

Technical Supplement to the Protocol

Evaluating the Health of Wetlands

Wetland Management Routine Effectiveness Evaluation

JANUARY 2023



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INTRODUCTION

This technical guidance will assist you in the completion of the Forest and Range Evaluation Program's (FREP) Wetlands Management Routine Effectiveness Evaluation (WMREE). Reviewing this document and referring to it during planning and assessments will greatly assist you in collecting and entering data efficiently, and with confidence.

Much of the information provided in this document is also available in a simplified online training format at [Forest & Range Evaluation Program \(FREP\) - Province of British Columbia \(gov.bc.ca\)](https://www2.gov.bc.ca/gov2/forestry/forestry_programs/frep/). Prior to attending the formal FREP field training, all participants will be required to review this material in preparation. This training and reference material is intended for foresters, technical staff, and others interested in monitoring wetlands.

Why Wetlands are Important

Wetlands play a critical role in our environment, supporting both people and wildlife. They are involved in a number of ecological services that we as a society receive for free (Figure 1). Functions include mitigating the impacts of flood events, filtering water, moderating stream flows, and providing key habitat for a number of our wildlife species (including nearly one third of our species at risk). Furthermore, wetlands provide a vast supply of traditional medicines for many indigenous communities, and are frequently visited by hunters, wildlife enthusiasts (e.g., birders), and science educators. Despite their value on the landscape, we've globally lost 35 % in 45 years (i.e., between 1970 and 2015) (Ramsar 2018).

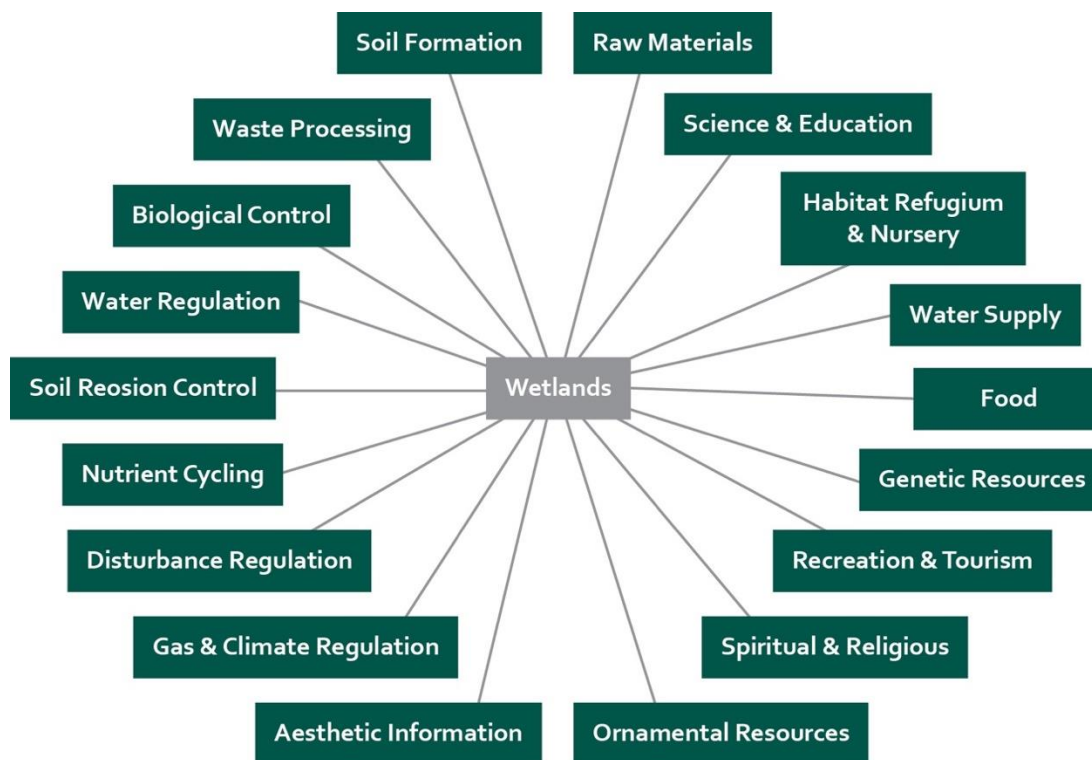


Figure 1. The many functions of wetlands.

Assessing Properly Functioning Condition

A wetland that is properly functioning has the ability to:

- Withstand inputs from upslope and inlets to filter runoff and improve downstream water quality;
- Support a variety of wildlife species, both within and directly surrounding the edge of the wetland by providing habitat niches and adequate cover through a diversity of well-vegetated canopy layers, coarse woody debris, microtopography, and snags;
- Maintain the connectivity of fish habitats where these occur;
- Withstand hydrodynamic processes in terms of water input timing and quantity that is appropriate for the specific wetland's composition and trajectory; and,
- Attenuate flooding events without erosion or modifications to vegetation types.

Wetland health assessment

You are about to embark on a journey that will allow you to understand the inner workings of a wetland and explore the key conditions that support its functional health. At the end the assessment, users evaluate the wetland based on a series of attributes that were measured, counted or estimated to support "Yes" or "No" answers to indicator questions. A "No" answer indicates a component of the wetland may be impaired. The following breakdown determines the relative condition of the wetland based on the number of "No" answers to the 15 main indicator questions:

Properly functioning: 0–2 of the characteristics of wetland functioning are impaired

Functioning, but at risk: 3–4 of the characteristics of wetland functioning are impaired

Functioning, but at high risk: 5–6 of the characteristics of wetland functioning are impaired

Not properly functioning: 7 or more of the characteristics of wetland functioning are impaired

PRE-FIELD DESKTOP INFORMATION

This section covers how to collect information about your target wetland prior to heading out into the field. Gathering this information will improve your ability to: (1) identify any discrepancies between available wetland spatial files previously delineated and recent satellite imagery; (2) answer questions regarding the landscape condition; (3) prepare maps for interpretation in the field; and, (4) possibly identify stressors you'll want to further investigate once in the field. *Note that wetlands less than 5 ha should be given preference for this assessment.* Users should be somewhat familiar with navigating various online mapping tools and setting up basic spatial queries. Some step-by-step guidance will be provided within this tutorial. By the end of this section you should be able to complete Tables 1.1 to 1.6 of your field cards.

Starting a new record (A note for FileMaker Go users):

If you are using the FREP wetland FileMaker form on the FileMaker Go app, then start your record by selecting the "New Record" button, then enter a Sample #, confirm the evaluators (i.e., the first and last names or initials of those involved in the field evaluation), confirm if the wetland is within 2 Riparian Management Area (RMA) widths of a cutblock, and record the District Code and the Opening ID. Further information on forestry-related attributes are needed under field table T.1.3: *Opening Information*.

Pre-Field: Wetland Identification [Table 1.1]

Wetland ID

Record the wetland ID so that others who review your file can find the same wetland you've sampled and can look at the polygon information that informed your interpretation. Wetlands are notoriously poorly mapped in BC, so there may be different sources that display your wetland. After comparing available sources and linework, we recommend using what would appear to be the most accurate wetland polygon that has been digitized for your site (although it's possible that you may need to re-digitize/shift the boundaries as part of your assessment). Possible sources for wetland layers include the Freshwater Atlas of BC; the Vegetation Resource Inventory; or the Site Plan developed by the forest company. Other sources could also include any Terrestrial Ecosystem Mapping or Sensitive Ecosystem Inventory Products that may exist in the area. Finally, your own interpretation of available air/satellite imagery may prove to be the best source. Below is an example of finding the Wetland ID from the Freshwater Atlas.

Example of finding wetland ID from the Freshwater Atlas:

To obtain the wetland ID from the Freshwater Atlas, visit [iMapBC](https://www.mapbc.ca/). Zoom into the approximate location of your wetland site; then under the "Data Sources" tab turn on the Fresh Water Atlas (FWA) layer for wetlands, by




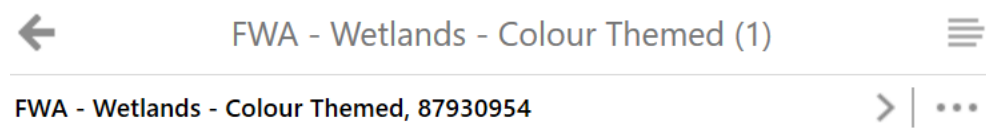
Add Provincial
Layers

selecting the "Add Provincial Layers" button: , then expand the following folders: "Base Maps">"Freshwater Atlas"; and select "FWA – Wetlands – Colour Themed". Once you select OK, your map screen should show some green polygons which represent mapped wetlands (Figure 2).



Figure 2. Base map showing FWA wetlands in green.

Within the Home tab, select the identify tool  under the sub-section “Find Data”. Then move your cursor over the wetland of interest and select it. The selected wetland should be outlined in yellow, and a side bar should show the following information:



By pressing the “>” button on the right-hand side of this entry, you will be able to expand the attributes associated with this wetland. Record the Waterbody Key, a unique number that is associated with one or multiple polygons associated with a unique wetland; adjacent wetland polygons are clumped under one Waterbody Key.

This Waterbody Key field can alternatively be obtained on the FREPmap portal for government staff. Select wetlands from the layer list and click the wetland polygon with your cursor. A subset of attributes, including the Waterbody Key, opens up when you press the expand button “>”.

Source

Record the source of the Wetland ID you obtained. Options include: Freshwater Atlas (FWA), Site Plan, and Other. If you select “Other”, provide sufficient information in the space provided or notes section so a reviewer can retrieve the same polygon information.

Biogeoclimatic classification

As you will see in the subsequent sections, the biogeoclimatic classification (BEC) is documented to help you classify your wetland plant association, determine your wetland riparian class (W1 to W5) and associated riparian management zones, and identify a target for the amount of mature and old growth forest within 2 kilometers.

To record the BEC, visit [iMapBC](#). Zoom into the approximate location of your wetland site; then under the “Data



Add Provincial
Layers

Sources” tab turn on the BEC layer by selecting the “Add Provincial Layers” button: , then expand the following folders: “Forest Grasslands and Wetlands” > BEC Analysis– Zones/Subzones/Variants – All” and select “BEC Analysis – Zones/Subzones/Variants – Colour Themed”.



Identify

Within the Home tab, select the identify tool under the sub-section “Find Data”. Then move your cursor over the Biogeoclimatic Zone of interest and select it. The selected zone should be outlined in yellow, and a side bar should appear that can be expanded by pressing “>” to show a set of fields. Record the zone (e.g., SBS), and subzone (e.g., dk) within the field “Biogeoclimatic Classification”. Note that opening info boxes may not work on an iPad.

Natural disturbance type

Natural disturbance types (NDT) are broad categories that describe how frequently forest stands are naturally regenerated due to disturbances such as fires. As you will see later, the NDT is documented to determine the target mature and old-growth forest within 2 km of your wetland. To obtain your NDT, follow the same steps as described in the Biogeoclimatic section above, but record the natural disturbance (e.g., NDT3) which is also found within the attribute data of the layer “BEC Analysis – Zones/Subzones/Variants – Colour Themed”

Coordinate system

Record coordinates for the approximate center for your wetland of interest. Options include: Decimal Degrees, Degrees – Minutes - Seconds, and UTM coordinates. Advantages of using UTM is that numbers in this system correspond to a meter change on the ground (e.g., an increase of 1 on the northing corresponds to 1 meter change moving north). If using iMapBC, you can change the coordinate system from the default of Decimal Degrees to UTM coordinates, by first zooming in to the region of interest, and then expanding the options list



next to the icon that appears at the bottom of the screen. By selecting the black triangle, a



UTM Zone 10

list of options appear, including UTM: . Hover your cursor over the wetland of interest and record the associated Northing and Easting. The Easting (i.e., the X coordinate) is 6 whole numbers, while the Northing (i.e., the Y coordinate) is 7 whole numbers. Do not forget to also record the zone as there are three different zones in BC.

Hydrogeomorphic system

Select the hydrogeomorphic position that best explains how water occupies the site based on its position on the landscape (Figure 3).

Marine systems are affected by tides and occur along the coast.

Estuarine systems are at the confluence of freshwater fluvial and marine environments.

Fluvial systems are associated with freshwater streams and or rivers that are influenced by flood events and can be affected by erosion, deposition, and sedimentation processes.

Lacustrine wetlands are associated with large freshwater bodies (e.g., lakes); they can also be affected by sedimentation, flooding, and wave action.

Palustrine systems are not influenced by lakes or fluvial processes, and there are a few subcategories: Basins & Hollows; Ponds & Potholes; and Seepage Slopes. Basins & Hollows occur in topographical low points, with water near or at the surface; they receive water primarily from groundwater and rainwater. Ponds & Potholes are typically next to small waterbodies. Seepage slopes occur on sloped terrain where groundwater is near or at the surface.

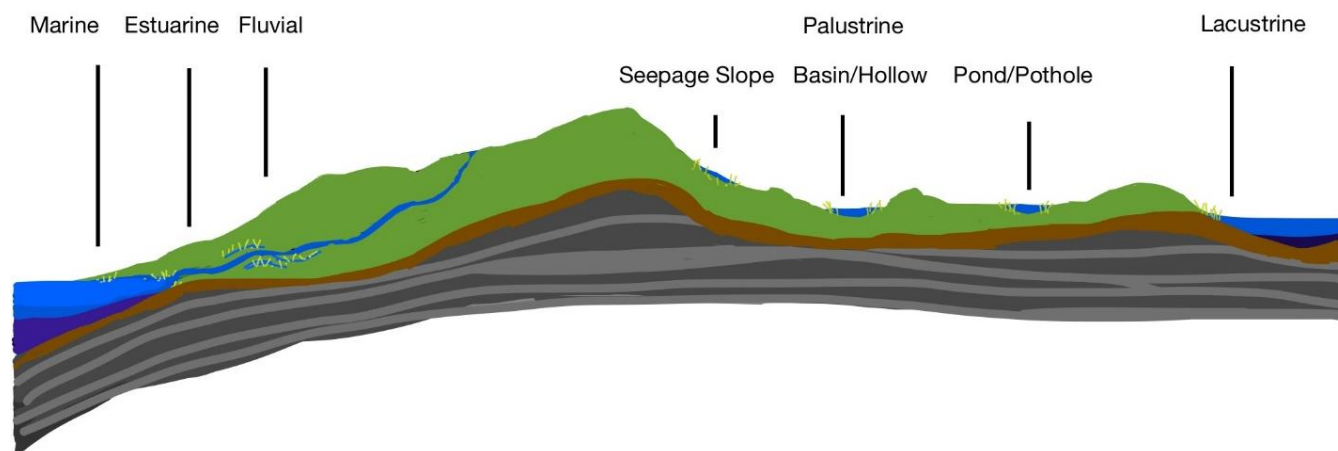


Figure 3. Hydrogeomorphic positions of wetlands. Source: BC Wildlife Federation.

Hydrologically connected to a stream

You will have an option to answer “Yes” or “No” to the question of whether a wetland is hydrologically connected to a stream. If you answer “Yes”, you’ll want to investigate the inlet and outlet of your stream during your site visit to observe any issues of deposition or erosion that may compromise the health of the wetland. During the desktop review there are a few options to determine if a wetland is hydrologically connected to a stream. In some cases, the stream can be directly observed with available satellite imagery (i.e., via FREPmap, or iMapBC). Another option is to open the Freshwater Atlas streams layer and determine if a documented stream overlaps with your wetland of interest. To view this layer on iMapBC, open Basemaps>Freshwater Atlas> and select “FWA – Stream Network – Lines”. If you’re using FREPmap select “Stream Network” in the layers option.

It is helpful to note that the stream layer is divided into observed streams and construction lines. Within the attribute data of the FWA streams layer, “edge types” labelled 1000, 1050, 1100, 1150, 2000, 2300 were observed by the person digitizing the layer, while the other codes were not (they were inferred and are constructed lines). We recommend only considering the stream layers that were observed by referring to the listed codes above; as some of the constructed lines serve more as a convention for coding/grouping wetlands within watershed groups, as opposed to documenting any potential stream. If observations from your field visit contradicts your desktop response, you can always change your answer.

Two streams are documented in Figure 4 below (Source: iMapBC). The line that traverses the wetland at the top that is colored blue then red as it moves through the wetland, is an observed stream (edge type: 1050); whereas the one through the wetland near the bottom, colored purple, is a construction line (edge type: 1400). In this situation, only the wetland on the top would be considered hydrologically connected to a stream.



Figure 4. Two wetlands, but only one is hydrologically connected to a stream.

Pre-Field: First Nations Information [Table 1.2]

First Nations are also often interested in activities occurring within their traditional territory (including assessing the health of wetlands). Many First Nations communities have close relationships to wetlands both spiritually, culturally, and for utilization such as harvesting of fish, wildlife, and plants. It's important to involve local First Nations in the assessment process and ensure they have an opportunity to participate.

Finding First Nations territories that overlap with wetland/block

To determine which First Nation(s) should be contacted, use the mapping tool shown in Figure 5 below found at: <http://maps.gov.bc.ca/ess/hm/cadb/>

Add the FWA wetlands layer under "Base Maps" and zoom to the wetland of interest. Within the "Navigation" tab select the "SOE Report" icon. An option to use point, line, polygon, or box will allow you to select the area of interest (i.e., the wetland). By selecting Next, then Submit, a pop-up box will appear with a list of First Nations, as well as recommended contact information for First Nation communities who should be contacted based on the Province's current knowledge of First Nations territories that overlap with the site. List all First Nations identified within the pop-up box. Include both hereditary offices and First Nations governments, if applicable.

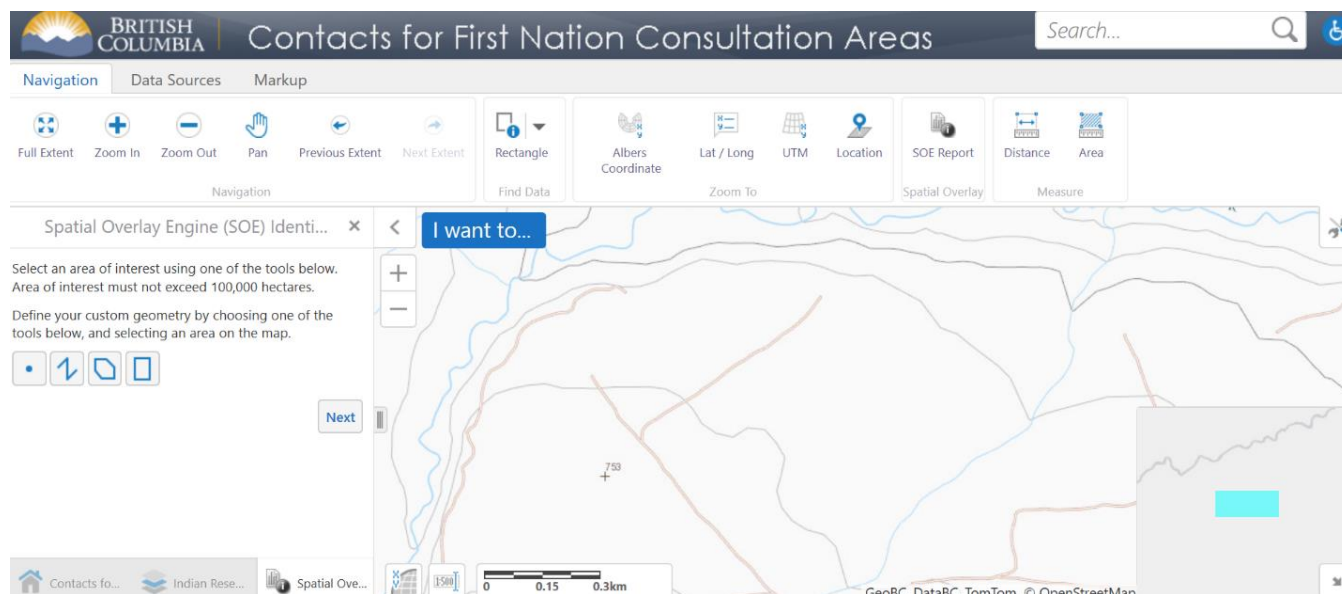


Figure 5. Screenshot from mapping feature of the consultative areas database.

First Nations communications

The relevant First Nation office(s) should be both informed about this assessment as well as invited to join the assessment prior to conducting the field component of the wetland assessment. Confirm that you completed this consultation by selecting the Yes/No options.

Pre-Field: Opening Information [Table 1.3]

If you are using the FREP wetlands form on the FileMaker app, several fields (i.e., the Forest Licence, Block, and Harvest Year) will auto-populate after you identify the District Code and Opening ID under the New Record tab as described near the start of this section under the heading “Starting a New Record.”

District

Refers to the official three-letter code for the natural resource district (e.g., DCR for Campbell River Natural Resource District). See Figure 6 for an overview of districts and their codes.

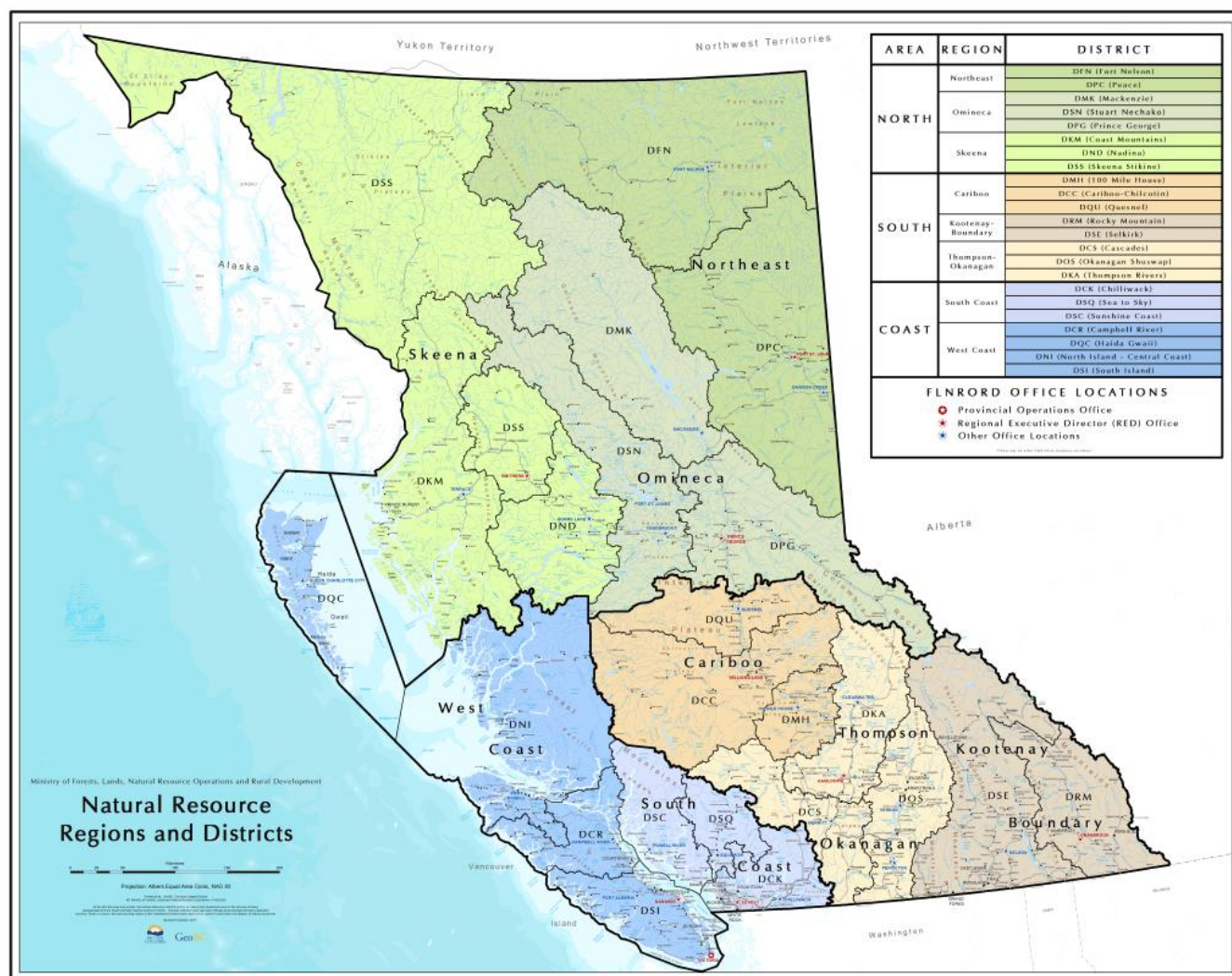


Figure 6. Map showing the Natural Resource Districts and their 3-letter codes across British Columbia (Province of British Columbia, 2020).

Opening ID

Opening ID is a unique 5-7-digit code that refers to a specific cutblock. For the purposes of FREP sampling, the selection of Opening ID will generally be constrained to a set of random sites in the district that represent recently harvested (1-3 years ago) cutblocks. These are pre-loaded into the FileMaker app for you to choose from.

If using the FREPmap tool, the opening ID can be selected by using the search function. If using iMapBC, and the Opening ID is desired from an identified polygon, load: "Openings – ALL – RSLT – Colour Filled" layer. Select the layer so it's visible on your map, and then hover your cursor over the cutblock opening of interest and select it and expand the data by pressing ">". The code will be listed under the field "Opening ID".

Licensee

Refers to the company that holds the forest licence for the block. This will auto populate if you are using the iPad FileMaker form. Otherwise, this information can be found using the FREPmap tool; the licensee is in the attribute table of the "RESULTS Openings" layer. If using iMapBC, the same information will be found in the "Openings – ALL

– RSLT – Colour Filled” layer. Select the layer so it’s visible on your map, and then hover your cursor over the cutblock opening of interest and select it and view the attribute table by pressing “>”. The licensee will be listed under the field “Client Name”.

Forest licence

Refers to the forest licence recorded for the cutblock. This will auto populate if you are using the ipad FileMaker form. Otherwise, this information can be found using the FREPmap tool; the forest licence is in the attribute table of the “RESULTS Openings” layer. If using iMapBC, the same information will be found in the “Openings – ALL – RSLT – Colour Filled” layer. Select the layer so it’s visible on your map, and then hover your cursor over the cutblock opening of interest and select it and view the attribute table by pressing “>”. The forest licence will be listed under the field “Cut Block Forest File ID”.

Block

Refers to the designation used by the licensee on their logging or site plan map for the cutblock. This will auto populate if you are using the ipad FileMaker form. Otherwise, this information can be found using the FREPmap tool; the Block is in the attribute table of the “RESULTS Openings” layer. If using iMapBC, the same information will be found in the “Openings – ALL – RSLT – Colour Filled” layer. Select the layer so it’s visible on your map, and then hover your cursor over the cutblock opening of interest and select it and view the attribute table by pressing “>”. The block will be listed under the field “Cut Block ID”.

Harvest year

Refers to the year timber in the selected block was harvested along the sample reach. This will auto populate if you are using the ipad FileMaker form. Otherwise, this information can be found using the FREPmap tool; the harvest year is in the attribute table of the “RESULTS Openings” layer. If using iMapBC, the same information will be found in the “Openings – ALL – RSLT – Colour Filled” layer. Select the layer so it’s visible on your map, and then hover your cursor over the cutblock opening of interest and select it and view the attribute table by pressing “>”. The harvest year will be listed under the field “Disturbance End Date”.

Harvest location

Refers to the location of harvesting in the block relative to the sample wetland; record north, east, south, and/or west, as applicable.

Wetland riparian class on plans

Record the wetland forestry riparian class (W1-W5 or unclassified wetland-NCW) indicated on the logging plan and/or site plan map. The licensee should be able to provide a copy of these plans upon request. Note that wetlands less than 5 ha should be given preference for this assessment.

Wetland riparian class in field

Record a different wetland riparian class only if it was misclassified. This sometimes can occur if the boundaries of the wetland were inaccurately delineated. It’s helpful to use both air imagery and ground observations to verify the boundaries of the wetland. If the boundaries are inaccurate you may have to calculate wetland size (see **Field Sampling Information** on pg 37 for details on how to do this). Wetland riparian classes are based on size and biogeoclimatic location and can be determined by using the flow chart in Figure 7 below. **NOTE:** A wetland complex (W5) must consist of two or more individual wetlands with overlapping riparian management areas and a combined wetland area of 5 ha or more. Use the following key to help identify which wetland riparian class the wetland that is being assessed falls into.

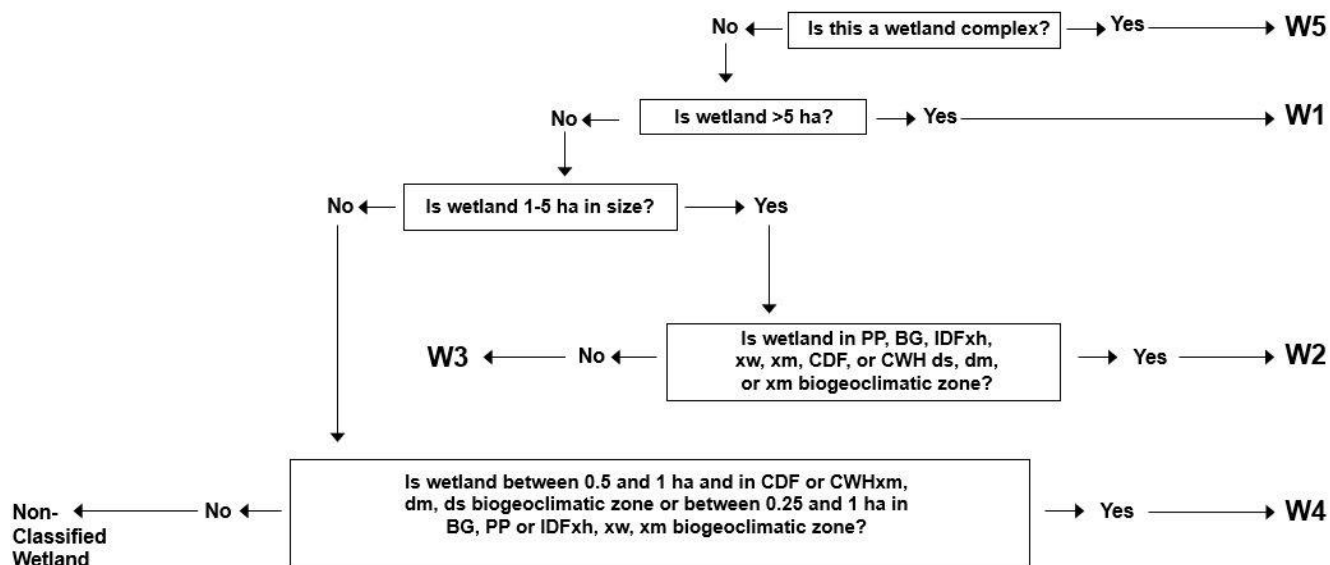


Figure 7. Key to wetland riparian classification (Source: Forest Practices Code Guidebook: Riparian Management Area Guidebook 1995).

Riparian management area (RMA)

The RMA is the forested area next to a riparian area or wetland where riparian forest management and logging is conducted (Figure 8). The RMA includes the Riparian Management Zone (RMZ), and Riparian Reserve Zone (RRZ).

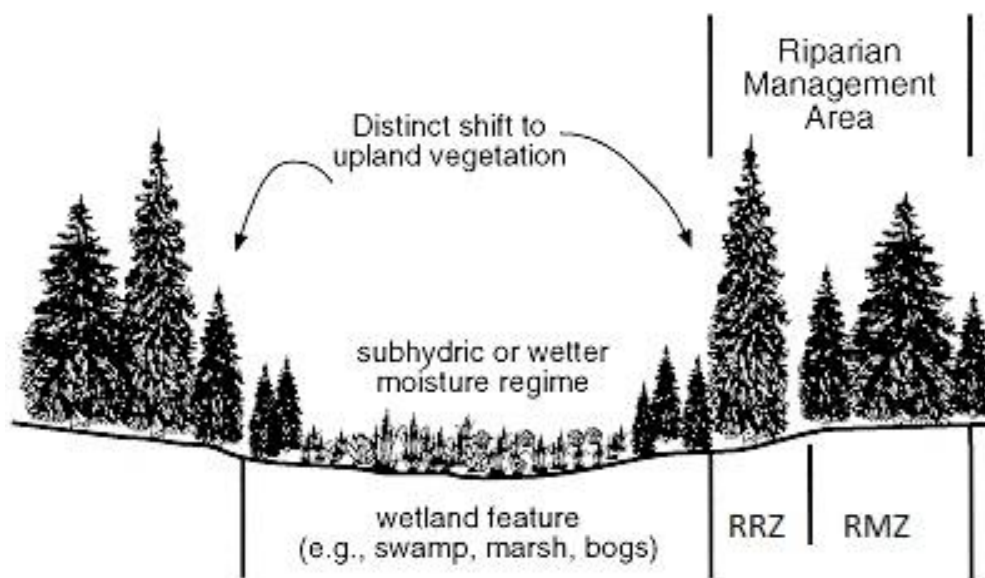


Figure 8. Diagram showing the Riparian Reserve Zone (RRZ), the Riparian Management Zone (RMZ) within the Riparian Management Area (RMA).

Riparian reserve zone (RRZ)

The RRZ is located within the RMA and makes up part of the RMA area. No forestry operations will take place in the RRZ. The width of the RRZ will depend on the Wetland Riparian Classification (Table 1).

Wetland Riparian Class	RMA (m)	RRZ (m)	RMZ (m)
NCW	0	0	0
W1	50	10	40
W2	30	10	20
W3	30	0	30
W4	30	0	30
W5	50	10	40

Table 1. Associated riparian management distances from edge of wetland based on wetland riparian class from the B.C. Riparian Management Area Guidebook. NOTE: NCW = non-classified wetland

Riparian management zone (RMZ)

The RMZ is located within the RMA, and where prescribed harvesting and forestry activities may still take place. Generally, a lighter footprint of disturbance is anticipated within this area in comparison to the rest of the cutblock. Various management techniques can help to lighten the footprint, such as partial harvesting, retention of non-merchantable timber and other canopy layers, or feathering/stubbing of merchantable wood to reduce windthrow to the RRZ or forested wetland.

Pre-Field: Riparian/Buffer Retention Information [Table 1.4]

Describing the Riparian and Buffer retention information in this table helps FREP analysts to better quantify effective mitigation measures in terms of forestry effects to wetlands.

Length of wetland perimeter within assessment polygon (m)

Measure the length of the perimeter around the wetland, and only consider the perimeter that is within the assessment polygon. Generally, this will include the entire wetland perimeter, unless there is a rationale to constrain the assessment to a smaller area.

Using FREPmap, this can be accomplished with the drawing tool. First select the freehand polygon tool and ensure “show area measurement” and “show perimeter measurement” features are turned on. Select m² and m as the units respectively. Results will display on the map. Record the perimeter measurement in metres.

Full retention refers to a buffer next to the wetland where dominant and co-dominant trees are 100 % retained after a recent disturbance (e.g., logging or clearing). Partial retention refers to an upland buffer where a portion of the dominant and co-dominant trees were removed, but at least some were retained. No retention refers to a site where no dominant and co-dominant trees remain.

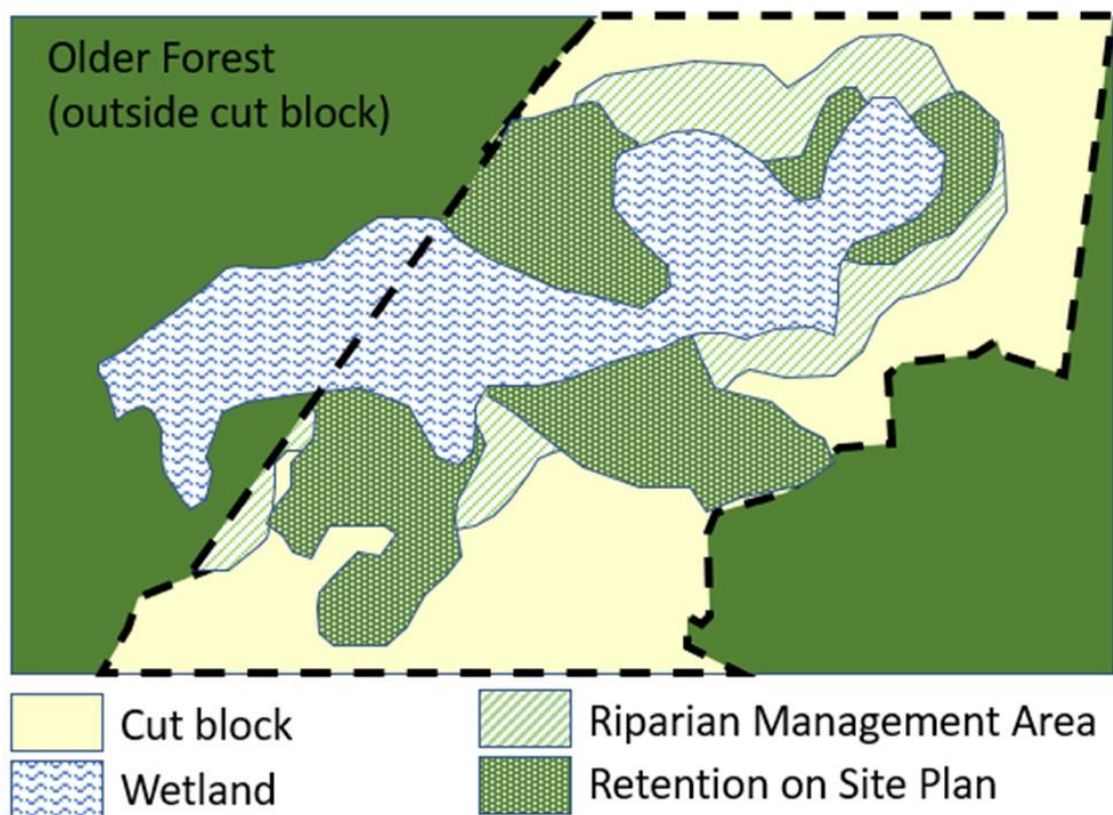


Figure 9. Example Site Plan with various retention components. Source: BC Wildlife Federation.

Figure 9 depicts information typically provided on a forestry site plan that can help interpret the treatment components next to a wetland. Full retention would be the sum of the wetland's perimeter shown in solid green (Older Forest) **and** the patterned green with white dots (Retention on Site Plan). In the example above, assume that no RRZ is required, so the RMA may be a combination of either partial retention or no retention. Recent air imagery will further help the evaluator determine if the wetland perimeter in the RMA is partial retention or no retention. If there is no retention, then the imagery in the RMA will look similar to the rest of the cut block.

Length along wetland perimeter with full retention (m)

In the example above (Figure 9), Full retention would be the sum of the wetland's perimeter shown in solid green (Older Forest) and the patterned green with white dots (Retention on Site Plan). Measure the wetland perimeter with these components and sum them up to obtain the length with full retention.

Average width of full retention

Where full treed retention is present, take multiple measurements perpendicular from the wetland edge around the wetland perimeter, then divide by the number of samples to get your average. Maximum width is 100 m.

Length along wetland perimeter with partial retention

In the example above (Figure 9), partial retention will be confined to a portion of what is within the RMA, but outside of the retention zones. Compare the site plan with remote imagery and look for areas that are greener than the adjacent cut block. In some cases, you'll need to verify the treatment by visiting the field site. After determining the amount of partial retention present, measure the wetland perimeter with these components and sum them up to obtain the length with partial retention.

Average width partial retention

Where partial retention is present, take multiple measurements perpendicular to the wetland edge around the wetland perimeter, then divide by the number of samples to get your average. Maximum is restricted to 100 m.

Average partial retention (% of basal area)

The basal area is the cross-sectional area of a tree at breast height. Imagine you were to take all the cross-sectional areas prior to harvest, then compare that to a forest that has partial retention, record the % basal area that remains. This measurement is likely easier to determine in the field, but you may be able to estimate if you have high quality aerial imagery. In the field, looking for recently cut stumps will help inform your answer. Sampling a few 10 m x 10 m patches can give you a reasonable approximation.

Length along wetland perimeter with no retention (m)

In the example above (Figure 9), a section of perimeter with no retention should be confined to a portion of what is within the RMA, but outside of the retention zones. Compare the site plan with remote imagery and look for areas that are light brown or paler green. In some cases, you'll need to verify the treatment by visiting the field site. You are looking for areas where no dominant or co-dominant trees remain. After determining the wetland section abutting "no retention", measure the associated wetland perimeter sections and sum them up to obtain the length with no retention.

Adequate description of the condition of the riparian area

It's possible that the treatment widths or amount of retention is highly variable at your site, or the estimates on averages are skewed (e.g., if older forest was averaged with retention within the cut block leading to a higher amount of retention that masks the cut block treatment information).

If you're using the FREP FileMaker form and select "No" to this question, and you will be prompted to upload a sketch and/or photo. Include a birds-eye sketch of your site or screen shot of your digital analysis, that depicts the various treatment components (full, partial, and no retention features) with the submission of your assessment. Regardless, you'll also be prompted to include a map of your site in the "Field" tab when using the app, or at the end of the paper version of the form.

Pre-Field: Description of Dominant Upland Vegetation Strata [Table 1.5]

The structure and condition of the surrounding area that abuts a wetland can influence the health of the wetland. This stratification process helps determine where sample transects will be placed in the field. When reviewing maps and remote imagery, try to stratify the surrounding area that abut your wetland into a few distinct zones with each stratum covering no less than 10 % of a perimeter edge (Figure 10). Consider how the different strata may influence the health of the wetland. If completing a FREP assessment, then ensure the recent cutblock is represented by at least one of the strata. In wetlands < 5 hectares, limit this process to 3 major strata where you will place transects.



Figure 10. Example of stratifying distinct areas abutting the perimeter of the wetland.

Once strata are selected along the perimeter of the wetland then you will randomly select a position along the perimeter within each of the strata that will mark your transect locations (Figure 11). If you are entering data directly into the FileMaker form, the app will automatically assign a random number for you. Once in the field, if this location is not suitable (inaccessible or other reason), this number can be adjusted.

Upland Descriptor for Strata and Age	Upland Modifier for Strata and Age	Retention Width (m)	Length along perimeter (m)	Fraction along wetland perimeter	Number of Transects	Location(s) of transect(s) along perimeter section ⓘ		
						T _a	T _b	T _c

Figure 11. Table 1.5 headings for upland vegetation strata around perimeter of wetland, as shown in the FREP Wetland FileMaker form.

Upland descriptor for strata and age

To describe the abutting land around the perimeter of the wetland, consider the dominant characteristics within 100 m of the wetland edge. We generally consider the vegetation characteristics and the relative age of that vegetation. Below is the dropdown list, within the FREP FileMaker form, of common vegetation strata and relative age descriptors used to classify abutting areas:

- Young Coniferous
- Mature Coniferous
- Old Coniferous
- Young Deciduous
- Mature Deciduous
- Old Deciduous
- Young Mixed Forest
- Old Mixed Forest
- Lake/Pond – abutting
- Stream/River – abutting
- Grassland
- Cutblock
- Other

Upland modifier for strata and age

Include a modifier if there has been a disturbance. Disturbances could be human-caused or natural that disrupt the long-term trajectory of the vegetation. Drop down options in the FREP FileMaker form include:

- Recent cutblock
- Old cutblock
- Recent fire
- Log sort – landing
- Road within 100 m
- Other

Retention width

Record the approximate distance the dominant retained vegetation type extends beyond the wetland perimeter, starting at the wetland edge. If it extends beyond 100 m, then record 100 m.

Length along wetland perimeter

Record the length of the wetland perimeter occupied by the strata. It's possible that you may need to add segments of the strata if it's not contiguous along the perimeter.

Fraction along wetland perimeter

This is the fraction that the abutting strata occupies along the perimeter of the wetland edge. If your total perimeter is 800 m and the cutblock is along 200 m, then the fraction is 0.25 (or 25 %). The combined fractions of all strata should sum to 1.

Number of transects

Record the number of transects you intend to place in each stratum. On occasion there will be fewer than 3 strata present abutting the perimeter of the wetland (e.g., the wetland is entirely surrounded by the cutblock). If there is only one stratum, place 2 or 3 transects into that strata. If there are 2 strata, place 2 transects into the strata that has the greatest fraction.

Location of transect along perimeter section

You'll need to randomly select the distance (or multiple distances) along the perimeter within each specific stratum where you will place your transect(s). If you are using the FileMaker form, it will automatically generate sample locations around the perimeter. If you are using a paper form, then use a random number generator (e.g., with MS excel) to select a number that is a fraction of the perimeter length of a stratum. To locate the point of commencement (POC) for your transect, find the corresponding distance by moving in a clockwise fashion around the perimeter of the wetland.

Pre-Field: Other Development [Table 1.6]

This section asks you to record other potential threats due to human activity.

Delineating a wetland's contributing basin

A contributing basin is all of the surface area upslope of your wetland that directs surface water flow towards the wetland and that would flow through the outlet. The contributing basin for wetlands is not readily available as a data layer in BC and will require that you review maps and some key data layers to delineate the boundaries of a contributing basin. The contributing basin can generally be interpreted with a stream layer and an elevational contour line layer. First, observe all the streams that are connected and flow through your wetland. If the streams are flowing away from your wetland, and do not traverse through your wetland, then these are outside your contributing basin. Distinguishing between the headwater areas of streams passing or not passing your wetland will give you a coarse approximation of where the boundaries of the contributing basin exist (Figure 12).

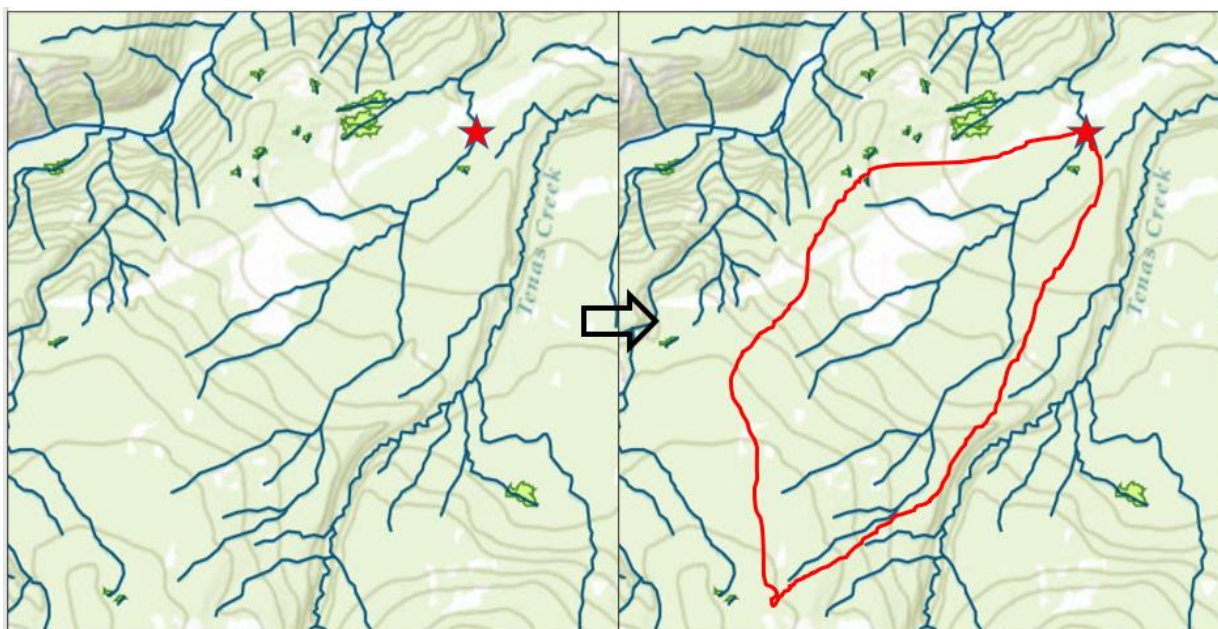


Figure 12. A rough approximation of the contributing basin of a wetland (marked with red star) based on identification of adjacent drainage basins.

The contour lines will further help you refine the contributing basin by identifying ridges and hill/mountain tops that act as basin divides (Figure 13). Water flows downstream perpendicular to the contour lines (i.e., blue arrows show approximate direction of surface water). This is generally water's shortest path downslope. The "V" and "U" shaped notches that appear as part of the contour lines that point upslope generally are located where water accumulates and often coincide with locations of streams, whereas the "V" or "U" shaped notches that point downslope are ridges, and can be used to represent the boundary of the contributing basin (dashed line).



Figure 13. Maps showing contour lines (red solid line), streams (blue solid lines), flow path of surface water (arrows), and delineation of a contributing basin (dashed line).

Number of road crossings

Once you have a contributing basin delineated, road crossings can be easily tallied. Record the number of road crossings within the assessment polygon, the number of road crossings within the wetland, and the number of road crossings on any upstream tributaries that flow into the wetland being assessed (Figure 14). **NOTE:** the assessment polygon includes the wetland being assessed plus a buffer of 10 m that abuts the wetland perimeter.

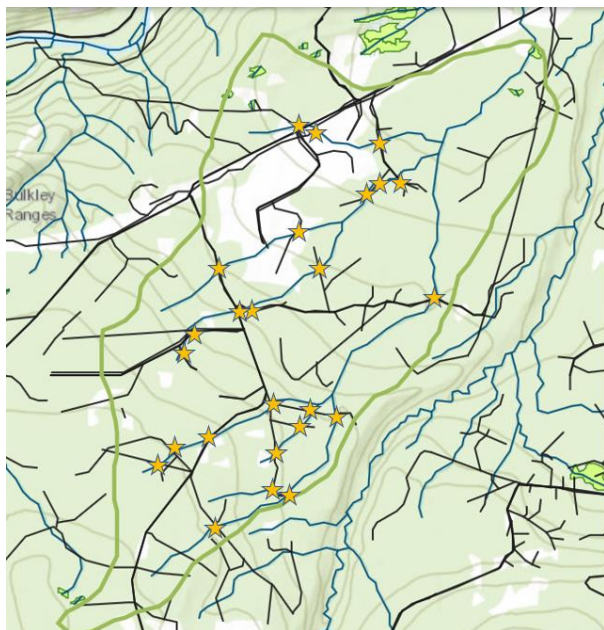


Figure 14. Example of road crossings. After delineating your wetland's contributing basin (green line), count where the streams and roads intersect (orange stars).

Upstream developments

Using an area-based measurement tool (iMapBC or FREPmap), calculate the amount of the contributing area that has evidence of human development as a percent of the total contributing area. You may be able to determine this best by reviewing satellite imagery, in combination with layers such as roads and cut blocks.

Record the main development within the wetland assessment polygon which likely has the highest impact to the wetland.

Main Developments can include:

Roads



Figure 15. Forest Service Road crossing through a wetland. Insufficient culverts led to pooling of water upstream (left), and more vigorous growth and shrinking of wetland on right hand side.



Figure 16. Highway directly adjacent to a wetland, which leads to high levels of noise pollution, runoff into the wetland and has no accommodations for wildlife access.

Forestry (except roads)



Figure 17. Harvesting has compacted the soil, opened the canopy, and changed the hydrology of this forested swamp.

Agriculture



Figure 18. Pugging by cattle that had access to this wetland.

Recreation



Figure 19. Rutting and compaction by off-road ATV and 4X4 users.

Mining

- No photo available

Oil & Gas



Figure 20. Forested wetland cleared for pipeline ROW.

Transportation

Since roads has its own class of upstream development, transportation covers all other forms of transportation development that could impact a wetland. This includes rail, airports, marinas, etc.

Utilities



Figure 21. Open water wetland under utility line.

Pre-Field: Landscape Indicators [Table 2]

The following observations inform two landscape indicator questions that are part of the FREP assessment (hydrological connectivity and connectivity for wildlife). These questions are included as part of the pre-field assessment, as they either partially or completely require remote imagery interpretation and some geospatial analysis, ideally completed prior to heading out into the field.

Upland area from wetland edge modified by human activities

Prepare this analysis by utilizing the buffer and measurement tool to review on iMapBC or FREPmap. Details on how to do this can be found in the section *Calculating a 10 m Riparian Area Upland of Wetland Assessed* on pg 38 but here you adjust buffer to the required size (i.e. 30 or 50 m). The percent of the area surrounding the wetland edge within the zone that is modified is then estimated (Figure 22).



Figure 22. In the above image, a 30 m buffer was applied to the wetland, and approximately 60 % shows evidence of human disturbance (i.e., a recent cut-block to the south, and a younger cut-block to the west).

Wetland's visible shoreline

Visual screening is important for wildlife species such as moose and waterfowl. A wetland that lacks visual screening exposes possible prey to hunters and other predators. It can also increase overall disturbance to wildlife which can affect energy reserves if animals are forced to escape or find better cover. This indicator is best confirmed in the field from various vantage points along roads or right of ways. However, you can plan your field work by selecting possible vantage points from reviewing your satellite imagery. Look for possible roads or ROW within 300 m (for wetlands < 5 ha) or 500 m (for wetlands > 5 ha). Consider the topography (contour lines) of the site as higher ground will provide better vantage points. For the purposes of answering this indicator question, the term "a wetland's shoreline" should be interpreted as the portion of the wetland where there is a distinct edge and vegetation change from that observed in the upland plant community. What is the maximum percentage of this area of the wetland that is exposed from a human-made linear feature? Ultimately, we are attempting to determine if an animal occupies the wetland's "shoreline", are they exposed?

Right-of-ways within 100 m impinging on wetland's perimeter

Similar to the last indicator, right-of-ways can provide easy access to predators (both human and other animals) and increase overall disturbance to a site. Roads and other right-of-ways may also disrupt surface or sub-surface flows, which may affect the wetland's hydrology. Create a 100 m geospatial buffer around your wetland perimeter and determine the % of the perimeter that has roads impinging within that zone. To better visualize the amount of the buffer that is impinged by right-of-ways, it may help to draw a polygon that runs perpendicular from the wetland edge to the 100 m buffer (Figure 23).

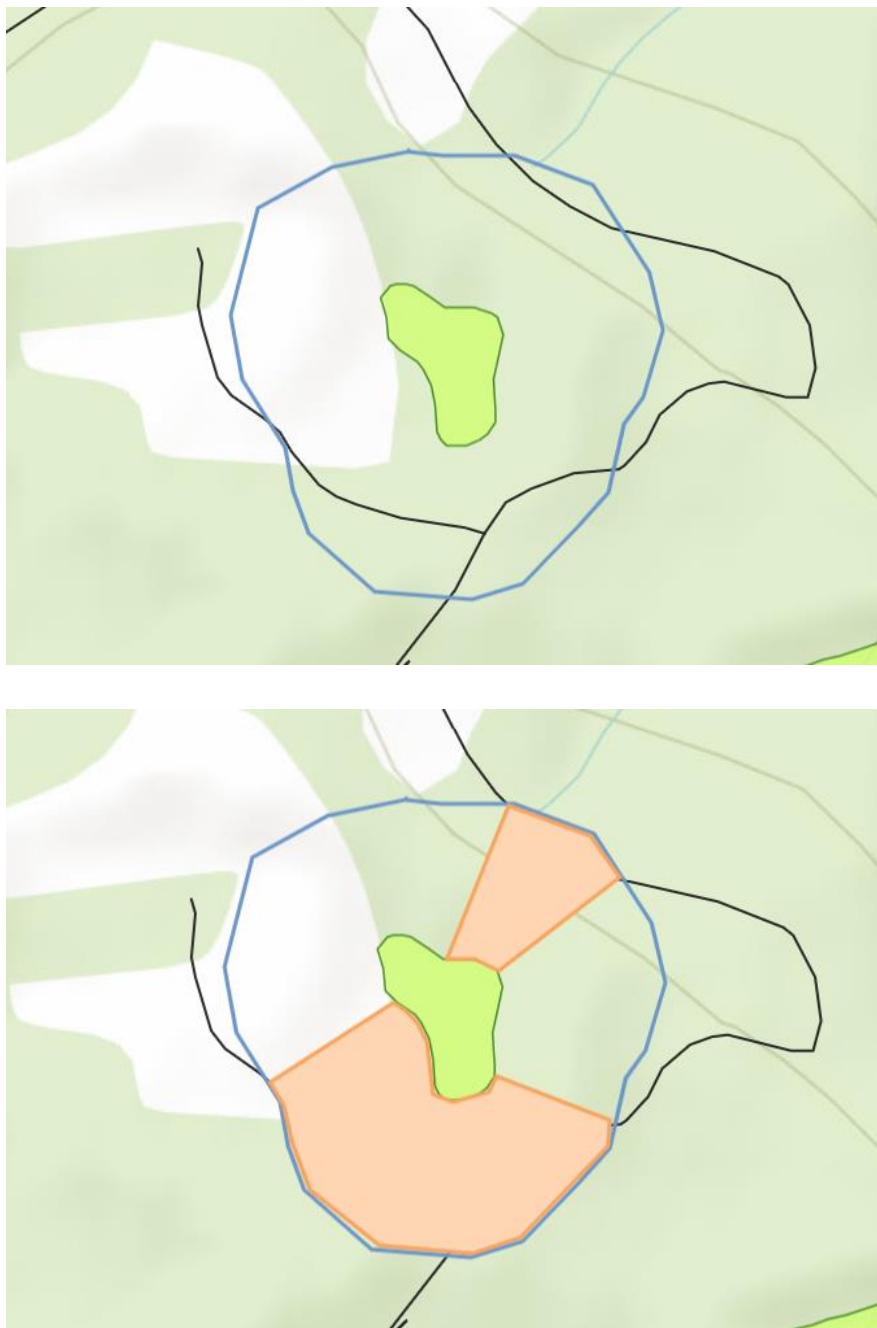


Figure 23. A 160 m segment of the wetland perimeter has a road within 100 m; 180 m of the wetland perimeter lacks roads within 100 m. Thus 47 % ($[160 / (160 + 180)] * 100$) of the wetlands perimeter has road impingement within 100 m.

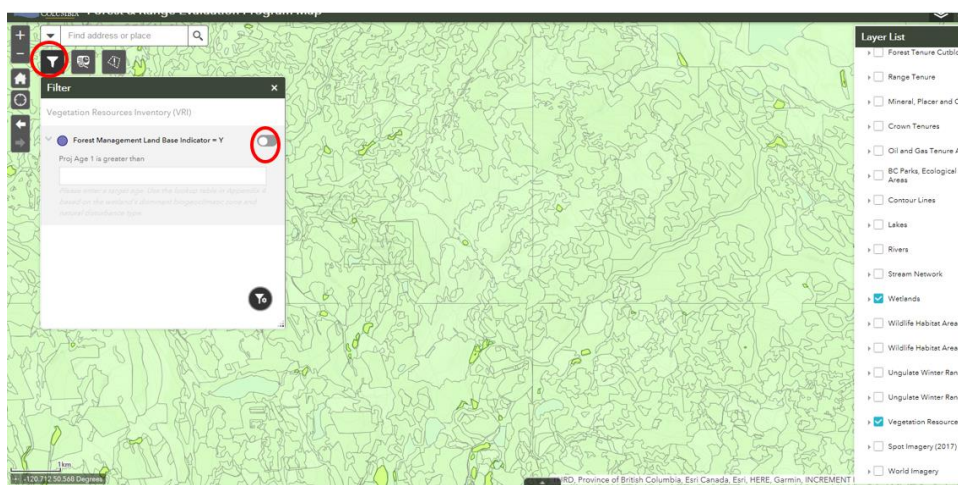
Percent coverage of mature and old forest within 2 Kilometers

The percent of mature and old forest within 2 km is used as an indicator of landscape connectivity. The amount of mature and old forest, and what age constitutes mature, should reflect typical distributions and ages based on the surrounding area's biogeoclimatic classification and natural disturbance regimes. Appendix 5 of the Protocol provides targets for specific biogeoclimatic classifications and natural disturbance types. If using FREPmap, then follow steps below to calculate the amount of mature and old forest within 2 km.

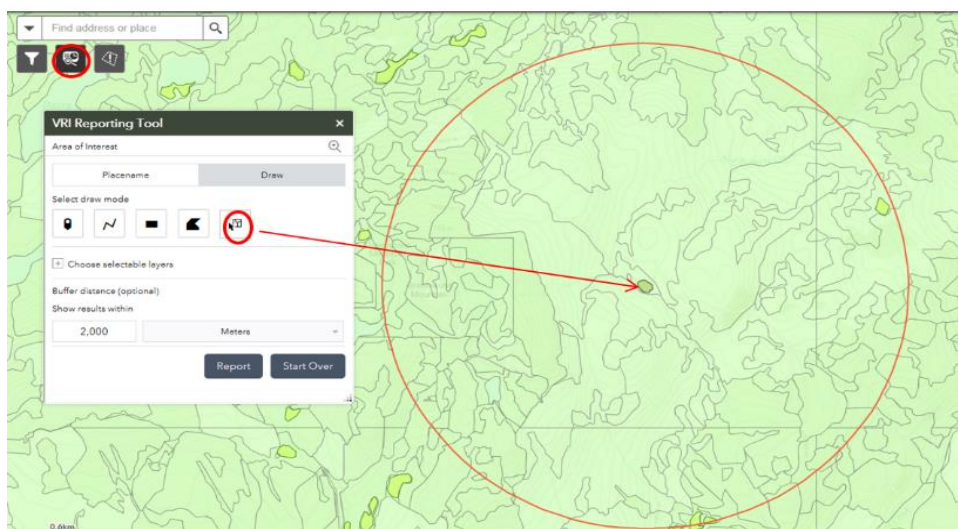
Using FREPmap to calculate old forest within 2 km

Steps:

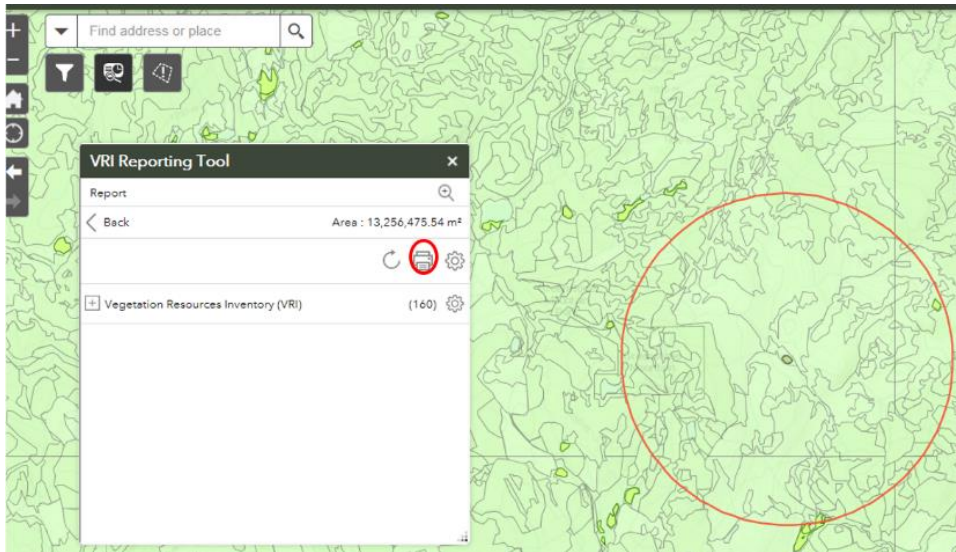
1. Turn on wetlands and VRI data in the layer list and zoom to your area of interest.
2. Click the filter widget (see below) and check to make sure it is turned off (to estimate all of the FMLB within your buffer), then close the window.



3. Next, open the VRI reporting tool, click the draw tab and select your wetland using the selection tool (see below). Enter the desired buffer size and a buffer will appear- you might have to zoom out to see it.



- Click the Report button at the bottom (it will take a minute or two to calculate) then click the "print" icon and the print button for the results to appear on your screen.



- These results represent all of the FMLB in your circle. Take down this number and close the window.

Forest & Range Evaluation Program

Area of Interest (AOI) Information

Area : 13,256,475.54 m²

Feb 6 2019 12:7:30 Pacific Standard Time

Enter comments here

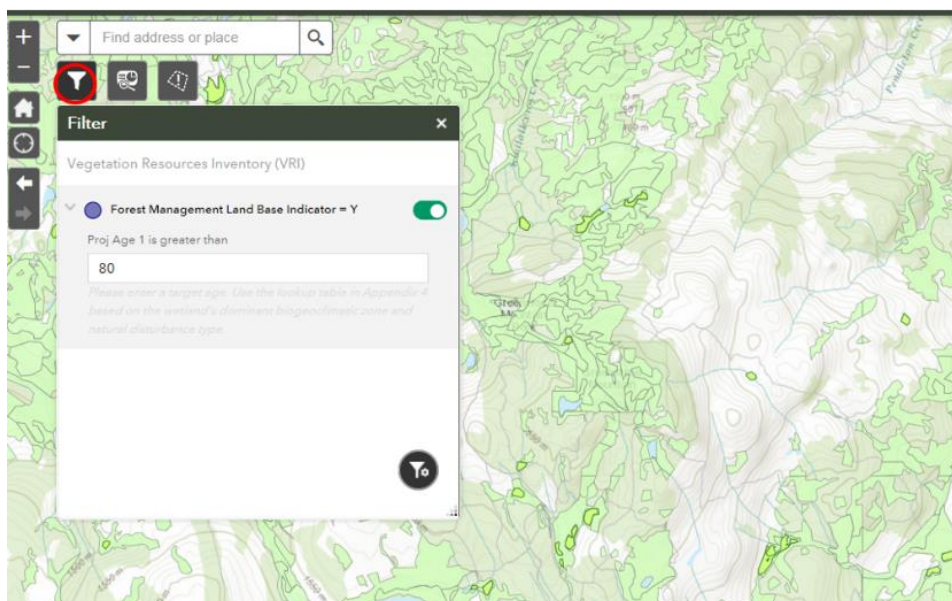
Summary

Name	Count	Area(m²)	Length(m)
Vegetation Resources Inventory (VRI)	160	13,256,475.24	N/A

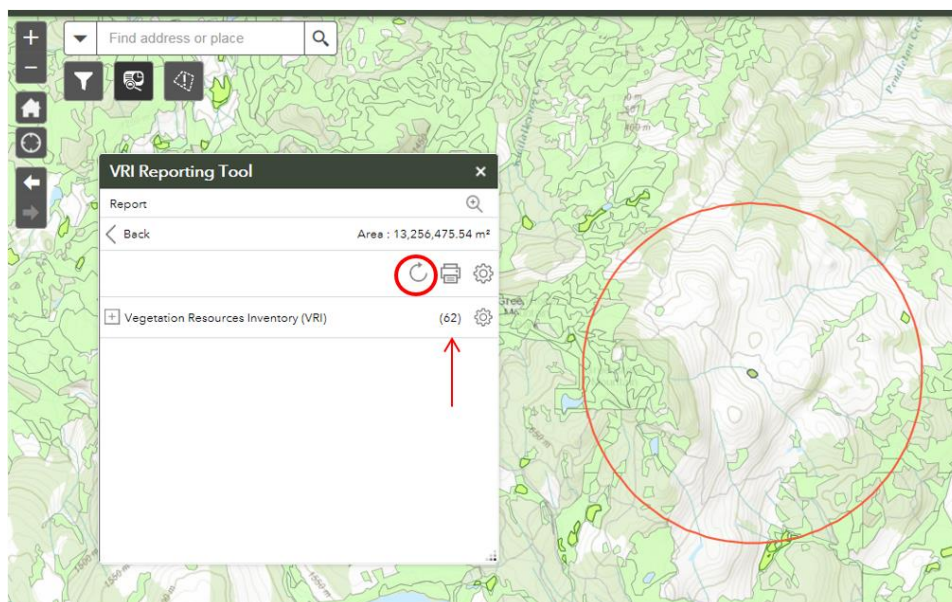
Vegetation Resources Inventory (VRI)

#	FEATURE_ID	MAP_ID	POLYGON_ID	OPENING_IND	OPENING_SOURCE
1	11041891	0921067	19234958	Y	4
2	11041895	0921067	16224306	Y	4
3	11041896	0921067	16224306	Y	4

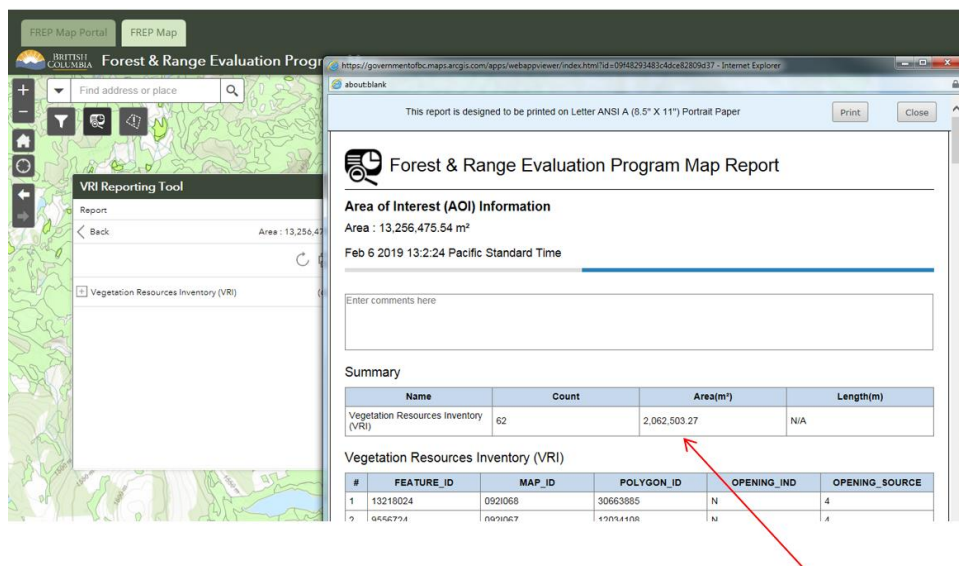
- Exit all of the windows and go back to step two. Activate the filter widget by using the slider button as per the figure below. Enter the desired age for selection based on the reference table in Appendix 5 of the Protocol.



- Repeat steps 3 & 4. If the buffer is already there when you click on the VRI reporting widget, make sure to click the refresh button (see below) to recalculate based on your selected age. Notice the difference in # of polygons.



8. Hit print as before, but this time the results represent only those stands greater than the age that was specified. Divide by the total recorded previously to calculate percent.



In this example, the proportion of 80 yr old stands within 2 km of the wetland is 13 %, and below the minimum threshold for this NDT.

*Note: VRI may not reflect status since recent wildfires. This can be checked by turning on the fire boundaries and clicking the info button to learn date of burn while working in FREPmap.

All mapped and unmapped streams at roads and ROWs are in their original water courses?

Roads are one of the most common disturbances that can disrupt drainage patterns affecting a wetland's inflow or outflow (Figure 24). Inappropriately sized, blocked, or poorly positioned culverts may lead to disruptions in surface water flows. Before you head out to the field, identify road crossings at mapped streams in the contributing area that may warrant investigation. There may be limited information that can be determined from available maps or remote imagery. When approaching (or leaving) your wetland by vehicle, and as time allows, visit as many of the mapped streams that flow into your wetland or that are near any of the wetland's outlets. Inspect the sides of the road for water movement that may divert flow away from the natural downstream receiving waters. Imagery collected by drones could help with this part of the assessment and may become a more standard monitoring tool in future years.



Figure 24. Ditch on the right of the road carries water from an unmapped seasonal stream over 300 m in the ditch, passing several blocked culverts, before passing under the road, through a still functioning culvert, and into the wetland (on left of road). Water no longer follows a natural water course.

Percent (%) of contributing basin intercepted by roads and ROWs

After you've established the contributing basin, turn on your roads layer and estimate the amount of land where surface water would need to pass across a road before it reaches the wetland (Figure 25).

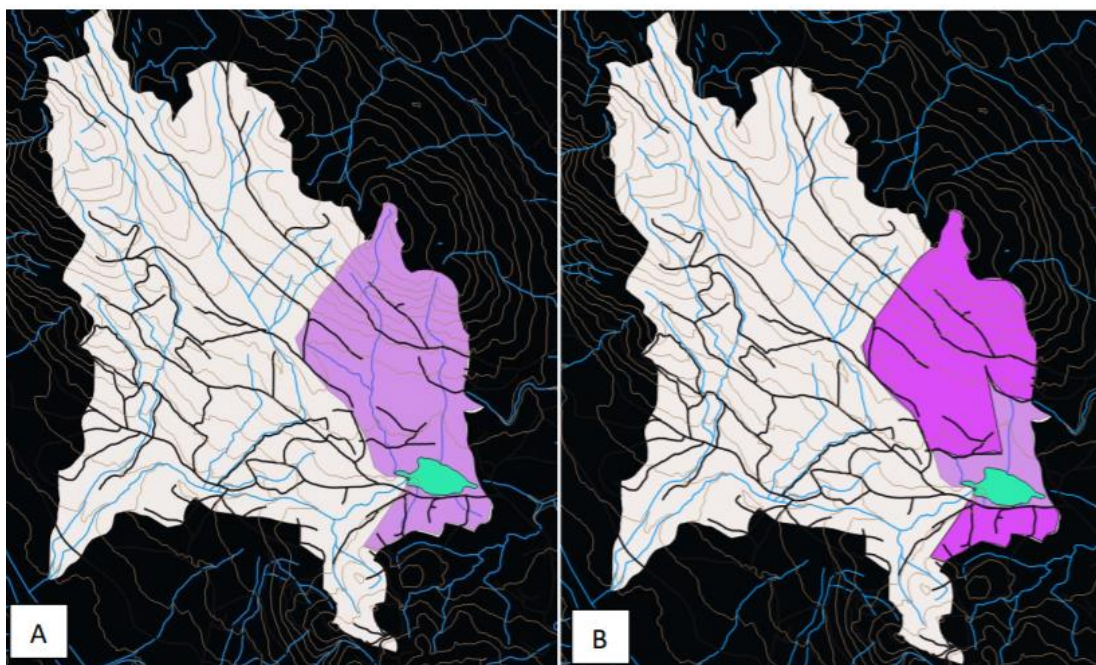


Figure 25. Contributing basin shown as light pink (A); area of contributing basin with surface water flow requiring to pass across/through road shown as dark pink (B).

Pre-Field: Supplementary Management Observations [Table 3]

Site associated with a forestry cutblock?

Your response helps categorize this wetland assessment entry into cutblock and non-cutblock sites.

Boundaries on site plan for wetland coincide with observations in the field?

In general, site plans provided by forest companies tend to be much more accurate than available provincial layers (e.g., Fresh Water Atlas), because a field crew has typically visited and mapped the boundaries of the proposed cut block and delineated the wetland boundary as part of their field work. However, it's not uncommon to find details in the site plan that don't coincide with observations you make from interpreting satellite information or observations you make in the field. It is important to accurately determine boundaries for several reasons: if the wetland is larger in reality, it may pass a regulation threshold requiring larger riparian reserve zones or riparian management zones and/or an inaccurate boundary may inadvertently lead to forestry operations that impact the wetland or its riparian management area (Figure 26).



Figure 26. The image on the left shows two wetlands delineated by the Freshwater Atlas (green solid line). However, upon further investigation of remote imagery, it's highly probable that the dashed white line more closely represents the boundaries of the wetland, which is actually just one larger wetland.

When attempting to delineate a wetland, look for clues such as changes in color and texture (graininess) of the vegetation community. With the exception of productive forested wetlands, which may have a similar canopy to the adjacent upland forests, most wetlands will have distinct characteristics that can help to separate them out from the forested landscape. Smaller and more refined textures typically indicate smaller vegetation growing in areas that constrain taller vegetation from establishing due to the wet soils. Lighter colours, can indicate herbaceous or bryophyte vegetation. Open water typically appears as a darker color or sometimes bright green if covered in floating aquatic vegetation or algae blooms. If available, it's helpful to look at multiple remote images of your site as the distinction in vegetation can be more pronounced in some air imagery due to time of day, image quality, or season. The FREPmap tool has multiple satellite images in its base map gallery and layers that you can further explore. In many cases, you may need to confirm your assumptions by investigating the wetland boundaries in the field. Pay close attention to swamp communities since they are frequently poorly delineated from remote imagery.

Swamps typically occur between the margins of the upland forest community and other wetland classes because their soils are likely to be raised higher relative to other wetland types. Often, a mixture of obligate wetland vegetation, the presence of water within 30 cm, or soils modified by the presence of water within the first 30 cm, can help to distinguish the transition between upland and swamp habitat.

Retention around other wetlands on block

Due to time constraints in the field, you're not expected to investigate every wetland on a block, but if you incidentally observe a wetland that has not been adequately safeguarded by an adequate RRZ or RMZ, then mark "No" and add some comments into the notes section/tab.

Four-wheel drive access blocked on roads within 100 m

Record if any measures were taken to limit four-wheel access within 100 m of the wetland edge. If you are uncertain of any measures taken during the desktop review, you can flag any potential access points on your map for field confirmation. Mark "Yes" if there has been any attempts to block access by road removal, gates, or physical barriers. Figure 27 is an example of disturbance caused by 4-wheel drive use in the wetland.



Figure 27. *There were no measures to block motorized access to this wetland and the result was rutting, compaction and bare soil from recreation use.*

If rangeland present, measures taken to reduce/block livestock access

If not properly managed, cattle and other livestock can have a tremendous impact on the functioning health of a wetland by removing riparian vegetation, compacting soils, increasing sedimentation, lowering water quality, and reducing recruitment of trees and shrubs (Figure 28). By clearing forests and building roads, forestry can increase the accessibility of wetlands for cattle. Potential sources of cattle (range tenures) can be identified during the desktop review and access confirmed in the field. Document if any measures have been taken to limit cattle access to the site: including cattle guards, fencing, or felling of trees to create barriers (Figure 29).



Figure 28. This photo shows how fences play an important role in managing cattle access, and the difference between healthy (left) and unhealthy (right) riparian vegetation.



Figure 29. These logs were placed around the perimeter of the wetland in an effort to reduce cattle grazing within the riparian area.

TRANSECT LAYOUT, WETLAND CLASSIFICATION, AND VEGETATION PLOTS

To complete the Wetlands Management Routine Effectiveness Evaluation (WMREE), up to three transects are randomly placed within the wetland. Wetlands less than 5 ha in size are the best choice for this sample design, though larger wetlands can be sampled if additional transects are established. Once in the field, before starting any measurements, first confirm the wetland is a wetland, the wetland polygon boundary is accurate/appropriate, and the wetland is within two riparian management areas if it is to be included as an official FREP site.

Field Sampling Information [Table 4]

Entire wetland sampled OR partial wetland sampled

Most of the time, you will be able to sample the entire wetland, but on occasion you'll need to constrain your sampled wetland to a smaller portion. Partial wetland sampling may be warranted if the wetland is too large or there is a physical barrier that prevents you from making observations at a specific section (e.g., deep stream crossing). In this case, prepare a map that shows the portion of wetland that is included within your assessment, and provide a rationale in the notes section for your decision to limit the assessment to only a portion of the wetland.

Wetland assessed size (m²)

Document the wetland size in square meters. Only consider the wetland portion as defined ecologically. If you selected "Partial Wetland Sampled", then do not include any portion you're excluding from analysis. If you are satisfied with a layer that is already digitized, such as the FWA wetlands layer, then you can generally find the area within the attribute data of that layer. However, if you suspect that the wetland polygon differs from available shapefiles, then you will need to digitize the boundaries of your wetland (Figure 30). For FREPmap users, you can






measure the size of your wetland by using the draw tool . First select the polygon option  and select a preview option that has a transparent fill. Remember to turn on "show area measurement" and "show perimeter measurement"; configure measurement settings to display units in meters squared and meters respectively.



Figure 30. Digitized wetland from FREPmap shows area in square meters. Here our wetland is 8,828 m², or 0.88 hectares.

Calculating a 10 m riparian area upland of wetland assessed (m²)

For FREPmap users, to digitize a 10 m buffer around a wetland, select the situation awareness tool, . A pop-up appears on the bottom of the screen. In the tab "Area of Interest", within the "locate area" section choose the polygon tool, select 10 m for the buffer distance, and then you can then trace the wetland of interest using the polygon tool, it will automate a 10 m buffer around the wetland. From this point, you can measure the assessment

area that includes the 10 m buffer by using the measurement tool , then using the polygon tool  with units set to square meters.

If you measure the area of the buffer and the wetland, then remember that you'll need to subtract the area of the wetland you recorded in the last field. Keep track of the full measurement (buffer + wetland) to insert into the next field.

Field Sampling Information – Transect Information [Table 4.1]

In field table 1.5, you were asked to stratify the area that abuts your wetland into a few distinct zones and consider how the different strata may influence the health of the wetland. Table 1.5 and 4.1 are intrinsically linked. Table 1.5 is completed at the desktop; however, you will now record further information in table 4.1 regarding the transects you lay out in the field within each of the dominant strata. Transects are used to sample each of the dominant strata, with at least one transect placed in each stratum (Figure 31)

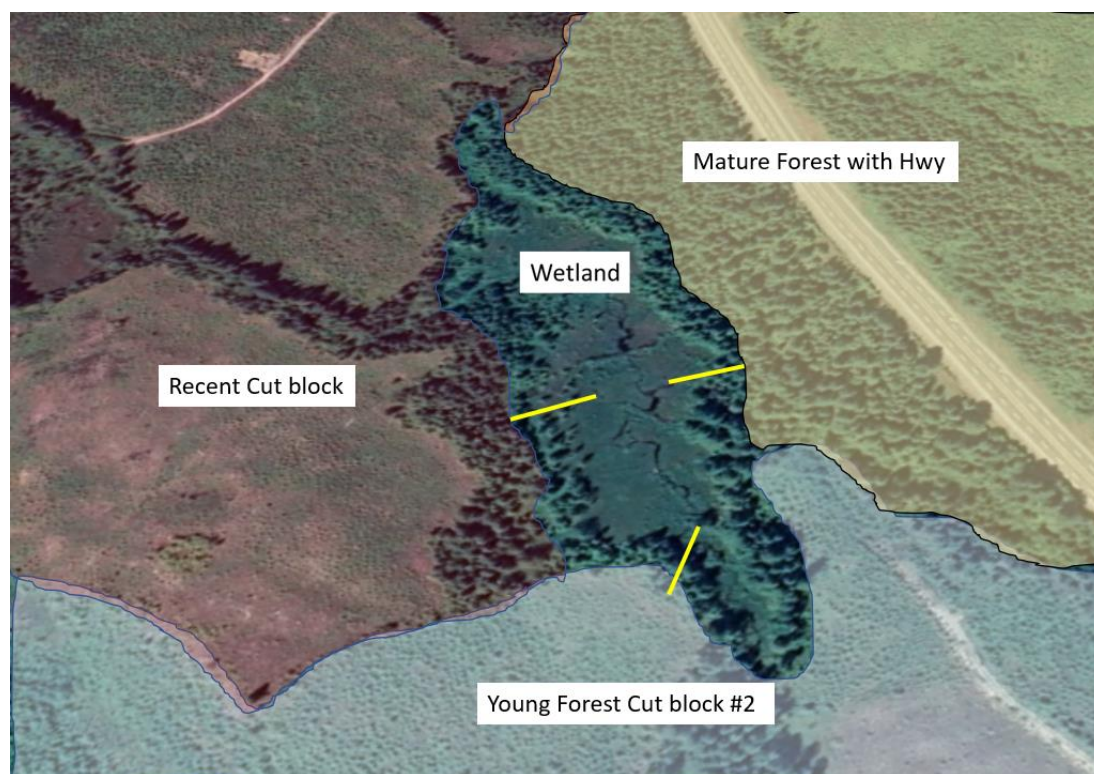


Figure 31. In this example a transect (yellow line) is placed into each of the dominant strata.

Field table 4.1. captures the following information:

Transect number

Transects are numbered consecutively starting at one, and are conventionally labelled: T1, T2, T3, etc.

UTM coordinates

Recall in field table 1.5 that you recorded the distance along the perimeter of each strata where you would place your transect. Now, as you work in the field and move around the wetland to capture transect information, the first thing you'll do at each site is record the UTM coordinates at the wetland edge where you will place your transect. It is also helpful to place flagging tape at the boundary and record FREP W/L with the Transect #.

Universal Transverse Mercator (UTM) is a coordinate system that is broken down into:

- a Zone which divides BC into vertical swaths east to west;
- an Easting, that is a 6 digit number that increases from east to west (numbers approximate 1 m increase travelling east within the zone); and,

- a Northing, a 7 digit number that increases from south to north (numbers approximate 1 m increase travelling north).

Transect bearing into the wetland (0° - 360°)

Using a compass, record your bearing into the wetland that is perpendicular from the wetland edge.

Transect is representing wetland influenced from upland strata composed of ...

The first two columns that described your strata in field table 1.5 are re-entered within table 4.1. If you are using the FileMaker form, then this should auto-populate when you add a transect (button: + New Transect) and select the descriptor from a dropdown list based on strata options you've already described in table 1.5.

Entering the wetland

Once you've flagged the edge of your wetland and set a bearing (perpendicular to the wetland perimeter), walk into your wetland following that bearing with your rotary tape. Keep the start of the tape at the wetland edge with the tape rolling out in increasing meters as you enter the wetland. It's helpful to have one field partner hold the rotary tape at the wetland edge, and ensure the other partner stays on their bearing. While walking along the bearing and into the wetland, use flagging tape to mark distinct zones of wetland vegetation (i.e., ideally marking distinct breaks that identify different wetland plant associations – to be described shortly) that you traverse as you walk out with your rotary tape.

End type

In field table 4.1, you'll record how your transect ended based on several scenarios:

M = Middle of wetland. Record this if you've reached the middle of the wetland. For example, if you were to continue on your bearing, you'd need to walk the same distance (double the distance from where you started) to reach the other side of the wetland. You'll only go half-way, as you are attempting to measure potential impacts from the abutting strata next to where you marked the edge of the wetland boundary (0 m). To put it simply, you should only go as far into the wetland as where your starting point remains the closest wetland edge.

E = End of 50 m transect. Some wetlands can be massive in size, and at some point the influence and impacts of the condition of the abutting strata will diminish with greater the distance from the edge. You'll limit walking out to the full 50 m.

OW = Open water. A non-flowing, or very slow flowing, body of open water (with less than 10 % submerged or floating aquatic vegetation) is too deep to traverse. This could include a beaver pond or deep (> 2 m) lake or pond. For safety reasons, you are not expected to go further.

Ww = Shallow open water. A shallow open-water wetland (with greater than 10 % submerged or floating aquatic vegetation) is too deep to traverse. This could include a well vegetated beaver pond or generally a shallower (< 2 m) body of water. For safety reasons, you are not expected to go further. However, since this is a wetland type, you can add observations about the wetland by standing at the edge and documenting information into the subsequent tables (field tables 4.2 and 4.3). Given limits on your ability to make observations from the edge, these should be constrained up to 10 m out into the Ww (or less if the Ww is not that wide).

C = Channel. A flowing channel is too deep to traverse. For safety reasons, you are not expected to go further.

Ot = Other. Wetlands can be very diverse places, and it's hard to predict all the various scenarios you'll encounter which may require you to end your transect. A few reasons have included:

- the random placement of your transect has you walking up a narrow lobe (“finger”) of your wetland, and the distance to the wetland edge is closer to the right or left of you, in comparison from where you walked in. In this case the influence of the abutting landscape is likely more influenced from the landbase to the left and right of you than the location where you started. In this case, and similar to the rationale of stopping at the middle of the wetland, you should only go as far into the wetland as where your starting point remains the closest wetland edge.
- A deep marsh or other wetland inundated wetland.
- Impenetrable brush.

Transect length TL (m)

Regardless of your end type, you’ll add 10 m or 20 m to your transect length as follows:

You’ll always add 10 m (to account for your upland observations) to the length measured into the wetland.

In some cases you may add up to another 10 m in the following circumstances:

- You’ve walked to the end of your 50 m rotary tape, and there is a new wetland plant association that you’ve just entered and it makes sense to add observations up to 10 m from the end of the rotary tape so you can better describe the features of that plant association
- You’ve encountered a shallow open water wetland that is not passable, but since it is a wetland plant association, you’re able to describe its features up to 10 m from where you stopped.

A note on fractions and weighting our observations

As part of this protocol, you will pool your observations from around the entire wetland to roll up all of your measurements on specific indicator questions (i.e., those collected at your transects). Because the length of transects, and the size of abutting strata along the perimeter of the wetland are not equal, we apply a weight to these observations.

Transect wetland fraction F_a (TL/TTL)

After you’ve collected ALL of your transect lengths, you’ll be able to calculate the fraction of length that each transect represents. We consider this, because not all transects are equal in length of observations.

Transect upland fraction F_b (calculated from field table 1.5)

There’s a spot in field table 4.1 where you’ll re-record your upland or abutting land strata fraction, also labeled in field table 1.5 as “fraction along wetland perimeter”.

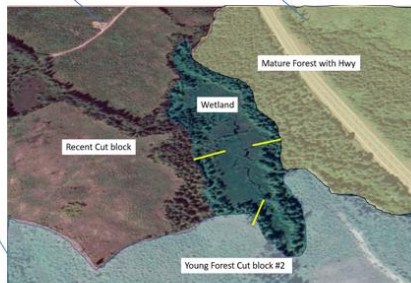
Weighted Fraction; $WF = (F_a + F_b)/2$

We combine both the fractions of the transect lengths (F_a) and upland fractions (F_b) to add a weight to many of our transect observations.

Depending on the indicator question, we can sometimes just use F_b (if it’s solely an abutting/upland indicator question), but in other cases we use WF , when it’s an observation that includes both upland and wetland factors. An example of this is seen in Figure 32 to summarize the extent of invasive plants.

Weighted Averaging to Roll Up Transect Observations

$$(I_{T1} \times WF_{T1}) + (I_{T2} \times WF_{T2}) + (I_{T3} \times WF_{T3}) = \% \text{ Invasive Species in Wetland}$$



I = % Invasive
 WF = Weighted Fraction

- Weights determined by % wetland perimeter connected to upland strata and, for some questions, by length of transect
- Option to add non-homogenous observations

Figure 32. Accounting for the proportion of upland strata and length of each transect in weighted fractions to estimate the total percent invasive species in the assessment polygon.

Wetland Plot Information [Table 4.2]

Now the fun really begins! It's time to explore your wetland. You'll fill out field table 4.2 and 4.3. concurrently. Table 4.2 captures the key elements of your plot information, whereas 4.3 will be your plant list and associated details. It's helpful to note that you'll only need to record plot information *within* the wetland in table 4.2, but you will also put some weed and disturbance species from your upland/abutting area in table 4.3. An example of a transect and plot locations can be seen in Figure 33. Field table 4.2 can be seen in Table 2 below.

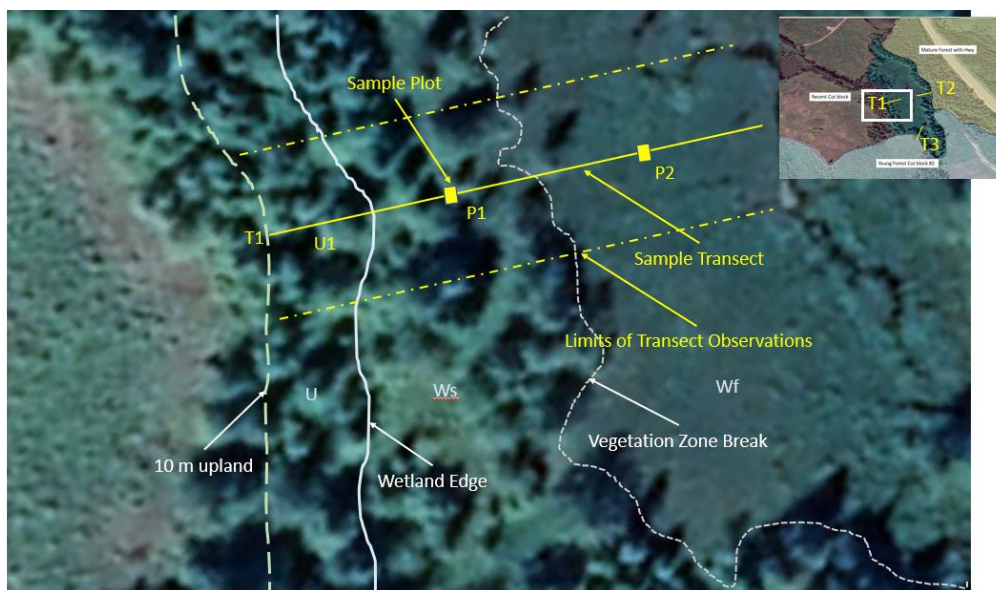


Figure 33. Layout of sample transect (yellow line), sample plots (yellow squares), limits of transect observations on either side of the transect set at 10 m width on either side (dot-dash yellow line), wetland edge (solid white line), 10 m upland from wetland edge (large white dashed line), and a vegetation zone break within the wetland (small white dashed line), U = Upland, U1 = upland zone within the first transect (T1), P1 = plot 1 within first transect (T1), P2 = plot 2 within first transect (T1) documenting a different vegetation zone, Ws = Wetland Swamp within the wetland, and Wf = Wetland fen.

T.4.2. WETLAND PLOT INFORMATION							Soil		Water			Summary	
Transect	Plot ID	UTM Coordinates in wetland plots			Vegetation Zone Length (m)	Plot Location (C = Centre of veg. zone, E = End of zone)	Mineral or Humic / Organic Soil within 30 cm? (pg. 19)	Fibric or Mesic Organic Soil within 30 cm? (pg. 19)	Depth to water (cm) (Note: pos. is below surface, neg. is above surface)	pH	Temperature (Celsius)	Wetland Class (i.e. Wf = fen)	Wetland Plant Association (optional – if known) (e.g., Wf02)
		UTM Zone	Easting	Northing									
T_	P1												
T_	P2												
T_	P3												
T_	P4												
T_	P5												
T_	P6												
T_	P7												
T_	P8												
T_	P9												
T_	P10												
T_	P11												
T_	P12												
T_	P13												
T_	P14												
Question Indicator										13b	13b		

Table 2. Wetland plot information from field cards (T.4.2)

Transect ID

Record your transect ID in the first column, this should correspond with the transects identified in field table 4.1., however multiple rows in 4.2. may have the same transect (e.g., T1), and the number of rows with the same transect depends on how many plots you place along each transect.

Plot ID

Plots are consecutively labelled P1, P2, P3, etc. They won't repeat in field table 4.2.

UTM coordinate in wetland plot

Record a UTM coordinate at the location where you take your water samples and soil samples. This allows for repeatability (if your work is audited, or to potentially allow for trend analysis at a later date). If you're writing by hand, to save time you can generally abbreviate subsequent UTM coordinates to the last 4 digits, as it's unlikely you'll be further than 1 km away from anywhere in your wetland from your first observation.

Vegetation zone length

This is the length in meters of distinct vegetation along your transect and in your wetland (i.e., typically a distinct wetland plant association). You should be able to determine the length by referring to your rotary tape. If you are at the end of your tape and you are looking past into a wetland type that is too deep to traverse, your zone will be 10 m in length.

Soil information

Wetlands are defined by soils that have been modified by the presence of water due to the anaerobic or oxygen-deficient nature of water submersion. Wetland soils are categorized into mineral (inorganic) or organic soils. Both types of soils exhibit indicators that they have been modified by water:

- Mineral soils exhibit **Gleying** (uniform blue-grey mineral soil) or **Mottling** (reddish-brown splotches in soil) (Figure 34)
- Organic soils exhibit peat in various stages of degradation (Figure 35)



Figure 34. Examples of mineral soil with mottling or gleying effects.



Figure 35. Example of organic soil with well-preserved peat.

Organic soil characterization

Organic soils can further be categorized by their decomposition, or humification, using the **von Post** method. To use this test, a palmful of wet soil is squeezed very hard, until as much as possible has escaped through the fingers. The amount of peat that escaped and the colour of the water is then assessed with a chart (Table 3) to determine if the soil is Fibric, Mesic, or Humic (Figure 36). For a more detailed explanation of this method, you can view this [video](#).

Mark 'Y' in the appropriate soil column in table 4.2 of the field form

VP Classification		Decomposition	Plant structures	Water	Peat Escape
Fibric Peat	1	None	Unaltered	Clear or light yellow-brown	No peat escapes
	2	Almost none	Distinct	Light yellow brown	
	3	Very weak		Turbid brown	
Mesic Peat	4	Weak		Strongly brown turbid	Very little peat escapes
	5	Moderate	Clear but becoming indistinct	Very strongly brown turbid. Some peat suspension	Some peat escapes
	6	Moderately strong	Somewhat indistinct	Muddy with much suspended peat	Aprox. ⅓ of peat escapes
Humic Peat	7	Strong	Indistinct but recognizable	Strongly muddy	Aprox. ½ of peat escapes
	8	Very Strong. Remnants resistant to decomposition (ex. roots and wood)	Very indistinct	Thick mud with little water	Aprox. ¾ of peat escapes
	9	Almost complete	Almost unrecognizable	No water	Almost all peat escapes
	10	Complete	Unrecognizable		All peat escapes

Table 3. von Post chart to determine if organic soil is categorized as Fibric, Mesic, or Humic



Figure 36. Three categories of organic soils.

Depth to water

Water can be below, at, or above the surface depending on the type of wetland. Depth to water is recorded in cm. Water below the surface is recorded as a positive number and water above the surface is recorded as a negative number (e.g., -5 cm is recorded where the water table is 5 cm above the ground). If no water is observed during the soil excavation, record *> [max depth sampled]*.

PH and temperature

pH and temperature can be measured either directly from the soil using a special soil pH meter (e.g., Soilstik) or from the water with a common pH meter. For samples from water, take the measurement at the surface or where the water-table is inside the excavation hole of the soil core. Use a recently calibrated pH meter and record the pH and record the temperature in degrees Celsius. If you are in a sphagnum bog, sample water by squeezing peat into a small container because if it has recently rained, the pH in pooling water may not reflect the pH of the site very well.

Wetland classification

Consistent with the Canadian Classification System and within B.C.'s Land Management Handbook 52: Wetlands of British Columbia (the pdf can be found here: <https://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh52.pdf>) there are 5 ecological types of freshwater wetlands found within BC (Figure 37): 1) bogs (Wb), 2) fens (Wf), 3) marshes (Wm), 4) swamps (Ws), and 5) shallow open water (Ww). The wetland classification and its plant association can be determined by the soil type and pH in combination with the vegetation plot information in table 4.3 of the field form. In addition to the information below, refer to figure 1 in the *Protocol to Evaluate the Health of Wetlands* (Fletcher et al., 2020) or page 32 of *Wetlands of British Columbia: A Guide to identification* (Mackenzie & Moran, 2004) for more information on wetland class.

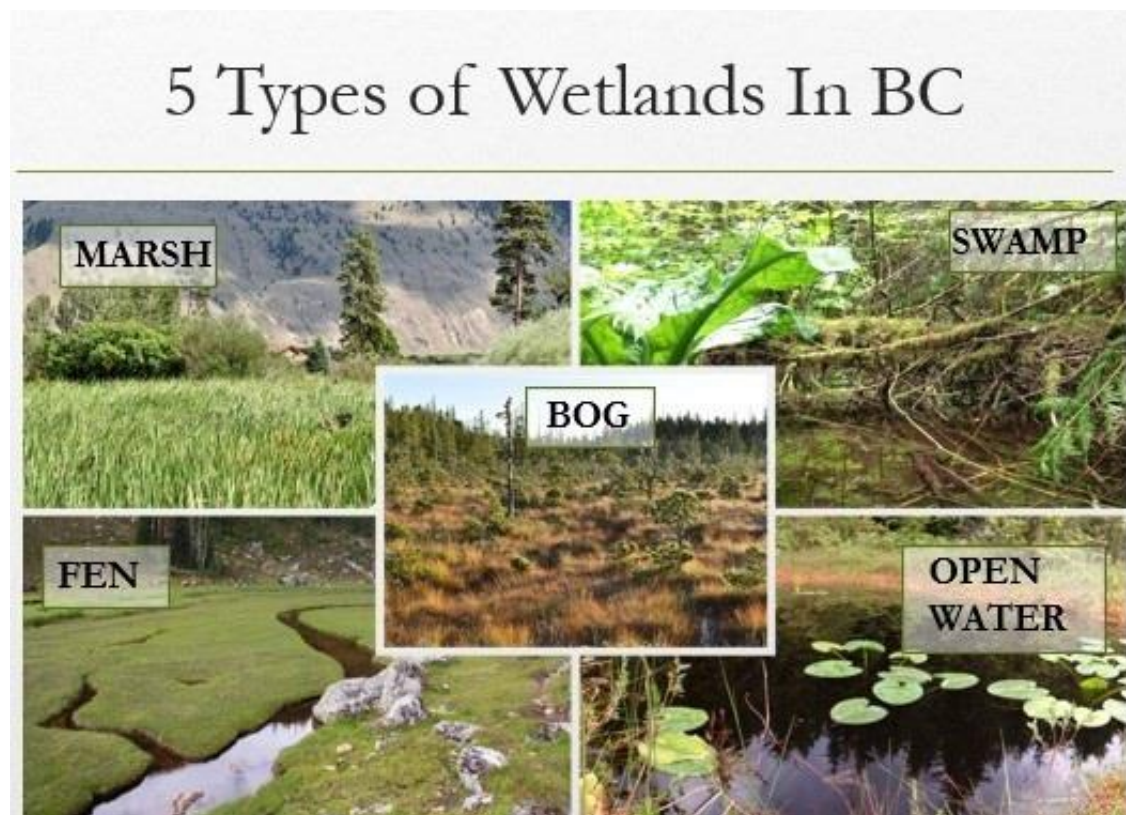


Figure 37. The five wetland classes found in British Columbia.

Bogs (Wb)

- Bogs are peatlands with mesic or fibric organic soils. The water table is generally below the surface. Typically, there is no connection to groundwater and as such, bogs are only influenced by rainwater as their primary input of water. Bogs do not experience seasonal flooding or water flow. Vegetation is primarily dominated by a layer of sphagnum and soil of decomposing sphagnum. Bogs are highly acidic and nutrient poor. Common plants: sundews, Labrador tea, bog laurel, stunted shorepine, black spruce. Visit BC Wildlife Federation's (BCWF) virtual [Bog Tour](#)

Fens (Wf)

- Fens are also peatlands with mesic or fibric organic soils. They are common in mountainous areas in the south and more widespread further north in the province of BC. Fens are wetter than bogs with more nutrients due to greater connectivity to groundwater. They are slightly acidic to neutral. Organic peat is built up primarily from graminoid species and brown mosses. Common plants: sedges or other graminoid species, dwarf birch, marsh cinquefoil, hookmosses. Visit BCWF's virtual [Fen Tour](#)

Marshes (Wm)

- Marshes are wetlands with mineral or humic organic soils. pH is typically neutral to alkaline. They are periodically flooded by slow-moving or standing water and are rich in nutrients. Water can vary from fresh to saline. Marshes are common in dry climates but found throughout province. Although vegetation can sometimes be similar, marsh hydrology is more dynamic than fens. There is no build up or fibric or mesic peat due to fluctuations in oxygen levels in soils. Marshes are often found next to lakes and streams. Common plants: non-woody emergent vegetation, cattails, bullrushes, grasses and sedges. Visit BCWF's virtual [Marsh Tour](#)

Swamps (Ws)

- Swamps are wetlands with mineral or humic organic soils (sometimes with coarse woody fragments). They have fluctuating water tables similar to marshes with standing or slow-moving water. Swamps have pronounced internal water movement and are rich in nutrients. There is presence of decomposed wood. Plants: trees & shrubs often occupying raised hummocks. Common plants: willow, red-cedar, skunk cabbage. Visit BCWF's virtual [Swamp Tour](#)

Shallow Open Water (Ww)

- Open water covers at least 75 % of an open water wetland in summer. Mid-summer depth is less than 2 m. Shallow open water is common on lake margins but can occur adjacent to many other wetland types. Plants: floating and submerged aquatic vegetation (e.g., pond lilies, pond weeds, bladderwort). Visit BCWF's virtual [Shallow Open Water Tour](#)

Plant association

Wetlands can further be classified by plant association, which is similar in concept to a bio-geoclimatic site series. Marshes, for instance can be further classified in terms of their dominant plant cover (e.g., a cattail marsh is a Wm04). This step is optional for the FREP assessment, although classifying down to plant association can improve your understanding regarding the underlying ecological drivers of your wetland ecosystem and identify possible issues. Refer to vegetation plot information in table 4.3 of the field form and the *Wetlands of British Columbia: A Guide to identification* (Mackenzie & Moran, 2004) to assist in classification. In the guidebook, bog, fen, marsh and swamp plant associations can be determined by using the two reference tables that are at the start of their respective chapters (Figure 38). The first table organizes wetland plant associations by bio-geoclimatic zone and their relative frequency. The second table organizes wetland plants by typical percent cover occupying a wetland plant association. To verify the plant association classification, you can review more about that class in the following pages of the chapter (Figure 39). If you can't identify the appropriate class or association, then label "?" for undetermined.

xx = incidental < 5% of wetlands
n = northern subspecies only

L
a
N

20

47

Vegetation Information for 10 m Upland and Within Wetland [Table 4.3]

Percent (%) cover

A full plant list is not necessary when filling out table 4.3 of the field form. When sampling your vegetation plot, only consider 10 m on either side of the transect and up to 10 m in front or behind you within that vegetation zone. Example, if the band of vegetation is within a particular zone is 14 m, then limit your observations to 7 m in front and behind you. In the upland area, only record invasive or disturbance-increaser species. In each wetland plot, focus on a few of the most dominant wetland plants, invasive and disturbance-increaser species (Appendix 2 of the Protocol), and plants of cultural importance (Appendix 3 of the Protocol). The dominant wetland plants can help you determine the wetland plant association in table 4.2. If you cannot identify a species, then make a quick note (e.g., *Salix* sp.), record percent cover, and then move on. Percent cover is determined by assessing what percent of the ground is covered by vegetation when looking from a bird eye view. Include all rooted plant material (live or dead), but do not consider the plot area covered by water (such as between emergent plants). Fallen wood or other plant litter do not count as rooted plant material. See Table 4 below for an example of a completed field table 4.3. See Figure 40 to help you estimate percent cover.

Transect (e.g., T1, T2)	Plot ID (e.g., U1 or P1)	Species Name For Upland Plots (U), just record invasive or disturbance increasers. For Wetland Plots (P), record dominant, invasive (pg. 53), disturbance (pg. 24), and plants of cultural significance (pg. 56) (if known)	% Cover	Mark N if there is poor form, vigor or recruitment			Check if applicable		
				Form	Vigor	Recruitment	Invasive	Disturbance/ Increaser	Cultural Value
T1	U1	Dandelions	10				<input type="checkbox"/>	x	<input type="checkbox"/>
T1	P1	Cattail	90	Y	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T1	P1	Yellow Flag Iris	5	Y	Y	Y	x	<input type="checkbox"/>	<input type="checkbox"/>
T1	P1	Marsh Cinquefoil	2	Y	N	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T1	P1	Bare compacted ground	3	NA	NA	NA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T1	P2	Willow Sp. 1. Sample taken.	40	N	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T1	P2	Sedge Sp. 1. Sample taken.	30	Y	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T1	P2	Mountain Alder	30	Y	Y	Y	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Table 4. Example of completed vegetation table (T 4.3)

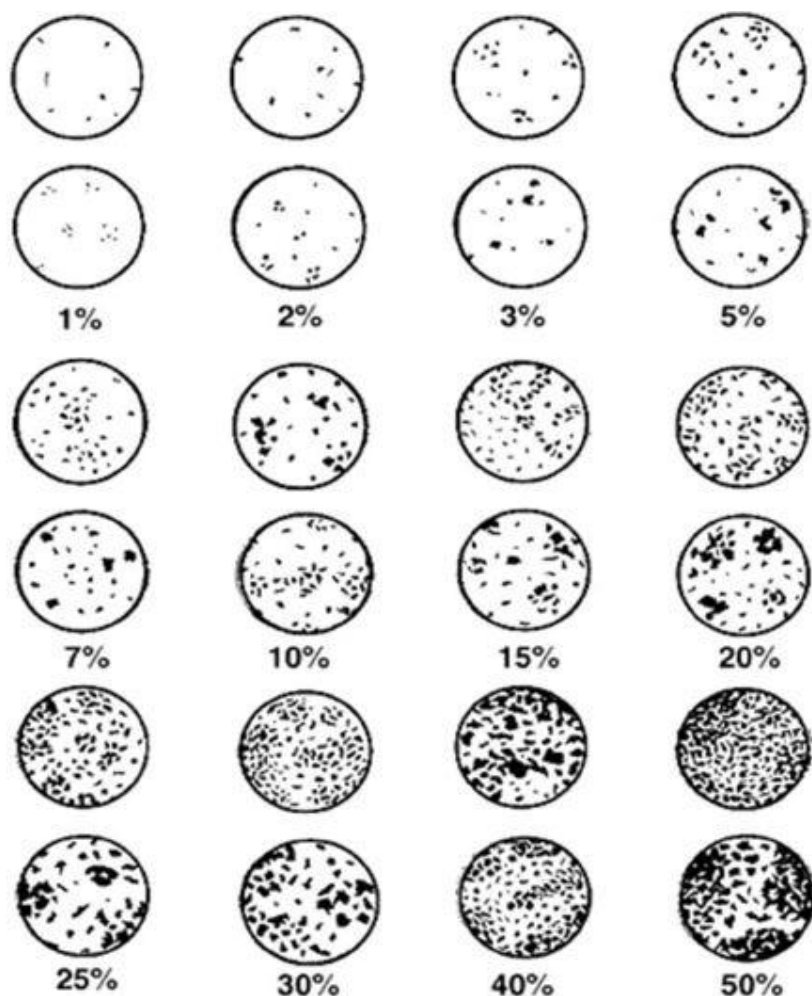


Figure 40. Examples of percent cover estimates. Source: *Vegetation Resources Inventory Ground Sampling Procedures*, Ministry of Forest and Range, 2007.

Form, vigor, and recruitment

Mark "N" if there is poor form, vigor or recruitment.

Form

Poor form may include observations of atypical plant structure or physical damage, e.g., mechanical damage to trees along edge post-harvest; or when sedge hummocks are over browsed; plants may look irregular as opposed to well-rounded (Figure 41).



Figure 41. Heavy browse from cattle. Also note that heavily browsed areas often have poor recruitment.

Vigor

Poor vigor includes atypical colour (e.g., browning or yellowing), stunted growth, or disease (Figures 42 & 43).



Figure 42. Invasive insects (L: swarm of tent caterpillars (*Malacosoma* spp.), R: Insect gull on pine tree) can decrease the vigor of vegetation.



Figure 43. Excessive pine beetle has affected the vigor of this forest, upland of the wetland.

Recruitment: Poor recruitment includes lack of younger age classes (Figure 44).



Figure 44: Due to introduced deer on Haida Gwaii, the more palatable Western Red Cedar was completely missing as a component in the understory due to excessive browsing.

NOTE: Form, vigor and recruitment are also assessed for upland plants within the buffer.

Invasive, disturbance/increaser, and culturally significant plants

Check off if any of the species are invasive, undesirable disturbance-increaser, or culturally significant plants. A list of each of these groups of plants is provided in the Protocol. Common lists for disturbance-increaser and culturally significant plants are not necessarily extensive and could be supplemented by local/regional knowledge. **NOTE:** if you're using the FileMaker form, these last three columns in table 4.3 will auto-populate based on those identified within these lists.

Invasive species

A list of some common invasive species can be found in Appendix 2 of the Protocol. Invasive plants can quickly out-compete native plants within the wetland and decrease biodiversity and thus decrease suitability of wildlife habitat. Invasive plants can also contribute to wetland edge instability and increased erosion, decreasing the water quality and functionality of the wetland. Invasive species often have no natural predators or competitors to control them.

Noxious species are native or non-native species that cause damage to economic resources, public health, or the environment. Helpful resources to identify invasive/noxious species are the Invasive Species Council of BC (ISCBC) website <https://bcinvasives.ca/invasive-species/identify/invasive-plants/> and ISCBC's Field Guide to Noxious Weeds and Other Selected Invasive Plants of British Columbia (2019) <https://bcinvasives.ca/resources/publications/field-guide-to-noxious-weeds-and-other-selected-invasive-plants-of-BC>

Disturbance-increaser species

Disturbance-increaser species are adapted to living and thriving (increasing) in an environment that has been disturbed or is subjected to continual disturbance or stress, such as intense grazing, or erosion. Undesirable species will often perform poorly, have shallow roots, and are less productive than other plants. Common disturbance-increaser species are found in Table 5 below.

Common disturbance-increaser species in BC			
Common name	Latin name	Common name	Latin name
Strawberry	<i>Fragaria spp.</i>	Pineapple weed	<i>Matricaria matricariodes</i>
Cinquefoil	<i>Potentilla spp. (excl. Marsh Cinquefoil)</i>	Dock	<i>Rumex spp.</i>
Yarrow	<i>Achillea millefolium</i>	Pasture sage	<i>Artemisia frigida</i>
Baltic rush	<i>Juncus balticus</i>	Gumweed	<i>Grindelia squarrosa</i>
Dandelions	<i>Taraxacum spp.</i>	Pussytoes	<i>Antennaria spp.</i>
Sow thistles	<i>Sonchus spp.</i>	Buttercups	<i>Ranunculus spp.</i>
Foxtail barley	<i>Hordeum jubatum</i>	Bluegrasses	<i>Poa spp.</i>
Yellow salsify/ Western goat's beard	<i>Tragopogon dubius</i>	Plantains	<i>Plantago spp.</i>
Clovers	<i>Trifolium spp.</i>	Willowherbs	<i>Epilobium spp.</i>

Table 5. List of common disturbance-increaser species in BC

Cultural value species

Culturally significant plants are important to indigenous peoples in BC, such as for medicinal or ceremonial purposes (Figure 45). Many wetland plants have some use. A select list of species is found in Appendix 3 of the Protocol. Consult your local First Nations to determine if there are specific plants they consider a priority to monitor.



Figure 45. Culturally important Wapato, also known as broadleaf arrowhead (top) and Western Labrador tea (bottom).

FIELD-BASED UPLAND INDICATORS

Upland Buffer Information [Table 5.1]

Width in meters of treed retention upland

Measure the treed retention (buffer) area from the wetlands edge to the start of the cutblock or other human disturbance (e.g., cleared land), to a maximum of 100 m (Figure 46). If the buffer is greater than 100 m, then record 100 m.

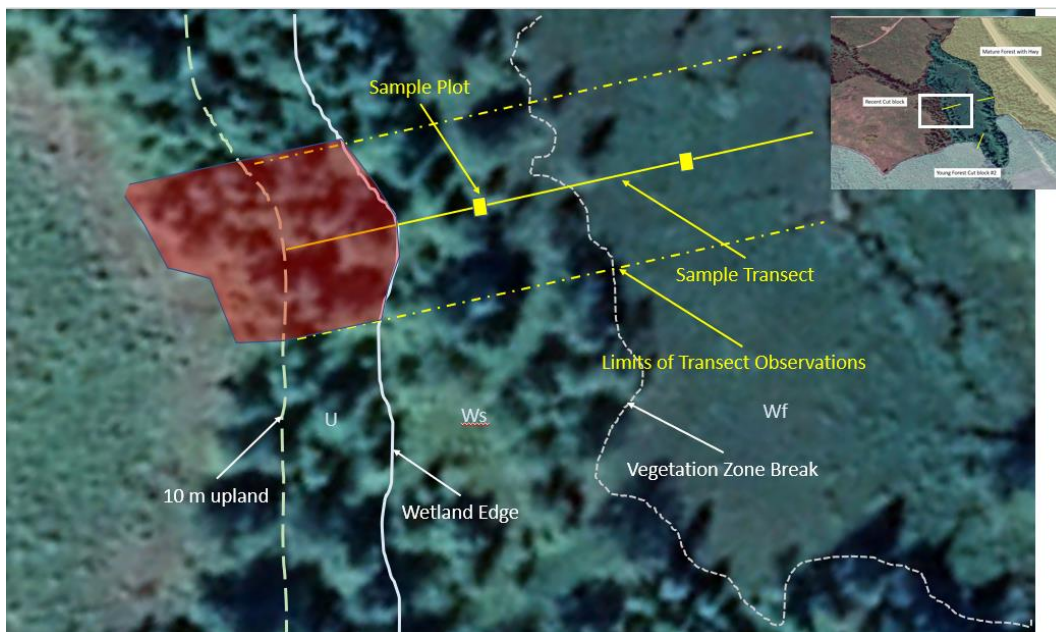


Figure 46. In this example, the area of interest for treed retention applies to the highlighted red polygon. There is an opening, recent cutblock, further left of the imagery. The treed retention extends beyond the limits of the transect observation but averages approximately 18 m from wetland edge.

Percent (%) retention (basal area) upland from wetland edge

If there is only partial retention, then estimate the amount of basal area at diameter at breast height (dbh) of the trees that remain within the retention area.

Percent (%) cover of disturbance/increaser plants 10 m from wetland edge

Estimate the percent cover within the herbaceous layer that consists of disturbance/increaser species in the 10 m upland portion of the transect (Figure 47). A list of these species is provided on pg 54.

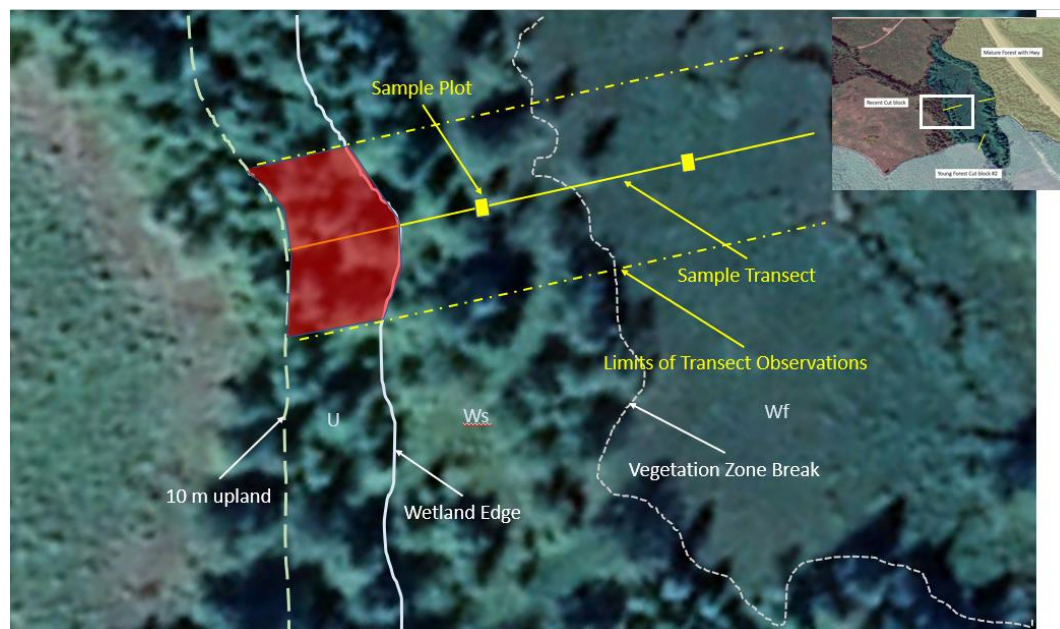


Figure 47. Document disturbance-increaser species within 10 m upland from wetland perimeter.

Non-merchantable conifers, understory deciduous trees, shrubs, and herbaceous vegetation

Observe vegetation retained between the wetland edge and 20 m upland (see Figure 48). Estimate the nonmerchantable conifers, understory deciduous trees, shrubs, and herbaceous vegetation that has been left between 20 m and the wetland's edge. This can give you an idea of how fast the area may recover and if it can support wildlife. Forestry equipment should retain a relatively "light" footprint within 20 m of the wetland if harvesting within this zone. Since there are multiple layers (i.e., non-merchantable conifers, understory deciduous trees, shrubs, and herbaceous vegetation), consider each layer that would have been present prior to the harvest and weigh each equally. If all layers would have been present pre-disturbance, then weigh each with a total possible score of 25 %. If only 3 would have been present, then assign each with a possible score of 33.3 %, etc. As an example, imagine a site where all 4 layers are present: if only half the nonmerchantable conifers remain, but all the other layers are fully represented, then you would score: 87.5 % (i.e., 12.5 % non-merch. conifer + 25 % understory deciduous trees + 25 % shrubs + 25 % herbaceous vegetation).

Examples of Nonmerchantable:

- Interior regions:
 - Cedar – less than 15 cm diameter inside bark (DIB)
 - All other tree species – less than 10 cm (DIB)
- Coastal Regions:
 - Harvesting within mature stands – less than 15 cm DIB, where mature stands are < 121 years for conifers and > 41 years for deciduous stands.
 - Harvesting within immature stands (e.g. for thinning) - less than 10 cm DIB, where immature stands are < 121 years for coniferous stands and < 41 years for deciduous stands.

(Source: Ministry of Forests 2005. Provincial Logging Residue and Waste Measurement Procedures Manual. Timber Pricing Branch)

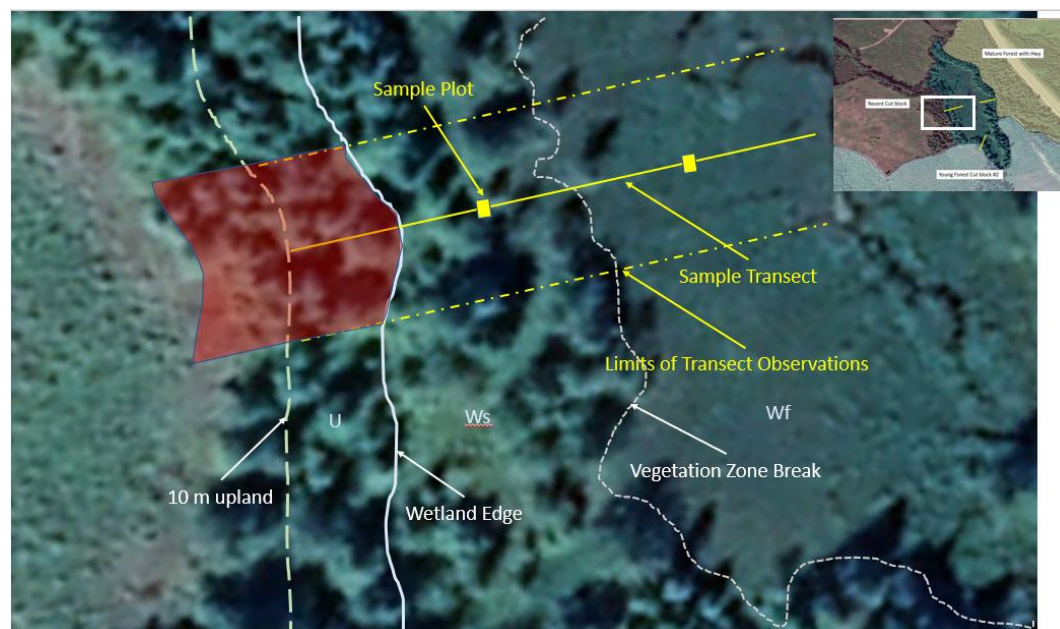


Figure 48. Location for estimating non-merchantable cover is the area 20 m from the wetland edge (red polygon).

Mature co-dominant windfirm conifers retained within RMZ

If needed, it's helpful to review widths of Riparian Management Zones (RMZ) in field table 1.3 to determine where this indicator is measured. Depending on the wetland size and biogeoclimatic region, the RMZ can range from 0 to 40 m in size, and either abuts the wetland edge or the riparian reserve zone if present (Figure 49). Riparian management zones were established to conserve the fish, wildlife habitat, biodiversity, and the water values of the riparian management zone, and to protect the riparian reserve zone, if any, within the riparian management area.

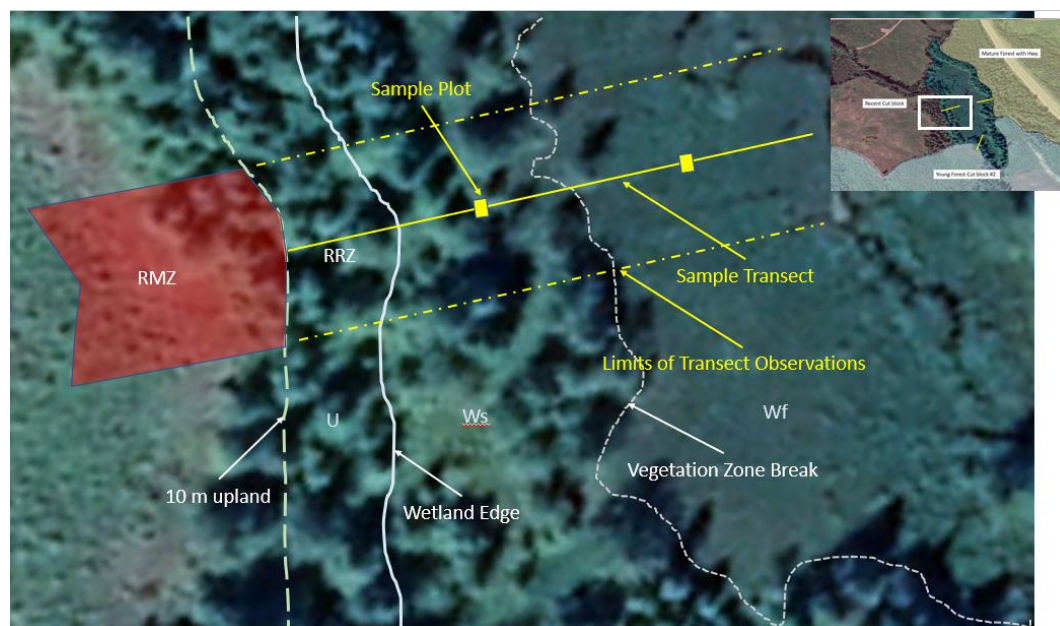


Figure 49. In this example, the wetland has a 10 m RRZ, and a 20 m RMZ. Only consider the RMZ (red polygon) for this question.

A few definitions to consider:

Co-dominant trees: a tree whose crown helps to form the general level of the main canopy in even aged stands, or in uneven-aged stands, the main canopy of the tree/s immediate neighbors, receiving full light from above and comparatively little from the sides.

Windfirm conifers: trees able to withstand strong winds (i.e. to resist windthrow, windrocking and major breakage)

Percent deciduous trees retained within RMZ

This indicator is similar to the previous, but considers deciduous trees, instead of coniferous. They are treated separately, as there are different (higher) thresholds in terms of best management practices for retention. If your retained riparian forest had low presence of deciduous trees before harvest and was left undisturbed, answer 100%.

(Ministry of Forests 2005. Provincial Logging Residue and Waste Measurement Procedures Manual. Timber Pricing Branch)

Weighted average calculations

Once you've completed all of your transects, you'll need to calculate your weighted averages to arrive at a pooled answer. Use information provided on field table 5.1 as well as table 1.5. For each row/question, use the following calculation:

Weighted average = (% of observation from T1 x Fb(T1)) + (% of observation from T2 x Fb(T2)) + (% of observation from T3 x (Fb(T3))

*Fb(T#) is found in field table 1.5

Alternatively, these calculations are automated with the FREP wetland FileMaker form.

Windthrow Upland of Wetland [Table 5.2]

While you're walking the upland portions of your transects take note of the following windthrow information. We are primarily concerned about the recruitment of coarse wood debris & snags into the future, visual screening for wildlife, and retaining wildlife passage/corridors. If recent windthrow on the cutblock side doesn't exist or is minimal, then you do not need to complete this section. However, if you suspect excess windthrow since recent harvest, then you'll complete this section. If you are in a wetland that has an RRZ, make observations within 10 m upland of the wetland and 10 m on either side of the transect line. If you are in a wetland with no RRZ, consider the area 20 m upland to the wetland perimeter and 10 m on either side.

In this table you are comparing old windthrow rates to new windthrow rates to determine if the rate of windthrow has increased beyond a percent threshold since recent harvest. You'll only count trees which were growing within your assessment area, not those that fell into the assessment area, and not those that were dead when they fell. Also note, we do not consider ancient windthrow (i.e., fell trees that no longer have vertical root wads attached).

Number of old windthrow trees

Record the number of old windthrow trees. Old windthrow trees will show possible signs that they fell prior to recent harvest. For old windthrow, major lateral roots are still attached. Indicators of old windthrow may include:

- Absence of green leaves or needles and the tree shows a progression of more advanced decay;
- Bracket fungi will show more concentric rings on their tops than the age since recent harvest;
- The age of vegetation growing on the root wad is older than the age since recent harvest;
- A moss layer is well developed on the tree in an orientation of its current position.

Number of new windthrow trees

Record the number of new windthrow trees. These trees may have been tipped (on to other trees often at an angle less than 45° from ground), been upturned, or been live when snapped (and the associated stump is within the assessment area). New windthrow will often show more fine roots on root wad, or fine twigs on branches, and possibly have leaves still present.

Number of standing live trees

In order to compare the rates of windthrow, you'll also need to capture the number of standing dominant and codominant trees within your assessment area. The calculations for new and old windthrow are as follows:

$\% \text{ new windthrow} = (\text{number of new windthrow}) / (\text{number of new windthrow} + \text{number of standing trees}) \times 100$

$\% \text{ old windthrow} = (\text{number of old windthrow}) / (\text{number of old windthrow} + \text{number of new windthrow} + \text{number of trees still standing}) \times 100$

Bare Ground Hydrologically Connected to Wetland [Table 5.3]

This is a "continuous" indicator, meaning that if you observe bare ground hydrologically connected to the wetland from upland sources, anywhere around its perimeter, ensure you capture information within this table. Bare ground that is located upland from the wetland may cause fine sediment to be deposited within the wetland. Possible sources of bare ground include road cuts, fill slopes, bladed trails, gouges, tipped over root wads and windthrow scares, slides and slumps, and animal or recreation trails.

Bare ground includes any soil or fill with particles smaller than 2 mm that is not covered by plants, litter, lichen, moss, downed wood or coarse gravel. Evidence of sediment transport can include minor or major channels that form within the exposed soils and show flow, and possibly deposition, into the wetland.

If encountered, measure the total size of the exposed area and then multiply by the fraction of fines (< 2 mm) and the fraction hydrologically connected to the wetland. By multiplying by these fractions, you are providing a more conservative estimate, and accounting only for exposed areas that will contribute to sediment transport (Figure 50).



Figure 50. This spur road slopes down towards the wetland and is hydrologically connected (wetland is on either side of the road at the bottom of the hill). The amount of bare erodible soil will include the length and width of this bare ground, multiplied by the fraction of fines (< 2 mm) and the fraction considered to be hydrologically connected.

Form, Vigor, and Recruitment of Buffer Features [Table 6]

This indicator attempts to capture the condition of forest layers (e.g., snags, over-story trees, etc.) within 10 m upland from the wetland perimeter. This is another “continuous” indicator, meaning that you assess it after completing your transects and walking around the assessment polygon. Observations don’t necessarily need to be limited to the transects. However, transects can aid your assessment. Exploring forested areas in proximity to your assessment area, such as adjacent reserve zones or forested areas outside of the cutblock can help you confirm which layers were likely present prior to disturbance. An example of the field table can be found in Table 6 below.

T.6. FORM VIGOR AND RECRUITMENT OF BUFFER FEATURES							
Using the table below, estimate the percent (%) of layers and features that are observed or have been 100% lost due to a disturbance. Additionally, using Yes or No answers, determine if layers and features show good form, recruitment, and vigor. This estimation is based only on the upland portion of the polygon. (Q4c+d, pg. 25)							
Layer	Check if present OR evidence of 100% lost		NA	Remaining after a disturbance (%)	Form (Y/N)	Vigor (Y/N)	Recruitment (Y/N)
Snags	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			NA	
Over-story Trees	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Under-story Trees	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Tall Shrubs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Low Shrubs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Herbs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Gaps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			NA	
Mosses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Lichens	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
CWD	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			NA	
				Total (Sum of %'s)	Total possible number of Yes answers		
					Actual number of Yes answers		
				Average (%) (Q4c)	% of cells with Yes answers (Q4d)		

Table 6. Table of forest layers from field table 6

If there was a relatively intact upland strata (e.g., old or mature forest), then this information can help you better interpret the layers and composition of the forest prior to harvest. Be aware of old harvesting which may have occurred in these areas (look for evidence of old cut stumps). Old logging may result in the under-representation of some layers (ie. shrubs) because of the dense canopy of second-growth timber. Note that the opening of a new cutblock would be scored 50% in terms of the canopy gap layer, as the size of the opening is not representative of a natural canopy gap.

Once you've determined the layers that should be present, record the amount that remains post-disturbance. Under form, vigor, and recruitment, mark N if less than 75 % of the layer lacks appropriate form, vigor, and/or recruitment. It's helpful to review the section describing field table 4.3 on form, vigor, and recruitment (pg 53). In terms of recruitment, the presence of one layer may indicate the recruitment of another layer. For instance, the presence of understory trees signifies that overstory trees have good recruitment. In turn, the presence of overstory trees signifies good recruitment for snags, CWD, and canopy gaps.

FIELD-BASED FULL TRANSECT INDICATORS

Transect Observations: Full Polygon Assessment Observations [Table 7.1]

The full transect observations include transect summary information from the full transect length, including both the wetland and 10 m upland from the wetland's edge. Unless otherwise indicated, answer the questions based on the entire area as shown in Figure 51. An example of the field table to fill out while walking this transect is shown in Table 7.

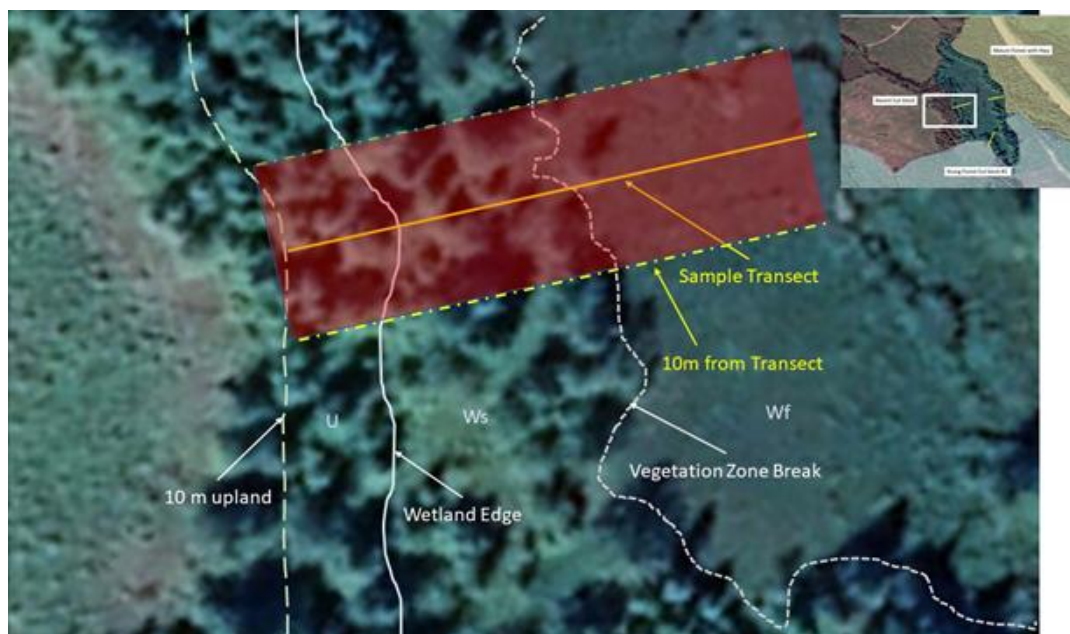


Figure 51. The transect observations that incorporate the full assessment polygon includes observations both in the wetland and 10 m upland (i.e., red polygon).

T.7.1. FULL POLYGON ASSESSMENT OBSERVATIONS							
Question Indicator	Transect summary info in both wetland and 10 m upland from wetland edge	T1	T2	T3	Transect Summary	Large non-homogeneous patches outside transects but within assessment polygon (% of poly)	Total = Transect summary plus large patches
1	% vegetation cover (pg. 21)				Weighted Average % use WF*		
2a	% cover invasive species (pg. 49)				Weighted Average % use WF*		
5e	% live woody vegetation removal in the wetland (other than browsing) (pg. 28)				Weighted Average % use WF*		
7a	% bare ground (pg. 30)				Weighted Average % use WF*		
9a	% Dead or Decadent trees of all trees (pg. 35)				Weighted Average % use WF*		
9c	Old (O) or New(N) Coarse Woody Debris (>7.5 cm diameter) – that crosses transect % old to new (pg. 36) Note: <i>Talley O and N within each transect for CWD that intersects with rotary tape.</i>				Weighted Average % use WF*		
10c	# of wildlife trees no longer functioning as wildlife trees				Sum		
<p>*To calculate the weighted average, look up table on page 3 for Weighted Fractions (WF), and use the following calculations:</p> <p>q1 (_____ x _____) + (_____ x _____) + (_____ x _____) = _____ (T1%veg.cover.*T1WF) + (T2%veg.cover.*T2WF) + (T3%veg.cover.*T3WF) = Weighted Average</p> <p>q2a (_____ x _____) + (_____ x _____) + (_____ x _____) = _____</p>							

Table 7. Full transect measures from field table 7.1

Percent (%) vegetation cover

A healthy establishment of vegetation supports many wetland functions, such as filtering pollutants, cycling carbon and nutrients, and providing habitat to fish and wildlife. Estimate the amount of rooted vegetation (alive or dead) within both the wetland and 10 m upland. Bare soil, downed CWD and plant litter do not contribute vegetation cover and could negatively affect the % vegetation cover. However, a healthy tree or shrub canopy layer may help to improve the scoring if there is bare soil below this canopy (**NOTE:** Bare soil and compacted soil is considered in a separate indicator). Ignore the spaces between floating and emergent plants that are inundated by water as part of this question (i.e., those spaces shouldn't affect the question). Using field observation, and information supplemented from field table 4.3, estimate the % cover of vegetation along the entire transect swath (Figure 51).

After completing all transects, you can then calculate the weighted average using the **Weighted Fraction (WF)** calculated in field table 4.1. (also described on pg 42) and the percent cover recorded along each transect. For example, the weighted average for % vegetation cover would be calculated as follows: (Transect 1 % vegetation cover x Transect 1 Weighted Fraction) + (Transect 2 % vegetation cover x Transect 2 Weighted Fraction) + (Transect 3 % vegetation cover x Transect 3 Weighted Fraction) = Weighted Average.

Percent (%) cover of invasive species

Invasive and noxious plants are often considered problematic species. For example, they may displace native plants by forming monotypic stands, lower habitat quality for wildlife, displace culturally important species, negatively impact livestock forage or health, and may destabilize banks in riparian areas due to shallow-forming roots.

Using a plant guide, an app (such as Seek by iNaturalist), or local knowledge, make note of invasive plants within your wetland site. For a list of common invasive and noxious plants in BC, see Appendix 2 in the Protocol. If you're using the FREP FileMaker form to gather your data, then field table 4.3 will automatically populate which species are invasive based on this list. For more detailed information about estimating percent cover of vegetation and an overview of some invasive species, see pg 51. Record the percent cover of all invasive species combined along the entire transect swath (Figure 51).

A few additional resources include:

List of Regulated and Unregulated Invasive Species in BC:

<https://bcinvasives.ca/invasive-species/about/regulated-invasive-species-in-bc/list-of-regulated-invasive-plants-in-bc>

Factsheet on common aquatic invasive plants and plants for Early Detection and Rapid Removal:

<https://bcwfbogblog.files.wordpress.com/2014/03/aquatic-invasive-species-factsheet-live-ver.pdf>

Percent (%) live woody vegetation removal in the wetland

Live woody plants provide important structure and help recruit CWD and snags for wildlife. Using field observation, you will estimate the live woody vegetation removal in the wetland only (removal in the upland is considered elsewhere in field table 5.1). Include all causes of live wood removal (not only from harvesting) except for impacts from browsing, which is captured in a separate question. Attempt to estimate the loss of wood in three dimensions, as older trees likely contribute more to the structural complexity of the site and have greater habitat value than the same canopy cover measured by saplings. Consider regrowth that has occurred as a mitigating factor against the loss. Do not consider the loss of volume from woody species that are purposely removed because they are non-native and invasive.

Percent bare ground

Using field observation and/or aerial photography you will estimate the % of bare ground within the assessment area, both within the wetland and 10 m abutting the wetland. Bare ground means there is no vegetation. This is problematic as it can serve as a sediment source to receiving waters, and it is no longer providing functions associated with growing vegetation. Sources of bare ground can include heavily grazed sites (Figure 52), tipped tree roots (Figure 53) areas of mass erosion and disturbance from machinery. You will consider only bare ground for Question 7a within the entire swath of your transect when answering this question. Compacted ground is considered when evaluating physical and hydrological alterations. If there is bare ground beneath trees or shrubs, consider the entire exposed area, then net out that which would be protected from rain splash erosion (year-round) by overhead branches and needles. Do not net out areas only covered by leaves as these will likely be absent during the wetter seasons.



Figure 52. Heavily grazed site from livestock is both bare and compacted.



Figure 53. Tipped over tree roots can expose bare ground and become a source of sediment.

Percent dead and decadent trees

Using field observations and/or aerial photography record the % of dead or decadent trees in comparison to live and healthy trees. Focus only on the dominant and co-dominant stems. For this situation, decadent refers to a tree that is marked by decay or decline, with more than 30% of its canopy unvegetated. The total percentage is a fraction of the canopy cover, not a fraction of the total polygon. Here we are looking for trees affected due to impact or disease, climatic, or hydrological stresses (e.g., too much or too little water). Do not include trees that are naturally dying, such as early seral species (e.g., cottonwood and poplars), unless you can determine that they are rapidly dying or decadent due to a stressor. More than 25% dead and decadent is considered beyond the range of natural variation.

Percent old and new coarse woody debris

Coarse woody debris (CWD) supports a number of functions such as habitat for invertebrates, small mammals and amphibians, healthy soil formation processes, and microtopography to support a diversity of vegetation, etc. However, too much or too little is problematic. For the purposes of this protocol, CWD is dead woody material, in various stages of decomposition, located above the soil, larger than 7.5 cm in diameter (or equivalent cross section) which is not self-supporting located at the transect crossing point. Trees and stumps (intact in ground) are considered self-supporting, therefore not CWD. To be considered CWD, the piece must be at least 50 % emerged from the soil, if it is more buried than not beneath a layer of surface organic matter (forest floor) and/or mineral soil, it is not recorded (Figure 54). The observation of CWD is only recorded for those pieces that intersect your rotary tape marking the transect.

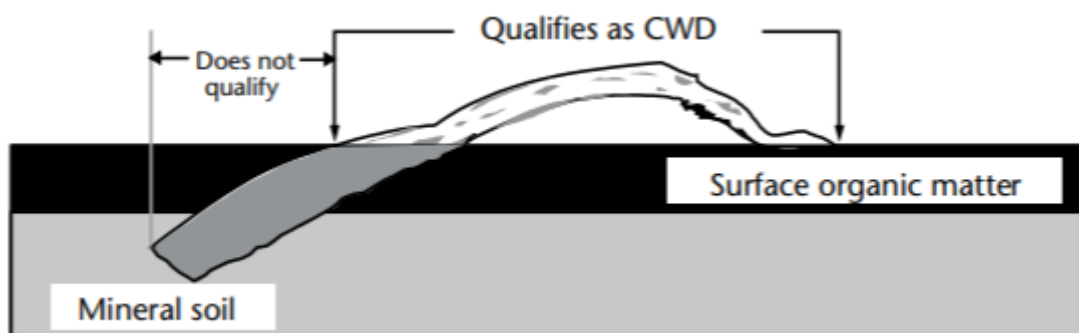


Figure 54. Tally only coarse woody debris that lies above the soil from BC Ministry of Forests and Range Field Manual for Describing Terrestrial Ecosystems 2nd Edition (2010).

With this indicator we are interested in knowing if there is excess CWD from recent disturbances. While walking your transect line, you'll document each piece of coarse woody debris that intersects with your transect line (Figure 55) and document if it is new (N), meaning since harvest, or old (O). This will help you determine the % of old CWD. "New" CWD means recently fallen (since adjacent disturbance), regardless of when the tree died.

As part of the health assessment you'll also be determining if there is a diversity of diameter and decay classes, so it's helpful to also make these observations while you are assessing CWD.

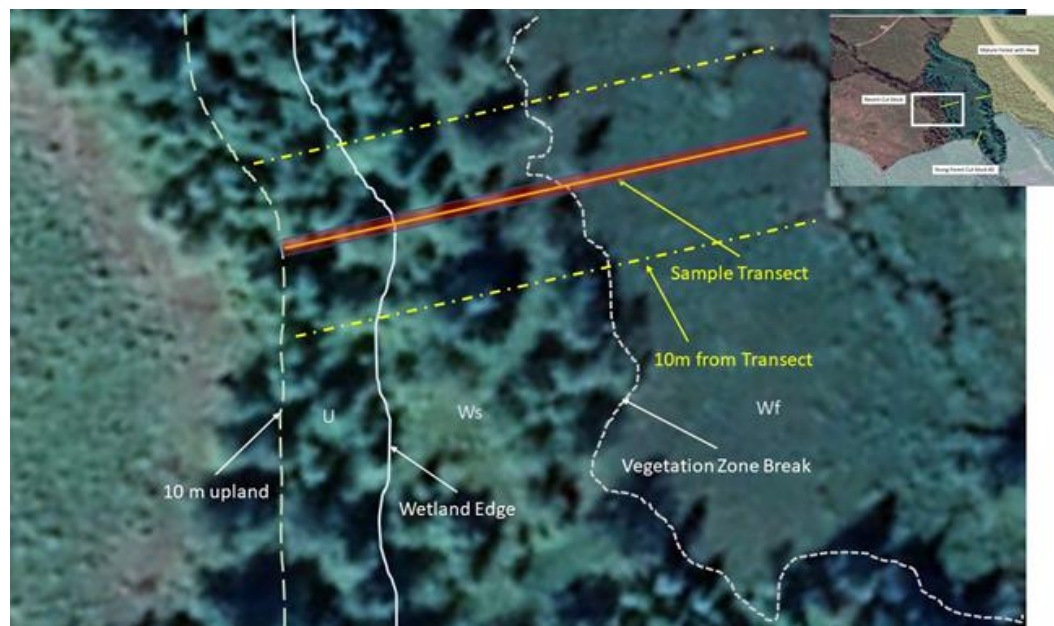


Figure 55. Assess CWD that falls along your transect line (red line).

Wildlife trees no longer functioning as wildlife trees

During the walk along each transect, assessors need to be aware of wildlife trees. The premise for this indicator is that wildlife trees are one of the most valuable components of stand-level biodiversity. There are more than 80 wildlife tree-dependent species in British Columbia, with the largest group consisting of cavity-nesting birds, such as owls, woodpeckers, and some ducks. They are any standing dead or live trees with special characteristics that provide habitat for enhancement or conservation of wildlife. While walking along the transect, make sure to record any observations of wildlife trees that were damaged during the treatment (e.g., logging) then document the impact and record the number of trees impacted. This requires direct observations of impacts to trees that showed evidence of supporting wildlife species (e.g., nesting cavities, nests, etc.). Record the number of wildlife trees no longer functioning as wildlife trees for each transect at the bottom of field table 7.1.

Some things to watch for that indicate the trees have been used by wildlife include cavities in trees, loose bark (suitable for a bat roost), nests, snags used as perches, and witches' broom growing on the tree (provides habitat for marten and other wildlife). If you identify these but they look like they are damaged and no longer functioning properly for wildlife, record them.

Large non-homogenous patches

While walking around the wetland, observe any anomalies that are significant stressors that may be located outside of the transect. This can include large patches of bare soil, invasive plants, disturbance/increaser species, harvesting in the wetland, low retention within the RMZ or high disturbance in RMA, dead or decadent trees, excessive windthrow or newly deposited coarse woody debris. These can be recorded in the column of field table 7.1. under "large non-homogenous patches outside transect but within assessment polygon" as they may affect your overall score.

Density of Invasive Plant Species [Table 7.2]

This table represents a “continuous” indicator that should be evaluated as you are collecting information from your wetland and riparian areas. You have already collected percent cover for invasive plant species along your transect in field table 4.3. Use this information and further observations to estimate the density distribution of invasive species present. The density distribution code roughly describes the abundance and spread of the invasive plant (Figure 56). Select all the distribution codes that best reflects the invasive species distribution.

Once you’ve checked off a density distribution code, you do not need to check off the same one again as this is a continuous observation. Make sure to take photos of any invasive species found showing their density distribution. It’s possible that an invasive species may be widespread in one vegetation zone (e.g., a marsh zone), but not another. For the purposes of this question, although you are considering the entire sample polygon, record its distribution relative to the vegetation zone that it is found in. For example, if an invasive species dominates the entire marsh zone of the wetland, then record it as a density distribution of 9, even if it is not found in the upland area, or in an adjacent wetland zone.










T.7.2. Select the density distribution code of Invasive Species that approximates their extent. Q2b (pg. 22) or mark NA <input type="checkbox"/>								
								
Code 1 <input type="checkbox"/>	Code 2 <input type="checkbox"/>	Code 3 <input type="checkbox"/>	Code 4 <input type="checkbox"/>	Code 5 <input type="checkbox"/>	Code 6 <input type="checkbox"/>	Code 7 <input type="checkbox"/>	Code 8 <input type="checkbox"/>	Code 9 <input type="checkbox"/>
Rare individual, a single occurrence	Few sporadically occurring individuals	Single patch or clump of a species	Several sporadically occurring individuals	A few patches or clumps of a species	Several well spaced patches or clumps of a species	Continuous uniform occurrence of well spaced individuals	Continuous occurrence of a species with a few gaps in the distribution	Continuous dense occurrence of a species

Figure 56. Invasive density distribution codes from field table 7.2.

Snags and CWD Diameter and Decay Classes [Table 7.3]

Snags and Coarse Woody Debris (CWD) are critical components of forest ecosystems. It is estimated that 80 – 90 % of CWD in riparian areas of wetlands originates from trees and snags located within 10 m of the edge of the wetland. These recordings are assessed in the wetland and 10 m up from the edge.

For snags, observations are made along a 20 m wide zone of the transect, 10 m on each side of it, as seen in Figure 57 below.

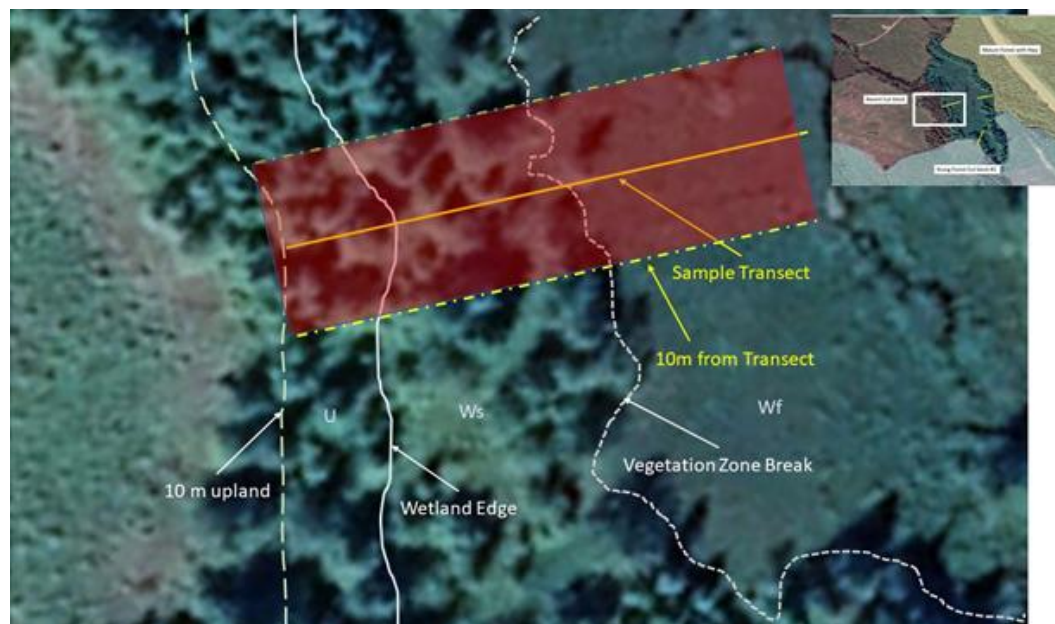


Figure 57. Snag observations are recorded along the transect in the wetland and 10 m upland, including the area 10 m to either side of the transect as highlighted in red.

While observing CWD and snags, check off the decay class and diameter class in field table 7.3. Based on wood type (soft or hard wood) and visual classification. Once you've checked off a decay class or diameter range, you don't need to check off the same class or diameter range again (this is a continuous observation).

Coarse woody debris (CWD) was defined in a previous section: *Percent Old and New Coarse Woody Debris* on pg 68. Similar to snags, we are looking for a diversity of diameter and decay classes. Unlike snags, the observation of CWD is only recorded for those pieces that intersect your rotary tape marking the center of the transect (Figure 58).

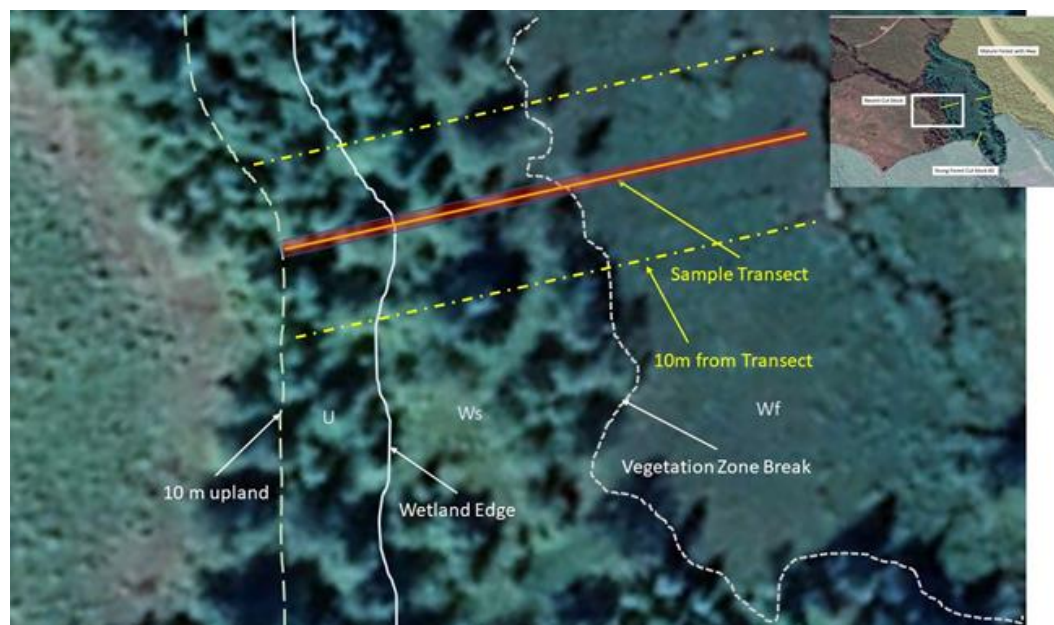


Figure 58. Assess CWD that falls along your transect line (red line).

Decay classes

The decay classes for snags and CWD vary. Snag decay classes are differentiated by softwood and hardwood, as these types of trees decay at different paces. If the snag still has branches on it and is at its original height, it is less decayed than a snag that has no branches, loose bark, and is only standing at a portion of its original height (Figure 59).

Softwood						Hardwood					
Dead						Dead Fallen	Dead			Dead Fallen	
Hard →			Spongy	→ Soft			Not Sampled	Hard →	Spongy	→ Soft	Not Sampled
3	4	5	6 2/3 original height	7 1/2 original height	8 1/3 original height	9	3	4	5	6	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Check all decay classes of snags observed within 10 m upland of the wetland edge											
Check all Diameter Sizes observed: 0 < 10 cm <input type="checkbox"/> ; 10 < 20 cm <input type="checkbox"/> ; 20 < 30 cm <input type="checkbox"/> ; 30 < 40 cm <input type="checkbox"/> ; 40 < 50 cm <input type="checkbox"/> ; 50 cm + <input type="checkbox"/>											
9b: # decay classes of standing dead trees: _____ # Diameter Size Classes of standing dead trees: _____											

Figure 59. Soft and hard wood classes of snags that may be present.

Coarse woody debris is assigned a decay class (1 to 5) based on the main condition of each piece encountered along the transect (Figure 60). The five classes used to describe the condition of coarse woody debris are based primarily upon wood texture, and secondarily on other characteristics (Figure 61). CWD decay is due to respiration, biological transformation, leaching, fragmentation, and weathering. Refer to table 7.3 in your cards when out in the field for detailed descriptions of each decay class to estimate the correct class.

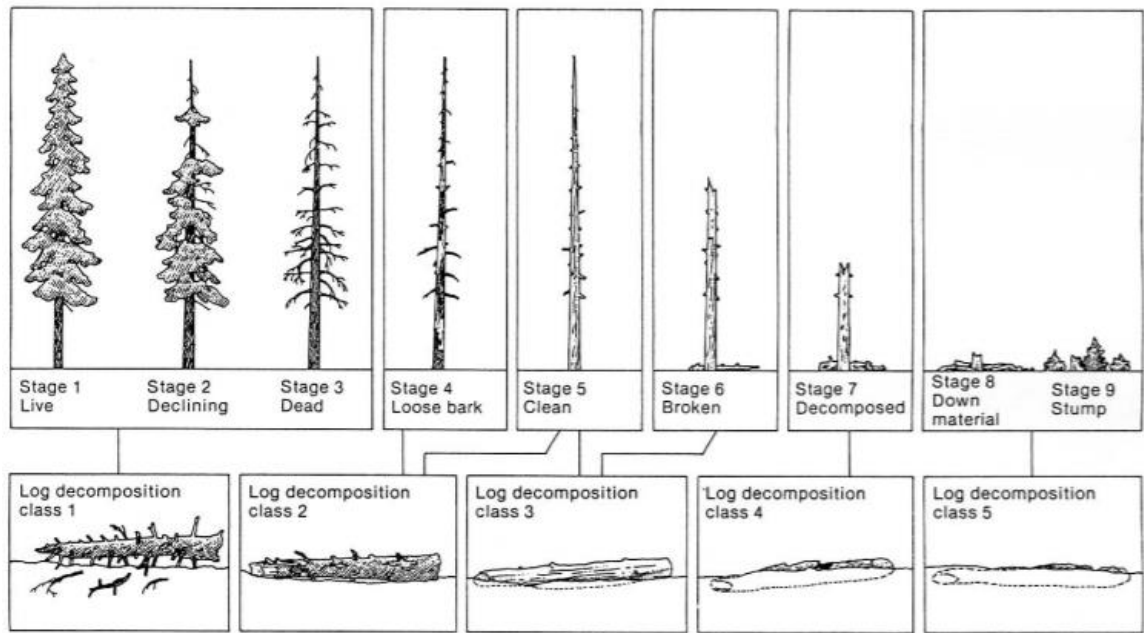


Figure 60. Dead standing trees can enter different CWD decay classes after falling, depending on their existing conditions. Figure from Maser et al. (1979).






					
	Class 1	Class 2	Class 3	Class 4	Class 5
Wood Texture	Hard	Sap rot (but still hard, thumbnail penetrates)	Advanced decay (spongy/large piece)	Extensive decay (crumbly-mushy)	Small pieces, soft portions
Portion on Ground	Elevated on support points	Elevated but sagging slightly	Sagging or broken	Fully settled on ground	Partly sunken
Branches	Hard branches with twigs	Soft branches	Branches/stubs absent	Absent	Absent
Bark	Firm	Loose	Trace	Absent	Absent
Wood Appearance	Fresh/recent	Colour fading	Fading colour	Light or brown	Reddish brown
Wood Strength	Supports person	May not support person	Breaks easily. Pieces snap	Collapses with weight. Pieces do not snap	Feels firm like ground
Invading Roots	None	None	In sapwood	In heartwood	In heartwood
Check all decay classes of CWD observed:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check all Diameter Sizes observed:	0 < 10 cm <input type="checkbox"/> ; 10 < 20 cm <input type="checkbox"/> ; 20 < 30 cm <input type="checkbox"/> ; 30 < 40 cm <input type="checkbox"/> ; 40 < 50 cm <input type="checkbox"/> ; 50 cm + <input type="checkbox"/>				
9d: # decay classes of coarse woody debris:	_____				
# Diameter Size Classes of coarse woody debris:	_____				

Figure 61. CWD descriptions from field table 7.3.

Additional Vegetation Indicators [Table 7.4]

While walking the transects, it is important to record notes or mental observations pertaining to additional vegetation indicators. Table 7.4 of the field cards includes continuous observations for vegetation within the wetland and 10 m upland that are used to finish the health assessment checklist (Table 8).

CONTINUOUS OBSERVATIONS FOR VEGETATION

T.7.4. ADDITIONAL VEGETATION INDICATORS WITHIN WETLAND AND 10 M UPLAND		%	NA
4e	% of impact affecting the long term trajectory of the climax plant community	<input type="checkbox"/>	<input type="checkbox"/>
6a	Maximum % browsed of 2nd year & older leaders in polygon (pg. 28)	<input type="checkbox"/>	<input type="checkbox"/>
6b	Maximum % grazed of available grazing area in polygon (pg. 29)	<input type="checkbox"/>	<input type="checkbox"/>
6c	% seedlings/saplings of palatable species. To indicated recruitment (pg. 29)	<input type="checkbox"/>	<input type="checkbox"/>

Table 8. Additional vegetation indicators from field table 7.4

Percent (%) of impact affecting the long-term trajectory of the climax plant community

Consider the percent of the assessment area that underwent a long-term impact on the plant community due to a disturbance, specifically changes that will alter the trajectory of the vegetation of the community over the long term. Large tree growth is often confined to raised microsites in wetlands, but when harvesting removes the canopy, the water table can rise and reduce the microsites that are otherwise dry enough to support trees. In other circumstances, competing vegetation within the shrub layer may limit future tree establishment. When areas are cleared, they may become more frost prone and cause seedling mortality due to frosts during the growing season. Such observations should be recorded as affecting the long-term trajectory of the vegetation community at the site.

Other long-term impacts to vegetation may include the limitation for native vegetation communities to establish due to colonization by invasive/noxious non-native species. If, for example, reed canary grass (*Phalaris arundinacea*) encroaches on marsh vegetation, this is considered a dis-climax community (Mackenzie and Moran, 2004). In other circumstances, conversion of the site to lawns, agricultural fields, or planting of non-native trees can affect the site's long-term trajectory.

Heavy Browse

Browsing of second year or older material affects the overall health of the plant, and continual high use will affect the ability of the plant to maintain itself on the site. For the purposes of this evaluation, **heavy** browse is when more than half of second year and older leaders are browsed on one shrub (Figure 62). Leaders are long, thin new branches that grow from the stem of a bush or tree beyond other branches. Attempt to make observations on at least three palatable shrubs or trees, such as *Thuja plicata* (Western red cedar), *Salix* species (willows), *Cornus stolonifera* (red-osier dogwood), or *Amelanchier alnifolia* (Saskatoon berry) within the polygon.

Estimate the amount of recent browse that surpasses this year's growth and encroaches on last year's growth or older (i.e., older branches are often more rigid and dull in colour). A shrub or tree that appears to have unusually compact branches or is umbrella shaped is an indication of heavy browse. Do not count utilization on dead plants, unless it is clear that death resulted from over-browsing. If stems have recently been chewed by beaver, count that as heavy browse. Evaluating patches of palatable species will help estimate the percent of stems that display heavy browse. The presence of just one heavily browsed shrub is all you need to conclude there is heavy browse present and if any one plant can be categorized as having heavy browse, the answer to this sub-indicator question will be 'NO'.

Palatable Species

In heavily browsed areas, there may be under-representation of palatable species and overrepresentation of less-palatable species, including:

- *Crataegus* spp. (hawthorn);
- *Elaeagnus commutata* (silverberry/wolf willow);
- *Dasiphora fruticosa* or *Potentilla fruticosa* (shrubby cinquefoil);
- *Rosa* spp. (rose); and,
- *Symphoricarpos* spp. (buckbrush/snowberry).

If these less palatable species dominate the understory, look for adjacent sites at similar elevations to compare and determine if the site's vegetation community may have shifted due to overbrowsing.



Figure 62. Evidence of browse occurring on second or older leaders within a wetland.

Percent (%) heavily grazed of available grazing area in polygon

The polygon is considered free of heavy grazing if 90 % or more of the available forage has a stubble height greater than the recommended minimum (usually 5 cm or 2 in for most ranges). Consider heavy grazing present if short stubble remains, almost all plant biomass has been removed, and only the root systems and parts of the stems remain. Heavy grazing can lead to undesirable invaders inhabiting the site as the native plants are prevented from flowering and often extirpated. Do not count dead plants unless it is clear that death resulted from over-grazing. Establish a set of random plots across the area of available forage to better estimate % grazing if the area seems relatively homogeneous. If grazing impacts seemed clumped, consider that overgrazed areas are often easy to access- inspect these patches and compare with those behind blowdown or otherwise more difficult to access. Add the areas together and estimate the percent that has been heavily grazed.

Percent (%) of seedlings/saplings of palatable species

The aim of this question is to see whether seedlings or saplings of palatable tree and shrub species make up more than 5% of those species in the entire polygon. (e.g., *Thuja plicata* (Western red cedar), *Salix* species (willows), *Cornus stolonifera* (red-osier dogwood), *Amelanchier alnifolia* (Saskatoon serviceberry))

This question should be marked NA if the site lacks potential for trees or shrubs; for example, the site is a cattail marsh or herbaceous wet meadow, or all woody plants have already been removed. Not all wetland areas can support trees and/or shrubs; however, on those sites where such species do belong, they play important roles. The root systems of woody species are excellent shoreline stabilizers, while their spreading canopies provide protection to soil, water, wildlife, and livestock. Young age classes of woody species are important for the continued presence of woody communities not only at a given point in time but into the future. On severely disturbed sites, the evaluator should seek clues to vegetation potential by observing nearby sites with similar landscape position. **NOTE:** Vegetation potential is commonly underestimated on sites with a long history of disturbance.

FIELD-BASED WETLAND INDICATORS

Structural Vegetation Composition Within Wetland [Table 8]

In this section we are revisiting concepts we visited in field table 4.3. when filling out our plant list, and in table 6 when considering the extent and quality of layers in the area 10 m upland from the wetland edge; however, here we are assessing the extent and quality of features within the wetland itself (Figure 63).

T.8. FORM, VIGOR, AND RECRUITMENT WITHIN WETLAND							
Using the table below, estimate the percent (%) of all observed layers or those 100% lost due to a disturbance. Additionally, using Yes or No answers, determine if all expected layers and components show good form, recruitment, and vigor. This estimation is based only on the wetland portion of the polygon. (Q4a+b)							
Layer/ Feature	Typical Associated Wetland Class	Check if present OR evidence of 100% lost	NA	Remaining after a disturbance (%)	Form (Y/N)	Vigor (Y/N)	Recruitment (Y/N)
Snags	Wb, Ws	<input type="checkbox"/>	<input type="checkbox"/>			NA	
Over-story Trees	Wb, Ws	<input type="checkbox"/>	<input type="checkbox"/>				
Under-story Trees	Wb, Ws	<input type="checkbox"/>	<input type="checkbox"/>				
Tall Shrubs	Wb, Ws	<input type="checkbox"/>	<input type="checkbox"/>				
Low Shrubs	Wb, Ws, Wf	<input type="checkbox"/>	<input type="checkbox"/>				
Herbs – Terrestrial/ Emergent	Wb, Ws, Wf, Wm, Ww	<input type="checkbox"/>	<input type="checkbox"/>				
Herbs – Aquatic	Wm, Wf, Ws	<input type="checkbox"/>	<input type="checkbox"/>			NA	
Elevated Microsites	Wb, Wf, Ws	<input type="checkbox"/>	<input type="checkbox"/>				
Mosses/ Lichens	Wb, Wf, Ws	<input type="checkbox"/>	<input type="checkbox"/>				
CWD	Wb, Ws	<input type="checkbox"/>	<input type="checkbox"/>				
Open Water Pools (>4m ²)	Wb, Wf, Wm, Ws	<input type="checkbox"/>	<input type="checkbox"/>			NA	
				Total (Sum of %'s)	Total possible number of Yes answers		
					Actual number of Yes answers		
				Average (%) (Q4c)	% of cells with Yes answers (Q4d)		

Figure 63. Structural composition with form, vigor and recruitment within wetland.

Layers to consider within a wetland include snags, over-story trees, understory trees, tall shrubs, low shrubs, herbs (terrestrial/emergent), herbs, elevated microsites, mosses/lichens, CWD, and open water pools (i.e. > 4m²). This is a continuous indicator, meaning that you assess it after completing your transects and walking around the wetland. Observations don't necessarily need to be limited to the transects. However, transects can aid you in assessing the overall wetland.

Some of the layers may not apply to your wetland, as those layers may not have been historically present. For instance, marshes and shallow open water communities typically don't support the woody plant components found in snags, overstory trees, tall shrubs, low shrubs, or coarse woody debris. Depending on the site you are evaluating, certain structural features may not be relevant. Wetland layer/features listed in column 1 are more common in those wetland classes listed in column 2. **NOTE:** Wb = bog, Wf = fen, Wm = marsh, Ws = swamp, Ww = shallow open water. For all layers not naturally present, you can record NA in the paper form or N in the FREP wetland FileMaker form. You will then ignore the adjacent columns for that particular layer and this will reduce the total possible "Yes" answers when you roll up the information.

Once you've determined the layers that should be present, record the amount that remains post disturbance. Under form, vigor, and recruitment, mark N if less than **85%** of the layer lacks appropriate form, vigor, and/or recruitment. It's helpful to review the section on vegetation form, vigor, and recruitment on pg 53. In terms of recruitment, the presence of one layer may indicate the recruitment of another layer. For example, the presence of understory trees signifies that overstory trees have good recruitment. In turn, the presence of overstory trees signifies good recruitment for snags and CWD. An example of a completed table is in Figure 64.

FORM, VIGOR AND RECRUITMENT WITHIN WETLAND Using the table below, estimate the percent (%) of all observed layers or those 100% lost due to a disturbance. Additionally, using Yes or No answers, determine if all expected layers and components show good form, recruitment and vigor. This estimation is based only on the wetland portion of the polygon. (Q4a+b)							
Layer/Feature	Typical Associated Wetland Class	Check if present OR evidence of 100% lost	NA	Remaining after a disturbance (%)	Form (Y/N)	Vigor (Y/N)	Recruitment (Y/N)
Snags	Wb, Ws	x	<input type="checkbox"/>	75	N	NA	Y
Over-story Trees	Wb, Ws	x	<input type="checkbox"/>	75	N	Y	Y
Under-story Trees	Wb, Ws	<input type="checkbox"/>	<input checked="" type="checkbox"/>	NA	NA	NA	NA
Tall Shrubs	Wb, Ws	<input type="checkbox"/>	<input checked="" type="checkbox"/>	NA	NA	NA	NA
Low Shrubs	Wb, Ws, Wf	<input type="checkbox"/>	<input checked="" type="checkbox"/>	NA	NA	NA	NA
Herbs – Terrestrial/ Emergent	Wb, Ws, Wf, Wm, Ww	x	<input type="checkbox"/>	100	Y	Y	Y
Herbs – Aquatic	Wm, Wf, Ww	x	<input type="checkbox"/>	50	N	N	Y
Elevated Microsites	Wb, Wf, Ws	x	<input type="checkbox"/>	100	Y	NA	Y
Mosses/Lichens	Wb, Wf, Ws	x	<input type="checkbox"/>	100	Y	Y	Y
CWD	Wb, Ws	x	<input type="checkbox"/>	80	Y	NA	Y
Open Water Pools (>4m ²)	Wb, Wf, Wm, Ws	x	<input type="checkbox"/>	50	N	NA	Y
				Total (Sum of %'s)	Total possible number of Yes answers		
				630	20		
				Average (%) (Q4c)	Actual number of Yes answers		
				79	15		
					% of cells with Yes answers (Q4b)		
					75		

Figure 64. Example of structure and vegetation form, vigor and recruitment within the wetland portion of the polygon. **NOTE:** depending on the site you are evaluating, certain structural features may not be relevant. Wetland layers/features listed in column 1 are more common in those wetland classes listed in the column 2.

FIELD-BASED INDICATORS WITHIN ENTIRE ASSESSMENT POLYGON

Physical and Hydrological Alterations [Table 9]

This table includes some of the most impactful continuous observations you'll make regarding your assessment area. Observations are not just limited to transects.

Percent (%) of total polygon physically altered

Consider any "hardscaping" that has involved the deposition or removal of soils or other materials within the assessment area, such as corduroy timbers that were installed to allow for equipment crossing. Also include any compacted ground in this question. Compacted soils are limited in their ability to allow for water percolation and may facilitate increased erosion and surface water runoff. Sources of compacted ground can include cattle pugging, fill, roads, and trails. This question assesses the accumulated effects of all physical alterations (both natural disturbances and human caused). The purpose of this question is to assess physical change to the soil, bank/shore integrity, hydrology, etc. as it affects the ability of the natural system to function normally.

Severity of physical or hydrological alteration

Hydrologic changes include modifications to the hydroperiod of the wetland site in terms of quantity and timing of water inputs. Roads, ditches, dams, and land-clearing can potentially alter the hydrology of the site. If the wetland has shifted plant communities or is no longer a functioning wetland then record "No".

Four categories of alteration severity are described below in terms of change to the site vegetation and hydrologic function. **NOTE:** This criterion uses vegetation change to indicate the degree of physical and hydrological alteration, but the alteration must be physical in nature, not just vegetative change alone (e.g., disruption of soil, hydrology (including infiltration/interception of water), topography, etc.).

No alteration/non-existent: No human-caused physical/hydrological alteration observed on the polygon.

Slight/Minor: Physical or hydrological site integrity is near natural. Alteration (including recovery from any past severe alterations) is apparent but reflects minimal impact to plant communities and hydrological function in the altered areas.

Moderate: Such alteration is either in the process of becoming revegetated with appropriate species or is well covered with a mix of less desirable and appropriate species. Wetland may transition from one plant association to another plant association.

One example of an alteration is when a road is installed across or downstream of a wetland and facilitates drainage to or from wetland. The plant community shifts and the wetland may transition to a different ecological type (ie. a fen to swamp, as indicated by encroaching woody terrestrial vegetation). This is an example of a moderate alteration, as the wetland is still functioning as a wetland, but the plant association has altered. If enough water is removed and the soils dry out, the alteration would be considered severe.

Severe: Disruption of the microtopography of the soil profile or hydrology is severe in depth of disturbance. Alterations remain mostly bare of plant cover, are no longer supporting wetland habitat, or are becoming vegetated with invasive or undesirable species.

Dead trees or shrubs around the wetland edge that would indicate a rise in water level

Dead trees and shrubs around the perimeter are a strong indicator of a change in hydrology. A “Yes” answer would suggest that the wetland is healthy, whereas a no answer may indicate that the site has become wetter.

Absence of encroaching upland plant or tree species

Conversely, the presence of younger trees in a wetland, can indicate that the site is drying out or shrinking (Figure 65). A “Yes” answer to this indicator would indicate that there is NO encroachment, and that the site remains intact.



Figure 65. This wetland is located directly downstream from FSR road, and contrasts significantly in vegetation community in comparison to the wetland on the other side (which is much more open), the presence of younger shrubs and trees indicate that this wetland may have dried out. Tree core samples could help better understand both the age of the trees and may show alterations in growth rings that coincide with the installation of the road.

Stream channel incisement is minor or non-existent

A stream flowing through a wetland is intrinsically linked to the hydrology of the wetland. It may periodically flood the surrounding wetland or maintain subsurface groundwater levels. Channel incisement, if moderate or severe, can remove the stream channel's connectivity to its floodplain, and increase the drainage of subsurface groundwater levels.

Natural surface or subsurface areas not altered by disturbance

Recent and historic efforts to move water is extensive in BC and across North America. Sometimes past practices of drainage or soil alteration is not readily obvious on the landscape as reforested landscapes can mask past practices. Researching about past practices or speaking to older generations who worked on the land can reveal historical practices that have had residual impacts. Forestry practices in the past may have involved moist soil management – sometimes referred to as site prep. It can take a trained eye to find subtle clues regarding past practices. Drainage tiles (e.g., buried rock, logs, clay tiles, or pipes) can be very difficult to find if installed properly. These are designed to lower the water table. There are accounts of split cedar logs being buried on eastern Vancouver Island to drain wetlands in areas that are now forested. Ditches, dikes, and gullies are more evident as they can appear on the surface. Often ditches will be too straight to be natural or may run along the toe of a slope in an effort to divert runoff from reaching a downstream valley. A “No” answer to the statement above means that the impacts are moderate or severe.

Stable outlet structure

It’s important to take a close look at any outlets of your wetland (i.e., where water flows out of the wetland). In some cases, water leaves through a confined space and if the elevation of the soil is prone to erosion and downcutting, this can lead to a drawdown in the wetland’s hydrology. Look for evidence of downcutting or erosion at the outlet. Generally, a wetland outlet that has a wide floodplain or outflow will help to reduce sheer stress on the soils below and reduce potential for downcutting whereas a narrow channel concentrates the shear-stress. A wetland that has a hardened outlet with deep root masses or is armoured with rock or bedrock will protect the outlet from erosion. If a beaver dam is located at the outlet of your wetland, then look to see if there is still beaver activity (e.g., freshly cut logs); if the beaver dam is breached and there is no recent sign of beaver, then your wetland may be at risk.

Percent of the streambank or wetland shoreline that is structurally altered

Estimate the percent of the shoreline’s perimeter that has any shoreline impacts such as physical structures, livestock compaction or vegetation removal. Compromised shorelines are unable to provide proper wetland function such as fish cover, habitat for aquatic invertebrates/amphibians, erosion control or support other natural processes.

Percent streambank with deep binding root mass

Deep binding root masses help reduce streambank erosion and downcutting. Most shrubs as well as sedges often have deep root masses. Estimate the percent of the stream within the wetland assessment polygon that contains deep binding root mass.

Signs of excessive nutrient loading such as algae mats, blooms, fish kills

Algae mats/blooms or fish kills signify poor water quality. A “No” response likely indicates a problem with the water-quality

Basic water quality parameters (smell, color, pH, turbidity, temperature)

Document any abnormalities. Refer to the Wetlands of BC: A guide to classification to determine the natural range of pH for specific wetland plant associations. A wetland that has lost its canopy cover may experience an increase in water temperature.

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