Alberta Biodiversity
Monitoring Institute

www.abmi.ca

Wetland Field Data Collection Protocols (Abridged Version)

Version 2019-07-02

Disclaimer
These standards and protocols were developed and released by the ABMI. The material in this publication does not imply the expression of any opinion whatsoever on the part of any individual or organization other than the ABMI. Moreover, the methods described in this publication do not necessarily reflect the views or opinions of the individual scientists participating in methodological development or review. Errors, omissions, or inconsistencies in this publication are the sole responsibility of ABMI.

The ABMI assumes no liability in connection with the information products or services made available by the Institute. While significant effort is made to ensure the information contained in these products and services is correct, the ABMI disclaims any liability in negligence or otherwise for any loss or damage which may occur as a result of reliance on any of this material. All information products and services are subject to change by the ABMI without notice.

Suggested Citation: Alberta Biodiversity Monitoring Institute, 2016, Wetland Field Data Collection Protocols (Abridged Version) 2019-07-02. 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

ABMI surveys 1656 sites across Alberta, with the sites arranged in a grid pattern with 20km spacing. This systematic sample of Alberta's biota and ecosystems has been labeled "terrestrial data collection" because many of these sites are in uplands, although some occur in lowlands. 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 plant. 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

Near every terrestrial site, ABMI also surveys an open-water wetland site. 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. Many of the aquatic invertebrates can only be accurately identified by taxonomic experts; these specimens are collected at the wetland and later identified in a laboratory.

Data are collected for a variety of species and habitats at each ABMI wetland 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, nutrient content and isotopic signature of water in the wetland	
Wetland classes (mineral or organic)	
Area covered by open water, emergent vegetation, graminoid and wooded vegetation.	
% 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 terrestrial and wetland site are determined. Detailed landscape information is collected at three spatial scales: i) the area in which field data are collected (this area varies among protocols, Section 3), ii) within a 5% sample of the landscape (i.e. within a 3 x 7 km rectangle) that encompasses the terrestrial site, and iii) throughout Alberta. At the smallest spatial scale information is collected while at the ABMI site. At the intermediate spatial scale, information is collected based on manual interpretation of air photos. At the largest spatial scale, coarse landscape information is mapped throughout Alberta using satellite images.

Quality Control for Data Collection

All ABMI field staff receive extensive training (in the classroom and field) prior to the beginning of data collection. This training includes learning what to do in the variety of field conditions encountered, as well as tests while conducting data collection at a variety sites. To ensure that data collection remains accurate through the season, field supervisors visit each crew during data collection and assess accuracy. A detailed description of the training is outlined in the ABMI Field Training Manuals.

Data sheets / field data tablets are filled in so they reflect exactly what is found / measured at each ABMI site. If the options for a data field do not include an appropriate response, crews record the most appropriate option and make notes. Data are checked in the evening for legibility and completeness. If required, data are transcribed onto a new data sheet. Data on tablets are backed up to USBs every evening. In addition, electronic verification routines are performed on the database to ensure that data are consistent with the allowable codes. Data are transferred to a computer in the office at the end of each field shift.

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. Water samples from wetlands are shipped to analytical laboratories to determine water chemistry and isotopic signature. 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 the peer-reviewed literature and distributed freely via the ABMI website.

Information Dissemination

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

2. WETLAND SITE SELECTION

Choosing Sites

- Wetland sites (N=1656) are spaced throughout Alberta using the 20 km National Forest Inventory (NFI) grid (Figure 1).
- To ensure that a random wetland is chosen near each NFI site, a pool of suitable wetlands is established for each NFI site and a wetland randomly chosen from this pool.
  - Using satellite imagery all the suitable wetlands that are within 10 km of the NFI site are identified as candidates.
  - To be considered suitable the wetland must:
    - Be permanent.
    - Have at least 1.0 ha of open water >0.5 m deep during July so that aquatic invertebrates can be sampled effectively.
    - Have a well-developed zone of wetland vegetation so that vegetation can be sampled effectively.
  - The candidate wetlands are ordered based on a random numbers table.
  - Candidate wetlands are assessed during field visits and the first one that is deemed suitable is chosen.
- The exact locations of ABMI wetlands and NFI sites are not shared.
  - ABMI has created approximate locations near the NFI sites and these approximate locations are noted on the ABMI website.
  - The approximate locations are randomly located within 10km of the actual NFI site.

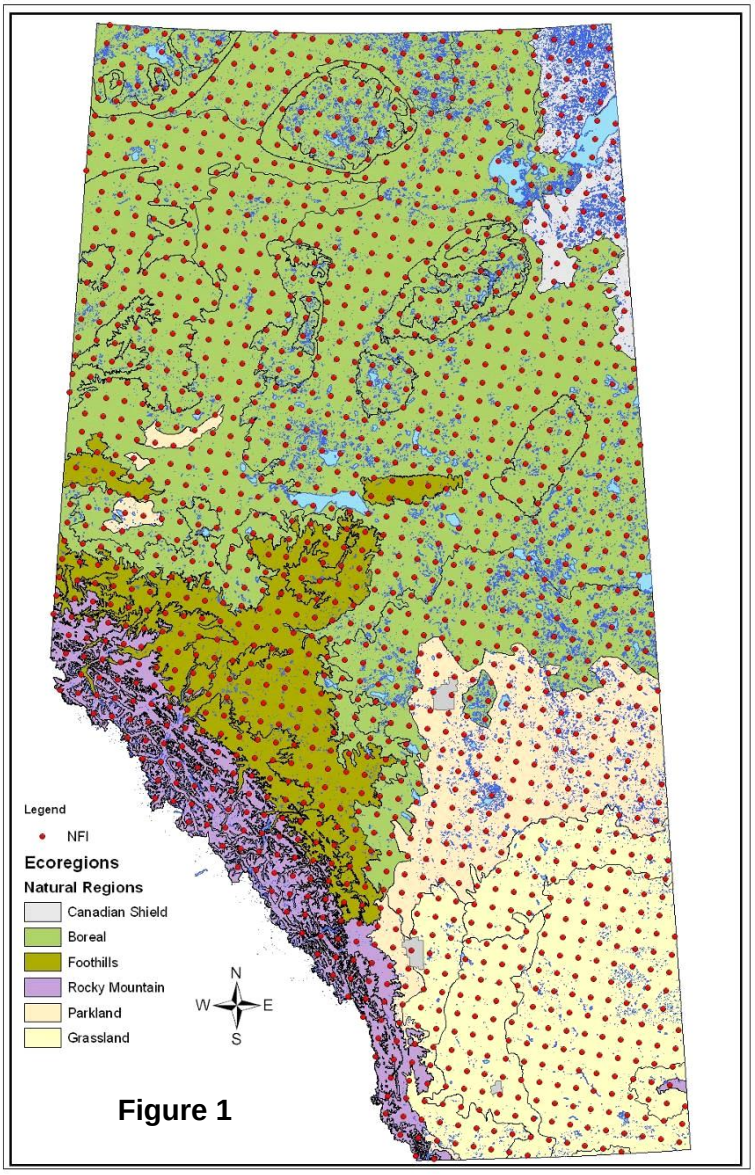


Figure 1

Field Reconnaissance

- At each ABMI site, candidate wetlands are "ground truthed" to ensure the required conditions are present
- Candidate wetlands are visited based on their rank order.
- Wetlands must have >1.0 ha of open water to be considered acceptable.
  - Area of open water at candidate wetlands is assessed by comparing the shape and size of the wetland in the field to that indicated on the satellite image.
- Wetlands must be >0.5 m deep during July to be considered acceptable. Water depth is assessed by:
  - Wading into the wetland as far as it is safe to measure depth. It is important to enter wetlands cautiously if the bottom is not visible.

  - If it is not safe to wade, an inflatable kayak is used to measure water depth.
  - If neither wading nor kayaking are possible, then water depth is estimated based on emergent vegetation → if cattails are present, then the wetland is judged to have sufficient water in July to sample aquatic invertebrates.
- Candidate wetlands must have sufficient emergent, graminoid and wooded zones to be considered acceptable. Presence of these zones is assessed by:
  - Determining whether the total of the emergent, the graminoid and wooded are >3 m wide around at least 50% of the wetland.
  - In some wetlands, vegetation in these zones may have been altered or removed by human / agriculture disturbance(s). Under these circumstances, the total width the zones would have been if the human / agriculture disturbance had not been present is estimated.
  - Width of wetland emergent/ graminoid and wooded zones are of secondary importance in comparison to wetland depth → if none of the permanent wetlands >0.5 m deep have a well-developed emergent/ graminoid and wooded zones, then the vegetation width criteria is ignored.
- Once a suitable wetland has been selected:
  - Access maps for the wetland are created.
  - The length of time required to access the wetland is determined.
  - The best route to the wetland is recorded along with potential hazards along the way. If possible, hazards along the route are removed.
- If takes more than 2.5 hours to travel on the ground to a wetland then helicopter access is used so that field crews can access the site and complete the data collection during a single day.
  - Helicopter pads are created >200 m from the wetland edge but otherwise as close as possible.
  - The most unobtrusive pad (i.e., the fewest and smallest trees and shrubs) possible is created.

3. FIELD SURVEYS

- Wetlands are sampled between June 15 and July 31 to ensure most vascular plants are mature when surveyed.
- To obtain data that are comparable among years, each wetland is assigned to a 2-week window based on Julian date, and the wetland is always re-sampled during that window
- If the crew accesses a wetland and finds that, despite site reconnaissance, it does not meet the minimum requirements (see Section 2.2), then a new wetland is selected.

Areas in which surveys are conducted must be categorized in one of the 6 zones:

- **Open-Water zone (OPW)**
- **Emergent zone (EMG)**
- Wet-Meadow-**Graminoid (WG)**
- Wet-Meadow -**Wooded (WW)**
- Peatland-**Graminoid (PG)**
- Peatland-**Wooded (PW)**

Upland (UPL) is also a classification type, but vegetation surveys are not completed in this zone.

Key to define the zones

1. An area of a wetland that has permanent standing water with <10% emergent vegetation cover. Submerged plants may develop under water and some plants may have floating leaves or flowering structures that extend slightly above the surface. Non-rooted, floating vegetation may be present in this zone. This zone can also be devoid of vegetation. This zone must always be present when assessing a wetland.
……..……..……. **Open-Water Zone (OPW)**

- Ecosites: OW

2. An area of a wetland that has water present above the soil surface throughout most of the growing season during most years. This zone is characterized by ≥10% of emergent vegetation cover. Emergent plants are rooted under water but most of their developing structures extend well above the water surface. Species in the emergent zone would not be able to persist in the long term with water levels below the rooting zone. Not every wetland has an emergent zone.
……..……..……..……..…...…….**Emergent Zone (EMG)**

- Ecosites: VD

3. An area of a wetland that has water present at or just below the soil surface throughout all or part of the growing season during most years. This zone is hydric and is typically spongy. In this zone, the percent of species composition of hydrophytic plants (plants that grow where soil is saturated with water for extended periods) may vary from 100% to ≥20%. This zone may be characteristic of mineral or organic (peatland) wetlands
…….…….....**skip to 5 (Wet-Margin Zones)**

4. An area where the species composition includes <20% hydrophytic (require water to survive) plant species. Upland can be mesic, xeric or hygric.
……..……..……**Upland (UP)**

5. Wet-Margin Zones

5.1. The zone is mineral. The zone is mineral when it has < 40 cm of peat (partly decomposed organic materials). Mineral zones are typical of the wetlands found in the prairies but can also be found in wetlands located in the northern regions of Alberta. ……..……..…….. **proceed to 6 (Mineral (Wet-Meadow) Zone)**

5.2. The zone is organic. The zone is organic when it has ≥40 cm of peat (partly decomposed organic materials). Organic zones are typical of the wetlands in the northern regions of Alberta. They are very spongy zones and their ground cover is dominated by brown mosses (fens) or sphagnum (bogs).… **skip to 7 (Organic (Peatland) Zone)**

6. Mineral (Wet-Meadow) Zone

6a. Large shrubs and trees usually comprises <10% of the vegetation cover of this zone. This zone is typically spongy during most of the growing season during most years. This zone is dominated by hydrophytic plants (plants that grow where soil is saturated with water for extended periods). This zone is typical of wet-meadows. Not every mineral wetland has this zone…….....….Wet-Meadow-**Graminoid (WG)**

- Ecosite: *RDm (10.5c)*
  AD (13a)

6b. This zone is considered the dryer zone of a mineral wetland, and is adjacent to upland. This zone is spongy in the spring or after a heavy rain, but can be relatively dry on the surface during most of the growing season. Typically this zone comprises ≥20% hydrophytic plant species (plants that grow where soil is saturated with water for extended periods). This zone is typical of wet-meadows. In the northern regions, large shrubs and trees typically comprises >10% of the vegetation cover of this zone. However, **in the southern regions (e.g. Prairies), shrubs and trees may be completely absent in this zone**[1]. Every mineral wetland has this zone.
…….……...…….……..…Wet-Meadow-**Wooded (WW)**

- Ecosite: *RDm(10.5a, 10.5b)*
  SD(12a, 12b)

7. Organic (Peatland) Zone

7.a. Large shrubs and trees usually comprises <10% of the vegetation cover of this zone. This zone is typically spongy during most of the growing season during most years. This zone is dominated by hydrophytic plants (plants that grow where soil is saturated with water for extended periods). This zone is typical of graminoid fens. Brown and sphagnum mosses are present and are intermixed with sedges and forbs. Not every organic wetland has this zone. …….……..…...Peatland-**Graminoid (PG)**

- Ecosite: *RDp (10c)*

7.b. Large shrubs and trees usually comprises >10% of the vegetation cover of this zone. This zone is spongy in the spring or after a heavy rain, but can be relatively dry on the surface during most of the growing season. This zone is typical of shrubby and wooded fens or shrubby and wooded bogs. Brown mosses (typically dominate the ground cover of fens) and peat mosses (typically dominate the ground cover of bogs) are present. Every organic wetland has this zone. …….……..……..Peatland-**Wooded (PW)**

- Ecosite: *RDp(10a, 10b)*
  MD (9a, 9b)
  PD(8a, 8b)

[1] Despite that the Wet-Meadow-Wooded zone of wetlands in the Prairies may not comprise any shrubs and trees, for simplification purposes, the dryer area of the wet-zone is called Wet-Meadow-Wooded zone.

Table 3: Common and indicator species for wetlands in Northern and Southern Alberta.

		North	South
Open-water	Common species[1]	*Ceratophyllum demersum* *Nuphar variegata* *Potamogeton friesii*	*Ceratophyllum demersum* *Stuckenia pectinata* *Myriophyllum spp.*
	Indicator Species[2]	*Ceratophyllum demersum* *Nuphar variegata* *Potamogeton spp.*	*Ceratophyllum demersum* *Stuckenia pectinata* *Myriophyllum sibiricum*
Emergent	Common species	*Calla palustris* *Schoenoplectus spp.* *Typha latifolia*	*Eleocharis palustris* *Schoenoplectus spp.* *Typha latifolia*
	Indicator Species	*Schoenoplectus spp.* *Typha latifolia*	*Typha latifolia*
Wet-Meadow-Graminoid	Common species	*Carex spp.* *Comarum palustre* *Galium trifidum*	*Carex spp.* *Rumex crispus* *Ranunculus cymbalaria* *Beckmannia syzigachnene*
	Indicator Species	*Carex spp.*	*Carex spp.*
Wet-Meadow-Wooded	Common species	*Alnus incana* *Betula spp.* *Carex aquatilis* *Carex disperma*	*Sonchus arvensis* *Salix spp.* *Cirsium arvense* *Hordeum jubatum* *Poa pratensis*
	Indicator Species	*Salix spp.* *Betula spp.* *Alnus incana ssp. tenuifola*	*Salix spp.*
Peatland-Graminoid	Common species	*Eriophorum spp.* *Vaccinium oxycoccos*	*Eriophorum spp.* *Vaccinium oxycoccos*
	Indicator Species	*Carex Spp.*	*Carex Spp.*
Peatland-Wooded	Common species	*Picea mariana* *Andromeda polifolia* *Chamaedaphne calyculata* *Carex gynocrades* *Rubus chamaemorus* *Ledum groenlandicum*	*Picea mariana* *Andromeda polifolia* *Chamaedaphne calyculata* *Carex gynocrades* *Rubus chamaemorus* *Ledum groenlandicum*
	Indicator Species	*Salix spp.* *Betula x sargentii* *Rubus chamaemorus* *Larix laricina* *Sphagum spp.* *Vaccinium oxycoccos*	*Salix spp.* *Betula x sargentii* *Rubus chamaemorus* *Larix laricina* *Sphagum spp.* *Vaccinium oxycoccos*

1. Common species are abundant in wetlands. Common species are not necessarily good indicator species because they can be abundant in more than one zone of a wetland.
2. Indicator species have strong preference for a specific zone. Indicator species may or may not be abundant species.

3.1 Transect Establishment

Fixed Transect Line & Random Start Point

- All transects and sample points are determined in reference to the random start point and shape / size of the wetland.
- Start at the center of the wetland and proceed in the direction of the random start bearing (RSB) until meeting the transition between the open water and vegetation.
- Standing at or near the shoreline and facing towards the open water, determine the bearing that is perpendicular to the general shoreline; this becomes the fixed transect line.

- Note, if the wetland was created by a beaver dam, start at the center of the wetland and proceed perpendicular to the direction of water flow to the left bank of the river/stream. The fixed transect line uses this same bearing.
- Travel along the fixed transect line 60 m into vegetation (Figures 2a and b) and establish the "random start point".
- The random start point is marked by driving an orange 1.5 m steel bar into the ground, so it protrudes 1 m above ground. A marker buoy is attached to the top of the steel bar using 1 m of rope.
- A 12" metal spike is driven 30 cm below the ground surface at this start point.
- If the wetland is on private land and in a location likely to be disturbed by humans (e.g. in a cultivated field or near buildings), the steel bar and spike are not used. Instead, the random start point is "marked" using a precision GPS capable of relocating the location to within 1 m.

Transect Re-establishment

Our goal when resurveying a wetland is to establish plant transects located on the FTL in the same locations they were surveyed during the initial visit.
Use a GPS to navigate to the coordinates of the Start Pin. A metal detector may be used to find the buried nail if the conduit has been removed.

Layout FTL

- Starting at the Start Pin, a tape measure and compass are used to navigate to the shore line on the FTL bearing.
- Ideally using a second measuring tape, start at the Start Pin and navigate away from the Start Pin using the FTL back-bearing.
- Note: If the FTL intersects a beaver dam do not move the FTL or any of the transects.

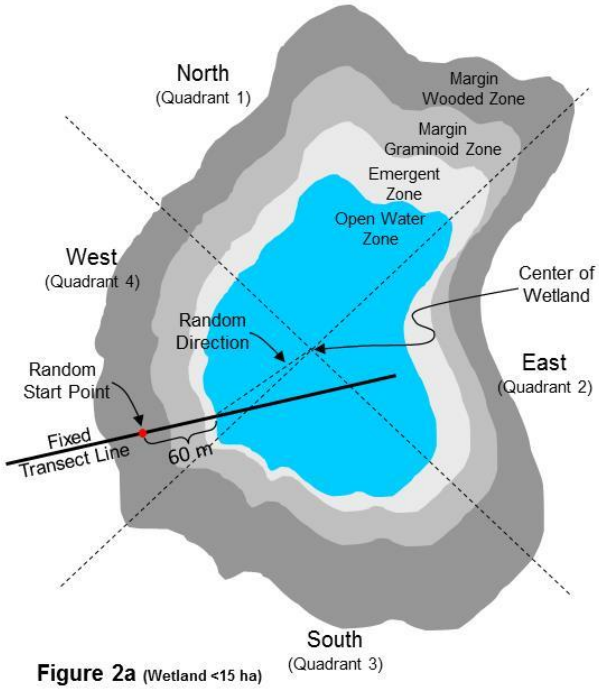


Figure 2a (Wetland <15 ha)

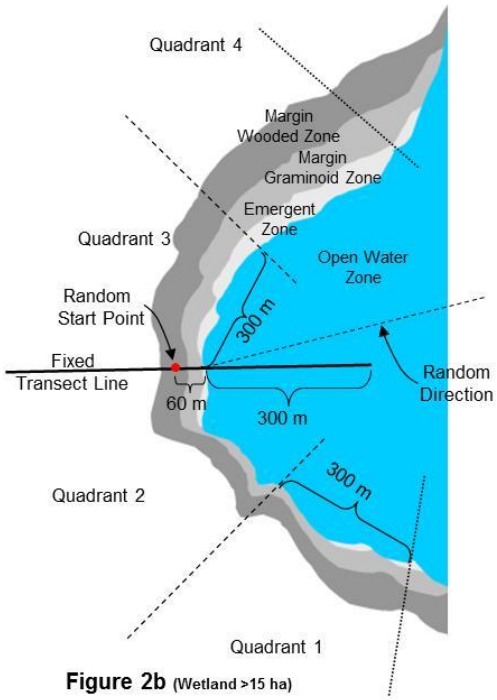


Figure 2b (Wetland >15 ha)

Wetland Quadrants

- At each wetland four quadrants are delineated.

- Quadrants for wetlands <15 ha are centered on the four cardinal compass direction (Figure 2a).
- Quadrants for wetlands >15 ha extend 300 m each along the shoreline in a counterclockwise (quadrants 1 & 2) and clockwise (quadrants 3 & 4) direction from the fixed transect line (Figure 2b). Note that in wetlands >15 ha all quadrant lines are perpendicular to the general shoreline and thus are not parallel to each other.

3.2 Site Characteristics

Bathymetric Measurements

- Depth of water is measured at 3 or more locations within the wetland to determine the location where the depth of the water column is the deepest.
- GPS locations for all depth measurements are recorded.
- The deepest point found during bathymetric mapping is used as the initial water-sampling point.

Wetlands <15 ha

At least three locations will be measured to search for the deepest point in the wetland: wetland center, and two points 1/3 and 2/3 along the primary axis of the wetland. Use the satellite image and your knowledge of the wetland to measure the depth at any additional places that may have deeper water than the three original points. (Figure 3a).

Deepest point: the point that is determined to be the deepest should be renamed as W[Site#]-DP (e.g. W345-DP).

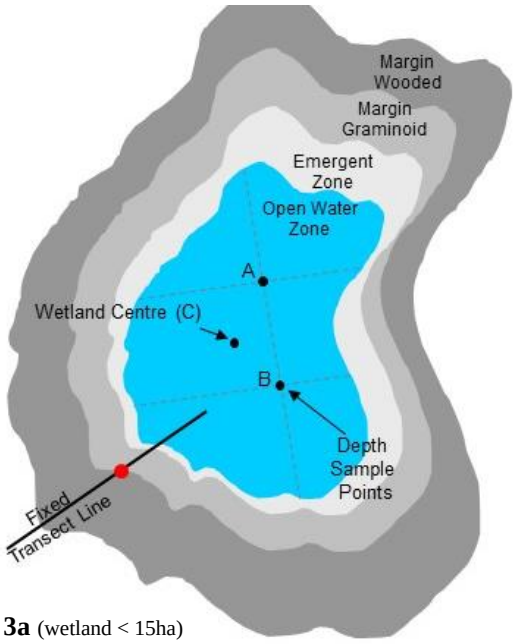


Figure 3a (wetland < 15ha)

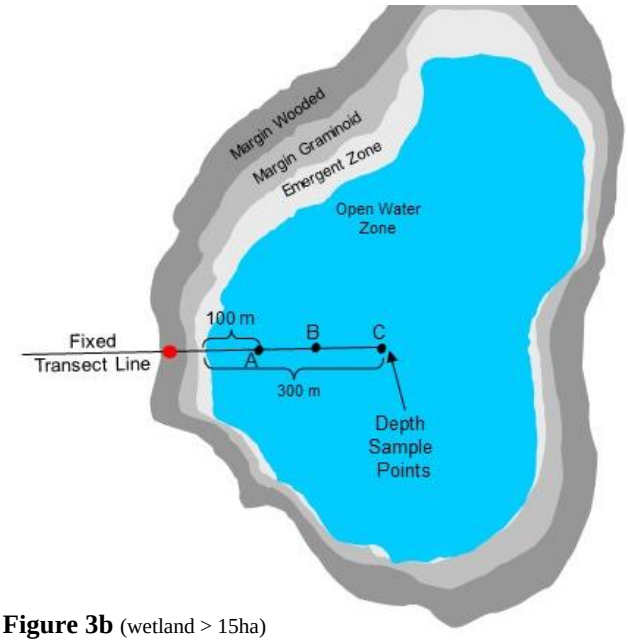


Figure 3b (wetland > 15ha)

Wetlands >15 ha

The objective is to determine the deepest point within 300m of shore along the FTL. Project 3 waypoints from the point where the FLT meets the shoreline using the FTL bearing. Create waypoints at 100 m (A), 200 m (B), and 300 m (C) from the shoreline. Measure the depth at these points. (Figure 3b).

Deepest point: the point that is determined to be the deepest should be renamed as W[Site#]-DP (eg. W345-DP).

Revisit Sites

Sites which have been surveyed previously do not require bathymetric measurements to be taken, as the deepest point of the wetland was determined during the previous visit. This waypoint (W[Site#]-DP) will be provided to technicians in order to complete the water chemistry and invertebrate protocols.

Site Photos

- Five photographs are taken using a digital camera with a 35 mm focal length and a quality setting of approximately 3 Mega-pixels.
- Pictures are taken while standing on the fixed transect line at the edge of the open water.
  - Open Water – one picture looking along the fixed transect line toward the open water
  - Upland – one picture looking along the fixed transect line toward the upland
  - Two pictures, one looking 90° in a clockwise direction from the fixed transect line, and the other looking 90° counter-clockwise from the fixed transect line.
  - Shoreline – one picture towards the shoreline from 50 m into the open water along the fixed transect line
- Check the photos and re-take if they are blurry.
- A back pack or meter stick is included approximately 5 m from the camera for scale.
- Photos are backed up and labeled on a laptop computer once back at camp.

General Shoreline Characteristics and Human Disturbance

- Between wetland center to 100m of the shore:
  - Record the presence of any surface inflow large enough for the kayak to travel in (about 1m by 0.15m deep)
  - Record the presence of any surface outflow large enough for the kayak to travel in.
  - Record the presence of beaver made structures like lodges or a dam.
- General shoreline characteristics are determined separately for each quadrant (Figure 2a & b).
- Within the first 5 m of the shore
  - Average height of the tallest layer of vegetation is classified into one of the following categories: VNA (Variable Not Applicable because there is no vegetation), <0.25 m or to the nearest 0.5 m
- Within 20 m (i.e., 0 to 20 m) of the shore – % cover (0, <1%, or in 5% increments) is estimated for each of the following classes. The 5% category includes any cover between 1 and 5%. In terms of vegetation, percent cover is the proportion of the ground obscured by a species' leaves, stems, flowers, branches etc. it is estimated as if one were looking down from an aerial view.
  - Number of dead trees with a DBH >15 cm is classified into one of the following categories: 0, 1-5, 6-25, 26-100, or >100.
  - Natural Habitats
    - Water
    - Rock
    - Bare soil from natural causes (e.g., waves, overland water flow, slumping)
    - Leaf litter
    - Lichens, Fungi, and Non-vascular Plants
    - Forbs (all vascular plants except shrubs, trees, and grasses/sedges/rushes)
    - Grasses/Sedges/Rushes
    - Shrubs (woody vascular plants)
    - Deciduous trees
    - Coniferous trees.
  - Human Created Habitats
    - NONE – No human caused disturbance present
    - 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
    - PUGG – Livestock trails and pugging/hummocks
    - 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
    - WELL – Any type of area cleared for oil/gas/coal-bed-methane including pump jacks or well heads
    - IND – Any type of building, roadway, yard, etc. associated with industrial development
    - RES – Any type of residential dwelling, farm building, farm yard in a rural or acreage setting
    - URB – Any type of human dwelling, associated building, or yard/driveway/road in an urban setting
    - CAMP – Recreation facilities including improvised campsites
    - RAIL – Railway
    - 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 (usually vegetation covered but the tire tracks may be bare)
    - BARE – Human caused bare ground for which the cause cannot be determined
    - OTHER – Please specify

- The classes often will be intermingled, making it difficult to estimate percentages accurately.
- It may be easiest to estimate the percentage in each class after viewing the entire quadrant.
- If necessary, access the shore periodically to better determine type of vegetation cover and presence of human disturbance.
- The area of natural plus human created habitats must sum to 100%.

- 20 to 100 m from the shore – % cover (0, <1% or in 5% increments) is estimated for each of the following classes. The 5% category includes any cover between 1 and 5%. In terms of vegetation, percent cover is the proportion of the ground obscured by a species' leaves, stems, flowers, branches etc. it is estimated as if one were looking down from an aerial view
  - Observe each of the quadrants from the boat to best determine the vegetation cover.
  - In addition, use satellite images / air photos to confirm estimates.
  - If necessary, access the shore periodically to better determine type of vegetation cover.
  - The area of these covers must sum to 100%.
    - Water
    - Bare soil/rock probably from natural causes
    - Bare soil probably from human associated activities
    - Low vegetation (grass, forbs, shrubs, non-vascular plants) probably natural
    - Low vegetation probably from human associated activities
    - Deciduous forest
    - Coniferous forest

3.3 Water

Water samples and physiochemistry readings are collect at three places in each wetland.

- At the deepest point of the wetland, as determined when creating the bathymetric map.
- At two locations spaced 25 m apart toward the center of the wetland (Figure 4). If the wetland is too small to space these 25 m apart, collect the measurements at two equally spaced points between the deepest point and the shore.
- Samples must be >1m form vegetation, away from outlets and inlets, in an area representative of the chemical and physical characteristics of the open-water zone, and not disturb the sediment.
- The locations of the water sampling points are noted on the wetland map.
- Water depth is recorded at all three locations.
- To ensure consistency, water samples and physiochemistry data are collected between 1:00 and 2:00 pm.

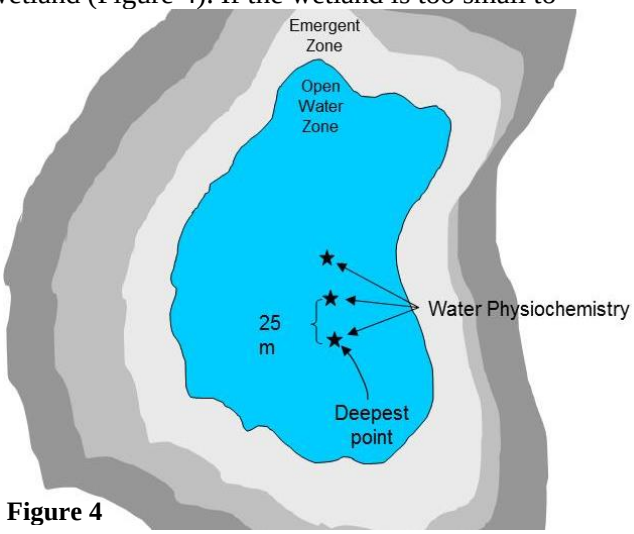


Figure 4

Multiprobe Reading

- Water physiochemistry is measured using a Hydrolab multiprobe meter is used to determine Temperature, pH, Dissolved Oxygen, Conductivity, and Salinity.
- To ensure the meter is working correctly, the meter is 1) tested prior to the field season to ensure accuracy and consistency and 2) calibrated for pH, dissolved oxygen and conductivity/salinity as per the manufacturer's directions prior to each shift.
- Recordings are taken from the middle of the water column if the water is <2 m deep, and at 1 m depth if the water is >2 m deep.

Nutrient Sample

- At each of the three locations sampled using the multiprobe meter, 1 L of water is collected for nutrient analyses.
- Rinse a 1 L Nalgene bottle three times with water from the wetland then collect the sample from just below the surface (do not disturb the bottom of the wetland or allow coarse organic material to enter the sample).
- The three 1 L samples are mixed in a 5L cooler by gently shaking and a 125 mL sub-sample is collected in a dark Nalgene bottle.
- To avoid contamination and degradation, wear nitrile gloves, avoid touching the mouth of the water bottles when collecting samples and ensure the 125 mL sample bottle is completely full.
- Store the water sample in a cooler with an ice pack until it can be refrigerated.
- At camp, 8 ml of 5% H_2SO_4 is added and samples are stored at 4º C until they are shipped to the laboratory.

Isotope Sample

- Collect 30 mL of water from the deepest point of the wetland.
- Rinse the bottle three times with water from the wetland and wear nitrile gloves to collect the sample from just below the surface (do not disturb the bottom of the wetland or allow coarse organic material to enter the sample).

- To include as little air as possible in the sample bottle, submerse the bottle and cap so they both fill with water and then screw the cap onto the sample bottle while both are below the water surface.
- Store the water sample in a cooler packed with ice until it can be refrigerated.
- Samples are labeled and shipped to the laboratory for processing.

Turbidity

- Six turbidity measurements are taken (two at each of three locations).
- At each of the three locations sampled using the multiprobe meter, fill two 1 L Nalgene bottles with water. When collecting water, lower the bottle 5 cm below the surface of the water.
- Once on shore:
    - Gently flip the bottle of water upside down a few times to resuspend particles in the water column. Avoid introducing air bubbles because these interfere with the readings from the Turbidity Tube.
    - Completely fill the Turbidity Tube using one of the bottles of water collected at the first sampling location.
    - Look down from the top of the tube and determine if the Secchi Disk at the bottom is visible. If visible record the height of the water column as "> 60 cm".
    - If the Secchi Disk is not visible, use the valve to drain water out of the Tube until the black and white outlines of the Secchi Disk appear. Record the height of the water column in the Tube.
    - Empty the Turbidity Tube and repeat the steps for the remaining 5 samples.

3.4 Vascular Plants

- The goal is to survey vegetation in up to 14 plots at each wetland, (3plots in the open water, 3 in the emergent vegetation, 3 in the graminoid (mineral and organic) zone, and 5 in the wooded (mineral and organic) zone; Figure 5).
- The vascular plant technician is to complete all of the plots on shore. Either technician, or both working together, may complete the open water and/or emergent surveys.
- If a zone is absent, fewer than 14 vegetation plots may be surveyed.
- Vegetation plots are placed perpendicular and clockwise to the fixed transect line.

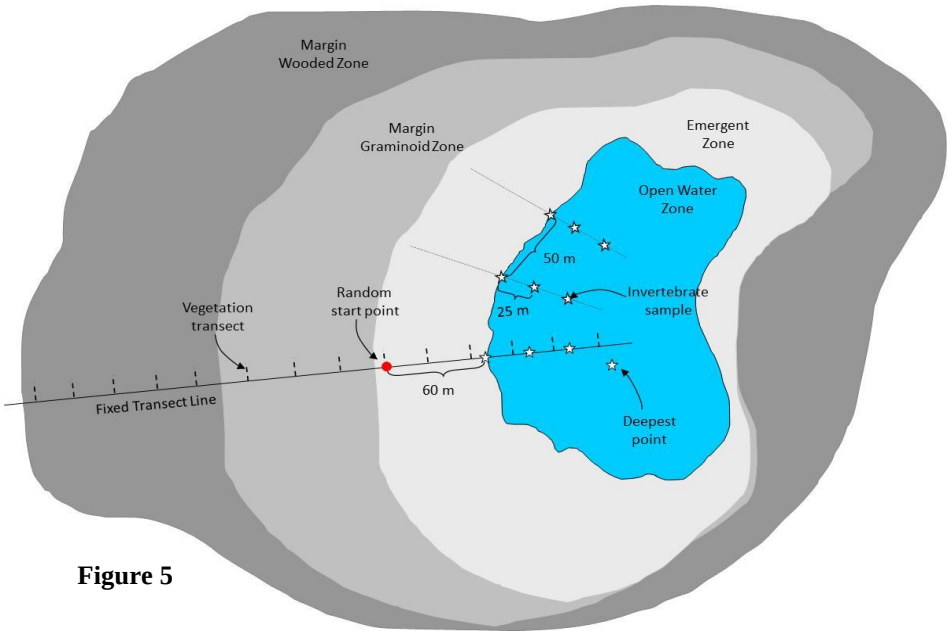


Figure 5

- The location of all vegetation plots are drawn on the map of the wetland.
- Note that vegetation plots are not surveyed in upland habitats.

Plot Layout

Ideal Layout (Figure 5)

- A vegetation plot is located at the random start point (i.e., 60 m from the edge of the open water).
- Additional vegetation plots are located at 25 m intervals along the fixed transect line, both towards / into the water (5 vegetation plots) and towards the upland (8 plots).
- Due to wetland zones being a variety of shapes and sizes, this ideal layout of vegetation plots will seldom occur.

Layout for Wetlands with Narrow Zones (Figure 6)

- When sampling wetlands with zones that are narrower than the ideal layout (this commonly occurs), it is not possible to include sufficient plots along the fixed transect line.
- A modified layout is used for these wetlands.

Vegetation Plots along the Fixed Transect Line

- As many vegetation plots as possible are established along the fixed transect line (e.g. Figure 6).
- To monitor change in wetland size and shape over time at least 7 vegetation plots are established along the fixed transect line → 1 at the random start point, and 1 towards the upland, 2 between the random start point and the open water, and 3 in the open water.

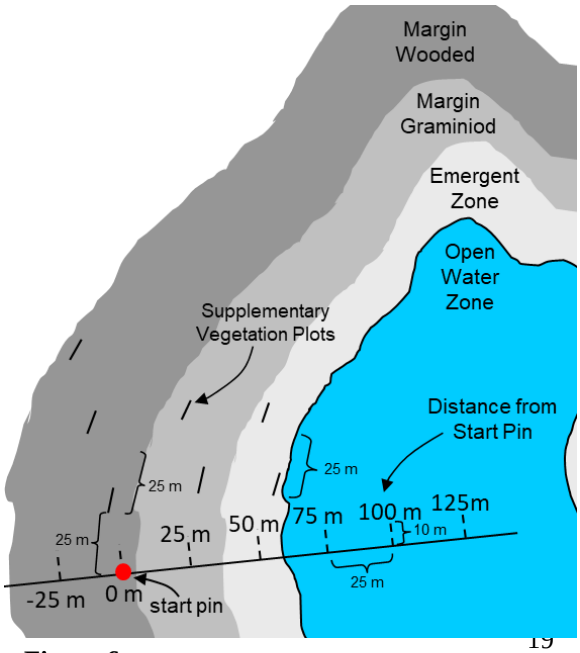


Figure 6

- Although plots locations are established in the upland, vegetation is not surveyed there → upland vegetation is surveyed during the ABMI terrestrial protocols. Note that at some wetlands, (especially during revisits) the start point may be in the upland and under this circumstance vegetation is not be surveyed at this plot.

Supplementary Vegetation Plots

- It is often necessary to survey supplementary plots to achieve the desired number in each wetland zone.
- If the vegetation zone that is incompletely sampled on the fixed transect line is present within 150 m of the fixed transect line, supplementary vegetation plots are sampled to complete the required number of plots (3 in the open water, 3 in the emergent vegetation, 3 in the graminoid, and 5 in the wooded zones.
- Plots are spaced with their starting points 25 m apart along the shoreline, parallel to the shoreline at stratified distances from the shore within the zone.
- All supplementary plots for a wetland must be in the same direction from the FTL, either clockwise or counter-clockwise.
- For the example in Figure 6, only 2 vegetation plots fit on the fixed transect line within the wetland wooded zone, 1 within the graminoid zone, 1 within the emergent zone, and 3 within the open water zone. In this case 3, 2, 2, and 0 additional plots are required for each zone respectively.
- It is possible that some zones will may have no vegetation plots along the fixed transect line and thus require all plots to be "supplementary".
- Note that the location (and possibly number) of supplementary plots may vary between visits if the wetland zones change size and shape.

<u>Layout When Re-visiting a Site</u>

- The start point and fixed transect are established in the same position/direction during each visit to document change in the wetland over time.
- Due to rising or lowering water levels the location and size of wetland zones may vary over time.
  - As a result the location of zones during the initial survey may be different from that during a revisit.
  - In addition, since the location of the start point is fixed, this may not be 60 m from the edge of open water during a revisit (the start point may even be in a different wetland zone).
- During the re-visit:
  - Vegetation plots that start at the fixed transect line, and that were surveyed during the initial visit, are re-surveyed during re-visits. However,
    - If due to changes in water level the plot is in upland habitat during the revisit, this is noted and the plot is NOT re-surveyed.
    - Only the maximum number of plots in each wetland zone (3 in the open water, 3 in the emergent vegetation, 3 in the wet-meadow, and 5 in the wetland margin) are surveyed.
  - Supplementary vegetation plots are added to complete the required number of plots in each zone during each re-visit (3 in the open water, 3 in the emergent vegetation, 3 in the wet-meadow, and 5 in the wetland margin).
  - If vegetation along the fixed transect is different during the re-visit than that found during the initial visit, then the required number of supplementary plots for a zone may also differ.

Labeling the Vegetation Plots

- Vegetation plots that fall on the fixed transect line (FTL) are labelled in relation to the Start Pin.
- The plot located at the Start Pin is always zero (0) and the others are labelled as the distance in meters from the Start Pin, in multiples of 25.
- For plots that fall between the Start Pin and the wetland centre, the numbers are positive (FTL25, FTL50, FTL75, etc.),
- Negative numbers are used for the plots that occur between the Start Pin and the upland (-25, -50, -75).
- The location of all supplementary plots are marked using a GPS waypoint labeled with the site number and plot name (e.g. W1234_WMD2).

Wetland Sketch

At the end of the day, draw and label the locations of the Start Pin, FTL, and plant plots on the wetland map provided.

Plot Shape

- Vegetation plots are established perpendicular to the fixed and supplementary transect lines in a clockwise direction.
- Where ever possible, vegetation plots are 10 x 2 m.
- If a zone is <2 m wide, then plots 20 x 1 m are surveyed.

Plot Characteristics

- The % (0, <1%, or in 5% increments) of each vegetation plot that is disturbed by humans is recorded separately for each of the human disturbance classes identified in Section 3.2.
- If water is present, record the water depth to the nearest 0.1 m at the center of the plot. If water level is below ground level, record the water depth as "0".
- For each vegetation plot record ecosite type (OPW, EMG, WG, WW, PG, PW) based on the vegetation that is present.

Ecosites

- Ecosite is determined for each vegetation plot based the simplified forest classification system (Table 4). These ecosites describe the type of vegetation present on the plot, or that would have been present on the plot if there had been no human disturbance.
- Ecosite categories were developed for forested regions and ecosites in the Grassland and Parkland regions do not fit these categories well.
  - Open-Water plots are classified as OW
  - Bare Ground plots are classified as NT.
  - Emergent plots are classified as VD
  - Wet- Zones plots are classified as:
    - Wet-Meadow-Graminoid plots are classified as RDm (10.5c), or AD (13a).
    - Wet-Meadow-Wooded plots are classified as RDm (10.5a, or 10.5b) or SD (12a, or 12b).
    - Organic-Graminoid plots are classified as RDp (10c).
    - Organic-Wooded plots are classified as RDp (10a, or 10b), or MD (9a, or 9b), or PD (8a, or 8b).
- Tree species modifiers listed in Table 4 are the most common scenarios, and may not perfectly fit each scenario found at a wetland.
- Structural stage (as described in Table 4) is determined based in the type, height and complexity of vegetation in the plot.

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				
Poor-Xeric 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.
Poor-Mesic 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%	
Medium-Xeric Hairy Wild Rye, Bearberry, Canada Buffalo-berry, Feather Moss common at some sites	3 - **MX**	3a **None**	No Trees	
		3b **Pine**	Pj + Pl > 50%	
		3c **AwMix**	Aw > 20%	
		3d **Spruce**	Sw + Se + Fa >50%	
Medium – Mesic Low-bush Cranberry, Canada Buffalo-berry Blueberry, Rose, Alder, Labrador Tea, Bearberry, Thimbleberry, Bog Cranberry, Feather Moss common at some sites	4 - **MM**	4a **Pine**	Pj + Pl + Fa >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
		4b **PjMix**	Aw + Bp + Sw >20%, AND Pj >20%	
		4c **Aw**	Aw > 50%	
		4d **AwMix**	Aw >20% AND Sw + Sb + Pl > 20%	
		4e **Spruce**	Sw > 50%	
Medium - Hygric Horsetail, Dogwood, Rose, Willow, Feather Moss common at some sites	5 - **MG**	5a **Poplar**	Pb + Aw > 50%	**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%
		5b **Spruce**	Sw + Se > 50%	
		5c **Sb**	Sb > 50%	
Rich - Hygric Dogwood, Fern, Feather Moss, Rose, Alder, Bracted Honeysuckle, Devil's Club Fir common at some sites	6 - **RG**	6a **Pine**	Pl > 50%	
		6b **Poplar**	Pb + Aw > 50%	
		6c **Spruce**	Sw + Se + Fa > 50%	
Not Treed	7 - **NT**	7a **Alpine**	Elevation above tree line	**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%
		7b **Flood**[4]	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**[5]	Site disturbed recently by humans	
Aw – trembling aspen, Pb – balsam poplar, Pc – plains cottonwood Bp – paper birch, Ba – Alaska birch Mm – Manitoba maple Am – western mountain ash 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		

Dominant Shrub/Herb/Ground Cover	Nutr./ Moist. Code [1]	Tree Species Modifier	Tree Species Composition [2] (In an area without human disturbance)	Structural Stage [3]
Lowland/Wetland Vegetation Communities				
Bog – Poor- Hydric Labrador Tea, Peat Moss, Lichen, Bog cranberry and Cloudberry may also be present (Soil saturated for part or all the year. undecomposed organic soil substrate)	**8 - PD**	**8a Sb[6]**	≥10% tree cover (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 – Medium – Hydric Labrador Tea, Peat Moss, Sedge, Bog cranberry, Dwarf Birch and Willow may also be present (Soil saturated for part or all the year. undecomposed organic soil substrate)	**9 - MD**	**9a SbLt[6]**	≥10% tree cover (may only be in shrub/ground strata) Sb + Lt > 50%	
		9b Shrub	<10% tree cover	
Rich Fen – Rich - Hydric Dwarf Birch, Willow, Sedge, Grass, Moss, (Soil saturated for part or all the year; undecomposed organic soil substrate; includes floating mats of vegetation)	**10 - RDp**	**10a SbLt**	≥10% tree cover (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	
Wet-Meadow-Rich-Hydric Dominated by sedge, grass, presence of shrub and trees (e.g. willow). Conductivity < 15; soil, saturated for part or all of the year. Well decomposed, organic soil substrate.)	**10.5 - RDm**	**10.5a Tree**	, ≥10% tree cover (usually along wetland edge, may only be in shrub/ground strata)	
		10.5b Shrub	<10% tree cover AND ≥10% shrub cover	
		10.5c None	<10% tree cover AND <10% shrub cover	
Marsh – Very Rich – Hydric Cattail, Rush, Reed, Conductivity < 15 mS/cm, sedge and grass may also be present (Water is above the rooting zone for most or all of the year)	**11 - VD**	**11a None**	usually along a water body edge ≥10% emergent vegetation cover <10% tree cover	
Swamp Trees and shrubs present, poorly developed bryophytes, often with pools of water (Water is above the rooting zone for some of the year, mineral or humified organic soil rather than peaty)	**12 - SD**	**12a Tree**	>10% tree cover	
		12b Shrub	<10% tree cover	
Alkali Conductivity > 15 mS/cm, white salt flats at water's edge, (Water is above the rooting zone for most or all of the year)	**13 - AD**	**13a None**	<10% shrub/tree cover	
Open Water	**14 - OW**	**14a Lake**	In standing water <10% emergent vegetation cover	
		14b River	In flowing water <10% emergent vegetation cover	

Classifications are based on Dominant Shrub/Herb/Ground Cover before determining the Tree Species Modifier and Structural Stage. Tree species compositions in the tables are the "simplified categories" for the ABMI - these may not fit perfectly with what is seen at the site (see Appendix 3 for details).

1. Moisture nutrient category names are approximate and the category often also includes adjacent nutrient and moisture categories (Nutrient Status: P=Poor, M=Medium, R=Rich, V=Very Rich; Moisture Status: X=Xeric, M=Mesic, G=Hygric, D=Hydric, OW=Open Water. NT, SD, AD are exceptions)
2. Tree species composition is determined from both the dominant/co-dominant (canopy) and intermediate/suppressed (sub-canopy) trees, giving more weight to the dominant and co-dominant trees.
3. Determine the structural stage by first determining if the site is tree-dominated, non-tree dominated, or open-water dominated after ecological-site type is determined. Then choose the appropriate code combination paying careful attention to the descriptors.
4. Use 7b (NT-Flood) for sites at the edge of rivers, streams, lakes and wetlands where vegetation is disturbed frequently by flooding. The area is either non-vegetated or dominated by grasses, sedges and forbs, with trees/shrubs absent Note that areas with water present seasonally, often with small permanent pools, but with trees/shrubs present, are classified as Swamp
5. Use category 7f (NT-Human) only when other ecosite classifications are not appropriate. Note that NT-Human CANNOT be used for historic conditions.
6. Poor Fens are often black spruce (Sb) dominated and do not always contain Larch/Tamarack (Lt). The absence of Larch does not indicate that the site is PD – it could still be MD. Differentiation between PD and MD must be determined based on the understory species (i.e., presence of cloudberry and lichen in PD, with the addition of sedge, dwarf/bog birch and willow for MD

Plant Species Presence

- To standardize sampling effort at each site a single person completes all of the vascular plant surveys.
- When conducting the open water vegetation surveys with two crew members, the second crew member can maneuver the boat but does not help find or identify plants.
- 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.
- Spend about 5 minutes before surveying each zone writing down the names of all the vascular plants observed in the zone.
  - This initial list of plant names is conducted so that the subsequent timed searches of the 10 x 2 m plots are spent mainly looking for species, with minimal time spent writing down plant names.
  - During the initial 5-minutes when species names are being recorded, locate the most diverse areas in the zone and spend time in these habitats recording species names.
  - Organize the plant species on the data sheet by group (grasses, trees, shrubs, herbs) so that species names can be found, and so that a species names are not recorded multiple times.
  - Unknown species can be quickly identified during this initial 5-minute search, but if unable to identify the species quickly, collect a specimen. Unknown specimens are assigned a unique specimen number and carried by the surveyor to avoid multiple collections in each plot.
- Mark the center line of each vegetation plot using a tape measure.
- Measure the water depth at the middle of each plot in the emergent and open water zones.
- In the open water plots use a cultivator to selectively harvest plants you cannot reach by hand. Be careful not to destroy the wetland floor.
- Spend exactly 5 minutes moving slowly along each plot and record the species that are present.
  - Use a meter stick to identify whether plants are within 1 m on either side of the tape measure.
  - Field guides are not used during the 5-minute searches
  - Use flagging to mark the unidentified species during the 5 minute survey, this will minimize time spent on marking unknowns during the survey; collect voucher specimens of unknown or uncertain vascular plant species.
- After the 5-minute search of the plot is complete, attempt to quickly identify the species you have collected using field guides.
- For specimens that cannot be identified quickly, place them in a plant press and take them to camp for identification during the evening.
- Ensure that identification numbers for unknown specimens are not repeated at the site.
- For any vascular plant categorized as S1 or S2 by Alberta Conservation Information Management System (ACIMS) and/or species detected outside their historic range, even those that are known by the field staff, collect a specimen so its' identity can be confirmed by experts.
- When collecting specimens for unknown of S1/S2 species, choose a specimen from a population of greater than 5 individuals and outside the plots, if possible.
- If the specimen was taken from a habitat that was atypical for the site (e.g., a sandy ridge in a peatland site, a wet depression in an otherwise dry site, a copse of trees in a grassland site, or a clearing in a forest), include this information on the specimen tag.
- For specimens that cannot be identified in the evening, or for S1, S2 and specimens from outside their range, remove them from the field press and place them a different plant press. Ensure that the information (location, 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 for identification by experts.

Relative Density of Plant Species

- Coarse estimates of density for vascular plant species are determined in each of the 10 x 2 m plots.
- After the 5-minute search, stand near the center of the plot and record which vascular plant species are "uncommon", "common" and "dominant".
  - Mentally divide the plot up into ten 1-m sub-sections.
  - Common species are defined as those that are present in five or more of the sub-sections.
  - Uncommon species are defined as present in four or fewer 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 some plots may contain many common species whereas other plots may not contain any.

% Cover of Shrubs & Trees

- Shrub and tree cover is measured in each 2 x 10 m plot.
- Shrubs and trees are defined as woody vascular plants and all live shrubs and trees are included.
- Estimate percent canopy cover (as 0, <1% or in 5% increments) independently for each shrub/tree species in each of four height categories (<0.5, 0.5-1.29, 1.3-5.0, and >5 m high).
- Note that due to overlap of leaves, the sum of the estimates can exceed 100%.
- 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.

3.5 Aquatic Invertebrates

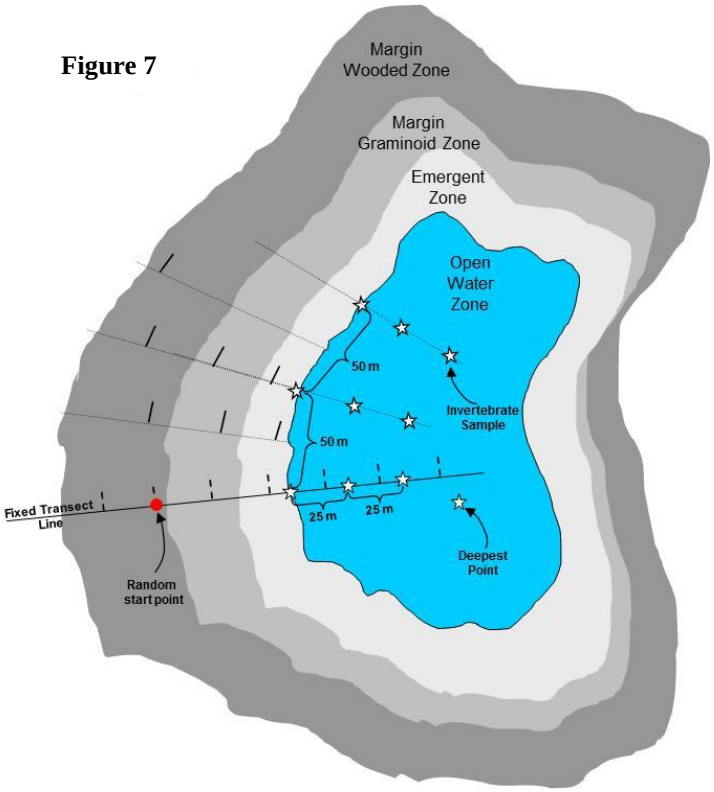


Figure 7

- Collect 10 aquatic invertebrate sweeps from each wetland (Figure 7).
- Invertebrates are sampled just prior to leaving the wetland, so they can be preserved quickly at camp.

Sample Layout

- Nine samples are collected in a systematic pattern.
  - Three invertebrate samples are collected along the fixed transect line.
    - Collect one sample at the vegetation / open water interface.
    - Collect a second sample 25 m into the open water.
    - Collect the third sample 50 m into the open water.
  - Six more samples are collected along two additional transects.
    - These two transects are spaced 50 m around the wetland in a clockwise direction and aligned so they are perpendicular to the vegetation / open water interface,
    - Collect invertebrate samples at the same distance from the vegetation / open water interface as was done along the fixed transect.
  - For the 3 samples that are collected along the shoreline:
    - Search a 10 m radius circle around the location to find an area with at least 50% cover of rooted aquatic vegetation.
    - Maximize the number of invertebrates collected by sampling among and/or immediately adjacent to the rooted aquatic vegetation.
    - Avoid areas with dense mats of filamentous algae or duckweed. If required, use a stick spread mats of algae/duckweed and sample within the cleared area.
    - Ensure the sample is obtained from water > 25 cm deep.
  - For the 6 samples that are collected in open water:
    - Search a 10 m radius circle around the location to find the closest area with >50% rooted submergent plus emergent vegetation. In some circumstances it may be necessary to restrict the search radius so that locations sampled during adjacent sweeps are ≥10 m form each other.
    - Maximize the number of invertebrates collected by sweeping the net through the submergent/emergent vegetation.
    - Avoid areas with dense mats of filamentous algae or duckweed. If required, use a stick spread mats of algae/duckweed and sample within the cleared area.
    - If there are no areas with >50% submergent plus emergent vegetation within 10 m, then sample at the location with the most vegetation.
- The 10th invertebrate sample is collected at the deepest point of the wetland:
    - Search around the deepest point to find the closest area with submergent or emergent vegetation.
    - The chosen location must be at least 25 m from all previous samples.

- Maximize the number of invertebrates collected by sweeping the net through the submergent/emergent vegetation.
- Avoid areas with dense mats of filamentous algae or duckweed. If required, use a stick to spread mats of algae/duckweed and sample within the cleared area.
- If there is no submergent or emergent vegetation within 10 m, then sample at the deepest point.

Sample Collection

- Record the water depth at each sample location.
- If the water is <1 m deep, sample the entire water column. If the water is >1 m deep, only sample the top 1 m of water.
- Collect samples using a modified D-ring dip net with a mesh size of 500 µm.
- Place the mouth of the net just above the bottom of the wetland (if the water is <1 m deep), or 1 m below the water surface (if the water is >1 m deep), with the handle held at a 45^{o} angle.
- Draw the net rapidly up through the water column to the surface.
- The three net sweeps must be done quickly to:
  - Capture organisms that attempt to move away from the net.
  - Dislodge and capture organisms that are clinging to the surrounding vegetation.
  - Dislodge and capture organisms that are in the epibenthic layer.
- Conduct two additional net sweeps (in rapid succession) at the same location as the first sweep.
- If mud/silt is present in the sample, discard the sample, wash the net, and take a new sample 2 m away. Do not mistake benthic debris (unconsolidated organic material) for mud/silt.
- If there are weeds hanging outside of the net; the portion of the weeds extending more than 15 cm outside of the net are broken off and discarded. The portion of the weeds extending less than 15 cm outside of the net are placed inside the net and included in the sample.
- Samples are flushed to the bottom of the net by pouring water down the outside the net.
- Invert the net into a 1 L Nalgene bottle to collect the sample. Flush the sample into the bottle by pouring water down the inside of the net.
- Samples may be combined into a single composite sample. If there is a lot of plant material in the samples, up to 10 bottles may be required so that specimens are not crushed.
- If more than one bottle is used per site, ensure that the label identifies the number of bottles per site (eg., "Bottle 1 of *x*").
- Place the aquatic samples in a cool location for storage while in the field.
- To preserve the samples, hold the net over the mouth of the sample bottle and drain enough water to allow for the addition of at least 250 ml of 10% buffered formalin.
- Ship the cooler to the laboratory for processing.

3.6 Mammal & Bird Survey Using Remote Detectors

Prior to 2018 mammals and birds were surveyed using a 10-minute search. In 2018 mammals and birds are also surveyed using remote cameras and ARUs respectively. Beginning in 2019 the 10-minute search was dropped.

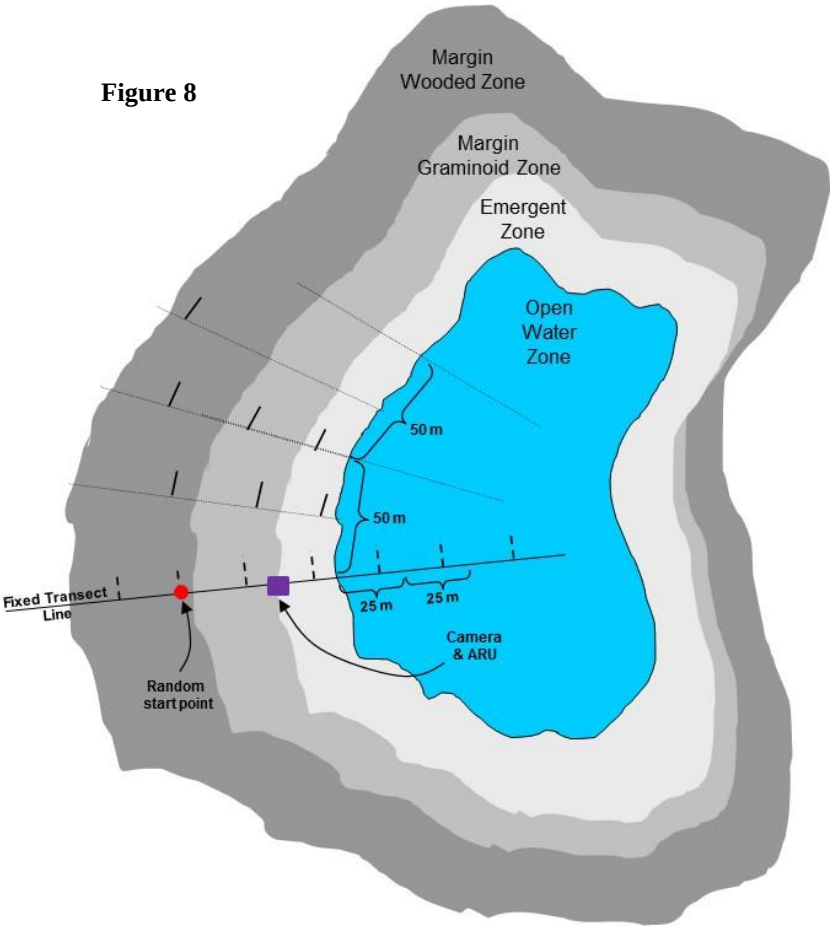
- Mid- and large-sized mammals are surveyed using Reconyx PC900 with pictures triggered based on heat and movement in front of the camera.
- Birds are surveyed using Wildlife Acoustic Song Meter 4 audio recording units (ARUs).
- Cameras and ARUs are installed during the fall or winter and retrieved in July.
- Pictures form the cameras, and vocalizations from the ARUs, are interpreted by experts with the aid of computer programs.

Camera & ARU Installation

General

- One camera and one ARU are fastened to a tree within 10 m of the location where the fixed vegetation transects meets the emergent zone of the wetland (Figure 8).
  - Ideally the camera and ARU are placed on the same tree/shrub, but if required can be installed on different trees/shrubs up to 10 m apart.
  - If suitable trees/shrubs are not available within 10 m of the location where the fixed vegetation transects meets the emergent zone, the camera and ARU are fastened to the closest suitable tree/shrub that is within 10 m of the emergent zone edge, and within 300 m of the fixed transect line.
  - If no suitable trees/shrubs are not available, the camera and ARU are fastened to a stake driven into the ground where the fixed vegetation transects meets emergent zone of the wetland. Ensure the stake is stabilized so that it does not fall over between when the camera and ARU are deployed in (fall/winter) and when they are retrieved in July. Additional protection for the stakes (and the cameras and ARUs) is required in areas where domestic livestock may rub against and/or destroy the equipment.
- If it is not possible to access the wetland due to some type of obstruction (e.g., bear activity, etc.), the camera and ARU are not installed and the reason for the absence of data recorded.

Figure 8



Cameras

- The camera is fastened to the selected tree/shrub using wood screws and the appropriate bracket.
  - To ensure the correct height, a snow probe is used to determine snow depth.
  - A locking cable is fed through the hole in the camera, around the tree/shrub/stake and locked to secure the camera in place and reduce theft.

- Install a painted conduit stake 5 m in front of the camera to aid photo interpretation and analysis.
  - Drive the 1.3 m conduit stake into the ground, so that 1 m of it remains above the ground.
  - The conduit is painted with a variety of colors in 10 cm bands. Starting from the top of the stake, the bands are: black, yellow, red, grey, orange, blue, yellow, green, red.
- Position the camera to detect mid- and large-sized mammals that pass the wetland edge (or pass slightly upland of the wetland edge).
  - Fasten the camera to the tree/shrub/stake 1 m above the ground.
  - Position the camera so that it is aimed at the painted stake (5 m in front from camera) 0.8 m above the ground.
  - If possible in open habitats, the camera is set facing north (or south) to avoid direct sunlight. However, the field of view must be aimed to detect animals passing along the edge of the wetland.
  - In forests and shrubby areas the camera is pointed towards an unobstructed view of at least 5 m wide and 10 m long. Where necessary, branches and shrubs that will obstruct the camera field of view when vegetation is "leafed out" are removed.
  - Record any problems encountered while setting up the camera.
  - Ensure the camera lens is clean.
  - If the camera is handled for any reason during the session, ensure the field of view does not change.
- After installation of cameras has been completed, take a photo that shows the installed camera and the immediate surrounding area. Ensure the ground is visible at the bottom the photos with the camera is in the center of the image.

ARUs

- A tree or shrub with a diameter sufficient to hold the ARU, but not wider than 18 cm is chosen to mount the ARU.
  - A tree/shrub with a diameter greater than 18 cm cannot be used because it will interfere with sound reaching the microphones.
  - Remove branches that interfere with the ARU microphones.
  - If a suitable tree/shrub is not present a stake is used to mount the ARU.
- Fasten the ARU 1.5 m above the ground to the selected tree/shrub/stake using wood screws or the appropriate bracket.
  - To ensure the correct height, a snow probe is used to determine snow depth.
- A locking cable is fed through a hole in the ARU, around the tree/shrub/stake and locked to secure the ARU in place and reduce theft. Ensure the cable does not touch the microphones.
- Position the ARU on the north side of the tree/shrub/stake (microphones facing east-west) to reduce heating from direct sunlight.
- After installation if the camera and ARUs are on different trees/shrubs, take a photo that shows the installed ARU and the immediate surrounding area. Ensure the ground is visible at the bottom the photos with the ARU in the center of the image. Note only one photo including both the camera and ARU is needed if they are on the same tree/shrub/stake.

General Site Characteristics in Front of the Camera

- When retrieving the camera and ARU in July, general site characteristics are recorded within a pie-shaped area immediately in front of the camera (15 m long and 15 m wide at the end of the pie).
  - Record ecosite type as described in Section 3.4.
  - Record presence of the different wetland habitats: Water, Alkali, Marsh, Swamp, Beaver Dam, Lake, River, Stream, Wet Margin Lake, Wet Margin Wetland, Wet Margin River/Stream
  - Record presence of human created open areas: Harvest, Cultivation, Pasture, Well site
  - Record presence of natural open areas: Fire, Wind, Ravine edge, Other natural funnels.

  - Record presence of human created linear features: Railway, Road Paved, Road Gravel, Trail, Seismic Line, Pipeline, Power Line, Fence, Windrow.
- Record the GPS location of for the camera and ARU.

Camera & ARU Activation

Cameras

- A Reconyx PC900 camera is used to survey mid- and large-sized mammals.
- Ensure that the SD card is properly inserted and that the date and time are properly set on the camera.
- Record the SD card number on the data sheet.
- Review camera sensitivity settings, and change if required, to ensure consistent pictures are obtained from all cameras:
  - Set camera to take the picture as fast as possible after the trigger, with one picture in each burst.
  - Allow subsequent pictures to be taken with no waiting time.
  - Use the standard internal motion trigger.
  - Schedule a reference pictures to be taken every second hour (e.g., at 1:00 am, 3:00 am, 5:00, etc.) for a total of 12 pictures each day
  - Set time laps to ON.
  - Label images based on ABMI site number (e.g., for ABMI site 1642 the label is ABMI-1642).
  - Set brightness to medium-low.
  - Set contrast to medium-high.
  - Set sharpness to medium.
  - Set saturation to medium.
  - Set temperature to Celsius.
  - Set clock to 24 hour.
  - Set night shutter speed to medium.
  - Set night ISO sensitivity to medium.
  - Set resolution to high.
  - Set no border for prints.
- Ensure the camera is aimed correctly at the target area.
- Switch the camera to “Walk Test”, and test the responsiveness of the camera in the target area:
  - Walk once slowly through the target area 5 m in front of the camera. Ensure the red light flashes.
  - Crawl once through the target area. Ensure the red light flashes.
  - If the red light on the camera did not flash during the walk/crawl test, repeat the set up and walk/crawl test.
- Create a photo sheet with the ABMI site number, camera number and date.
  - Wait for the camera to “arm” itself and take a photo 1 m in front of the camera.
  - Hold the photo sheet tilted slightly downward to avoid sun glare.
- Record any problems encountered while setting up the camera.
- After the camera has been installed wait for it to “self-arm”.
  - The camera will automatically “self-arm” and begin taking pictures after a two minute period during which it does not detect any motion.
  - Walk perpendicularly through the camera field of view at three distances (at 5, 10, and 15 m) in front of the camera.
  - These pictures are used as reference when interpreting subsequent photos to establish where in the field of view animals are detected.
    - Before leaving the station, check that the camera lens is clean and if required clean it.

ARUs

- A Wildlife Acoustic Song Meter 4 audio recording unit (ARU) is used to record vocalizations of birds (and other animals) at each wetland.
- Ensure that the two 16 Gig SD cards are properly inserted and that the date, time and location are properly recorded in the ARU.
- Record the SD card numbers on the data sheet.
- Review microphone sensitivity settings, and change if required, to ensure consistent detections of vocalizations for all ARUs:
    - Set sample rate to 44100.
    - Use stereo channels.
    - Set gain to 12.5 dB for both left and right channels.
- Set the daily recording periods for each ARU to be:
        - 10 minutes at midnight.
        - 3 minutes at 2:00 am.
        - 10 minutes at 30 minutes after sunrise.
        - 3 minutes 2 hours after sunrise.
        - 3 minutes at noon.
        - 3 minutes at 3:00 pm.
        - 3 minutes 1 hour before sunset.
        - 3 minutes 1 hour after sunset.
- Set the location to latitude 54.40 N and longitude 115.00 W.
- Set time zone to "mountain standard daylight savings time".
- Set mode to sunrise/sunset.
- Start the ARU, and conduct 1-minute test recording.
- Record any problems encountered while setting up the ARU.

Camera & ARU Retrieval

- Immediately after getting to the site take a photo (or two photos if the camera and ARU are on different trees/stakes) that show the ARU, camera and the immediate surrounding area at time of pick-up. Ensure the ground is visible at the bottom this photo with the camera and ARU in the center of the image.
- Note whether the camera is located/focused on a natural animal trail, a human trail, a fence line, a vegetative strip, or a wetland.
- Take six additional site photos at each station:
    - *Cardinal Directions* –Four photographs at eye level in each of the four cardinal directions (N, W, S, E).
    - *Representative Photo* – From anywhere near the camera/ARU; take a single photograph that best represents the physical and vegetation characteristics of the site.
    - *Canopy Photo* – Standing at the camera/ARU, take a photograph of the canopy from waist height with the camera pointing directly up.
    - Check the quality of the photos and re-take if blurry.
- On the data sheet, record ABMI site, camera/ARU numbers, card numbers for both the camera and ARU, date, time of pickup, and condition of the camera and ARU.
- Unlock the camera and ARU, remove them from the tree/shrub/stake and deactivate them.
- Check that the site programed in the camera and ARU, match the site you are at.
- Record the number of pictures on the camera SD card, how full (%) each of the cards are, and remaining battery life (%) for the camera and for the ARU.
- At the end of each field shift, SD cards are transferred to the lab.