Place a label in the bag with the same information as above, or write the information on the bag itself.
- At the end of the shift, group tree cores from the same site together by tying them together with flagging tape, pack samples in a cardboard box and submit them to a supervisor for further transport.

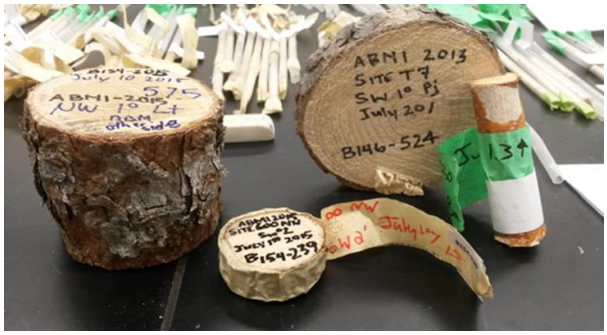

Figure 21. Cookies can be labelled on the cut face of the cookie if large enough. If the cookie is not large enough than wrap the cookie in tape and write the label on the tape.

CANOPY COVER

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

Field Equipment:

Spherical (concave) densiometer

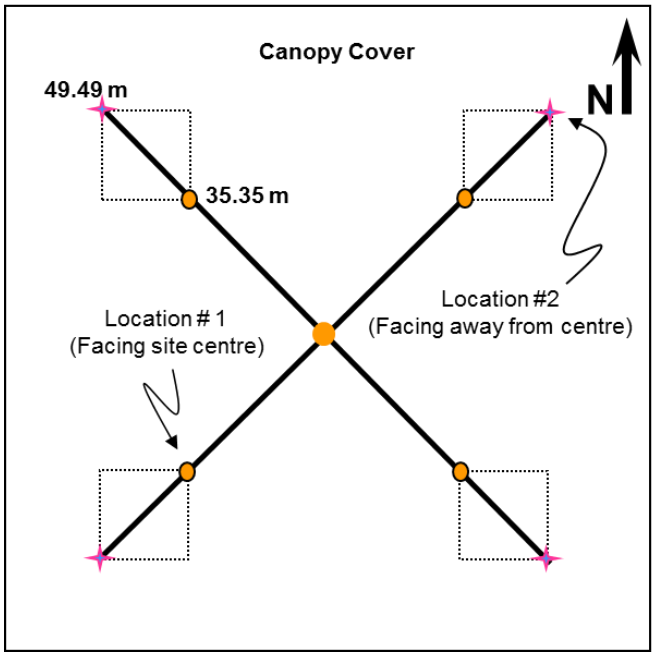

Figure 22. Canopy cover protocol layout

- Take readings at 35.35 m and 49.49 m (***Figure 22***) from site center along each ordinal transect (a total of 8 readings per site).
- 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.
- Stand facing site center at 35.35 m and stand with your back to site center at 49.49 m.
- Using your dominant eye, imagine four dots equally spaced in each of the 24 squares on the densiometer (4 equal quarters) (***Figure 23***). Count the dots (quarters) that are in canopy openings (e.g., NOT covered) and record the number of open dots (quarters) in the tablet or on the data sheet.
- Only consider squares covered by shrubs or trees. Do not consider coverage of forbs or human-made structures when measuring canopy cover.

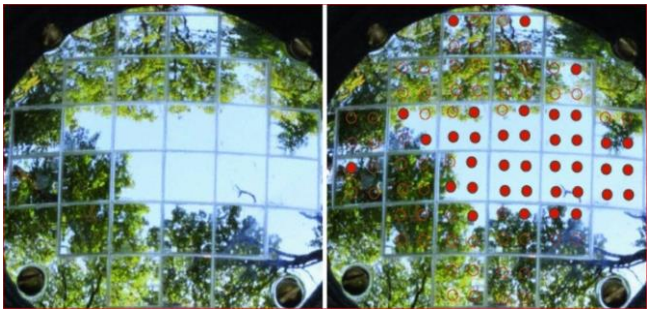

Figure 23. Densiometer open dot representation

VASCULAR PLANTS

This protocol is designed to detect as many species of vascular plants as possible during a time constrained search within the 1 ha area. All quadrants must be sampled on the same day.

Field Equipment:

Plant press

Plant Tags

Plant Storage Binder

Watch

Ruler

Camera

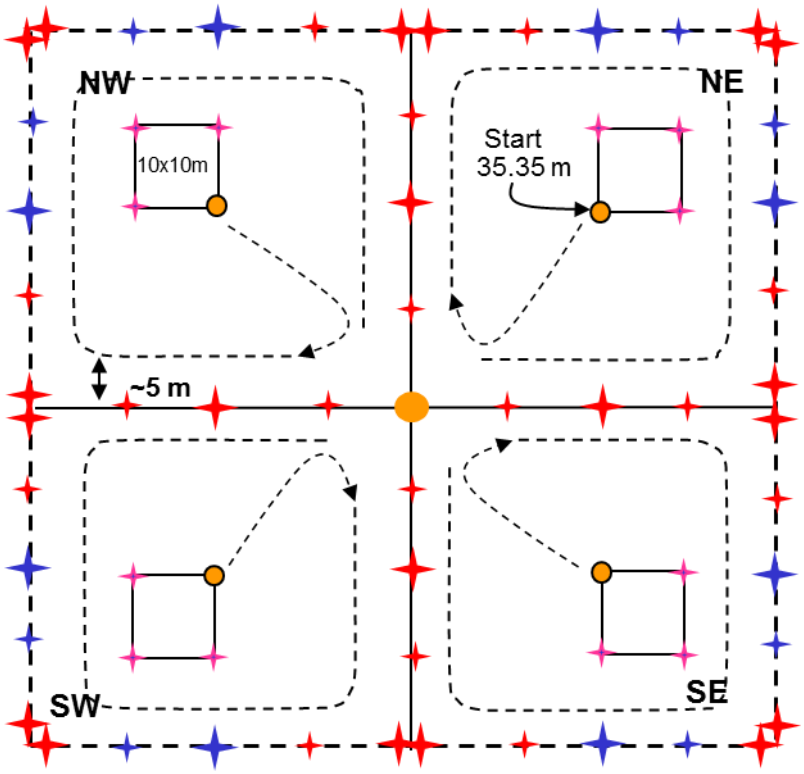

Figure 24. Vascular plant survey layout

Vascular Plant Searches

- Surveys for vascular plants are conducted by field staff that spend a minimum of two days in the field brushing up on vascular plant identification with vascular plant expert instructors prior to conducting ABMI surveys.
- To standardize sampling effort a single person completes all of the vascular plant surveys at a site, in the time specified, in one day.
- The crew member surveying vascular plants spends an initial 10 minutes populating a list in the tablet with the names/codes of vascular plants seen at the site. This initial listing of plant names is conducted so that the subsequent timed searches of the 50 x 50 m quadrants are spent mainly looking for species, with less time spent recording plant names/codes. During the initial 10 minutes when species names are being recorded, locate the most diverse habitat types within the 1 ha site and spend time in these habitats

recording species names. Species can be arranged alphabetically in the tablet by plant code, scientific name or common name. Species can be searched by common name, scientific name, or code. Note that a separate index is available for searching species synonyms.

- If the technician is unable to quickly identify the species after the initial 10-minute search, they will follow the Unidentified Species protocol (see below) and collect a specimen from a population of greater than 5 individuals, from outside the plot if possible. These samples are assigned a unique specimen number and carried with the technician to avoid multiple collections in each quadrant if possible.
- The technician then spends 20 minutes in each of the four quadrants (a total of 80 minutes) finding as many species of vascular plants as possible while walking a predetermined path.
- To maintain consistency among observers, start at the 35.35 m stake, and then begin heading toward site center, to within 5-10 m. Then head in a clockwise direction around the quadrant staying approximately 5-10 m from the quadrant edge. Stop every 4 or 5 steps to examine the plants in the immediate area (***Figure 24***). Ensure that all habitat types in the quadrant are searched for vascular plants.
- When a vascular plant species is detected in a quadrant, place a tick mark in the tablet for that species in that quadrant.
- Always start the surveys in the NE quadrant and progress clockwise to the next quadrant (NE, SE, SW and NW).
- Field guides should not be used during the 20-minute search time. Collect voucher specimens of unknown or uncertain vascular plant species (see *Unidentified Species* below) and record any relvant identification features in the tablet in the comments section for each. After the 20-minute search in a quadrant is complete, attempt to quickly identify the species you have collected using field guides. After a maximum of 10 minutes spent identifying, replace all unidentified and voucher specimens in the plant binder. The plant binder is used as a reference in the following quadrants to positively identify other specimens and avoid recollecting the same species.
- Keep the plant storage binder containing the unidentified and voucher specimens out of the sun between the time of collection and the return to camp.
- If the tablet determines a species Tracked and Watched on the ACIMS (Alberta Conservation Information Management System) list, collect a specimen so its identity can be confirmed by experts. Collect the specimen from a population of greater than 5 individuals, outside the plot if possible. Follow the Voucher naming naming convention (VS; see below).
- Specimens for ACIMS Tracked and Watched plants, or specimens that cannot be identified in the evening, will be placed in a press at camp to be identified by an expert at a later date. Ensure that the information (ABMI site number, reference code, date, collector's name, and additional data) in the tablet matches the information included with the specimen on the plant label (see *Pressing* below).
- The tablet will create a plant press log using UIS/VS numbers. In the tablet, these display as 1, 2, 3 etc. The label on the specimen tag and in the plant press log will be written as UIS/VS-SiteNumber-SpecimenNumber (e.g., the fifth unidentified specimen from site 383 would be: UIS-383-5). Ensure that specimen numbers are not repeated for the site. Be diligent if collecting specimens from a low vegetation survey (used at Grassland/Parkland/agricultural sites), that specimen numbers are not repeated within the quadrants.

- Any plants that are identified at camp are removed from the plant press unless a voucher is required. The UIS number is deleted in the tablet, replaced with the correct species code, and all quadrants where it was recorded are added under the species code. Do not forget this step.

- At times it will be necessary to enter a new species code into the tablet. Each time a new species code is added you will be required to submit a voucher. Label and press specimens appropriately. Submit at end of shift with unknown plant samples.
- Voucher specimens as determined by the tablet or due to species code entry need only be submitted the 1st occurrence of the plant. At subsequent sites you will link your observation to the initially collected specimen.
- At the end of the field shift, labelled plant presses with USBs containing records of all pressed specimens are delivered to the Royal Alberta Museum (see *Pressing* below). These unknown specimens and vouchers will be identified/verified by experts.

Unidentified Species

IF A SPECIES CANNOT BE IDENTIFIED IMMEDIATELY:

- If the unidentified specimens have a population of greater than 5 individuals within the site pause your time and collect a good quality specimen. Should the unidentified species be uncommon within the site, use flagging tape to mark the unidentified specimen during the 20 minute survey so you can return later. If flagging the specimen is insufficient (e.g., in a densely forested area), mark the location with your GPS so that you can return to it after your survey.
- After the 20 minute search period, the technician may choose to look up or confirm identifications with their field resources; however, these confirmations should be kept short (a maximum of 10 minutes per quadrant).
- If the unknown species cannot be quickly and correctly identified with a field guide after the search time, take the best possible sample of that species from at least 5 m outside the site if possible.
- Collection protocols:
    - Specimens should include as many different parts of the plant – roots, stems, leaves, flowerheads, fruits, etc. – as possible.
    - If necessary, use a knife to cut out a small clump of soil containing the specimen's roots. Remove excess soil from the rootball to the extent possible. Place sample in a labelled plastic sleeve and transport to camp.
    - For willows:
        - Collect flowering specimens where possible (pistillate catkins)
        - Collect specimens that are most representative of the plants/populations that are growing in the quadrant. A specimen that is as "average" as possible is best for identification.

- Whenever possible, collect a branch containing multiple branchlets. This should be easily doable in most cases, except when sampling seedlings and suckers.
- Note the approximate height of the plant/shrub on the UIS/VS tag. This can be a distinguishing characteristic for many species. Precision should be to the 0.5 meter for plants <2 m tall, and to the closest meter for plants >2 m.

- For grasses:
  - Roots/rhizomes are **necessary** for the identification of vegetative grass specimens. Please ensure these are collected.

PHOTO VOUCHERING:

When working in a residential setting, you might not be able to collect physical specimens for submission to the RAM, while at other sites, physical impediments (e.g., a cliff) might prevent you from safely collecting a specimen. Should this occur, and with permission from your field coordinator, use the following photo vouchering protocols.

Photographs must show the plant along with a ruler for scale. At least one photograph should be taken for each of the following:

1. Distinguishing key features used to identify the plant. Where possible, including a macro shot.
2. A close-up photo showing the entire plant.
3. A zoomed-out photo showing the plant in its immediate surroundings (aim to capture an area of about 0.25-1m^2).
4. A large-scale photo showing the ecosite where the plant is found.

Photos should always be checked prior to leaving site to ensure the plant is clearly visible and in focus. It is recommended to include the photo numbers in comment section for each plant in the tablet. Also include any pertinent information that would usually be recorded for an unknown specimen tag.

Labelling photographs:

- File names for photographs follow the same format as UIS or VS specimen tag labels, but using the prefix "PS" (photo specimen)
- Label photos as follows:
  - Photos showing distinguishing key features: PS_[site#]_[specimen#]_FEATURES
  - Photos showing close-up of entire plant: PS_[site#]_[specimen#]_FULL
  - Photos showing plant with 1 x 1 m area: PS_[site#]_[specimen#]_HABITAT
  - Photos showing large area of ecosite plant is found: PS_[site#]_[specimen#]_LRG
- If there is more than one photo per category, simply add a (2), (3), etc. to the end of the label. E.g. PS_W123_1_FEATURES(4) or PS_T123_CALACAN_FULL(2)

- Create folder called “Photo Specimens” and include all photographed specimens. In this folder, along with the photos, create an associated .txt file using WordPad on the tablet. This text file must list all the species found in the folder in the following format: PS_[site#]_[7-letter species code OR UIS Specimen #]
- The “Photo Specimens” folder must be included on the USB with your shipping document that is attached to the plant press.

PRESSING

- If there is **any** uncertainty regarding the identification of a species, a specimen must be pressed and sent to the Processing Centre. Tentative identifications can be made, but the specimen must still be sent in for verification.

- Technicians may identify an unknown species back at camp if they have the tools, training, and skills to do so. Excessive time and effort should not be spent keying species. It is recommended that multiple examples of UIS (and VS) specimens be collected (population numbers permitting) during the plant survey. This ensures that a good sample will be available for pressing if the UIS cannot be identified back at camp.

- Specimens should be placed in a plant press and labeled as soon as possible to prevent wilting. An unidentified species tag (***Figure 25***) includes: ABMI site number and a unique reference code (UIS-[site #]- #) from the tablet or field data sheet (e.g., the fifth unidentified specimen from wetland 383 would be: UIS-W383-05).

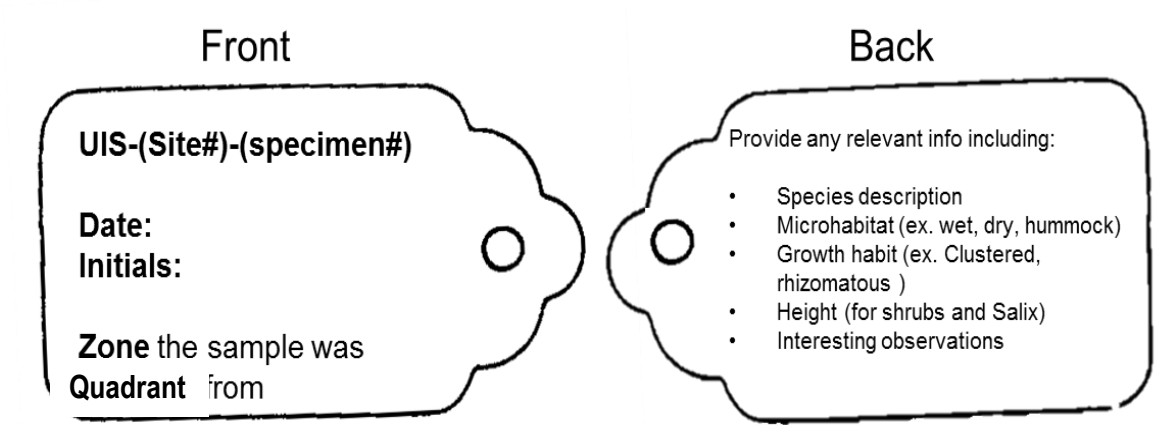

Figure 25. UIS Tag with required fields

- Vouchers should be pressed with the UIS’s and labeled with the reference code (VS-[site#]-SPECIES CODE) from the tablet. Ensure that the information (Site, reference code, date, and collector’s name) on the data sheet matches the information included with the specimen in the plant press.

- **UIS/VS Tag Should Include:**
    - **Quadrant:** (NE, SE, SW, NW) the specimen was taken from
    - **Habitat:** If the specimen was taken from a habitat that was atypical for the site (e.g., a sandy ridge in a peatland site, a wet depression in an otherwise dry site, a copse of trees in a grassland site, or a clearing in a forest), including this information on the specimen is required. A descriptor ("shady spot", "sandy", "wet") to indicate the conditions the specimen was found in is valuable.
    - Remember to note the **extra information** for willows (e.g., height, ecosite, microhabitat, growth form).
- Attach tags in a manner that is secure, while ensuring that the tags or strings will not 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.

Pressing Instructions:

- 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 26***).
- 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 specimens.
- Do not press stocky specimens, like shrub cuttings or bulky bunchgrasses, with delicate specimens. The delicate ones will not flatten properly.

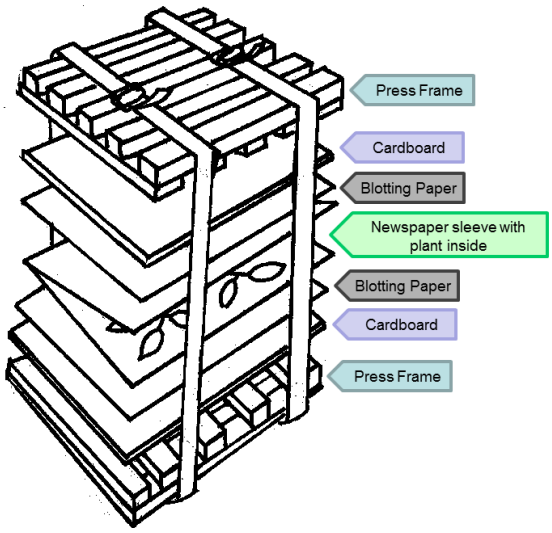

Figure 26. Plant press layout

- Bulky rootballs 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 mouldy in the press. Wet specimens should be given extra blotting papers and cardboard or be pressed between sheets of wax papaer, and should be checked periodically for mould. Replace blotters/cardboard with fresh ones if they are found to be damp.

- At the end of each field shift, a submitted plant press labeled with flagging tape will include: Crew ID, shift, date, technician CODE, and sites completed. A USB with the shipping document will also be attached to the plant press with flagging tape.

Relative Density of Common Vascular Plants

Vascular plant searches do not provide estimates of abundance for detected species. Thus, coarse estimates of relative density are determined for common species at the center of each quadrant.

- After each 20-minute search in the quadrant, stand at the 35.35 m stake and survey the 10 x 10 m plot
- Determine which vascular plant species are common or dominant within the 10 x 10 m plot.
- Common species are defined as those that are present in five or more of the plot sub-sections if the plot was divided up into 9 imaginary sub-sections. Place a “C” beside species that are common.
- Note: Some quadrants may contain many common species (vegetatively diverse quadrants) whereas other quadrants may not contain any (e.g., quadrants with few species sparsely dispersed).
- Of the species labeled as common, determine which has the highest percent cover; label this as the dominant species by selecting “D” for that quadrant in the tablet.
- **Important Note**: Trees cannot be defined as Dominant, but can be recorded as common.

PROTOCOL DIFFERENCES BETWEEN MOUNTAIN AND FOREST SITES WITHOUT AGRICULTURAL MODIFICATION AND GRASSLAND/PARKLAND/AGRICULTURALLY MODIFIED SITES

Trees and snags and downed woody material are lacking or quick to survey in Grassland, Parkland, and previously forested sites that have been modified for agriculture. Grasses, herbs, and shrubs dominate these habitats. An additional plot is used for the Detailed Low Vegetation Measurements protocol (***Table 6***).

Table 6. Grassland/Parkland/Agriculturally Modified Specific Protocols (timing differences are in bold and italics)

Mountain and Forest Sites without Agricultural Clearings (Standard Protocol for Treed sites outside Grassland/Parkland ecoregions)	**Grassland/Parkland/Cleared upland forests for Agriculture (Standard protocol for Grassland and Parkland sites)**
Spring Protocols	**Spring Protocols**
Site Description	Site Description
Trees and Stumps	Trees and Stumps
Downed Woody Material	Downed Woody Material
Soil Arthropods	Soil Arthropods
Mineral Soil	Mineral Soil
Bryophytes	Bryophytes
Lichens	Lichens
Summer Protocols	**Summer Protocols**
Vascular Plants	Vascular Plants
Tree cores	Tree Cores
Canopy Cover	Canopy Cover
	Detailed Low Vegetation Measurements
Camera/ARU Retrieval	Camera/ARU Retrieval

PROTOCOL ADDITIONS FOR SITES IN THE GRASSLAND AND PARKLAND REGIONS

DETAILED LOW VEGETATION MEASUREMENTS IN THE PRIMARY SITE TYPE

This protocol is designed to monitor relative abundance of common vascular plants. The protocol is conducted in the Grassland and Parkland regions of the province and is completed after the Vascular Plant (Snail) protocol described above.

Field Equipment:

Plot frame (0.5 m x 0.5 m)

Plant press

Vascular plant field guide

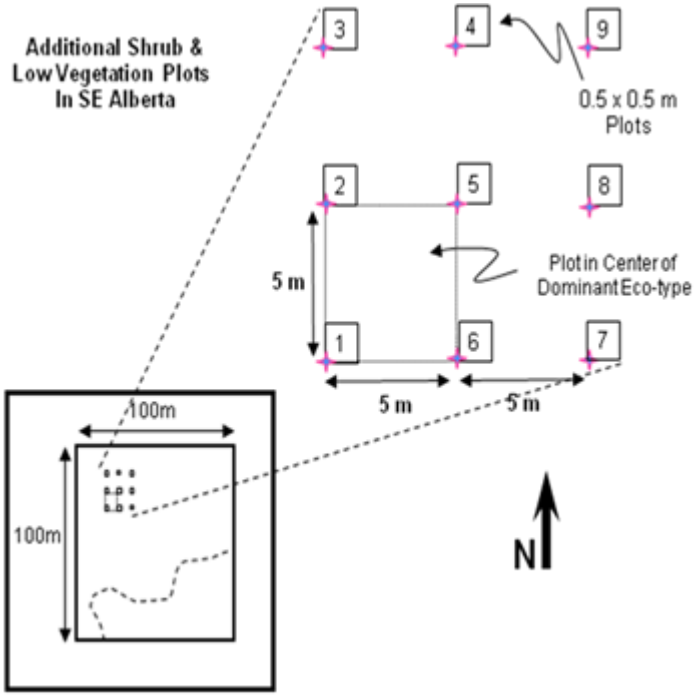

Figure 27. Low vegetation plot layout in grassland and parkland regions

- The primary (most common) ecosite type in the 1 ha site is identified.
- Nine vascular plant cover plots (0.5 x 0.5 m) are established so they are totally contained within the center of the primary ecosite type (***Figure 27***).
- The nine low vegetation plots should not overlap with any of the existing small or medium tree plots
- Using a Trimble GPS record the exact coordinates of the SW corner of all 9 low vegetation cover plots so that the same plots can be re-measured during the next visit. Name each Trimble point using the following convention: [Site]-5th-[Plot#]. For example, the point for plot 1 at site 1245 would be 1245-5th-1, while the point for plot 2 at the same site would be 1245-5th-2. Continue naming in this way until all 9 plots have been recorded.

Plot Description

- Take a landscape oriented photo of the vegetation plot
  - Stand 1 m SW of the SW corner of plot 1 and take the photo towards the NE corner.
  - Include laminated site information sheet 5 m from the camera for scale.
  - Record the photo number in the tablet and re-label later.
  - Copy the photo onto a laptop computer or tablet when back at camp and ensure it is complete and readable. In addition, back-up the photo onto a computer or other digital storage device.

- At the end of each field shift or when visited by a field coordinator, transfer photos to the field coordinator.
- Check the resolution and quality of all photos at the site; re-take if necessary.
- Label the photo ABMI_[year]_[site]_[5thPlot].jpg (e.g., ABMI_2021_1609_ 5thPlot.jpg).

% Foliar Cover for Low Vegetation Species

- Estimate foliar cover (0, <1, and 5% increments) for each vascular plant species found inside each of the nine 0.5 m x 0.5 m plots.
- Only vegetation less than 50 cm high is included in these estimates.
- Vascular plants do not need to be rooted within the plot to be included in the estimation.
- Foliar cover is determined by ocular estimation and requires practice before the start of the data collection to ensure the estimates are precise.
- Due to overlapping of leaves at different heights, cover percentages for each species, and all species combined can be greater than 100%.
- Collect voucher specimens of unknown or uncertain species from outside the plot if possible. Take the voucher specimens to camp for identification during the evening.
- When collecting unidentified/voucher specimens, record the ABMI site number and a unique reference code (UIS-Site Number-Specimen Number) and collector's name on the tag attached to the plant (e.g., the fifth unidentified specimen from site 383 would be: UIS-383-5). Ensure that specimen numbers do not repeat those collected during the vascular plant search and all data represents what samples you have on hand.
- For specimens that cannot be identified in the evening, remove them from the field binder and place them in a plant press for temporary storage. Ensure that the information (ABMI site number, reference code, date, collector's name) on the tablet matches the information included with the specimen's tag in the plant press.
- Any plants that are identified at camp can be removed from the plant press if the tablet does not identify them as requiring collection/voucher. If you are in Low Veg protocol, the UIS line in the tablet must be deleted and the new species code inserted in the identified species tab. Note: do not forget to manually enter the newly identified species into the Vascular Plant search and delete the unknown from the UIS tab.
- At the end of the shift, hand in the plant press to your supervisor. These unknown specimens will be identified by experts.

PROTOCOL ADDITIONS FOR AGRICULTURE DOMINATED SITES IN THE ROCKY MOUNTAIN, FOOTHILLS, BOREAL AND SHIELD REGIONS

Some ABMI sites outside the Grassland/Parkland regions have had the forest cover removed to facilitate agriculture activities. At these sites, little or no data will be collected for trees, DWM, bryophytes, and lichens. Specific communities may be simpler than those found in non-disturbed sites and due to extensive human use in the area these sites should be relatively easy to access.

To facilitate agriculture use of ABMI information, extra information for shrubs, grasses/sedges and herbs will be collected at sites that have had > 60% of the vegetation in the central 1 ha area modified by mechanical agricultural activities. In these sites, 2 low vegetation plots are established in the center of the most common ecosite type. Low vegetation is described in these plots. These surveys are conducted during the ABMI summer visit.

DETAILED LOW VEGETATION MEASUREMENTS IN THE PRIMARY SITE TYPE

This protocol is designed to monitor relative abundance of common vascular plants. It is only conducted in the Rocky Mountains, Foothills, Boreal Forest or Shield regions where mechanical agricultural activities (e.g., cultivation, brush removal, etc.) have resulted in > 60% of the vegetation in the central 1 ha area being altered. This protocol is completed after the Vascular Plant (Snail) protocol described above.

Field Equipment:

Plot frame (0.5 m x 0.5 m)

Plant press

Vascular plant field guide

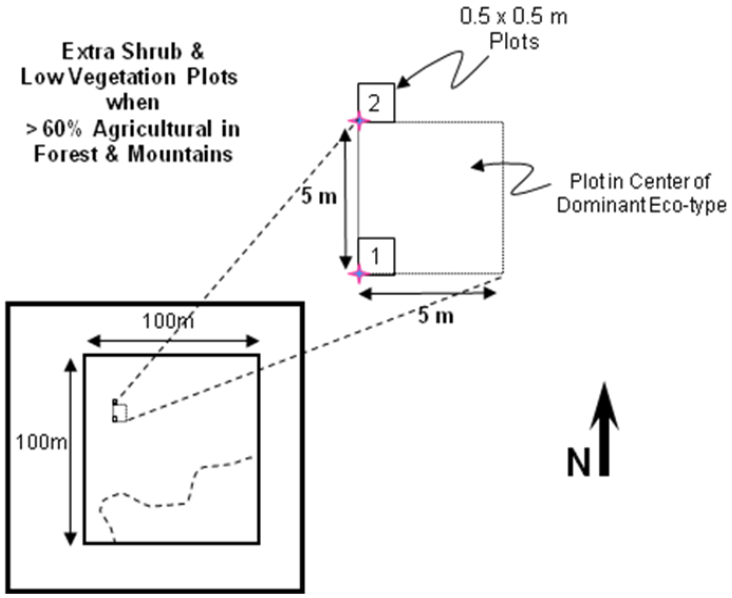

Figure 28. Low vegetation plot layout for agriculture-dominated sites in the Rocky Mountain, Foothills, Boreal and Shield regions

- The primary (most common) ecosite type in the 1 ha site is identified.
- The two vascular plant cover plots (0.5 x 0.5 m) are established so they are totally contained within the primary ecosite type (***Figure 28***).
- The two low vegetation plots should not overlap with any of the existing small or medium tree plots.
- Using a Trimble GPS record the exact coordinates of the SW corner of the 2 low vegetation cover plots so that the same plots can be re-measured during the next visit. Name each Trimble point using the following convention: [Site]-5th-[Plot#]. For example, the point for plot 1 at site 738 would be 738-5th-1, while the point for plot 2 at the same site would be 738-5th-2.

Plot Description

- Take a landscape oriented photo of the vegetation plot
    - Stand 1 m SW of the SW corner of plot 1 and take the photo towards the NE corner
    - Include laminated site information sheet 5 m from the camera for scale.
    - Record the photo number in the tablet and relabel later.
    - Check the resolution and quality of all photos at the site; re-take if necessary.
    - Copy the photo onto a laptop computer or tablet when back at camp and ensure it is complete and readable. In addition, back-up the photo onto a storage device.
    - Label as ABMI_[year]_[site]_5thPlot.jpg (e.g., ABMI_2021_1609_ 5thPlot.jpg).

% Foliar Cover for Low Vegetation Species

- Estimate percent cover (0, <1, and 5% increments) for each vascular plant species in each of the two 0.5 m x 0.5 m plots.
- Only vegetation less than 50 cm high is included in these estimates.
- Vascular plants do not need to be rooted within the plot to be included in the estimation.
- Foliar cover is determined by ocular estimation and requires practice before the start of the data collection to ensure the estimates are precise.
- Due to overlapping of leaves at different heights, cover percentages for each species, and all species combined can be greater than 100%.
- Collect voucher specimens of unknown or uncertain species from outside the plot if possible. Take the voucher specimens to camp for identification during the evening.
- When collecting unidentified/voucher specimens, record the ABMI site number and a unique reference code (UIS-Site Number-Specimen Number) and collector's name on the tag attached to the plant (e.g., the fifth unidentified specimen from site 383 would be: UIS-383-05). Ensure that specimen numbers do not repeat those collected during the vascular plant search and all data represents what samples you have on hand.
- For specimens that cannot be identified in the evening, remove them from the field binder and place them in a plant press for temporary storage. Ensure that the information (ABMI site number, reference code, date, collector's name) on the tablet matches the information included with the specimen's tag in the plant press.
- Plants that are identified at camp can be discarded ONLY if the tablet does not identify them as requiring collection/voucher. If you are in Low Veg protocol, the UIS line in the tablet must be deleted and the new species code inserted in the identified species tab. Note: do not forget to manually enter the newly identified species into the Vascular Plant search and delete the unknown from the UIS tab.
- At the end of the shift, hand in the plant press to your supervisor. These unknown specimens will be identified by experts.

PART 2. APPENDICES

APPENDIX 1: EQUIPMENT LIST

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

- Personal Equipment provided to each crew member
- Crew Kits provided to each 2 person crew
- Optional Field Gear
- Equipment needed by each of the crews specific to spring terrestrial protocols
- Equipment needed by each of the crews specific to summer terrestrial protocols

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

Personal Equipment (*Cloth Bag*)
GPS
Compass
Clipboard
First Aid Kit
Mora knife
Bear spray
Safety whistle
Leather work gloves
Safety glasses
Insect repellent/sunscreen
Tablet/charger/spare batteries

Crew Kits (*Blue Bin*)
2 VHF radios
6 VHF batteries
2 VHF radio chargers
Aqua pac for radio
2 VHF radio harness
Satellite phone and batteries
GPS cable
Mammals of AB, Sibley's Birds, Moss/Lichen/Ferns, Plant ID terminology, Flora of AB, Plants of Rocky Mountains, Plants of Western Boreal, Wetland Plants, Northern Plants, Common Plants
Vol1/2/3, Weeds of the Prairies
#2 First Aid Kit
Map books
Duffle bag
Admin kit

Folding saw
Hand lens
Plant tweezers
Battery Charger
AA+AAA batteries for camera and GPS
Camera Kit
USB Stick

Optional Field Gear
Binoculars
Nomex Coveralls (provided for if required for JOSM/Industry crews)
Cruiser vest
Hardhat (provided if required by law)
Daypack
Rubber boots
Field boots
ATV Helmet (provided if using a Quad)
Jacket (nylon shell)
Chest waders (Hip waders optional, but often not sufficient)
Rain jacket
Rain pants
Found in Truck, Emergency kit containing:
- Alberta #2 First aid kit
- Safety triangles
- Fire Extinguisher

Equipment Specific to Spring Terrestrial Crews (BackPack)
2 100 m tapes
Large and small paper collection bags
Santa sacs
Vertex hypsometer
Pelican case (1050)
Soil corer
Soil collection bags
500 ml measuring cup
DBH calipers (L)
DBH tape
Carpenters tape
Plastic sheets
Go-No-Go gauge
Coleman cooler(s)
Cloth bags
Metal detector
Tree paint
Markers, pens, and pencils
Maps, air photos, satellite images
Flagging tape

Pigtails
Rebar/conduit/magnetic spikes
Mallet

Equipment Specific to Summer Terrestrial Crews
Plant press
Plant tags
100 m tape
Vertex hypsometer
Pelican case (1050)
DBH calipers (L)
DBH tape
Increment borer w/ straws & tape
Tree core tube
Folding saw
Spherical (concave) densiometer
50 cm folding ruler
Common Range Plants Guide (South Specific)
Trimble (given to specific crews only)
0.5 x 0.5 m plot frame (South Specific)
Camera/ARU retrieval gear (drill, screwdriver)

Spring	Data Type	Format	Examples	Follow these Table of Contents Headings for more Information
GPS Coordinates	Garmin - Terrestrial Site Access	T[Site#]-Suffix[Sequential #]* *Suffixes: T=Truck, Q=Quad, A=Argo, W=Walking, C=Camp, H=Helicopter pad* **No sequential # needed for camp or helicopter pad locations*	- T432-T1 - T392-A2 - T1178-W1 - T410-C - T208-H	**Field Manual:** - GPS Garmin 78 - Labelling GPS Waypoints
	Garmin - Wetland Site Access	W[Site#]-Suffix[Sequential #]* *Suffixes: T=Truck, Q=Quad, A=Argo, W=Walking, C=Camp, H=Helicopter pad* **No sequential # needed for camp or helicopter pad locations*	- W432-T1 - W1352-Q3 - W1178-W1 - W410-C - W208-H	**Field Manual:** - GPS Garmin 78 - Labelling GPS Waypoints
	Garmin - Terrestrial Site Waypoints *(5 points/site)*	Site Centre: [Site]-SC *(1 point/site)* 35.35 Conduit: [Site]-[Quadrant]-35 *(4 points/site)*	- 958-SC - 958-NW-35 - 958-SE-35	**Field Manual:** - GPS Garmin 78 - Labelling GPS Waypoints
	Trimble - Terrestrial Site Waypoints *(9 points/site)*	Site Centre: [Site]-SC *(1 point/ site)* 35.35 Location: [Site]-[Quadrant]-35 *(4 points/site)* 70.70 Location: [Site]-[Quadrant]-70 *(4 points/site)*	- 955-SC - 1456-SC - 955-NW-35 - 1456-SE-35 - 955-NW-70 - 1456-SE-70	These points will be provided and pre-named as shown
Spring Photos	Terrestrial Spring *(6 photos/site)*	ABMI_[Year]_[Site]_[NE/SE/SW/NW/CANOPY/SITE]	- ABMI_2021_546_NW - ABMI_2021_678_CANOPY - ABMI_2021_1329_SITE	**Terrestrial Protocols:** - Spring Terrestrial Protocols - Site Photographs
	Wetland Recon *(4 photos/site)*	ReWetland_[Year]_W[Site#]_[Direction] Directions: OPW, UPL, SCL, SCC	ReWetland_2021_W123_UPL	**Wetland Protocols** - Physical Characteristics of Wetlands - Site Photos
Spring Samples	Moss and Lichen Specimens	Include on label for each bag (Note: quadrants and strata are pre-labelled on each bag): - Site # - Date - Collector initials - Collection status for strata (circled) Collection Status: - C = substrate present and specimens collected - NONE = substrate present, but no specimens found - VNA = No substrate present and therefore no specimens found	Site 488 May 30, 2021 ASC NONE (i.e. the strata was present, but no specimens were found) Site 489 June 6, 2021 SLU VNA (i.e. the strata didn't exist in the plot, therefore no specimens were found)	**Terrestrial Protocols:** - Spring Terrestrial Protocols - Methods for Surveying Bryophytes & Lichens
	Soil - LFH and Mineral Samples	Include on each label: - Sample Type (LFH or Mineral) - Site # - Quadrant - Date - Collector's initials	LFH 579 - NE June 10, 2021 NKO Mineral 579 - NE June 10, 2021 NKO	**Terrestrial Protocols:** - Spring Terrestrial Protocols - Soil Cores: Soil Arthropods & Mineral Soil - Soil Collection and Codes
	Soil - Shipping Slip	Include one tag for each site in cooler. Include on each tag: - Site # - Date collected - Observer (Collector's initials) - NE: Mineral sample Y or N, LFH sample Y or N - SE: Mineral sample Y or N, LFH sample Y or N - SW: Mineral sample Y or N, LFH sample Y or N - NW: Mineral sample Y or N, LFH sample Y or N	Site #: 364 Date: June 3, 2021 Observer: JHO NE - M Y LFH Y SE - M N LFH Y SW - M Y LFH Y NW - M Y LFH Y	**Terrestrial Protocols:** - Spring Terrestrial Protocols - Soil Cores: Soil Arthropods & Mineral Soil - Preserving and Packing Soil Samples

Summer	Data Type	Format	Examples		Follow these Table of Contents Headings for more Information
Terrestrial GPS Coordinates - Summer	Trimble - Low Vegetation Plots *(9 points/grassland or parkland site, 2 points/rocky mountain, foothills, or boreal site as needed)*	[Site]-5th-[Plot#]	- 1328-5th-1 - 1328-5th-2 - 1328-5th-3		**Terrestrial Protocols:** - Protocol Additions for Grassland/Parkland OR Agriculture Dominated Sites… - Field Equipment
	Trimble - Terrestrial Site Waypoints *(9 points/site)*	Site Centre: [Site]-SC *(1 point/ site)* 35.35 Location: [Site]-[Quadrant]-35 *(4 points/site)* 70.70 Location: [Site]-[Quadrant]-70 *(4 points/site)*	- 955-SC - 1456-SC - 955-NW-35 - 1456-SE-35 - 955-NW-70 - 1456-SE-70		These points will be provided and pre-named as shown
Terrestrial Photos - Summer	5th Plot *(1 photo/site if Low Vegetation Surveys are completed)*	ABMI_[Year]_[Site]_5thPlot	- ABMI_2021_1328_5thPlot		**Terrestrial Protocols:** - Protocol Additions for Grassland/Parkland OR Agriculture Dominated Sites… - Plot Description
Terrestrial Samples - Summer	Plant Tags - Unidentified Species	Include on tag: - UIS-T[Site]-[Specimen#] - Date - Initials - Quadrant sample came from - Useful habitat information (can write on back of tag) - For Willows: Include shrub height and microhabitat information	UIS-T1225-5 July 15, 2021 DEV NE Willow - approx. 1.3m tall, in moist roadside ditch, shaded by treed windbreak		**Terrestrial Protocols:** - Summer Terrestrial Protocols - Vascular Plants - Unidentified Species - Pressing
	Plant Tags - Voucher Specimens	Include on tag: - VS-T[Site]-SPECIES CODE - Date - Initials - Quadrant sample came from - Useful habitat information (can write on back of tag) - For Willows: Include shrub height, growth form, and microhabitat information	VS-T234-TANAVUL July 15, 2021 DEV SE Growing on disturbed cutline		**Terrestrial Protocols:** - Summer Terrestrial Protocols - Vascular Plants - Unidentified Species - Pressing
	Photo Vouchering - Photo Specimens* **Use only if unable to collect a speciemen*	PS_T[Site]_[SpecimenID]_[FEATURES/FULL/HABITAT/LRG](#)* **If more than 1 photo is taken for any photo-class (e.g., Features, Full, etc.), differentiate file names with sequential numbers (see examples).*	- PS_T123_CALACAN_FEATURES1 - PS_T123_CALACAN_FEATURES2 - PS_T123_CALACAN_HABITAT - PS_T243_3_FULL - PS_T243_3_LRG		**Terrestrial Summer Protocols:** - Summer Terrestrial Protocols - Vascular Plants - Unidentified Species - Photo Vouchering - Labelling Photographs
	Photo Vouchering - Text File	Each photo vouchered specimen listed in this format: PS_T[Site]_[SpecimenID]	- PS_T123_CALACAN - PS_T243_3		**Terrestrial Summer Protocols:** - Summer Terrestrial Protocols - Vascular Plants - Unidentified Species - Photo Vouchering - Labelling Photographs
	Tree Cores *(Up to 5 samples/site)*	Include on label: - Site # - N, S, or Site (Site for "Largest" only) - Tree species code - Sample type (Largest, Leading, or Second) - Initials - Date	765 - Site Pj - Largest AWI2 July 19, 2021	765 - N Sw - Leading AWI2 July 19, 2021	**Terrestrial Summer Protocols:** - Summer Terrestrial Protocols - Tree Cores

APPENDIX 3: EXAMPLE OF AN ACCESS DATA SHEET

Alberta Biodiversity Monitoring Institute ABMI Site# 829 Year 2015

P1-1. Site Access Description Boreal Sites

Date: May 30, 2015 **Crew Member(s):** DGR, NVE

GPS Information:

Accuracy[2]	3m
Declination[3]	14E
Established[4]	Y

Location of Site Center:

Latitude[1]	56.78109
Longitude[1]	-111.00345

Camp Location: Cold Lake

Time from Camp To Site: 1h, 45min

Location NW 35.35 m:

Latitude[1]	56.781314
Longitude[1]	-111.003041

Location NE 35.35 m:

Latitude[1]	56.780866
Longitude[1]	-111.003041

Location SW 35.35 m:

Latitude[1]	56.781314
Longitude[1]	-111.003859

Location SE 35.35 m:

Latitude[1]	56.780866
Longitude[1]	-111.003859

Access Summary[5]: From Cold Lake campground take HWY 55 West to Hwy 892. Follow 892 North approx. 36 Km then turn right onto gravel industry road. Follow for 6.2 Km and park in entrance to cutline. Quad in 2.3 km. Bushwack 600 m to site center. Waders recommended.

Truck Access to Site[6]

Total distance driven: 84.9 Km **Total time driven**: 50 mins

Road conditions and notes: Hwy 55 and 892 paved. Industry road gravel and narrow, would be quite slippery in wet conditions. Watch out for washed out road (in features to note)

	GPS Label with Latitude and Longitude	Condition	Distance and direction to quad parking or site
Parking location	T829-Q1 56.53209, -111.00129	Dry pull-out	2.3 km, NW

Quad Access to Site

Total distance driven: 2.3 Km **Total time driven:** 30 mins

Trail conditions and notes Cutline, wet stay to left

	GPS Label with Latitude and Longitude	Condition	Distance and direction to site
Parking location	T829-W1 56.98952, -111.23943	Side of cutline, dry	600 m, SE

Walking Access to Site Centre

Total distance walked: 600 m **Total time walked:** 25 mins

Trail conditions and notes: Alder and willow on way to site. Use waypoint at beaver dam to cross wet section.

Features to note:

Feature	GPS Label with Latitude and Longitude	Feature	GPS Label with Latitude and Longitude
Beaver Dam	T829-Beaver, 56.98433, -111.23913		
Washout	T829-Washout, 56.97658, -111.24568		

1 – record decimal degrees (5 decimals) 2 – record GPS accuracy (in meters) 3 – record declination used to establish site 4 – check off when site is established or indicate in summary why site not established. 5 – Describe in brief how to get to the site and any access challenges (boat required, river crossing, winch etc.) 6- Draw your entire route on the map and make note of any special/unusual directions with waypoints.

Alberta Biodiversity Monitoring Institute

P1-1. Helicopter Site Access ABMI SITE# **134** Year **2014**

Temporary GPS Label: _T134-H____ **Date of Recon:** _June 1, 2014
Permanent GPS Label: _T134-H____ **Initials:** _DGR, GGI_____

Landing Pad

		Distance and Direction to Site Center	Landing Pad Brief Description
Latitude[1]:	58.67459	850 m, 245 Degrees	Open area on edge of fen
Longitude[1]:	-114.32651		

1 – record decimal degrees (5 decimals)

Heli Pad Description

Natural _x__ Improved ___ Cut ___ Site Established _X__

Description (describe type of habitat, kind of helipad; dry, wet, need waders, special gear required for landing or negotiating helipad, etc.)
__Landing area is an open area on the edge of a fen. Wet, requires rubber boots or waders

Camping (describe distance and direction or landmarks to acceptable camping, gear required; spring camping same as summer, etc.)
_Campsite is 200 metres west of the landing area. Dry spruce upland, should be fine for both spring and summer.

Site Access (describe site habitat, route to site, barriers to negotiate, distance and direction to site)
Site access through bush, mainly a mix of bog and alder/willow swamp.

APPENDIX 4: 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).

Twelve broad categories of vegetation types were created – these were labeled based on the common moisture/nutrient level. The categories were then 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=Hygric, 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 strata are 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 a moisture regime of xeric to subxeric.

1a) Pine –The shrub/ground strata 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 Pl)
- SB a2 (bearberry PlAw)
- SB a3 (bearberry Aw)
- CS a1 (bearberry Pj)
- WC_LF b1 (bearberry/lichen Pl)

- SW_LF a1 (bearberry Pl)
- WC_UF b1 (bearberry lichen Pl)
- SW_UF a1 (bearberry Pl)
- SW_MN a1 (limber pine/juniper FdPf)
- SW_MN b1 (bearberry Pl)
- WC_SA b1 (bearberry/lichen Pl)
- SW_SA a1 (lichen Pl)

2. Labrador Tea/Feather Moss --- PM

The shrub/ground strata is usually dominated by Labrador tea and feather moss, although at bog cranberry is common at some sites, and 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 strata is usually dominated by Labrador tea and feather moss, although bog cranberry, blueberry, are common at some sites, and 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 PlSb)
- CS c1 (Labrador tea – mesic PjSb)
- WC_LF d1 (Labrador tea-mesic PlSb)
- SW_LF c1 (Labrador tea-mesic Pl)
- SW_LF f1 (Labrador tea-hygric Pl)
- WC_UF d1 (Labrador tea-mesic PlSb)
- WC_UF e1 (tall bilberry/arnica Pl)
- SW_UF c1 (tall bilberry/Labrador tea Pl)
- WC_SA d1 (rhododendron-mesic Pl)
- WC_SA f1 (rhododendron-subhygric Pl)
- SW_SA e1 (false azalea-grouseberry Pl)

2b) Other – The shrub/ground strata is usually dominated by Labrador tea and feather moss, although bog cranberry is common at some sites, and 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 AwSwPl)
- WC_UF e2 (tall bilberry/arnica AwSwPl)
- 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 strata 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 a moisture regime of subxeric to mesic. These soil conditions are mainly found on south facing slopes in mountains.

3a) None – The shrub/ground strata 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 strata 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 Pl)
- WC_MN c1 (hairy wild rye Fd)
- WC_MN c2 (hairy wild rye Pl)
- SW_MN c1 (Canada buffalo-berry/hairy wild rye Fd)
- SW_MN c2 (Canada buffalo-berry/hairy wild rye Pl)
- WC_SA c1 (hairy wild rye Pl)
- SW_SA b1 (bearberry/hairy wild rye Pl)

3c) AwMix – The shrub/ground strata 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 AwSwPl)
- SW_LF b2 (bearberry/hairy wild rye Aw)
- SW_LF b3 (bearberry/hairy wild rye AwSwPl)
- WC_UF c2 (hairy wild rye Aw)
- WC_UF c3 (hairy wild rye AwSwPl)
- SW_UF b2 (bearberry/hairy wild rye Aw)
- SW_UF b3 (bearberry/hairy wild rye AwSwPl)
- WC_MN b3 (bearberry Aw)
- WC_MN b4 (bearberry AwSwPl)
- WC_MN c3 (hairy wild rye Aw)
- WC_MN c4 (hairy wild rye AwSwPl)
- WC_MN b2 (bearberry Aw)
- WC_MN b3 (bearberry AwSwPl)
- SW_MN c3 (Canada buffalo-berry/hairy wild rye Aw)
- SW_MN c4 (Canada buffalo-berry/hairy wild rye AwSwPlFd)
- WC_SA c2 (hairy wild rye PlAw)

3d) Spruce – The shrub/ground strata 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 strata 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 a moisture regime of submesic to mesic.

4a) PineMix – The shrub/ground strata 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 popular, 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 strata 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 Aw(Bp))
- 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 strata 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 AwSwPl)

4d) Sw – The shrub/ground strata 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 strata 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 strata 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 popular 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 strata 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 strata is dominated by Labrador tea and feather moss with horsetail present in lesser amounts. The overstory is usually dominated by black spruce.

- 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) Pl – The shrub/ground strata 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 Pl)
- SW_LF e1 (bracted honeysuckle fern Pl)
- WC_UF f1 (bracted honeysuckle Pl)
- SW_UF e1 (green alder/fern Pl)
- SW_SA f1 (thimbleberry Pl)

6b) PbMix – The shrub/ground strata 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 AwSwPl)
- SW_LF e2 (bracted honeysuckle fern AwPb)
- SW_LF e3 (bracted honeysuckle fern AwSwPl)
- WC_UF f2 (bracted honeysuckle Pb)
- WC_UF f3 (bracted honeysuckle PbSwPl)
- 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 strata 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 are 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 be 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 in 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 strata 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 strata 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 strata 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 strata 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 l2 (shrubby poor fen)
- WC_UF l2 (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 strata 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 strata 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 *at 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
- D8 Mrytle 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 strata 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 *at 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 edge 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 *at 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

Water salinity is less than 15mS/cm. Trees and/or shrubs are present. The shrub/ground strata 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 30 metres in diameter.

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

13 Alkali

Water salinity is greater than 15mSc/m. 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 30 meteres in diameter.

14. OW (Open Water)

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%.

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