Alberta Biodiversity
Monitoring Institute

www.abmi.ca

Terrestrial Field Data Collection Protocols (Abridged Version)

Version 2014-03-21

June 2012

Acknowledgements
Between 1998 and 2003 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 (mosses), Anna-Liisa Sippola, Jogeir Stokland (fungi), Neville Winchester, Bert Finnamore, Jeff Battigelli, Heather Proctor (arthropods)], and others, reviewed the literature and helped to develop protocols for sampling terrestrial biota and habitat structures. These protocols were combined into an integrated suite protocols by Jim Schieck, Chris Shank and Dan Farr. The resulting suite of protocols was designed to be cost effective and capable of monitoring a diversity of biota, over broad spatial scales and long time periods. The present document incorporates changes suggested during peer review. Numerous technicians and managers also provided feedback during development and testing of the protocols. Minor revisions continue to be incorporated based on results from data collection throughout Alberta. Updates to this document are incorporated by Jim Schieck.

Suggested Citation: Alberta Biodiversity Monitoring Institute. 2014. Terrestrial field data collection protocols (abridged version) 2014-03-21. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca [Date Cited].

Contact Information
If you have questions or concerns about this publication, you can contact:
ABMI Information Centre
CW-405 Biological Sciences Centre
University of Alberta
Edmonton, Alberta, Canada, T6G 2E9
Phone: (780) 492-5766
E-mail: abmiinfo@ualberta.ca

Table of Contents

1. OVERVIEW OF ABMI DATA COLLECTION

Data Collected at Terrestrial Sites

The ABMI terrestrial data collection is designed to be implemented by a field crew of two. At least one of the crew members must have a strong background in identifying vascular plants. Both crew members must be able to identify common mammals and birds. Many of the non-vertebrate and non-vascular plant species can only be accurately identified by taxonomic experts. As a result, bryophyte, lichen, and mite specimens are collected in the field and later identified by experts in a laboratory.

Data are collected for a wide variety of species and habitats at each ABMI terrestrial site (Table 1). A few additional soil and vegetation protocols are implemented at approximately 10% of the sites to meet National Forest Inventory needs.

Table 1. Types of data collected at ABMI terrestrial sites.

General Habitat	*Taxa*
Physical characteristics (latitude, longitude, elevation, ecosite)	Vascular Plants
Photographs of the site	Bryophytes
% cover of water, bare soil, and low vegetation, shrubs, trees	Lichens
Area and type of natural and human created disturbance	Birds
Detailed Habitat	Mammals
Trees (live, dead, down logs)	Mites
Standing dead vegetation	
Soil (LFH, organic, mineral)	

Data Collected at Wetland Sites

ABMI wetland data collection is designed to be implemented by a crew of two. At least one of the crew members must have a strong background in identifying vascular plants. Both crew members must be able to identify common mammals and birds. Many of the aquatic invertebrates can only be accurately identified by taxonomic experts; these specimens are collected at the wetland and later identified by experts in a laboratory.

Data are collected for a variety of species and habitats at each ABMI terrestrial site (Table 2).

Table 2. Types of data collected at ABMI wetland sites.

General Habitat	*Taxa*
Physical characteristics (latitude, longitude, elevation, ecosite)	Vascular Plants
Photographs of the site	Aquatic Invertebrates
Chemistry and nutrient content of water in the wetland	Birds
Area covered by open water, emergent vegetation, fen, and moist meadow	
% cover of water, bare soil, low vegetation, shrubs and trees around the wetland	
Area and type of natural and human created disturbance in an around the wetland	
Detailed Habitat	
Trees (live, dead, down logs)	

Landscape Information

To complement field data collection, information about the vegetation, physical features, climate, and human land uses around each ABMI site are determined. Detailed landscape information is collected at two spatial scales: i) the area in which field data are collected (this area varies among protocols, Section 3), and ii) within a 4% sample of the landscape (ie. within a 3 x 7 km rectangle) that encompasses the terrestrial site. This detailed information is collected based on manual interpretation of air photos. To complement the detailed landscape information, coarse landscape information is mapped throughout Alberta using satellite images.

Quality Control for Data Collection

All ABMI field staff receive classroom and field based training prior to beginning data collection. This training covers all protocols and prepares staff for the variety of habitats and field conditions they may encounter. To ensure that data collection remains consistent and accurate among crews, field supervisors visit each crew during data collection.

Field data are entered into electronic tablets to reflect exactly what is found / measured at the ABMI site. Electronic verification is built into the database to ensure that data are consistent with allowable codes. If the options for a data field do not include an appropriate response, crews record the most appropriate option and make notes in the comments. Completed data forms are checked in the evening for completeness, and copied to a computer for backup.

Differences in Data Collection Among Natural Regions

Trees and down logs are absent, or at very low densities, in sites located in the Grassland and Parkland natural regions, especially when agriculture activities are present. This results in crews having time available to survey additional elements. To better quantify low vegetation in agricultural areas, supplemental sampling is done for shrubs, grasses and herbs.

Specimen and Sample Processing

A variety of samples and specimens are collected during field sampling. These are shipped from the field to the lab for processing and storage. To ensure nothing gets lost, shipments are accompanied by a document describing what was sent.

Tree cores/cookies are processed at the lab to determine tree age, and organic soils are processed to extract mites. Organic and mineral soils are then shipped to analytical laboratories to determine soil chemistry and carbon content. Vascular plants that were not identified in the field during terrestrial and wetland surveys, are identified by experts. Bryophyte, lichen, mite, and aquatic invertebrate specimens are sorted by technicians and then sent to experts for identification. A sample of specimens identified by one expert are re-identified by a second expert to ensure accuracy.

Data Analyses & Interpretation

To facilitate interpretation of ABMI data, a group of researchers have developed scientifically robust analyses. As data become available, status and trend for species, habitats, human disturbance and biodiversity are determined using these analyses. Results are presented for the province as a whole, and for selected regions. In addition, analyses have been developed to assess ecological condition at specific sites. ABMI analyses methods are published in ABMI reports and the peer-reviewed literature.

Information Dissemination

All data collected by the ABMI are stored and managed on the ABMI web-site (www.abmi.ca). To the degree possible, data are uploaded to the web-site within 12 months of being collected. To facilitate use of the data, it can be down-loaded freely by everyone. As data summaries and analyses are completed, these are posted on the web-site.

2. SITE SELECTION & ESTABLISHMENT

2.1 Choosing Sites & Transects

Terrestrial Sites

- Terrestrial sites are spaced throughout Alberta using the 20 km National Forest Inventory (NFI) grid. This results in ABMI having 1656 terrestrial sites (Figure 1).
- To ensure the site locations remain confidential, the ABMI sites are offset a random direction and distance from the NFI sites.
- Exact ABMI site locations are not shared. ABMI has created approximate locations (randomly located within 5 km of the actual site), and these are available from the ABMI web-site.

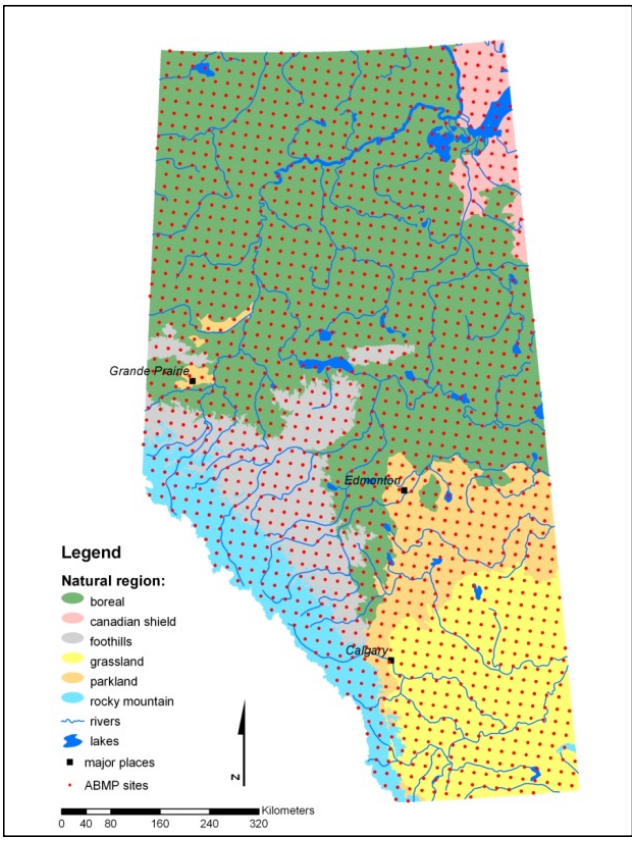

Figure 1

Mammal Transects

- Mammal transects are designed to pass through habitats in as random a manner as possible. However, to facilitate data collection using snow machines transects mainly follow trails, cutlines or small roads.
- High resolution satellite imagery is used to create a 10 x 10 km image of the area with the NFI site marked at the center.
- A primary snow tracking transect 10 km long, is marked on the image (Figure 2) – this becomes the preferred route for snow tracking, and all effort is made to use that transect.
- A secondary transect is identified as a back-up, and used if the primary transect is found to be impassable.
- Snow tracking transects:
  - Are as straight as possible.
  - Are continuous with no breaks in the middle.
  - The transect midpoints are as close as possible to the NFI site.
  - Transects have as large a horizontal distance as possible between the start and end.
  - Depending on the position of existing trails and seismic lines, the transect may have many corners.

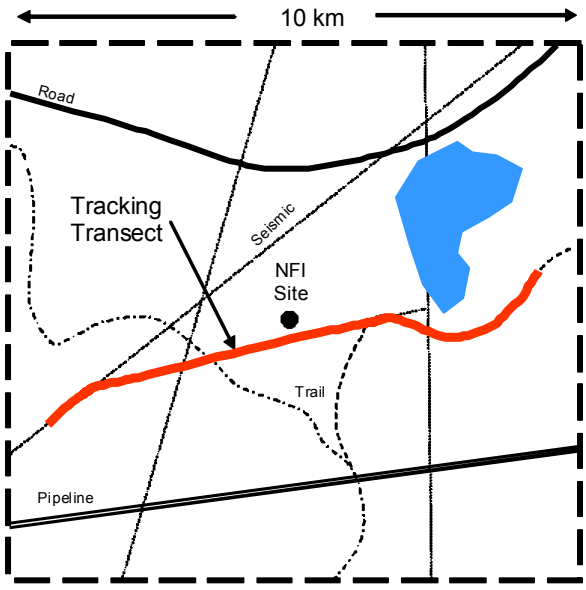

Figure 2

Public Land

- If the 10 x 10 km area is on public land, obtaining permission to travel through the area will not be an issue.
- Where possible, transects are located along narrow trails, seismic lines, pipelines, power lines or small roads.
- Transects are not located on trails/roads that have an improved road surface, unless there are no other viable options.
- For transects in areas with few man-made linear features:
  - The primary transect is laid out as a straight line from NW to SE with the center close to the NFI site.
  - The secondary transect is laid from NE to SW.
  - If a transects crosses a large lake or river that would be dangerous, the route is altered so it passes near the edge of the water feature.

Private Land

- If the 10 x 10 km area is mainly on private land, extensive work will be required to obtain permission from land owners.
- Many fewer people will need to be contacted if the transect is located along road allowances, but the surrounding habitats probably are less random.
- Where possible, transects in areas with private land are located along trails on unimproved road allowances, pipelines, or power lines.
- If there are no acceptable unimproved trails, transect are located along trails/roads that have a gravel/mineral soil surface. Surveys along roads are conducted in the road ditch.

Mixture of Public and Private Land

- If the 10 x 10 km area is a mixture of public and private land, the transect is located along narrow trails, seismic lines, pipelines, power lines, unimproved roads and where necessary locate the transects along improved roads.

2.2 Field Reconnaissance

Terrestrial Sites

- Prior to data collection, crews create maps and visit each site to determine the length of time required for travel, identify the best route to the site, and record potential hazards along the route.
- During field reconnaissance it is important to remove as many impediments to travel as possible.
- Satellite images are used as base-maps, with GIS layers showing access features (roads, trails, rail lines, pipelines, cutlines, well sights, and water features) are overlaid.
- For sites located in open water, distance from vegetation to site center (and to all bird point counts) is determined on the maps.
    - If the site center and all bird point count stations are obviously >200 m from vegetation, the site is recorded as "Open Water" and is not visited to collect field data.
    - If either site center or the bird point count stations are <200 m from vegetation, then the site is visited. Note that it may be necessary to visit the site and/or the bird point count stations to confirm they >200 m from vegetation.
        - Normal data collection occurs at these sites <200 m from vegetation.
        - Note that at some sites, some bird point count stations (and/or site center) may be in open water >200 m from vegetation and therefore not surveyed, even though other bird point count stations are in upland areas or <200 m of vegetation and thus surveyed.
- If takes more than 2.5 hours to travel to a site then helicopter access probably is required so that field crews can access the site and complete the data collection in a single day.
    - If a helicopter pad is required, it must be located >200 m from site centre but otherwise as close as possible.
    - The most unobtrusive pad possible is created (i.e., the fewest and smallest trees and shrubs are cut).

Mammal Transects

- When using a snow machine to collect mammals data, crews first travel the entire 10 km of the primary transect to ensure it is passable.
- If the primary transect is not passable, then the secondary transect is assessed.
- If neither transect is passable, then an alternate route is selected.
    - Alternate trails, seismic lines roads must be as random as possible.
    - Adjusted transects must remain as straight as possible and be such that the center of the transect remains as close as possible to the NFI site.
- If takes more than 2.5 hours to travel to a site then helicopter access probably is required so that field crews can access the site and complete the data collection in a single day.
    - If a helicopter pad is required, it must be located >200 m from site centre but otherwise as close as possible.
    - The most unobtrusive pad possible is created (i.e., the fewest and smallest trees and shrubs are cut).

2.3 Establishing Plots and Transects

Terrestrial Sites

- Sites are visited early in the spring to establish plots and layout transects that will be sampled during subsequent visits.
- By doing this work prior to data collection, it ensures there is sufficient time to collect data during subsequent visits.

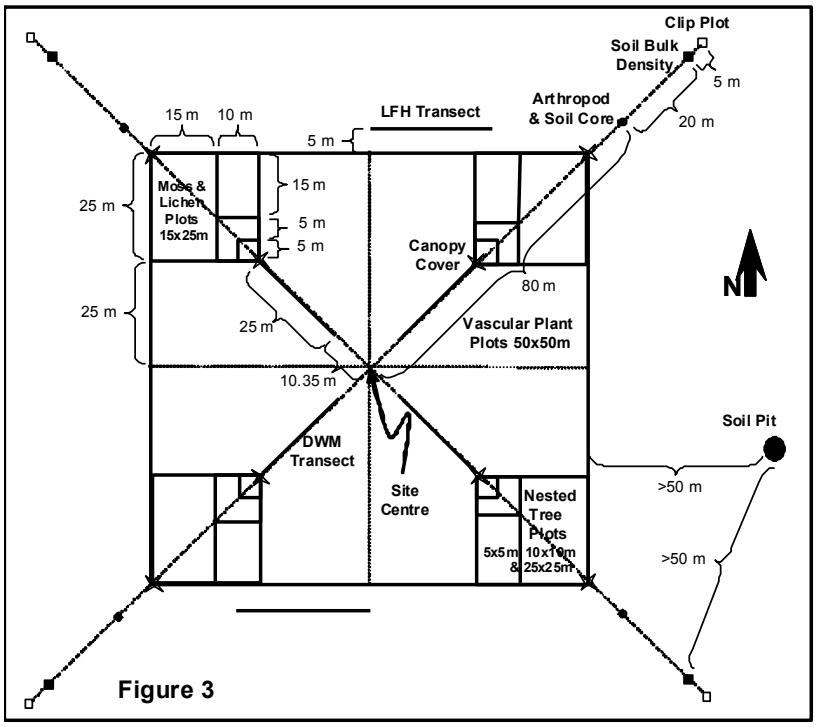

Figure 3

Layout on Public Land

- Site center is located as precisely as possible using a hand-held GPS.
- A 1.5 m steel bar is driven into the ground at site center so it protrudes 1 m.
- A 12" metal spike is driven 30 cm below the ground surface.
- The nested plots and transects (Figure 3) are laid out with the aid of a GPS, compass and measuring tape.
    - The boundary of the 1 ha area, and the lines dividing this into four 50x50 m vascular plant plots, are marked with flagging tape.
    - The four 5 x 5 m, 10 x 10 m, 25 x 25 m nested tree plots, and four 25 m DWM transects are marked with pin flags at the corners and end of the transects. The distance between the corners of the nested plots are measured diagonally to ensure they are within 20 cm of true locations.
    - To ensure the tree plots and DWM transects can be accurately relocated in future years, four 1.5 m steel bars are driven into the ground so they protrude 1 m. These bars are located at the pin flags that mark the inside corner of the tree plots (ie., at 35.35 m along each of the sub-ordinal transects).
    - The two 30 m surface substrate (LFH) transects and four soil/arthropod sample locations are marked with pin flags.
    - Note that no extra marking are used for the 4 lichen and moss plots, when collecting data these are marked with a tape measure based on pin flags from the tree plots.

Layout on Private Land, National Parks, Provincial Parks, DND, and Reserve lands

- Plots and transects are laid out the same as that for sites on public land.
- To avoid using permanent markings at sites on private property, the plots and transects are laid out at the start of each field visit and all flagging/pigtails are removed at the end of each visit.
- Permanent stakes are not used on private land; rather a GPS that is accurate to <30 cm is used locate site center and mark the inside and far corners of each of the tree plots.
- Care is taken to minimize impact on crops and livestock while laying out plots and collecting data on private land.

Mammal Transects

- Mammal transects are not visited prior to survey.
- Route reconnaissance, and adjustment if required (see above), are conducted immediately prior to surveying these transects.

3. FIELD SURVEYS

3.1 Site Characteristics

- General site characteristics are described at site center and at each of the other eight bird point count stations.
- Site conditions are designed to be completed within 2-3 minutes from a standing position.
- A reduced version of site characteristics is recorded at the surface substrate transects, the soil arthropod sampling locations, and the vegetation plots.

Photographs

- Six photographs are taken using a digital camera with a 35 mm focal length and a quality setting of approximately 3 Mega-pixels.
  - Transect Photos – From site centre, landscape photographs are taken at eye level in each of the four sub-ordinal directions.
  - Representative Site Photo – From anywhere within the 1 ha plot; a single photograph is taken that best represents the physical and vegetation characteristics of the site.
  - Canopy Photo – Standing at site centre, a photograph of the canopy is taken while looking directly overhead.
- Except for the canopy photo, a back pack or DBH calipers are included approximately 5 m from the camera for scale.
- Check the quality of the photos and re-take if they are blurry.

Physical Conditions

- Physical conditions are determined at site center and at the center of each bird point count.
- Elevation is determined using the digital elevation GIS layer that is maintained by the Alberta provincial government.
- Aspect (direction in degrees when looking down-hill) is determined using a compass.
- Slope is determined using a clinometer and recorded in degrees. From a standing position, sight to a reference point that is eye-level above the ground 20 m away in the direction of maximum slope.

Tree Composition

- General tree characteristics are assessed within a 150 m radius circle around site center and around the center of all other bird point counts.
- Tree characteristic are determined for both the primary (most common) and secondary ecosite types.
- For each of the three height strata, tree species composition (in 10% increments), average distance between trees (in 1 m increments), and average height (in 5 m increments) are recorded. The height strata are:
  - Veteran Trees – see description in Section 3.2 below.
  - Dominant and Co-dominant Trees – see description in Section 3.3 below.
  - Intermediate and Suppressed Trees – see description in Section 3.3 below.
- Some stands may be missing one or more of the strata.
- Dead trees (snags) are not included when determining tree composition, density or height.

Low Vegetation

- Low vegetation characteristics are assessed within a 150 m radius circle around site center and around the center of all other bird point counts.

- Low vegetation characteristic are determined for both the primary (most common) and secondary ecosite types.
- The most common shrub species (based on % cover) in two height categories ≤1.3 m, and >1.3 m is identified. If no shrubs are present then the species is recorded as "none".
- For both height categories, shrub cover is estimated as one of five categories (none, <25%, 25-50%, 51-75%, >75%), based on what would be obtained if a photograph had been taken from above the shrubs.
- Percent cover of dead herbaceous vegetation is estimated as one of five categories (none, <25, 25-50, 51-75, >75%) and the predominant height of this dead vegetation is recorded.
- The type of ground vegetation (grass, herbs, shrub, sedge/rush, moss, or lichen) that has the highest % cover based on what would be obtained if a photograph had been taken from 0.5 m above the ground is recorded. If there is no ground vegetation, then the category "none" is recorded.
- The % bare ground (defined as ground surface without vegetation) is recorded in 10% increments.
- The % of the ground surface covered by water is recorded in 10% increments.

Ecological Site Type

- Ecosite types are assessed within a 150 m radius circle around site center and around the center of all other bird point counts.
- Ecological (ecosite) site types identify the dominant vegetative community present, or that would have been present pre-disturbance.
- Ecosite site types are named based on soil characteristics, soil nutrients, moisture status and vegetation community.
- Structural stage describes the composition and structure of vegetation within an ecosite. Structural stages often vary among seral stages as vegetation regrows following disturbance.
- Historic/natural ecosite site type and structural stage
  - The most common (primary) ecosite type and structural stage is recorded along with the % (in 10% cover increments) of the 150 m radius area that is occupied by this type.
  - If there is more than one ecosite type and structural stage present, and the second type occupies more than 20% of the 150 m radius area, then determine the secondary ecosite site type and structural stage and the % (in 10% cover increments) of the 150 m radius area occupied by this secondary type.
  - Secondary ecosite types must make up ≥0.1 ha of a continuous habitat (i.e., be ~ 35 m in diameter) otherwise they are considered part of the primary ecosite.
  - The sum of the primary and secondary ecosite types may be less than 100% if more than two ecosite types are present.
- Current ecosite site type and structural stage
  - Current ecosite type will only differ from historical/natural ecosite type if the topography, hydrology or soils have been altered by anthropogenic activities.
  - The most common (primary) ecosite type and structural stage present and the secondary ecosite type and structural stage within the 150 m radius area are recorded.
- Ecosite types are determined differently among natural regions; thus two designations are assigned to each ABMI site.
  - First ecosite types are classified in the lab based on AGRASID (AGRASID 3.0, Alberta Soil Information Center 2001), GVI (Grassland Vegetation Inventory 2006) soil types and vegetation information from the site (Table 3).
  - Second, ecosite types are classified in the field based on forest conditions (Table 4).

Table 3. Thirty-three land classes based on AGRASID and GVI.

Primary Class	Land Sub-Class	Site Type	Description	ABMI Code
Open Water	Lentic	Standing water	Permanent open standing-water with no emergent vegetation, generally larger than 1.0 ha and >15 cm deep.	LenW
	Lotic	River	Open water of rivers, generally rivers wider than 20 m.	LtcR
Native / Natural Lentic	Lentic	Temporary	Water present <3 weeks (dry by July) <15 cm deep.	LenT
		Seasonal	Water usually present >3 weeks (usually dry by July) >15 cm deep.	LenS
		Alkali	Water present >3 weeks and >15 cm deep	LenA
		Semi-Permanent to Permanent	Throughout the year except during periods of extreme drought (present in autumn in 70% of the years); often occurs adjacent to LenW; includes the march zones; water is generally >15 cm deep; if open water is present it is smaller than 1.0 ha	LenSP
Native / Natural Lotic	Lotic	Coniferous	Coniferous trees with a combined canopy cover of greater than 25%.	LtcC
		Deciduous	Deciduous trees with a combined canopy cover of greater than 25%.	LtcD
		Shrub	Shrubs have a combined cover of at least 10%.	LtcS
		Herbaceous	Herbaceous species (including sedges) have a combined cover of at least 5%.	LtcH
Native / Natural Grassland	Grassland	Subirrigated	Water table is close to surface during growing season, but rarely above. Does not have a defined depressional edge.	Sb
		Overflow	Areas subject to water spreading and sheet flow. Typically on gentle inclines or terraces above the frequent flood zone. For locations where flood frequency is less than once every ten years.	Ov
		Clayey	Clayey-textured soils including silty clay, sandy clay, clay, and heavy clay. Generally >40% clay.	Cy
		Loamy	Includes loam, silt loam, silt, clay loam, sandy clay loam, and silty clay loam.	Lo
		Sandy	Sandy-loam-textured soils.	Sy
		Limy	Eroded or immature soils with free lime ($CaCO_3$) at the soil surface. Soil pH generally >7.5.	Li
		Sand	Loamy sand and sand soils, and not with a duned surface.	Sa
		Blowouts/ Solonetzic Order	Areas with Solonetzic (hardpan) soils. The surface may or may not have eroded pits.	BlO
		Choppy Sandhills	Loamy sand and sand soils with a duned land surface.	CS
		Thin Breaks	Areas with bedrock at or near the soil surface. Amount of vegetation is intermediate between Limy and Badlands. TB may include thin, eroded or immature soils on gentle to steep slopes.	TB
		Shallow to Gravel	Soil with 20 to 50 cm of a sandy or loamy surface overlying a gravel or cobble- rich substrate.	SwG
		Saline Lowland	Areas with negligible vegetation due to electrical conductivity (salts) and/or sodium adsorption ratio limitations.	SL
		Gravel	Dominated by gravels or cobbles (>50% coarse fragments). May be covered by a mantle <20 cm thick with some gravels.	Gr
		Badlands/ Bedrock	Nearly barren or barren lands, with exposures of soft rock, hard rock, or surficial geology. Includes steep valley walls.	BdL
Anthropogenic	Crop	Irrigated	Row crops (small grains, oilseeds, and fallow) with water supplemented by anthropogenic means.	CI
		Non-irrigated	Includes row crops without water supplementation.	CN
	Tame Pasture	Irrigated	Planted grasses or legumes for livestock grazing or the production of hay with water supplemented by anthropogenic means.	PI
		Non-irrigated	Planted grasses or legumes without water supplementation.	PN
	Industrial	Pits	Vegetative cover removed for the extraction of surface deposits; may be active or inactive.	Pit
		Developed	Invasive developments that are very difficult to return to crop, pasture, or native/natural conditions; does not include urban.	Dev
	Settled	Urban	Areas where much of the land is covered by structures and the population density is high (cities, towns, villages, hamlets, cottage development, strip developments, cemeteries, and shopping centers).	Ur
		Rural	Sparsely populated areas outside urban (country residential developments (acreages), farmsteads, golf courses, parks and campgrounds).	Ru
Unknown	No Data	Not Determined	No information in AGRASID and GVI	UNK

Table 4. Ecosite categories based on a simplified forest classification.

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				
Bearberry/Lichen Bog Cranberry common at some sites	1 - **PX**	1a **Pine**	Pj + Fd > 80%	**A. Tree Dominated Ecosites** *(Trees ≥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.
Labrador Tea / Feather Moss Bog Cranberry, Bilberry, Grouse-berry common at some sites	2 - **PM**	2a **Pine**	Pj + Pl > 50%	
		2b **Other**	Aw + Sw + Se +Fa +Pw > 50%	
		2c **Sb**	Sb > 50%	
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 + La >50%	
Low-bush Cranberry / Canada Buffalo-berry Blueberry, Rose, Alder, Labrador Tea, Bearberry, Thimbleberry, 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%	
Horsetail Dogwood, Rose, Willow, Feather Moss common at some sites	5 - **MG**	5a **Poplar**	Pb + Aw > 50%	**B. Non-Tree Dominated Ecosites** *(Trees <10% cover)* **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
		5b **Spruce**	Sw + Se > 50%	
		5c **Sb**	Sb > 50%	
Dogwood / Fern / Feather Moss Rose, Alder, Bracted Honeysuckle, Devil's Club Fir common at some sites	6 - **RG**	6a **Pine**	Pl > 50%	**Only Ground Vegetation Present** *(Shrubs <10%; Trees <10%; Other Vasc. >10%)* – Add 3-letter code combining dominant vegetation type and density Vegetation Type **(GB) Bryoid/Lichen** – Bryophyte and lichen **(GF) Forb** – Non-graminoid herbs and ferns **(GG) Graminoid** – grasses, sedges **(GR) Marsh** – reeds, and rushes Vegetation Density **(D) Dense** – Cover >75% **(M) Moderate** – Cover 25-75% **(S) Sparse** – Cover <25%
		6b **Poplar**	Pb + Aw > 50%	
		6c **Spruce**	Sw + Se + Fa > 50%	
Not Treed	7 - **NT**	7a **Alpine**	Elevation above tree line	
		7b **Flood**[3]	Site disturbed frequently by 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**[4]	Site disturbed recently by humans	
Aw - trembling aspen, Pb - balsam poplar, Bp - paper 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, and Lt - larch		**Shrubs Present** *(Shrubs >10%; Trees <10%)* – Add 3 letter code combining shrub height and density. Shrub Height **(SL) Low** – Shrubby vegetation <2 m tall **(ST) Tall** – Shrubby vegetation >2 m tall Shrub Density **(D) Dense** – Shrubs cover >75% **(M) Moderate** – Shrubs cover 25-75% **(S) Sparse** – Shrubs cover <25%

Dominant Shrub/Herb/Ground Cover	Nutr./ Moist. Code [1]	Tree Species Modifier	Tree Species Composition [2] (In an area without human disturbance)	Structural Stage
Lowland/Wetland Vegetation Communities				
Bog - Labrador Tea / Peat Moss / Lichen Bog Cranberry and Cloudberry may also be present (Soil saturated for part or all the year)	**8 - PD**	**8a Sb[5]**	≥10% tree cover (may only be in shrub/ground strata) Sb > 50%	**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 and density are not added to the code) 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.
		8b Shrub	<10% tree cover	
Poor Fen - Labrador Tea / Peat Moss / Sedge Bog Cranberry, Dwarf Birch and Willow may also be present (Soil saturated for part or all the year)	**9 - MD**	**9a SbLt[5]**	≥10% tree cover (may only be in shrub/ground strata) Sb + Lt > 50%	
		9b Shrub	<10% tree cover	
Rich Fen - Dwarf Birch / Willow / Sedge / Grass / Moss (Soil saturated for part or all the year; includes floating mats of vegetation)	**10-RD**	**10a SbLt**	≥10% tree cover (may only be in shrub/ground strata) Sb + Lt ≥ 50%	
		10b Shrub	<10% tree cover AND ≥10% shrub cover	
		10c None	<10% tree cover AND <10% shrub cover	
Swamp Conductivity <15 mS/cm, trees and shrubs present, poorly developed bryophytes, often with pools of water (Water is above the rooting zone for some of the year, organic soil humified rather than peaty)	**11-SD**	**11a Tree**	>10% tree cover	
		11b Shrub	<10% tree cover	
Marsh – 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)	**12-VD**	**12a None**	usually along a water body edge ≥10% emergent vegetation cover <10% tree cover	
Alkali Conductivity >15 mS/cm, white salt flats at water's edge, saltwater widgeon grass dominates (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 vegetation cover	
		14b River	In flowing water <10% emergent vegetation cover	

First, the ecosite classifications (Moisture/Nutrient category) is determined based on Dominant Shrub/Herb/Ground Cover.
Secondly, Tree Species Modifier is determined within the selected Moisture/Nutrient category. Tree species compositions are the "simplified categories" and may not fit perfectly with what is present.
Finally, Structural Stage is determined by assessing if the site is tree-dominated, non-tree dominated, or open-water dominated and then choosing the appropriate code.

1. Moisture nutrient category names are approximate (Nutrient Status: P=Poor, M=Medium, R=Rich, V=Very Rich; Moisture Status: X=Xeric, M=Mesic, G=Hygric, D=Hydric, OW=Open Water; Swamps and Alkali are represented by S and A respectively)
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.
3. 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.
4. Use 7f (NT-Human) only when other ecosite classifications are not appropriate. Note that NT-Human cannot be used for historic conditions.
5. 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)

- Note that in addition to site center and the center of each bird point count, elevation, aspect, slope, ecosite site type and structural stage are also determined at:
  - All four 5 x 5 m shrub plots
  - All four arthropod / mineral soil sampling locations
  - Both surface substrate sampling transects
  - The soil pit
  - For these slope measurements category of slope (not slope degree) is recorded:
    - C = Crest – situated in a relatively level area on the top of a hill
    - S = Slope – situated on the side of a hill; a modifier is always included for the category S: 1 (i.e., S1) for slopes 2-5^{o}, 2 for slopes 6-10^{o}, 3 for slopes 11-30^{o}, and 4 for slopes >30^{o}
    - 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^{o} slope
    - D = Depression – situated in an area that accumulates water after rains
  - For each of these plots/transects, the primary ecosite type is determined within the area sampled.

Natural Disturbance

- Natural disturbance is assessed within a 150 m radius circle around site center and around the center of all other bird point counts
- Record the type and % (0, <1% or in 5% increments) of the area affected by each natural disturbances.
- Multiple disturbance types, if present, are recorded in order of % cover. The sum of area disturbed naturally cannot exceed 100%.
- Categories of natural disturbance include:

  None – No natural disturbance present

  Fire – Any evidence of scarring or burning (may be human caused); may coincide with salvage-harvesting

  Wind – Evidence of wind throw (i.e., many trees up-rooted and laying on the ground and/or snapped along the bole); often occurring along canopy openings, cutblocks, roads; potentially human induced

  Erosion – Evidence of soil removal by precipitation or wind; potentially human induced; examples include: side of a hill has eroded from rain (natural), culvert under logging haul road is plugged causing run-off through low lying areas undercutting trees

  Flooding – Evidence of high water mark, dead trees, etc.; potentially human induced; examples include: stream overflows its banks in spring and fills in forest depressions and/or "historic" flood plain (natural) evident by standing dead trees, grass and debris build up; road is built through spruce bog not allowing proper water transfer (human) evident by standing water and large stands of dead trees

  Snow/Ice – Evidence of vegetation breakage caused by snow or ice

  Insect – Any evidence of vegetation experiencing insect ; 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, oths, 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 dye-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; 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 dye-off (especially young trees; root rot)
Confirmation – check for absence of insect damage and describe scenario in comments; tree dye 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 – colored 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

Beaver – any evidence of beaver activity altering landscape or vegetation
Other – please describe any other type of disturbance
Unknown – 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, describe what is observed

Human Disturbance

- A map of human disturbances is drawn for the 1ha area at site center.
- The type and % (as 0, <1% or in 5% increments) of the area affected by each human caused disturbances is recorded. The sum of area disturbed by humans cannot exceed 100%.
- Multiple disturbance types, if present, are recorded in order of decreasing % cover.
- Categories of human disturbance include:
  NONE – No human caused disturbance present
  HARV – Any type of forest harvesting (i.e., clear-cut, partial-cut, understory retention, etc. <30 years old)
  PIPE – Pipeline
  POWER – Power line
  SEIS – Any type of cutline or seismic line
  RAIL – Railway
  WELL – Any type of area cleared for oil/gas/coal-bed-methane including pump jacks or well heads
  ROADP – Any type of road with paved surface
  ROADG – Any type of road with gravel surface
  TRAIL – Any type of truck or ATV trail with an unimproved surface
  CULT – Any type of cultivated field that is used to grow agriculture crops including forage
  PAST – Any type of uncultivated pasture (tame or native) with grazing
  RES – Any type of residential dwelling, farm building, or farm yard in a rural or acreage setting
  URB – Any type of human dwelling, associated building, or yard/driveway/road in an urban setting
  IND – Any type of building, roadway, yard, etc. associated with industrial development
  BARE – Human caused bare ground for which the cause cannot be determined
  OTHER – Please specify

3.2 Human Disturbance Intensity

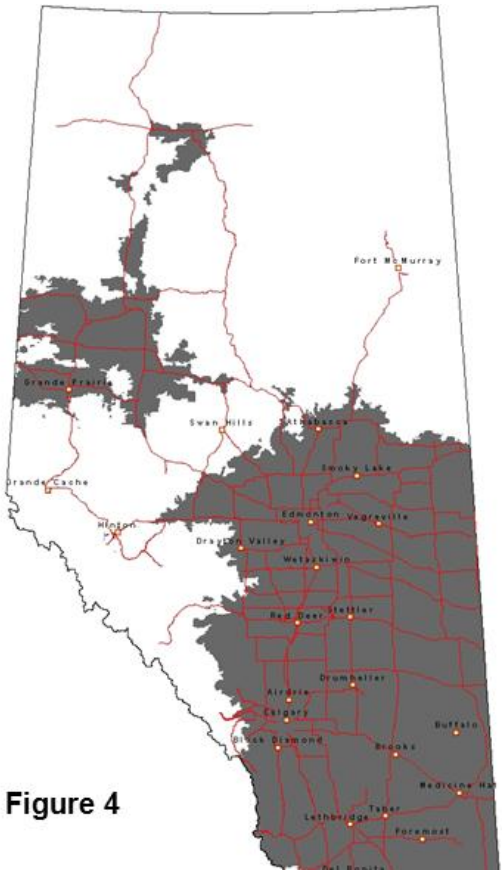

Figure 4

- This protocol is only implemented at ABMI sites where agriculture disturbance including grazing by domestic animals, could occur (Figure 4). Note that human disturbance intensity is not determined for cultivated fields.
- Human disturbance intensity is inferred based on the degree to which vegetation characteristics differ from that expected under undisturbed conditions.
- Assessment of human disturbance intensity is conducted in the central 1 ha square.
- Sampling methods are adapted from the manual "Range health assessment for grassland, forest and tame pasture, Alberta Sustainable Resource Development, Publication Number T/44, B. Adams, G. Ehlert, C. Stone, D. Lawrence, M. Alexander, M. Willoughby, C. Hincz, D. Moisey, A. Burkinshaw, J. Carlson, K. France 2009."
  - In grassland areas, survey methods follow "Grassland" portion of the handbook.
  - In forested and parkland areas, survey methods follow "Forest" portion of the handbook.
- A great deal of experience and training are required to understand the expected vegetation conditions at sites, and to accurately describe the changes that have occurred at that site. At these sites:
  - Surveys must be completed by experts.
  - Published descriptions of vegetation communities found in various combinations of soil and moisture conditions in each natural sub-region are used as background to determine expected undisturbed conditions.
  - Additional information or knowledge about vegetation communities in the region is used to facilitate assessment of expected undisturbed vegetation conditions.
  - To describe the conditions accurately, it is necessary to spend approximately one hour walking in a zigzag pattern throughout the complete 1 ha area
- Less experience and training are required accurately describe the changes in vegetation communities caused by human disturbance at tame pasture sites. Consequently, at these sites surveys are completed by summer technicians.
- For each characteristic that is evaluated, response categories are numbered ordinally with a value of 1 or zero assigned to the most heavily disturbed condition.
- Surveys are conducted between late June and late September when vascular plants are fully developed.

General Site Type

- For site center, record the code from the Alberta soil AGRASID layer.
- For site center, record the code from GVI.
- If there is no GVI information for site center OR if the GVI code is an anthropogenic type, then record the GVI conversion type expected based on AGRASID code.
- Describe soil characteristics at site center:

  Sb - Subirrigated - Water table is close to surface during growing season, but rarely above. Does not have a defined depressional edge.

  Ov - Overflow - Areas subject to water spreading and sheet flow. Typically on gentle inclines or terraces above the frequent flood zone. For locations where flood frequency is less than once every ten years.

  Cy - Clayey - Clayey-textured soils including silty clay, sandy clay, clay, and heavy clay. Generally >40% clay.

Lo - Loamy - Includes loam, silt loam, silt, clay loam, sandy clay loam, and silty clay loam.
Sy - Sandy - Sandy-loam-textured soils.
Li - Limy - Eroded or immature soils with free lime ($CaCO_3$) at the soil surface. Soil pH generally >7.5.
Sa - Sand - Loamy sand and sand soils, and not with a duned surface.
BlO - Blowouts/ Solonetzic Order - Areas with Solonetzic (hardpan) soils. The surface may or may not have eroded pits.
CS - Choppy Sandhills - Loamy sand and sand soils with a duned land surface.
TB - Thin Breaks - Areas with bedrock at or near the soil surface. Amount of vegetation is intermediate between Limy and Badlands. TB may include thin, eroded or immature soils on gentle to steep slopes.
SwG - Shallow to Gravel - Soil with 20 to 50 cm of a sandy or loamy surface overlying a gravel or cobble-rich substrate.
SL - Saline Lowland - Areas with negligible vegetation due to electrical conductivity (salts) and/or sodium adsorption ratio limitations.
Gr - Gravel - Dominated by gravels or cobbles (>50% coarse fragments). May be covered by a mantle <20 cm thick with some gravels.
BdL - Badlands/ Bedrock - Nearly barren or barren lands, with exposures of soft rock, hard rock, or surficial geology. Includes steep valley walls.

Rangeland Assessment

Grassland Sites

- *Question 1: What kind of plants are on the site?*
  Evaluation is based on criteria from 1A in the manual.
  4 – The plant community closely resembles the reference plant community and alteration of the plant community is light.
  3 – Compared to the reference plant community, the plant community shows only minor alteration.
  2 – Compared to the reference plant community, the plant community shows moderate alteration.
  1 – Compared to the reference plant community, the plant community shows significant alterations.
- *Question 2: Are the expected plant layers present?*
  4 – The life form layers closely resemble the reference plant community.
  3 – Compared to the reference plant community, one life form layer is absent or significantly reduced.
  2 – Compared to the reference plant community, two life form layers are absent or significantly reduced.
  1 – Compared to the reference plant community, three life form layers are absent or significantly reduced.
- *Question 3: Is the expected amount of plant litter present?*
  3 – Litter amounts are more or less uniform across site and include standing dead plant material, fallen dead plant material and variably decomposed material on the soil surface. Litter (lb./ac.) is 65-100% of that expected under moderate grazing by native ungulates.
  2 – Litter amounts are slightly or moderately reduced and are somewhat patchy across the site. The standing dead plant material is less frequent than expected with fallen dead plant material and variably decomposed material on the soil surface being the dominant litter types. Litter is 35-65% of that expected under moderate grazing by native ungulates.
  1 – Litter is greatly reduced or absent with little or no standing or fallen litter. Decomposing material on the soil surface is the main type of litter. The distribution of litter is fragmented across the site. Litter is <35% of that expected under moderate grazing by native ungulates.
- *Question 4A: Is there evidence of soil erosion?*
  4 – No sign of soil erosion (eg., no sign of deposition of soil/litter, plant pedestalling, coarse sand or aggregate remnants, flow patterns and/or scouring, or hoof sheering) beyond the natural extent for the site.
  3 – Slight evidence of soil erosion that is human-caused beyond the natural extent expected for the site. Old erosion features are stable and vegetated, and flow patterns are short and shallow.

2 – Moderate amounts of soil erosion across site. Erosion features are present and active but with limited extent and with no off-site movement of material. Flow patterns have a well-defined branching pattern. Vegetation (live plants and litter) still protects most of the site.

1 – Extreme amounts of active soil erosion with material being carried off site. Flow patterns are obvious, fan deposits may be present, rills are abundant and deep, gullies are deep with sharp edges, plants are pedestalled and hoof sheering may be common.

- *Question 4B: Is there human-caused bare soil?*
  - 4 – Less than 10% of the exposed soil is human-caused.
  - 3 – Between 10 and 20% of the exposed soil is human caused.
  - 2 – Between 20 and 50% of the exposed soil is human caused.
  - 1 – Greater than 50% of the exposed soil is human caused.
- *Question 5A: Are noxious weeds present?*
  - 4 – No noxious weeds are present.
  - 3 – Noxious weeds cover <1% of the site.
  - 2 – Noxious weeds cover 1-15% of the site.
  - 1 – Noxious weeds cover >15% of the site.
- *Question 5B: Are noxious weeds broadly distributed?*
  - 4 – No noxious weeds are present.
  - 3 – A few single individuals or patches of noxious weeds are present.
  - 2 – Sporadic patches of noxious weeds are present.
  - 1 – Noxious weeds are common and distributed throughout the site.

Forest & Parkland Sites

- *Question 1: What kind of plants are on the site?*
  - 6 – The plant community resembles the reference plant community and alterations if present are light. There are no invader species present. Increaser and decreaser species are of similar as that found in the reference community.
  - 5 – The plant community closely resembles the reference plant community and alteration is fairly light. There are no invader species present. Increaser species are more common and decreaser species less common in unprotected portions of the site, but not affected in protected locations.
  - 4 – Compared to the reference plant community, the plant community shows minor alterations. Small patches of invader species are present. Increaser species are more common and decreaser species less common in unprotected portions of the site, but not affected in protected locations.
  - 3 – Compared to the reference plant community, the plant community shows moderate alteration. Large patches of invader species are present and/or these species are distributed throughout the site. Increaser species are more common throughout the site and decreaser species are only found in very protected locations or may be absent.
  - 2 – Compared to the reference plant community, the plant community shows heavy alteration. Invader species dominate the site. Increaser species are common. Decreaser species are absent.
  - 1 – Compared to the reference plant community, the plant community shows very heavy alteration. Invader species dominate the site. Unpalatable increaser species are common. Palatable invaders and increasers are uncommon. Decreaser species are absent.
- *Question 2: Are there changes to forest community structure?*
  - 5 – All life form layers closely resemble the reference plant community. Less than 25% of the preferred shrubs are browsed.
  - 4 – All life form layers are present in comparison to the reference plant community. 25-50% of the preferred shrubs are browsed. Less than 25% of the non-preferred shrubs are browsed.
  - 3 – One life form is significantly reduced or absent in comparison to the reference plant community. 50-75% of the preferred shrubs are browsed. 25-50% of the non-preferred shrubs are browsed.
  - 2 – Two life forms significantly are reduced or absent in comparison to the reference plant community. Preferred shrubs are absent or >75% browsed. 50-75% of the non-preferred shrubs are browsed.
  - 1 – Three life forms are significantly reduced or absent in comparison to the reference plant community. Preferred shrubs are absent or >75% browsed. Non-preferred shrubs are absent or >75% browsed.

- *Question 3: Is the organic layer compacted?*
  - 4 – LFH thickness is similar in disturbed and protected locations. Resistance to penetration is similar between disturbed and protected locations.
  - 3 – LFH thickness is 10-25% less in disturbed that in protected locations. Resistance to penetration is 20-50% greater in disturbed than in protected locations.
  - 2 – LFH thickness is 25-50% less in disturbed that in protected locations. Resistance to penetration is 50-200% greater in disturbed than in protected locations.
  - 1 – LFH thickness is >50% less in disturbed that in protected locations. Resistance to penetration is >200% greater in disturbed than in protected locations.
- *Question 4A: Is there evidence of soil erosion?*
  - 4 – No sign of soil erosion (eg., no sign of deposition of soil/litter, plant pedestalling, coarse sand or aggregate remnants, flow patterns and/or scouring, or hoof sheering) beyond the natural extent expected for the site.
  - 3 – Slight evidence of soil erosion that is human-caused and beyond the natural extent expected for the site. Old erosion features are stable and vegetated, and flow patterns are short and shallow.
  - 2 – Moderate amounts of soil erosion across site. Erosion features are present and active but with limited extent and with no off-site movement of material. Flow patterns have a well-defined branching pattern. Vegetation (live plants and litter) still protects most of the site.
  - 1 – Extreme amounts of active soil erosion with material being carried off site. Flow patterns are obvious, fan deposits may be present, rills are abundant and deep, gullies are deep with sharp edges, plants are pedestalled, and hoof sheering may be common.
- *Question 4B: Is there human-caused bare soil?*
  - 4 – Human caused bare soil covers <1% of the site.
  - 3 – Human caused bare soil covers 1-5% of the site.
  - 2 – Human caused bare soil covers 5-15% of the site.
  - 1 – Human caused bare soil covers >15% of the site.
- *Question 5A: Are noxious weeds present?*
  - 4 – No noxious weeds are present.
  - 3 – Noxious weeds cover <1% of the site.
  - 2 – Noxious weeds cover 1-15% of the site.
  - 1 – Noxious weeds cover >15% of the site.
- *Question 5B: Are noxious weeds broadly distributed?*
  - 4 – No noxious weeds are present.
  - 3 – A few single individuals or patches of noxious weeds are present.
  - 2 – Sporadic patches of noxious weeds are present.
  - 1 – Noxious weeds are common and distributed throughout the site.

3.3 Trees, Snags & DWM

- Tree data are collected in three nested plots (Figure 5) for three different size categories of trees.
  - The small plot is 5 x 5 m
  - The medium plot is 10 x 10 m, and encompasses the small plot
  - The large plot is 25 x 25 m and encompasses both the small and medium plots.
- Information on size, condition and abundance of trees, snags and stumps are collected in these nested plots.

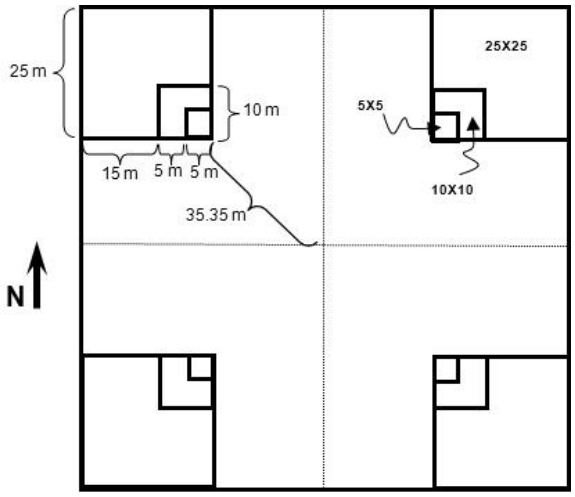

Figure 5

Definitions

Live Trees

- Live trees are defined as any living woody species that that normally grows ≥1.3 m tall and that does not have multiple stems originating together.
- Willow and alder are not classified as trees because they normally have multiple stems originating together.
- Only trees >1.3 m high are measured in the tree plots; smaller trees are measured as part of the shrub and low vegetation layers.

Snags

- Snags are defined as dead trees ≥1.3 m in length, leaning ≤45°from vertical.
- Snags leaning >45° from vertical are included as part of the DWM.

Stumps

- Stumps are defined as dead trees <1.3 m high.
- Dead saplings <1.3 m high are considered stumps

Down Woody Material

- Down woody material includes:
  - Twigs, stems, branches, and chunks of wood >10 cm long from trees and shrubs with or without bark.
  - Wood above 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.
  - Fallen or suspended (not self-supporting) dead tree boles and branches, with or without roots attached, that intersect the plane of the transect line and are leaning >45° from vertical. Stems and branches may be suspended on nearby live or dead trees, other coarse woody debris, stumps, or terrain features.
  - Fallen and uprooted (not self-supporting) trees/branches/stumps with or without green foliage that are no longer rooted in the ground and not connected to the tree bole.
  - Recently cut logs.
  - Exposed dead roots of fallen trees/snags.
- Down woody material does not include:
  - Cones, bark flakes, needles, leaves and forbs.
  - Live trees, snags, and stumps (still rooted) which are self-supporting and leaning <45° from the vertical.
  - Dead branches still connected to standing trees.
  - Exposed roots of self-supporting trees/snags/stumps.
  - A piece of woody material that is decomposed to the point where it could be described as forest floor humus (no discernible shape of log left).

Trees, Snags & Stumps

- All trees, snags and stumps ≥25 cm DBH are measured in the 25 x 25 m plot (note that due to the nested nature of the tree plots this includes both the 10 x 10 m and 5 x 5 m plots).
- All trees, snags and stumps ≥7 cm and <25 cm DBH are also measured in the 10 x 10 m plot (note that due to the nested nature of the tree plots this includes the 5 x 5 m plot).
- All trees, snags and stumps <7 cm DBH are also measured in the 5 x 5 m plot.
- Species code is recorded for every tree, snag and stump measured.
- Trees, snags and stumps on the boundary of the plots are included only if greater than half of the stem is within the plot.

Diameter

- DBH is recorded for every tree and snag measured.
- Diameter of trees and snags are measured at 1.3 m high (this is referred to as diameter at breast height DBH).
- Diameters of stumps are measured inside the bark, at the top of the stump.
- If the diameter is <7 cm, it is measured to the nearest 0.1 cm.
- If the diameter is ≥7 cm, it is measured to the nearest 0.5 cm.

Height

- Top height is only determined for trees in the 10 x 10 m plot (note that due to the nested nature of the tree plots this includes the 5 x 5 m plot).
- Canopy base height is only determined for trees >7.0 cm DBH in the 10 x 10 m plot (note that due to the nested nature of the tree plots this includes the 5 x 5 m plot).
  - If there are less than 10 trees ≥7.0 cm DBH within the 10 x 10 plot, then all are measured for top and base height using the vertex hypsometer.
  - If there are 10 or more trees ≥7.0 cm DBH within the 10 x 10 m plot, then a sub-sample of 9 trees are measured for top and base height (Figure 6).
    - The 4 trees closest to each corner of the plot, the 4 trees closest to the mid-point of the 10 x 10 m plot boundary, and the tree closest to the centre of the plot are selected.
    - All 9 trees selected must be within the 10 x 10 m plot and cannot be measured twice (i.e., select a different tree if it is the closest to more than one location).

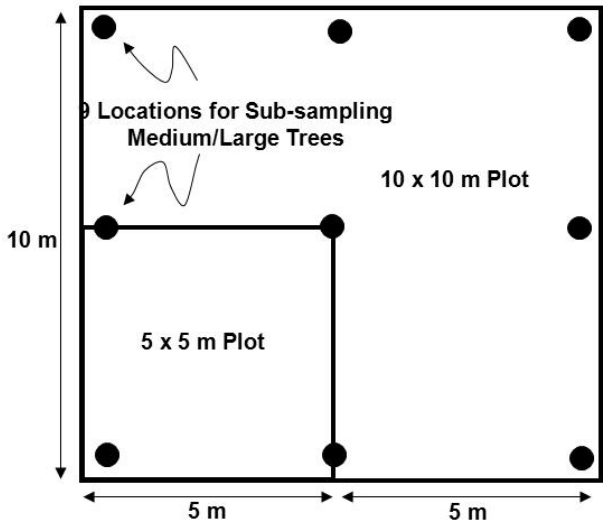

Figure 6

- For trees where top and base heights are measures explicitly.
  - Top height is measured (to the nearest 0.1 m using the vertex hypsometer) to the highest leaf on the tree.
  - Base height is measured as 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. If possible use the vertex hypsometer and measure base height to the nearest 0.1 m. In some cases it may be easier (and more accurate) to estimate base height when standing under the tree and not using the vertex hypsometer.
  - Since snags and stumps do not have a live crown, only top height is measured.
  - Stump height is measured to the nearest 0.1 m using a meter stick
  - Note that since top height is used a surrogate for "length of the main stem", top height for leaning trees and snags must be measured along the length of the stem.
- For trees where top and base heights are NOT measured explicitly, these are estimated based on 9 trees that are measured in the 10 x 10 m plots.
  - If there are more than 9 trees ≥7 cm DBH in the 10 x 10 m area, then for the additional trees top height and base height are estimated to the nearest 0.5 meter.

- For trees where heights are estimated (and not measured directly), this is recorded on the data sheet.

Crown Class

- For each tree, record crown class as:
  - ***Veteran*** - Trees that are considerably older than rest of the stand, usually remaining from a previous forest.
  - ***Dominant*** - Trees with well-developed crowns extending slightly above the general level of surrounding trees, receiving full light from above and partial light from the side.
  - ***Co-dominant*** - Trees with crowns (slightly smaller than dominant and crowded from the sides) forming the general level of surrounding trees, receiving full light from above and little light from the side.
  - ***Intermediate*** - Trees with crowns (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.
  - ***Suppressed*** - Trees with crowns entirely below the general level of the surrounding trees, receiving virtually no direct light from above or the side.

Condition & Decay Stage

- For living trees, condition is recorded as "alive".
- For snags condition is recorded as "dead".
- For snags with complete tops, decay stage (Figure 7) is recorded as:
  - **Stage** 1 - recently killed, all twigs/ branches present, wood hard, bark (normally) intact
  - **Stage 2** - twigs and small branches missing, major branches remain, wood hard
  - **Stage 3** - no branches, bole mostly intact, wood starting to soften.
- If the snag is snapped along the bole so that the presence of twigs and branches cannot be evaluated, then decay is recorded as:
  - **Stage 1-2S** - recently killed, wood hard, bark (normally) intact
  - **Stage 3S** - wood starting to soften
  - **Stage 4S** - wood soft throughout

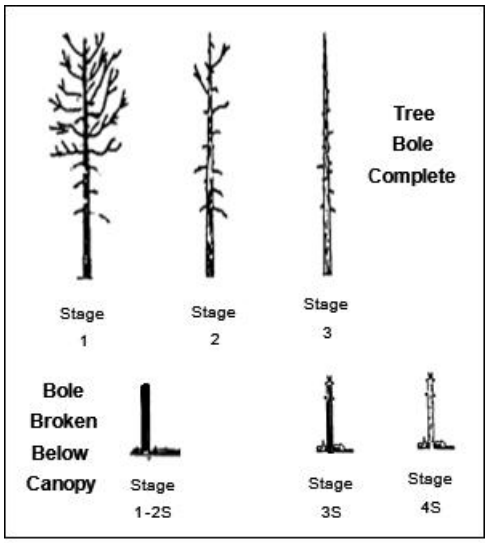

Figure 7

Down Woody Material

Regular Pieces of DWM

- DWM is measured on four sub-ordinal transects (Figure 8).
- To be included as DWM, the dead wood must intersect the transect and be above the litter layer (i.e., <50% buried).
- Transects start 10.35 m from site centre and extend for 25 m to the edge of the nested tree plots.
- DWM is divided into Coarse Woody Debris (CWD; ≥7 cm), Small Woody Debris (SWD; in 3 size classes [1.0-3.0, 3.1-5.0 and 5.1-7.0 cm]) and Fine Woody Debris (FWD; ≤1).
- The number of pieces of FWD that intersect the transect above the litter layer are tallied.
  - FWD are tallied along only the last 5 m of each DWM transect.
  - FWD includes only twigs, stems, and branches of trees and shrubs and does not include cones, bark flakes, fragments of stems and branches <10 cm long, or needles.

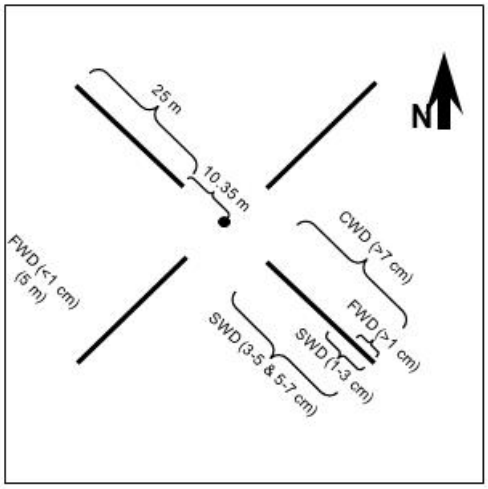

Figure 8

- Pieces of FWD often are short, thus it is necessary to have the tape measure within a few inches of the forest floor to accurately determine whether or not the FWD piece crosses the transect.

- The number of pieces of SWD that intersect the transect above the litter layer are tallied.
  - SWD 3.1-5.0 cm and SWD 5.1-7.0 cm are tallied along the entire 25 m transect.
  - The smallest size class of SWD (1.0-3.0 cm) is only tallied along the last 10 m of each DWM transect.
- CWD is surveyed along the entire 25 m transect.
  - CWD is measured (in 0.5 cm increments) using DBH calipers, at the point where the piece crosses the transect, in a plane perpendicular to the long-axis of the CWD.
  - Odd shaped (ie. not round) pieces of CWD are assigned an estimated diameter that is determined as if the piece was round.
  - Record the species code for each piece of CWD.
  - For CWD record decay stage at point of intersection of the transect (Figure 9):
    - Class 1 **Recently Dead** - Bark (normally) attached to the wood; little fungus mycelium developed under patches of loose bark. (~100-95 % of the initial dry density)
    - Class 2 **Weakly Decayed** - Loose bark (intact or partly missing); well-developed fungus 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)
    - Class 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)
    - Class 4 **Very Decayed** - Rotten throughout (entire knife penetrates into wood); log shape conforms to forest floor; often elliptical. (~50-25 % of the initial dry density)
    - Class 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)

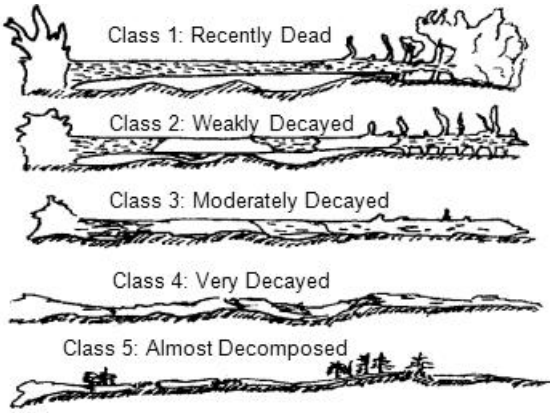

Figure 9

  - Scan closely for logs in a decay class of 5, as some can be hidden by moss and litter. If no clear log can be discerned, then it should be considered organic material and no longer woody debris.

Woody Accumulation and/or Slash Piles DWM

- In some cases there are many pieces of downed wood→ measure a portion of these a groups and estimate total amount from that measured:
  - **CWD Piles** (e.g., logging debris or slash piles): If a pile of CWD is encountered along the transect, and it is too time consuming to measure each piece individually, then a portion of the accumulation is measured and the total estimated from that partial measurement.
    - Estimate the horizontal width of the pile, and the average vertical depth of the pile. "Visually" compress the pile to determine the actual cross sectional area of wood, not including the space between the pieces. Based on length and width, estimate an approximate diameter of the accumulation as if it were round.
    - If the pile is at an angle to the transect line, estimate perpendicular diameter at the point of intersect similar to what would be done for a log.
    - Identify the most common species in the accumulation and the most common decay stage.
    - Make a note that the measurement is an estimate from a pile of CWD
  - **Many pieces of FWD and SWD**: If a tree crown has fallen across the transect containing many small branches, a proportion of the branches/pieces are counted and the total number estimated by multiplying by the proportion of length sampled.

- Measure the entire horizontal length of the debris field crossing the transect (i.e., debris field is 5 m wide along intersect).
- Choose a representative sub-sample (not just the first portion of transect) and tally the number of FWD and SWD pieces (i.e., 42 pieces of FWD and 25 pieces of SWD 1-3cm 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 debris field (i.e., in the above scenario multiply by 10; 420 pieces FWD and 250 pieces of SWD in class 1-3cm).

Tree Cores

- Trees to core are selected based on their relative abundance, and DBH
- A maximum of 9 trees are cored at each site
- Obtain a tree core from the **largest** (biggest DBH) live tree within the 1 ha area, regardless of species.
- Obtain a tree core from the **largest** live tree from the **leading** species (species with the highest stem density of dominant and/or co-dominant canopy trees), within each 50 x 50 m quadrant (total of 4 trees per site), not including veteran or residual trees from a former stand.
- Obtain a tree core from the **largest secondary** species (species with the 2nd highest stem density of dominant and/or co-dominant canopy trees), if it occurs, within a 50 x 50 m quadrant (potentially one tree from each quadrant), not including veteran or residual trees from a former stand. To be classified as the secondary species, the species must comprise >20% of the canopy stems in the quadrant.
- For all trees that are cored:
  - Use a vertex hypsometer to determine tree height to the nearest 0.1 m.
  - Use calipers or a DBH tape to record DBH to the nearest 0.5 cm.
  - Record significant tree damage (any condition that could affect the normal height or growth rate of the tree) 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, anthropogenic factors)
- For round trees, face site center and use the increment borer to obtain cores at a height of 1.3 m. If a tree is not round, obtain the core from the narrow width.
- If cores are rotten or break into more than 3 pieces while being extracted, recollect. If three attempts fail due to rot, collect a core from another similar tree. In some cases, a core will not be able to be obtained due to rot; in this case record the DBH, height, and damage for these trees and indicate that a core was not collected and why.
- Preserve the cores in straws. Staple the straw ends (do not tape) and puncture the straws in many places to allow air flow and reduce mold/rot.
- Place all cores/straws in a protective case (to ensure they do not become broken) to transport from site to camp.
- If all trees are <10 cm DBH, destructively sample a representative tree from the leading species from **outside** of the quadrant by taking a "cookie" at a height of 1.3 m (i.e., total of 4 trees per site). Place the cookie in a paper bag.
- Label the straws/cookies with the following information: site, quadrant, tree species, tree type (largest, leading, second) and date.
- When back at camp, dry the cores/cookies in a warm environment.
- At the end of the shift, take the samples to the laboratory for processing.

Canopy Cover

- Take a total of 8 canopy cover readings at each site.
- Readings are obtained at two corners of the 10 x 10 m tree plot (Figure 10; at 35.35 m and 49.49 m from site centre along each sub-ordinal transect).
- Stand facing site centre when obtaining the reading at 35.35 m and stand with your back to site centre when taking the reading at 49.49 m.
- Hold the densitometer in the palm of your hand at elbow height (i.e., with your arm bent at right angles) and ensure that it is level.
- Using your dominant eye, imagine four dots equally spaced in each of the 24 squares on the densitometer (4 equal quarters). Count the dots (quarters) that are in canopy openings (i.e. NOT covered) and record the number of open dots (quarters).

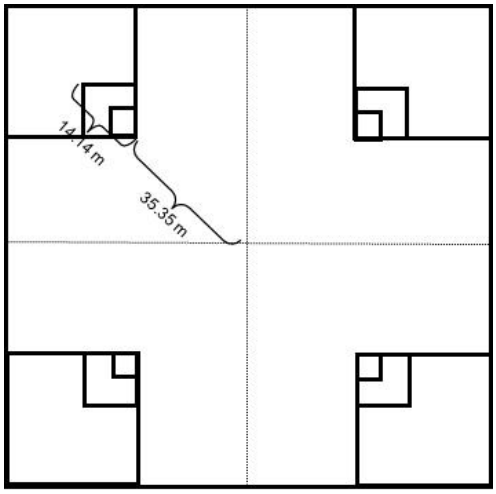

Figure 10

3.4 Soils & Mites

- Surface substrate is measured on two 30 m transects located to the north and south of each 1ha site (Figure 11).
- Soil cores are collected from outside the four corners of each 1ha site (Figure 11). These samples are used to quantify soil mites and obtain chemical composition of the mineral soil
- In order to maintain the integrity of the forest floor within the 1 ha site, all soil surveys are done outside this area.

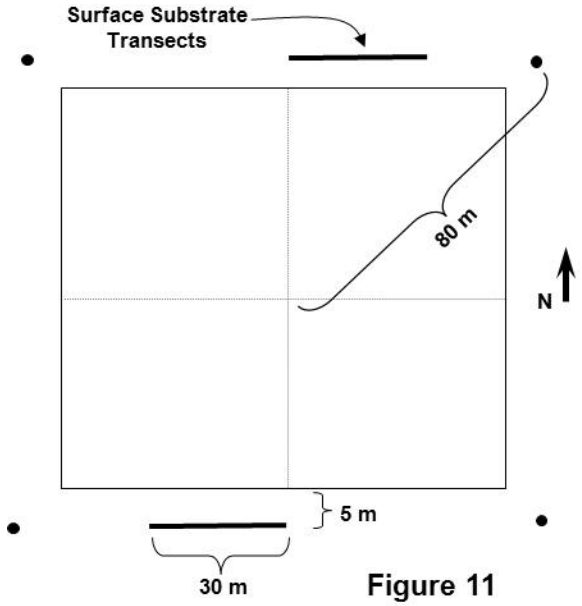

Figure 11

General Ecological Characteristics of Sample Areas

Surface Substrate Transects

- At the start of both surface substrate transects describe slope position (as described above) and direction (looking down hill) in degrees.
- Indicate the amount and cause of the disturbance (either by humans or naturally) and percent area affected (see above description) for the transect (30-m length, 2-m width).

Soil Cores

- Record ecosite type (see methods in Section 3.1) within a 2-m radius circle at the four locations where soil cores will be extracted.
- Record slope position (as described in Section 3.1) and direction (looking down hill) in degrees for each of the four locations.
- Indicate the amount and cause of the disturbance (either by humans or naturally) and percent area affected (see in Section 3.1) for the 2-m radius circle at the soil locations.

LFH Depth

- Depth of organic soil is measured on two 30 m transects, parallel to the 1 ha boundary (Figure 11).
- Organic matter is defined as the litter, fibric, and humic (LFH) layer of the soil horizon.
  - Determining the LFH horizon is usually straight forward based on the color and texture of the soil and resistance of the shovel to penetrate far into the mineral layer.
  - The organic layer is typically dark, coarse and fibrous (containing rooting systems) whereas the mineral soil is typically lighter colored, finely particulate, and lacking most roots.
  - LFH does not include live vegetation on the surface.
- Depth of organic matter and/or buried wood are measured every 2 m along the 30 m transect (15 sampling points per transect).
- At each sampling point, insert the shovel into the ground and pry to one side exposing the LFH.
- After distinguishing the transition from LFH to mineral soil, measure the LFH to the nearest 0.5 cm.
- If leaf litter is present, compress it before measuring LFH depth.
- Gently push the opening closed with your foot after the LFH depth has been measured.
- If the LFH is indistinct from the mineral soil layer (e.g., natural grasslands, cultivated fields, roads, etc.), only the litter is measured. This may only include leaves, grass, or debris on the surface.
- If buried wood is encountered, record depth of LFH and buried wood separately. For this survey buried wood is defined as downed wood, independent of decay stage, that is >50% below the ground surface AND >10 cm in diameter, otherwise it is considered organic matter.

- If the organic layer is deeper than 40 cm, (eg., bogs, some wetlands) record depth measurements at 4 m intervals (7 measurements along each of the 30 m transects). Use a 5 m soil probe to measure depth to mineral soil or to an impenetrable substrate, such as rock or a frozen layer.
- If only a partial depth of LFH can be obtained at a point because an impenetrable object is contacted, then indicate the following on the data sheet:
  - "HF" for Hit Frost,
  - "HO" for Hit Object (e.g., root, rock, etc.)
- In some cases LFH cannot be measured because the sample point falls on an impenetrable surface:
  - If the sampling point is more than 1 m from an area containing >1 cm of LFH, then note <1 cm as LFH depth and include a code for the reason in the description.
    - "B" for Bedrock
    - "R" for Rocks, cobbles and stones (rock fragments >7.5 cm in diameter)
    - "M" for Mineral soil (unconsolidated mineral soil and cobbles <7.5 cm in diameter, including human created gravel surfaces)
    - "O" for Other human created surfaces (eg., pavement, cement, building materials, etc.)
    - "D" for large DWM (DWM or stumps in decay class 1 or 2 AND >10 cm in diameter AND >50% above the ground surface)
    - "W" for Water (water above the ground surface before standing on the sample point; note that if water seeps to the surface after standing at the sampling point the location is treated like a regular upland point)). Streams and rivers are treated similar to standing water.
  - If it is possible to move the sampling point <1 m to either side of the transect to an area containing > 1 cm of LFH, then move the sample point, measure the LFH and record the following code in the description:
    - "B-S" for Bedrock–Side
    - "R-S" for Rock–Side,
    - "M-S" for Mineral-Side,
    - "D-S" for DWM–Side, or
    - "W-S" for Water-Side

    If there are multiple possibilities for moving to LFH, move in a direction as close as possible to south.

Organic Soil

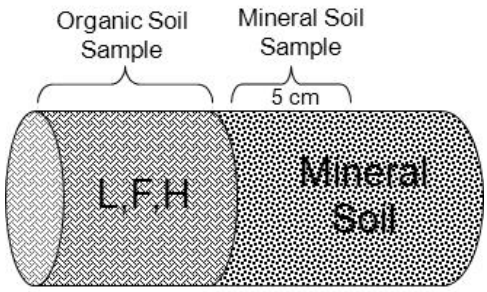

Figure 12

- Soil arthropods, organic soil and mineral soil are sampled in four locations at each site (Figure 11).
- Only the organic component of the cores is used when describing organic soil. The organic layer consists of the LFH soil and excludes the mineral soil (Figure 12).
- Determining the boundary between the LFH horizon and mineral soil is usually straight forward based on the color and texture of the soil. The organic layer is typically dark, coarse and fibrous (containing rooting systems), whereas the mineral soil is typically light colored, finely particulate, and lacking 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.
- If the LFH is indistinct (e.g., native grasslands), only the plant residue (litter) layer and the top 2 cm of the soil are included as organic soil.
- Where LFH layer has been mixed artificially by mechanical equipment (e.g., cultivated agriculture fields), or where inorganic soil and other materials have been spread over the surface (e.g., roads), only the plant residue (litter) layer on the surface and if possible the top 2 cm of the soil are included as organic soil. Note that this may include only a few leaves, grass, or other debris on the top of the core location.
- If a core location is in standing water, no core is taken. 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.

- If the organic layer is deeper than the corer can penetrate (i.e., corer is not long enough to reach the mineral soil) then the entire 40 cm of organic material the corer extracts is collected.
- A minimum of 4 cores are taken (Figure 13) from each sample location.
  - If more than 4 cores are required to accumulate 500 mL of organic material, additional cores are taken in a clockwise fashion (Figure 13) until 500 mL is attained or until 24 cores have been taken.
  - The number of cores required to get 500 mL of organic soil is recorded.
- For each location where a core could not be obtained, the reason for omitting this core is recorded:
  - SW = Standing Water
  - R = Rocks
  - SL = Stumps/Logs
- If cores can be taken, but are unique or only partial cores can be acquired then record the reason:
  - AM = Animal Material
  - HD = Human Disturbance (i.e., mineral soil,gravel road, pavement, residence))
  - WT = Water Table
  - DWM = Downed Woody Material (i.e., decayed logs, roots, etc.)
  - RT = Roots

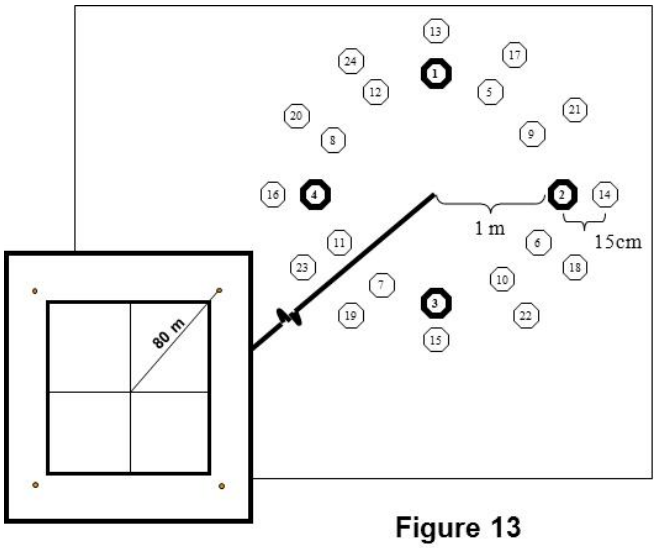

Figure 13

- The LFH from all cores at a location are mixed together and a random 500 mL sample is placed into a cloth bag for processing.
- Samples are labeled with the Sample Type (LFH), Collector's Initials, Date, Site Number, and Quadrant.
- If you a sample is not taken for any reason: label a soil bag, state reason with given code and submit with other collected samples.
- The volume of any remaining LFH is measured and returned to the site.
- Since organic material is collected from four locations, a total of 2 L of organic material is sampled per site.
- All samples from a site are placed into an open plastic bag to protect the sample from desiccation or water absorption and placed into a cooler with ice. The plastic bag must remain open to allow the mites to in the sample to live. Samples are separated from the ice in the cooler by a piece of plywood.

Mineral Soil

- Soil arthropods, organic soil and mineral soil are sampled in four locations at each site (Figure 11).
- Only the mineral component of the cores is used when describing mineral soil. The mineral layer is below the organic layer (Figure 12; see description of the organic layer above).
- Four 250 mL composite samples of mineral soil are collected – one in each of the four quadrants at each ABMI site. Each of these samples is created from multiple soil cores.
- When obtaining each core, ensure the corer enters into the mineral horizon for at least 10 cm.
- After removing the LFH layer from the core (see organic soil methods above), use a knife to cut the core 5 cm below the LFH horizon.
- If no mineral soil is present at the sampling point, or if mineral soil is too deep to reach with the soil corer, record that no mineral soil was collected. In these circumstances include an empty bag labeled as "No Mineral Soil" when shipping the soil to the lab.
- If after 4 cores at a location more than 250 mL of mineral soil is collected, then mix the mineral soil and sub-sample 250 mL.
- If there is <250 mL of mineral soil after 4 cores at a location, then continue collecting the mineral soil from

core samples, via the same sequence as described for organic soil, until a total of 250 mL of soil is collected per quadrant.
- Place the 250 mL of mineral soil sample in a cloth bag.
- Samples are labeled with the Sample Type (Mineral), Collector's Initials, Date, Site Number, and Quadrant.
- If you a sample is not taken for any reason: label a soil bag, state reason with given code and submit with other collected samples.
- Keep samples in a dry place while in the field.
- When back at camp, allow the samples to air dry in a well-ventilated space for 3 days.
- Store mineral soil samples in a dry location until they are shipped to the lab.
- Pack samples in the cooler and ship to the laboratory for processing.

Soil Mites

- Soil arthropods, organic soil and mineral soil are sampled in four locations at each site (Figure 11).
- Only the organic component of the soil cores is used when extracting mites. The organic layer consists of the LFH soil and excludes the mineral soil (Figure 12).
- Organic soil is sampled as described above.
- All organic soil samples from a site are placed into an open plastic bag to protect the sample from desiccation or water absorption and placed into a cooler with ice. The plastic bag must remain open to allow the mites to live. Samples are separated from the ice in the cooler by a piece of plywood.
- After a maximum of 3 days, coolers with fresh ice are couriered to the lab for mite processing. Note that to obtain reasonable samples of mites, extraction must be started within 6 days of the samples being collected.

3.5 Vascular Plants

General Site Characteristics

- General site characteristics are assessed in each 5 x 5 m tree plot (Figure 14).
  - Determine the ecosite type (as described in Section 3.1).
  - Describe slope position (as described in Section 3.1) and direction (looking down hill) in degrees.
  - If the 5 x 5 m plot is disturbed (either by humans or naturally), indicate the cause of the disturbance and the percent area affected (see methods in Section 3.1)

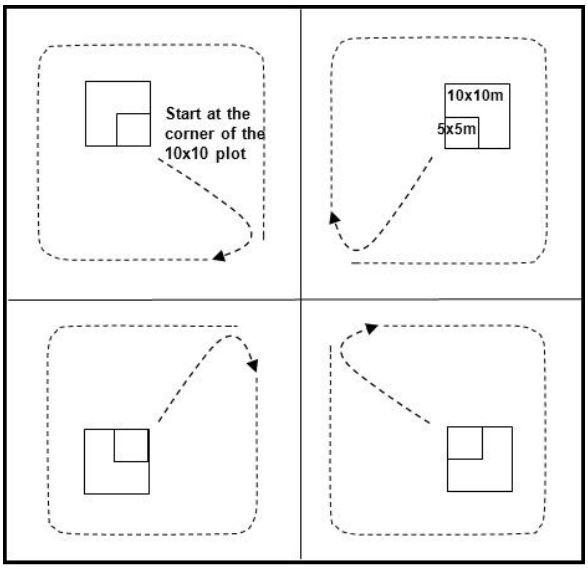

Figure 14

Plot Searches to Determine Species Presence

- To standardize sampling effort a single person completes all of the vascular plant surveys at a site.
- Vascular plant surveys are performed by a person that is capable of identifying >80% of the species encountered (including all common species).
  - This person must have at least one year experience surveying vascular plants and/or courses learning plant identification.
  - This person must spend a minimum of two days in the field "brushing up" on vascular plant identification prior to conducting surveys.
- Walk enough of the boundaries of each 50 x 50 m quadrant to ensure they are well marked prior to starting vascular plant surveys. If necessary add flagging to better mark the boundaries.
- Spend an initial 10 minutes writing down the names of all the vascular plants observed at a 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 little time writing down plant names.
  - During the initial 10 minutes when species names are being recorded, locate the most diverse habitat types within the 1 ha area and spend time in these habitats recording species names.
  - Organize the plant species on the data sheet by group (grasses, trees, shrubs, herbs) to aid in quickly finding the species while searching and to avoid recording a species multiple times.
  - Unknown species can be quickly identified during this initial 10-minute search, but if unable to identify the species quickly, collect the specimen from a population of greater than 5 individuals, outside the plot if possible. These unknown specimens are assigned a unique specimen number and carried to avoid multiple collections in each quadrant.
- Spend 20 minutes in each of the four quadrants (a total of 80 minutes) finding and recording presence for as many species of vascular plants as possible.
  - To maintain consistency among observers, start at the center of the quadrant, then move to within 5-10 m of site centre, then move in a clockwise direction around the quadrant staying approximately 5-10 m from the quadrant edge (Figure 14).
  - Stop every 4 or 5 steps to examine the plants in the immediate area.
  - Ensure that all habitat types in the quadrant are searched for vascular plants.
  - Always start the surveys in the NE quadrant and progress clockwise to the next quadrant (NE, SE, SW and NW)
- Field guides are not used during the four 20-minute searches; collect specimens of unknown or uncertain vascular plant species.

  - After the 20-minute search in a quadrant is complete, attempt to quickly identify the species you have collected using field guides.
  - Place "unknown" specimens in a plant press and take them to camp for identification during the evening.
  - Ensure that identification numbers for unknown specimens are not repeated for the site. Be especially diligent when collecting specimens from the "extra" low vegetation and shrub cover plots at agriculture sites (see below).
- For any vascular plant categorized as S1 or S2 by Alberta Conservation Information Management System (ACIMS), collect a specimen so its identity can be confirmed by experts. Refer to the "List of Plants to Collect" when deciding whether or not to collect a specimen. Collect the specimen from a population of greater than 5 individuals, outside the 1-ha area if possible.
- For specimens that cannot be identified in the evening, and for ACIMS S1 or S2 specimens, remove them from the field press and place them a different plant press. Ensure that the information (ABMI site number, reference code, date, collector's name) on the data sheet matches the information included with the specimen in the plant press.
- At the end of the field shift, take the plant press with unknown plants to the laboratory. These unknown specimens will be identified by experts.

Assessing Relative Density of Species

- Coarse estimates of density for vascular plant species are determined in the 10 x 10 m tree plots at the center of each quadrant (Figure 14).
- After each 20-minute search in a quadrant, stand at the corner of the 10 x 10 m plot and record which vascular plant species are "common" or "dominant" within the 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.
  - Of the species labeled as common, determine which has the highest percent cover and label this as the dominant species in the plot. Note that trees cannot be defined as dominant, but can be recorded as common.
  - Note that some quadrants may contain many common species (vegetatively diverse quadrants) whereas other quadrants may not contain any.

Shrub / Small Tree % Cover

- Shrub cover is estimated in the four 5 x 5 m tree plots at the center of each quadrant (Figure 14).
- Estimate 2-dimensional cover (0, <1, and 5% increments) of shrubs plus small trees (a single measurement that includes both).
  - Shrub/small tree cover is estimated independently for two height categories (>0.5 to <1.3 m high, and >1.3 m high). Each of these estimates cannot be greater than 100%. Note that % cover for shrubs is estimated in a third height category (<0.5 m high) as part of Low Vegetation measurements below.
  - The first estimate of shrub/tree cover is the percent cover that would be recorded if a photo was taken at 1.3 m above the ground and foliage from all shrubs/trees <0.5 m was excluded.
  - The second estimate of shrub/tree cover is the percent cover that would be recorded if a photo was taken at 5.0 m above the ground and foliage from all shrubs/trees <1.3 m was excluded.
- Percent cover is determined by ocular estimation and requires practice before the start of the data collection to ensure the estimates are accurate and consistent.

2-Dimensional % Cover for Low Vegetation

- 2-dimensional cover of the ground layer is measured in the four 5 x 5 m tree plots at the center of each quadrant (Figure 14).
- The ground layer is defined as vegetation and physical features <0.5 m high.
- Estimate 2-dimensional cover (0, <1, and 5% increments) as the percentage of the 5 x 5 m plot covered by:

  - shrubs/trees,
  - grasses,
  - sedges/rushes,
  - all "other" vascular plants combined,
  - mosses,
  - lichens,
  - fungi,
  - litter (dead vegetation material plus DWM <2 cm in diameter),
  - wood (live and dead trees >1.3 m tall, plus DWM >2 cm diameter),
  - water,
  - bare ground,
  - rock, and
  - animal matter.
- Estimates are the % cover that would be recorded by a photo taken at 0.5 m above the ground.
- Values of the independent categories must sum to 100%.

3.6 Bryophytes & Lichens

- Four 25 x 15 m plots are surveyed for bryophytes and lichens (Figure 15).
- A single person spends up to 35 minute in each of 4 quadrants (maximum total 140 minutes) collecting bryophytes.
- A second person independently spends up to 35 minute in each of 4 quadrants (maximum total 140 minutes) collecting lichens.
- Since the two field staff search different substrates it is necessary for them to work separately.
- To have consistent data, field staff do not change taxa throughout the season.

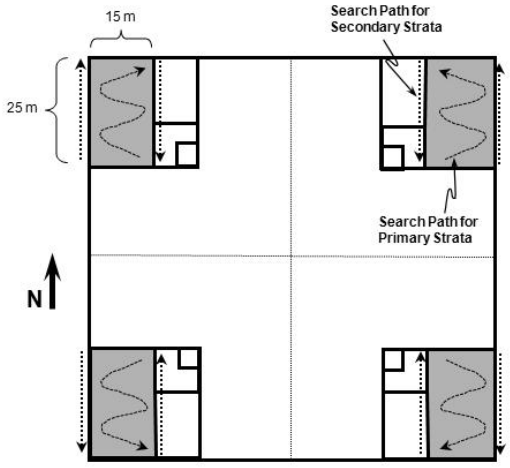

Figure 15

General Site Characteristics

- In each of the four 25 x 15 bryophyte/lichen plots record the % (0, <1% or in 5% increments) of the plot affected by human caused and natural disturbances (see descriptions in Section 3.1).

Plot Searches to Determine Species Presence

- Surveys for bryophytes and lichens are started in the NE quadrant and progress clockwise through the quadrants (NE, SE, SW, NW).
- In each quadrant, surveys are divided into two periods:
  - **First Period**: the strata (i.e., the appropriate microhabitat types describe in Table 5) that have diverse communities are searched in the 25 x 15 m plot.
    - **For bryophytes:** Strata #1 logs/ stumps, strata #3 wetlands/peatlands and strata #4 rocks and cliffs (Table 5) are searched.
    - **For lichens:** Strata #1 logs/stumps, strata #2 trees/other structures and strata #4 rocks and cliffs (Table 5) are searched.
    - To maximize the number of species detected, begin by surveying one example from each stratum that has the most diverse community. 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.
    - Continue searching the three primary strata by zigzagging through the plot (Figure 15).
    - Stop every 4 or 5 steps to examine the microhabitat types in the immediate area. When examples of the any of the primary strata are found, search these as you encounter them.
    - Note that if there are no examples of the 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 looking for examples of the primary stratum in each plot as some microhabitats are small and dispersed (e.g., rocks).
    - Specimen collection from primary strata may terminate after 10 minutes in a plot if all examples of the appropriate microhabitat have been searched (for example, if you are searching for lichens and there is a single tree, no logs, and no rocks/cliffs in the plot then sampling may be terminated after 10 minutes).
    - All forested plots with trees and/or logs should be searched for the full 25 minutes.

Table 5. Strata, and microhabitat types within strata, used during searches for Bryophytes and Lichens

Stratum #1: Logs and Stumps (samples in 1 bag)
Microhabitat Type A: Soft stumps & logs (decay classes 3-5) - sample roots and all sides
Microhabitat Type B: Hard stumps & logs (decay classes 1-2) - sample roots and all sides
Stratum #2: Trees, Shrubs and Other Vertical Structures (samples in 1 bag)
Microhabitat Type C: Deciduous Trees - all sides of the roots, bases, trunks, and branches of both live and dead deciduous trees
Microhabitat Type D: Coniferous Trees - all sides of the roots, bases, trunks, and branches of both live and dead coniferous trees
Microhabitat Type E: Shrubs - all sides of the roots, bases, stems, and branches of live & dead shrubs
Microhabitat Type F: Human Structures - vertical and horizontal parts of the structures (survey from the ground)
Stratum #3: Wetlands and Peatlands (samples in 1 bag)
Microhabitat Type G: Wetlands, marshes, & fens - within the wetland survey both under and away from trees
Microhabitat Type H: Shores/banks of wetlands, ponds, lakes, & streams - survey on organic or mineral soil adjacent the water's edge
Microhabitat Type I: Moist depressions/seasonal wetlands dry at time of survey - sample sides and bottom in the area influenced by water
Microhabitat Type J: Peatlands with or without standing water - survey both standing water and vegetation hummocks
Stratum #4: Rocks and Cliffs (samples in 1 bag)
Microhabitat Type K: Boulders (>50 cm diam.) - survey all surfaces (top, sides, and base) from the soil upwards
Microhabitat Type L: Rocks (<50 cm diam.) - survey all surfaces (top, sides, and base) from the soil upwards
Microhabitat Type M: 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)
Microhabitat Type N: Humus soils under trees/shrubs (shaded by canopy) - survey as large a variety as possible
Microhabitat Type O: Humus soils without trees/shrubs (open to sunlight) - survey as large a variety as possible
Microhabitat Type P: Agriculturally cultivated soils
Microhabitat Type Q: Mineral soil in upland areas from any causes

  - **Second Period:** the strata (i.e., the microhabitat types) that have less diverse communities are searched in a 50 m belt transect following the 2 long sides of the 25 x 15 m plot (Figure 15). Walk along the plot boundary and sample within 1 m of either side of the transects. This results in two 25 x 2 m transects in each of the 4 quadrants.
    - **For bryophytes:** Strata #2 trees/structures and strata #5 upland soils (Table 5) are searched.
    - **For lichens:** Strata #3 wetlands/peatlands and strata #5 upland soils (Table 5) are searched.
    - Ensure that examples of both secondary strata are searched if they occur in 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 bryophytes 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/lichens that appear distinctive.
- When collecting specimens:
  - Select only a small sample (i.e., 5-10 cm^2) so that the vegetation community remains intact.
  - If the specimen is growing on soil, wrap the sample with toilet paper so it does not break apart (and disintegrate) once the soil dries.
  - If the specimen is growing on a large boulder/rock/cliff, wet it thoroughly to help detach it from the substrate.
  - Place small/fragile specimens in paper packets so they don't get damaged or lost.
  - When in doubt about whether a specimen is unique or has been collected already, collect it again.
  - Do not collect 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 into a single paper bag. Note that there are multiple microhabitat types in each strata, and specimens for these are combined.
  - Create 5 paper bags with location and strata type clearly labeled for each quadrant.
  - 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.
- If no specimens are found in a stratum of a plot/transect, then indicate "None" on the empty paper bag and on the field data sheet.
- 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 for 3 days by spreading out the paper bags, checking the contents to ensure they're dry at the end of that time.
- Once dry, place all bryophyte sample bags into one large paper bag and label it with the location and "Bryophyte". Do the same for Lichens.
- Fill a large cloth bag with all the bryophyte samples and another with all the lichen samples, and transfer these to the laboratory.
- Specimens are sorted into species groups in the laboratory, and then identified by experts.

3.7 Birds

- To maximize detections of birds surveyed are conducted between May 25 and June 22. Note that the appropriate start date varies with latitude; a start date of May 25 is appropriate for southern Alberta with a gradient of start dates so that bird surveys start on May 30 in northern Alberta.
- This protocol is completed by one crew member while the other member surveys trees/snags/stumps, DWM, and collects soil cores at the site.
- Nine point count stations are surveyed in a grid pattern with a spacing of 300 m between stations (Figure 16).
- Point count station #1 is at ABMI site centre. The locations of the other eight stations are determined using a GPS.

General Site Characteristics

- General site characteristics are determined for each of the nine bird point count stations.
- All site characteristics (except photographs) that are recorded at site center (Section 3.1) are also recorded for each of the other eight point count stations.
- Record wind speed at the start of each point count:
  - 0 = No wind
  - 1 = Calm
  - 2 = Leaves rustling
  - 3 = Small branches moving
  - 4 = Large branches moving and tree swaying
- Record precipitation at the start of each point count.
  - None
  - Drizzle
  - Fog
  - Rain
  - Sleet
  - Snow
- Record time (24 hour clock) at the start of each point count.
- If wind or rain become strong during the survey, temporarily stop or discontinue the recording.

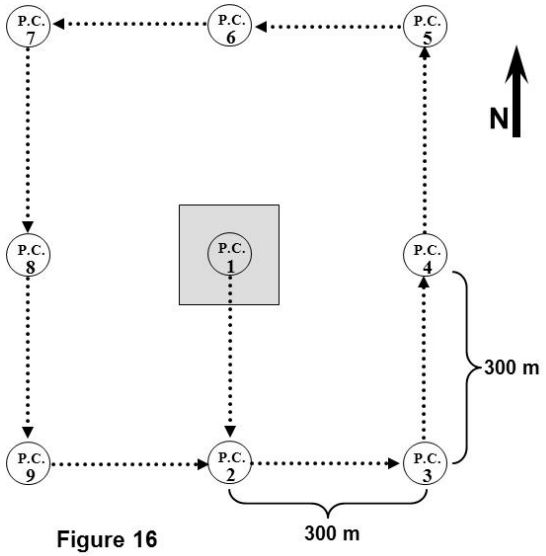

Figure 16

Bird Recordings

- Begin bird recordings approximately ½ hour before sun-rise.
- Unless inhibited in some manner, start at point count station #1, and proceed in numerical order until all point counts have been conducted.
- When conducting recordings at point count at station #1, the second crew member must be quiet to avoid disturbing the birds in the area and creating noise easily heard on the recording.
- Record bird vocalizations using the omni-directional microphone and recording unit.
  - Move the recording equipment directly north or south (keeping the right microphone on the east side) and as far as the cable will allow from the microphone; this will deliver any noise you make equally to the left and right microphones.
  - Recording levels must be standardized so recordings are comparable and to avoid potential for poor recordings.
  - Set the recording level based on the value for the particular model of microphone being used (described in the field manual) and use this setting consistently among sites regardless of wind or environmental conditions.
  - Ensure that all recordings are made at ≥320 kbps.
- Wear the headphones for the duration of the recording to ensure a recording is being made.

- Record the unit number of the microphone and recorder.
- At the beginning of each recording, state your name, crew number, date, site number, point count station number and the start time.
- Follow the voice introduction with a tone standard. It is important the tone standard be recorded for >5 seconds so that recording intensity can be standardized.
- Record birds for a full 10 minutes; the total length of the recording file will be about 10.5 minutes to include the introduction.
- During the 10 minutes in which the recording is being made, scan the surrounding area using binoculars. Scanning is particularly significant for stations near water.
    - For all birds observed (even those that are vocalizing), state the species identity, number of individuals, and distance they are from the microphone so that this information is also recorded.
    - State flock sizes for all birds flying overhead.
    - Say the information quickly and clearly so that it does not obscure natural vocalizations.
- Avoid movement during the recording because noises from even slight movements obscure bird vocalizations on the recordings.
- To ensure data are not lost, the 9 bird recording files must be digitally copied to a laptop computer or portable hard drive at the end of each day.
- All recordings are saved on the recorder as well as on the laptop for backup in the field.
- At the end of each field shift, bird recordings are transferred to the lab.

Point Count Stations in Difficult to Access Areas

- If a bird station is in open water and >200 m from vegetation, then it is not surveyed.
- If a bird station is located within a water body <200 m from vegetation, a recording (or visual count) is made from shore at the nearest location to the point count station. Mark the "new" recording location with the GPS and make appropriate comments on the data sheet (i.e., distance and direction from desired station).
    - If you cannot get to within 100 m of the bird station, conduct a 10-min **visual** point count (using binoculars) to scan the water body recording your observations into the microphone and on a datasheet.
- If you cannot reach a bird station due to some type of obstruction (e.g., river, bear activity), note the cause for the absence of data and continue to the next accessible bird point count station.

3.8 Mammals

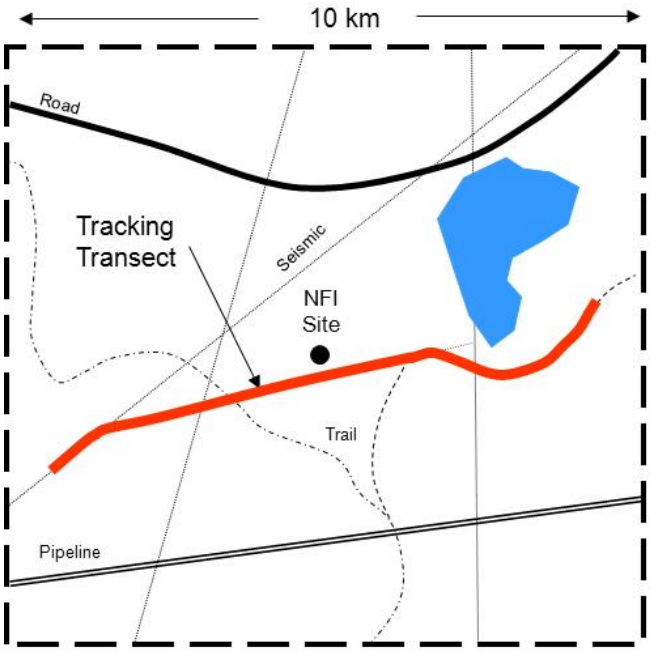

Figure 17

- Mammals that are active during the winter are surveyed along a 10 km long transect (Figure 17).
- The 10 km transect is divided into forty 250 m segments.
- Species are recorded as detected or not-detected on each segment based on whether or not their tracks cross the segment.
- Surveys are conducted between November 1 and March 31 on days with good snow-tracking conditions.
- Since tracks of wildlife accumulate in snow over time, the number of days since last track-obliterating event (i.e. "days since last snow") is determined to "correct" the data.
- Days since last snow is defined as the number of days between the date of the last track-obliterating event and the day of the survey.
  - A track obliterating event is considered to be a snowfall >1 cm, or a daily average wind speed that exceeds 30 km/hr.
  - Track surveys are only done between 3 and 6 days after "track-obliterating" events.
  - Information from Environment Canada (http://weatheroffice.ec.gc.ca) is used to obtain regional overviews of weather events.
  - Wherever possible contact local residents or government personnel to verify Environment Canada information.
  - Information about track-obliterating snowfall at a specific area can be determined based on snow accumulation over vehicle tracks on roads in the area.

General Site Characteristics

Climatic Conditions

- Before starting and after finishing the 10 km transect climatic conditions are recorded:
  - Air temperature
  - Snow depth (push the meter stick or meter tape through the snow to the ground in three places and record the depths)
  - Snow conditions (powder, wet, or crust)
  - General weather (cloudy, clear, overcast)
- If it snows while conducting the survey, determine whether the snow is sufficient to obliterate tracks; if this happens data collection is abandoned for that day. If tracking is abandoned, record the number of transect segments surveyed.
  - If possible the entire transect should be re-sampled at a later date.
  - If it is not possible to redo the complete transect, then the portion that was not surveyed must be completed.

Vegetation Information

- For each of the 40 segments on the 10 km transect, record the primary habitat type.
- Classification is based on habitat types along the entire segment.
  - Coniferous forests:
    - C10 = >80% Coniferous 0-30 years old
    - C50 = >80% Coniferous 31-80 years old

        - C100 = >80% Coniferous >80 years old
    - Deciduous forests:
        - D10 = >80% Deciduous 0-30 years old
        - D50 = >80% Deciduous 31-80 years old
        - D100 = >80% Deciduous >80 years old
    - Mixedwood forests (20-80% Deciduous AND 20-80% Coniferous):
        - M10 = >80% Mixedwood 0-30 years old
        - M50 = >80% Mixedwood 31-80 years old
        - M100 = >80% Mixedwood >80 years old
    - BURN = Burned forest <30 years old with >100 burned standing snags per ha
    - HARV = Cutblock < 30 yrs old
    - GRASS = <10% tree cover with grass dominated low vegetation
    - HERB = <10% tree cover with herb dominated low vegetation
    - SHRUB = <10% tree cover with shrub dominated low vegetation
    - CULT = Agriculture Cultivation
    - PAST = Agriculture Pasture
    - IND = Industrial (e.g. mine site, compressor station etc.)
    - RES = Urban or Rural Settlements (e.g. farmsteads, subdivision, cottages, etc.).
    - WET = 20-80% bog, sedge, rush, etc.
    - WATER = >80% ice/water,
    - BARE = >80% non-vegetated.
- If more than one habitat type is present, then record the secondary habitat type along with percent composition of each type in brackets (the sum of percentages may be less than 100 if more than two habitat types are present).
- Some habitat types may be difficult to determine because of snow cover; estimate these based on the surrounding habitat types.

Human Disturbance

- Record evidence of human disturbance present along each segment (see description in 3.1 above).
- Multiple human disturbance types may be present; record all types that are encountered.

Surveying Mammal Tracks

Training

- Field staff must be capable of accurately identifying all mammal tracks that could be encountered along the snow transects.
- To ensure accuracy, all staff:
    - Must spend at least one day in a class room becoming familiar with tracks.
    - Must spend at least two days in the field practicing finding and identifying mammal tracks.
    - People without previous experience tracking mammals, must spend at least two days conducting mammal tracking while accompanying a person with experience.

Data Collection

- Use a GPS to record the transect where data is collected.
    - Divide the 10 km transect into forty 250 m segments.
    - Ensure the GPS track log is turned on to record the "on-the-ground" location of the transect while conducting the survey.
    - Record GPS waypoints at the beginning and end of each 250 m segment.
    - Once the 10 km transect is completed, save and name the track log.
- Caution must be exercised if crossing a water body to ensure that the ice is thick enough (>15 cm) for travel.
- For safety reasons, do not conduct surveys when the temperature is below -30^{o}C, or if the wind-chill is below -30^{o}C.

- In remote locations where access by helicopter is necessary, and in locations where snow machines will not be very effective, transects are surveyed on snowshoes or skis.
- If using a snow machine travel along the complete transect first and then survey tracks of animals while traveling back along the transect (travel at a rate not exceeding 10 km per hour). If surveying on foot, it is not necessary to travel the transect both ways.
- Within each of the forty 250 m segments, determine species identity for all tracks that cross or meet the segment.
  - Species are included if their tracks occur within ~1 m on either side of the transect.
  - Tracks of domestic animals are identified and recorded.
  - Common species codes include:

Species	Code		Species	Code
Badger	BADG		Moose	MOOS
Beaver	BEAV		Mountain goat	MOGO
Bighorn sheep	BISH		Musk rat	MUSK
Bison	DBIS		Otter	RIOT
Black bear	BLBE		Porcupine	PORC
Bobcat	BOBC		Pronghorn	PRON
Caribou	CARI		Raccoon	RACC
Cougar	COUG		Skunk	STSK
Coyote	COYO		Snowshoe hare	SNHA
White-tailed Deer	WTDE		Squirrel	UNSQ
Mule Deer	MUDE		Swift fox	SWFO
Elk	WAPT		Weasel	ERMI
Red Fox	REFO		Wolf	GRWO
Fisher	FISH		Wolverine	WOLV
Grizzly bear	GRBE			
Horse	DHOR		Unidentified Deer	UNDE
Lynx	CALY		Unidentified Mustelid	UNMU
Marten	MART		Domestic Dog	DDOG
Mink	MINK			

  - Some animals may travel along the transect. Include the species in any of the segments that it was observed.
    - Record the species as "1" if it crosses the transect and the track does not enter the next segment.
    - Record the species as "2" in a transect if it moved along the transect so that it was present in both the previous and present segment.
    - Note that if an animal moves from one segment to the next and a new individual of the same species enters the new segment, then the new entry takes precedence and is recorded as "1".
  - When tracks cannot be easily identified, additional information is collected.
    - Follow the tracks for up to 200 m on either side of the transect in search of clear prints and/or additional sign (like scat).
    - If the tracks still cannot be identified, record notes and rough sketches or photographs of the track including track dimensions and the depth that the animal sunk into the snow.
  - Some species are of special interest to stakeholders. When tracks of lynx, bobcat, cougar, wolf, swift fox, wolverine, river otter, fisher, martin, badger, caribou, antelope, bighorn sheep, or mountain goat are encountered, a GPS waypoint is recorded (using the species code to label the waypoint) for up to a maximum of 10 waypoints, per species, per transect.
  - Photos and measurements are taken for:
    - Tracks that cannot be definitively identify.
    - Species encountered outside their normal range (e.g., raccoon tracks in northern Alberta)
    - Species that are rarely encountered in winter (e.g., black and grizzly bears).
    - Species in habitats or geographic locations where two or more similar species may be easily confused (e.g., bighorn sheep and mountain goats or caribou, elk and moose).

        - Species that leave unusual tracks (e.g., badger or porcupine) and that may be difficult to identify.
        - To save time, measurements and photographs are only required for the first 3 encounters of a special interest species.
    - When taking photos, the following is required:
        - The animal's print.
        - A series of three or four prints.
        - The animal's track (emphasis on the track).
        - The animal's track (with emphasis on surrounding habitat).
        - All photographs must include an object for scale.
        - Obtain as much contrast as possible in the photos.
    - In addition to photographs, it is essential to measure prints and tracks:
        - Length and width of animal's print.
        - Centre straddle of the track (i.e., the width between the centers of the right and left prints).
        - Stride of the track (i.e., the distance from the centre of one print to the centre of the next one).
    - Where possible collect information on habitat, group size, and behavior (e.g., caribou cratering) of the animal.
- To ensure data are not lost, the GPS track log must be downloaded to a secure computer at the end of each day.
- Photographs (if any) are forwarded to experts for verification.

3.9 Incidental Vertebrates

- While conducting surveys at a site, special interest vertebrates that are observed or heard are noted (Text Box).
- Vertebrate sign (scat, nests, dens, track, tree scars) are also recorded if the species creating the sign can be determined.
- For species detected indicate how it was using the area (i.e., fly-over, heard way-off in the distance, etc.)
- Record the date, start time (as soon as you arrive at the site) and end time (just before you leave) to allow sampling effort to be calculated for incidental sightings. It is important to record the date and time even if no incidental species were detected.

Special Interest Vertebrates
- Birds (corvids/jays, raptors, grouse, waterfowl/shorebirds, woodpeckers)
- Mammals
- Amphibians
- Reptiles
- Fish
- Domestic & Feral Animals (cows, dogs, cats, etc.)

- Each crew member fills out their own incidental species report even if observations are made while working together.
- Terrestrial filed surveys are conducted at three spatial scales (within the central 1-ha area for most measurements, within the point count area when surveying birds, and along a 10 km transect when surveying mammal tracks). Since spatial scale affects the probability of detecting vertebrates, record observations and the start and end times separately for each scale.

4. SUPPLEMENTAL DATA COLLECTION

4.1 Supplementary Data Collection at Sites in the Grassland and Parkland Regions

Some of the attributes measured during field sampling (e.g., Trees/Snags/Stumps and Downed Woody Material) are absent or at very low densities in sites dominated by agricultural activities. At these sites grasses, herbs and shrubs are the dominant habitat elements. To better quantify low vegetation in the Grassland and Parkland Natural Regions (Figure 18), supplemental sampling is done for shrubs, grasses and herbs.

- All survey protocols conducted in the outside grassland and parkland regions are also conducted in the agricultural zone.
- Supplementary protocols are conducted in the grassland and parkland regions:
  - A 5th vegetation plot is established in the center of the most common ecosite type to collect detailed information on low vegetation and shrubs.
    - Shrub and low vegetation protocols (described in 3.4) are completed in this 5th plot.
    - An additional protocol – % cover of low vascular plant species – is also conducted.

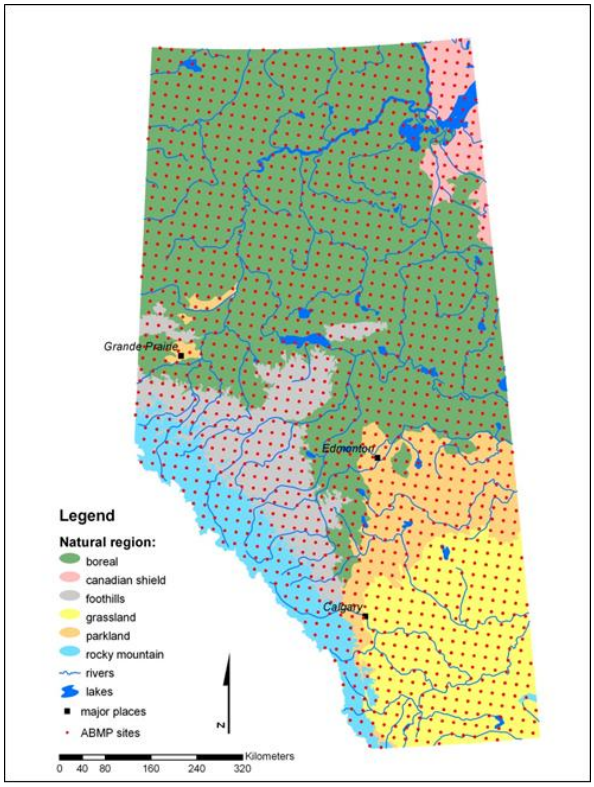

Figure 18

Establishment of the 5th Vegetation Plot

- The primary (most common) ecosite type in the 1 ha area is identified.
- A large relatively homogenous area of the primary ecosite type is identified in or near the 1 ha area.
- A 5th shrub plot (5 x 5 m) plus nine vascular plant cover plots (0.5 x 0.5 m) are established so they are totally contained within the primary ecosite type (Figure 19).
- It is important to locate the additional plots so they are totally within the primary ecosite type.
- The exact coordinates of the SW corner of all 9 low vegetation cover plots is are recorded so that the same plots can be re-measured during the next visit.

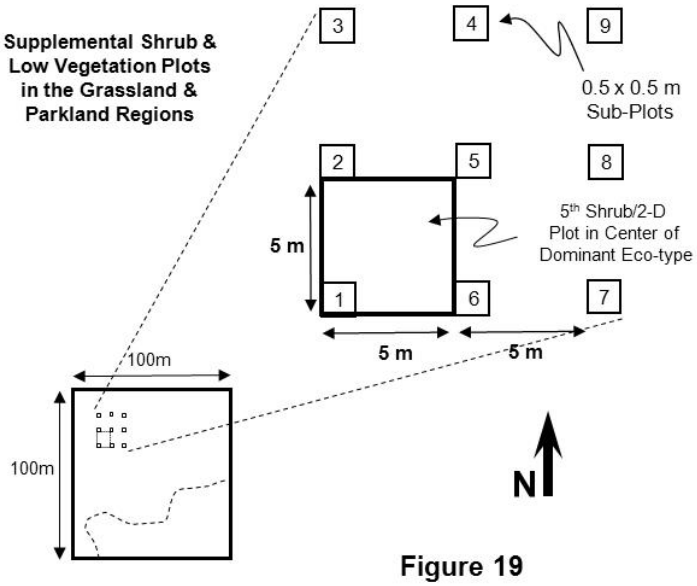

Figure 19

Site Characteristics of the 5th Vegetation Plot

- Determine slope position and direction using the protocols described in Section 3.1.
- Determine the ecological site type using the protocols described in Section 3.1
- Take a single photo of the 5th plot based on protocols described in Section 3.1. Stand 1 m SW of the SW corner of plot 1 and take the photo towards the NE corner
- Record amount of the 5th plot that is disturbed by humans and the amount that is naturally disturbed (based on protocols described in Section 3.1).

Vascular Plant Characterization of the 5th Vegetation Plot

2-Dimensional Cover of Shrubs

- Throughout Alberta, shrub cover is measured in the four 5 x 5 m tree plots (Figure 11, see Section 3.4).
- In Grassland and Parkland natural regions shrub cover is also measured in the 5th vegetation plot (Figure 19).
  - 2-dimensional cover is estimated (0, <1, and 5% increments) for shrubs plus small trees as a single measurement that includes both.
  - Note that shrub/tree cover is measured in the height category <0.5 m high as part of 2-Demensional Cover for Low Vegetation below.
  - Shrub/small cover is estimated for the category 0.5 to 1.3 m.
  - Shrub cover only (not including trees) is estimated for the category >1.3 m high.
  - % cover is estimated based on protocols described in Section 3.4

2-Dimensional Cover for Low Vegetation and Ground Features

- Throughout Alberta, % cover of low vegetation and ground features are measured in the four 5 x 5 m tree plots (Figure 11, see Section 3.4).
- In the Grassland and Parkland natural regions % cover of low vegetation and ground features are also measured in the 5th vegetation plot (Figure 19).
- 2-dimensional cover is estimated (0, <1, and 5% increments) for each of the following:
  - shrubs/trees,
  - grasses,
  - sedges/rushes,
  - all "other" vascular plants (i.e., not including shrubs/trees/grasses/sedges/rushes) combined,
  - mosses,
  - lichens,
  - fungi,
  - litter (dead vegetation material plus DWM <2 cm in diameter),
  - wood (live and dead trees >1.3 m tall, plus DWM >2 cm diameter),
  - water,
  - bare ground,
  - rock, and
  - animal matter.
- Cover is estimated independently for each of four height classes (<10 cm, 11-25 cm, 26-50 cm, >50 cm); note that shrub cover >50 cm is also measured in 2-Demensional Cover of Shrubs above.
- Estimates are the percent cover that would be recorded by photos that just included the height class in question.
- For the <10 cm height class estimates must sum to 100%. For each of the other height class, estimates of percent cover cannot be greater than 100%, and may be < 100% because open space is not recorded and the categories bare ground, water and animal matter will not be present in these height categories.
- Percent cover is determined by ocular estimation and requires practice before the start of the data collection.

% Cover for Each Shrub Species

- Estimate percent cover (0, <1, and 5% increments) for each individual shrub and tree species rooted within the 5 x 5 m area of the 5th plot.
    - Due to overlapping of leaves at different heights, percent cover for each individual species, and all species combined, can be greater than 100%.
    - Percent cover is determined by ocular estimation and requires practice before the start of the data collection to ensure the estimates are precise.
- Collect voucher specimens of unknown or uncertain species from a population of greater than 5 individuals, outside the plot if possible. Take the voucher specimens to camp for identification during the evening.
- For any shrub or tree categorized as S1 or S2 by ACIMS, collect a specimen so it's identity can be confirmed by experts. Collect the specimen from a population of greater than 5 individuals, outside the plot if possible.
- When collecting voucher specimens, record location and a unique reference number. Ensure that specimen numbers do not repeat those collected during the regular vascular plant search.
- For specimens that cannot be identified in the evening, remove them from the field press and place them a different plant press for temporary storage. Ensure that the information (location, reference number, date, collector's name) on the data sheet matches the information included with the specimen in the plant press.
- At the end of the shift, take unidentified and S1/S2 specimens to the laboratory for identification.

% Cover for Each Low Vegetation Species

- Estimate percent cover (0, <1, and 5% increments) for each vascular plant species in each of the nine 0.5 x 0.5 m sub-plots within the 5th plot (Figure 19).
- Vascular plants must be rooted within the plot to be included in the estimation.
- Percent 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 for each species (and all species combined) can be greater than 100%.
- Collect voucher specimens of unknown or uncertain specimens from outside the plot if possible. Take the voucher specimens to camp for identification during the evening.
- For any vascular plant categorized as S1 or S2 by ACIMS, collect a specimen so it's identity can be confirmed by experts. Collect the specimen from a population of greater than 5 individuals, outside the plot if possible.
- When collecting voucher specimens, record the location and a unique reference number. Ensure that reference numbers do not repeat those collected during the vascular plant search.
- For specimens that cannot be identified in the evening, remove them from the field press and place them a different plant press for temporary storage. Ensure that the information (location, reference number, date, collector's name) on the data sheet matches the information included with the specimen in the plant press.
- At the end of the shift, take unidentified and S1/S2 to the laboratory for identification.

4.2 Supplementary Data Collection at Agricultural Dominated Sites in Mountain, Foothills, Boreal and Shield Regions

Some sites outside the Grassland and Parkland natural regions (Figure 20) have had the trees removed to facilitate agriculture activities. At these sites, little information will be collected for trees and DWM, and the bryophyte and lichen communities may be much simpler than found in sites with trees. As such, at sites within the Mountain, Foothills, Boreal and Shield natural regions that have had >60% of the vegetation in the central 1 ha area modified by cultivation, supplemental survey is conducted. To better quantify low vegetation in these agricultural dominated sites, additional measurements are done for shrubs, grasses and herbs.

- All survey protocols conducted at other sites outside the "agricultural dominated sites" are also conducted at the agricultural dominated sites.
- Supplementary protocols are also conducted:
  - A 5th vegetation plot is established in the center of the most common ecosite type to collect detailed information on low vegetation and shrubs.
    - Shrub and low vegetation protocols (described in 3.4) are completed in this 5th plot.
    - Similar to that in the agricultural zone, an additional protocol – % cover of low vascular plant species – is also conducted.

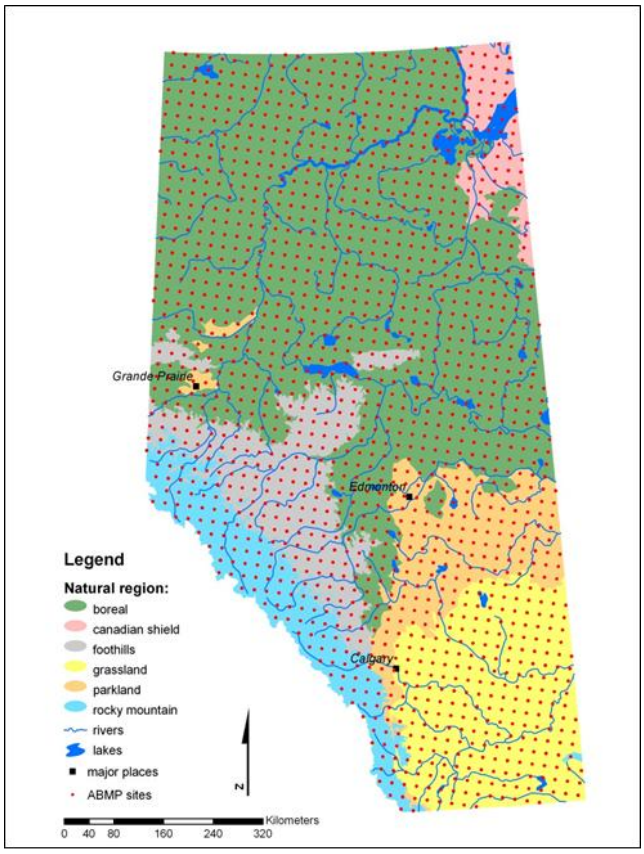

Figure 20

Establishment of the 5th Vegetation Plot

- The primary (most common) ecosite type in the 1 ha area is identified.
- A large relatively homogenous area containing the primary ecosite type is identified in or near the 1 ha area.
- A 5th shrub plot (5 x 5 m) plus two vascular plant cover plots (0.5 x 0.5 m) are established so they are totally contained within the primary ecosite type (Figure 21).
- The exact coordinates of the SW corner of both low vegetation cover plots are recorded so that the same plots can be re-measured during the next visit.
- Data collection is similar to that described for the 5th vegetation plot in the Agricultural Zone (Section 4.1).

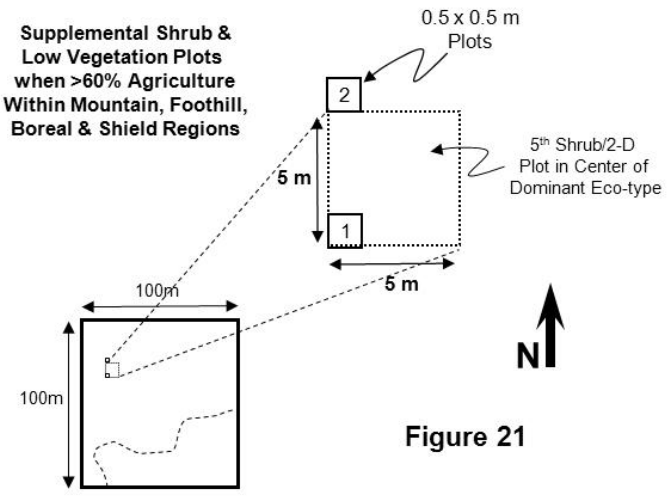

Figure 21

4.3 Supplementary Data Collection for the National Forest Inventory

Most of the information required by the National Forest Inventory (NFI) is collected as part of the ABMI. However, a few additional elements are required to complete NFI. These supplementary protocols will be implemented at only 10% of the ABMI sites.

Vegetation Clipping

- Four 1.0 x 1.0 m plots are located, 105 m from site centre, in each sub-ordinal direction (Figure 22).
- Vegetation is collected in four separate bags from each clip plot. Samples are not combined among plots.
  - Bag 1 – Shrubs: includes all woody shrubs and small trees ≤1.3 m in height
  - Bag 2 – Herbs: includes herbs, forbs and graminoid species, regardless of height
  - Bag 3 – Bryoids: includes mosses, lichens, slime molds and mushrooms
  - Bag 4 – Fine Woody Debris: all woody material ≤1.0 cm in diameter
  - If one or more of the bags has no material, still label the bag, indicate on the bag that it is empty, and return it with the other bags

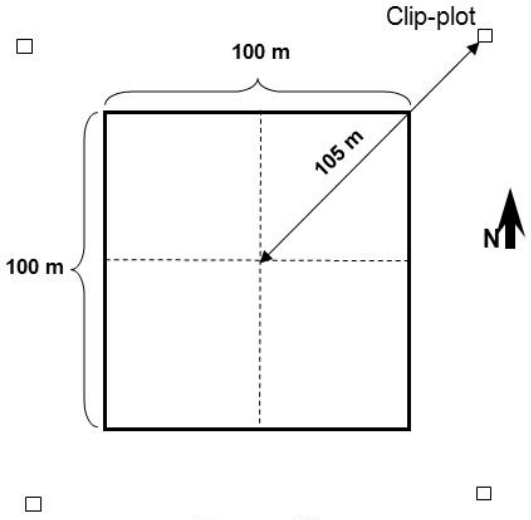

Figure 22

- Shrubs are in species, but not limited to: *Betulaceae, Caprifoliaceae, Cupressaceae, Ericaceae, Grossulariacaeae, Rosaceae (most), Salicaceae*.
- Clip all shrubs/trees <1.3 m high, herbs, and graminiod species at the ground level.
- Only clip plants if the germination point is within the plot. If a plot splits a large clump of grass (where the germination point is not easily determined) then clip the portion within the plot. If the base of the forage is in standing water, clip the material below the water line at the 2 cm height (if practical). If not practical, clip the material at the water line and record an estimate of the portion clipped in the comments.
- Clip the moss layer using large angled shears, or simply pull out the moss. Care must be taken to clip the living mosses at the base of the green, photosynthetic material. The brown part of the moss layer is included as part of the forest floor organic sample.
- Collect all fine woody debris (FWD) ≤1.0 cm in diameter (includes cones, bark, wood chunks and other debris – Note that this is not consistent with the definition of FWM in the ABMI [FWD does not include cones, bark flakes, fragments of stems and branches <10 cm long, or needles]), that is above the litter layer. Clip pieces of FWD ≤1.0 cm at the plot edge if they extends outside the plot.
- If a piece of FWD is ≤1.0 cm at one end and >1.0 cm at the other, clip the piece and collect the portion ≤1.0 cm (e.g., if a large woody debris piece located in the micro plot has fine branches ≤1.0 cm, these would be clipped at the tree bole or at >1.0 cm and collected). Pieces are cut into convenient lengths to facilitate bagging.
- Pieces of FWD that extend into the litter are clipped at the surface of the litter layer.
- Only collect aerial pieces of FWD located in the shrub layer (≤1.3 m above ground level).
- Clipped material is air dried, when back at camp to inhibit development of mold or fungal growth. Leave the material in open paper bags in a dry room for several days (shrubs and herbs for at least 24 hrs. and FWD for at least 48 hours) to remove excess moisture. Rotate the forage in the bags to ensure even drying and to prevent decomposition.
- Ensure bags are labeled correctly and store them in a dry location until they are shipped.

Soil Bulk Density

- Four soil samples are obtained 100 m from site center; one in each sub-ordinal direction (Figure 23).
- Minimize site disturbance by excavating as little soil as possible and by placing the excavated soil on a tarp. All of the excavated material must be returned to the pit (mineral soil on the bottom, covered with the organic soil) and the surrounding areas returned to as close to natural as possible.
- A total of seven mineral soil samples are collected during the initial survey (Figure 23):
  - 4 samples are taken from the top layer (0 to 15 cm), one from each corner of the 1 ha area,
  - 2 samples are taken from the middle layer (15 to 35 cm), only the NE and SW locations, and
  - 1 sample is taken from the bottom layer (35 to 55 cm), only the NE location.
- During re-measurement only four mineral soil samples are collected:
  - 4 samples are taken from the top layer (0 to 15 cm), one from each corner of the 1 ha area,

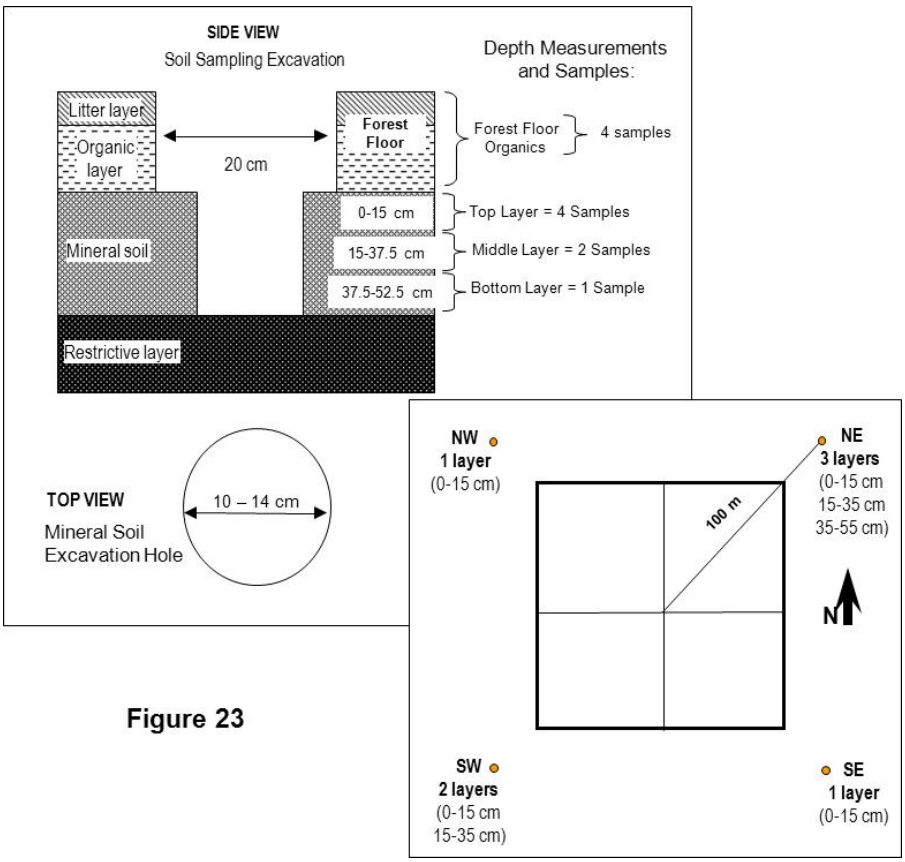

Figure 23

Bulk Density of Forest Floor Organics (LFH above the mineral soil)

- Samples of the forest floor are taken from all four locations.
- Taking care not to compact soil in the sample area, remove all live vegetation, woody debris and green moss and lichens from the sampling location (Note that live vegetation and woody debris will have been removed from the clip-plot already and soil could be sampled from the center of this plot. However, if the forest floor was compacted in the clip-plot during vegetation collection, then soil must be collected in a different area and the live vegetation/woody debris removed from this other area.)
- Place the 12 x 12 cm sample frame on the LFH soil surface.
- Use a sharp knife, handsaw, and/or clippers, carefully cut through the forest floor (LFH) along the inner surface of the frame to separate the sample from the surrounding soil.
- With a hand trowel, use inward scooping motions to remove the entire volume of forest floor from within the confines of the sampling frame.
- Working over a tarp, place the LFH that has been collected into a sample bag.
- To avoid carrying large rocks, scrape all the LFH from the rocks >7.5 cm diameter (note that this soil must be saved in the sample bag). Weigh the rocks to the nearest gram, record the weight so that volume can be calculated assuming rock to have a density of 2.65 g/cm^3, and discard the rocks.
- Note that if large rocks were not included in the sample bag, then record the weight of the rocks on the bag and on the data sheet.
- Alternatively, retain all rocks as part of the sample.
- Ensure that the forest floor sample extends to the point where it meets the mineral soil.

  - Distinguishing the organic/mineral interface can be difficult on sites with humus forms that are well mixed (e.g. a Moder humus over an Ah layer).
  - Technically, a soil horizon is classed as mineral soil when it contains an organic carbon content ≤17% by weight.
  - For field purposes, the determination is usually made by hand by feeling for the presence of mineral materials in order to judge the organic/mineral interface.
  - Where the determination is unclear, make a best judgment in the field and then note it on the data sheet in the comments section.
- Record the average depth (in 0.1 cm increments) of the forest floor organic sample by taking four different measurements within the excavation. These measurements are used to calculate the volume of the excavation, and in turn, the bulk density of the forest floor organic layer.
- If the sample location is on a slope, ensure the average of the 4 depth measurements gives an accurate measure of the depth of forest floor organic sample (i.e., measure throughout the 12 x 12 cm area in a representative manner). Under these circumstances, also measure the slope and record it in the comments.

Bulk Density of the Top Layer of Mineral Soil (0-15 cm depth)

- Samples of the top layer of mineral soil are taken from all four locations.
- After the organic layer has been removed, collect the first layer of mineral soil.
  - Place the 10 cm sampling ring on the mineral soil surface, sharp edge downwards.
  - Select an area where there are no large roots or visible stones.
  - Drive the ring 7.5 cm into the mineral soil by placing a block of wood on the ring and hammering on the block until the ring is flush with the ground. Be careful to not damage the sampling ring by driving it into stones.
  - Dig carefully around the ring with a soil knife or trowel until the ring can be lifted out with the soil sample intact.
  - Slide the piece of aluminum under the sampling ring to create a core that is exactly 7.5 cm deep.
  - **The use of the core to calculate bulk density requires that the soil sample be exactly the volume of the ring.**
  - Working over a tarp, place the soil sample into a heavy plastic bag for storage and transportation. If soil spills onto the tarp, add that to the plastic bag also.
  - Repeat the extraction process for the next 7.5 cm core of mineral soil. **It is important that the cores are a continuous sample of the soil column – start the second core exactly where the first core stopped.**
  - Working over a tarp, place this second soil sample into the same heavy plastic bag as was used for the first sample.
  - Together these first two samples from the top layer of mineral soil.
- If during extraction, a sample partially falls out of the ring, then a new sample must be taken.
- Clean the sampling ring between the top and middle layers to eliminate contamination (note that samples will be used for chemical analyses). Normally a simple wipe with a clean rag is sufficient; however, if the rings have dried clay residue on them they must be washed with clean water.
- Due to the presence of specific features (e.g., rocks, DWM, etc.) it may not be possible to collect a sample to the desired depth. Take the sample from as close to the proper depth as possible. In addition:
  - Record the reason the sample was collected from a different depth,
  - Note the actual depth range of the sample (e.g., 0-12.5 cm) on: i) the data sheet, ii) the tag inside the bag and iii) on the outside of the bag,.
- If a sample was not collected note the reason (e.g. hit bedrock, only large coarse fragments present, etc.). Include an empty bag for the missing sample. On the data sheet, the tag inside the bag and on the outside of the bag, note that no sample was collected.

Bulk Density of the Middle Layer of Mineral Soil (15-35 cm depth)

- This layer is sampled during the first round of data collection, but not sampled during subsequent re-measurements.
- Samples from the middle layer of mineral soil are taken from two locations only – the NE and SW.

- Start the samples of the middle layer of mineral soil exactly where the top layer finished. **It is important that the cores are a continuous sample of the soil column.**
- It will be necessary to clear the top layer of mineral in an area that is approximately 2 times larger than the core diameter to allow sampling of the middle layer. To reduce disturbance, do not clear more than a 20 cm diameter hole for sampling. Insure that the top sample area (i.e. where the core will be continued) is not disturbed or contaminated when clearing the surrounding top layer of mineral soil.
- Excavate the middle layer of mineral soil (15 to 35 cm depth) using the same method as for the top layer.
- Two samples 8 cm diameter and 10 cm deep (i.e., 15-25, and 25-35 cm depth) are required to sample the middle layer of mineral soil.
- Working over a tarp, place the middle layer of mineral soil into a single heavy plastic bag that is different from that used for the top layer.
- **The use of the cores to calculate bulk density requires that the soil samples be exactly the volume of the sampling ring.**

Bulk Density of the Third Layer of Mineral Soil (35-55 cm depth)

- This layer is sampled during the first round of data collection, but not sampled during subsequent re-measurements.
- Samples from the bottom layer of mineral soil are taken from the NE only.
- Start the samples of the bottom layer of mineral soil exactly where the middle layer finished. **It is important that the cores are a continuous sample of the soil column.**
- It will be necessary to clear the middle layer of mineral in an area that is larger than the core diameter to allow sampling of the bottom layer. To reduce disturbance, do not clear more than a 20 cm diameter hole for sampling. Insure that the top sample area (i.e. where the core will be continued) is not disturbed or contaminated when clearing the surrounding middle layer of mineral soil.
- Excavate the bottom layer of mineral soil (35-55 cm depth) using the same method as for the middle layers.
- Two 8 cm diameter samples 10 cm deep (i.e., 35-45, and 45-55 cm depth) will be required to sample the bottom layer of mineral soil.
- Working over a tarp, place the bottom layer of mineral soil into a single heavy plastic bag that is different from that used for the top and middle layers.
- **The use of the cores to calculate bulk density requires that the soil samples be exactly the volume of the sampling ring.**

Sampling Sandy Soils

- Sampling sandy soils requires extra care because the cores may fall out of the ring during extraction.
- Slide the piece of aluminum under the sampling ring to create a core that is exactly the depth of the ring.
- Do not use ring samplers on the face of the soil pit because the rings are circular and will therefore introduce bias to the area of soil sampled by the 'top' and 'bottom' of the ring.

Bead Sampling Method for Stony Soils

- When soils are excessively stony the ring method cannot be used. In these circumstances use the bead method.
- Use information about mineral soil plus a careful look at the aerial photography for the site to help determine the type of conditions that will be encountered.
    - Generally higher elevation sites in the eastern slopes of the mountains have a higher probability of being stony, as does the Kazan upland in the NE corner of Alberta. Otherwise fluvial sites adjacent to streams or rivers are most likely to have stony conditions.
    - Bring both the ring and the bead sampling materials to sites.
- Extraction of the forest floor layer proceeds as described above.
- After extraction of the forest floor layer, clear an area of the surrounding organic material that is larger than the template (e.g. 20 cm diameter) to begin excavation of the mineral soil samples.

- Level an area about 20 x 20 cm and excavate a circular hole to extracting the first soil sample. The circular hole should be approximately 8 cm in diameter to allow for the extraction of approximately 1.0 liter of soil from each layer (note the three layers are 15, 20, and 20 cm deep).
- During the excavation, extreme care must be taken not to compact the sides of the hole, as this will affect the bulk density of the sample. A good way to avoid soil compaction during excavation is to keep the handle of the trowel pointed in towards the centre of the hole, with the blade of the trowel pointing outwards.
- Use inward scooping motions when extracting the sample.
- Work over a tarp and take care so that none of the sample is lost or spilled.
- Extract the loose soil and gravel (< 7.5 cm) from the hole using a long-handled soupspoon and place in a 10 mm, heavy-duty bag.
- Clean the face of the hole using the hand-clippers or knife. All roots extending into the hole must be clipped and included in the sample.
- Using your fingers or knife, smooth the surface of the hole and make sure there are no voids (i.e., where coarse fragments may have been extruding). If there are voids, the dimensions of the hole must be extended to accommodate a reasonably smooth surface.
- Using a 5 mm weight plastic bag, line the hole and fill the bag with the glass beads. Make certain the surface of the beads is flush with the top of the excavated hole.
- Pour the beads into the 1.0 L graduated cylinder, to the nearest 100 mL graduation. The volume of the remaining 100 mL to 500 mL of beads can be measured using the 100 mL cylinder for greater accuracy. Record the total volume, to the nearest 10.0 mL.
- Rocks less than or equal to 7.5 cm in diameter are included in the sample.
- To avoid carrying large rocks, scrape all the soil from the rocks >7.5 (note that this soil must be saved in the sample bag). Weigh the rocks to the nearest gram, and record the weight so that volume can be calculated assuming rock to have a density of 2.65 g/cm^3.
- Note that if large rocks were not included in the sample bag, then record the weight of the rocks on the bag and on the data sheet.
- In very rocky soils, it may not be possible to excavate samples at each of the four locations. If this occurs:
  - Collect as many of the samples as possible from the locations describe in Figure 22.
  - For missing samples, move within a 1.5 m radius of the pre-define location and attempt to collect.

Sloped Terrain

- Sample bulk density on as level a surface as possible.
- Prior to evacuating the first layer of mineral soil, clear away enough soil to create a flat surface.
- Measure the maximum depth of soil that was removed to create the flat surface, and note this in the comments along with the slope (in degrees) of the surface.

Frozen Layer

- Only soil above the frozen soil is sampled.
- Note the depth of this frozen layer in the comments of the appropriate soil layer.

Unobtainable Samples

- If a sample cannot be obtained, note the reason on the data sheet (e.g., hit bedrock, wasp nest).
- Label an empty bag, and note the reason no sample was collected on the bag.

Wetland Soils and Deep Organics (Peat Soils)

- Only sample wetland soils at one location; use the normal NE location.
- If possible, wetland soils should be sampled during the driest period of the year.
- Clear the living biomass from the area to be sampled.
- Unlike that for other soils, the soil surface after living biomass removal represents ‘zero depth’.
- The top layer of organic soil is collected using the 12 x 12 x 15 cm aluminum sampling frame.
- Place the frame on the sampling point and cut, collect and measure the total organics in the layer 0-15 cm deep.

- If the organic material is fibrous and/or rooty, use a serrated bread knife to pre-cut the organic layer prior to inserting the frame to 15 cm depth (use clippers or a saw to sever large roots).
- Excavate the area approximately 20 x 20 cm adjacent to one side of the sampling frame and use a serrated knife to cut along the bottom of the frame prior to removal of the sample.
- Record the sample volume. Assuming a depth of 15 cm, the sample volume is 12 x 12 x 15 cm = 2160 mL (2.16 L).
- If the average depth is different from 15 cm, measure the depth of the excavation at four points, record the depth represented by the sample, and calculate the sample volume.
- Three more samples of organic soils are collected at the next three depths (15-35, 35-55, and 55-75 cm) using the 11 x 11 x 20 cm aluminum sampling frame.
- If necessary, remove surface material around the sampling area before inserting the sampling frame to 35 cm depth.
- Assuming the second sample represents the depth from 15-35 cm, its volume is 11 x 11 x 20 cm = 2420 mL (2.42 L)
- The third (depth 35-55 cm) and fourth (depth 55-75 cm) sample are collected similar to the second sample, and will be similar volume if the complete sample is obtained.
- With each successive excavation, bale out as much water as possible and attempt to take the sample.
- If the sample is very wet and heavy, then only bring back as much of the sample as possible. Make a note on the data sheet, in the comments section, as to why the sample was unobtainable and how much of it (what depth and volume) was obtained.

Field Processing Of Soil Samples

- Place a label inside each of the sample bags describing the location and depth from which the sample was obtained. In addition, label the outside of the bag with similar information.
- Keep soil samples at approximately 4°C in a refrigerator (or cooler with ice) while in the field to maintain the sample chemistry.
- Ship the sample bags in a cooler with ice to the lab within 7 days of soil collection.

Soil Pit

Location of Soil Pit

- Choose a location (Figure 24) that is:
  - at least 50 m but no more than 100 m outside the boundary of the 1 ha area
  - at least 30 m for all other sampling areas/plots outside the 1 ha area
- The actual soil pit location is determined by a soil scientist when visiting the site to ensure it is as undisturbed as possible and in the same ecosite type (i.e., moisture / nutrient category) as the primary ecosite site type within the 1 ha area

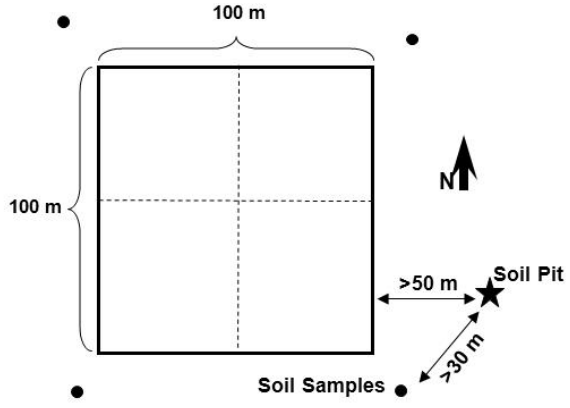

Figure 24

Ecosite Description

- Determine slope position and direction using the protocols described in Section 3.1.
- Take an additional photo of the soil pit site based on protocols described in Section 3.1. Stand 3 m SW of the pit and take the photo towards the NE corner
- Record amount of plot disturbed by humans and naturally based on protocols described in Section 3.1.
- Determine the ecological site type using the protocols described in Section 3.1

Sampling Method

- Dig a soil pit > 60 cm deep in mineral soils, and >100 cm deep in organic soils.

- Minimize site disturbance by excavating as little soil as possible and by placing the excavated soil on a tarp. The soil pit needs to be large enough to examine the soil profile. All of the excavated material must be returned to the pit (mineral soil on the bottom covered with the organic soil and tramped down) and the surrounding areas returned to as close to natural as possible.
- Record the exact coordinates (latitude and longitude in decimal degrees) of the soil pit, and the general location (e.g. 60 m east of the SW corner of the 1 ha plot)
- Soil is classified according to the Canadian System of Soil Classification (1998) codes (e.g., GLCU.HR for Gleyed Cumulic Humic Regosol, GLG.SO for Gleyed Gray Solod).
  - Clean one wall of the pit (on the side with bright uniform lighting) for horizon identification.
  - Ensure the pit face is not damaged when digging the pit (do not step on this side of the pit).
- Obtain a photograph of the soil profile on a digital camera at a 3M pixel setting. Include a measuring tape in the photo for scale with the "zero" of the tape at the top of the mineral soil.
- Enter the CSSC classification for the profile, including the Order, Great Group, and Subgroup (up to nine characters long).
- The profile must be classified to the Order level as a minimum, and to the Subgroup level, if possible.
- Record one of the seven soil drainage classifications (Agriculture Canada Expert Committee on Soil Survey 1983):
  1. Very Rapidly – Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse textured, or shallow, or both. Water source is precipitation.
  2. Rapidly – Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5 – 4 cm) within the control section, and are usually coarse textured, or shallow, or both. Water source is precipitation.
  3. Well – Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses.
  4. Moderately Well – Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination within the control section and soils are usually medium to fine-textured. Precipitation is the dominant water source in medium to fine textured soils; precipitation and significant additions by subsurface flow are necessary in coarse-textured soils.
  5. Imperfectly – Water is removed from the soil sufficiently slowly in relation, to supply to keep the soil wet for a significant part of the growing season. Excess water moved slowly downward if precipitation is the major supply. If subsurface water or groundwater, or both, is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well-drained subgroups.
  6. Poorly – Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are the main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.
  7. Very Poorly – Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are the major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration.

Soils have a wide range in available water storage capacity, texture, and depth, and are either Gleysolic or Organic.

- Record one of three moisture classifications:
  Xeric: water removed very rapidly in relation to supply; soil is moist for brief periods following precipitation. The primary water source is precipitation.
  Mesic: water is removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short, period of the year. Available soil moisture reflects climatic inputs. The primary water source is precipitation in moderate to fine-textured soils and limited seepage in coarse-textured soils.
  Hygric: water is removed so slowly that the water table is at or above the soil all year; gleyed mineral or organic soils. The primary water source is a permanent water table.
- Record the wetland class.
  Upland (U): Non-wetland, terrestrial system
  Bog (B): Accumulated peat, most frequently dominated by *Sphagnum* mosses, with tree, shrub or treeless vegetation, Cover, Water table at or slightly below the surface and wetland raised above the surrounding terrain
  Fen (F): Accumulated peat, Peat materials derived primarily from sedges with inclusions of partially decayed stems of shrubs formed, Graminoids and shrubs characterize the vegetation cover, Fluctuating water table which may be at, or a few centimeters above or below, the surface
  Swamp (S): Mineral wetland with highly decomposed woody peat and organic material, Coniferous or deciduous trees, or shrub vegetation cover, Water table at or below the surface
  Marsh (M): Mineral wetland with little accumulation of organic material and peat or aquatic plants, Emergent aquatic plants include rushes, grasses, sedges, and some floating aquatics, Shallow surface water which fluctuates dramatically
  Shallow Water (W): Contain standing or flowing water less than 2m deep in mid-summer, Transitional area between wetlands and permanent deep water bodies (i.e. lakes), Usually contain limnic peat, May dry intermittently in semi-arid regions, leaving evaporate alkaline salt deposits, May be bordered by rooted emergent vegetation (<25% of wetland area), may also contain rooted submerged and floating aquatic vegetation, algae, and aquatic mosses
- Describe the landform on the basis of parent soil material and mode of deposition:
  A = Anthropogenic – Artificial or human-modified material, includes landfills, road fill and mine spoils.
  C = Colluvial – Deposits as a direct result of gravity (talus, landslide deposits); on steep terrain, below rock bluffs; coarse fragments, angular, same rock type as bedrock; coarse fragments > 35%, loosely packed, porous; landslide and slope failure deposits
  E = Eolian – Materials deposited by wind action
  F = Fluvial – River deposits
  L = Lacustrine – Lake sediments; includes wave deposits
  M = Morainal – Material deposited directly by glaciers
  S = Saprolite – Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering; note that physically weathered shales and sandstone are included in this parent material type
  V = Volcanic – Unconsolidated pyroclastic material
  W = Marine – Marine sediments; includes wave deposits
  UU = Unspecified Unconsolidated – A layered sequence of more than three types of genetic material
  R = Bedrock – Outcrops/rocks covered by less than 10 cm of soil
  I = Ice – Permanent snow, glaciers, and ice fields
  B = Bog – Sphagnum or forest peat material
  F = Fen – Sedge peat materials derived primarily from sedges with inclusions of partially decayed stems of shrubs formed in a eutrophic environment due to the close association of the material with mineral-rich waters
  SW = Swamp – A peat-covered or peat-filled area with the water table at or above the peat surface. The dominant peat materials are shallow to deep, mesic to humic forest and fen peat formed in a

eutrophic environment resulting from strong water movement from the margins or other mineral sources

UO = Unspecified Organic Genetic Material

- Record the humus form, and if possible further subdivide this form based on http://sis.agr.gc.ca/cansis/publications/manuals/describing_soils.pdf Appendix 3. Humus form represents the layer of the organic and organic-enriched mineral horizons at the soil surface. Subdivision is based essentially on those primary morphological features that reveal fundamental differences in genesis. These are the presence or absence of diagnostic organic horizons, and the degree of incorporation of fine humus into the mineral soil and the intensity of binding between organic and mineral fractions. Secondary morphological features (such as structure, thickness, and composition of horizons) and distinctive characteristics allow for further division.
  L = Mull – Subdivisions: LC=Compact; LF=Fine; LM=Medium; LC=Coarse
  D = Moder – Subdivisions: DM=Mull-like; DT=Typical; DR=Raw
  R = Mor – Subdivisions: RF=Fibrimor; RH=HumiFibrimor; RM=Fibrihumimor; RI=Humimor
  P = Peaty Mor – Subdivisions: PH=Humic; PM=Mesic; PF=Fibric
  AM = Anmoor
- Record the horizontal designation according to CSSC (1998) conventions.
- Record depth (cm) from the top of the mineral/organic soil surface (zero depth) to the upper horizon boundary.
- Note that 0 is the boundary between the LFH layer and the top of the mineral/organic soil – thus the top of the first mineral/organic horizon is recorded as "0" zero.
- All depths are recorded as positive values.
- LFH depths are listed starting with "L", then "F", then "H". Organic and mineral horizons are listed in ascending order.

Example of recording horizons attributes.

0 line

Horizon	Horizon Upper Depth (cm)	Horizon Thickness (cm)
L	10.0	8.0
F	2.0	1.0
H	1.0	1.0
Ae	0.0	2.0
Bf	2.0	45.0
C	47.0	14.0

- Record the color description of the rooting-zone mineral soil (based on the Munsell Color Chart codes). Record "NA" to indicate not applicable when there is bedrock or no soil present**.**
- Record any soil features that are encountered in the soil pit and the depth (in centimeters) to each feature. Depth is measured from "zero depth" (interface between mineral soil and organic soil):
  W = Water table or seepage
  M = Mottles (not applicable in organics)
  R = Root restricted pan
  B = Bedrock
  F = Frozen layer
  C = Carbonates
  N = Not applicable or no feature
- Describe the soil texture determined by estimating the percentage of clay (less than 0.002 mm diameter) and sand (0.05 to < 2.0 mm diameter). Soil textural classes and codes are determined from the soil texture triangle according to CSSC classification rules: HC = Heavy Clay, C = Clay, SC = Sandy Clay, SCL = Sandy Clay Loam, CL = Clay Loam, SI = Silt, SIL = Silty Loam, SICL = Silty Clay Loam, L = Loam, SL = Sandy Loam, LS = Loamy Sand, S = Sand, VFS = Very Fine Sand, FS = Fine Sand, MS = Medium Sand, CS = Coarse Sand, VCS = Very Coarse Sand, R = Rock, NA = Non-mineral Layers.

- Record the percentage of coarse fragment content, based on volume within the mineral horizon, for 3 categories of coarse fragments:
  Gravel = <7.5 cm diameter or <15 cm length;
  Cobbles = 7.5 to 25 cm diameter or 15 to 38 cm length;
  Stones = >25 cm diameter or >38 cm length.
- Collection of soil samples from the soil pits is still under development including aspects of storage and chemical analysis. Collect soil samples from up to 5 of the most important (usually the major) horizons in the soil pit to help characterize soil type, and to determine bulk density of these horizons.
  - Create a flat vertical surface along one side of the soil pit.
  - At the center of each horizon to be sampled, drive the 10 cm ring sampler into face of the soil. Placing a block of wood on the ring and hammer on the block until the ring is flush with the face.
  - Dig carefully around the ring with a soil knife or trowel until the ring can be lifted out with the sample intact. Some work may be required to free the sample behind the ring.
  - When the ring is out, trim the bottom and top of the ring of any excess soil projecting beyond the ring. The use of the sample to calculate bulk density requires that the soil sample be coincident with the edges of the ring.
  - If during extraction, a sample partially falls out of the ring, then a new sample must be taken.
  - Samples will be used for chemical analyses. Thus it is important to clean the sampling ring between samples. Normally a simple wipe with a clean rag is sufficient; however, if there is dried clay residue on the ring it must be washed with clean water.
  - Place the soil sample into a heavy plastic bag for storage and transport.
  - Place a label with ABMI Site Number and the Horizon Name inside the sample bag. In addition, label the outside of the bag with the same information.
  - Keep soil samples at approximately 4^{o}C in a cooler with ice while in the field and subsequently in a refrigerator to maintain the chemistry of the sample.
  - Pack the sample bags in a cooler with ice and courier the cooler to an appropriate lab within 7 days of soil collection.