Guidance for Mapping Wetlands from Imagery in British Columbia for the Canadian National Wetland Inventory

B.A. Blackwell & Associates Ltd.

GUIDANCE FOR MAPPING WETLANDS FROM IMAGERY IN BRITISH COLUMBIA FOR THE CANADIAN NATIONAL WETLAND INVENTORY

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LIST OF ACRONYMS

Acronym	Description
ArcGIS	ESRI's Geographic Information System version (v10.5)
ArcMap	ESRI GIS mapping program
Blackwell	B.A. Blackwell & Associates
BC	British Columbia
BCGS	British Columbia Geographic System
BEC	Biogeoclimatic Ecosystem Classification
BGC	Biogeoclimatic
BGxh1	Very Dry Hot Bunchgrass variant
CMAun	Coastal Mountain-heather Alpine undifferentiated
CNWI	Canadian National Wetlands Inventory
CWCS	Canadian Wetland Classification System
CWHdm	Dry Maritime Coastal Western Hemlock subzone
CWHvm1	Submontane Very Wet Maritime Coastal Western Hemlock variant
CWHwh1	Submontane Wet Hypermaritime Coastal Western Hemlock Variant
CWHxm1	Eastern Very Dry Maritime Coastal Western Hemlock variant
CWHxm2	Western Very Dry Maritime Coastal Western Hemlock variant
CWS	Canadian Wildlife Service
DEM	Digital Elevation Model. A three-dimensional representation of the Earth's bare surface.
ECCC	Environment and Climate Change Canada
ESRI	Environmental Systems Research Institute
ESSFun	Engelmann Spruce - Subalpine Fir undifferentiated zone
ESSFwv	Wet Very Cold Engelmann Spruce - Subalpine Fir subzone
gdb	File geodatabase (file type used by ESRI)
GIS	Geographic Information System
ha	Hectares
LiDAR	Light Detection and Ranging
ICHwc	Wet Cold Interior Cedar – Hemlock subzone
IDFdk5	Columbia Dry Cool Interior Douglas-fir variant
IDFxk	Very Dry Cool Interior Douglas-fir subzone
m	Metres
MoECCS	Ministry of Environment and Climate Change Strategy
NWA	National Wildlife Area
PEM	Predictive Ecosystem Mapping
PPxh1	Okanagan Very Dry Hot Ponderosa Pine variant
PurVIEW	ArcGIS Desktop extension, 3D photo stereo-viewing software
RIC	Resources Inventory Committee

RISC	Resources Inventory Standards Committee
SBSmks	Moist Cool Scrub Sub-Boreal Spruce subzone
SEI	Sensitive Ecosystem Inventory
SIL	Survey Intensity Level
TEI	Terrestrial Ecosystem Information
TEIS	Terrestrial Ecosystems Information System
TEM	Terrestrial Ecosystem Mapping
TRIM	Terrain Resource Information Management
VRI	Vegetation Resources Inventory
WET	Wetland Mapping
WLRS	Water, Land and Resource Stewardship

1. Introduction

The Canadian National Wetland Inventory (CNWI) is an initiative to compile, process, quality control, and publish best available wetland mapping and field validation data, with its metadata, into a comprehensive publicly available national database. It also aims to acquire additional wetland data to fill high priority gaps in coverage, with an emphasis on peatlands and coastal wetlands. The CNWI data will be used to train and validate predictive mapping models using remote sensing technology to measure changes in wetlands over time at a national scale, and ultimately support Canada's Nature-Based Climate Solutions Initiative by informing biodiversity conservation, climate change adaptation, and greenhouse gas (GHG) emission reduction reporting.

The CNWI national database product will be used for analysis and reporting by a wide range of organizations, including governments, environmental non-governmental organizations (ENGOs), academia, land managers, industry, and the public. It supports Canada's Nature-Based Climate Solutions Initiative by providing a baseline to help inform biodiversity conservation, climate change adaptation, and GHG emission reduction reporting. It also supports Canada's national reporting (ECCC, 2016).

The CNWI is available for download on the Government of Canada's Open Data Portal (https://open.canada.ca/en/open-data) and will be updated periodically. The geospatial data is available as a geodatabase (.gdb) for use in various geographic information system (GIS) software programs.

The CNWI BC Supplement (the geodatabase spatial product this document describes) is intended to be made openly available for download through the BC Data Catalogue, also with regular periodic updates (https://catalogue.data.gov.bc.ca/).

In British Columbia, all data submissions to the CNWI will follow the **CNWI BC Supplement** standards**,** which includes additional fields and domains to capture unique attributes and categories as described in various BC classification systems and documents ((BCMFR and MOE 2010; MacKenzie and Moran, 2004; MacKenzie, 2012, etc.) and to ensure integration with to provincial datasets.

Wetlands are often mapped from a variety of imagery sources such as orthophotos, air photos, drone images, satellite imagery, etc. Many factors influence the quality of a final wetland mapping product including the type of the source imagery, the resolution of the source imagery, the experience and skills of the mapper as an ecologist, the experience and skills of the mapper as an GIS analyst, the familiarity of the mapper with the local ecology of the mapped area, the scale that the line-work was completed at, and the type of software used to complete the mapping.

As British Columbia (BC) has a highly varied landscape with major ecosystem changes with latitude, longitude, and elevation, mapping wetlands from imagery can be particularly challenging in this province.

The purpose of this report is to describe the process and best practices of mapping wetland and ecosystem boundaries from imagery. Photographs and orthophoto examples of CNWI wetland classes and surface cover types are provided to assist mappers. This report also describes types of imagery, the process for imagery acquisition, and the geospatial tools and processes required to produce high-quality wetland mapping coded to the CNWI BC Supplement standards.

1.1 Project Team

The project was conducted for Erin Roberts (Wetland Specialist, Pacific Region, Canadian Wildlife Service Environment and Climate Change Canada / Government of Canada).

The descriptions of wetland mapping methods were completed by Ben Andrew and Avram Sandor (GIS related procedures).

2. Canadian National Wetland Inventory in British Columbia

The CNWI National User Manual (ECCC, 2024b) provides the scope and definitions for the national wetland database and is built upon two foundational documents: the Canadian Wetland Classification System (National Wetlands Working Group 1988, 1997) and the Canadian Wetland Inventory Data Model (Ducks Unlimited Canada, 2016; ECCC 2024a). The CNWI User Manual describes twenty-one standardized fields with drop down coded domain selection options.

A CNWI BC Supplement was developed to describe necessary additional attributes that capture unique ecological features and enable integration with provincial wetland inventories and databases (ECCC 2024a). The CNWI BC Supplement (currently V12) is the standard format that new wetland polygon, field plot data, mapping, and inventory work will be coded to in BC. A ESRI gdb spatial template is available that is pre-coded to include all the appropriate fields and domains in the CNWI BC Supplement.

In total, the BC CNWI Supplement (V12) contains thirty-three fields. Twelve additional attributes are included in the BC CNWI Supplement (ECCC 2024a) to capture unique attributes and categories as described by the B.C. Ministry of Forests and Range and B.C. Ministry of Environment (MOFR &MOE 2023); MacKenzie, W.H. and J.R. Moran (2004); and MacKenzie, W.H. (2012). Relevant land management handbooks and the metadata from BC provincial datasets should also consulted as required. An additional six national attributes have expanded selection options for BC.

Full classification of wetland mapping with all thirty-three fields is completed after field validation has been completed (Section 5), during the final classification stage (section 6).

This document focuses on the initial imagery interpretation and mapping process (described in Section 4). In the initial mapping and delineation process, only seven attribute fields will be completed (detailed in Section 4.4).

For definitions and field keys of CNWI BC Wetland Class, Surface Cover, metadata standards, as well as a full description of the CNWI wetland mapping, field validation final classification, and data collection program in BC, please refer to the CNWI BC Supplement (ECCC 2024a).

2.1 Canadian Wetland Classes and Surface Cover

Mapping wetland classes and surface cover requires the mapper to interpret imagery using their own field observations or information recorded at field data points; a process that is termed photo signature interpretation. To assist in interpreting imagery and correlating wetland class and surface cover, a series of figures showing field photos and orthophotos are provided (Appendices A and B).

While it is hoped that the photos and images provided in this document assist mappers during interpretation of imagery, **there is no replacement for conducting field work to help understand the relationship between imagery and reality**. It should be noted that the availability of high-resolution imagery is limited for many of the areas that the photos were taken. Most of the orthophoto imagery used is Base Map imagery available through ESRI.

To provide the guidance on photo interpretation of wetland classes and surface cover codes, paired photos and orthophoto imagery of the photo location have been included for most of the wetland classes and surface cover codes (Appendices and B). The photos that have been included have either been taken from a low-flying helicopter or from the ground. These photos are always located on the left side of the page. The corresponding photo point is then shown on orthophoto imagery (right side of the page). The yellow arrows (where direction could be determined) on the orthophotos indicate the general direction/view of the photographer. The Biogeoclimatic unit based on the Biogeoclimatic Ecosystem Classification (BEC) used in BC is also provided.

The folder titled: Report_Photos_Geospatial contains two folders Cover Class and Wetland Class. I these two subfolders are copies of most of the photos presented in this report as figures. They folders also include two file geodatabases (Wetland_Class_Photo.gdb and Wetland_Cover_Class.gdb). These geodatabases can be used in a GIS environment to view the photos relative to other available imagery (e.g., ESRI, BING™, or orthophotos) to compare how imagery affects interpretation. When using the imagery in ESRI programs, such as ArcMap, the HTML popup can be used to click on the photo points and view the photos presented in this report and the location they were taken in.

3. Imagery and Other Spatial Data

Imagery is one of the most important inputs that determines the spatial accuracy of wetland polygon delineation and the ability of the mapper to accurately identify wetland attributes. The date, type, resolution, and availability of imagery is important to consider before conducting new mapping. In addition to imagery, there are other types of spatial data that can assist in mapping including Light Detection and Ranging (LiDAR), Terrain Resource Information Management (TRIM), Digital Elevation Model (DEM), and Terrestrial Ecosystem Inventory (TEI) data. Imagery and other spatial data useful for wetland mapping are described below and sources for acquiring the data in BC are provided.

3.1 Imagery Type

Imagery used to map wetlands should be selected based on the goals of the mapping. Because wetlands are typically very localized features on the landscape and generalized mapping is less suitable for end uses of wetland-focused mapping products, higher resolution imagery is preferred. Imagery types suitable for wetland mapping are typically acquired through aerial imaging using planes, helicopters, or drones, and less commonly through satellite imagery. The main types and sources of imagery are discussed in the following sections.

3.1.1 Aerial Imagery

The term aerial imagery is used a generic term that includes photographs taken from the air (e.g., planes, hot air balloon, drones). It includes types of imagery such as 3D Stereo imagery (air photos), orthophotos, and drone imagery. Aerial imagery does not include satellite imagery.

3.1.1.1 3D Stereo Imagery – Air Photos

3D stereo imagery is typically taken using low flying planes or drones (air photos), although some 3D imagery may be available from satellites, it is generally of poor resolution. Air photos can be either hardcopy (actual photos) or digital images.

To create 3D airphotos, the photo frames overlap each other by around 60%. When two overlapping photos are used, the two perspectives allow the mapper to view the imagery in 3D. The two overlapping images are known as a stereo pair. It allows the mapper to see the topographic relief, vegetation height, and improves delineation of bioterrain features and interpretation of ecosystem attributes. It is the highest quality imagery and can dramatically improve mapping accuracy.

Historically, hardcopy air photos were viewed using stereoscopes that allowed the mapper to see the imagery in 3D. Mapping linework (also referred to as typing) was completed manually on the actual air photos using pen and ink. The mapped air photos were then digitized using software to create a digital mapping product. This method is seldom used now but can still be employed when mapping is conducted on old air photos for purposes such as determining historic ecosystem conditions. Most mapping is now completed using digital imagery.

Digital air photos are viewable in 3D using photogrammetry programs such as Purview or Summit Evolution. To use stereo pairs in a photogrammetry program, models must be created to orient the imagery. A DEM is also required to create a surface file (e.g., TIN [triangular irregular network]) to provide a z-axis during mapping. Setting the imagery up for use in these programs requires expertise in photogrammetry and specialized software. After the imagery is setup for use in a photogrammetry program, users with basic GIS experience can be easily taught to use the program for mapping. Further discussion on mapping workflow is provided in Section 4.1.

The major limitations of air photos are cost (see below), difficulty with setup, and availability of recent imagery with suitable scale. While most of BC has air photo imagery, in some areas of the province, the imagery can be decades old, black and white (no colour), or small scale (e.g., 1:50,000).

Sources

The *UBC Department of Geography* provides hard copy prints of air photos for a fee. Air photos are available for most of BC, dating back to the 1940's for urban areas. The following link provides information on air photos available from the UBC Department of Geography:

Air Photo Request | Geographic Information Centre (ubc.ca)

The BC government *Base Map Online Store* provides air photos for most of BC. The Air photos are available as high-resolution digital files and cost $18.50/image. To order the imagery, the locations of air photos can be searched using the *Base Map Online Store* or displayed as a KML in Google Earth. As noted previously, use of these images still requires setup (e.g., models, TIN) for the photogrammetry program being used.

The following link provides information on digital air photos available from the *Base Map Online Store* in BC:

Digital Air Photos of B.C. - Province of British Columbia (gov.bc.ca)

3.1.1.2 Orthophotos

Orthophotos are the least expensive and the most available imagery type. Because orthophotos are more often collected than 3D air photos and are easier to distribute and use, recent imagery is most often available in this format.

Orthophotos are typically collected using planes or drones and may be created using the same air photos used in stereo imagery. Whereas overlapping images must be taken for stereo imagery, less overlap is required if only orthophotos will be created because overlapping perspective is not required to enable 3D use.

The imagery used to create orthophotos must be geometrically corrected (aligned so it matches features on the earths surface to be spatially correct) and can be used to create orthomosaics (groups of air photos that appear as one image).

While orthophotos are useful for mapping, they provide less information for mappers to consider when typing and attributing. Because orthophotos are two dimensional, they do not provide the mapper with 3D information to interpret topography and landscape position as accurately as 3D imagery. This is an impediment to accurately mapping ecosystems such as floodplains or incised features such as riparian ravines that commonly contain forested swamps. 2D imagery also limits the accurate mapping of structural stage based on vegetation height. Some of these limitations may be overcome using contours or preferably Light Detection and Ranging (LiDAR), which allows for the mapping of topographic features and can be used to determine vegetation height for structural stage mapping. LiDAR is discussed below in Section 3.4.5.

Sources

Orthophotos are publicly available through Google Earth™, BING™, or ESRI Base Map data™. The resolution (pixel size) varies depending on the available imagery. Google Earth also provides some historical imagery, which can be useful for change detection.

The BC government *Base Map Online Store* provides digital orthophotos for most of BC. The orthophotos are available with resolutions of 0.5 to 1.0 m and cost $200 for a 1:20,000 BCGS (British Columbia Geographic System) mapsheet. To order the imagery, orthophotos can be searched using the *Base Map Online Store* for orthophotos.

The following link provides information on digital orthophotos available from the *Base Map Online Store* in BC:

Orthophotos of B.C. - Province of British Columbia (gov.bc.ca)

3.1.2 Drone Imagery

Drone imagery is collected using low flying drones and provides an excellent base on which to conduct wetland mapping. Drone imagery can be taken to create orthophotos or stereo imagery. Because of the low height at which the imagery is taken, the resolution of the imagery can allow for the identification of plant species and reliable wetland delineation and classification.

2D drone imagery has similar limitations to orthophotos with respect to interpreting topography. However, drone imagery can also be collected as 3D stereo imagery and used in a photogrammetry program if the correct imagery is taken, and software is used to convert the imagery to matching stereo pairs. Drone imagery is suitable for relatively small areas where suitable air photo imagery is not available or greater mapping accuracy is required. Acquiring imagery for large areas, is often not feasible because of the limited flying time and number of photos required compared to imagery taken with planes.

Sources

Drone imagery is not publicly available in BC but can be acquired through private companies that provide drone services.

3.1.3 Satellite Imagery

Imagery taken from satellites and is typically of too coarse a resolution for the accurate delineation and interpretation of wetland extent and class. Examples of satellite imagery include Sentinel-2 with a resolution of 10 to 60 m and Landsat which has a resolution of 30 m. These satellite images cover large areas with sufficient detail to broadly characterize large changes in land use, such as urbanization, but not the detail required to interpret small, localized features such as wetlands. It may be a useful input for modelling or machine-based learning; however, due to the large pixel size it is typically not used for the manual delineation of wetlands.

Sources

Satellite imagery is available through private providers or government organizations.

The Province of B.C. has an inventory of satellite imagery for various internal government programs. Use of this imagery is generally restricted but inquiries regarding its availability can be directed to:

GeoBCinfo@gov.bc.ca

3.2 Mapping Scale and Imagery Resolution

Mapping scale describes the geographic area on the ground compared to the area represented on a map, or screen. A 1:20,000 scale shows a larger geographic area with less detail than a 1:5,000 scale which would show a small geographic area in greater detail.

Mapping scale should be chosen based on project specific considerations such as project size, objectives, and end uses of the mapping. As mapping scale becomes more detailed, so does the overall effort to complete the mapping and conduct the fieldwork (e.g., greater field validation is required for mapping at 1:5,000 scale vs a 1:20,000 scale), which will increase overall cost of the mapping. Therefore, its important to rationalize the use of mapping scales on a project basis.

Mapping scale should also be chosen based on the resolution of the available imagery (Table 3-1). Imagery resolution determines the detail visible in the imagery that can be interpreted and the minimum polygons size and feature width that can be accurately mapped (Table 3-1). Imagery with 1 m resolution or greater is more suitable for broad inventory projects (smaller scale) where less details are required and a larger minimum polygon size is acceptable; less than 1 m resolution imagery will support more detailed mapping (larger scale), suitable for site level planning and management. Colour imagery is preferred over black and white imagery at all scales of mapping because of its utility in differentiating vegetation types, especially herbaceous and bryophyte covers.

For example, wetland mapping at 1:20,000 scale, using 1 m resolution imagery could be considered when the primary goal of mapping is compilation of a wetland inventory to support regional planning objectives. Wetland mapping at 1:5,000 scale, using imagery with =< 0.5 m resolution) wetland mapping would be more appropriate for projects designed to support public use planning, site level restoration, or active conservation management, where it is important that mapping be spatially accurate and correctly identify wetland characteristics that will inform development of the plans. Higher resolution imagery can always be used to complete project mapping at less detailed scaled (e.g. <0.5 m resolution could be used for a 1:20,000 scale project). But coarser resolution should not be for a more detailed wetland mapping project (e.g. imagery with resolution >0.5m should not be used when mapping at 1:5,000).

Digital mapping programs allow the mapper to change scales during mapping, which allows the mapper to see and map greater detail on the imagery. However, there are limitations in interpreting and mapping that are inherent in imagery resolution that should be considered when using digital zoom. Table 3-1 provides guidelines for using digital zoom for mappers.

Table 3-1. Recommended scale, digital zoom, and polygon size for wetland mapping.

Available Resolution of Imagery (m)	Project Mapping Scale	Recommended Zoom Scale	Detailed Polygon Zoom Scale	Recommended Minimum Polygon Size (ha)	Recommended Minimum Feature Width (m)
=< 0.5	1:5,000	1:2,500	1:2,000	0.1	5
~ 0.5	1:10,000	1:5,000	1:4,000	0.5-1*	10*
=< 1.0	1:20,000	1:10,000	1:7,000	2.0*	20*

**RISC 2023*

3.3 Imagery Age and Season

The age of imagery is an important consideration, particularly for riverine systems subject to change. Recent imagery should be preferred; imagery greater than 10 years old should be avoided.

Exceptions to this include areas where limited change to wetland extent and class is expected (hydrologically less active areas such as isolated bogs that have not been subject to disturbance). Older imagery can be verified by comparing this to new online imagery such as Google Earth™, BING™, or ESRI Base Map™ data to determine if the older imagery accurately represents the current conditions. Where the age of imagery is difficult to determine, ERSI has a website that provides a digital archive of world imagery created over time that is useful for identifying imagery back to 2014 [World Imagery Wayback (arcgis.com)].

Figure 3-1 to Figure 3-4 show the same area in the Wilmer Unit of the Columbia NWA. The figures are shown (clockwise starting with Figure 3-1) from May (two images, different years), July, and September. The wetland complex here is connected to the Columbia River through a narrow channel that allows flooding annually. From September to May, the marshes, fens, and exposed sediments wetland units are identifiable as they are not flooded. During flooding, these areas are inundated and appear as shallow water wetlands. This annual change in extent of open water makes wetland mapping difficult. In addition, interannual differences in timing and flooding extent occur based on annual differences in snowpack, rainfall, and temperature.

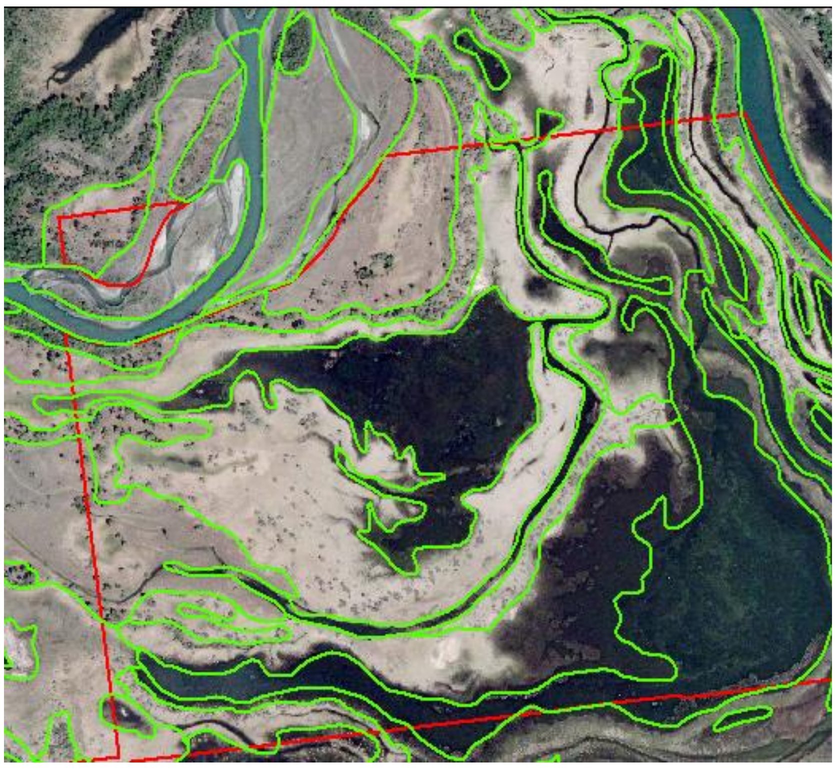

Figure 3-1. The annual differences between this figure (May 2012) and Figure 3-2 (May 2022) show how interannual differences in the timing and extent of flooding can alter the interpretation of wetland class. Date 5/27/2012 (Orthophoto).

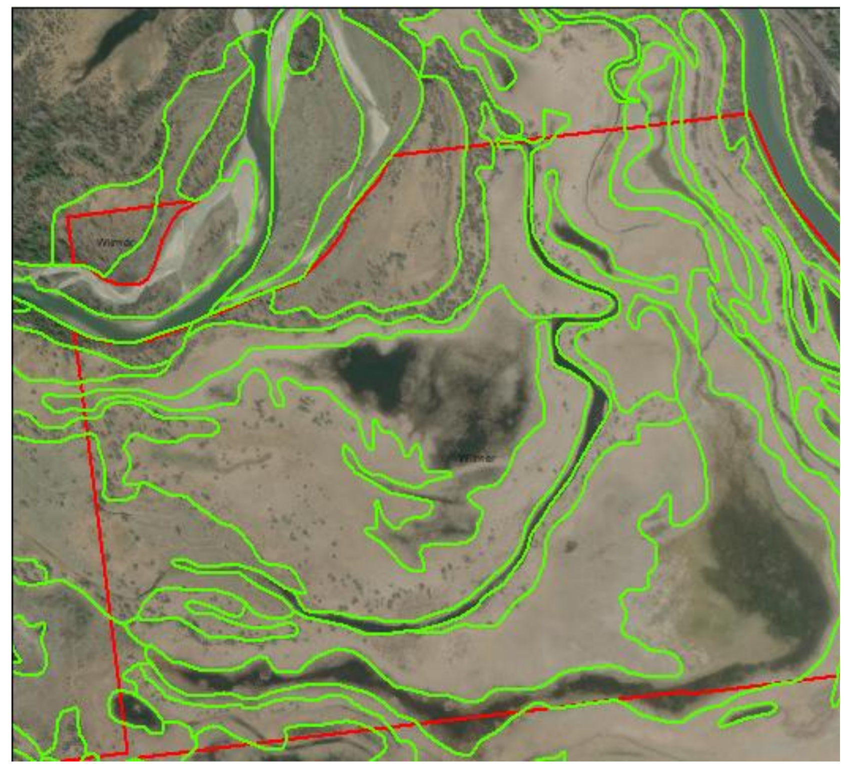

Figure 3-2. In Figure 3-1, shallow open water wetlands appear much more abundant due to flooding. Figure 3-3 is a more extreme example of how seasonally different imagery can influence wetland mapping. Date 5/8/2022 (ESRI Base Map).

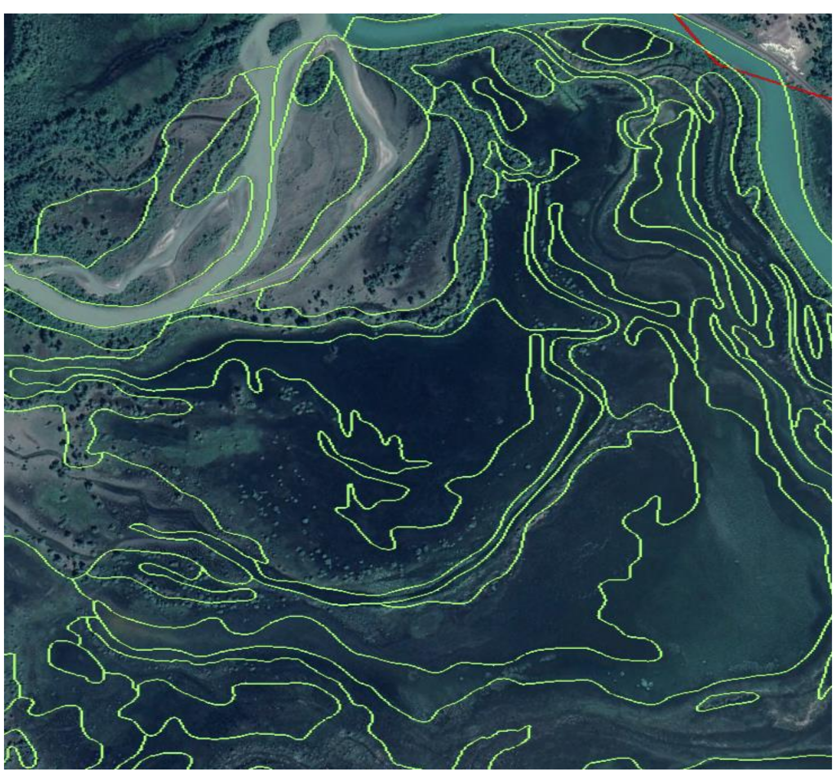

Figure 3-3. This orthophoto taken in July 2020 shows inundation of most of the wetland complex due to flooding associated with the Columbia River. Date 7/25/2020 (Google Earth).

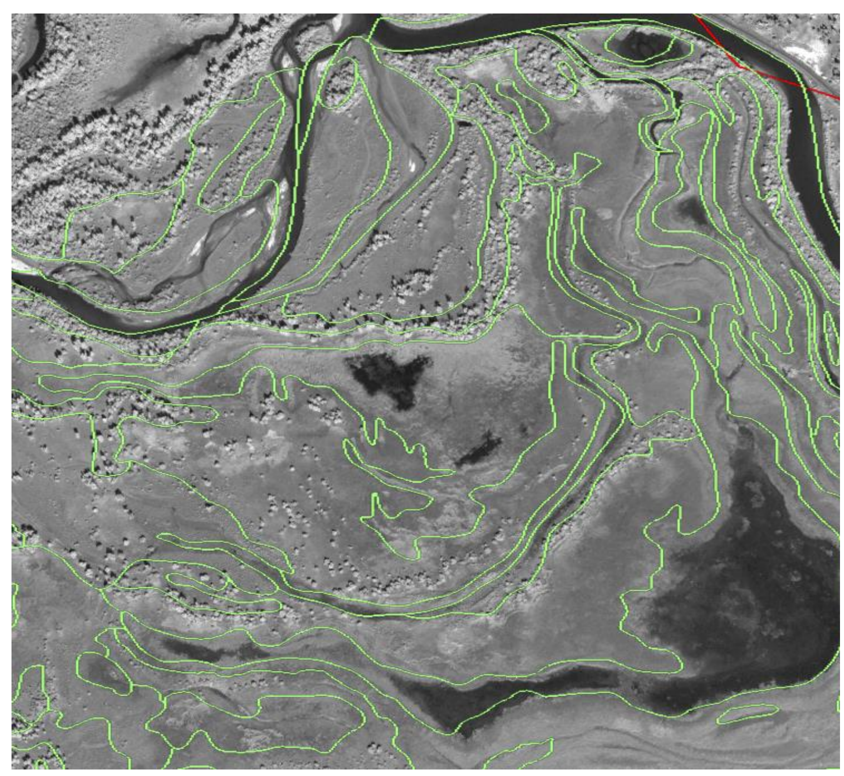

Figure 3-4. This September 2008 orthophoto exemplifies the hydrologic connectivity between the wetland complex and the Columbia River and how wetland water levels are affected by river levels. Date 9/14/2008 (Google Earth).

3.4 Other Spatial Data

3.4.1 Terrestrial Ecosystem Inventory Data

Terrestrial Ecosystem Inventory (TEI) data is administered by the Geospatial and Ecosystem Services Branch, within the Province of BC's Ministry of Water, Land and Resource Stewardship (WLRS).

TEI includes inventory, mapping, and modeling of terrestrial ecosystems, soils, terrain, habitat, and species. TEI includes Terrestrial Ecosystem Mapping (TEM), Predictive Ecosystem Mapping (PEM), Sensitive Ecosystem Inventory (SEI), terrain mapping, soils survey, Wildlife Habitat Ratings (WHR) mapping, wetland mapping (WET), and other related inventory and mapping. Resource Inventory Steering Committee (RISC) provides standards that describe how data must be provided. TEI inventories result in the delineation of a landscape into polygons, based on characteristics such as climate, physiography, surficial material, bedrock geology, soil, and vegetation (RIC 1998, 2006; BC MOFR & BC MOE 2023). TEM, SEI and WET inventories can often be used to create wetland inventories and mapping, depending on their scale and objectives.

The CNWI incorporates suitable TEI datasets into the national inventory through close consultation and engagement with WRLS representatives from the Province of BC.

Sources

Terrestrial Ecosystem Information System (TEIS) data is accessible through DataBC:

Index of /esd/distdata/ecosystems/TEI/TEI_Data (gov.bc.ca)

3.4.2 Freshwater Atlas

The Freshwater Atlas (FWA) is a spatial dataset containing hydrological features in BC. The FWA defines watershed boundaries and provides a connected network of streams, lakes, and wetlands. The FWA streams and hydrology layer is quite helpful for mappers to understand regional hydrology patterns and identify potential wetland locations and boundaries. The streams layers should always be consulted when completing wetland mapping from imagery for the CNWI.

The FWA wetland layer does not distinguish wetland class and the spatial accuracy is based on 1:20,000 mapping scale. The spatial accuracy of FWA wetlands is variable and is more accurate for wetlands with easily interpretable boundaries such as shallow water wetlands, marshes, and certain fens and less accurate for forested bogs and swamps. The FWA wetland layer is useful for identifying potential wetland locations to guide mapping effort but should not be used as an authoritative resource for determining wetland boundary or presence.

The FWA can be downloaded for the entire province at no cost from:

ftp://ftp.geobc.gov.bc.ca/sections/outgoing/bmgs/FWA_Public/

3.4.3 Vegetation Resource Inventory

Vegetation Resource Inventory (VRI) is a vegetation inventory that provides spatial data on vegetation cover in BC including tree species, ages, heights, crown closure, etc. The VRI consists of polygon delineation and estimation through photo interpretation, ground sampling, statistical adjustment methods designed to estimate overall population totals and averages for some timber and non-timber attributes, and polygon averages and totals.

VRI can be useful in wetland mapping in providing additional information to assess cover class, particularly in forested wetlands to determine characteristics such as tree species composition and age.

Sources

VRI can be downloaded from the BC government *Data Catalogue* at the following link provides information on digital orthophotos available from the *Base Map Online Store* in BC:

Data Catalogue (gov.bc.ca)

3.4.4 Terrain Resource Information Management Data

Terrain Resource Information Management (TRIM) is the base cartographic data for the Province of British Columbia. TRIM contains 3D digital files that are used in the development and management of land-related information.

TRIM positional data includes cartographic base data such as contours, water bodies, roads, and railways. Minimal attribute data is available. TRIM positional data is useful for helping understand watercourse locations in relation to wetlands as well as providing information to construct maps.

TRIM includes a Digital Elevation Model (DEM) geospatial file with elevation points and breaklines. DEM can be derived from Light Detection and Ranging (LiDAR) but is commonly acquired from the province as part of TRIM data managed by GeoBC. The provincial DEM is only accurate to 25 m and is not useful for creating "hillshade" (shaded topographic maps), but it is required to provide Z-axis values in photogrammetry programs and can be used for modelling. To use DEM from TRIM to create surface files such as TIN for use in photogrammetry programs like Purview, both the DEM points and breaklines are required. The TRIM DEM and the point cloud and breaklines are available for the entire province but must be requested through a government representative.

DEM derived from LiDAR is much more accurate than TRIM DEM and is discussed in the next section.

Sources

The TRIM DEM points and breaklines must be provided by a government representative. TRIM DEM (25 m resolution) can downloaded by 1:20,000 BCGS mapsheet for $200 per mapsheet through the *Base Map Online Store* through the following link:

Base Map Online Store - Province of British Columbia (gov.bc.ca)

TRIM positional data can searched and downloaded by 1:20,000 BCGS mapsheet for $200 per mapsheet through the *Base Map Online Store* through the following link:

TRIM Positional Data - Province of British Columbia (gov.bc.ca)

For additional assistance GeoBC should be contacted.

GeoBC Email: GeoBCInfo@gov.bc.ca

3.4.5 LiDAR

Light Detection and Ranging (LiDAR) is typically collected from planes, helicopters or unmanned aerial vehicles (UAVs, drones). LiDAR is created using a laser to measure the distance to the ground and/or vegetation surfaces. Laser pulses create LiDAR data that is collated in a "point cloud" that represents physical features of the earth in 3D. Then LiDAR are combined with other data recorded by the airborne system to create a 3D model of the ground (and vegetation if collected) surfaces.

. . This 3D model of the ground (or vegetation surface) allows for the accurate delineation of topographic features, especially when mapping floodplain swamps and marshes. Depending on the data collected when the LiDAR was completed, it can also be used to identify vegetation height and structural stage.

LiDAR data can be very useful in conjunction with stereo imagery, drone imagery, or orthophotos LiDAR must be processed using GIS software for the desired end use such as creation of a Digital Elevation Model (DEM) (described below) and hillshade (2D shading showing relief).

DEM from LiDAR is useful for mapping wetlands as it high enough resolution and quality to create "hillshade" (shaded topographic maps), that helps in the interpretation of surficial material and disturbances (e.g., organic soils and flooding), but it must be used in conjunction with imagery to allow the user to interpret vegetation patterns and ecosystem characteristics.

Sources

LidarBC is an initiative to provide open public access to LiDAR and associated datasets collected by the Government of British Columbia. Available LiDAR can be identified and downloaded from:

LidarBC - Download and Discovery | LidarBC (gov.bc.ca)

4. Initial Mapping & Delineation

4.1 Spatial Software

Mapping requires a GIS program such as ESRI ArcMap, ArcGIS Pro, or QGIS. As previously mentioned, supplementary photogrammetry programs such Summit Evolution, Purview, or ESRI ArcGIS Image Analyst are required if air photos must be used in to work in a 3D format.

The following sections provide a summary of the mapping process including drawing boundaries quality control and spatial clean up, and initial attributing. It does not include a description of the final classification and attributing process, see Section 6 for a brief overview.

4.2 Project Extent and Scale

Wetland mapping usually begins with a compilation of data in a GIS program including study area boundary, imagery, and other spatial data described in Section 2.1.

Polygon delineation can occur before or after field work has been completed. Often, completing polygon delineation prior to field work is helpful (if time, project schedules and budgets allow), as it creates a hypothesis of wetland location and helps to inform the field sampling program. If it is completed prior to field work, there are typically revisions completed to the polygon boundaries based on observations and data collected during field work, see Section 6.

Project Extent

While study areas typically represent areas such as parks, conservation areas, ownership, or other jurisdictional boundaries, mapping should extend beyond the study area boundaries and not be artificially clipped to the boundary (Figure 4-1). Wetlands that extend outside the study area boundaries should be mapped to their full extent to help guide conservation planning.

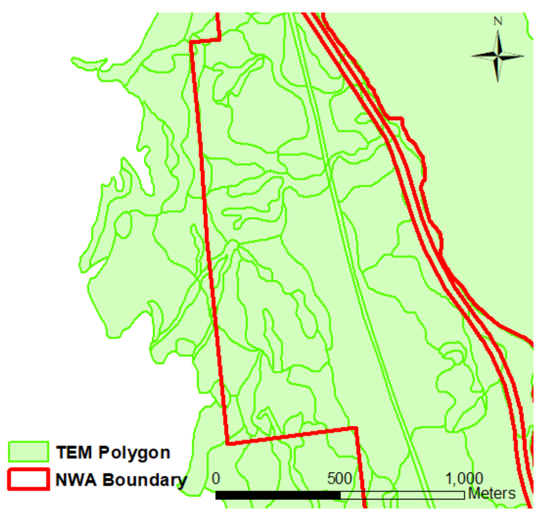

Figure 4-1. Vaseux Bighorn TEM provides and example of how mapping boundaries must extend past the study area boundaries based on natural ecological boundaries..

While there may be limitations on field sampling due to jurisdictional boundaries or ownership, mapping can extend across these boundaries but without field confirmation. Ensuring that mapping extends beyond study area boundaries is particularly important for wetlands due to hydrologic connectivity and conservation concerns that are not demarcated by artificial boundaries.

The exception to this could be when wetland mapping is being conducted for large study areas, in these cases, it may be appropriate to only map wetland extent and exclude non-wetland ecosystem types; however, when the non-wetland ecosystem occur within the matrix of a wetland (e.g., forested 'island' of upland areas within a large wetland complex), the non-wetland ecosystems should be mapped with boundaries based on changes in CNWI surface cover.

Scale

Wetland mapping should be conducted at a scale of 1:5,000 to 1:10,000 with a minimum mapping unit of 0.1 to 1.0 ha to capture small features such as shallow open water wetlands.

The mapper should be cognizant of the inherent difficulties associated with being able to zoom in using digital imagery. It is easy to shift to scales of less than 1:1,000 to capture more detail, but care should be taken to keep to mapping at the stated map scale. A good practice is to use zoom primarily to confirm ecosystem attributes and to limit the zoom used to delineate boundaries to the recommended scales (Table 3-1) so that the mapping is completed at or close to the stated scale, and only mapped using imagery with an appropriate resolution for the scale of the project (Table 3-1).

4.3 Drawing Boundaries

The actual delineation of wetland boundary lines is based on CNWI wetland class and CNWI surface cover. Wetland classes (such as shallow open water, swamps, bogs, and fens) can include multiple types of surface cover (e.g., treed and shrub swamps; shrub and bryophyte bogs; open water, shrub and herbaceous fens).

The process of drawing boundaries to discern differences in wetland class and surface cover class is done concurrently. For example, drawing boundaries for a swamp consisting of treed and shrub surface cover classes delineate the treed and shrub surface covers of the swamp as two separate polygons.

Non-wetland areas are also delineated based on the surface cover classes (e.g., treed upland areas and herbaceous agricultural fields).

While wetland class and surface cover two most easily discernable attributes from the CNWI BS Supplement, other attributes may be used to delineate polygon boundaries such as permafrost, nutrients, soil, woody vegetation canopy cover, woody vegetation height, woody vegetation type, and herb type. These attributes are much more difficult to interpret using imagery and often require field confirmation to assist in refining mapping products.

4.4 Initial Classification

The final polygon spatial file should be delivered using the CNWI BC Supplement as the standardized attribute table with coded fields and domains within the ESRI gdb spatial file. When mapping has been completed for multiple study areas (e.g., individual conservation areas), separate feature classes should be delivered for each study area.

The following CWNI BC fields (ECCC 2024a) must be completed in the submitted product:

- Source Title,
- Source Org, and
- Feature Created Date (when the polygon was created)
- Identification of polygons as wetland or non-wetland
- Hectare
- Shape Length
- Shape Area

The remaining fields in the CNWI BC Supplement (ECCC 2024a) will beattributed after field work, when final polygon classification is completed.

4.5 Quality Control and Spatial Clean Up

In quality control, topology rules should be implemented and enforced using the standard tools available in GIS software. Gaps should not exist between polygons in the dataset except for gap areas that have not been mapped (e.g., private land). Each feature in a feature class must be a single part polygon with no overlap (slivers) with adjacent polygons or gaps. Quality control will identify and correct errors including geometry, self-intersections, invalid features, multipart and overlapping features, and missing/empty geometry.

A review of the spatial data should be conducted to confirm that:

- geometry errors have been resolved;
- coordinate system is correct; and
- mandatory fields are complete.

A final visual review should be completed by the mapper using imagery to check that the wetland polygon boundaries and attributes are correct and match what is visible on the imagery.

For final delivery, the spatial data must adhere to the following specifications:

- Format: ESRI File Geodatabase (gdb) version 10.0 or higher;
- Coordinate system: BC Environment Albers Projection (see Coordinate System section below for details);

- Single part polygons; and
- Topologically correct (i.e., no null geometry, slivers, or gaps).

In the BC Environment Albers projection, locations are stored in projected coordinates (i.e., the map is projected on a two-dimensional grid, rather than a 3D globe) that specify northing, easting and elevation. Northing and easting are stored in meters.

The parameters of the BC Environment Albers projection are as follows:

- **Projection**: Albers
- **Units:** Meter (stored without offsets, e.g., in direct Albers projection coordinates)
- **Datum:** NAD83 (GRS80) - North American Datum 1983, with earth-centered ellipsoid derived from Geodetic Reference System 1980
- **Central Meridian:** 126° 00' 00" West Longitude (-126.0)
- **First Standard Parallel:** 50° 00' 00" North Latitude (50.0)
- **Second Standard Parallel:** 58° 30' 00" North Latitude (58.5)
- **Latitude of Projection Origin:** 45° 00' 00" North Latitude (45.0)
- False northing: 0.0 m
- False easting: 1000000.0 m

4.6 Metadata

Metadata must be provided for each mapping project that is delivered (ECCC 2024a). Metadata can be submitted as an excel spreadsheet as part of project deliverables.

Each BC CNWI dataset included in the CNWI geodatabase will have accompanying metadata broadly grouped into three categories:

1. Information about the objective of inventory, wetland classification system, partnering organizations and data ownership, and contact details;
2. Documenting the mapping methodology, minimum mapping unit, and information about imagery use (resolution, scale, type, season and age); and
3. Wetland classification accuracy and validation details.

5. Field Validation

Creation of the preliminary wetland polygons will assist in field planning and determination of sampling locations and survey intensity level.

5.1 Field Work and Timing

Field work should be completed prior to final classification wetland polygons according the newest CNWI BC Supplement (V12 currently; ECCC 2024a). Field validation should be conducted according to CWS guidance, standards, and forms between May to September during the growing season The CNWI in BC uses a three-level system for characterizing field data Quantitative Ground Plots, Qualitative Ground Plots, and Air Based Qualitative Plots.

See CNWI BC Supplement V12 (or most recent) for full details on plot types, survey level intensity level and scenario examples of different field programs (ECCC 2024a).

6. Final Classification

Final attribution of all fields in the CNWI BC Supplement polygon product should occur after all field plot validation has been completed. This is an opportunistic time to re-draw ecosystem and wetland boundaries based on field validation results. This is also the stage where all wetland polygons (even those without field validation) are attributed, based on the results of field plots in a subset of the polygons. The final mapping polygon product should be submitted in the CNWI BC Supplement standard, using the standardized pre-coded domains and definitions described in the CNWI BC Supplement (ECCC 2024a). A template polygon spatial file (.gdb) with the pre-coded fields and domains is available from CWS Pacific.

7. Appendix A: Wetland Class Examples

The following sections provide the definitions of the CNWI BC wetland classes and some representative photos and orthophotos.

7.1 Bog

A wetland typically with >40cm surficial organic horizon where bryophytes (typically *Sphagnum* moss) dominate the ground cover and are often co-occurring with lichens and ericaceous shrubs and trees (often black spruce trees).

Bogs are ombrogenous (typically receive water inputs from precipitation, fog, snow melt only) with the water table at or slightly below the surface for all or most of the year. The land surface is raised or level with the surrounding terrain. Water is low in dissolved minerals and generally acidic (ranging from pH 4.0-4.8).

In BC, bog typical dominant organic soil texture in the top 40 cm is fibric organics (Von Post 1-4).

Where there are deciles in a BC polygon, cross-walked bog site associations must sum to be greater than or equal to 0.8 (80%).

Figure 7-1. Bog along the margins of a suspected shallow open water wetland grading to (possibly) a fen by the contiguous treeline (Iskut; ICHwc; See Acronyms for BGC unit names).

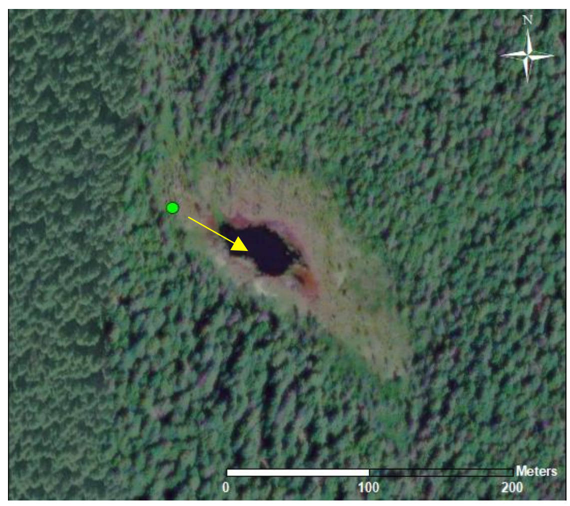

Figure 7-2. The slightly red margins of the bog are distinguishable, and the treed/shrub dominated margins have a rougher texture on the image (Iskut; ICHwc).

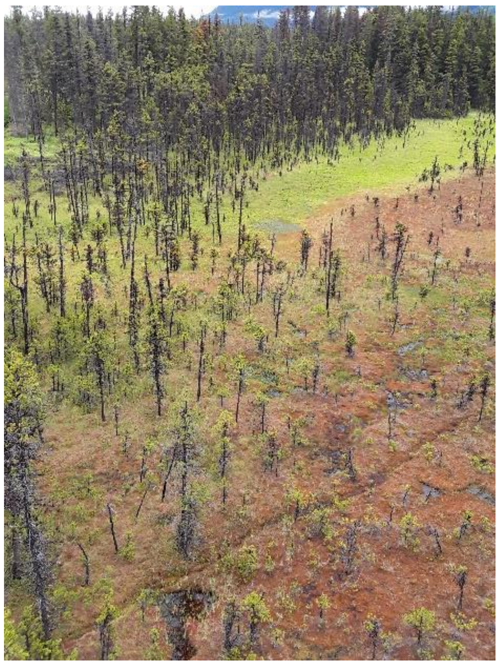

Figure 7-3. Bog in the foreground with typical red colouration and a lighter green fen in the background. Tree species are a mix of black spruce and lodgepole pine (Iskut; ICHwc).

Figure 7-4. The bog is darker in appearance than adjacent areas. The fen appears smoother and greener than adjacent upland areas which are clearcuts. Scattered trees are visible to the west of the photo point (Iskut; ICHwc).

Figure 7-5. Shrubby bog with shallow open water. Tufted clubrush, prostrate yellow cedar, and juniper are common. (Haida Gwaii; CWHwh1).

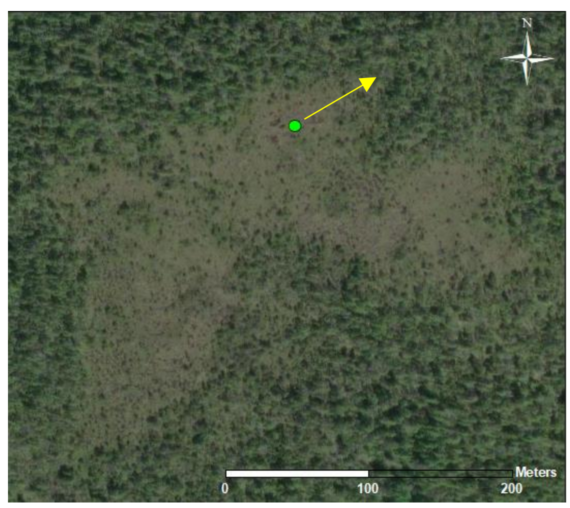

Figure 7-6. The shrubs and short trees are difficult to discern due to poor image quality (Haida Gwaii; CWHwh1).

Figure 7-7. Extensive bog complex with coniferous shrubs, sphagnum, and shallow open water (Haida Gwaii; CWHwh1).

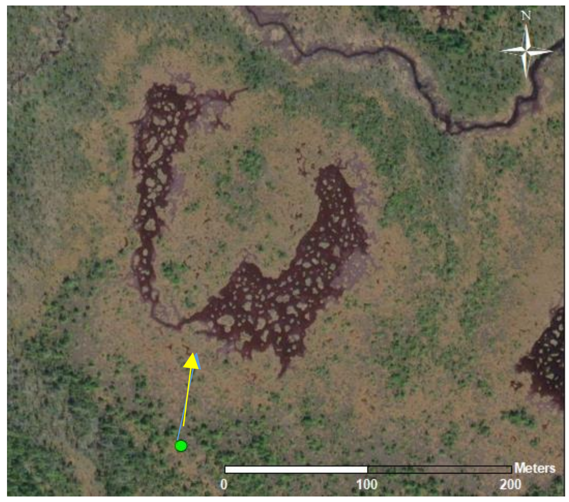

Figure 7-8. Shrubs are discernable as darker green patches, whereas sphagnum dominated areas appear as a smoother, tan colour. The shallow open water may not be present after extended summer drought (Haida Gwaii; CWHwh1).

Figure 7-9. Bog located on stabilized beach deposits. Shrub cover typically increases along the forested margins (Haida Gwaii; CWHwh1).

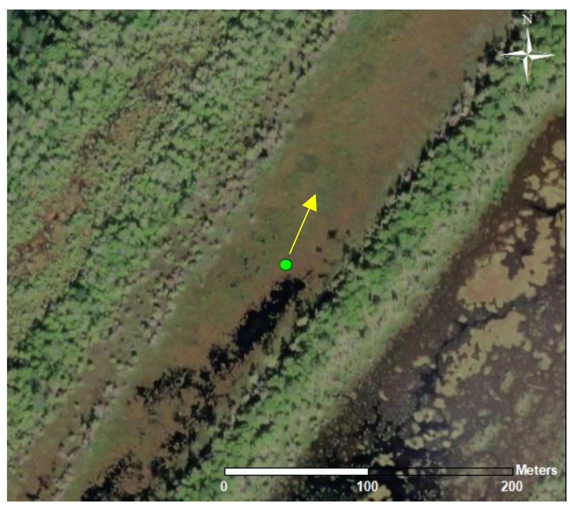

Figure 7-10. Note the smooth appearance of the sphagnum and herb dominated areas versus the lighter green, more textured margins along the forested edges (Haida Gwaii; CWHwh1).

Figure 7-11. Myrica gale bog with sedge species (Widgeon NWA; CWHdm).

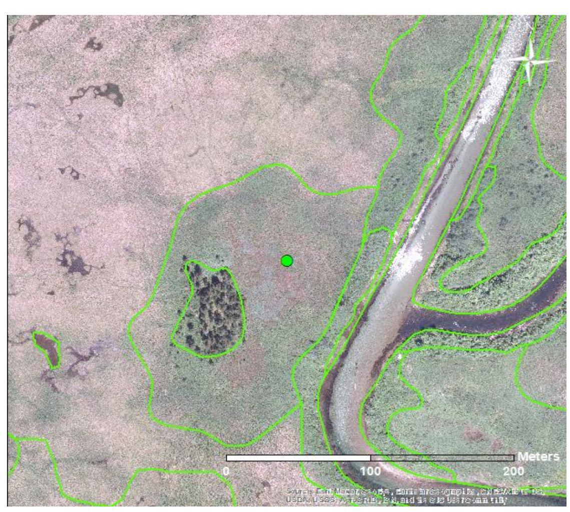

Figure 7-12. The colour of the shrub dominated bog was used to differentiate it from the adjacent fen (light colour area) and small forested bog to the west. Swamp wetland class occurs adjacent to the river and floods due to the proximity to the river (Widgeon NWA; CWHdm).

7.2 Fen

A wetland typically with >40cm surficial organic horizon where bryophytes and/or graminoids dominate ground cover. Fens are minerogenous (receiving water inputs from precipitation, surface water, runoff, and groundwater). Water flows through fens can create different fen surface characteristics (e.g., patterning, and open water pooling). Fen surface cover can be water, herbaceous, bryophyte, shrubby, or treed. Nutrient rich fens have a pH generally >5.5; poor fens have a pH <5.5.

In BC fens typically have a dominant organic soil texture in the top 40 cm of fibric/mesic organics (Von Post 1-6).

Where there are deciles in a BC polygon, cross-walked fen site associations must sum to be greater than or equal to 0.8 (80%).

Figure 7-13. Sedge fen with shrubs. Note the sedges are in water (Dease Lake; SWBmks).

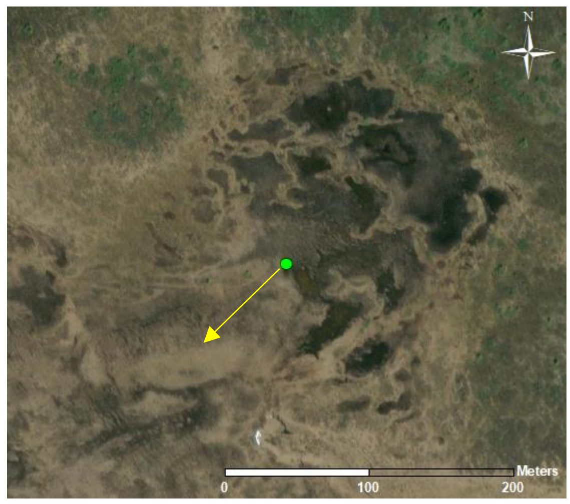

Figure 7-14. This imagery shows much of the area innundated with water (dark areas) in contrast to the photo taken mid-summer. The tan coloured areas are sedge dominated fen and the darker areas or inundated fen (Dease Lake; SWBmks).

Figure 7-15. Fen located on the margins of a slow moving creek. Note the colour of the sedges as the photo was taken in mid-September (Haida Gwaii; CWHwh1).

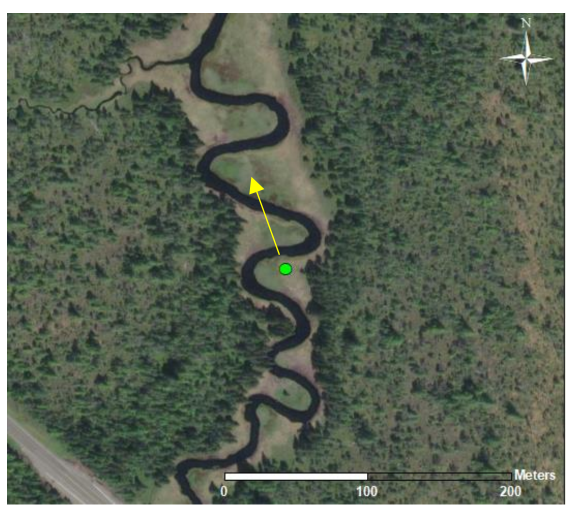

Figure 7-16. Colour differences may occur between vegetation observed during field visits and imagery due to seasonal differences (Haida Gwaii; CWHwh1).

7.3 Swamp

Wetland area with >25% woody vegetation canopy coverage on mineral soils (<40cm surficial organic horizon) or organic soils (>40cm surficial organic horizon). It includes coniferous, deciduous, mixed wood, and shrub swamps. Periodic or persistent surface water may occur with water levels that can fluctuate seasonally and annually.

In BC organic soil swamps have a typical dominant organic soil texture in the top 40 cm is humic organics (Von Post 7-10). Swamps can also occur on mineral soils (where there is <40cm organic soil of any type [humic, fibric, mesic] in the surficial organic horizon).

Where there are deciles in a BC polygon, cross-walked swamp site associations must sum to be greater than or equal to 0.8 (80%).

Figure 7-17. Willow based swamps are common adjacent to fluvial units and may include floodplains (Unuk River; ESSFun).

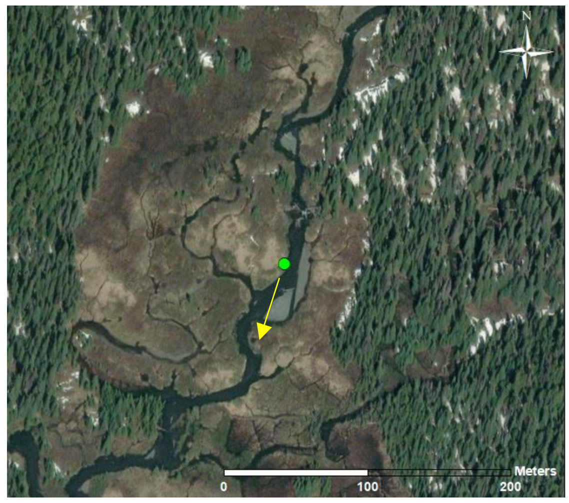

Figure 7-18. The willows appear brown in this image as it was taken shortly after snowmelt. Graminoid dominated areas are visible and appear as a tan colour (Unuk River; ESSFun).

Figure 7-19. Wetland swamp with willow and alder species located adjacent to the Columbia River. The swamp floods annually during high water (Columbia NWA; IDFdk5).

Figure 7-20. The dark colour and mixed density of shrubs interspersed with grasses contrasts with the adjacent tan coloured areas that are primarily marshes. The green lines are Terrestrial Ecosystem Mapping (TEM) boundaries (Columbia NWA; IDFdk5).

Figure 7-21. Willow and alder species (shrub cover class) intermixed with grasses. Upland forest is visible in the background of the photo (Columbia NWA; IDFdk5).

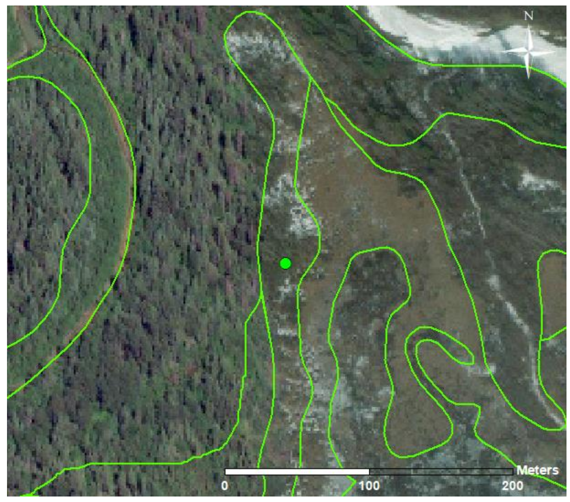

Figure 7-22. The imagery shows snow on the ground in the open gaps that are likely dominated by grasses. Forested upland is visible to the west of the photo point and marsh occurs to the east (Columbia NWA; IDFdk5).

Figure 7-23. Dense shrub and tree cover located in a localized, linear swamp (Vaseux-Bighorn NWA; PPxh1).

Figure 7-24. The photo point occurs between talus slopes and a road to the west and meadows that were historically used for agricultural purposes but were likely marshes prior to ditches and dams were established (Vaseux-Bighorn NWA; PPxh1).

7.4 Marsh

Wetland area dominated by herbaceous vegetation (i.e., emergent, graminoids, forbs) covering >25% of the surface area. Shrubs and trees canopy cover <25% of the surface area. Vegetation can occur randomly across a marsh or can be arranged in distinct zones of parallel or concentric patterns in response to gradients of water depths, frequency of drawdowns, water chemistry or disturbance. Periodic or persistent surface water may occur with water levels that can fluctuate seasonally and annually.

In BC organic soil marshes the typical the dominant organic soil texture in the top 40 cm is humic organics (Von Post 7-10). Marshes can also occur on mineral soils (where there is <40cm organic soil of any type [humic, fibric, mesic] in the surficial organic horizon).

Where there are deciles in a BC polygon, cross-walked marsh site associations must sum to be greater than or equal to 0.8 (80%).

Figure 7-25. Marsh with a small creek that floods frequently. Note characteristic tall graminoid vegetation (Iskut River; ICHwc).

Figure 7-26. The colour of the marsh indicates nutrient rich conditions and in combination with the meandering stream provide clues that this is a marsh and not a fen (Iskut River; ICHwc).

Figure 7-27. This horsetail marsh occurs in an area that is seasonally inundated. The bright green colour helps distinguish it from fens which are usually lighter in colour (Columbia NWA; IDFdk5).

Figure 7-28. The season of the imagery make this marsh difficult to distinguish from a fen. Field confirmation and the use of alternative imagery is important to identify local wetland types (Columbia NWA; IDFdk5).

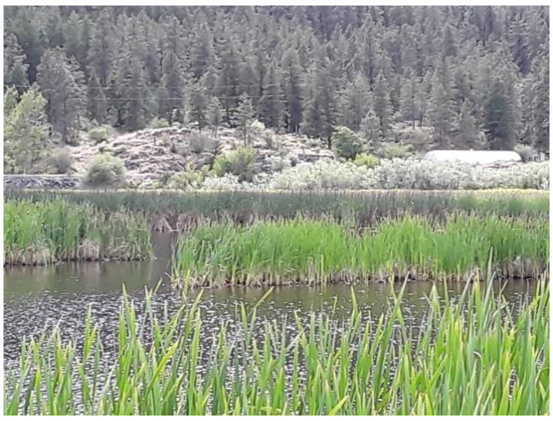

Figure 7-29. A cattail marsh with shallow open water interspersed (Vaseux-Bighorn NWA; PPxh1).

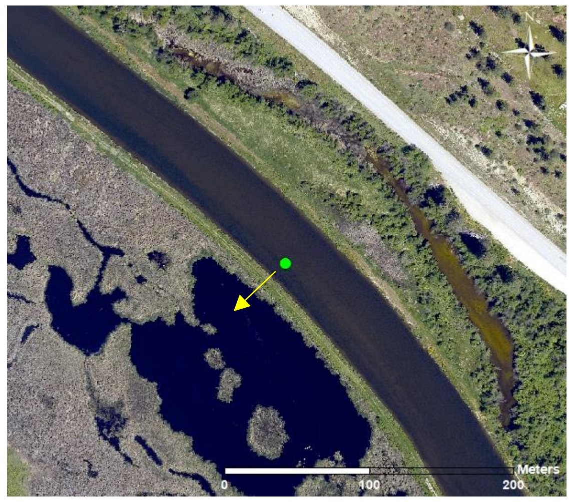

Figure 7-30. The photo was taken looking southwest from the point. Cattail marshes often have a mix of textures and colours due to the mix of last years dead vegetation and current growing season vegetation. The darker green strip adjacent to the river is a dam with a road (Vaseux-Bighorn NWA; PPxh1).

7.5 Shallow Open Water

Wetland area with standing, slow moving or flowing water present for all or most of the year. Water depth can fluctuate seasonally but is typically less than 2 m during mid-summer. Aquatic vegetation (floating or submerged plants) and eelgrass may or may not dominate shallow open water. Sediments may be exposed during a tidal cycle or low water conditions. Water and exposed sediment must cover >75% of the surface area; terrestrial vegetation (e.g., trees, shrubs, and herbs) and emergent herbaceous vegetation (e.g., cattails and bulrushes) must cover <25% of the surface area. A shallow open water wetland can be situated on deltas, floodplains, along rivers and streams, or along the margins and shores of lakes, oceans, and other open water bodies.

In BC, organic humic shallow open waters typical have a dominant organic soil texture in the top 40 cm of humic organics (Von Post 7-10). Shallow open waters can also occur on mineral soils (where there is <40cm organic soil of any type [humic, fibric, mesic] in the surficial organic horizon).

Where there are deciles in a BC polygon, cross-walked shallow open water site associations must sum to be greater than or equal to 0.8 (80%).

Figure 7-31. Shallow open water with emergent vegetation (Columbia NWA; IDFxk).

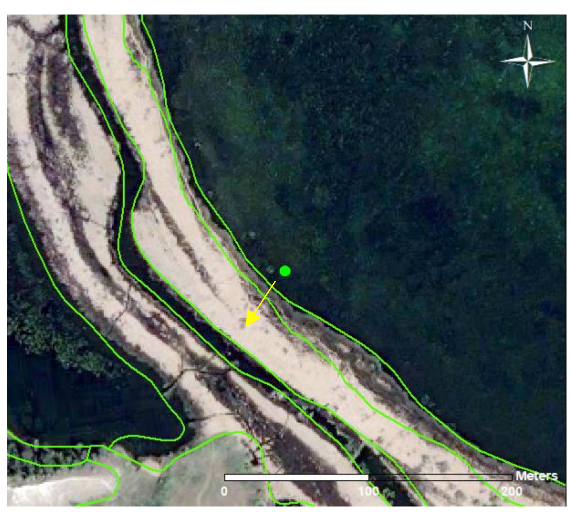

Figure 7-32. The emergent vegetation is difficult to discern but the submerged aquatic vegetation is often visible in shallow water wetlands (Columbia NWA; IDFxk).

Figure 7-33. Aquatic vegetation close to, or at, the surface is a good indicator of shallow water depths when water depth is obscured by sediment (Columbia NWA; IDFdk5).

Figure 7-34. The season of the imagery and poor resolution make identifying shallow water challenging. The mottled appearance of the water indicates it is shallow (Columbia NWA; IDFdk5).

Figure 7-35. Submersed aquatic vegetation makes this easily identifiable as a shallow open water wetland (Vaseux-Bighorn NWA; PPxh1).

Figure 7-36. It is difficult to identify this as shallow open water in the imagery given the dark colour of the water which typically indicates greater depth (Vaseux-Bighorn NWA; PPxh1).

Figure 7-37. Submersed aquatic vegetation makes this easily identifiable as a shallow open water wetland (Widgeon NWA; CWHdm).

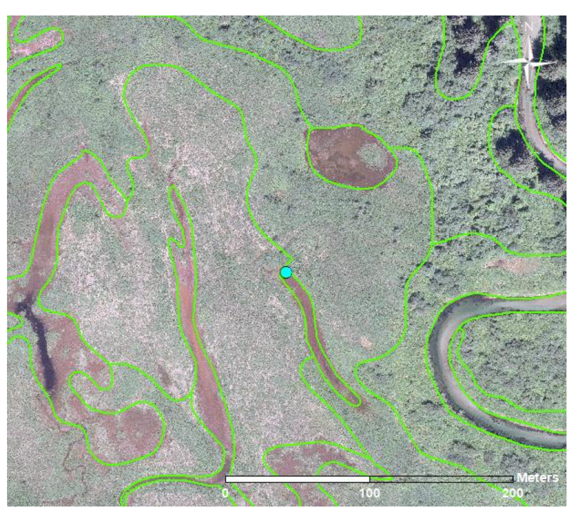

Figure 7-38. The red colour that is visible in the photo to the left is clearly visible in the aerial imagery, making it easier to identify these water features as shallow open water wetlands (Widgeon NWA; CWHdm).

7.6 Peatland

An area with (typically) >40 cm of accumulated organic matter with a surface dominated by bryophytes, graminoids, and/or brown mosses. Shrubs, trees, and open water pooling may be present.

Note: only use peatland category when it is not possible to discern a bog vs a fen from imagery. These boundaries and linework should be classified into bog vs fen after field validation.

In BC, the dominant organic soil texture in the top 40 cm of peatlands is typically fibric/mesic organics (Von Post 1-6).

Figure 7-39. A mix of bog (foreground) and fen (background by the forested upland) wetland classes (Iskut: ICHwc).

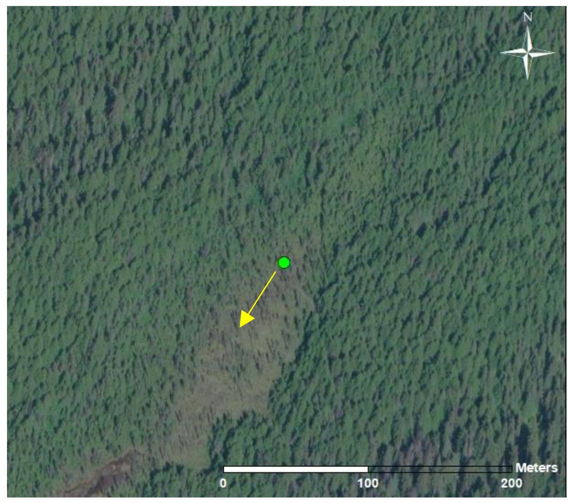

Figure 7-40. The treed areas are likely bogs while the non-tree areas are more likely fens (Iskut: ICHwc).

7.7 Mixed

Adjoining wetlands classified as 'wetland complex' or individual wetland polygons reported with two or more wetland classes in source datasets.

Note: minimize the use of the 'mixed' category by applying logic with the minimum mapping unit (0.1 ha) and 25% thresholds in the wetland class definitions (ECCC 2024a). For example:

- If there is a patch of one wetland class (e.g. shallow water), within the larger wetland class (e.g. marsh) that is >0.1ha. Then the small patch (e.g. shallow open water) should be drawn out as a separate polygon.
- A swamp has 25% woody veg cover. Therefore, if you have a marsh is some random shrubby patched in it (<25% of total cover) and those shrubby patches are not >0.1 ha, then those shrubby areas do not need to be drawn out. The whole wetland should be coded to marsh in this case.
- Similarly, a marsh has 25% herbaceous cover. Therefore, if you have a marsh with some random ponds/open water patches in it (<25% of total cover) and those individual ponds are not >0.1 ha, then those shallow open water wetlands areas do not need to be drawn out. Code it all to marsh.
- Same goes for shallow open water which has <25% above ground veg cover. If there some random patches of herbaceous or woody veg (<25% of total cover) and those individual vegetation patches are not >0.1 ha, then those patches do not get drawn out and the entire polygon gets coded to shallow open water.

Where there are deciles in a BC polygon, cross-walked wetland site associations must sum to be greater than or equal to 0.8 (80%).

7.8 Non-wetland

An area does not fit the definitions of a wetland.

7.9 Unclassified

Wetland polygons should be classified as unclassified (and un-validated) after the desktop mapping stage.

8. Appendix B: Surface Cover Examples

The follow sections provide the definitions of the CNWI BC surface cover and provide representative photos and orthophotos of most of the classes.

Surface cover ifs based on the general physiognomy of the cover rather than on species composition (ECCC 2024a).

Common wetland class and surface cover types are shown in Table 8-1 to assist in interpretation of imagery. While these relationships occur under typical conditions, mappers should be cognizant that there will be exceptions.

Table 8-1. Typical Surface Cover Types for each Wetland Class.

Wetland Class	Typical Surface Cover Types
Bog	Tree, Shrub, Bryophyte, Water
Fen	Tree, Shrub, Herbaceous, Bryophyte, Water
Swamp	Tree, Shrub
Marsh	Herbaceous
Shallow Open Water	Aquatic Vegetation, Algae, Eelgrass, Exposed Sediments, Water

8.1 Woody

The woody cover class is defined as an area with woody plants with ≥ 25% canopy cover. Used only where treed / shrub height cannot be determined, or where there is >25% canopy cover of trees and shrubs combined.

Figure 8-1. Woody surface cover class in the Columbia NWA. Tree height is both above and below 5 m in height (Columbia NWA; IDFdk5).

Figure 8-2. Example of imagery where differentiation into shrub or tree classes is not possible. The woody class varies from 2 to 10 m in height and is difficult to differentiate the treed and shrub classes. 3D imagery or Light Detection and Ranging (LiDAR) is required to accurately differentiate the classes or field data (Columbia NWA; IDFdk5).

8.2 Treed

The treed class is defined as an area with woody plants ≥ 5 m high with ≥ 25% canopy cover.

Figure 8-3. Tree surface cover swamp with a wetland species such as horsetail and skunk cabbage (Qualicum NWA; CWHxm1).

Figure 8-4. Orthophoto of the treed surface cover class. Note slight gaps in the tree canopy near the photo point. Similar conditions occur to the polygon to the east in the image. The gaps between trees also indicate the extent of forested swamp which comprises 30% of the polygon (Qualicum NWA; CWHxm1).

Figure 8-5. Tree cover is visible in the background. The foreground is herbaceous surface cover, then shrub and treed cover in the background (Widgeon NWA; CWHdm).

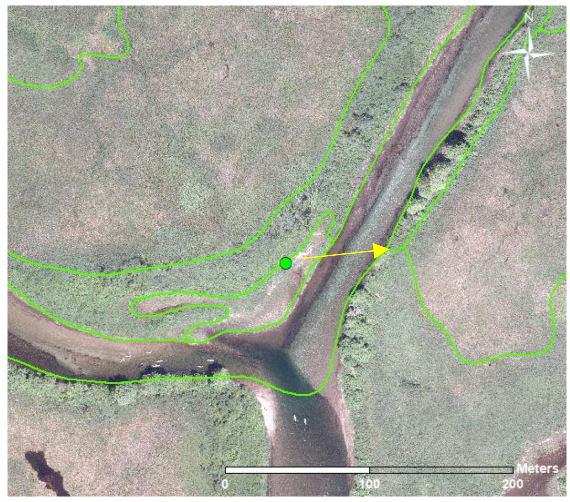

Figure 8-6. Example of imagery that allows differentiation of treed surface cover (round vegetation across the creek to the east and south of the plot, herbaceous and shrub surface cover (north as well as east across the creek) classes. (Widgeon NWA; CWHdm).

Figure 8-7. Forested swamp with a mixed canopy of red alder, western hemlock, and western redcedar (Victoria, BC; CWHxm2).

Figure 8-8. Orthophoto of treed surface cover class for the forested swamp. Note the very broken tree canopy in the image. The gaps in the tree canopy are caused by wet edaphic conditions that limit tree density and are a good clue for identifying forested swamps (Victoria, BC; CWHxm2).

8.3 Shrub

The shrub class is defined as an area where woody plants, typically less than 5 m in height, contribute ≥25% surface cover.

Figure 8-9. Shrub surface cover swamp with 50% cover of pink spirea and sedge species intermixed (Widgeon NWA; CWHdm).

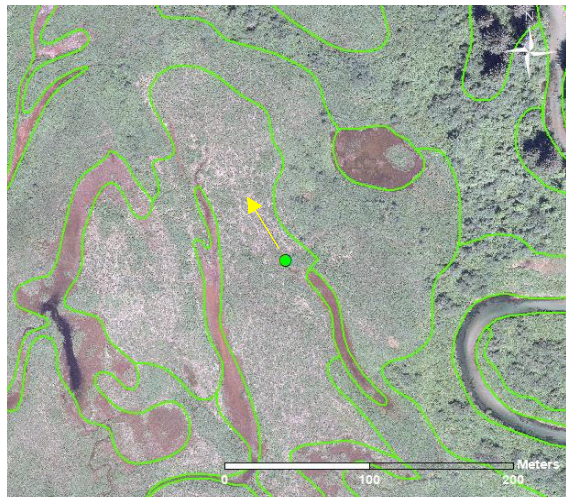

Figure 8-10. Most of the area visible in the orthophoto is shrub cover class except the dark colored polygon in the northeast corner which is treed (Widgeon NWA; CWHdm).

Figure 8-11. Shrub swamp with Myrica gale in the foreground (Widgeon NWA; CWHdm).

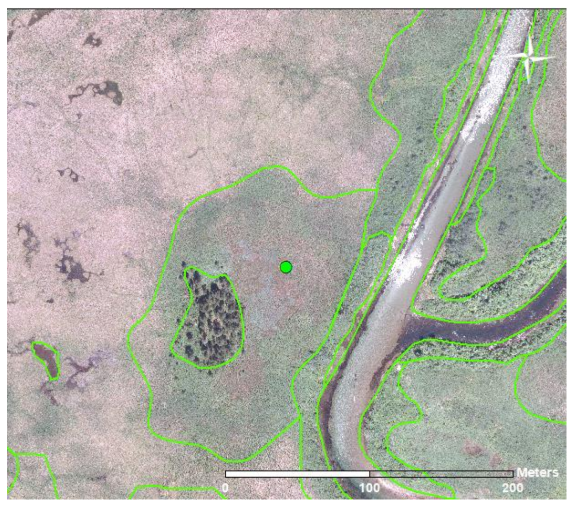

Figure 8-12. Delineation of surface cover classes uses characteristics such as colour, texture, and density to differentiate classes. Lighter colour areas with a smoother texture have greater cover of herbaceous plants than the green-coloured areas. The small dark circle is treed cover class associated with a treed bog (Widgeon NWA; CWHdm).

Figure 8-13. Shrub surface cover dominated swamp with willows and minor cover of roses in the foreground. Some of the background vegetation may be greater than 5 m in height and would be considered treed (Vaseux-Bighorn NWA; BGxh1).

Figure 8-14. The shrub surface cover class can be distinguished from the adjacent cattail herbaceous cover (gray areas) by the green colouration and coarse texture (Vaseux-Bighorn NWA; BGxh1).

8.4 Herbaceous

The herbaceous class is defined as an area where herbaceous plants contribute ≥25% surface cover and tree and shrub cover can only constitute <25% surface cover. Bryophytes and some standing water may be present. Herbaceous plants are defined as vascular plants without a woody stem, including ferns, fern allies, grasses, rushes, sedges, reeds, forbs, and grass-like plants.

Figure 8-15. Herbaceous marsh dominated by grass and sedge species (Work Channel, BC central coast; CWHvm1).

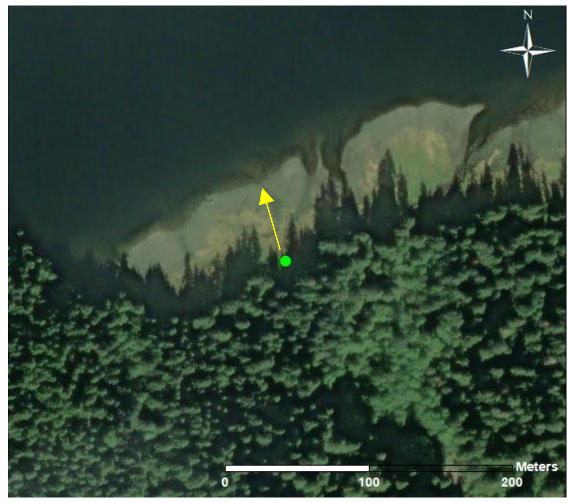

Figure 8-16. Tidal marsh with herbaceous cover. The even texture and light green colour indicate herbaceous cover. The change in colour closer to the ocean indicates a shift in species due to more frequent tidal inundation (Work Channel, BC central coast; CWHvm1).

Figure 8-17. Herbaceous surface cover class in a great bullrush marsh (Columbia NWA; IDFxk).

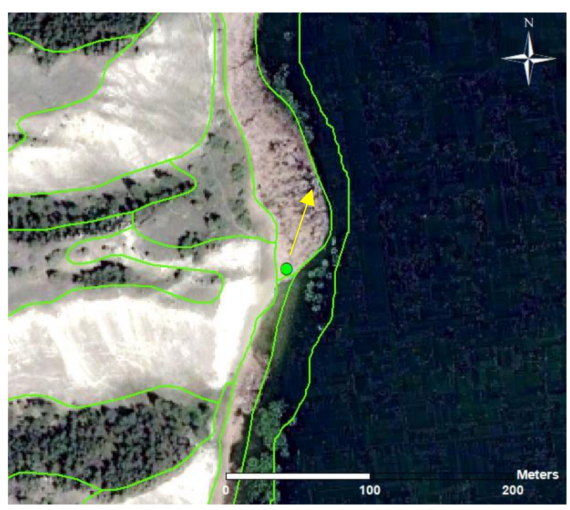

Figure 8-18. Orthophoto showing the location of the marsh in the previous photo. Light coloured areas are typically graminoid dominated however, the areas to the west are exposed sediments and grassland on steep slopes. Without contours, LiDAR, or 3D imagery, differentiating uplands and wetlands can be difficult (Columbia NWA; IDFxk).

Figure 8-19. Herbaceous cover class represented by an old field and a cattail marsh in the background visible as light-coloured strips of dead cattail (Vaseux-Bighorn NWA; BGxh1).

Figure 8-20. The old field dominated by grass species is visible as the light green area, whereas the cattail marsh appears as grey with water filled channels (Vaseux-Bighorn NWA; BGxh1).

8.5 Bryophytes and Lichens

The bryophyte class is defined as an area where bryophytes or lichens constitute ≥25% of the vegetation cover, and shrub and tree cover can only constitute <25% surface cover each. Herbaceous plants and some standing water may be present. Bryophytes include mosses, liverworts, and hornworts.

Figure 8-21. Bryophyte dominated talus slope (Vaseux-Bighorn NWA; PPxh1).

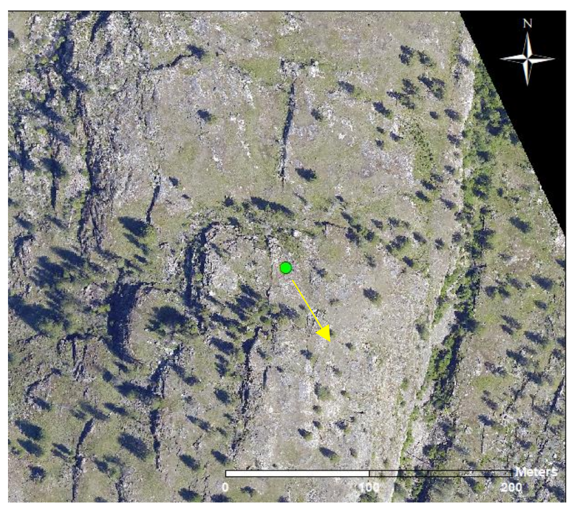

Figure 8-22. The bryophyte dominated areas are difficult to distinguish from the adjacent grasslands based on colour as (less green colour) well as soil depth. Field verification is important for correct identification of this cover class (Vaseux-Bighorn NWA; PPxh1).

Figure 8-23. Bryophyte cover class such as this sphagnum dominated area are often very spatially limited as shrubs often co-occur. The wetland changes to a shrub then forested bog in the background (Haida Gwaii; CWHwh1).

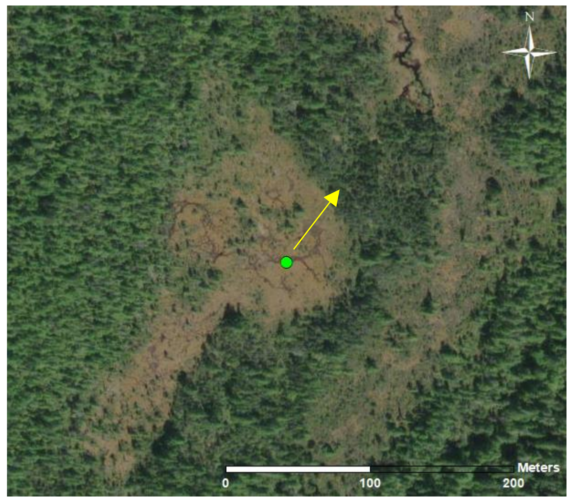

Figure 8-24. The colouration and smooth texture apparent at the photo point location are indicative of either herbaceous cover or bryophytes. Field data and local knowledge is important in correct identification of this cover class (Haida Gwaii; CWHwh1).

Figure 8-25. Red coloured areas are bryophyte surface cover class, comprised of sphagnum species. The darker areas are dominated by herbaceous species and would be classified as herbaceous cover (Iskut River, BC; ESSFwv).

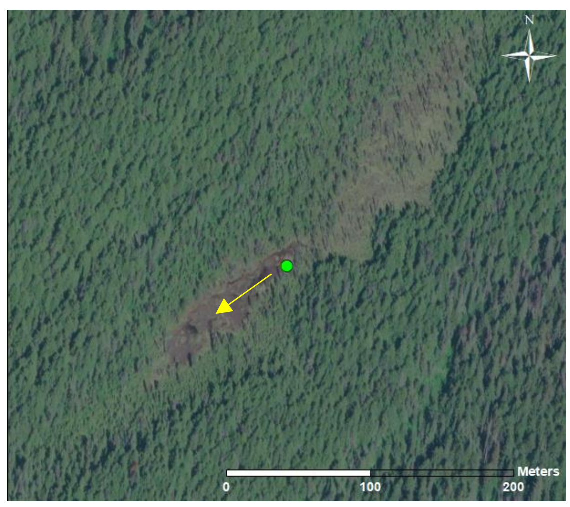

Figure 8-26. The poor quality of this imagery makes identification of the cover class difficult. Field verification is vital to correctly identifying bryophyte cover unless high resolution imagery is available (Iskut River, BC; ESSFwv).

8.6 Aquatic Vegetation

The aquatic vegetation class is defined as an: Area where aquatic vegetation dominates ≥25% of surface area. Aquatic vegetation includes floating or submerged macrophytes not including eelgrass.

Figure 8-27. Shallow open water wetland The floating vegetation is discernable in the image (Vaseux NWA, BC; BGxh1).

Figure 8-28. The dark colour of this shallow open water wetland typically indicates greater water depths than shown in the adjacent photo. This may be attributable to the time of year of the imagery (Vaseux NWA, BC; BGxh1).

Figure 8-29. Shallow open water with lily pads. These are typically very easily identifiable (Columbia NWA; IDFdk5).

Figure 8-30. The shallow open water is south of the photo point and are recognizable based on the pattern of the floating vegetation in the image (Columbia NWA; IDFdk5).

8.7 Eelgrass

The eelgrass class is defined as an: Area with marine angiosperms (eelgrass/seagrass) at densities ≥1 plant/m^2. Eelgrasses grow in soft substrates like sandy soils and form large tidal and subtidal meadows in coastal regions.

8.8 Algae

The algae class is defined as an: Area where algae dominate ≥25% of surface area.

8.9 Exposed Sediment

The exposed sediment class is defined as an: Area with exposed soil, sand, gravel, or other substrate (≤25% vegetated surface cover of any type). Note: Exposed sediments are often the result of low water conditions (drought, temporary or seasonal fluctuations) or tidal conditions.

Figure 8-31. Exposed sediment cover class located adjacent to the Columbia River (Columbia NWA; IDFdk5).

Figure 8-32. The exposed sediment cover class shown in the previous image is shown above. During spring freshet, this area is covered in water. The orthophoto above was taken during winter and illustrates how the season when imagery is collected can affect mapping (Columbia NWA; IDFdk5).

Figure 8-33. Exposed sediment cover class (Columbia NWA; IDFxk).

Figure 8-34. This orthophoto shows the location of the exposed sediment cover class show in the previous photo. In the orthophoto above, this would be mapped as shallow open water. It demonstrates that the timing and age of imagery can greatly influence mapping of some wetlands, especially those associated with larger riverine systems (Columbia NWA; IDFxk).

8.10 Exposed Bedrock

The exposed bedrock class is defined as an: Area with exposed bedrock (≤25% vegetated surface cover of any type).

Figure 8-35. Exposed bedrock in a matrix with shallow soils (Vaseux-Bighorn NWA, BC; PPxh1).

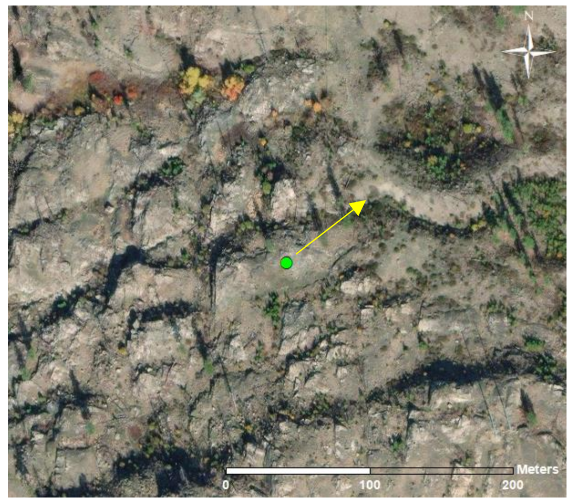

Figure 8-36. Shallow bedrock ridges are visible on the orthophoto interspersed with graminoid dominated, herbaceous cover. The exposed bedrock is the light gray areas on the orthophoto. Because of their limited spatial extent, these areas would not be individual polygons (Vaseux-Bighorn NWA, BC; PPxh1).

Figure 8-37. Exposed bedrock associated with cliffs (Vaseux-Bighorn NWA, BC; PPxh1).

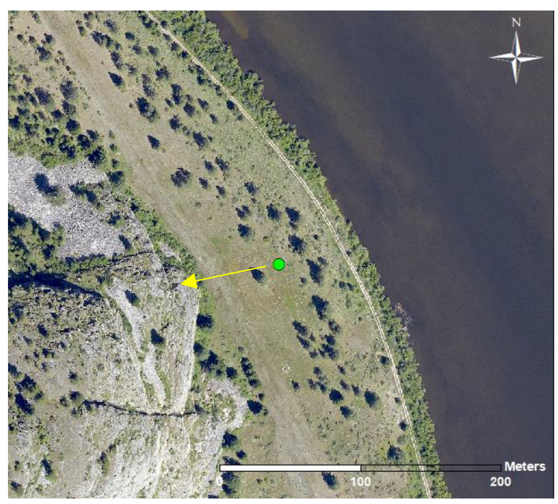

Figure 8-38. Exposed cliffs can be difficult to map because they are not visible because of the vertical nature of these features (Vaseux-Bighorn NWA, BC; PPxh1).

8.11 Water

The water class is defined as an area with open water with ≤25% vegetation cover of any kind.

Figure 8-39. Water surface cover class that is a shallow water wetland (Columbia NWA; IDFdk5).

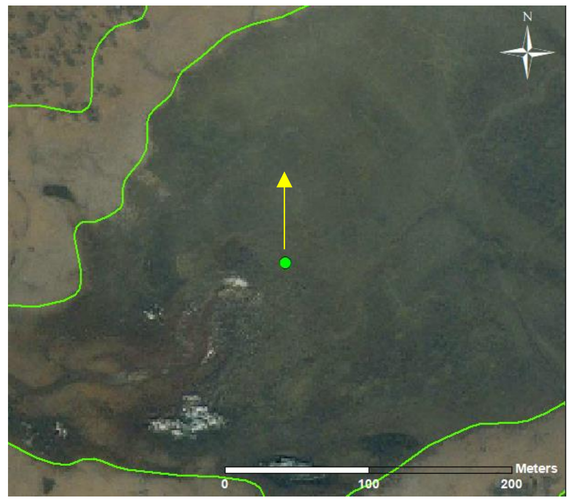

Figure 8-40. This orthophoto shows shallow open water. The vegetation and shallow depth of the water is clearly discernable based on the patterns in the image (Columbia NWA; IDFdk5).

Figure 8-41. Water associated with a lake (non-wetland) (Vaseux NWA, BC; BGxh1).

Figure 8-42. Note the dark colour and even texture of the water, indicating it is not shallow (Vaseux NWA, BC; BGxh1).

8.12 Snow/Ice

The exposed snow/ice class is defined as an: Area covered with snow, ice, glaciers >25% of surface area.

Figure 8-43. Snow/Ice cover class as represented by glaciers (Coastal mountains, BC; CMAun).

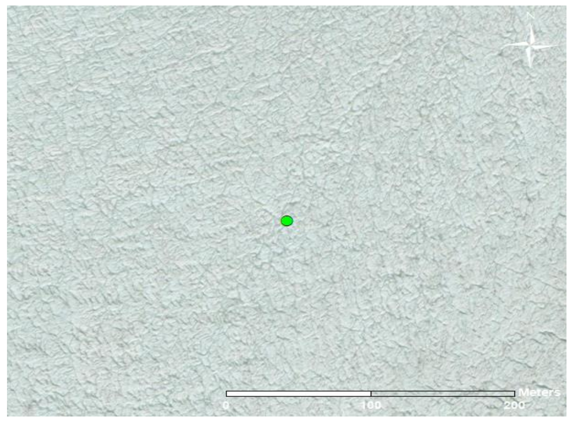

Figure 8-44. Close-up of a glacier showing the textured surface that indicate crevasses which develop from glacier movement. Snow on the glacier surface would create a smoother appearance (Coastal mountains, BC; CMAun).

8.13 Anthropogenic

The anthropogenic class is defined as an: Area with development, man-made cover, structures, roads, and/or resource extraction.

Figure 8-45. Anthropogenic cover class with a road and camping site (Vaseux-Bighorn NWA; PPxh1).

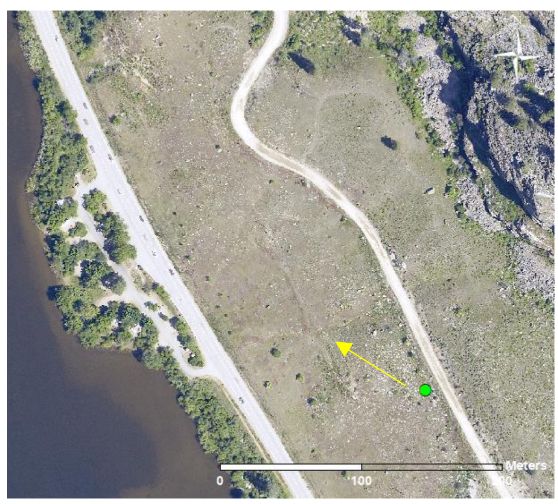

Figure 8-46. Roads and associated features are relatively easy to delineate. Care must be taken to not underestimate the anthropogenic cover due to tree canopy occluding altered areas such as pavement (Vaseux-Bighorn NWA; PPxh1).

Figure 8-47. Road surfaces are common anthropogenic features and extend to cut- and fill slopes as well as ditches and other areas altered due to construction and use (Vaseux-Bighorn NWA; PPxh1).

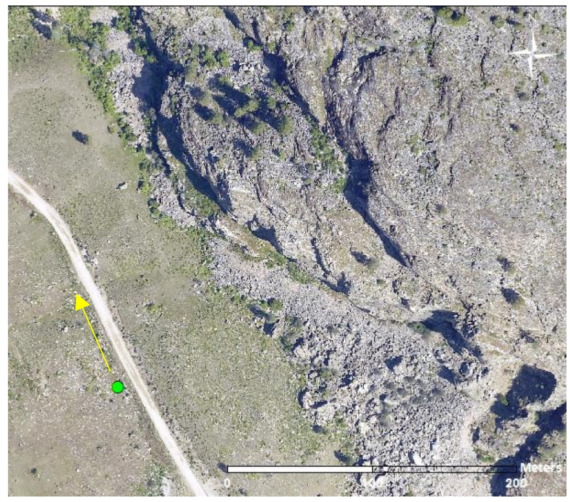

Figure 8-48. Include road verges, pullouts, and altered rights-of-way in anthropogenic feature delineation (Vaseux-Bighorn NWA; PPxh1).

8.14 Other

Any other possible land cover value not explicitly mentioned in this code list.

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