Beaver Hills Biosphere Reserve Wetland Inventory

FINAL REPORT

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Beaver Hills Biosphere Reserve

Project #2051

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Front Cover Photo:
Aerial view of a wetland in the Beaver Hills Biosphere Reserve captured from a unmanned aerial vehicle.
Credit: Fiera Biological Consulting Ltd.

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1.0 Introduction

1.1. Background

The Beaver Hills moraine is a geologically distinct area that covers approximately 1,595 km^2 in central Alberta. The area is characterized by its knob and kettle terrain, which supports a high density of wetlands and small lakes, as well as native forest and grassland habitats that are generally larger and more intact than those located elsewhere in central Alberta. In turn, these habitats provide a range of ecosystem functions that support a high level of biodiversity and a wide range of ecosystem services.

In 2016, the Beaver Hills moraine was recognized by the United Nations Education, Scientific and Cultural Organization (UNESCO) as a Biosphere Reserve. Biosphere Reserves are considered by UNESCO to be "Science for Sustainability support sites", where the relationship and interaction between social and ecological systems can be explored and managed through interdisciplinary approaches (UNESCO 2017). In particular, Biosphere Reserves have three interconnected functions: conservation, development, and logistical support, whereby sustainable development can be achieved through open dialogue with local communities and other stakeholders, as well as through the integration of both cultural and biological diversity. Importantly, a key function of a Biosphere Reserve is to facilitate demonstration projects, environmental education, and sustainable development education and training, research, and monitoring.

To this end, the Beaver Hills Biosphere Reserve Association is initiating a wetland conservation and stewardship pilot project in the Beaver Hills Biosphere that aims to explore alternative approaches to wetland conservation and stewardship in a way that supports both traditional and current cultural attributes of the Biosphere. Through this approach, the BHB will be a living laboratory in which knowledge can be co-created and explored by a wide range of stakeholders, and potential solutions and approaches to land management can be tested and refined in an applied context. A key goal of the BHB wetland pilot is to test and evaluate a diverse set of policy and market approaches for incentivizing wetland stewardship within the Biosphere, such that the multiple benefits associated with wetland conservation and restoration can be maintained or enhanced.

In order to support this work, the Beaver Hills Biosphere Reserve Association commissioned two review projects: the first project synthesized the type and scope of existing wetland policies and regulations that apply to wetlands in the Biosphere (Fiera Biological 2019), and the second project provided a review of the state of science as it relates to the assessment and management of wetland function and associated ecosystem services (Fiera Biological 2020). A key component of the second report was an evaluation of existing spatial datasets, including an assessment of existing wetland inventories, which is an essential dataset for the pilot project. While there are a number of existing wetland inventories for the BHB, the general conclusion from the review was that the existing wetland inventories were out-of-date and lacked attributes that would allow for their use in the pilot. Specifically, the existing inventories lacked any information on the location and extent of impacts related to drainage and cultivation activities that have

impaired the ecological and/or hydrologic function of wetlands. Given that an objective of the pilot project is to create incentives for wetland restoration, having information about the type of wetland impacts, as well as the number and location of those impacts, is essential to the success of the pilot project.

1.2. Project Goal

Given that accurate and up-to-date wetland mapping data is essential for improving management outcomes, as well as for identifying wetlands that have been previously impacted and are candidates for restoration, the goal of this project was to create a current wetland inventory for the Beaver Hills Biosphere Reserve. While there is presently no wetland inventory standard available for Alberta, we followed guidance that is currently contained in a draft provincial standard for wetland mapping, which stipulates that inventories for the Parkland Natural Region must include the five major classes from the Alberta Wetland Classification System (i.e., Bog, Fen, Marsh, Shallow Open Water, and Swamp) and must meet a minimum mapping unit of at least 0.04 ha.

2.0 Methods

2.1. Mapping Wetlands

An existing land cover layer created for the North Saskatchewan Watershed Alliance, and derived using SPOT images from 2017 and 2018, was used as the basis for the creation of a current wetland inventory for the Beaver Hills Biosphere Reserve. The original land cover data set was a supervised pixel-based classification that was created using a random forest model. The original land cover dataset included 15 classes, including five generic classes of wetland cover (open water, marsh, swamp, bog, fen). In order to create the BHB wetland inventory, all wetland classes were extracted from the original land cover and were reassigned to a wetland cover class type (Table 1). The land cover was then manually reviewed and edited to correct misclassification errors such as class mislabeling, commission errors (areas mapped as wetlands that were not wetlands) or omission errors (wetland areas that were missed in the classification).

Once wetland land cover types had been assigned and checked, wetland objects were derived from the land cover data. This step is required to differentiate individual wetlands with distinct boundaries. Wetland objects were created by dissolving all adjacent wetland land cover types into single wetland objects. A four-neighbour rule was used to define connected features; that is, features were dissolved into wetland objects only when the pixels shared a complete side.

Once wetland objects were identified, the area and proportion of each wetland land cover type was quantified. A primary wetland class was then assigned to each wetland object based on the majority proportion of wetland land cover within each wetland object (Table 1). If there was more than one land cover type within a wetland object, a secondary wetland class was assigned for each additional cover type that comprised more than 1 ha or 25% of the object.

Table 1. Wetland land cover classes and associated wetland class labels and definitions.

Wetland Land Cover Class Label & Definition	Wetland Class Label & Definition[1]
Open Water: Areas dominated by open water or floating/emergent vegetation on/in the water	**Shallow open water**[2]: Mineral wetlands dominated by aquatic forms inhabiting an open water zone. Shallow open water wetlands are covered by open water in the majority of years, but may dry up during periods of extreme or prolonged drought.
Graminoid: Lowland vegetation dominated by sedges, rushes, grasses, and/or forbs	**Marsh**: Mineral wetlands dominated by graminoid forms. Marshes commonly occur along the margin of shallow open water wetlands, lakes, and streams, but also occur on their own in small isolated depressions. Water levels are highly dynamic and surface water often dries up during the growing season; however, soils typically remain saturated throughout the year.
Woody: Lowland woody vegetation dominated primary by deciduous trees or shrubs such as willows, but may also contain coniferous trees or shrubs such as larch or black spruce	**Swamp**: Mineral wetland that contains more than 25% tree or shrub cover. Swamps are hydrologically dynamic and are often located in wetland/wetland and wetland/upland transition zones.
Black spruce: Lowland woody vegetation dominated by black spruce trees/shrubs	**Bog**: Peatlands that are isolated from ground water and surface water flows that receive water inputs from precipitation only.
Graminoid Fen: Peatland areas with grasses and/or forbs covering >25% of the area, where surface or ground water flow is apparent	**Fen**: Peatlands that are hydrologically connected to groundwater or surface water flows. Includes both graminoid and wooded/shrubby fens
Woody Fen: Peatland areas with woody deciduous and/or coniferous vegetation covering >25% of the area, where surface or ground water flow is apparent	
Disturbed: Lowland vegetation that has been disturbed by agricultural activities, most typically cultivation	**Cultivated Depression**: Typically marsh or shallow open water habitats that have been drained and/or seeded to increase agricultural productivity within crop or pasture lands. May also include wetlands previously dominated by woody vegetation that have been cleared for agricultural purposes.

[1]NOTE: With the exception of the Cultivated Depression class, wetland class labels and definitions are consistent with the Alberta Wetland Classification System (AESRD 2015). The Cultivated Depression class was included in this wetland inventory to capture wetlands that have been impacted and/or modified by agricultural activity, such that an accurate wetland class label could not be accurately or consistently derived.

[2]NOTE: In this inventory, the Shallow Open Water wetland class also includes lakes and other open water areas, such as dugouts and constructed features like as stormwater management facilities.

2.2. Wetland Drainage & Consolidation

Each wetland was assigned a condition attribute identifying whether the basin appeared to have been impacted by drainage or consolidation. Wetlands identified as “drained/consolidated” are those that appear to be losing surface water (drained) or those that may be receiving additional drainage as a result of ditching (consolidated). Wetland basins were considered to have been impacted by drainage or consolidation if a ditch within or between basins was apparent on one or more high resolution air photographs, or if there were signs of ground recontouring to improve surface drainage into or out of a wetland basin. Time series imagery in Google Earth Pro dating back to 2012 was used as a reference to determine whether a wetland had been impacted by drainage, and a confidence score of high, medium, or low was assigned to each basin that was identified as drained or consolidated.

2.3. Wetland Inventory Ground Truthing

A field reconnaissance of Beaver Hills Biosphere Reserve was performed in August of 2020. A variety of upland and lowland sites were selected to visit based on the predictions from the land cover classification, and data collected at each site included both descriptions of classes present as well as information on condition and level of disturbance occurring at the site. The information collected in the field was used to increase the accuracy of wetland cover class assignment and ensure consistency of the manual land cover editing and QA/QC among analysts.

3.0 Results

3.1. Wetlands in the Biosphere Reserve

There were over 53,000 wetland objects covering just over 531 km^2 identified in the Beaver Hills Biosphere Reserve (Table 2). Swamp represented the greatest proportion of wetlands by number, while marsh represented the greatest proportion of wetlands by total area. Cultivated depression also represented a significant proportion of both the area and number of wetlands, suggesting that there is a significant number of opportunities for targeted wetland enhancement projects in the Biosphere Reserve.

Table 2. Summary of the number and area of wetlands identified in the Bear Hills Biosphere reserve.

Primary Wetland Class	Number of Wetlands	Total Area (ha)	Cover (%) within the Beaver Hills Biosphere Reserve
Bog	513	504.9	0.3
Cultivated Depression	9,508	2,312.7	1.5
Fen	3	75.3	0
Marsh	19,146	28,258.8	17.7
Shallow Open Water[1]	486	10,071.9	6.3
Swamp	42,717	11,881.2	7.5
		53,104.8	

[1]NOTE: Includes lakes and other open water areas such as dugouts and stormwater management facilities.

3.2. Drainage Impacts

There were 3,672 drained or consolidated wetlands identified in the Biosphere Reserve; the majority of which are located on private agricultural lands. These wetlands represent a substantial opportunity for initiating wetland restoration projects and/or engagement with private land owners on issues related to surface water management and wetland conservation.

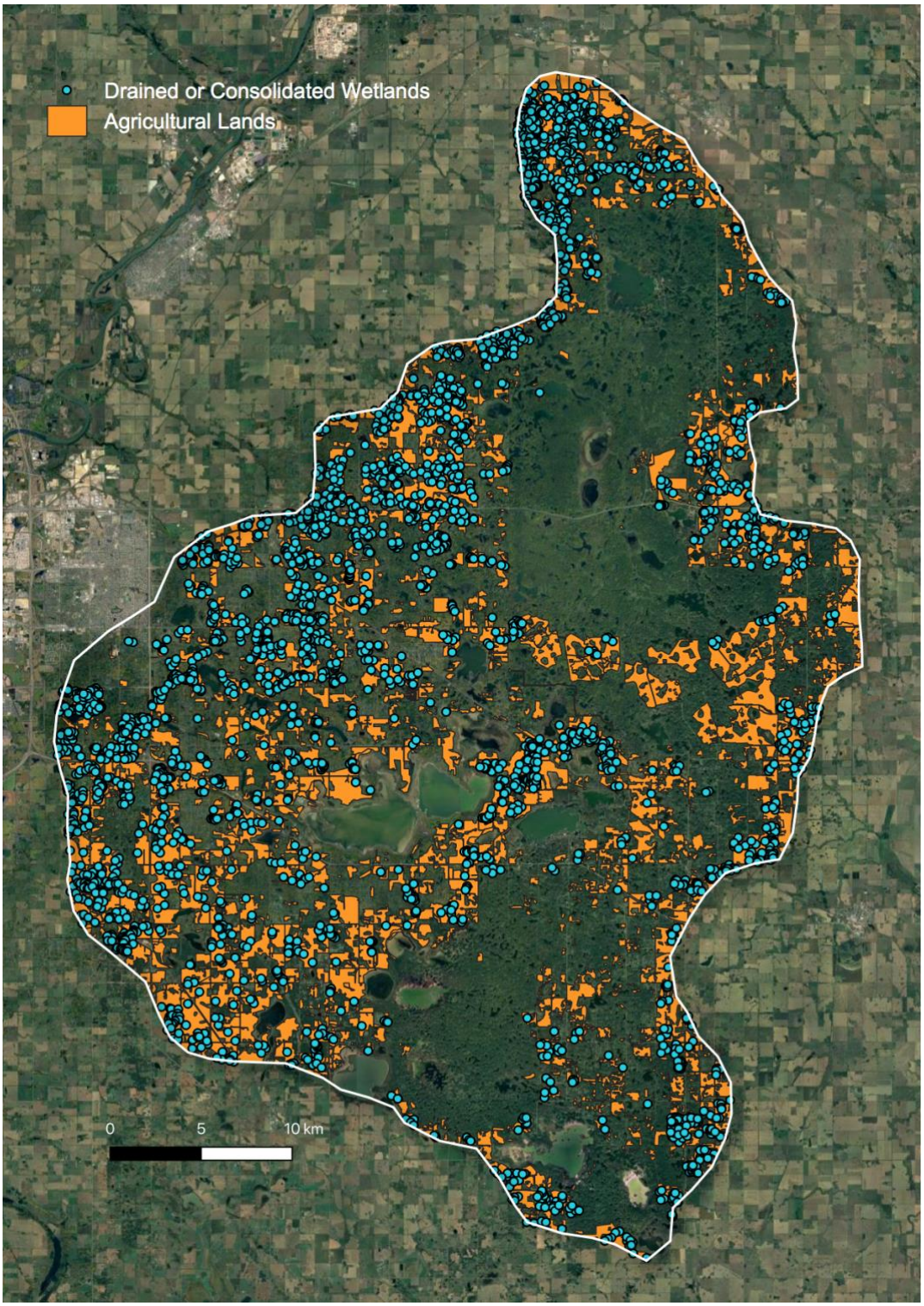


Figure 1. Location of drained or consolidated wetlands in the Beaver Hills Biosphere Reserve. Cultivated lands were identified using the 2018 Alberta Biodiversity Monitoring Institute Human Footprint layer (ABMI 2018).

3.3. Data Considerations & Limitations

Users of this dataset should be aware of the following considerations and limitations:

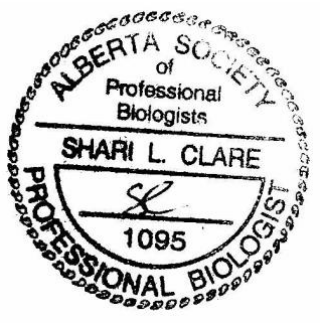
- **Minimum mapping unit**: The inventory was created using satellite imagery with a resolution of 6m. As part of the initial classification cleanup process, pixels were aggregated into six-pixel groups to remove small regions and noise. Therefore, the minimum mapping unit of classification is 0.0216 ha. Because the image is of medium resolution and pixels were aggregated, very small wetland features may have been missed in the inventory.
- **Boundary shape**: The inventory was created using a pixel-based classification of a 6 m resolution satellite imagery. Because pixels are square, this approach to image classification results in wetland features that appear “blocky”, as opposed to the “smooth” boundaries that are more typical of an object-based classification or manually-derived inventories. While post-classification processing included a step that smoothed the wetland object boundaries, edges still may be “blocky” in some cases. In particular, small features that consist of a small number of pixels tend to appear square or rectangular in shape.
- **Boundary accuracy**: Wetlands are hydrologically dynamic and water levels fluctuate seasonally and annually due to changes in climatic conditions, as well as in response to human activities such as road building, changes in surrounding land use, and drainage. Because of this, and in combination with the medium resolution of the imagery, accurately mapping wetland boundaries is very difficult. If highly accurate spatial boundaries are required, other information such as high resolution imagery, or methods such as field delineation, should be used to refine the boundaries of wetlands of interest.
- **Wetland size**: The inventory includes some very large wetland objects. This is because wetland objects were defined using a four-neighbour rule, meaning that any “wetland” pixel that shared a side with an adjoining “wetland” pixel were joined together into the same object, regardless of the type of wetland cover; therefore, wetland objects can contain multiple wetland cover types and wetland classes and can cover large areas.
- **Shallow open water wetlands**: Shallow open water wetlands are defined as features that are dominated by open water <2m in depth. There are other ecological and anthropogenic features that are also dominated by open water cover of various depths, including lakes, dugouts, stormwater management facilities, and sewage lagoons. When running an automated classification, it is difficult to reliably distinguish between different types of open water features, and because of this, the shallow open water class currently contains other features dominated by open water cover.

4.0 Conclusion

An updated wetland inventory has been created for the Beaver Hills Biosphere Reserve that provides information on the location, class, vegetation cover type, and condition of wetlands. This inventory differs from past inventories in that it includes all five wetland class types identified in the Alberta Wetland Classification System, as well as a sixth "Cultivated depression" class that identifies wetland basins that have been impacted by agricultural activities. Additionally, this inventory identifies wetlands that appear to have been hydrologically impacted by drainage or consolidation activities. In combination, this inventory provides information that can be used to help inform the design of a wetland conservation and stewardship pilot project by providing relevant information that will support spatial targeting of restoration and enhancement activities, as well as additional spatial analysis regarding wetlands and ecosystem services in the Biosphere Reserve.

4.1. Closure

This report was written by:



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5.0 Literature Cited

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