Southern Lakes
Terrestrial Environment Baseline Studies
2010 Wetland Ecosystem Mapping

(Photo: AM. Roberts)

Prepared for:

Yukon Energy Corporation
and
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September 4, 2012

Travis Ritchie
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Dear Travis:

Project No: 60146345 – Task 2.4.1

Regarding: Marsh Lake Fall-Winter Storage Concept – 2010 Wetland Ecosystem Mapping Report

Please find attached the above noted report prepared by Ardea Biological Consulting on behalf of AECOM.

We trust this report meets your current needs. If you have any questions regarding this report, or if we can be of further assistance, please do not hesitate to contact the undersigned.

Sincerely,
AECOM Canada Ltd.

Forest Pearson
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OM:om
Encl.
cc:

Executive Summary

This report provides a summary of the methods and results of a wetland ecosystem mapping project completed for Yukon Energy Corporation (YEC) at a 1:10,000 scale. Selected wetlands and adjacent upland areas were mapped within the Southern Lakes area of Yukon to provide baseline information to assess potential changes in wetland ecosystems from a proposed change in the operation of the Marsh Lake storage facility. The proposed Marsh Lake Storage Concept would increase the winter full supply level of Marsh Lake by 0.3 m and lower the low supply level by 0.1 m to increase winter flows downstream to the Whitehorse Rapids Generating Station. Water would also be stored in Tagish and Bennett Lakes since the head difference between those lakes and Marsh Lake is minimal (AECOM 2011).

Four large, representative wetland areas were selected for wetland mapping in 2010: Lewes Marsh, Nares Lake wetland, Tagish/6 Mile wetlands, and Monkey Beach wetlands. Wetland mapping was completed using principals of the Yukon Ecological and Landscape Classification (ELC) system and the British Columbia Terrestrial Ecosystem Mapping (TEM) process. Digital aerial photographs obtained at a 1:10,000 scale in July and August 2010 were used along with a digital elevation model (DEM) and PurView 3D software extension within ArcGIS to delineate wetland ecosystem polygons. Field verification of polygon characteristics was completed using a combination of full ecosystem plots as well as ground, and visual inspection plots from May to July 2010. Additional information was obtained using differential GPS and depth sounders to provide detailed elevation information for the creation of bathymetry and elevation maps for mapping wetland ecosystem elevations in relation to water levels.

A total of 23 wetland and upland ecosite units descriptions were developed, with many of the sites not previously well-described in the Yukon. Detailed information on the ecosite units were prepared, along with edatopic grids and toposequence information describing the ecosites. The wetland ecosystem mapping encompassed 3533.5 ha in 652 polygons within the selected wetlands. We completed 238 field plots in 2010, and an additional 58 ground inspections in 2011 during the CABIN monitoring for a total of 296 plots. The total number of polygons that contained plots was 191, which is a sampling rate of 29% and a plot density of 7.8 ha/plot. This inspection rate is within the criteria for Survey Level 3 of 26 to 50% polygons inspected that is outlined in RIC (1998). A significant portion of the wetland mapping areas were assessed, with 18% of all polygons being assessed with either a full plot or ground inspection plot.

Overall, we feel that the ecosite units described for this project are an accurate representation of the wetland ecosystems found within the selected wetlands in the Southern Lakes Study Area, and that the mapping is accurate at a 1:10,000 scale.

Suggested Citation:

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Disclaimer

This report has been prepared by the authors under the direction of Ardea Biological Consulting Ltd. (Ardea) for Yukon Energy Corporation and AECOM Canada Ltd. (the Clients) to provide baseline ecological information for the Marsh Lake Water Storage Concept. The information contained in this report have been obtained and prepared in accordance with generally accepted biological survey standards and is intended for the exclusive use of the Clients. The information contained in this report is dependent on the conditions at the time and any recommendations or conclusions are based on the author's best judgement at the time of preparation. The Clients acknowledge that ecological conditions can change over time and that the conclusions and recommendations outlined in this report are time sensitive.

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INTRODUCTION

Yukon Energy Corporation (YEC) has engaged AECOM Canada Ltd. (AECOM) to assist with implementation of key energy development and enhancement projects as identified in YEC's 20-Year Resource Plan. One of the proposed projects is the Marsh Lake Storage Concept, which proposes to apply to the Yukon Water Board to increase the winter full supply level of Marsh Lake by 0.3 m and lower the low supply level by 0.1 m to increase winter flows downstream to the Whitehorse Rapids Generating Station. Water would also be stored in Tagish and Bennett Lakes since the head difference between those lakes and Marsh Lake is minimal (AECOM 2011). The concept would use the existing Lewes Dam control structure to release water from November to early May, which would be the same as the current release regime.

Ardea Biological Consulting Ltd. (Ardea) was contracted by AECOM to complete terrestrial baseline studies within Marsh Lake, Tagish Lake, Nares Lake, and Bennett Lake, which comprise the Southern Lakes area. As part of the baseline environmental terrestrial studies, Ardea was retained to complete wetland classification, delineation, and mapping at a 1:10,000 scale for select representative and important wetlands in the system. This work was a team effort with assessments and mapping conducted by Anne-Marie Roberts (A. Roberts Ecological Consulting), Laurence Turney (Ardea), Frank Doyle (Wildlife Dynamics Consulting), Anne Macleod (Sialia Biological Consulting), Lis Rach (TerraNiche Environmental Solutions) and Patrick Williston (Gentian Botanical Research). Technical assistance during the summer field program was provided by Gareth Doyle, Graeme Turney and Joel MacFabe.

The goal of this project is to provide detailed 1:10,000 scale mapping of selected wetlands that can be used in the prediction of potential effects and risk analysis, development of mitigation measures, as well as provide a base for assessment of habitat effects on various wildlife species.

Use of terms Ecosite and Ecosystem

Within this report, the term ecosite is used as outlined in *The Yukon Ecosystem and Landscape (ELC) Framework: Overview and Concepts - Interim Draft* (Flynn and Francis 2011) for a mapping unit that describes a combination of plant associations, soils, terrain and climate. It is analogous to the term ecosystem unit, which is a term used in the *Standards for Terrestrial Ecosystem Mapping British Columbia* (RIC 1998). The term ecosystem is used in a more generic sense in this report to describe the combinations of plant associations, soils, terrain and climate that were actually found on the ground.

Purpose of Wetland Ecosystem Mapping

Resource management issues are generally quantitative, qualitative, or spatial in nature. Ecosystem mapping can help address each of these aspects by providing a common language that allows multiple resource management agencies and industries to communicate. Ecosystem mapping stratifies the landscape into map units that integrate abiotic (climate, physiography, surficial material, bedrock geology, soil) and biotic (vegetation) information into one common map (Francis and Steffen 2003). An ecosystem map provides a biological and ecological framework for land management. The process of classifying and naming the ecosystems allows them to be ranked in terms of their relative rarity on the landscape or for identifying sensitivities. Fundamental information on the geographic distribution of ecosystems allows for interpretations to be made, such as for wildlife management (RIC 1998). By portraying ecological information spatially, the ecological consequences of proposed resource activities on the landscape can be visualized. Ecosystem maps also provide a baseline record of ecological site conditions that can

be used for monitoring purposes to quantify impacts of a proposed management regime over time.

The process of ecosystem mapping can be applied at a variety of scales and landscapes, allowing interpretation for the purposes of providing information to a geographic or ecological question. In this context, we completed wetland ecosystem mapping that focuses on wetlands within the defined study area and may include adjacent aquatic, transitional and upland areas. The purpose of the wetland classification and mapping is to describe what types of wetlands are in the study area and use this information to assess the potential effects the Marsh Lake Storage Concept could have on those wetland ecosystems and the wildlife which depend on them.

BACKGROUND

Overview of Wetland Ecology

Wetland Definitions

Many definitions of wetlands are found in the literature and there are accepted definitions used in Canada. In general, a functional definition of wetlands stresses that saturation with water is the dominant factor determining the nature of soil development and the type of plant and animal communities living in the soil and on its surface (Cowardin *et al.* 1979). The *Wetlands of Canada* (NWWG 1988) defined wetlands as:

> *…lands having the water table at, near, or above the land surface or which are saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophilic vegetation and various kinds of biological activity which are adapted to the wet environment…*

British Columbia has adopted a similar definition suitable for most wetlands after Runka and Lewis (1981):

> *Wetlands are lands that are wet enough or inundated frequently to develop and support a distinctive natural vegetative cover that is in strong contrast to the adjacent matrix of better drained lands.*

Wetland Classes and Characteristics

Characteristic attributes of a wetland are functionally interconnected and include vegetation (particularly species composition and canopy structure), water (hydrology and water quality), soils (nutrient regime, pH, and organic content) and wildlife use. For example, wetland vegetation is integral in supporting food webs, creating habitats for a variety of animal species, removing sediments and toxic compounds from storm water, stabilizing stream banks, and providing erosion control (Zoltai and Vitt 1995, van der Valk 2009, Keddy 2010).

Wetland classes recognized in Canada include shallow open water, marsh, fen, swamp, and bog. Wetlands are categorized into two main groups: peatlands and non-peat forming wetlands. Peatlands usually have greater than 40 cm of accumulated organic matter and are subdivided into bogs, fens and some swamps. Non-peat forming wetlands usually have less than 40 cm of accumulated organic matter and are sub-divided into three groups: shallow open water, marsh and other swamps. Each of these wetland types is formed by a combination of geomorphic, hydrologic, edaphic, climatic or biological factors (Halsey *et al.* 2004).

Related types of ecosystems that can be included are flood and transition ecosystems, which are associated with wetlands and can have the vegetative structure similar to a wetland but moist, not wet or saturated soils with few indicator wetland species. Transition ecosystems are a

loosely defined set of plant associations that can occur adjacent to wetlands and have some structural and ecological similarities to wetlands. Examples include meadows and shrub-carrs that have moist to very moist actual soil moisture regime and support non-forested climax communities (Mackenzie and Moran 2004).

Below is a short summary of the five classes of wetlands from Pojar (1991):

- Shallow open waters are wetlands composed of permanent, shallow (less than 2m) standing water that lacks extensive emergent plant cover. Shallow open waters usually have various submerged and floating macrophytes.
- Marshes are wetlands that are permanently or seasonally inundated with nutrient water, that is dominated by emergent herbaceous vegetation and rooted in hydric mineral soils.
- Swamps are wooded wetlands dominated by 25% or greater cover of trees or tall shrubs and characterized by periodic flooding and nearly permanent subsurface water flow through various mixtures of mineral sediments and peat. They are rich in minerals and nutrients.
- Fens are wetlands composed if accumulations of well to poorly decomposed, non-sphagnic peats. Most fens have more than 40 cm peat accumulation and fen waters come mostly from groundwater and runoff.
- Bogs are wetlands covered or filled with poorly to moderately decomposed Sphagnum – derived peats. Bog surfaces are raised or level with their immediate surroundings and therefore receive very little of nutrient rich groundwater.

Water Regime

The broad environmental context of ecosystems is defined by regional climate. For wetlands, this influence is less pronounced than for upland ecosystems because of the overriding influence of wet site conditions. These wet site conditions and the water regime are a major determinant of plant community development and patterns of plant zonation in wetlands. It can be described by the depth, duration, frequency, rate of filling and drying and the timing and predictability of flooded and dry phases in a wetland (Bunn *et al*. 1997). Different types of wetlands arise and vegetation bands or belts occur in hydrological niches depending on the depth and duration of flooding.

Water movement and seasonal water-level fluctuation (hydrodynamics) are as important as soil moisture regime in wetland ecosystems. Soil moisture can be difficult to assess in many wetland and flood sites because the water table changes significantly over the growing season. As a general rule, sites with greater water flow are richer. Increasing lateral movement of water improves nutrient availability by bringing additional supplies of minerals and improving oxygenation. Vertical movements of the water table alternately floods and exposes the surface of the wetland, improving aeration, and increasing decomposition rates (Mackenzie and Moran 2004).

Stable, high water tables with stagnant or sluggish hydrodynamics promote peat formation and high bryophyte (moss) cover. Bogs and fens are ecosystems that form under these conditions. Peat accumulations on these sites can be very deep, are usually poorly decomposed, and are largely derived from mosses and sedges.

Sites with more dynamic water tables experience surface flooding followed by late-season drawdown. These types of sites usually have few bryophytes because most mosses are intolerant of prolonged submergence. Marshes, swamps, and shallow-water ecosystems may be underlain with peat but it is usually well humified (converted to humus) and derived from sedges or wood. On these sites and on flood ecosystems, the length and depth of flooding and

the degree of water flow are primary factors determining plant community composition. Species composition depends on species flood tolerance and life history requirements.

Water levels change over several timescales, the annual cycle of flooding as well as the differences among years (Keddy 2010). High water periods or pulses occur naturally in many systems and in most situations is an event that occurs in the spring with meltwater. In the Southern Lakes system, high water occurs starting mid summer and into the fall, with the filling of large lakes from glacier and upper elevation snow melt. Variation from one year to the next is dependent therefore on the accumulation of snow on the glaciers, the spring and summer temperature for melting, and to some extent on rainfall patterns. This can affect the timing, depth and duration of high water levels within years and year to year.

Ecological Classification in the Yukon

Ecological Land Classification (ELC) in the Yukon has been evolving for over ten years and the ELC Framework is still under review (Flynn *pers. comm*. 2011). The Draft Yukon ELC Framework considers and accounts for factors that influence ecosystem distribution by combining a climatic and site-level classification (Flynn and Francis 2011). The wetland mapping completed in this project utilized the methods and concepts outlined in the Yukon ELC, with additions based on the project team's experience in similar mapping projects completed in BC.

The Yukon ELC, like other classification systems is hierarchical, starting with generalizations of climatic and geographical conditions into broad geographic units, progressing to finer geographic scales. At the broadest scale, the bioclimate concept identifies areas with similar climate conditions that influence vegetation potential and ecosystem distribution. The three levels of bioclimate classification, from broad to more detailed, used in the Yukon are: bioclimate region, bioclimate zone, and bioclimate subzone. In the Yukon ELC, site-level ecosystems are the most detailed units of the classification and are termed ecosites. Ecosite phase describes the current vegetation structural or seral stage of the ecosite (Figure 1).

At the broadest level, the bioclimate region represents areas of broad, relatively homogenous climatic conditions. The provisional regions that are outlined in Flynn and Francis (2011) are used in this project. At the next level, the bioclimate zones are areas of similar climate conditions that influence vegetation potential. The current provisional zones are used in this project. The predominant vegetation community on reference sites where regional climate is the main influence on vegetation potential characterizes each bioclimate zone, and other factors such as soil and terrain are secondary. Bioclimate zones result primarily from elevation and/or latitude and within each bioclimate region, a bioclimate zone will occupy a characteristic range in elevation and corresponding temperature and precipitation conditions. Bioclimate subzones are provisionally identified through the integration of bioclimate regions and zones (Flynn and Francis 2011). Bioclimatic subzones describe climatic differences that arise when an area is either slightly cooler, warmer, wetter, or drier relative to other areas in the same bioclimate zone.

A bioclimatic subzone consists of unique sequences of geographically related ecosystems. Bioclimatic variants are a subdivision of a subzone and represent a further reduction in the climatic and geographic variability with a subzone. These climatic differences result in corresponding differences in vegetation, soil and ecosystem productivity. In the ELC framework, plant associations (recognizable vegetation communities) combined with toposequence (position on landscape) and edatropic grid (soil moisture and nutrients) concepts are used to classify and describe the vegetation component of ecosites.

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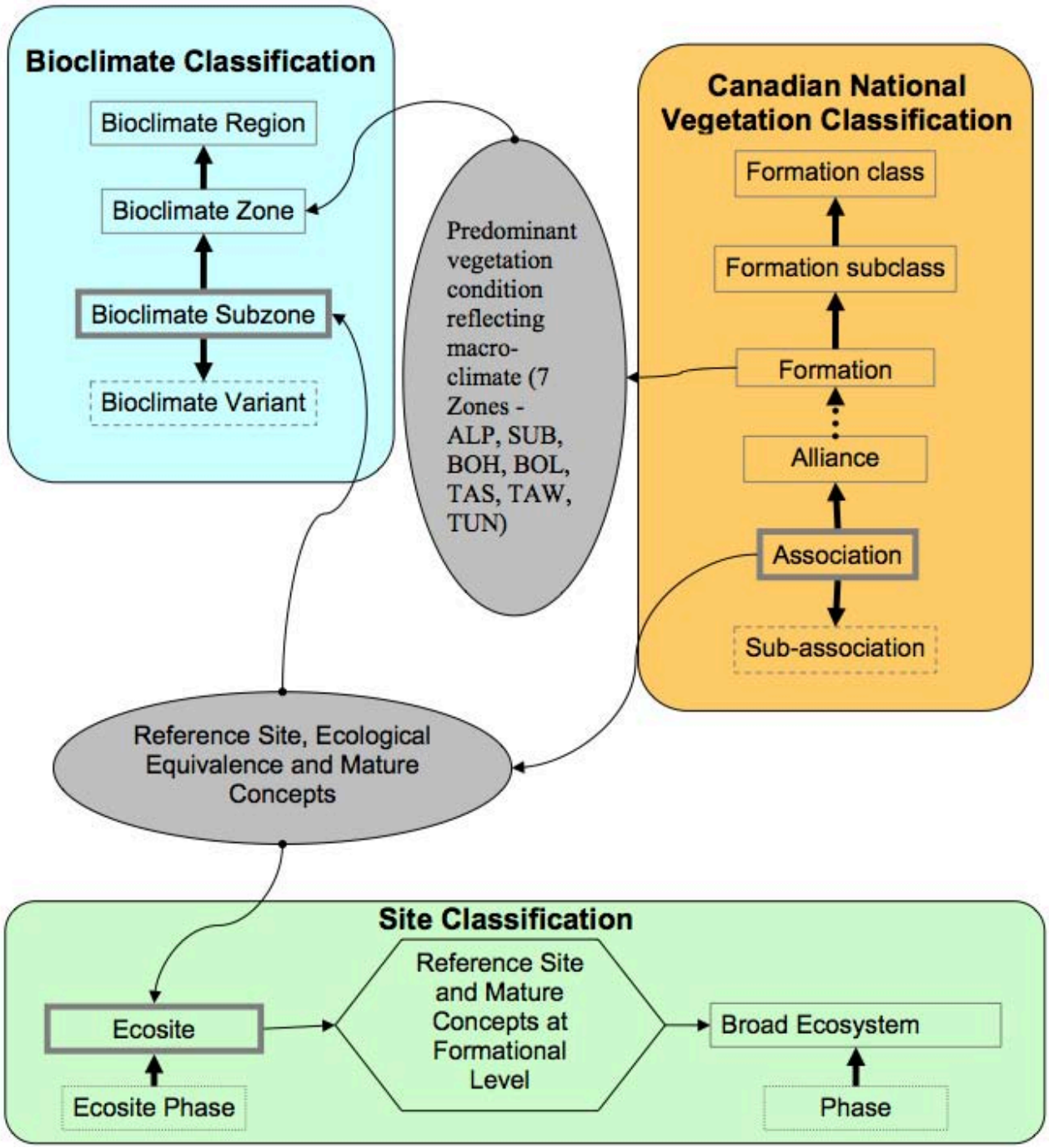

Figure 1. Relationship between classification systems within the Yukon Ecological and Landscape Classification (from Flynn and Francis 2011).

The Yukon ELC is designed to describe both broad level and site-level ecosystems; however, the classification of site-level ecosystems (ecosites) is still in development. To aid in the development of the ecosite classifications used in this project, concepts from the BC Terrestrial Ecosystem Mapping process were used (RIC 1998).

STUDY AREA

Location

The Southern Lakes Study Area for the 2010 and 2011 field studies is situated within the headwaters of the Yukon River watershed and extends along the Yukon River south of Whitehorse, into Marsh Lake, Tagish Lake and Bennett Lake, but does not extend into Atlin Lake. It includes the rivers, lakes, shorelines and major adjacent wetlands bodies in both the Yukon and Northern British Columbia that are influenced by the fluctuating water levels found in these water bodies (Figure 2.). Wetlands cover approximately 5% of the ecoregion, making wetland ecosystems fairly rare. Most of the wetlands found in the Southern Lakes Study Area are large complexes that have formed at inlets and at outlet of the lakes.

Within this broader study area, we selected four representative wetlands within Marsh and Nares Lakes to map based on their location, complexity and interpreted importance to wildlife, the public and First Nations. Marsh Lake is located approximately 30 km upstream of the city of Whitehorse and is part of the headwaters of the Yukon River. Nares Lake is located downstream of Bennett Lake at the town of Carcross, Yukon, and is functionally part of Tagish Lake.

The four wetlands selected for mapping were:

1) Lewes Marsh Wetland: along the upper Yukon River, including M'Clintock Bay;
2) Monkey Beach Wetland: wetland complex situated on the west side of Marsh Lake at the outlet of Monkey Creek;
3) Tagish/6 Mile Wetland: the wetlands situated at the inlet of Marsh Lake from Tagish Creek and Tagish Lake, including wetlands formed along the west side of Marsh Lake; and
4) Nares Wetland: the wetlands situated at the inlet of Nares Lake from Bennett Lake at the town of Carcross.

These four wetland areas encompass approximately 3533 hectares and are within the 1:50,000 scale mapsheets 105D.02, 105D.08, 105D.09, and 105D.10.

Physiography

The Southern Lakes Study Area lies within the Southern Lakes Ecoregion in the Boreal Cordillera Ecozone (Smith *et al.* 2004). The study area consists of broad valleys and large lakes set within the shadows of the St. Elias mountains with a mean elevation at 1,055m asl (range 610 to 2,380 m asl). The wetland mapping areas consists only of wetlands adjacent to large lakes that lie below 700 m asl. On average, the wetlands and associated upland areas range from 654 to 657 m asl.

Climate

Marsh, Tagish and Nares Lakes are in the Yukon Southern Lakes ecoregion. This area lies within the rain shadow of the St. Elias Mountains and its climate is considered to be dry and cool (Smith *et al.* 2004). Precipitation ranges from 200 to 325 mm, of which one third to one half falls during the summer. Mean annual temperatures are near -1° to -2° C in the southwestern portion of the ecoregion where these lakes are situated. July mean temperatures range from 12° to 14° C. Temperature extremes have ranged from -55° to 34° C, though these extremes are not as great in the valley bottoms where these wetland sites are located. The onset of spring can be delayed by up to two weeks in the wetlands adjacent to these large lakes due to the persistence of ice cover. Conversely, the onset of cold temperatures can be delayed up to a

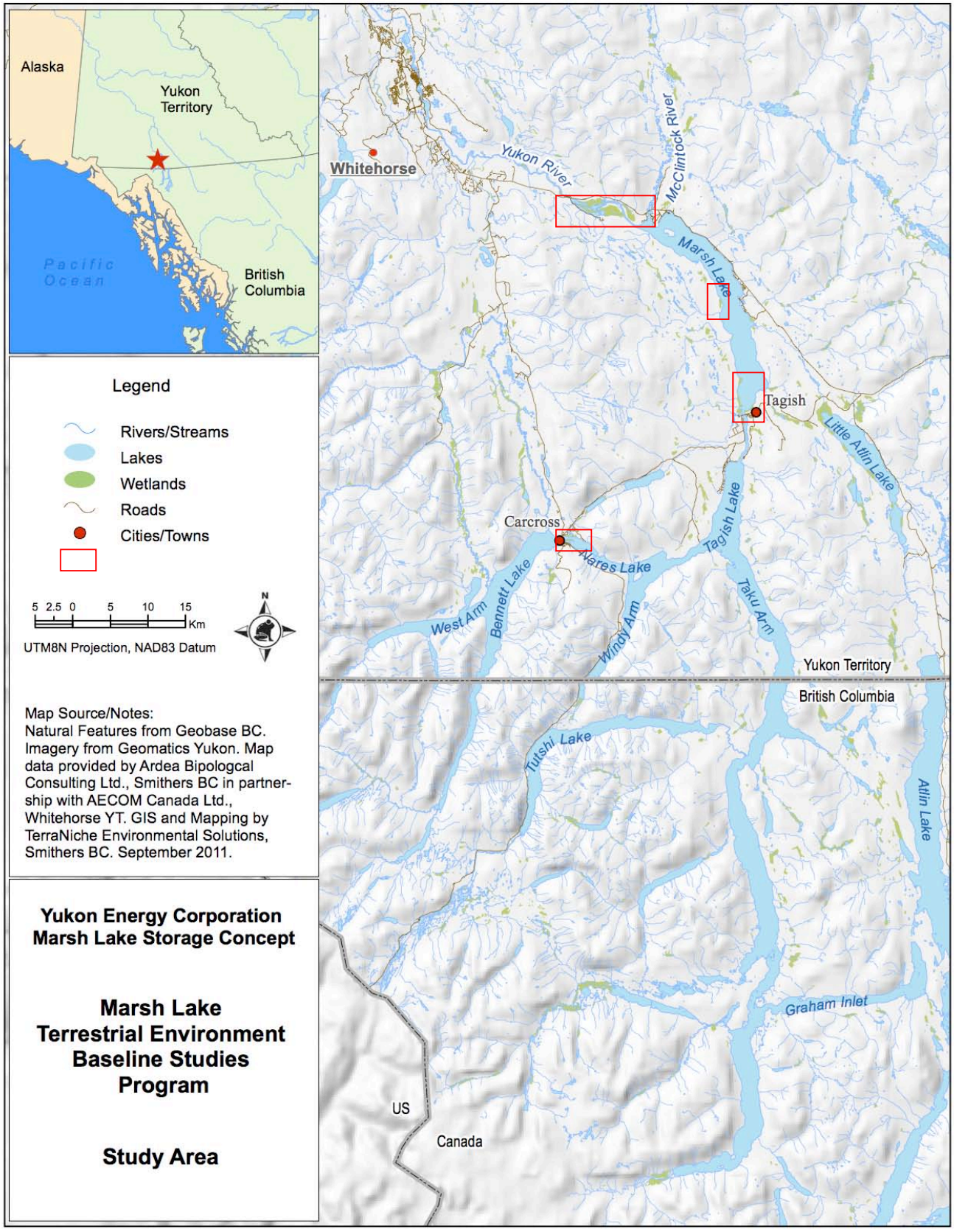

Figure 2. Focal wetlands within the Southern Lakes Study Area.

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month as these lakes do not freeze over until November and December due to extensive low cloud cover moderating air temperatures.

Bioclimatic Zones

The Marsh Lake study area lies entirely within the proposed elevation range of the Boreal Lowland (BOL) Bioclimate Zone (Meikle *pers. comm.* 2011, Flynn and Francis 2011). The BOL is described as having continuously forested areas at low to middle elevations, below the Boreal High (BOH) in all mountain valleys and plateau ecoregions of southern and central Yukon. Landscapes are generally wide valleys. Winters are long and cold, with short, cool and dry summers. Forests are generally mixed wood (lodgepole pine, white spruce and aspen) with moderately developed understories. Wetlands are relatively common (Flynn and Francis 2011).

Permafrost and Soils

The Southern Lakes Study Area is a low elevation and arid zone that lies within the sporadic discontinuous permafrost zone, where permafrost underlies less than 25% of the landscape. The active layer in mineral soils is commonly over 1.5 m deep, therefore permafrost may not be identified. In wet, organic terrain, the active layer may be less than 1 m deep. Permafrost is infrequent because this ecoregion is in the rain shadow of the coastal mountains, causing it to be dry and allowing the soils to warm in the summer (Smith *et al*. 2004).

In this region, mineral soils tend to be weakly weathered and peat accumulations are generally less than 1 m in thickness. In major valleys, such as in the study area, soils are predominantly alkaline glacio-lacustrine deposits classed as Eutric Brunisols. Soils of depressions are usually classed as Humic Gleysols. Floodplain soils are classed as Gleysolic or Regosolic if no soil development has yet occurred (Smith *et al*. 2004).

ECOSYSTEM MAPPING METHODOLOGY

In mid-2010, when the ecosystem mapping project was initiated, ELC in the Yukon was still under development and the ELC co-ordinator position was vacant. A methodology for wetland classification at a 1:10,000 scale was determined for this project based on discussions with Shawn Francis (previous Yukon ELC co-ordinator) (Francis *pers. comm.* 2010), John Meikle (Yukon ecologist) (Meikle *pers. comm.* 2010), Val Loewen (YTG Biologist) (Loewen *pers. comm.* 2010), and Will Mackenzie (British Columbia wetland specialist and Provincial Research Ecologist) (Mackenzie *pers. comm.* 2010). The methodology was later confirmed with the new ELC co-ordinator, Nadele Flynn (Flynn *pers. comm.* 2011).

The methodology used for the wetland ecosystem mapping followed the *Standards for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998) and *Standard for Terrestrial Ecosystem Mapping (TEM) Digital Data Capture in British Columbia* (RIC 2000), using principles outlined in *The Yukon Ecosystem and Landscape (ELC) Framework: Overview and Concepts - Interim Draft* (Flynn and Francis 2011). Elements of wetland description and classification derived from the *Wetlands of British Columbia: A Guide to Identification* (Mackenzie and Moran 2004) were also used. The methodology had the following phases, which are described in more detail in subsequent sections:

- Review of Existing Wetland and Ecosystem Mapping Information
- Pre-Typing and Field Planning
- Ecosystem Field Plots
- Detailed Elevation and Bathymetry Data Collection
- Post Field Data Processing

- Aerial Photograph Acquisition, Interpretation and Polygon Delineation
- Ecosite Unit Development
- Digital Database Creation
- Polygon Labelling and Mapping
- Quality Control and Assurance Process

Review of Existing Wetland and Ecosystem Mapping Information

Several wetland mapping studies in the southern part of the Yukon Territory have been undertaken, but few have been completed at a site-specific level describing potential ecosite units. To prepare for the wetland mapping, a list of preliminary wetland and transitional ecosite units were derived from available sources, with those describing ecosystems units in similar northern areas being more relevant than others. The two main sources of ecosite units were from *Wetlands of British Columbia* (Mackenzie and Moran 2004) and *A Field Guide to the Wetlands of the Boreal Plains Ecozone of Canada* (Smith *et al.* 2007). Other project reports that offered some ecosite unit information were also used, including:

- *Spring Staging of Waterbirds at Early Open Water Sites in the Yukon River Basin* (Johnson and McEwan 1983),
- *Southern Lakes, Yukon Territory Earth Cover Classification User's Guide* (Ducks Unlimited *et al.* 2002),
- *Concepts, Rationale and Suggested Standards for the Yukon Ecosystem Classification and Mapping Framework - First Approximation* (Francis and Steffan 2003),
- *Ecological Resources of the Yukon River* (AEM 1999),
- *Ecological Aquatic Units of British Columbia* (Ciruna *et al*. 2007),
- *The Lower Hyland River Wildlands Study: Background Report and Recommendations for Ecosystem-based Forest Management in the Hyland River Watershed* (CPAWS 2004),
- *Local-scale Biophysical mapping for Integrated Resource Management, Watson Lake Area* (Lipovsky and McKenna 2005), and
- *Tulsequah Chief Mine and Access Road Expanded Terrestrial Ecosystem Mapping* (Fuller and FIS 2002).

The reports by Johnson and McEwan (1983) and Lipovsky and McKenna (2005) were especially helpful by providing ecosystem descriptions for wetland ecosystems at an appropriate scale for the mapping in the Southern Lakes Study Area.

Other sources of information reviewed included:

- *Canadian Wetland Classification System developed by the National Wetlands Working Group* (Warner and Rubec 1997),
- *The Federal Policy on Wetland Conservation - Implementation Guide for Federal Land Managers* (Lynch-Stewart *et al.* 1996),
- *Working with Wetlands: A Training Course on Considering Wetlands in Environmental Assessment under CEAA* (Government of Canada 2000), and
- *Biogeoclimatic Ecosystem Classification in British Columbia* (Pojar *et al.* 1987), which was developed by Dr. V.J. Krajina and adapted by the British Columbia Ministry of Forests.

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Pre-Typing and Field Planning

Field planning for the project was initiated in April of 2010, prior to new 1:10,000 colour aerial photos being available. Black and white digital ortho-rectified images from 1:40,000 scale aerial photographs along with the preliminary list of wetland and transitional ecosite units were used to identify potential ecosystem polygons for field assessments and development of the sampling plan. Colour oblique photos obtained during aerial waterfowl and mammal surveys by Ardea in the late winter and into spring of 2010 were also used to help identify potential ecosite units and sampling areas.

The field sampling plan was developed with the following objectives in mind:

- collect sufficient detailed vegetation, soils, elevation and site data from representative wetland ecosystems to allow development of descriptions of the ecosite units, and
- ensure that between 15 and 25% of the preliminary polygons are assessed with a ratio of 5:20:75 for full, ground inspection and visual type plots (Survey Level 4 from RIC 1998).

During the development of the field sampling plan and the review of potential issues related to the proposed Marsh Lake Storage Concept, it became apparent that detailed bathymetry and elevation information would be required. The detailed elevation/bathymetry information would allow for accurate identification of the locations of representative ecosite units as well as allow for the assessment of potential effects of the Marsh Lake Storage Concept due to changes in water levels as well as the duration and timing of inundation. The field sampling plan was expanded therefore to include two additional tasks:

- collection of sub-meter elevation and X, Y location data of ecosite units along representative gradients within the wetlands during the low water period, and
- collection of detailed sub-meter bathymetry and X, Y location data during the high water period to provide a cost-effective method for a broader sub-meter elevation model to help delineate ecosite units.

Ecosystem Field Plots

Field sampling effort was conducted as defined in *Standards for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998), with the goal of visiting between 15 and 25% of map polygons and that the proportion of Full Plots, Ground Inspections and Visual Checks be 5:20:75 (i.e. (Survey Level 4). The sampling plan was also designed to provide a broad geographic coverage of the identified wetlands within the study area, with sampling across the spectrum of identified ecosite units. Field sampling was conducted by completing ecosystem plots using the procedures outlined in *Describing Ecosystems in the Field* (Luttermerding *et al.* 1990) and *Field Description of Wetlands and Related Ecosystems in British Columbia (Draft)* (Mackenzie 1999). Assessments and plot cards were completed using the methods outlined in the *Field Manual for Describing Terrestrial Ecosystems* (MOELP and MOF 1998). Guidelines from the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998) were followed for visual inspection data collection.

Vegetation identification references that were used during field work included: *Flora of the Yukon Territory* (Cody 1996), *Plants of the Western Boreal and Aspen Parkland* (Johnson *et al.* 1995), *Plants of Northern British Columbia* (MacKinnon *et al.* 1999), *Field Guide to the Sedges of the Pacific Northwest* (Wilson *et al.* 2008), and *Grasses: An Identification Guide* (Brown 1979).

Three types of ecosystem plots are used to identify and assess ecosystems: detailed ecological plots ('full plots'), ground inspections, and visual inspections. Full plots were completed using the *Ecosystem Field Form* (Standard RIC form FS882) and focused on ecosystems that were not well described from previous information. These plots are a thorough description of site features, soil horizons, and a complete vegetation list with percent covers of plant species. Ground inspection plots were completed using the *Ground Inspection Form* (Standard RIC form GIF), which allows for more general site and soil information description, but do require a complete vegetation list and percent cover of plant species. Visual inspections generally identified the ecosystem site unit and structural stage, and in some cases included a dominant vegetation list. Field notes and photos from the ground and the air were also taken of wetland ecosystems to provide documentation for upland and wetland ecosite unit description development and provide valuable information for future photo-typing.

Wetland plots were selected in homogenous areas within wetlands. Since most wetlands commonly occur as complexes of community types, homogenous plots ensured that these sites were useful for ecosystem classification. All plots were 400 m^2 and were usually standardized as 20 m x 20 m plots. Where wetland communities occurred as narrow bands, plots were made to fit the community type and retain a size of 400 m^2.

Ecosystem plots and field notes on wetland ecosystems were initiated in mid May in conjunction with aerial surveys for waterfowl and wildlife. Additional ecosystem plots and field notes were also conducted in early June 2010. Both of these spring surveys provided opportunities to assess wetland ecosystems at sites that were inaccessible at high water later in the summer

The majority of the field sampling took place in mid to late July 2010, in a concentrated effort to sample all wetlands as effectively as possible. Plots were normally completed in teams of two, with specialists familiar with vegetation ecology working with wildlife habitat specialists. In addition to the dedicated wetland ecosystem teams, wildlife habitat specialists conducting wildlife assessments would complete GIFs to help identify important wildlife habitats found during their assessment work. Additional plot data was collected in July 2011 during wetland sampling for baseline wetland monitoring according to the CABIN protocol as outlined in *Preliminary Wetland Aquatic Biomonitoring Data Collection Manual* (Bailey and Reynoldson 2009). These plots were completed using GIF plot forms and provided an opportunity to sample in detail several aquatic and semi-aquatic wetland communities.

The location of all full plots, ground inspection plots, and visual inspections were recorded as UTM coordinates using a GPS or pin marked on project aerial photographs and their UTM locations identified using ArcGIS and digital colour ortho-photos.

Detailed Elevation and Bathymetry Data Collection

Elevation Data Collection

A Thales ProMark3 differential global positioning system (DGPS) was used to gather sub-meter accuracy X, Y and Z coordinate data to delineate elevations for wetland ecosystems and the transition elevations between the ecosystems. The Thales ProMark3 DGPS has a base station equipped with a reference receiver to gather control point X, Y and Z positions during the mapping session, while a roving receiver equipped with an external antenna and a hand held data recorder gathered X, Y and Z positions of the ecosystem extents and transitions between ecosystems. The Thales ProMark3 DGPS was set up and used in a Stop and Go Survey, with initialization procedures, antenna height, positional dilution of precision (PDOP) and logging interval set to the manufacturer's recommendations (MGP 2007).

Field mapping of ecosystems was completed by walking in generally parallel lines, perpendicular to the elevation gradient marking a position at ecosystem transitions (e.g.

between sedge and willow habitats) (Figure 3.). Positions were also taken within an ecosystem if the zone was extensive and in some cases transition lines followed, outlining specific ecosystems of interest. Field mapping was limited to the extent of the wetland extending to the tree line, or the upper water line, and the wading depth of the water. A sketch map showing the transect lines and transition boundaries was created for each mapped area. Preliminary ecosite unit codes and the corresponding rover site number were recorded for each logged point on the sketch map. While the mapping was occurring, other team members within the mapped area or in adjacent similar sites completed full or GIF plots for the ecosystems. Voucher photographs were also taken at each site to record the ecosystems observed.

Figure 3. Ecosite unit elevation mapping using Thales DGPS unit at Lewes Marsh (June 6th, 2010).

Overall, seven mapping sessions were completed within selected identified wetlands in the study area during the June and July field sessions. A total of five sites were mapped in Lewes Marsh (three in June and two in July), while two sites were mapped in Nares Lake (one each in June and July).

Bathymetry Field Collection

Bathymetry data was collected in 2010 and 2011 using a Trimble Geo XT GPS and a Sonarmite (model SM2HPR) depth sounder combination, which obtained a GPS location at the same time that it was gathering depth data. A zodiac was used to move slowly within M'Clintock Bay and Lewes Marsh covering as much of the area as possible in a zig-zag pattern (Figure 4). The intent was to create cross-sections of the areas, capturing both shallow and deep water areas.

Bathymetry data capture occurred July 23rd, 2010 and from August 16 to 18th, 2010.

Figure 4 Bathymetry mapping at Lewes Marsh (July 23rd, 2010).

Additional bathymetry points were collected in August 2011 in selected portions of Lewes Marsh to provide information on sill depths for backchannel areas related to fisheries assessments.

Post Field Data Processing

Ecosystem Plot Data Processing

On completion of field sampling, the ecosystem full and GIF plot data was reviewed and then entered into specialized software designed to manage and classify ecological data (VPRO - VENUS Professional) (Mackenzie and Klassen 2004), while the visual inspection form data was entered into an Excel spreadsheet. GPS locations were mapped and field photos were organized. Data entered into VPRO was used together with the revised working legend to develop a final list of ecosite units to be mapped in the study area.

Elevation Data Processing

The data obtained from the GPS elevation data collection was uploaded into Thales GNSS Solutions software where it was processed to sub metre accuracy and converted into observation files (MPG 2005). The resultant observation files were submitted to Natural Resources Canada (CSRS 2010) for correction to the GPS X, Y and Z location data (NRC 2004). The corrected control point coordinates were applied to the data, adjusting the co-ordinates and elevation of each data point.

The ecosite unit codes obtained during the mapping were assessed and refined based on other plot data and the resultant coding was applied to standardize the data across all the surveyed sites. The mapped elevation and ecosite unit data was used to help develop the toposequence figures and refine the polygon delineation.

Bathymetry Data Processing

The data obtained from the GPS and depth sounder was processed using SonarXP software (Lymtech LLC 2011), which provides a GIS file with X, Y, and Z coordinates along with depth information. This information was processed against water level information from Environment Canada for the time of the sampling to provide elevation above sea level of the ground under the boat. This information was used to help develop the toposequence figures and refine the polygon delineation.

Development of the Working Legend

Prior to polygon delineation, a working legend was created based on the information gathered from previous mapping projects and other sources of preliminary ecosite units, and the information from the field plots. The working legend was the basis for the ecosite units used during the polygon delineation and used the vegetation lists, site information, soil data and hydrodynamic index information to create a preliminary classification. A draft topopsequence of general ecosite unit locations with respect to slope, landscape position, aspect, and/or water level position was also created from the plot data and used during the mapping.

Aerial Photograph Acquisition, Interpretation and Polygon Delineation

Colour 1:10,000 aerial photographs were flown for the wetlands of interest on July 8th, 2010 by Geographic Air Survey Ltd., with an additional flight to capture the north and south edges of the Monkey Beach wetland flown on September 7th, 2010. During the fall of 2010, Underhill Geomatics Ltd. scanned the aerial photos at 10 microns resolution. The scanned images were then processed to produce a number of digital products including: triangulated digital images for each air-photo; ortho-rectified 1:10,000 images of each wetland of interest; 1:10,000 scale cadastral mapping of water features (streams, islands, rivers, lake edges), roads, 1 m contour lines and vegetation edges; and a 1 m resolution digital elevation model (DEM).

The triangulated digital images and the DEM were used together in ArcView 9.3 with the PurView 3D extension to provide 3D images for polygon delineation. Polygons were delineated based on interpretation of vegetation attributes visible in the images, guided by the plot information obtained during the field assessments. All polygon delineation and interpretation was completed by Anne-Marie Roberts (R.P. Bio) to maintain consistency.

Polygon delineation was completed by identifying vegetation and elevation breaks on-screen and digitizing polygons that encompassed homogenous ecosite units. Where ecosite units were in complexes that were difficult to separate into separate polygons, complex polygons of up to 3 ecosite units were created. Due to the ability of the digital imagery to be used at a very fine scale (i.e. ~ 1:1,000) and the potential to delineate very small polygons at this scale, polygon delineation was conducted at a scale no less than approximately 1:5,000. This ensured that polygons were normally no smaller than approximately 0.5 ha.

During the polygon delineation, a spreadsheet was maintained to track the polygon number and the associated ecosite units within the polygon. This spreadsheet also contained notes on any additional attributes identified during the polygon delineation, which could be used to refine the ecosite unit descriptions.

Ecosite Unit Development

Classification of the wetland, transitional and upland ecosystems within the focal wetland areas into final ecosite units was a continuous process, starting with the preliminary list of potential ecosite units, progressing through the development of the working legend and finally the development of the final ecosite units and descriptions. The development of ecosite units and their descriptions is also hierarchical, recognizing that ecosite units can be aggregated into broader and more generalized groups eventually leading to the bioclimatic region scale (Flynn and Francis 2011).

Ecosite unit descriptions from other sources (e.g. Mackenzie and Moran 2004, Lipovsky and McKenna 2005, and Smith *et al.* 2007) and the field plot data were used to classify and create ecosite units and their descriptions. Data on vegetation species and percent cover, soil types, soil moisture, hydrodynamic index, pH, etc. from the field plots was reviewed using VPRO to group and classify the plots into ecosite units. Elevation data obtained from the DGPS mapping of ecosystems was used to create toposequence drawings of the relative locations of the ecosystems and helped visualize how they were located in relation to seasonal water levels.

The ecosite unit descriptions were compiled into a single page summary and are provided in the Vegetated Ecosite Unit Descriptions section. Each description outlines a variety of site information and summarizing the vegetation, soils, and terrain of each ecosystem mapped in the study area, plus the hydrodynamic index and pH for wetland ecosystems. This information is summarized in an edatopic grid for the site where possible. The ecosite unit descriptions also provide technical mapping information for each ecosite unit including the map code, the ecosystem name, a listing of the assumed modifiers for each unit, the modifier combinations that were mapped, and the mapped structural stage.

Digital Database Creation

Once the ecosite units had been finalized and draft descriptions created, the spreadsheet containing the polygon numbers and preliminary ecosite unit identifications were revised and all attributes input. The database attributes followed the structure outlined in the *Standard for Terrestrial Ecosystem Mapping (TEM) Digital Data Capture in British Columbia* (RIC 2000), modified to add data fields that would be appropriate for the Yukon ELC framework (e.g. use of the name bioclimate zone instead of biogeoclimatic zone).

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Polygon Labelling and Mapping

Polygon labels for map production were generated in ArcGIS 10.3 using the fields from the digital database and the labelling routines found in ArcGIS. Each map label included the polygon number and each ecosite unit for the polygon (up to three components) (Figure 5). More than one component is included in the label for a polygon where there is more than one ecosite unit component, structural stage, and/or modifier combination where it is not feasible to delineate separate polygons for each component. The proportion of each unit is indicated with the proportion of the polygon in 'deciles', where a decile of 5 indicates that 50% of the polygon area is of that ecosite unit/structural stage/modifier component.

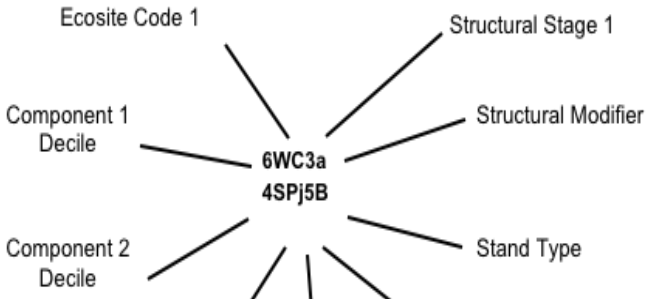

Figure 5. Example polygon label.

In the polygon example label to the right, the label 6WC3a - 4SPj5B would indicate that the polygon is composed of 60% of the WC ecosite, structural stage 3a and 40% of the SP ecosite unit on a gentle slope dominated by a broadleaf structural stage 5 stand.

Quality Control and Assurance Process

Quality control and quality assurance processes were in place at all stages of the mapping process. During the field plots, unidentified plants from plots were gathered and identified during the evening by team members. If it was not possible to identify species in the field, they were preserved or pressed for identification at a later date using additional plant references. All plot cards were reviewed in the field and again in the evenings to ensure that all relevant fields had been completed. Data entry of the plot cards allowed a further review of the data, as plant species names and data codes were checked during entry and post-entry through sorting and filtering the data to identify anomalous entries. During the polygon delineation phase, team members assisted Anne-Marie in ecosystem identification and ecosite unit determination by reviewing polygons and confirming interpretations and polygon boundaries. Database creation and data entry were reviewed during the data entry process by filtering and sorting entries to detect incorrect entries. A final check of the mapping and database entries was completed by Laurence Turney during the final mapping by checking the boundaries and ecosite unit information of polygons against the digital orthophotography for obvious differences (e.g. aquatic ecosite units in upland sites).

ECOSITE UNIT DEVELOPMENT PRODUCTS

During the development of the ecosite units, a number of tools were used and adapted from other sources. These included edatopic grids and toposequences that helped describe both wetland and upland ecosystems that were encountered during the mapping.

The Wetland Edatopic Grid

The wetland edatopic grid outlined in Mackenzie and Moran (2004) was adopted for this project to aid in the classification and description of wetland and associated sites (Figure 6). It is a modification of the model used in the Biogeoclimatic Ecosystem Classification (BEC) system

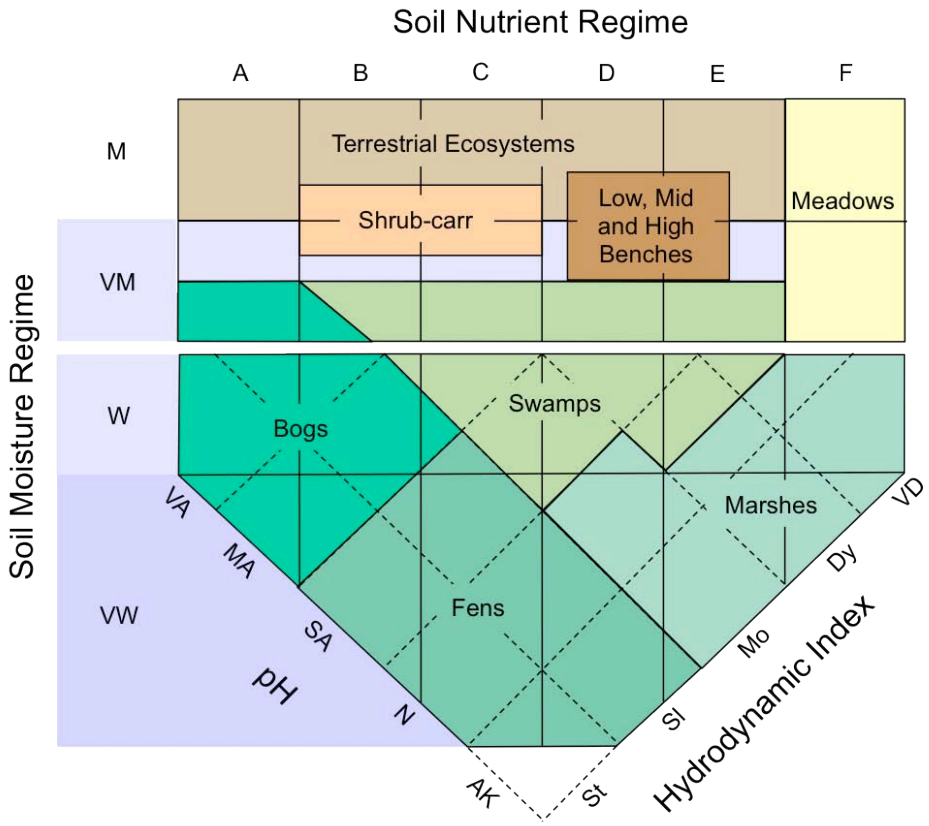

Figure 6. Wetland edatopic grid used in the Southern Lakes Study Area (adapted from Mackenzie and Moran 2004).

outlined in Pojar *et al*. (1987). The grid uses soil moisture and nutrient regimes as site descriptors as well as additional factors that are important in wetland and riparian ecosystems, including acidity/alkalinity and magnitude of lateral flow or vertical fluctuation (hydrodynamics). In the Wet and Very Wet portions of the edatopic grid, two axes have been added to accommodate hydrodynamics and pH (Mackenzie 1999).

The four axes of the grid describe specific site characteristics and are defined in in Appendix B based on the definitions provided in Mackenzie and Moran (2004).

The Forested Upland Edatopic Grid

A total of five upland forested ecosystems were mapped during this project and the interpretation of the ecosite units described for them are outlined in Figure 7. The forested upland edatopic grid developed for the five ecosystems is based on the concepts outlined in Pojar *et al.* (1987) and Flynn and Francis (2011). The position of the ecosite units outlined should be interpreted with caution as they only reflect what was observed and documented during our field work in the study area. The attributes observed for these sites are likely only a portion of the range of descriptors for these sites as they only reflect the observed ecosystems that are adjacent to wetlands on large lakes at low elevations of the Southern Lakes.

The definitions for the two axes of the grid are defined in Appendix B and are based on the definitions provided in Luttmerding *et al.* 1990.).

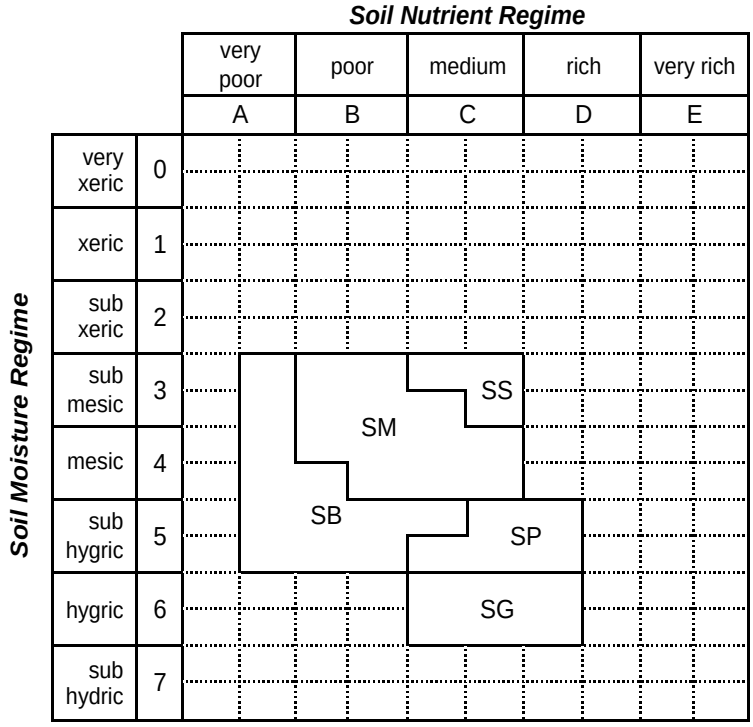

Figure 7. Upland forested edatopic grid developed for ecosite units in the Southern Lakes Study Area.

Toposequences

Wetland toposequences were assembled from plot and bathymetric data to aid in mapping and classification (Figure 8 and Figure 9). The toposequences were primarily compiled from the detailed elevation information gathered at Lewes Marsh, but photos and trends found from the data collected at 6-Mile and Nares wetlands were also used. The toposequences provide a valuable tool for visualizing the relationship between the ecosystems and the dynamic water regime found in the Southern Lakes Study Area. They also provide insights into the potential effects of the proposed Marsh Lake Storage Concept as they outline how the ecosystems are arranged vertically and how changes in water level could lead to changes in ecosystems over time.

ECOSITE UNIT DESCRIPTIONS

The following sections provide descriptions of the non-vegetated, sparsely vegetated, anthropogenic and vegetated ecosite units developed for this mapping project.

Non-Vegetated, Sparsely Vegetated and Anthropogenic Ecosite Units

Non-vegetated, sparsely vegetated and anthropogenic site units are mapped using a two-letter code based on standardized codes and definitions found in RIC (1998) (Table 1). Most of these ecosites do not have significant vegetation cover and so do not require structural stage or site modifiers. The definitions for the codes of common modifiers and structural stage can be found in Appendix B.

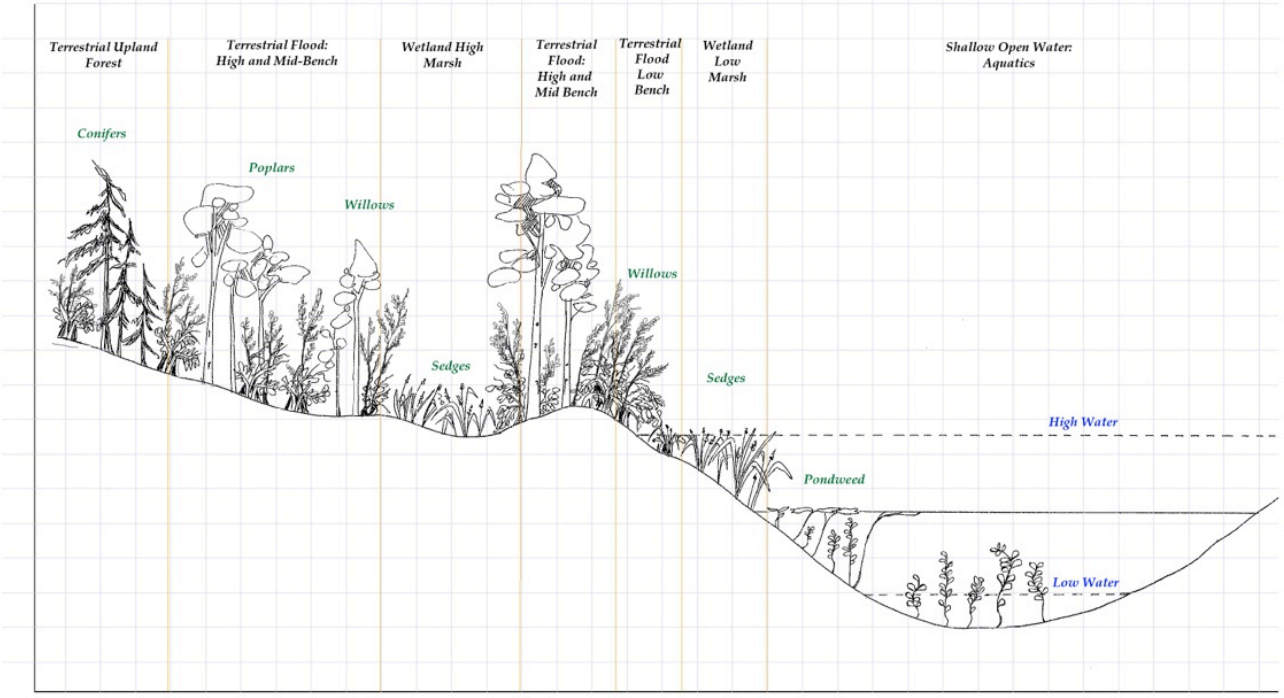

Figure 8. Toposequence of wetland ecosystems in the Marsh Lake study area, streamside.

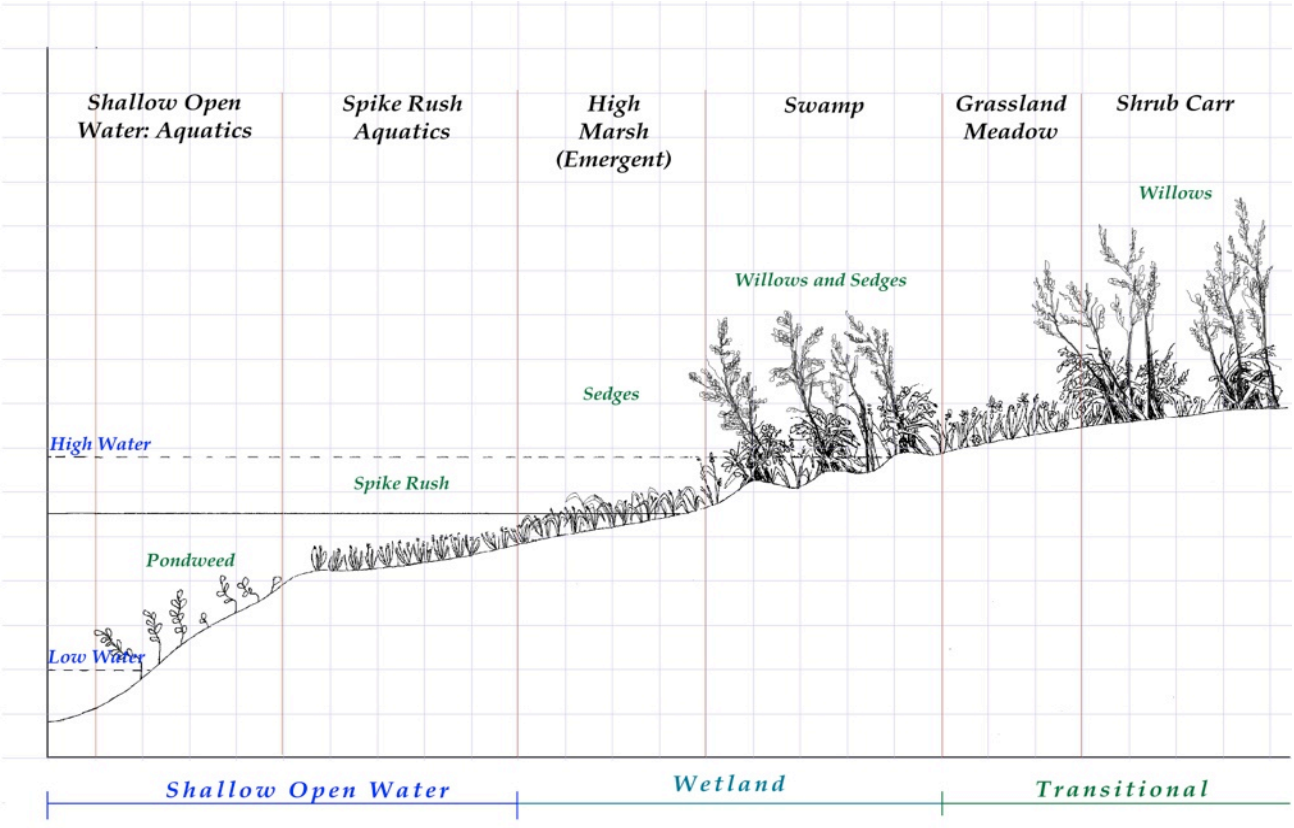

Figure 9. Toposequence of wetland ecosystems in the Marsh Lake study area.

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Table 1. Non-vegetated, sparsely vegetated and anthropogenic ecosite units mapped in the study area (from RIC 1998).

Ecosite Code	Ecosite unit	Definition	Common Modifiers	Structural Stage
BE	Beach	The area that expresses sorted sediments reworked in recent time by wave action. It may be formed at the edge of fresh or salt water bodies.	n/a	1
CB	Cutbank	A part of a road corridor or river course situated upslope of the road or river, which is created by excavation and/or erosion of the hillside	k, q, w, z	1
GB	Gravel Bar	An elongated landform generated by waves and currents and usually running parallel to the shore. It is composed of unconsolidated small rounded cobbles, pebbles, stones, and sand.	n/a	1
LA	Lake	A naturally occurring static body of water, greater than 2 m deep in some portion. The boundary for the lake is the natural high water mark.	n/a	n/a
MU	Mudflat Sediment	Flat plain-like areas dominated by fine-textured sediments. These areas are found in association with freshwater, saltwater, or estuarine bays (at low water), lakes, ponds, rivers and streams.	n/a	n/a
OW	Shallow Open Water	A wetland composed of permanent shallow open water and lacking extensive emergent plant cover. The water is less than 2 m deep.	n/a	n/a
PD	Pond	A small body of water greater than 2 m deep, but not large enough to be classified as a lake (e.g. less than 50 ha).	n/a	n/a
RI	River	A watercourse formed when water flows between continuous, definable banks. The flow may be intermittent or perennial. An area that has an ephemeral flow and no channel with definable banks is not considered a river.	n/a	n/a
RW	Rural	Any area in which residences and other human developments are scattered and intermingled with forest, rangeland, farm land, and native vegetation or cultivated crops. (Forested areas and cultivated fields should be mapped as separate units.)	n/a	n/a
RZ	Road Surface	An area cleared and compacted for the purpose of transporting goods and services by vehicles.	n/a	n/a

Vegetated Ecosite Unit Descriptions

Ecosite unit descriptions are provided in tabular form for each vegetated upland, transitional, wetland and aquatic ecosystem that was mapped. Within the selected wetlands in the study area, forested, wetland, and aquatic ecosystems were found that have not been previously described, or not fully described in previous studies. Many of the wetland ecosystems however, were variations of those found in Mackenzie and Moran (2004), while some upland ecosites have been previously described in field guides from British Columbia or other Yukon projects. A summary of ecosite units that are similar to those found in other projects or field guides is provided in Appendix C.

Each ecosite unit entry includes a summary description of the ecosystem and a representative photograph of the ecosystem. The ecosite name, two letter ecosite unit code, a list of all modifiers as well as site class, class code and cover types are provided. Environmental and physical site characteristics (from plots and other resources) are summarized and include elevation, slope, aspect, mesoslope position, structural stage, surficial material, drainage, soil moisture regime and soil nutrient regime. This information is summarized in either an upland or wetland edatopic grid for all sites except the aquatic sites. Each summary also provides a description of the vegetation structure including dominant species and the typical range of cover by layer with the mean cover in bold numbers. Where no field or other data is available, a note was made which indicated that insufficient information was available. Keys for the codes outlined within the ecosite unit description can be found in Appendix B.

Table 2 provides a summary of the terrestrial (flood, transitional, and upland), wetland and aquatic ecosystems for the ecosite units mapped.

Table 2. Summary of ecosite units mapped within the Southern Lakes Study Area.

Realm/ Group	Class	Class Code	Ecosite Unit Name	Ecosite Code	Cover Type
Terrestrial Realm					
Upland Forested Classes	Forest	Up	SwPl - Soopolalie - Kinnikinick	SS	Coniferous forest
			Sw - Feathermoss	SM	Coniferous forest
Flood Group	High and mid bench	Fm, Fh	SwAt – Willow	SP	Coniferous, deciduous or mixed forest
	Mid bench	Fm	Sw - Balsam poplar - Willow	SB	Deciduous or mixed forest
	Low bench	Fl	Willow - Bluejoint	WC	Tall deciduous shrub
	Shrub carr	Sc	Willow - Scrub birch	WB	Deciduous low shrub, graminoid and forb
			Willow Shrub	WS	Deciduous low shrub, graminoid and forb
	Grassland meadow	Gs	Tufted hairgrass Meadow	TH	Graminoid or forb
Wetland Realm					
Peatland Group	Fen	Wf	Willow – Sedge	WF	Deciduous low shrub and graminoid
			Sedge Fen	SF	Graminoid
Mineral Group	Marsh	Wm	Awned sedge	AS	Graminoid
			Bulrush Marsh	BR	Graminoid
			Beaked sedge - Water sedge	BW	Graminoid
			Swamp horsetail - Beaked sedge	HS	Forb and graminoid
			Mannagrass	MA	Graminoid and aquatic
			Sedge - Cinquefoil	SC	Forb and graminoid

Realm/ Group	Class	Class Code	Ecosite Unit Name	Ecosite Code	Cover Type
	Swamp	Ws	Sw - Willow - Glowmoss	SG	Sparsely treed – shrub
			Tea-leaved willow - Sedge - Cinquefoil	TC	Deciduous shrub
Mineral Group	Swamp	Ws	Tea-leaved willow - Sedge - Brown moss	TS	Deciduous shrub
	Shallow Open Water	Wa	Brown mosses	BM	Mosses with some aquatics and graminoids
			Pondweed - Mare's tail - Mixed aquatics	PM	Rooted and floating aquatics
			Pondweed Deep Pond	PP	Rooted aquatics
			Spike rush Mudflats	SR	Rooted aquatics

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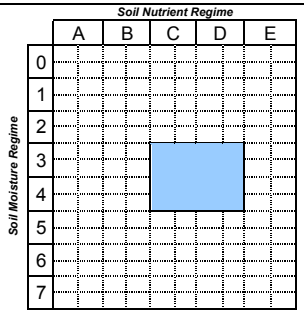
Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Upland Forest**	**Up**	**Coniferous Forest**	**SM**	**Sw - Feathermoss**

Mesic to submesic white spruce - feathermoss forests with limited shrub understory and a sparse herb layer. Found on level or gently sloping inactive fluvial sites. It is a moderately to well drained site with medium sized well spaced trees with average growth on mesic nutrient soils.



The tree layer consists of white spruce (*Picea glauca)*. The shrub layer can be variable but is typically dominated by willows (*Salix* spp.). Other species that can occur are prickly rose (*Rosa acicularis)* and soapberry (*Sheperdia canadensis).* The herb layer, though not extensive can be diverse. Dominate species include: *Arctostaphylos rubra, Geocaulon lividum,*and *Empetrum nigrum.* The moss layer is moderately well developed with extensive cover dominated by step moss (*Hylocomium splendens)* and feathermoss species. Lichens were also common at most sites and dominated by *Peltigera aphthosa* and *Cladonia* spp.

This unit was the most common upland forest type adjacent to the wetland complexes and is a relatively general white spruce, submesic to mesic forest type. It was mapped as both structural stage 5 and 6.

SITE INFORMATION

Elevation (masl):	661 - 680
Slope (%):	2 - 8
Aspect (º):	0, 165, 270, 194
Slope Position:	UP, MD, LW, TO
Structural Stage:	2, 3, 4, 5, **6**, **7**
Surficial Material:	FG, **F**, LG, M
Drainage:	m, w, r
SMR:	3-4
SNR:	B-C
Stand Composition	C, B, M

Assumed Modifiers:	f, d
Mapped Modifiers:	none
Number of Plots:	5
Plot Numbers:	072, 075, 091, 224, 803
List of Mapped Units:	SM6C, SM5M, SM5B

Occurrence:

Mapped in 19 out of 652 Polygons, 14 of these polygons are in Lewes Marsh

218 ha out of 3533 ha.

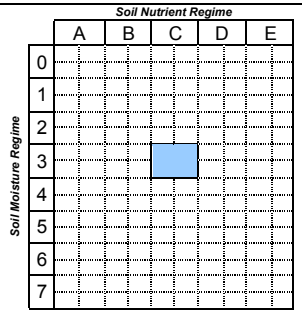
Tree Layer (5-**16**-30)	**Shrub Layer** (2-**10**-25)	**Herb Layer** (3-**15**-30)	**Moss Layer** (60-**75**-95)
Picea glauca	*Salix* spp., *Rosa acicularis, Sheperdia canadensis*	*Arctostaphylos rubra, Geocaulon lividum, Empetrum nigrum, Hedysarum alpinum, Linnea borealis*	*Hylocomium splendens, Bryum* spp., *Aulacomnium palustre*

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Upland Forest**	**Up**	**Coniferous Forest**	**SS**	**SwPl - Soopolalie - Kinnikinick**

White spruce – lodgepole pine forest occurring on dry warm, moderately well to well drained inactive fluvial sites. Stands are usually dominated by Pl but occur with both Sw and can also have a lesser component of trembling aspen. The canopy is relatively open, often with gap openings.

Understory is open, mainly with conifer regeneration and the occasional willow, soopalalie or prickly rose. Kinnikinik (*Arctostaphylos uva-ursi*) dominates the herb layer. Other herbs are sparse. The forest floor is thinly covered by a mix of mosses and lichens, including step moss, red-stemmed feathermoss plus *Cladonia, Cladina, Stereocaulon* and *Peltigera* lichens.

This was not a common site and was usually in localized areas in the Lewes Marsh complex.



SITE INFORMATION	
Elevation (masl):	660-662
Slope (%):	0-10
Aspect (º):	100, 312, no aspect
Slope Position:	DP, LV
Structural Stage:	2, 3, 4, **5**, **6**, 7
Surficial Material:	FG, **F**, LG, M
Drainage:	m
SMR:	3
SNR:	C
Stand Composition	**C**, M

Assumed Modifiers:	f, d
Mapped Modifiers:	none
Number of Plots:	3
Plot Numbers:	069, 235, 1032
List of Mapped Units:	SS5M, SS5C, SS6C

Occurrence:

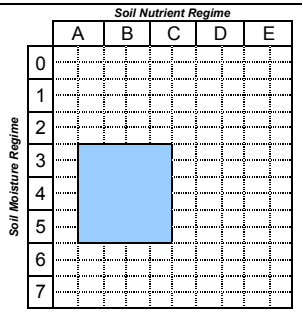
Mapped in 4 out of 652 polygons, all 4 located in Lewes Marsh.
24 ha out of 3533 ha

Tree Layer (10-**11**-12)	**Shrub Layer** (10-**12**-13)	**Herb Layer** (25-**33**-40)	**Moss Layer** (40-**48**-55)
Pinus contorta, Picea glauca, Populus tremuloides	*P.glauca, Salix scouleriana, Sheperdia 23anadensis, Rosa acicularis*	*Arctostaphylos uva-ursi, Festuca altaica, Pedicularis labradorica, Epilobium angustifolium, Linnea borealis*	*Hylocomium splendens, Pleurozium schreberi, Cladonia, Cladina, Stereocaulon, Peltigera*

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Mid - High Bench**	**Fm, Fh**	**Deciduous or Mixed Forest**	**SB**	**Sw - Balsam poplar - Willow**

Mid bench deciduous or mixed forests found on mid to high bench locations along creeks and rivers. These sites experience periodic flooding of medium to short duration, and can often found on old beach sites. Sites can be moderately to well-drained but the high water table keeps soils moist for most of the growing season. The movement of water in the high water table enriches nutrients in the soil but can also limit tree growth because the periodic high water table.

These sites were not common and were found in isolated, small patches. Even in the sites mapped as coniferous treed the presence of balsam popular either as minor cover in the canopy or in the tall shrub layer defined this site.



SITE INFORMATION

Elevation (masl):	661-665
Slope (%):	**0**-10
Aspect (º):	312, no aspect
Slope Position:	LV, MD
Structural Stage:	2, 3, **3b**, 4, 5, 6
Surficial Material:	FG, F, L
Drainage:	m, w
SMR:	3-5
SNR:	A-C
Stand Composition	**C**, B, M

Assumed Modifiers:	f
Mapped Modifiers:	j, h
Number of Plots:	5
Plot Numbers:	051, 098, 228, 404, 1113
List of Mapped Units:	SB4C, SB5C, SB5M, SB5B, SBjh6C

Occurrence:

Mapped 13 out of 652 polygons.
17.8 ha out of 3533 ha

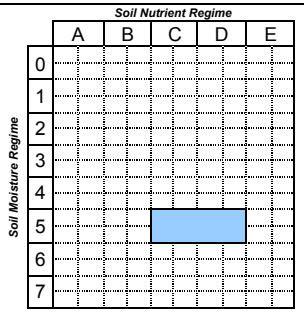
Tree Layer (0-**3**-5)	**Shrub Layer** (25-**40**-60)	**Herb Layer** (0.1-**43**-85)	**Moss Layer** (15-**23**-35)
Picea glauca, Populus balsamifera ssp. *balsamifera*	*Populus balsamifera, Salix arbusculoides, Salix glauca, Rosa acicularis*	*Juncus balticus, Equisetum arvense, Carex aquatilis, C. utriculata, Achillea millefolium*	*Aulacomnium palustre, Dicranum* spp., lichen species

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Mid - High Bench**	**Fm, Fh**	**Coniferous, Deciduous or Mixed Forest**	**SP**	**SwAt - Willow**

Lowland riparian sites with inactive fluvial/lacustrine soils that may experience a period influenced by flooding or high water table. These can be found on both mid and high bench sites.

These sites can be structurally complex coniferous, deciduous or mixed forests or even tall shrub sites distinguished by the presence of trembling aspen (*Populus tremuloides*). The shrub layer tends to be tall, trembling aspen and tall willows. Herbaceous cover is moderately low and species that can occur include sedges, grasses, scouring rush (*Equisetum scirpoides*), and common horsetail (*Equisetum arvense*). The moss layer is patchy and thin.

This site was a common site adjacent to both fluvial and lacustrine sites in the study area. Trembling aspen stands are common sites found in the fringe of high flood sites in both fluvial and lacustrine areas.



SITE INFORMATION

Elevation (masl):	658
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	LV
Structural Stage:	2, 3, **3b**, **4, 5, 6**
Surficial Material:	**F, L**
Drainage:	i
SMR:	5
SNR:	C-D
Stand Composition	C, B, M

Assumed Modifiers:	j, d
Mapped Modifiers:	h
Number of Plots:	13
Plot Numbers:	058, 068, 050, 077, 095, 1052, 1089, 1095, 1096, 1097, 1102, 1112, 1117
List of Mapped Units:	SP3b, SP4B, SP5C, SP5M, SP5B, SP6C, SPh6C, SP6M

Occurrence:

Mapped in 65 out of 652 polygons.
334.7 ha out of 3533 ha

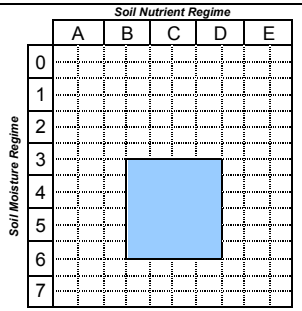
Tree Layer (0-**15**-20)	**Shrub Layer** (40-**50**-55)	**Herb Layer** (10-**18**-25)	**Moss Layer** (30-**32**-45)
Populus tremuloides	*Populus tremuloides, Salix glauca, S. planifolia, Rosa acicularis*	*Carex aquatilis, Deschampsia cespitosa, Equisetum arvense, E. scirpoides*	*Aulacomnium palustre, Brachythecium* spp.

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Low Bench**	**Fl**	**Shrub**	**WC**	**Willow - Bluejoint**

Low bench sites that are flooded or influenced by a high water table for moderate periods of the growing season. Found in lacustrine fringe locations and riparian sites in fluvial systems.

A tall shrub community (typically structural stage 3a or 3b) dominated by willows. The herbaceous layer can be diverse, though it is dominated by bluejoint (*Calamagrostis canadensis*). Other species that can be prevalent include water sedge, beaked sedge, and common horsetail. There is often evidence of high water in this zone with debris.

This site is common throughout the study area and was found on lake fringes above the regular water line and in the low riparian zone of fluvial systems.



SITE INFORMATION	
Elevation (masl):	658-668
Slope (%):	0-3
Aspect (º):	50, 100, no aspect
Slope Position:	DP, TO, LV, LW, UP
Structural Stage:	**3a, 3b**
Surficial Material:	F, L
Drainage:	p, i, m, w
SMR:	3-6
SNR:	B-D

Assumed Modifiers:	j, d
Mapped Modifiers:	none
Number of Plots:	23
Plot Numbers:	045, 052, 067, 057, 081, 085, 090, 093, 225, 234, 801, 805, 821, 802, 1009, 1016, 1033, 1063, 1064, 1068, 1088, 1101, 1118
List of Mapped Units:	WC3a, WC3b

Occurrence:

Mapped in 89 out of 652 polygons, found in all four wetland areas.
111 ha out of 3533 ha

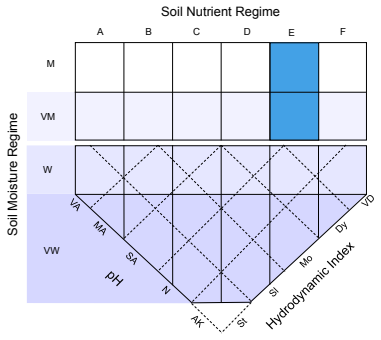
Tree Layer (0-**0**-5)	**Shrub Layer** (7-**38**-90)	**Herb Layer** (10-**41**-90)	**Moss Layer** (6-**41**-80)
Picea glauca	*Salix glauca, S. planifolia, S.discolor, S.scouleriana, S. arbusculoides, Populus tremuloides, P. balsmifera* spp.*balsamifera*	*Calamagrostis canadensis, Carex aquatilis, C. utriculata, C. canescnes, Equisetum arvense*	*Drepanocladus spp., Aulacomnium palustre, Climacium dendroides, Amblystegium, Bryum caespitucium, Hamatocaulis vernicosus*

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Grassland Meadows**	**Gs**	**Grasses and Forbs**	**TH**	**Tufted hairgrass Meadow**

Graminoid dominated meadow tolerant of brief periods of inundation in areas of transition between wetland and upland communities. Found on fluvial and lacustrine landforms and medium to fine silty - sandy imperfectly drained soils. May be associated with moist alkaline soils that a) occur within the drawdown zone of shallow temporary or permanent ponds and lakes and b) are dominated by alkali and inundations tolerant graminoids and forbs.

Tufted hairgrass *(Descampsia cespitosa)* dominates this site and can form nearly pure stands. Additional species that were found were foxtail barley (*Hordeum jubatum)* and bluejoint (*Calamagrostis canadensis).* Uncommon site mapped in the study area that was usually found moist areas adjacent to BW marshes.

Similar to Gs04 site in Mackenzie and Moran (2004).



SITE INFORMATION

Elevation (masl):	656
Slope (%):	0-5
Aspect (º):	no aspect
Slope Position:	LW, DP, TO
Structural Stage:	2b
Surficial Material:	**F**, L
Drainage:	i
SMR:	M-VM
SNR:	E

Assumed Modifiers:	j, f
Mapped Modifiers:	none
Number of Plots:	3
Plot Numbers:	063, 073, 1080
List of Mapped Units:	TH2b

Occurrence:

Mapped in 9 out of 652 polygons.
13.4 ha out of 3533 ha

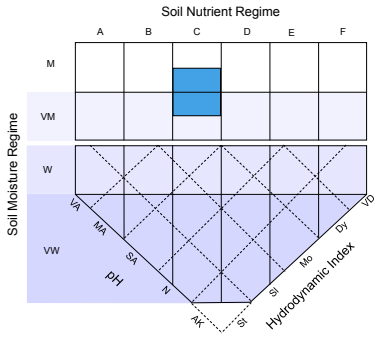
Tree Layer (0)	Shrub Layer (0)	Herb Layer (65-**70**-73)	Moss Layer (0)
		Descampsia cespitosa, Hordeum jubatum, Calamagrostis canadensis	

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Shrub-Carr**	**Sc**	**Deciduous low shrubs, grasses and forbs**	**WB**	**Willow - Scrub birch**

A deciduous low shrub ecosystem occurring on fresh to moist fine to medium textured imperfectly drained mineral soils, often in areas of cold-air drainage that together with the moist soils limit the growth of trees. These sites are not flooded and are typed as "transition" types between wetland and upland ecosites. Soils are cold and in this area were either Gleyed Brunisols, or Gleysols with very thin to no humus form.

This site has a relatively diverse species list. Scrub birch (*Betula nana)* dominates the shrub layer with a minor component of willows and the occasional stunted trembling aspen or white spruce. The forb layer is diverse but not extensive, with higher cover of *Arctostaphylos uva-ursi*, *Epilobium angustifolium*, *Festuca altaica*, and *Agropyron* spp. The bryophyte layer is patchy and generally thin with both mosses and some lichens. This site was not commonly found in or directly adjacent to the mapped wetland complexes.

Similar to the Sc01 site in Mackenzie and Moran (2004) but this site is moister and has more vigorous growth.



SITE INFORMATION

Elevation (masl):	662
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	LV
Structural Stage:	**3a,** 3b
Surficial Material:	F, L
Drainage:	m
SMR:	5
SNR:	C

Assumed Modifiers:	j, f
Mapped Modifiers:	none
Number of Plots:	1
Plot Numbers:	071
List of Mapped Units:	WB3a

Occurrence:

Mapped in 1 out of 652 polygons. Mapped polygon in Lewes Marsh. 6 ha out of 3533 ha

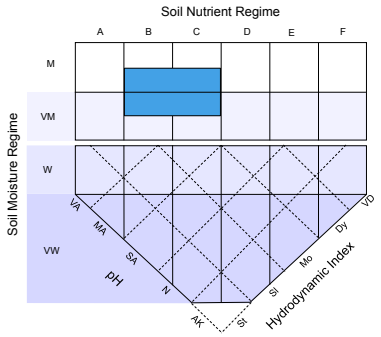
Tree Layer (0)	Shrub Layer (85)	Herb Layer (10)	Moss Layer (30)
	Betula nana, Salix glauca, S. maccalliana, Populus tremuloides, Picea glauca	*Arctostaphylos uva-ursi, Epilobium angustifolium, Festuca altaica, Hedysarum alpinum, Achillea millefolium*	*Bryum* spp.*, Hylocomium splendens, Clandonia* spp.*, Peltigera aphthosa*

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Shrub-Carr**	**Sc**	**Deciduous low shrubs, grasses and forbs**	**WS**	**Willow Shrub**

A deciduous low shrub ecosystem occurring on fresh to moist fine to medium textured imperfectly drained mineral soils, often in areas of cold-air drainage that together with the moist soils limit the growth of trees. These sites are not flooded and are typed as "transition" types between wetland and upland ecosites. Soils are cold and in this area were either Gleyed Brunisols, or Gleysols.

This site has a relatively diverse species list with herb layer having many species, most with sparse cover. *Salix glauca* dominates the shrub layer with a minor component of other willow species. The herb layer mainly consists of graminoid species, both grasses and sedges. The bryophyte layer is thin but with high cover.

Similarities to Sc02 site in Mackenzie and Moran (2004) but this site is moister and has more vigorous growth.



SITE INFORMATION

Elevation (masl):	658-660
Slope (%):	0-3
Aspect (º):	180
Slope Position:	MD, LV
Structural Stage:	**3a**, 3b
Surficial Material:	**F**, L
Drainage:	i
SMR:	5
SNR:	B-C

Assumed Modifiers:	j, f
Mapped Modifiers:	none
Number of Plots:	7
Plot Numbers:	097, 223, 761, 1026, 1055, 1085, 1094
List of Mapped Units:	WS3a

Occurrence:

Mapped in 20 out of 652 polygons, mainly in Lewes and Tagish
103 ha out of 3533 ha

Tree Layer (0)	**Shrub Layer** (30-**35**-40)	**Herb Layer** (**40**)	**Moss Layer** (60-**78**-95)
	Salix glauca, *S. planifolia, S. maccalliana*	*Descampsia cespitosa, Carex gynocrates, Equisetum scirpoides, Calamagrosis 29anadensis, C. aquatilis*	*Drepanocladus* spp., *Aulacomnium palustre, Climacium dendroides, Calligeron* spp.

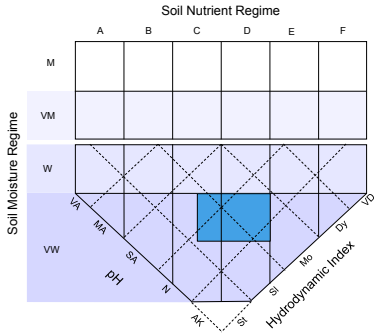
Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Fen**	**Wf**	**Graminoid**	**SF**	**Sedge Fen**

A sedge peatland dominated rich fen. This site is characterized by sedges, few grasses and brown mosses. Fens were uncommon in the wetland complexes and this was found only at protected lake margins. The water table is usually at or near the peat surface for most of the growing season. In drier areas of the fen there are open patches where small amounts of forbs are growing in.

The site is almost completely dominated by beaked sedge (*Carex utriculata).* The bryophyte layer is well developed and dominated by *Drepanocladus* brown mosses, which are indicative of relatively mineral rich conditions.

This site is mainly distinguished from similar looking sedge marshes by the depth of the peat extending to greater than 40 cm making this an organic soil. These sites are mainly fed by precipitation and a high water table.

Site similar to the Wf01 from Mackenzie and Moran (2004).



SITE INFORMATION

Elevation (masl):	659
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	LV
Structural Stage:	**2b**
Surficial Material:	O
Hydrodynamic Index:	St-Mo
pH:	SA-N
ASMR:	VW, **6**
SNR:	C-**D**

Assumed Modifiers:	
Mapped Modifiers:	j, f
Number of Plots:	3
Plot Numbers:	053, 1003, 1079
List of Mapped Units:	SF2b

Occurrence:

Fens are very uncommon in the wetland complexes mapped, with sites located in Tagish / 6 Mile wetlands.

Mapped in 3 out of 652 polygons.

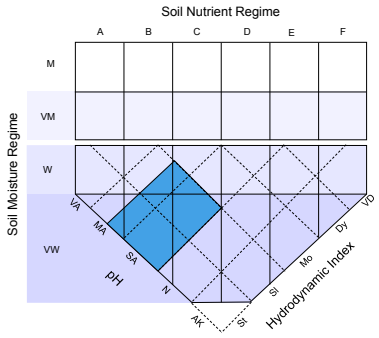
10.4 ha out of 3533 ha

Tree Layer (0)	Shrub Layer (0)	Herb Layer (70)	Moss Layer (65)
		Carex utriculata, Hippuris vulgaris, Epilobium palustre, Rorippa islandica, Ranunculus sceleratus	*Drepanocladus* spp.

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Fen**	**Wf**	**Shrub**	**WF**	**Willow - Sedge Fen**

Poorly drained sites with accumulated decomposed sedge and/or brown moss peat. Soils are very cold and wet, mainly receiving moisture through precipitation and ground water. Though these sites were defined as a fen based on their organic soil, this tended to be an organic veneer on fine textured gleyed fluvial or lacustrine soils.

Dominated by willow and sedges. These sites are not fully described. In the sites that were mapped, tea-leaved willow (*Salix planifolia*) and water sedge (*Salix aquatilis*) were the dominant vegetation. There can be micro-topography with willows residing on the tops of small hummocks.



SITE INFORMATION

Elevation (masl):	655-656
Slope (%):	0-3
Aspect (º):	no aspect
Slope Position:	LV
Structural Stage:	**3a**
Surficial Material:	O
Hydrodynamic Index:	Sl-St
pH:	MA-SA
ASMR:	W-VW
SNR:	A-C

Assumed Modifiers:	j, d, h
Mapped Modifiers:	None
Number of Plots:	5
Plot Numbers:	226, 232, 1002, 1086, 1087
List of Mapped Units:	WF3a

Occurrence:

Mapped in 3 out of 652 polygons, all occurring in either Lewes Marsh or Tagish/6-Mile wetlands.

5.4 ha out of 3533 ha

Tree Layer (0)	**Shrub Layer** (15-**28**-40)	**Herb Layer** (60-**65**-70)	**Moss Layer** (30-**50**-70)
	Salix planifolia	*Carex aquatilis*	*Drepanocladus* spp.

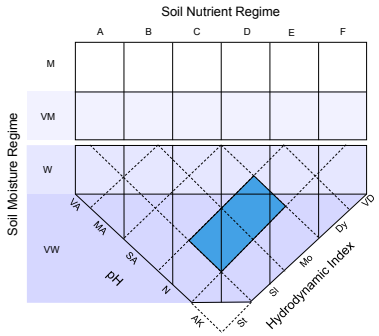
Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Marsh**	**Wm**	**Graminoid**	**BW**	**Beaked sedge - Water sedge**

Mineral wetland dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded hydrolic conditions. The most common and widespread Marsh ecosite unit. This site is commonly found on gleyed mineral soils.

Species diversity is low and plant cover is strongly dominated by beaked sedge (*Carex utriculata*) and/or water sedge (*C. aquatilis*) with scattered forbs, aquatics, and mosses. On sites that experience surface drying, species diversity increases and sites become more meadow like.

Floristically, this site can be very similar to the Sedge Fen (SF) and the two sites are primarily differentiated by the BW growing on mineral soils and the SF growing on organic soils.

The BW site is similar to the site description of the Beaked sedge - Water sedge (Wm01) site described in Mackenzie and Moran (2004).



SITE INFORMATION

Elevation (masl):	660-663
Slope (%):	0-2
Aspect (º):	140, no aspect
Slope Position:	DP, LV, TO, LW
Structural Stage:	**2b**
Surficial Material:	L, F
Hydrodynamic Index:	Si-Mo
pH:	N
ASMR:	VW **6-8**
SNR:	**C,** (**D-E)**

Assumed Modifiers:	j
Mapped Modifiers:	y
Number of Plots:	42
Plot Numbers:	006, 044, 060, 074, 076, 079, 082, 086, 227, 229, 230, 231,407, 800, 804A, 804B, 807, 809, 810, 812, 818, 814, 1000, 1005, 1007,1006, 1017, 1019, 1029, 1046, 1051, 1056, 1058, 1059, 1078, 1083, 1084, 1091, 1098, 1110, 1111, 1115
List of Mapped Units:	BW2b, BWy2b

Occurrence:

The most common ecosystem.
Mapped in 202 out of 652 polygons.
407 ha out of 3533 ha

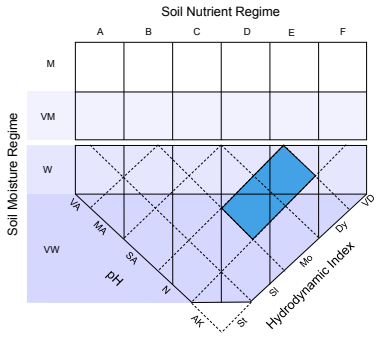
Tree Layer (0)	Shrub Layer (0)	Herb Layer (55-**79**-90)	Moss Layer (0-**46**-90)
		Carex utriculata, C. aquatilis, Hippurus vulgaris, Comarum palustre, Cerastium arvense	*Drepanocladus, Calliegeron, Amblystegium riparium*

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Marsh**	**Wm**	**Forb/Graminoid**	**HS**	**Swamp horsetail - Beaked sedge**

Mineral wetland dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded hydrolic conditions. These sites are restricted to the interface in mobile to dynamic systems.

This is a very uncommon site type and was restricted to complexes with either other marsh or swamp ecosystems. This site is not fully described and could be considered an extension of the BW but found in a position where water movement is consistently mobile.

The HS site is similar to the site description of the Swamp horsetail – Beaked sedge (Wm02) site described in Mackenzie and Moran (2004).



SITE INFORMATION	
Elevation (masl):	660
Slope (%):	0
Aspect (º):	140, no aspect
Slope Position:	LV
Structural Stage:	2a**, (2b)**
Surficial Material:	L, F
Hydrodynamic Index:	Mo-Dy
pH:	N
ASMR:	W-VW
SNR:	D-E

Assumed Modifiers:	j
Mapped Modifiers:	none
Number of Plots:	1
Plot Numbers:	820
List of Mapped Units:	HS2b

Occurrence:

Mapped in 2 out of 652 polygons.

0.3 ha out of 3533 ha

Note: The HS ecosystem in the photo is the darker green in the background.

Tree Layer (0)	Shrub Layer (0)	Herb Layer **(60)**	Moss Layer (0)
		Equisetum fluviatile, Carex aquatilis	

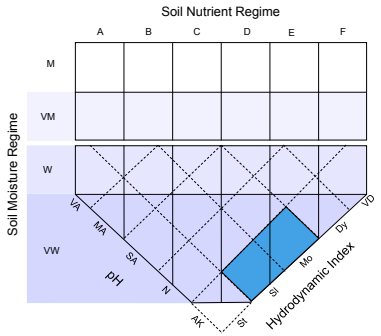
Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Marsh**	**Wm**	**Graminoid**	**AS**	**Awned sedge**

These sites are fairly restricted, are generally small and commonly occur in small potholes surrounded by forest where water levels are shallow. Standing water is slightly alkaline and substrates are fine-textured mineral soils. These are very rich sites and vegetative growth is vigorous.

Sites are dominated, and can be almost homogenous, with awned sedge (*Carex atherodes*), though there can be a very minor component of water sedge (*C. aquatilis*) found in some sites.

Very limited occurrence in the study area.

This site description is similar to the Awned Sedge Marsh (Wm03) described in Mackenzie and Moran (2004).



SITE INFORMATION	
Elevation (masl):	656-657
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	LV, DP
Structural Stage:	**2b**
Surficial Material:	L, F
Hydrodynamic Index:	Sl-Mo
pH:	Ak
ASMR:	VW
SNR:	D-E

Assumed Modifiers:	j
Mapped Modifiers:	none
Number of Plots:	1
Plot Numbers:	070
List of Mapped Units:	AS2b

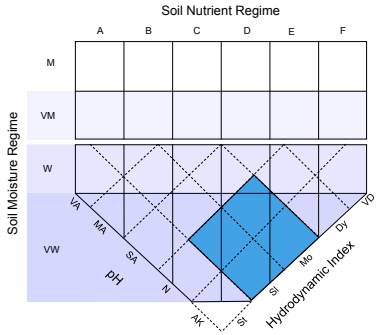
Occurrence:

Mapped in 7 out of 652 polygons, all sites in Lewes Marsh.
7 ha out of 3533 haa.

Tree Layer (0)	Shrub Layer (0)	Herb Layer (95)	Moss Layer (4)
		Carex atherodes, C. aquatilis	Minor – *Drepanocladus* spp.

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Marsh**	**Wm**	**Graminoid**	**MA**	**Mannagrass**

Marsh wetland dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded conditions, typically with standing water of at least 30 cm. This is an uncommon site association that is usually fairly small and occurs in standing water at the margins of lakes, ponds and slow-moving streams, typically on fine textured and mucky sediments. It is usually found adjacent to BW ecosites that are in slightly drier conditions or the shallow water sites of PM or BM.



Mannagrass (*Glyceria* spp.) dominates the emergent macrophytes. There is usually a minor component of *Carex aquatilis or C. utriculata,* though the sedges do not seem to thrive in these sites. Aquatics such as *Callitriche* spp. and *Hippurus vulgaris* are typically present, and in some situations there was a moderate cover of *Eleocharis acicularis, Subularia aquatica, Utricularia* spp. and *Ranunculus* spp. There may be a moss cover which when present is dominated by brown mosses.

There are similarities between this site to the Northern mannagrass site association described on page 117 in Mackenzie and Moran (2004).

SITE INFORMATION

Elevation (masl):	657-660
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	DP, LV
Structural Stage:	**2b**
Surficial Material:	L, F
Hydrodynamic Index:	Sl-Mo
pH:	N-Ak
ASMR:	VW
SNR:	C, **D-E**

Assumed Modifiers:	j, f
Mapped Modifiers:	none
Number of Plots:	7
Plot Numbers:	041, 092, 088, 094, 813, 808, 1104
List of Mapped Units:	MA2b

Occurrence:

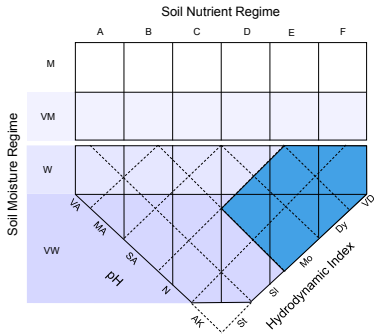
Relatively uncommon in project area.
Mapped in 18 out of 652 polygons.
14.7 ha out of 3533 ha.

Tree Layer (0)	Shrub Layer (0)	Herb Layer (80-**85**-90)	Moss Layer (0-**20**-40)
		Glyceria borealis, *Carex aquatilis, C. utriculata Ranunculus* spp., *Callitriche* spp, *Hippurus vulgaris*, *Subularia aquatica, Utricularia* spp	*Drepanocladus, Callliergon giganteum, Amblystegium riparium*

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Marsh**	**Wm**	**Graminoid**	**SC**	**Sedge - Cinquefoil**

Marsh wetland on firm mineral soils dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded conditions, with up to 30 cm of standing water.

Graminoid and forb site with sedges and cinquefoil occurring rooted in a saturated soils. This ecosite commonly occurs in areas where there is mobile or dynamic water movement and tends to have more exposure to wave and water action. Typically found on lake margins and is exposed early in the growing season.



Marsh cinquefoil (*Comarum palustris*) and water sedge (*Carex aquatilis*) are dominant on the SC site. The species diversity on these sites is fairly low and other species that may occur include: *Calamagrostis alcateis, Carex saxatilis, and Carex utriculata.* Brown mosses occur but are generally found in micro – depressions between mounds of *C. palustris* and sedges. These sites are easy to spot due to their vibrant red color as the marsh cinquefoil changes color in July.

SITE INFORMATION

Elevation (masl):	661-663
Slope (%):	0
Aspect (º):	999
Slope Position:	**LV**
Structural Stage:	**2a, 2b**
Surficial Material:	**L, F**
Hydrodynamic Index:	Mo-VD
pH:	N-Ak
ASMR:	W-VW
SNR:	C-**D**

Assumed Modifiers:	j
Mapped Modifiers:	none
Number of Plots:	15
Plot Numbers:	007, 054, 066, 078, 054, 066, 078, 1021, 1047, 1060, 1066, 1069, 1074, 1075, 1077, 1093, 1106, 09708
List of Mapped Units:	SC2a

Occurrence:

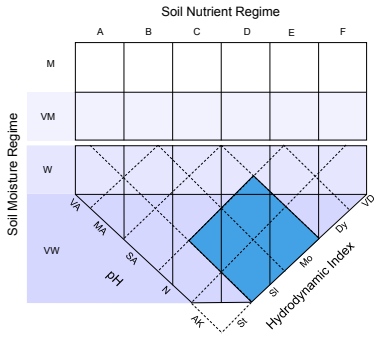
Mapped in 83 out of 652 polygons.
75 ha out of 3533 ha

Tree Layer (0)	**Shrub Layer** (0)	**Herb Layer** (90-**93**-96)	**Moss Layer** (**80**)
		Comarum palustre, Carex aquatilis, Calamagrostis alcateis, Carex saxatilis, Carex utriculata	*Drepanocladus, Calligeron*

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Marsh**	**Wm**	**Graminoid**	**BR**	**Bulrush marsh**

Marsh wetland on soft mineral soils dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded conditions, often in complex with aquatic bed ponds and shallow protected sites. The water at these sites tended to be shallow, warm and alkaline.

These sites are dominated by *Scirpus* spp. and *Cicuta* spp..



SITE INFORMATION

Elevation (masl):	654-655
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	**LV**
Structural Stage:	2b, 2c
Surficial Material:	**L**, F
Hydrodynamic Index:	Sl-Mo
pH:	N-Ak
ASMR:	VW
SNR:	D-E

Assumed Modifiers:	j, f
Mapped Modifiers:	none
Number of Plots:	1
Plot Numbers:	1103
List of Mapped Units:	BR2b

Occurrence:

This site type is uncommon and found only in complex with other wetland types.

Mapped in 5 out of 652 polygons.

5.4 ha out of 3533 ha.

Tree Layer (0)	Shrub Layer (0)	Herb Layer **(45)**	Moss Layer (5-**35**-50)
		Scirpus spp., *Cicuta* spp.	*Drepanocladus* spp., *Amblystegium riparium, Palustriella alcate* Other brown mosses

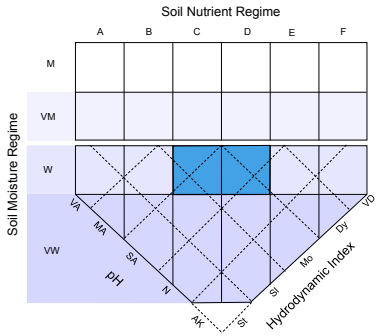
Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Swamp**	**Ws**	**Coniferous Forest**	**SG**	**Sw - Willow - Glowmoss**

Low productivity forested swamps on cold fine textured Gleysols with a moderate to well decomposed thin organic surface tier of humic peat. Occurring on level sites. These sites are often associated with marshes and shrub swamps. Due to the flow of ground water through this site and the cold conditions there is a different mix of species than in bog forests.

This site is uncommon in the wetland complexes typed and occurred on level areas on inactive fluvial sites. These sites are wet with saturated soils but are not frequently under water. White spruce growing on these sites is growing poorly with much of the taller over story as standing dead.

Other species that are found are *Salix glauca, S. commutata, Ribes hudsonicus, Calamagrostis canadensis, Equisetum arvense, Aulacomnium palustre and Hylocomium splendens.*

This site has similarities to the Ws15 SwSb-Labrador tea-Glow Moss (DeLong *et al*. 2011) and the BWBSdk1 - 11 (Sw-Willow-Glowmoss) described in Banner *et al*. (1993).



SITE INFORMATION	
Elevation (masl):	661-662
Slope (%):	0-4
Aspect (º):	no aspect
Slope Position:	**LV**
Structural Stage:	**3b, 6**
Surficial Material:	L, **F**
Hydrodynamic Index:	SI
pH:	SA
ASMR:	VM-W (6)
SNR:	C-D

Assumed Modifiers:	
Mapped Modifiers:	none
Number of Plots:	2
Plot Numbers:	815, 306
List of Mapped Units:	SG3b, SG4C, SG5C, SG6C

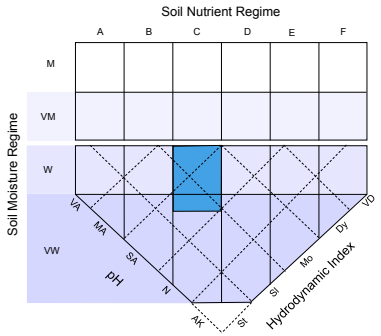
Occurrence:

Mapped in 12 out of 652 polygons.
21 ha out of 3533 ha

Tree Layer (0-**10**-20)	**Shrub Layer** (15-**20**-25)	**Herb Layer** (10-**20**-30)	**Moss Layer** (65-**80**-95)
Picea glauca	*Picea glauca, Salix glauca, S. commutata, Ribes hudsonicus*	*Calamagrostis canadensis, Equisetum arvense, Epilobium angustifolium, Stellaria longifolia*	*Hylocomium splendens, Aulacomnium palustre, Dicranum* spp.

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Swamp**	**Ws**	**Shrub**	**TC**	**Tea-leaved willow - Sedge - Cinquefoil**

Tall shrub swamp on fine-textured imperfectly drained soils. Can be some micro-topography with shrubs rooted on elevated microsites and sedges and cinquefoil occurring rooted in a saturated soils. In some situations this development can be more extreme so that the willows appear to be growing on pedestals. This ecosite tends to occur in areas of more mobile or dynamic water movement and tend to have more exposure to water movement.



The shrub layer consists of tea-leaved willow (*Salix planifolia*) and at some sites this cover can be tall and vigorous whereas at others there is evidence of die-back where bands of willow have not survived. The herbaceous layer is almost entirely covered by water sedge (*Carex aquatilis*) and marsh cinquefoil (*Comarum palustre*). If there is a bryophyte layer it is sparse and inconsistent.

SITE INFORMATION

Elevation (masl):	660
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	**LV**
Structural Stage:	**2b, 3a, 3b**
Surficial Material:	**L, F**
Hydrodynamic Index:	Mo
pH:	N-Ak
ASMR:	W-VW
SNR:	C

Assumed Modifiers:	h, j, f
Mapped Modifiers:	none
Number of Plots:	6
Plot Numbers:	059, 222, 1004, 1076, 1090, 1092
List of Mapped Units:	TC3a, TC3b

Occurrence:

Mapped in 107 out of 652 polygons.
22 ha out of 3533 ha

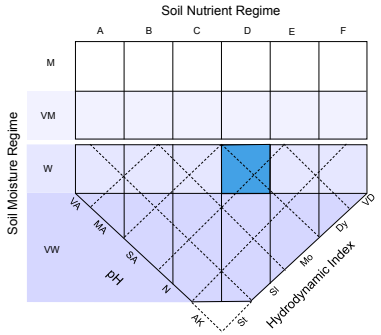
Tree Layer	Shrub Layer (20-**25**-30)	Herb Layer (70-**78**-85)	Moss Layer **(15)**
	Salix planifolia	*Carex aquatilis, Comarum palustre*	*Mnium* spp., *Brachythecium* spp.

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Swamp**	**Ws**	**Shrub**	**TS**	**Tea-leaved Willow - Sedge - Brown Moss**

Tall shrub swamp on deep fine-textured soils, often with fine mixing of organics in the top layer. This ecosite tends to occur in areas of more sluggish water movement and less exposure to wave action. Soils are poorly to imperfectly drained and are usually gleysolic.

There can be pronounced micro-topography with shrubs rooted on elevated hummocks and sedges and mosses occurring in the depressed areas between, rooted in saturated soils. Brown mosses are dominated by *Drepanocladus* and can occur in small mats between elevated sites. The tea-leaved willow (*Salix planifolia*) makes up the shrub layer; the herbaceous layer is almost entirely sedges, with some patches of marsh cinquefoil and few other forbs.

This site is similar to the TC and on the map they are not easily differentiated, except for the bright red foliage of the marsh cinquefoil in the TC. This site may be located on “mucky” soils.



SITE INFORMATION

Elevation (masl):	659-668
Slope (%):	0-3
Aspect (º):	no aspect
Slope Position:	DP, LV, TO
Structural Stage:	**3a, 3b**
Surficial Material:	L, F
Hydrodynamic Index:	Sl
pH:	N-Ak
ASMR:	W
SNR:	D

Assumed Modifiers:	j, f
Mapped Modifiers:	h
Number of Plots:	29
Plot Numbers:	403, 405, 406, 043, 046, 048, 056, 905, 080, 233, 228b, 234, 806, 811, 816, 817, 822, 1012, 1030, 1036, 1053, 1057, 1061, 1062, 1107, 1109, 9701
List of Mapped Units:	TS3a, TSh3a, TS3b

Occurrence:

Mapped in 107 out of 652 polygons.
265 ha out of 3533 ha

Tree Layer (0)	**Shrub Layer** (10-**27**-40)	**Herb Layer** (30-**56**-99)	**Moss Layer** (8-**73**-90)
	Salix planifolia, *(Salix glauca, Salix commutata)*	*Carex utriculata, C. aquatilis, C. saxatilis, Comarum palustre* *(Juncus balticus, Phragmites australis, Triglochin maritime)*	*Drepanocladus* spp.

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Shallow Open Water**	**Wa**	**Aquatic**	**BM**	**Brown Mosses**

This ecosite generally occur in areas of slow or stagnant water flow that are protected from direct exposure to wave and wind action. They are usually found in complex with other aquatic types, but are differentiated by the dominance of matt forming mosses that can exclude extensive marsh or aquatic rooted forb growth.

This site is dominated by brown mosses of the *Drepanocladus* genus, often with a minor component of other vegetation such as sedges (*Carex* spp.*)*, mannagrass (*Glyceria* spp.*)*, white water-buttercup (*Ranunculus aquatilis)*, spike rush (*Eleocharis acicularis*),and tufted hairgrass (*Deschampsia cespitosa*) in drier sites.

Note: the photo is from early June before the lake level has risen and vegetation is just starting to grow.

SITE INFORMATION	
Elevation (masl):	662
Slope (%):	0-2
Aspect (º):	90, no aspect
Slope Position:	**LV**
Structural Stage:	**2b**, 2c
Surficial Material:	L, F
Hydrodynamic Index:	St-Sl
pH:	N-Ak
ASMR:	VW
SNR:	D-E

Assumed Modifiers:	j
Mapped Modifiers:	none
Number of Plots:	7
Plot Numbers:	004, 040, 1013, 1034, 1049, 1072, 1073
List of Mapped Units:	BM2a

Occurrence:

Mapped in 57 out of 652 polygons.
40 ha out of 3533 ha

Tree Layer (0)	Shrub Layer (0)	Herb Layer (22-**41**-59)	Moss Layer (65-**78**-90)
		Carex aquatilis. C. saxatilis, Glyceria spp.*, Ranunculus aquatilis, Eleocharis acicularis, Deschampsia cespitosa*	*Drepanocladus* spp.*, Calliegeron* spp.*, Amblystegium riparium, Palustriella falcata*

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Shallow Open Water**	**Wa**	**Aquatic**	**PM**	**Pondweed - Mare's tail - Mixed aquatics**

This aquatic community occurs on fine "mucky" sediments where water flow is sluggish. These areas tend to be backwater channels off of main channels and can be moderate depths.

Species can be are diverse, usually with a mix of pondweed (*Potamogeton*) species, mare's tail (*Hippurus vulgaris*), water-starworts (*Callitriche* spp.), spike rush (*Eleocharis acicularis*), and even small amounts of brown mosses and sedges. Other species that can occur include *Sparganium* spp.*, Lemna* spp.*,* and *Ranunculus* spp.*.* Emergent macrophytes are restricted to < 10% cover.

Note: the PM type is in the foreground in the aquatic portion of the photo.

SITE INFORMATION	
Elevation (masl):	not recorded
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	**DP, LV**
Structural Stage:	**2a, 2b**, 2c
Surficial Material:	L, F
Hydrodynamic Index:	St-Sl
pH:	N-Ak
ASMR:	VW
SNR:	D-E

Assumed Modifiers:	f
Mapped Modifiers:	none
Number of Plots:	23
Plot Numbers:	005, 042, 049, 055, 062, 065, 083, 084, 087, 089, 091, 819, 1001, 1035, 1054, 1082, 1100, 1105, 1108, 1114, 1116, 1119, 1121
List of Mapped Units:	PM2c

Occurrence:

Mapped in 93 polygons out of 652.

153 ha out of 3533 ha

Tree Layer	Shrub Layer	Herb Layer (30-**55**-80)	Moss Layer (0-**40**-80)
		Potamogeton spp., *Hippurus vulgaris*, *Callitriche* spp., *Eleocharis,*spp. *Sparganium* spp.*, Lemna* spp.*, Ranunculus* spp.	*Drepanocladus* spp.

Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Shallow Open Water**	**Wa**	**Aquatic**	**PP**	**Pondweed Deep Pond**

Occurring in deeper water than the PM ecosite, this community appears to be relatively simple with only *Potamogeton* species and no other aquatics. Water depth is generally greater than 2m.

The PP has been observed in the centre of slow moving to sluggish, vegetated channels. It was not a common ecosystem and is considered to be not well described due the difficulties in sampling this deeper water aquatic type.

Note: The PP ecosite has been mapped in areas such as the deeper vegetated portion of this channel.

SITE INFORMATION	
Elevation (masl):	
Slope (%):	0
Aspect (º):	no aspect
Slope Position:	**DP, LV**
Structural Stage:	2c
Surficial Material:	L, F
Hydrodynamic Index:	Sl-Mo
pH:	N-Ak
ASMR:	VW
SNR:	D

Assumed Modifiers:	f
Mapped Modifiers:	none
Number of Plots:	2
Plot Numbers:	064, 1067
List of Mapped Units:	PP2c

Occurrence:

Mapped in 10 out of 652 polygons.
59 ha out of 3533 ha

Tree Layer (0)	**Shrub Layer** (0)	**Herb Layer** (20-**40**-60)	**Moss Layer** (0-**20**-40)
		Potemageton spp.	*Drepanocladus* spp.

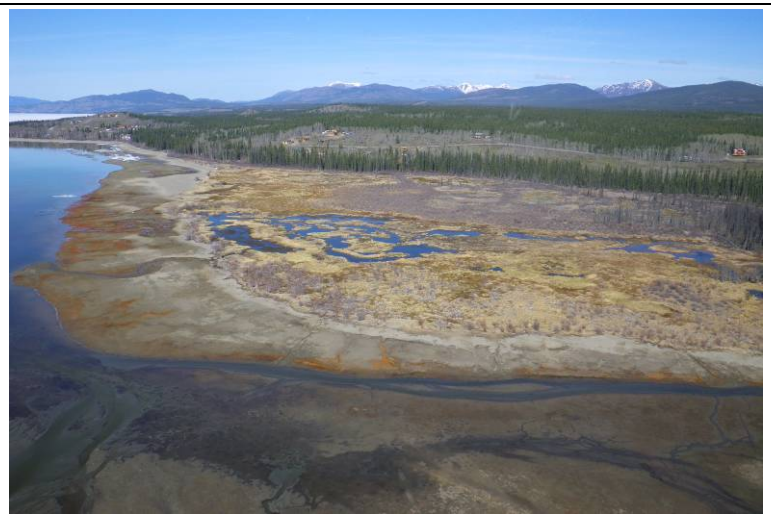
Bioclimatic Zone	Site Class	Class Code	Cover Types	Ecosite Code	Ecosite Unit Name
BOL	**Shallow Open Water**	**Wa**	**Aquatic**	**SR**	**Spike rush Mudflats**

These sites are typically found on shallow slope plain like areas. These sites are exposed early in the season and inundated for the remainder of the growing season once the lake water rises. Sediments are fine textured and ecosites are dominated by needle spike rush (*Eleocharis acicularis)* with minor cover of other aquatic species and some restricted patches of sedges.

These sites appear to be well-used feeding habitats early in the season (May and June) for aquatic birds in the area. These sites were mapped often in complex with mudflats and were relatively common at Nares, Monkey Beach and M'Clintock Bay. This site type is not likely to be extensive other than on these fine textured plains.

SITE INFORMATION

Elevation (masl):	647
Slope (%):	0-2
Aspect (º):	270, no aspect
Slope Position:	**LV**
Structural Stage:	2c
Surficial Material:	L
Hydrodynamic Index:	Mo
pH:	N-Ak
ASMR:	VW
SNR:	D-E



Assumed Modifiers:	j, f
Mapped Modifiers:	none
Number of Plots:	9
Plot Numbers:	1014, 1022, 1023, 1024, 1027, 1041, 1042, 1044, 09702,
List of Mapped Units:	SR2c

Occurrence:

Mapped in 53 out of 652 polygons.
387 ha out of 3533 ha.

Tree Layer (0)	Shrub Layer (0)	Herb Layer (30-**60**-70)	Moss Layer (0)
		Eleocharis acicularis, Carex aquatilis, Hippurus vulagaris	

SUMMARY OF MAPPED ECOSITE UNITS

A summary of ecosite units and their mapped areas was completed using the wetland ecosystem mapping and is presented in Table 3 and Table 4.

Table 3. Summary of the number of polygons and area of non-vegetated, sparsely vegetated and anthropogenic ecosite units within selected wetlands of the Southern Lakes Study Area.

Ecosite Code	Ecosite Unit Name	Total		Lewes Marsh		Monkey Beach		Nares Lake		Tagish/6 Mile	
		Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons
BE	Beach	22.0	16	2.6	4	2.8	4	1.8	6	14.8	2
CB	Cutbank	1.4	9	0.6	2	0.1	1	0.7	6		
LA	Lake	809.9	24	166.5	6	71.9	6	100.8	6	470.7	6
MU	Mudflat	56.7	21	9.9	6	1.6	1	15.7	9	29.5	5
PD	Pond	3.1	13	1.4	5	< 0.1	1			1.7	7
RI	River	263.5	13	227.6	5	0.2	1	1.3	2	34.4	5
RW	Rural	47.1	20	21.4	7			1.8	1	23.9	12
RZ	Road	6.8	11	1.4	2			4.7	4	0.7	5
	Total	1210.5	127	431.4	37	76.6	14	126.8	34	575.7	42

Table 4. Summary of the number of polygons and area of vegetated ecosite units within selected wetlands of the Southern Lakes Study Area.

Ecosite Code	Ecosite Unit Name	Total		Lewes Marsh		Monkey Beach		Nares Lake		Tagish/6 Mile	
		Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons
AS	Awned sedge	6.7	7	6.7	7						
BM	Brown Mosses	40.2	57	14.4	12	0.9	2	16.1	29	8.8	14
BR	Bulrush Marsh	5.4	5	5.1	3					0.3	2
BW	Beaked sedge - Water sedge	407.7	203	322.2	101	9.4	8	26.2	33	49.9	61
HS	Swamp horsetail - Beaked sedge	0.3	2	0.1	1	0.2	1				
MA	Mannagrass	14.7	18	10.1	8	0.4	1	3.7	7	0.5	2
PM	Pondweed - Mare's tail - Mixed Aquatics	153.0	93	113.2	39	1.4	1	23.0	22	15.4	31

Ecosite Code	Ecosite Unit Name	Total		Lewes Marsh		Monkey Beach		Nares Lake		Tagish/6 Mile	
		Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons	Area (ha)	# Polygons
PP	Pondweed Deep Pond	59.0	10	32.4	5			7.3	2	19.3	3
SB	Sw - Balsam Poplar - Willow	17.7	13	9.8	9	4.2	1			3.7	3
SC	Sedge - Cinquefoil	75.7	85	20.2	17	5.1	6	25.0	31	25.4	31
SF	Sedge Fen	10.4	3							10.4	3
SG	Sw - Willow - Glowmoss	20.9	12	3.6	4	16.5	6			0.8	2
SM	Sw - Feathermoss	217.8	19	203.8	15	5.9	1			8.1	3
SP	SwAt - Willow	338.9	68	281.8	31	5.6	6	7.6	8	43.9	23
SR	Spike rush Mudflats	387.6	54	223.2	16	61.6	5	61.5	20	41.3	13
SS	SwPl - Soopolalie - Kinnikinick	24.2	4	24.2	4						
TC	Tea-leaved willow - Sedge - Cinquefoil	21.5	23	4.6	5	1.3	2	2.6	2	13.0	14
TH	Tufted hairgrass Meadow	13.3	9	13.0	6					0.3	3
TS	Tea-leaved willow - Sedge - Brown moss	265.4	107	213.0	61	25.1	14	11.5	14	15.8	18
WB	Willow - Scrub birch	6.0	1	6.0	1						
WC	Willow - Bluejoint	117.9	93	62.3	38	9.9	7	14.8	14	30.9	34
WF	Willow - Sedge	5.4	3	1.9	2					3.5	1
WS	Willow Shrub	112.9	22	98.8	13	2.1	1			12.1	8
	Total	2,323.0	911	1,670.5	398	149.5	62	199.4	182	303.6	269

SAMPLING RATE AND MAP RELIABILITY

Polygon Sampling Rate

A summary of the polygon sampling rate is provided in Table 5. We mapped 652 polygons, totalling 3,533.5 ha within the selected wetlands. We completed 238 field plots in 2010, and an additional 58 ground inspections in 2011 during the CABIN monitoring for a total of 296 plots. To be efficient, many plots were conducted in close proximity of each other, sampling different ecosystems within the same complex polygon. The total number of polygons that contained plots was 191, which provides a polygon inspection rate of 30%. This inspection rate is within the criteria for Survey Level 3 of 26 to 50% polygons inspected that is outlined in RIC (1998). The average inspection rate for vegetated areas in the wetlands of 7.8 ha. per plot is within the density range outlined for Survey Level 2 (5.1 to 9 ha/plot) (RIC 1998).

We completed 1% of the plots as full plots, 39% as ground inspections, and 60% as visual inspections. This was more ground inspections, but fewer full plots and visual inspections than the suggested ratio of 5% full, 20% ground, and 70% visual. Our completing almost double the number of suggested ground inspections provided a relatively detailed and thorough coverage of the wetland ecosystems. We felt that the shorter time to complete each ground inspection than to complete a full plot provided a better balance of information for the wetland ecosystems.

Table 5. Polygon sampling rate within selected wetlands within the Southern Lakes Study Area.

	Total Study Area	Lewes Marsh Wetland	Monkey Beach Wetland	Nares Lake Wetland	Tagish /6 Mile Wetland
Total Mapped Area (Ha.)	3,533.5	2,102.0	226.1	326.1	879.3
Mapped Veg. Area (Ha.)	2,323.0	1,670.5	149.5	199.4	303.6
% of Total Mapped Area	100%	59%	6%	9%	25%
# Map Polygons	652	269	53	127	203
% of Map Polygons	100%	41%	8%	19%	31%
# Full Plots	3 (1%)	1	0	2	0
# Ground Inspections	116 (39%)	70	8	29	9
# Visual Inspections	177 (60%)	91	3	42	41
Total # Field Plots	296	162	11	73	50
# Polygons with Plots	191	95	10	46	40
% Polygons with Plots	29%	35%	19%	36%	20%
% Polygons with Full or Ground Plots	18%	26%	15%	24%	4%
# Ha. / Plot in Veg. Areas	7.8	10.3	13.6	2.7	6.1

Proportionally, the number of polygons visited within each wetland area was similar to the proportion of polygons within each area. There is a slight over-sampling in Lewes Marsh and Nares wetland, due to more intensive elevation sampling coupled with ecosystem descriptions completed during the detailed DGPS ecosystem elevation work, as well as the additional plots completed in 2011 for the CABIN monitoring work. These wetlands were also considered to be more complex, so the additional sampling greatly improved the development of the ecosite unit classification and descriptions.

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Map Reliability

The high quality of the colour digital aerial photographs and use of the 3D polygon delineation software allowed for very detailed polygons delineation. As the photographs were obtained at the peak of vegetation growth and essentially at the same time as the majority of the field work, there was a strong correlation to what the field team was seeing on the ground and what the photos portrayed.

The polygon sampling rate of 29% and a plot density of 7.8 ha/plot indicates that a significant portion of the wetland mapping areas were assessed, with 18% of all polygons having been assessed with either a full plot or ground inspection plot.

Aerial surveys for waterfowl and mammals were conducted in March, April, May, June and July, allowing extensive oblique aerial photos to be obtained as well as allowing members of the field and mapping teams to observe the wetlands at various water levels and stages of vegetation growth. In addition, the completion of the CABIN monitoring plots in 2011, provided an opportunity for a review of the mapping and collection of additional ecosystem information to aid in the completion of the ecosite unit descriptions.

Overall, we feel that the ecosite units described for this project are an accurate representation of the wetland ecosystems found within the selected wetlands in the Southern Lakes Study Area, and that the mapping is accurate at a 1:10,000 scale.

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APPENDIX A: 1:10,000 MAPS OF THE WETLAND ECOSYSTEM MAPPING AREAS

Map 1 – Lewes Marsh Wetland

Map 2 – Monkey Beach Wetland

Map 3 – Nares Lake Wetland

Map 4 – Tagish / 6 Mile Wetland

APPENDIX B: KEY TO ECOSYSTEM UNIT DESCRIPTION CODES

Bioclimate Region and Zone

Bioclimate regions and zones stratify the landscape into broad physiographically and climatically uniform units. The Southern Lakes Study Area is within the South-central Mountains and Plateau Bioclimate Region and the Boreal Low (BOL) Bioclimate Zone (Flynn and Francis 2011).

Realms, Groups and Classes

Realm, Group and Class designations are broad level groupings of plant associations with similar vegetation and environment characteristics, which help identify associations of ecosystems and were adapted from Mackenzie and Moran (2004).

Realm

Realms are the broadest site units and describe broad similarities in site conditions based mostly on water source and other hydrological factors. There are three primary Realms (Terrestrial, Freshwater and Marine) and four secondary Realms (Wetland, Estuarine, Intertidal and Wedge) (Figure B-1).

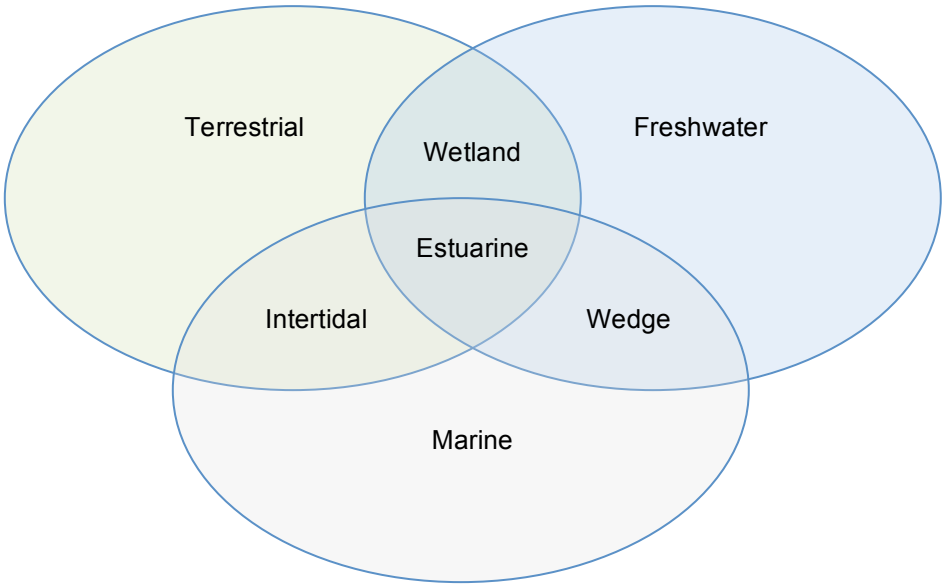

Figure B-1. Relationship between primary and secondary Realms (from Mackenzie and Moran, 2004).

The ecosite units identified and mapped within the selected wetlands in the study area were all contained within the Terrestrial and Wetland Realm.

Group

The Group describes functionally similar classes based on an ecological attribute that is common between the classes. For example, within the Wetland Realm, there are Mineral and Peatland Groups that are distinguished by the presence of deep, fibric peat accumulations in the Peatland Group.

There are three Groups of ecosite units identified and mapped within the study area: the Flood Group within the Terrestrial Realm; and the Peatland and Mineral Groups within the Wetland Realm.

Class

The Class as defined in this report follows the concepts outlined in Mackenzie and Moran (2004), which are based on the Wetland Class of the Canadian Wetland Classification System (Warner and Rubec 1997). The Ecosystem Class codes and their descriptions that were used in the ecosite unit descriptions are outlined in Table B-1.

Table B-1. Classes of ecosite units (from Mackenzie and Moran 2004).

Class	Class Code	Description
Upland Forest	Up	Upland terrestrial sites
High bench	Fh	Benches above normal waterflow, brief flood period
Mid bench	Fm	Elevated benches flooded most years for less than 21 days, areas of sedimentation
Low bench	Fl	Sites directly adjacent to water flooded annually for greater than 21 days, significant annual erosion and deposition
Shrub carr	Sc	Frost-prone depressions with fine- to medium textured moist soils
Grassland meadow	Gs	Slightly saline soils, prone to drying but having brief periods of inundation
Fen	Wf	Primarily groundwater fed, pH > 5.0, greater than 40 cm fibric/mesic peat
Marsh	Wm	Mineral soils or well-humified peat, protracted shallow flooding (0.1 to 2.0 m)
Swamp	Ws	Mineral soils or well-humified peat, protracted shallow flooding (0.1 to 1.0 m), significant water flow
Shallow Open Water	Wa	Prolonged (greater than 100 days) or permanent deep flooding (0.5 to 2.0 m)

Ecosite Units

Ecosite units have been developed to describe variation at the site level within the bioclimate units as per Flynn and Francis (2011) and the wetland classification units in Mackenzie and Moran (2004). The ecosite unit describes the areas that support a specific plant association and reflecting a specified range of soil moisture and nutrient regimes within the subzone. A two-letter ecosite code has been assigned to each ecosite unit. Generally, an ecosite unit is a relatively homogenous unit with regard to soils, surficial materials, topographic position, and hydrodynamic index; however, there are some situations where closely associated ecosystems (either ecologically or spatially) were combined into a single ecosite unit.

Ecosite units were named based on the dominant vegetation types found within the ecosystem as per guidelines outlined in Pojar *et al.* (1991) and Banner *et al.* (1993). In general, sites were identified using up to three vegetation species with the dominant vegetation layers appearing first, although some names included a descriptor of the wetland class (e.g. fen, marsh, etc.) or a general descriptor (e.g. shrub). Ecosite unit codes were generally the first letters of the two dominant vegetation types, although other combinations based on the ecosite unit name were used to ensure there were no duplicate codes.

Non-forested sparsely vegetated, non-vegetated and anthropogenic ecosite units such as cutbanks, rock outcrops, and roads were classified using standard two letter codes and descriptions from *Standards for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998).

Site Modifiers

Site modifiers are used to refine ecosite units into more specific ecosite units based on adjusting the assumed topography, moisture and soil as per the concepts outlined in RIC (1998). Typical environmental conditions such as topography (e.g. aspect, slope), soil (e.g. texture, percent coarse fragments, depth) and moisture are identified during the classification of the ecosite units and these modifiers are designated as assumed. If atypical situations of the ecosite units are mapped, then a modifier is used to distinguish that ecosystem and the ecosite unit. The site modifiers codes and definitions are listed in Table B-2.

Table B-2. Site modifiers for ecosite units (from RIC 1998).

Code	Criteria
Topography	
a	Active floodplain: located on an active fluvial floodplain, level or very gently sloping surface bordering a river
h	Hummocky terrain
j	gentle slope: < 25% in the interior, less than 35% in the CWH, CDF and MH zones
k	cool aspect: occurs on aspects 285–135, on moderately steep slopes (25% - 100% in the interior, 35%–100% in the CWH, CDFmm and MH zones)
q	very steep cool aspect–very steep slopes (< 100%) with aspects 285–135
w	warm aspect: 135–285, on moderately steep slopes (25% - 100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones)
z	very steep warm aspect –slopes > 100% on aspects 135–285
Moisture	
x	drier than typical
y	moister than typical
Soil	
c	coarse-textured soils (includes sand and loamy sand; and sandy loam, loam and sandy clay loam with over 70% coarse fragment volume)
d	deep soil: >100 cm to bedrock
f	fine textured soils, Si, SiL, SCL with <70% coarse fragment content volume
p	peaty: on deep organics or a peaty surface (15–60 cm) over mineral materials
s	shallow soils: 20–100 cm to bedrock
v	very shallow soils: < 20 cm to bedrock

Structural Stage

The structural stage of the ecosite unit describes the dominant stand appearance of the ecosystem being described and refers to its composition, height, and structural characteristics. Structural stage modifiers were used to subdivide shrub and herb structural stages. Standardized codes and definitions for structural stage are listed in Table B-3 and are based on RIC (1998), with some modifications to height classes and vegetation attributes provided outlined Flynn and Francis (2011) that better reflect boreal and taiga environments. Wetlands

with stunted trees were defined as Coniferous Tall Shrub and are equivalent to the term "treed" used in the Canadian Wetland classification (Warner and Rubec 1997).

Table B-3. Structural stage codes for ecosite units (from RIC 1998 and Flynn and Francis 2011).

Structural Stage[1]	**Description**
Post-disturbance stages or environmentally induced structural development	
1 Sparse/bryoid[2]	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance less than 20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover less than 20%; total tree layer cover less than 10%.
Substages	
1a Sparse	1a Sparse Less than 10% vegetation cover.
1b Bryoid	Bryophyte- and lichen-dominated communities (greater than ½ of total vegetation cover).
Stand initiation stages or environmentally induced structural development	
2 Herb[2]	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover less than 10%, shrubby layer cover less than or equal to 20% or less than 1/3 of total cover; time since disturbance less than 20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
Substages	
2a Forb -dominated	Herbaceous communities dominated (greater than ½ o the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid – dominated	Herbaceous communities dominated (greater than ½ of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic	Herbaceous communities dominated (greater than ½ of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d Dwarf-shrub – dominated	Communities dominated (greater than ½ of the total herb cover) by dwarf woody species.
3 Shrub/Herb[3]	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fir damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover less than 10%; shrub layer cover greater than 20% or greater than or equal to 1/3 of total cover.
Substages	
3a Low shrub[3]	Dominated by shrub layer vegetation less than 2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 20 years for normal forest succession.

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Structural Stage[1]	Description
3b Tall shrub[3]	Dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
Stem exclusion stages	
4 Pole/Sapling[4]	Trees > 10m tall, typically dense stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually > 10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stand at the same structural stage; time since disturbance ins usually < 40 years for normal forest succession; up to 100+ years for dense (5,00015,000+ stems per ha) stagnant stands.
5 Young Forest[4]	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions.
Understory re-initiation stage	
6 Mature Forest[4]	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years.
Old-growth stage	
7 Old Forest[4]	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and coarse woody debris in all stages of decomposition typical, as are patchy understories; understories may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally greater than 140 years.

1. In the assessment of structural state, structural features and age criteria should be considered together. Broadleaf stands will generally be younger than coniferous stands belonging to the same structural stage.
2. Substages 1a, 1b, and 2a-d should be used if photo interpretation is possible, otherwise, stage 1 and 2 should be used.
3. Substages 3a and 3b may, for example, include very old krummholtz less than 2 m tall and very old, low productivity stands < 10 m tall. Stage 3, without additional substages, should be used for regenerating forest communities that are herb or shrub dominated, including shrub layers consisting of only 10%-20% tree species, and undergoing normal succession toward climax forest (e.g., burned areas).
4. Structural stages 4–7 will typically be estimated from a combination of attributes based on forest inventory maps and aerial photography. In addition to structural stage designation, actual age for forested units can be estimated and included as an attribute in the database, if required.

Stand Composition Modifiers

Stand composition modifiers are used to describe the dominant stand composition and were mapped for all forested ecosystems. These modifiers differentiate coniferous, broadleaf and mixed stands and the codes and their definitions are outlined in Table B-4.

Table B-4. Stand composition modifiers (from RIC 1998).

Code	Description
C	Coniferous – greater than ¾ of total tree layer cover is coniferous

Code	Description
B	Broadleaf – greater than ¾ of total tree layer cover is broadleaf
M	Mixed – neither coniferous or broadleaf account for > ¾ of total tree layer cover

The Wetland Edatopic Grid Codes

The wetland edatopic grid outlined in Mackenzie and Moran (2004) was adopted for this project to aid classification and description of wetland and associated sites (Figure B-2). The four axes of the grid describe specific site characteristics and are defined in the following sections and are from Mackenzie and Moran (2004).

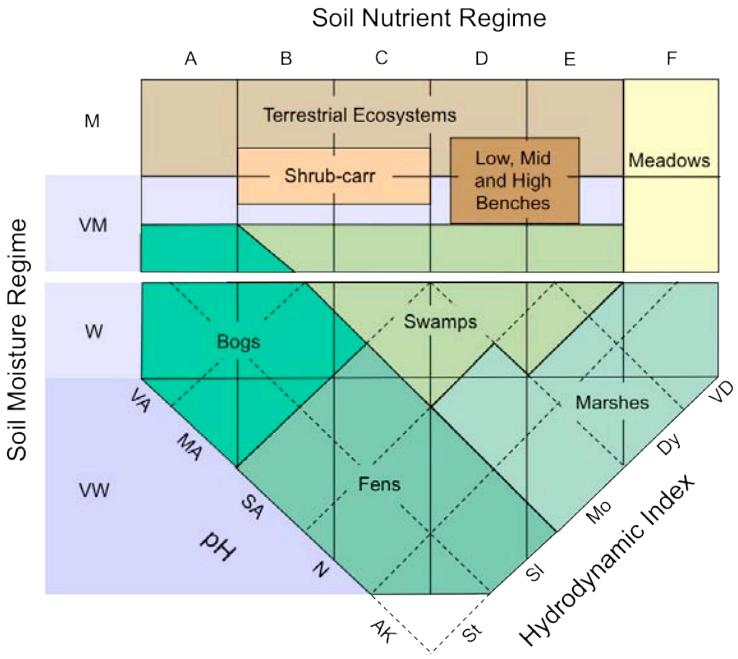

Figure B-2. Marsh Lake Wetland Edatopic Grid (adapted from Mackenzie and Moran 2004).

Soil Nutrient Regime

The Soil Nutrient Regime (SNR) is the essential soil nutrients available to vascular plants over a period of several years (Pojar *et al*. 1987). Six SNR classes are recognized from Very Poor (A) to Hyper Rich (F). Wetland and wetland-related ecosystems can occur throughout the range. Environmental factors that are useful for determining nutrient status in wetlands include: available nutrients, water pH, vonPost of surface tier, groundwater flow through site, C:N ratio, surface tier material, water colour, colour of surface peat, and surface tier saturation. Criteria for evaluating these factors are outline in Table B-5. Some wetland plant species can be used as indicators of nutrient regime as well.

Soil Moisture Regime

Most wetlands have a subhydric or hydric relative soil moisture regime (RSMR) or wet to very wet Actual Soil Moist Regime (ASMR). However, flood ecosystems and some wetland classes such as marshes and some swamps have a fluctuating water table. The assessment of soil moisture regime should therefore be based on mid-season water regime, not on flood or drought conditions. Sites with fluctuating water tables require an assessment of duration of flooding.

The ASMR is the average amount of soil water annually available for evapotranspiration by vascular plants over several years. There are nine moisture categories from Very Dry to Very Wet. Wetlands are only found on Wet to Very Wet sites. The wetland edatopic grid is therefore limited to this range. Codes of soil moisture classes used in this project are listed in Table B-6.

In general, wet sites are those sites on mineral soils where the water table is near but below the soil surface for most the growing season as indicated by prominent mottles or gleying within 30 cm of the soil surface and sites on organic soils where the water table may drop below 30 cm of the soil surface but the surface peat remains wet.

Very wet sites are those where the water table is at or above the soil surface for the majority of the season, as indicated by being flooded to mid-season, blue-grey gleyed horizons at the soil surface, or organic soils on floating mats or saturated at the surface in mid-season.

Table B-5. Environmental characteristics useful for determining nutrient status in wetlands (from Mackenzie and Moran 2004).

SNR	A Very Poor	B Poor	C Medium	D Rich	E Very Rich	F Hyper
Available nutrients	very low	low	average	plentiful	abundant	excess alkali or salt accumulation
Water pH	<5.0	4.5 – 6.0	5.0 – 6.5	6.0 – 7.4	6.5 – 8.0	8.0+
vonPost of surface tier	1 – 3	3 – 6	4 – 7	7 – 10	8 – 10	
Ground - water flow through site	stagnant		seasonal seepage		continuous seepage	
C:N ratio	High		Medium		Low	
Surface tier material	Fibrimor		Mesimor	Saprimoder	Marl	Mineral
Water colour	tea colored; yellowish-deep brown and turbid		green-brown and clear	green-brown and turbid		blue-green and very clear (alkaline)
Colour of surface peat	pale			dark		
Surface tier saturation	always saturated		seasonal exposure of substrate	diurnal exposure of substrate		

Table B-6. Actual Soil Moisture Regime Classes (from Mackenzie and Moran 2004)

Code	Actual Soil Moisture Regime	Description
M	Moist	No water deficit occurs. Current need for water does not exceed supply; temporary groundwater table may be present. Unless otherwise limited, supports forest.
VM	Very Moist	Rooting-zone groundwater present during the growing season (water supply exceeds demand). Groundwater table >30cm below the surface. Unless otherwise limited, supports forest.
W	Wet	Rooting-zone groundwater present during the growing season (water supply exceeds demand). Groundwater table between 0 and 30 cm below the surface. Can support tall shrubs and trees.
VW	Very Wet	Groundwater table at or above the ground surface during the growing season. Will not support tall shrubs or trees but can support low shrubs.

pH (acidity/alkalinity)

The pH is a correlate measure of base cation availability. This is important for peatlands and less important in hydrologically dynamic systems. Five categories are described from Very Acid

to Alkaline. Generally, as the acidity increases, available base cations decline, resulting in reduced site productivity. Codes and definitions for pH are listed in Table B-7.

Table B-7. Codes and descriptions for pH classes (from Mackenzie and Moran 2004).

Code	pH	Description
VA	Very Acid < 4.5 pH	Sites are true bogs with high cover of *Sphagnum* Group I or III mosses and few minerotrophic indicators.
MA	Moderately Acid 4.5 - 5.5 pH	Sites still have high *Sphagnum* cover but minerotrophic indicators also occur. Peatland sites include bogs and poor fens or poor swamps.
SA	Slightly Acid 5.5 - 6.5 pH	Sites are fens or swamps. *Tomenthypnum, Warnstorfii*, and *Drepanocladus* brown mosses are typical for sites with a stagnant or sluggish hydrodynamic index.
N	Neutral 6.5 -7.4 pH	Sites are fens, swamps, or marshes. Species are often a combination of species found on slightly acid and alkali sites.
Ak	Alkaline > 7.4 pH	Sites are dominated by minerotrophic byrophytes such as *Scorpidium* or *Campylium* mosses on peatland sites. Alkali – tolerant species occur in marshes.

The Hydrodynamic Index

The Hydrodynamic Index has five categories that describe the magnitude of vertical and lateral water movements in the soil on Wet and Very Wet sites. Codes and definitions for the hydrodynamic index are provided in Table B-8.

Table B-8. Hydrodynamic index codes and descriptions (from Mackenzie and Moran 2004).

Code	Hydrodynamic Index	Description
St	Stagnant	Stagnant to very gradually moving soil water. Vertical fluctuations minimal. Permanent surface saturation but minimal or no surface flooding. Basins or hollows with stable water regimes. Abundant organic matter accumulation with high bryophyte cover.
Sl	Sluggish	Gradual groundwater movement through peat or fine-textured mineral soils along a hydrological gradient. Minor vertical watertable fluctuations. Semipermanent soil saturation with some elevated microsites or brief periods of surface aeration. Hollows, slopes, and water tracks in basins or lake flats not directly influenced by the waterbody. Abundant peat accumulation and bryophyte cover.
Mo	Mobile	Distinct flooding and drawdown or pronounced lateral movements. Peripheral areas of peatlands, sites adjacent to open water tracks, small rivelets or ponds, small potholes with relatively stable water regimes, protected lake embayments, or backmarshes in estuaries. Can have deep but well-decomposed accumulations of peat. Patchy bryophyte cover.
Dy	Dynamic	Significant lateral flow and/or strong vertical watertable fluctuations through mineral soils. Potholes in arid climates that experience significant drawdown, wave-exposed shores, flood-plain back channels, and protected estuary sites. Little organic accumulation, few bryophytes.
VD	Very Dynamic	Highly dynamic surface water regime. Exposed tidal sites, shallow potholes in arid climated that experience significant drawdown, wave-exposed shores and sites directly adjacent to and influenced by river flow. No organic accumulation or bryophytes.

Forested Upland Edatopic Grid

An edatopic grid was developed for forested upland ecosystems mapped within the study area (Figure B-3), using concepts outlined in Flynn and Francis (2011) and Pojar *et al.* (1987). The

Soil Nutrient Regime and Soil Moisture Regime axes definitions are outlined below and are based on Banner *et al.* (1993).

Soil Nutrient Regime

As outlined above for wetlands, the soil nutrient regime outlines the ability of the soil to provide the major nutrients for plant growth. The soil nutrient regime can range from very poor to very rich and is dependent on factors such as soil depth, texture, coarse fragments, seepage water, humus form and geological parent material (Banner *et al.* 1993). Table B-9 outlines the criteria for evaluating the soil nutrient regime that was used during the field assessments.

Soil Moisture Regime

The soil moisture regime in upland ecosystems is the average amount of soil water available annually for evapo-transporation (Pojar *et al.* 1991) and ranges from dry (very xeric) to wet (sub-hydric). Luttmerding et al. (1990) provides a summary of criteria that can be used to help identify the soil moisture regime (Table B-10). Keys such as this were used in the field to help identify the soil moisture regime for the upland ecosystems and are the basis for the development of the ecosite unit descriptions.

Additional Ecosite Unit Descriptors

Other factors that were commonly recorded and help with the classification of ecosystems are the mesolope position, the drainage class and/or soil moisture subclass, and where possible the surficial material.

Mesoslope Position

Mesoslope position is a measure of the position of the ecosystem relative to the

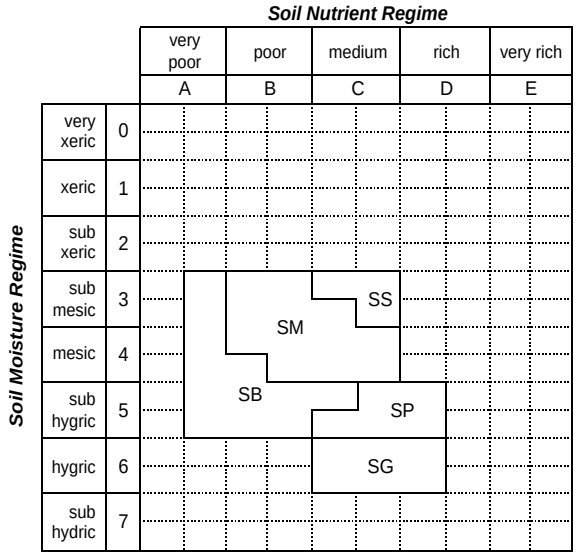

Figure B-3. Edatopic grid showing position of forested sites mapped in the BOL for the Marsh Lake wetland study.

Table B-9. Environmental characteristics useful for determining soil nutrient status in upland sites (from Banner *et al.* 1993).

		A very poor	B poor	C medium	D rich	E very rich
Available nutrients		very low	low	average	plentiful	abundant
Humus form		Mor				
				Moder		
						Mull
A horizon		Ae horizon present				
				A horizon absent		
					Ah horizon present	
Organic matter content		low (light coloured)				
			medium (intermediate)			
					high (dark coloured)	
C:N ratio		high				
				moderate		
					low	
Soil texture		very coarse	coarse	medium	fine	very fine
Examples		LS, 60% CF		L, 25% CF	SiCl, 15% CF	SiC, 15% CF
Slope position related to seepage		upper shedding		mid normal		lower receiving
Depth to impermiable layer		shallow < 0.5 m		medium 1–2 m		deep >2 m
Coarse fragment type	colour	light		medium, mixed		dark unless calcareous
	texture	coarse		medium		fine
	hardness	hard		medium		soft
	examples	granite quartzite sandstone	granodiorite	diorite schist argillite	gabbro	basalt slate limestone
Soil pH		extremely – mod. acid				
				moderately acid-neutral		
					slightly acid – mildly alk.	
Water pH (wetlands)		<4–5	4.5–5.5	5.5–6.5	6.5–7.4	>7.4
Seepage				temporary →		permanent

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localized catchment area and provides information important to determining if a site is receiving or shedding moisture. A summary of the codes and descriptions is provided in Table B-11.

Table B-10. Relative soil moisture regime classes and characteristics (from Luttmerding *et al.* 1990).

MOISTURE REGIME	DEFINING CHARACTERISTICS		FIELD RECOGNITION CHARACTERISTICS						SLOPE GRADIENT
			SOIL PROPERTIES						
	DESCRIPTION	PRIMARY WATER SOURCE	SLOPE POSITION	TEXTURE	DRAINAGE	DEPTH TO IMPERMEABLE LAYER	HUMUS FORM DEPTH	AVAILABLE WATER STOR. CAP.	
VERY XERIC 0	Water removed extremely rapidly in relation to supply, soil is moist for a neglible time after ppt	precipitation	ridge crests, shedding	very coarse (gravelly-S), abundant coarse fragments	very rapid	very shallow (<0.5m)	very shallow	extremely low	very steep
XERIC 1	Water removed very rapidly in relation to supply; soil is moist for brief periods following ppt	precipitation			rapid				
SUBXERIC 2	Water removed rapidly in relation to supply; soil is moist for short periods following ppt	precipitation						very low	
SUBMESIC 3	Water removed rapidly in relation to supply; water available for moderately short periods following ppt	precipitation	upper slopes, shedding	coarse to mod. coarse (LS-SL), mod. coarse frag.	rapid to well	shallow (<1m)	shallow	low	steep
MESIC 4	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period of the year. Available soil moisture reflects climatic inputs	precipitation in moderately to fine-textured soils & limited seepage in coarse textured soils	mid-slope, normal, rolling to level	moderate to fine (L-SiL), few coarse fragments	well to moderately well	moderately deep (1-2m)	moderately deep	moderate	moderate
SUBHYGRIC 5	Water removed slowly enough to keep the soil wet for a significant part of the growing season; some temporary seepage and possibly mottling below 20 cm	precipitation and seepage			moderately well to imperfect	deep (>2m)	deep	high	slight
HYGRIC 6	Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling present; possible weak gleying	seepage	lower slopes, receiving	variable, depending on seepage	imperfect to poor	variable, depending on seepage		variable, depending on seepage	
SUBHYDRIC 7	Water removed slowly enough to keep the water table at or near the surface for most of the year; gleyed mineral or organic soils; permanent seepage less than 30 cm below the surface	seepage or permanent water table			poor to very poor		very deep		
HYDRIC 8	Water removed so slowly that the water table is at or above the soil surface all year; gleyed mineral or organic soils	permanent water table	depressions, receiving	variable, depending on seepage	very poor	variable, depending on seepage		variable, depending on seepage	flat

Table B-11. Mesoslope position (from RIC 1998).

Code	Mesoslope Position	Description
CR	Crest	The generally convex uppermost portion of a hill; usually convex in all directions with no distinct aspect.
UP	Upper Slope	The generally convex upper portion of the slope immediately below the crest; has a specific aspect.
MD	Middle Slope	Area between the upper and the lower slope; the surface profile is generally neither distinctly convex or concave; has a straight profile with a specific aspect.
LW	Lower Slope	The area toward the base of the a slope; generally has a concave surface profile with a specific aspect.
TO	Toe	The area demarcated from the lower slope by an abrupt decrease in slope gradient; seepage is typically present.
DP	Depression	Any area concave in all directions; may be at the base of a meso-scale slope or in a generally level area.
LV	Level	Any level meso-scale area not immediately adjacent to a meso-scale slope; the surface profile is generally horizontal and straight with no significant aspect.

Drainage Class

Drainage class describes the speed and extent to which water is removed from a mineral soil in relation to additions and is related to the texture and coarse fragments within the soil (Table B-12).

Table B-12. Drainage classes and codes (from Luttmerding *et al.* 1990).

Code	Class	Description
x	Very rapidly drained	Water is removed from the soil very rapidly in relation to supply. Water source is precipitation and available water storage capacity following precipitation is essentially nil. Soils are typically fragmental or skeletal, shallow, or both.
r	Rapidly drained	Water is removed from the soil rapidly in relation to supply. Excess water flows down- ward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Water source is precipita- tion. Soils are generally coarse textured.
w	Well drained	Water is removed from the soil readily, but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Water source is precipitation. On slopes, subsurface flow may occur for short durations, but additions are equalled by losses. Soils are generally intermediate in texture and lack restricting layers.
m	Moderately well drained	Water is removed from the soil somewhat slowly in relation to supply because of impervi- ousness or lack of gradient. Precipitation is the dominant water source in medium- to fine- textured soils; precipitation and significant additions by subsurface flow are necessary in coarse-textured soils.
i	Imperfectly drained	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is the major source. If subsurface water or groundwater (or both) is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface or groundwater flow (or both) increases as available water storage capacity decreases. Soils generally have a wide range of texture, and some mottling is common.

Code	Class	Description
p	Poorly drained	Water is removed so slowly in relation to supply that the soil remains wet for much of the time that it is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface or groundwater flow (or both), in addition to precipitation, are the main water sources. A perched water table may be present. Soils are generally mottled and/or gleyed.
v	Very poorly drained	Water is removed from the soil so slowly that the water table remains at or near the surface for most of the time the soil is not frozen. Groundwater flow and subsurface flow are the major water sources. Precipitation is less important, except where there is a perched water table with precipitation exceeding evapotranspiration. Typically associated with wetlands. For organic wetlands, also evaluate the soil moisture subclass, and when entering on the form, separate from drainage by a slash.

Surficial Material Codes

Surficial material codes were provided in the ecosite unit descriptions and were based on those developed by Howes and Kenk (1997). Only those code that were mapped in this project are listed here.

Table B-13. Surficial material codes (from Howes and Kenk 1997).

Code	Name	Description
F	Fluvial	River deposits.
FG	Glaciofluvial	Ice contact fluvial material.
L	Lacustrine	Lake sediments; includes wave deposits.
LG	Glaciolacustrine	Ice contact lacustrine material.

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APPENDIX C: SUMMARY OF SIMILAR ECOSITE UNITS FROM OTHER PROJECTS OR FIELD GUIDES

Table C-1. Summary of ecosite units mapped within the Southern Lakes Study Area and similar ecosystems identified from other projects, areas or field guides.

Realm/ Group	Class	Class Code	Ecosite Unit Name	Ecosite Code	Similar Units
Terrestrial Realm					
Upland Forested Classes	Forest	Up	SwPl - Soopolalie - Kinnikinick	SS	BWBSdk/103: SwPl-Soopolallie - Toad-flax (DeLong et al. 2011) Similarities to: PB- Lodgepole pine-Bearberry (AEM 1999)
			Sw - Feathermoss	SM	BWBSdk/101: Sw-Soopolallie - Step moss (DeLong et al. 2011) Similar site: F5D-SwFm Fluvial: White spruce - Feathermoss (Lipovsky and McKenna 2005) Similarities to : SW White spruce-willow and SF White spruce - feathermoss (AEM 1999)
Flood Group	High and mid bench	Fm, Fh	SwAt – Willow	SP	BWBSdk/110$6B: At-Horsetail - Step moss, may also contain some components of the BWBSdk101$6b.1: At-Soopolalie-Highbush cranberry (DeLong et al. 2011)
	Mid bench	Fm	Sw - Balsam poplar - Willow	SB	Similarities to: BWBSdk/112: AcbSw-Mountain alder - Dogwood (DeLong et al. 2011) Similar site: F5D-SwB Fluvial: White Spruce - Balsam Poplar (Lipovspy and McKenna 2005) Similarities to: SP- White spruce - Balsam poplar riparian (AEM 1999)
	Low bench	Fl	Willow - Bluejoint	WC	Similar site: F6C-Wi: Ws Fluvial: Ws willow (Lipovspy and McKenna 2005)
	Shrub carr	Sc	Willow - Scrub birch	WB	Similar to: Sc01 - Scrub birch - Kinnikinick (Mackenzie and Moran 2004)
			Willow Shrub	WS	Similar to: Sc02-Grey-leaved willow- Glow moss (Mackenzie and Moran 2004)
	Grassland meadow	Gs	Tufted hairgrass Meadow	TH	Gs04 - Tufted hairgrass (Mackenzie and Moran 2004)
Wetland Realm					

Realm/ Group	Class	Class Code	Ecosite Unit Name	Ecosite Code	Similar Units
Peatland Group	Fen	Wf	Willow – Sedge	WF	Similarities to Wf02 - Scrub birch - Water sedge (Mackenzie and Moran 2004) but with willow, not scrub birch. Similarities to: FE Sedge fen (AEM 1999)
			Sedge Fen	SF	Wf01 - Water sedge - Beaked Sedge (Mackenzie and Moran 2004)
Mineral Group	Marsh	Wm	Awned sedge	AS	Wm03 - Awned sedge (Mackenzie and Moran 2004)
			Bulrush Marsh	BR	None
			Beaked sedge - Water sedge	BW	Wm01 - Beaked sedge - Water sedge (Mackenzie and Moran 2004)
			Swamp horsetail - Beaked sedge	HS	Wm02 -Swamp horsetail - Beaked sedge (Mackenzie and Moran 2004)
			Mannagrass	MA	Similar to Northern mannagrass site association (Mackenzie and Moran 2004), also described in Steen and Roberts (1988).
			Sedge - Cinquefoil	SC	Some similarity to Wm01- Beaked sedge - Water sedge (Mackenzie and Moran 2004) but with much greater cover of marsh cinquefoil and less of sedges.
	Swamp	Ws	Sw - Willow - Glowmoss	SG	Has similarities to the Ws15 SwSb-Labrador tea-Glow Moss (DeLong et al. 2011) (previously referred to as the BWBSdk1 - 11 Sw-Willow-Glowmoss described in Banner *et al.* (1993).
			Tea-leaved willow - Sedge - Cinquefoil	TC	Similar site: F6C-Wi: Ws Fluvial: Ws willow (Lipovspy and McKenna 2005)
Mineral Group	Swamp	Ws	Tea-leaved willow - Sedge - Brown moss	TS	Similar site: F6C-Wi: Ws Fluvial: Ws willow (Lipovspy and McKenna 2005)

Realm/ Group	Class	Class Code	Ecosite Unit Name	Ecosite Code	Similar Units
Aquatic Realm					
	Shallow Open Water	Wa	Brown mosses	BM	None described
			Pondweed - Mare's tail - Mixed aquatics	PM	Similar site: Aquatic Bed (Smith et al. 2007)

Realm/ Group	Class	Class Code	Ecosite Unit Name	Ecosite Code	Similar Units
			Pondweed Deep Pond	PP	Similar site: Aquatic Bed (Smith et al. 2007)
			Spike rush Mudflats	SR	Similar sites: Mudlfats and Emergent Marsh (Smith et al. 2007) and Warner and Rubec (1997) (p. 55)

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