Peace Project Water Use Plan

WILLISTON RESERVOIR WETLAND HABITAT MONITORING

Implementation Year 8

Reference: GMSMON-15

Study Period: April 2018 to December 2018

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PEACE PROJECT WATER USE PLAN

Program No. GMSMON-15

Williston Reservoir Wetland Habitat Monitoring




Final Report Year 8 (2018)

Prepared for

BC Hydro

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Peace River Water Use Plan
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Cover photos:

From left to right: Airport Lagoon, Western Toad (*Anaxyrus boreas)* tadpoles in Beaver Pond, Habitat diversity, Common Loons (*Gavia immer*). All photos © Guy Monty, LGL Limited.

EXECUTIVE SUMMARY

Under project GMSWORK-17 (Williston Reservoir Trial Wetlands), BC Hydro selected two Wetland Demonstrations Sites (WDS) for detailed design and construction in the Parsnip Arm of the Williston Reservoir to improve foreshore habitat for fisheries, wildlife, and riparian areas. The two sites are identified as Airport Lagoon and Beaver Pond. At Airport Lagoon, two 1200 mm diameter culverts with an invert elevation of approximately 664.5 masl, along a causeway at the southern end of the lagoon, where replaced with new 1200 m diameter culverts with staggered invert elevations, starting at 669.99 to 667.05 masl. The objective of this treatment was to create 27 to 34 ha of permanently wetted habitat upstream of the causeway. At Beaver Pond, a water control structure was constructed, approximately 3 m in height with an invert elevation of 667.25 masl, at the inlet to the pond. This created a 0.3 ha inundated area when reservoir levels are below 667.25 masl. Monitoring the effectiveness of these wetland demonstration projects in improving fish and wildlife habitat on the reservoir is being completed under GMSMON-15 Williston Reservoir Wetland Habitat Monitoring. GMSMON-15 is a 10-year monitoring program designed to determine the response of selected indicator groups (i.e., waterfowl, songbirds, amphibians, and vegetation) to the wetland enhancements. Fish populations were also identified for monitoring as fish were observed at both of the selected demonstration sites.

Four management questions and associated hypotheses were developed at the commencement of GMSMON-15 to direct the study design and monitoring program. This report presents the results of the eighth year of the program. Monitoring during the first seven years of the program was completed by Cooper Beauchesne and Associates Ltd. Monitoring in 2018 was conducted by LGL Limited. The ability to observe possible effects of wetland enhancement depends upon the availability of robust occurrence data (i.e., multiple confirmations of species identifications over multiple years). In 2018, species from all indicator groups were observed.

Vegetation: Terrestrial habitat classifications at Airport Lagoon, generated in 2016 have remained relatively stable over time, with little change in species composition of each community (i.e., the same dominant species can be used to define each community). However, the area and coverage of these communities has changed in the past two years. The biggest changes were a decreased in the area coverage for Basin Moss and Basin Smartweed and an increase in the coverage of Shoreline Driftwood (i.e., coarse woody debris). At Airport Lagoon, 56 herb species were recorded across the 14 transects. The most common species detected were *Drepanocladus aduncus* (common hook moss), *Persicaria amphibia* (water smartweed), *Calamagrostis canadensis* (bluejoint) and *Bidens cernua* (nodding beggarticks). Six species of moss were recorded on 11 of the transects, whereas shrub coverage, dominated by willows, was relatively low. At Beaver Pond, 31 herb species were recorded across the five transects. The most common species detected were *Equisetum arvense* (common horsetail), *Cryptantha torreyana* (Torrey's cryptantha) and *Juncus bufonius* (toad rush). Three species of moss and no shrub species were recorded at Beaver Pond. There was no tree coverage on any transects at Airport Lagoon or Beaver Pond. Vegetation species identified in the terrestrial components of the wetlands can be classified as both terrestrial plant species and aquatic plant species, which provides evidence of annual and/or frequent flooding. This flooding likely influences the density, diversity and spatial extent of vegetation at the enhancement sites.

At Airport Lagoon the aquatic macrophyte community is relatively well developed in the shallower portions of the wetland; however, this community type remains poorly developed at Beaver Pond. Fifteen species of aquatic plants were recorded at Airport Lagoon. The frequency ranged from 1.6% for a few species to a high of 64.5% for *Myriophyllum sibiricum* (Siberian water-milfoil). Sampling depths were between 20 cm and 240 cm. Only two aquatic plant species were recorded at Beaver Pond in 2018: *Potamogeton foliosus* and *Ranunculus aquatilis*. Both species were relatively low in volume and abundance and the majority of the aquatic vegetation samples were collected at depths between 50 cm and 100 cm.

Waterfowl and Shorebirds: Three replicates of waterfowl and shorebird surveys were completed at Airport Lagoon and only two replicates were completed at Beaver Pond. At Airport Lagoon, 29 individuals from six species of shorebirds and 11 waterfowl species, totaling 221 individuals, were recorded. At Beaver Pond, 10 individuals from four species of shorebirds and only one waterfowl species were recorded. Species diversity for shorebirds was highest in June, whereas it was highest for waterfowl in April. Likewise, for the number of individuals observed; more waterfowl were using the Airport Lagoon in April and numbers declined in May and June. Conversely, shorebird numbers were highest in June compared to the previous months. It is expected that waterfowl would use Airport Lagoon as stopover habitat in subsequent years.

Songbirds: At Airport Lagoon, 43 songbird species (303 detections of 371 individuals) were recorded. The ten most frequently detected species accounted for 57.4% of all detections and comprised representatives from five bird families: sparrows (3 species), swallows (1 species), warblers (4 species), thrushes (1 species) and vireos (1 species). Lincoln's Sparrow (*Melospiza lincolnii*) was the most frequently detected songbird (32 detections). Forest habitat types had higher species richness and diversity than the drawdown zone or shrub habitats. At Beaver Pond, 17 species (43 detections of 46 individuals) were recorded. Six bird families were represented by observations at Beaver Pond including warblers (7 species), sparrows (4 species), thrushes (2 species), flycatchers (2 species), vireos (1 species), and swallows (1 species). Yellow-rumped Warbler (*Setophaga coronata*) was the most frequently detected songbird (5 detections). Drawdown zone habitat types had lower species richness and diversity than forest or shrub habitats, neither of which significantly differed from each other.

Amphibians: In 2018, only one amphibian species, Western Toad (*Anaxyrus boreas*), was recorded at both Airport Lagoon and Beaver Pond. At Airport Lagoon, tadpoles were detected at the northern most section of the wetland where water is shallower and aquatic macrophyte species are more prevalent. Qualitatively, it appears that the productivity of Western Toads is consistent between years, as egg masses and adults have been repeatedly detected at the same locations each year.

Fish: Fish traps and nets were deployed at Airport Lagoon in May and July, and the reach at Airport Lagoon was electrofished each month. At Beaver Pond, minnow traps were deployed in May. Water levels were too shallow to deploy the fyke net or electrofish and Beaver Pond could not be accessed in July for a second visit. Eleven fish species from five families were captured in Airport Lagoon in 2018. In total, 7,348 fish, predominantly adults, were captured, with most (77%; 5,682) sampled in May. Minnows (*Cyprinidae*) dominated catches, followed by suckers (*Catostomidae*), Rainbow trout (Oncorhynchus mykiss), Prickly sculpin (*Cottus asper*), and Burbot (*Lota lota*). At Beaver Pond, two minnow species (Northern Pikeminnow and Lake Chub) were captured with minnow traps.

Data collected in 2018 for the GMSMON-15 project show that species from all indicator groups continue to be present at both wetland demonstration projects. The methods implemented to date will enable the collection of an adequate amount of data that can be used to address each management question and associated hypothesis.

Management Question (MQ)	Management Hypothesis	Year 8 (2018) Status
MQ1: Are the enhanced (or newly created) wetlands used by fish?	H_{01}: Fish species composition and density in wetland changes following enhancement.	Fish species were present in both wetlands in 2018. Species composition appears to be relatively consistent across monitoring years but will be fully assessed at the conclusion of Year 10 of the monitoring program.
MQ2: Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?	H_{03}: The species composition and density of waterfowl and songbirds changes following enhancement.	Both wetlands continue to show use by waterfowl and shorebird species, as do the upland habitats in terms of songbird use. Annual variation is evident, so a full assessment of this hypothesis will be prepared at the conclusion of Year 10 of the monitoring program.
	H_{04}: Amphibian abundance and diversity in the wetland changes following wetland enhancement.	Annual differences in amphibian species composition have been observed to date. Species composition appeared to be relatively high at the beginning of the monitoring program; however, for the past two monitoring years only one species of amphibian has been recorded. A full assessment of this hypothesis will be prepared at the conclusion of Year 10 of the monitoring program.
MQ3: Is there a change in the abundance, diversity, and extent of vegetation in the enhancement area?	H_{02}: The density, diversity and spatial extent of riparian and aquatic vegetation changes following enhancement.	Changes in habitat classification and spatial extent have been observed to date. There have also been changes in species composition and abundance of both terrestrial and aquatic vegetation. The significance of these changes will be assessed at the conclusion of Year 10 of the monitoring program.
MQ4: Is the area and quality of fish and wildlife habitat created by the wetland enhancement maintained over time?		The area of wetland habitat at Airport Lagoon and Beaver Pond appears to be remaining stable. A full assessment of this management question will be prepared at the conclusion of Year 10 of the monitoring program.

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1.0 INTRODUCTION

The annual reservoir cycling in Williston Reservoir created a drawdown zone of approximately 450 km^2 that was unproductive in both the inundated state as aquatic habitat and drawdown state as terrestrial habitat (BC Hydro 2003). The Peace Water Use Plan Committee (hereafter known as the Committee) recognized that the largely unproductive drawdown zone on Williston Reservoir contributed to low fishery productivity, a lack of riparian and wildlife habitat, and potentially increased predation risk for wildlife. To address this issue, the Committee recommended the Riparian and Wetland Habitat management plan to improve foreshore habitat for fisheries, wildlife, and riparian areas. The components of the plan were an inventory of sites that were potentially suitable for enhancement, selection of sites for implementation of demonstration wetland enhancement projects, and a monitoring program to test their effectiveness in improving riparian and foreshore habitat for wetland species over the life of the project.

Under GMSWORKS-16 Williston Reservoir Wetlands Inventory, a total of 42 candidate sites in the Parsnip Arm of the Williston Reservoir were surveyed as potential wetland enhancement sites by Golder Associates Ltd. (2010). Candidate sites were assessed based on biological, geotechnical and archaeological considerations as well as factors including cost, feasibility and potential benefits to wildlife. Through this work, the list of candidate sites was narrowed to five Wetland Demonstration Sites (Golder Associates Ltd. 2010). BC Hydro selected two Wetland Demonstrations Sites (WDS) for detailed design and construction: WDS 6-2 (Airport Lagoon) and WDS 34 (Beaver Pond). This phase was completed under GMSWORKS-17 Williston Reservoir Trial Wetland. At Airport Lagoon, two 1200 mm diameter culverts with an invert elevation of approximately 664.5 masl, along a causeway at the southern end of the lagoon, where replaced with new 1200 m diameter culverts with staggered invert elevations, starting at 666.99 to 667.05 masl. The objective of this treatment was to create 27 to 34 ha of permanently wetted habitat upstream of the causeway. At Beaver Pond, a water control structure was constructed, approximately 3 m in height with an invert elevation of 667.25 masl, at the inlet to the pond. This created a 0.3 ha inundated area when reservoir levels are below 667.25 masl. Monitoring of the effectiveness of the wetland demonstration projects in improving wildlife habitat on the reservoir will be completed under GMSMON-15 Williston Reservoir Wetland Habitat Monitoring.

1.1 Study Species

This effectiveness monitoring program is designed to determine the response of selected indicator groups to the wetland enhancements and to increase knowledge of wildlife use of the drawdown zone for the selected groups, particularly birds and amphibians. To provide some indication of wildlife response to the wetland enhancement BC Hydro (2008) identified waterfowl, songbirds, amphibians, and vegetation as the wildlife indicator groups to be used for monitoring in GMSMON-15. Fish populations were also identified for monitoring as fish were observed at both of the selected demonstration sites (Golder Associates Ltd. 2010, 2011). While improving fish habitat is not one of the goals of the wetland enhancement projects, little is known about the fish species composition and distribution at the selected locations (BC Hydro 2008).

2.0 STUDY OBJECTIVES

In 2011, BC Hydro initiated a long-term monitoring program (GMSMON-15) to assess the effectiveness of wetland enhancement in meeting the objectives of the Riparian and Wetland Habitat management plan (BC Hydro 2007). If wetland enhancement is deemed successful by this monitoring program, additional sites may be enhanced in the future.

2.1 Study Design

The general study design is to collect annual data on each of the indicator groups at locations within the core area of the enhancement treatments and in peripheral riparian areas. The multi-year time-series dataset, which includes data on the indicators groups both before and after the enhancements were in place, will be to assess the programs' management questions and hypotheses.

2.2 Management Questions and Hypotheses

BC Hydro developed four management questions (MQs) to address the effectiveness of wetland enhancement to improve fish and wildlife habitat:

MQ1: Are the enhanced (or newly created) wetlands used by fish?

MQ2: Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?

MQ3: Is there a change in the abundance, diversity, and extent of vegetation in the enhancement area?

MQ4: Is the area and quality of fish and wildlife habitat created by the wetland enhancement maintained over time?

Based on the management questions, the study was designed to test the following alternate hypotheses stated in the Terms of Reference (BC Hydro 2008):

H_{01} Fish species composition and density in wetland changes following enhancement.

H_{02} The density, diversity and spatial extent of riparian and aquatic vegetation changes following enhancement.

H_{03} The species composition and density of waterfowl and songbirds changes following enhancement.

H_{04} Amphibian abundance and diversity in the wetland changes following wetland enhancement.

These questions and hypotheses are tested directly by this monitoring program to test the effectiveness of wetland enhancement to improve fish and wildlife habitat as well as maintain this habitat over the life of the project.

3.0 STUDY AREA

3.1 Williston Reservoir

Williston Reservoir is located in northeastern British Columbia and was created by construction of the W.A.C. Bennett Dam at the head of the Peace River Canyon, about 20 km west of Hudson's Hope, B.C (BC Hydro 2015). The reservoir extends for about 260 km along the Rocky Mountain Trench from the Finlay River in the north to the Parsnip River in the south (Figure 1). The reservoir is generally divided into three geographic regions (from north to south): Finlay Reach, Peace Reach and Parsnip Reach (BC Hydro 2015).

Since 1971, reservoir elevations have ranged between 654 m and 672 m, with reservoir elevations fluctuating from year to year, driven by inflow and system generation needs. Inflows to the reservoir are primarily driven by snowmelt in the Peace River watershed and are much higher in summer than in winter. The reservoir is typically ice covered between the end of January and the beginning of May and generally reaches an annual minimum elevation in April or May, followed by reservoir refilling in the spring freshet. The reservoir generally reaches the maximum elevation in July or August and is then drafted through the winter as generation is increased to meet peak winter loads. The Normal Maximum Reservoir Level (NMRL) is 672 m and BC Hydro normally maintains a minimum elevation of approximately 655 m (BC Hydro 2015).

3.2 Physiography

The Williston Reservoir is nestled between the Hart Range of the Northern Rockies Mountain on its east and the Omenica Mountains on its west, which lie in a north-northwest to south-southeast orientation. The Finlay and Parsnip Reaches lie within the wide, flat-bottomed Rocky Mountain Trench and the former stream channels are deeply incised. Glacial till is the most abundant surficial deposit in the region.

The reservoir is located within the Sub-Boreal Spruce and Boreal White and Black Spruce biogeoclimatic zones (Meidinger and Pojar 1991). The Sub-Boreal Spruce zone is the dominant zone and occurs as two subzones and variants at lower elevations along most of the reservoir (Meidinger and Pojar 1991). The Boreal White and Black Spruce zone occurs only at the northern end of the reservoir in the Finlay Arm (Meidinger and Pojar 1991). The drawdown zone consists of large areas of mud, sand, and gravel flats with stranded large woody debris. Limited amounts of vegetation occur even following extended periods of drawdown.

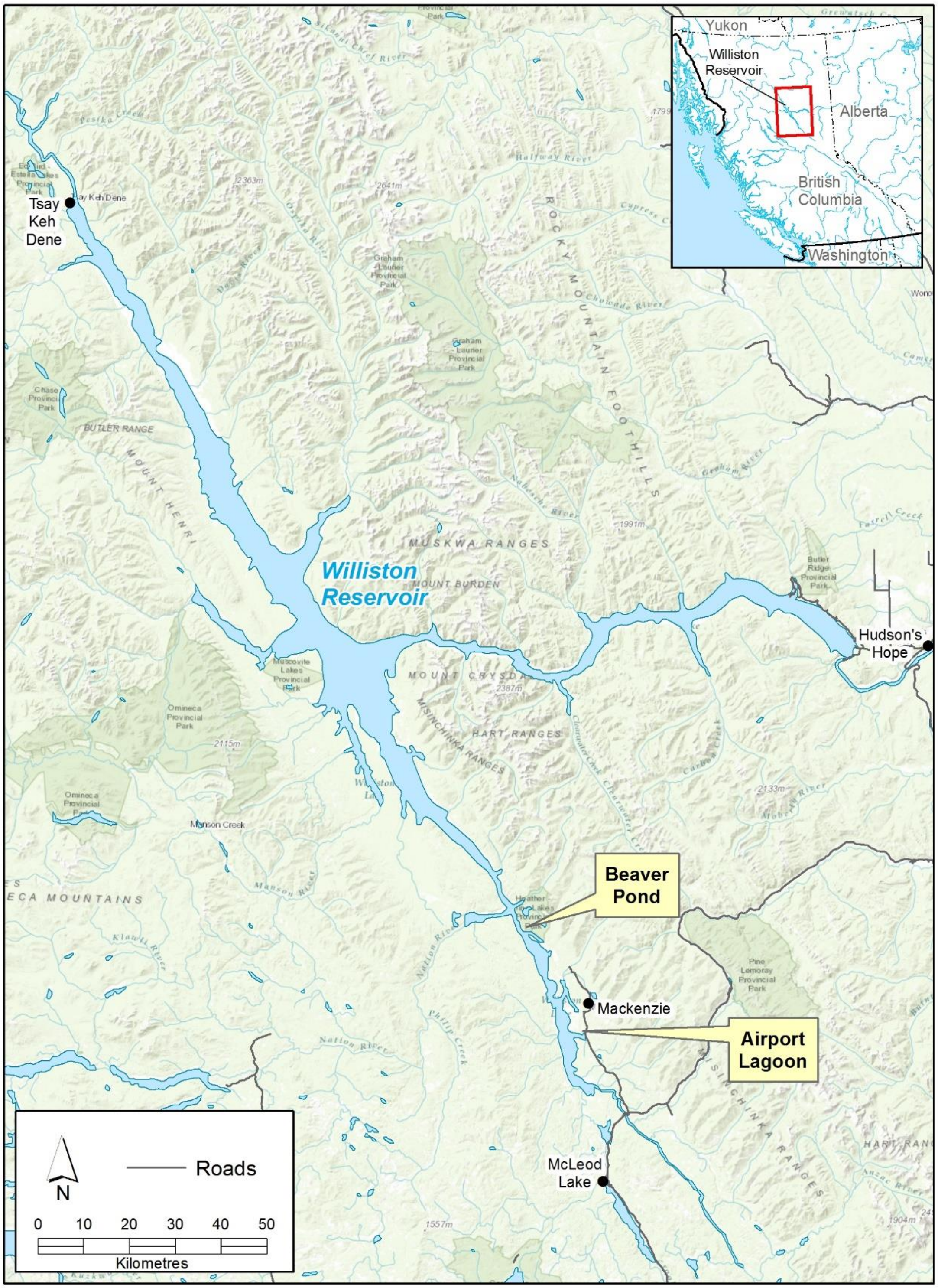

Figure 1. Location of the Williston Reservoir in northern British Columbia and locations sampled for GMSMON-15 in 2018.

3.3 Climatology

Daily weather in the region is influenced by middle-latitude cyclones that typically move from southwest to northeast British Columbia that respond to large scale features of the Rocky Mountains (Whiteman 2000, Klock and Mullock 2001). These lows tend to move over mountains and produce a widespread area of precipitation as well as unstable air where bands of clouds and showers develop. The middle-latitude cyclones dominate the weather during the fall through spring, while convection dominates during the summer months. The lows can become very slow moving and result in large amounts of precipitation in one place (Klock and Mullock 2001); combined with moist air that originates over the Pacific Ocean, that makes its way eastward through the narrow and deep valleys that occur through the Rocky Mountains (Vickers et al. 2001). The region experiences long, cold winters and ice formation on the reservoir begins as early as November and can extend into the beginning of May. Annual precipitation ranges between 40 cm to 50 cm with snowfall accounting for 35-45% of the annual precipitation. The Williston Reservoir receives and stores most of its hydrologic input from snowmelt. The large spring runoff typically begins in mid-May and peaks in June (Stockner et al. 2005).

3.3.1 Study Locations

Airport Lagoon

The two locations identified for the wetland demonstration projects are both located on the east side of the Parsnip Reach (Figure 2). The Airport Lagoon site (WDS 6-2) is located approximately six kilometres south of Mackenzie and is an approximately 75 ha site on the upstream side of a forest service road causeway. Except for two culverts at the base of the causeway, the area is isolated from the main reservoir. Water supply to the lagoon is primarily from two unnamed streams located at the north end of the lagoon.

Prior to the enhancements, conducted under *GMSWORKS-17 Williston Reservoir Trial Wetlands*, water levels in the lagoon corresponded to the reservoir level when water levels were >664.5 m. To create a larger area of permanently flooded habitat and reduce water level changes, the existing culverts were removed in May of 2013 and two new culverts were installed at an elevation of 666.99 m for the west culvert and 667.05 m for the east culvert, raising the pond elevation by ~2.5 m (Golder Associates Ltd. 2013).

Beaver Pond

The Beaver Pond site (WDS 34) is located approximately 22 km northwest of Mackenzie at the end of a narrow inlet on Heather Point. At this site there were two beaver ponds located at the head of the inlet with a small stream draining the ponds.

In 2014, a berm was constructed, under *GMSWORKS-17 Williston Reservoir Trial Wetlands,* part way up the inlet at an elevation of 667.25 m, which created a wetland of approximately 0.3 ha (Golder Associates Ltd. 2015). When reservoir levels are above this measure, the wetland is directly connected to the reservoir; however, more stable water levels remain in the enhanced area as the reservoir levels recede (Golder Associates Ltd. 2015).

The uniqueness of both sites, along with the completed enhancements, means there are no associated control or reference sites in this project. As such, pre-construction baseline data will be used to assess the post-construction changes associated with each enhancement.

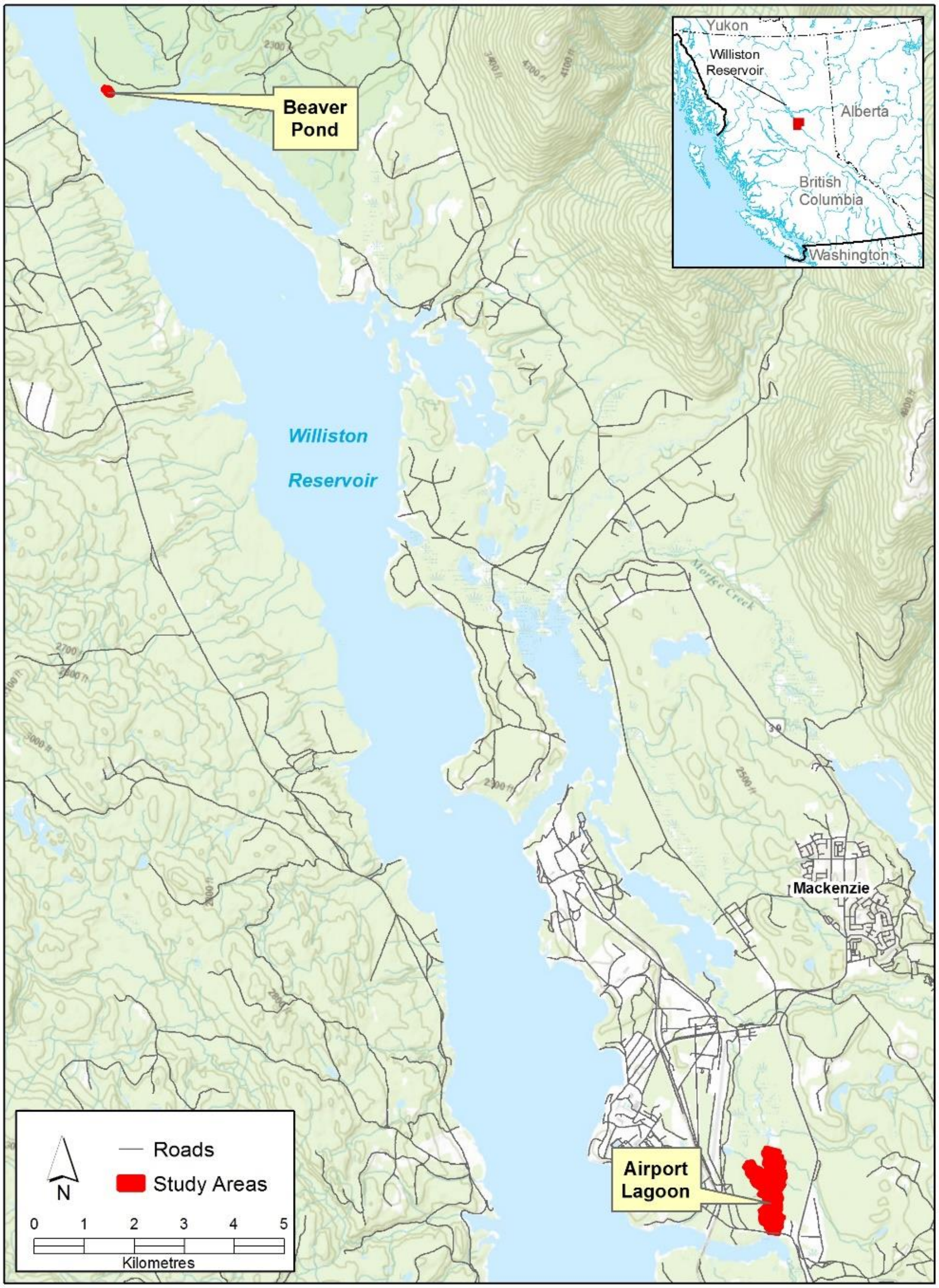

Figure 2. Location of the two wetland demonstration sites on the Parsnip Reach of Williston Reservoir.

4.0 METHODS

The field sampling methods employed in Year 8 of the GMSMON-15 were consistent with those used in the previous years of the monitoring program. The sampling methods for each of the indicator groups are described below, along with any adjustments that were required due to reservoir elevation or weather conditions at the time of sampling.

4.1 Environmental Conditions

Daily reservoir elevations were provided by BC Hydro (BC Hydro Commercial Resource Optimization (CRO) database) and daily mean air temperature and precipitation data prior to and during the survey period were downloaded from the Environment and Climate Change Canada's historical climate data web portal (Environment and Climate Change Canada 2018). Accumulated degree days were also calculated using a base temperature of 5°C as an additional method to compare environmental conditions between years. Accumulated degree days are used to measure the passage of time and temperature simultaneously, which can be used as an indicator of developmental activities. The base temperature of 5°C was selected as an indicator of activity for breeding amphibians; the minimum night-time temperature of 5°C was used as an indicator for the timing of early season call surveys (Weir and Mossman 2005, Bird Studies Canada 2018).

Specific data was compiled from the Mackenzie Airport weather station (Station name: Mackenzie Airport Auto). Daily environmental parameters, specific to each survey type, were recorded at the start of each survey and periodically during the surveys. These parameters included temperature, precipitation, cloud cover, relative humidity, wind speed and direction (Appendix 9-1).

4.2 Vegetation Surveys

A combination of ground sampling of terrestrial vegetation and sampling for aquatic vegetation was used in 2018 to address the following management question and associated alternative hypothesis:

- **MQ3**: Is there a change in the abundance, diversity and extent of vegetation in the enhancement area?
- **H_{02}**: The density, diversity and spatial extent of riparian and aquatic vegetation changes following enhancement.

4.2.1 Habitat Classification

Habitat class descriptions and their spatial distribution were reviewed in Year 6 (2016) of the monitoring program. Twelve habitat classes were identified at Airport Lagoon and six habitat classes were identified at Beaver Pond based on aerial imagery taken in 2014 (MacInnis et al. 2017). Each habitat class was based on the common plant species assemblages and elevation within the drawdown zone.

High resolution orthomosaic imagery of Airport Lagoon and Beaver Pond were obtained in May 2018 (Teri Neighbour, pers. comm.). The habitat class polygons delineated in 2016 were updated using a heads up (i.e., on screen) approach where each polygon was assessed relative to the 2018 imagery. Based on the visual comparison of 2016 to 2018, polygons delineated in 2016 were either left unchanged, modified to fit the extent of vegetation cover on the 2018 images, or deleted. Imagery interpretation was completed in QGIS (Version 3.4.1).

4.2.2 Ground Sampling of Terrestrial Vegetation

Ground sampling of terrestrial (i.e., riparian) vegetation was conducted between July 4-9, 2018 along 19 belt-transects at the study sites (i.e., 14 transects at Airport Lagoon and five transects at Beaver Pond). Belt-transects were 20 m in length and consisted of ten 2 m by 0.5 m quadrats to allow for sub-sampling and to increase accuracy of vegetation cover estimates (Figure 3). Each transect was laid out using a 30 m measuring tape and a 2 m measuring rod. Transect start and end coordinates were recorded and photographs were taken at both the start and end points. Within each quadrat, vegetation was identified to species and the percent cover of each species was recorded.

All vegetation within or overhanging each quadrat was identified to species, or in some cases to genus. Per cent cover (vertical crown projection) of each taxon was visually estimated and rounded as follows: <1% - traces; 1-10% - rounded to nearest 1%; 11-30% - rounded to nearest 5%; 31-100% - rounded to nearest 10%.

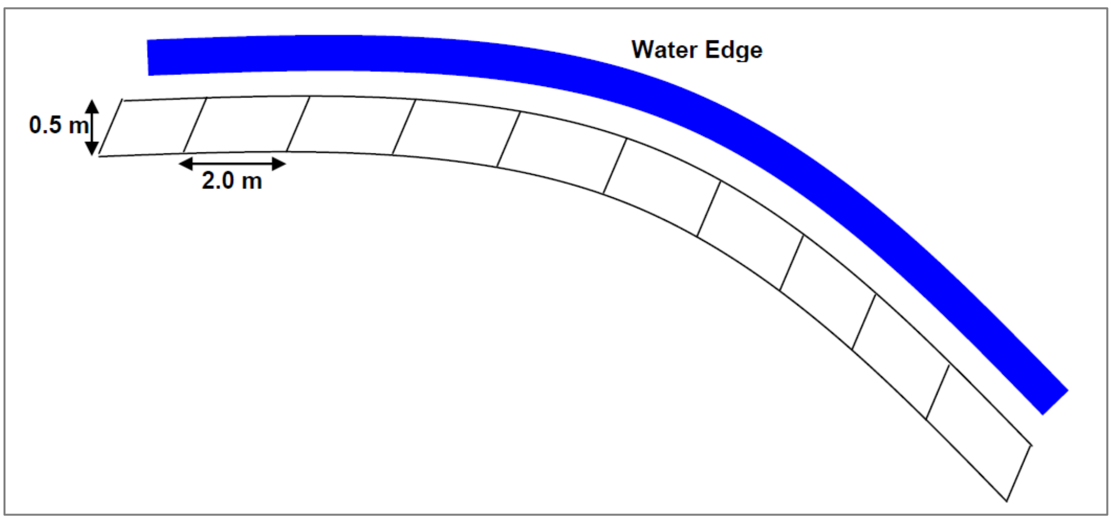

Figure 3. Location of belt transects surveyed for the ground sampling of terrestrial vegetation at Airport Lagoon and Beaver Pond.

In 2018, four of the previously established transects (two at Airport Lagoon and two at Beaver Pond) were flooded during the time of the survey so new (temporary) transects at the water's edge were established. Further, two new belt transects were added to Airport Lagoon (Figure 4).

Site and soil characteristics for each transect were recorded on provincial ecosystem field forms (Province of British Columbia 2010). The ground cover (per cent area) of each quadrat was apportioned among substrate classes as follows: organic matter, coarse woody debris, rock, mineral soil, and water (standing and flowing). Additional field observations on vegetation composition and structure made during ground inspections of the study sites assisted with ground-truthing the polygon mapping and with updating habitat class abundance and distribution.

Figure 4. Location of belt transects surveyed for the ground sampling of terrestrial vegetation at Airport Lagoon and Beaver Pond.

4.2.3 Sampling of aquatic vegetation

Sampling of aquatic vegetation occurred in July 2018 and was based on a systematic design (Hawkes et al. 2011, Miller and Hawkes 2013) using transects spaced at 100 m to 400 m intervals with sampling points located every 25 m to 50 m along each transect (Figure 5). Transect length and spacing varied depending on the width of the wetland and environmental conditions at the time of the survey. Geographical coordinates corresponding to the sample points were loaded into a hand-held GPS unit to facilitate navigation from point to point in the field.

Aquatic macrophyte species composition and relative abundance was recorded at each sample point using a benthic rake drags (i.e., using a double-headed rake attached to a rope). At each location the rake was dropped to the bottom and dragged for a distance of 1-3 m. A cluster sampling approach was used in which two samples were taken at each location. The volume of each sample was estimated based on a categorical scale from 1 to 3 (Table 1). Also, each macrophyte species in the sample was assigned a relative cover class (Table 2). Water depths were measured by dropping a weighted tape measure to the bottom at each surface sample point.

Table 1. Volume classes for vegetation samples collected during the sampling of aquatic vegetation in 2018.

Volume Class	Sample Volume	Definition
1	Trace	Sample is restricted to one or very few strands of vegetation
2	Small	Sample fills less than half of the tines of the sampling rake
3	Large	Sample fills half or more of the tines of the sampling rake

Table 2. Cover class for vegetation samples collected during the sampling of aquatic vegetation in 2018.

Cover Class	Definition
T	Species is present but contributes negligibly (< 1 per cent) to the sample volume
1	Species contributes less than 10 per cent of the sample volume
2	Species contributes 11–20 per cent of the sample volume
3	Species contributes 21–50 per cent of the sample volume
4	Species contributes 51–75 per cent of the sample volume
5	Species contributes 76–100 per cent of the sample volume

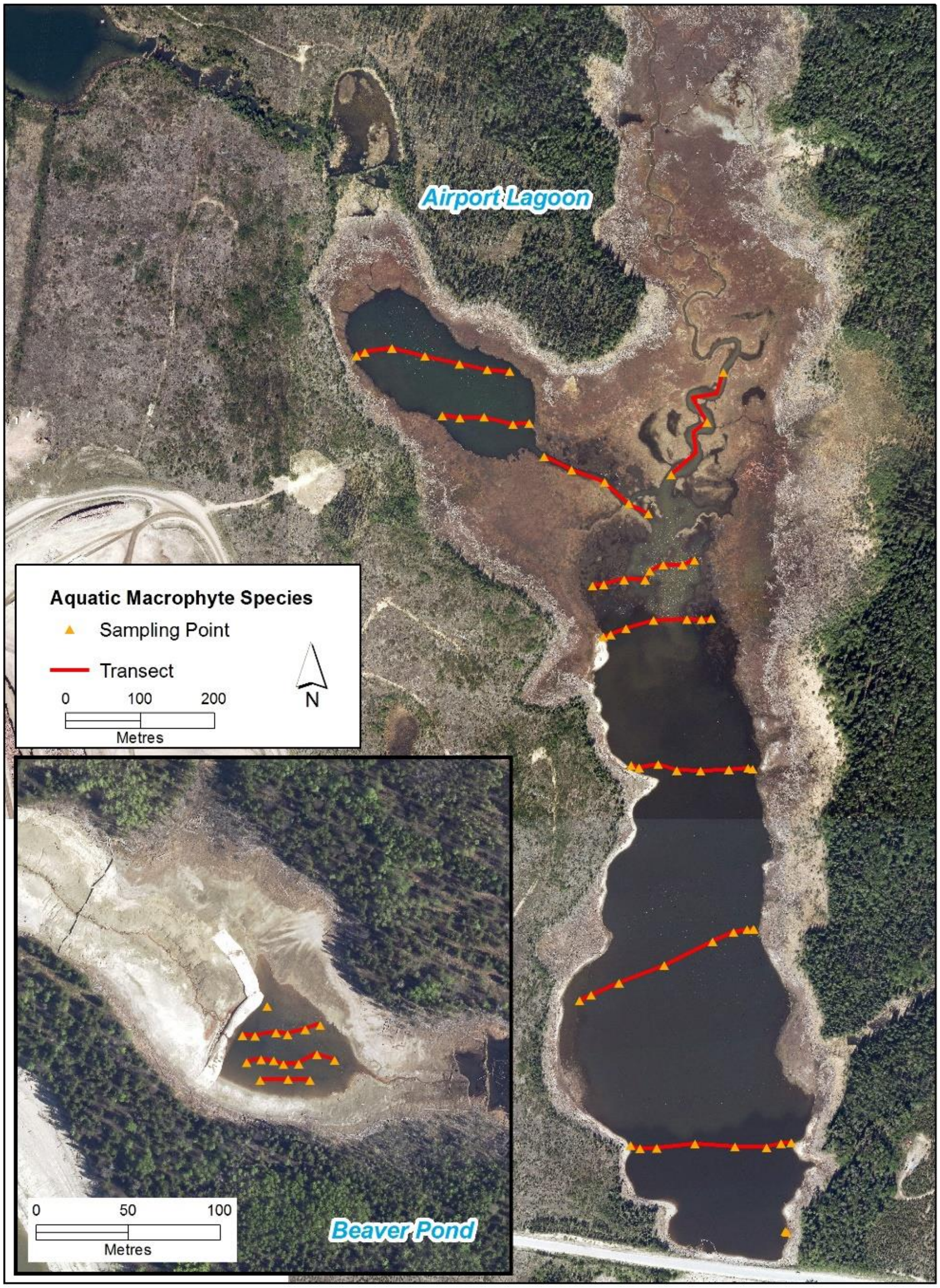

Figure 5. Locations of transects and sampling points used in 2018 in the sampling of aquatic macrophyte species at Airport Lagoon and Beaver Pond.

4.3 Waterfowl and Shorebird Surveys

Data on waterfowl and shorebirds are being collected to address the following management questions and hypothesis:

- **MQ2:** Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?
- **MQ4:** Is the area and quality of fish and wildlife habitat created by the wetland enhancement maintained over time?
- **H_{03}:** The species composition and density of waterfowl[1] changes following enhancement.

Three replicates of waterfowl and shorebirds surveys were conducted between April to June 2018. Survey methods were consistent with all previous years of the project (McInnis et al. 2017) and followed provincial standards for relative abundance inventories (RIC 1999a). Surveys were conducted at five observation stations at Airport Lagoon and one observation station at Beaver Pond (Figure 6). Data on flock or individual number, species, sex, behaviour, and general habitat (e.g., mid pond, in water near pond edge, standing on shore in water, on shore) were recorded on a modified Resource Inventory Committee data form (RIC 1999a) and their corresponding location was recorded on a map with an orthophoto background of each site. Discrete scan areas were delineated on maps to ensure double counting of birds did not occur. Weather conditions were recorded at the beginning and end of each survey, and any unusual conditions or circumstances that potentially affected waterfowl and shorebird presence in the wetland areas were noted.

4.4 Songbird Surveys

Data on songbirds are collected to address the following management questions and hypothesis:

- **MQ2:** Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?
- **MQ4:** Is the area and quality of fish and wildlife habitat created by the wetland enhancement maintained over time?
- **H_{03}:** The species composition and density of waterfowl *and songbirds* changes following wetland enhancement[2].

Songbird surveys were conducted in early June 2018 and were consistent with previous years of the project (MacInnis et al. 2017), while following provincial standards and established protocol (Ralph et al. 1995, RIC 1999b, Bird Studies Canada 2009). Point count surveys were conducted at 17 stations at Airport Lagoon and three stations at Beaver Pond (Figure 7) during acceptable weather conditions according to modified standards (RIC 1999b; Hentze and Cooper 2006). Surveys commenced at dawn and

[1] Shorebirds have been included in the surveys since Year 2 (2012) of the monitoring program to provide additional detail on bird use of the enhancement areas.

[2] Hypothesis H_{03} originally did not include reference to songbirds (BC Hydro 2008); however, the annual report from Year 1 includes songbirds in the hypothesis (MacInnis et al. 2012).

Figure 6. Waterfowl and shorebird survey stations at Airport Lagoon and Beaver Pond sampled in 2018.

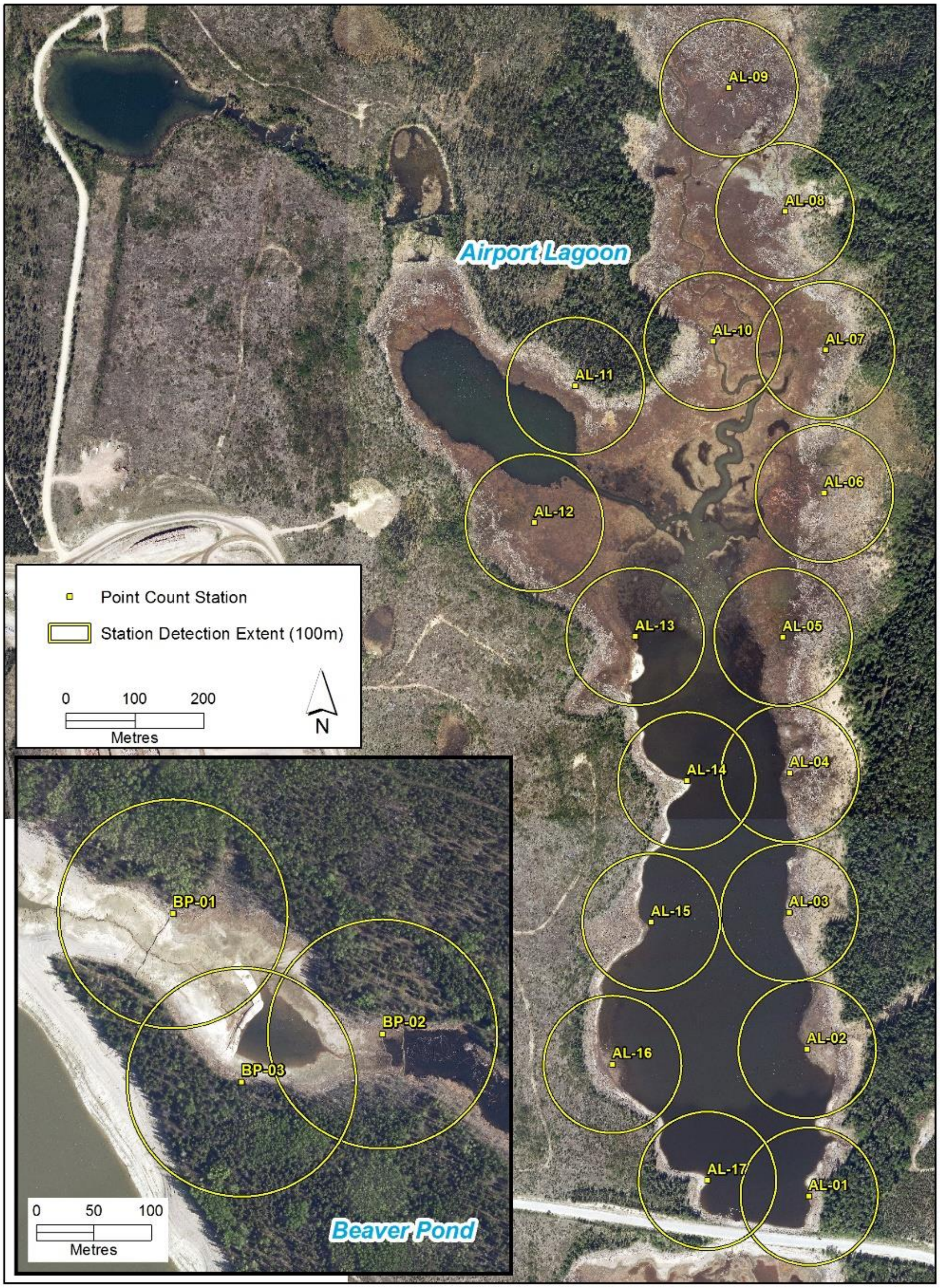

Figure 7. Point count station locations at Airport Lagoon and Beaver Pond sampled in 2018. The yellow circles represent the 100 m detection radius.

ended within four hours to capture the most stable song period (Ralph et al. 1995). At each station counts were conducted for a duration of 5 minutes, during which all birds detected were recorded, with an emphasis on birds detected within 100 m of the point count centre. Each detection was assigned to a temporal category based on the time of detection (0-3 and 3-5 minutes), and the species, sex, age, detection distance from the point count centre, direction to the bird, detection type, and habitat was recorded. Additional comments, such as breeding evidence, were also noted. Each point count station at Airport Lagoon was surveyed on three separate visits in early June. Due to access constraints, only one visit was completed at Beaver Pond.

4.5 Amphibian Surveys

Amphibian surveys were conducted to address the following management questions and hypothesis:

- **MQ2:** Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?
- **MQ4:** Is the area and quality of fish and wildlife habitat created by the wetland enhancement maintained over time?
- **H_{04}:** Amphibian abundance and diversity in the wetland changes following wetland enhancement.

Amphibian surveys occurred over three sampling intervals (i.e., replicates) between April and June 2018. Visual Encounter Surveys (VES) followed the inventory methods for pond-breeding amphibians (MELP 1998) and the study design of MacInnis et al. (2017). At Airport Lagoon 11 transects distributed along the periphery of the inundated areas were sampled; whereas, at Beaver Pond the entire site was considered a single transect (Figure 8). The search area included shallow water (< 1 m deep), the shorelines, and areas within 3 m of the shoreline. A zig-zag search pattern was applied to areas above the waterline.

Observational data was recorded on animal observation forms modified from MELP (1998). Environmental conditions were recorded at the start and end of each transect. Species, developmental stage, behavior and habitat variables were recorded for each adult, larvae and egg mass observed. Aggregations of tadpoles and metamorph amphibians were treated as a single detection and the total number of individuals was estimated.

Amphibian survey work was conducted under Wildlife Act Permit PG18-304877, which was valid from April 25, 2018 to July 31, 2018.

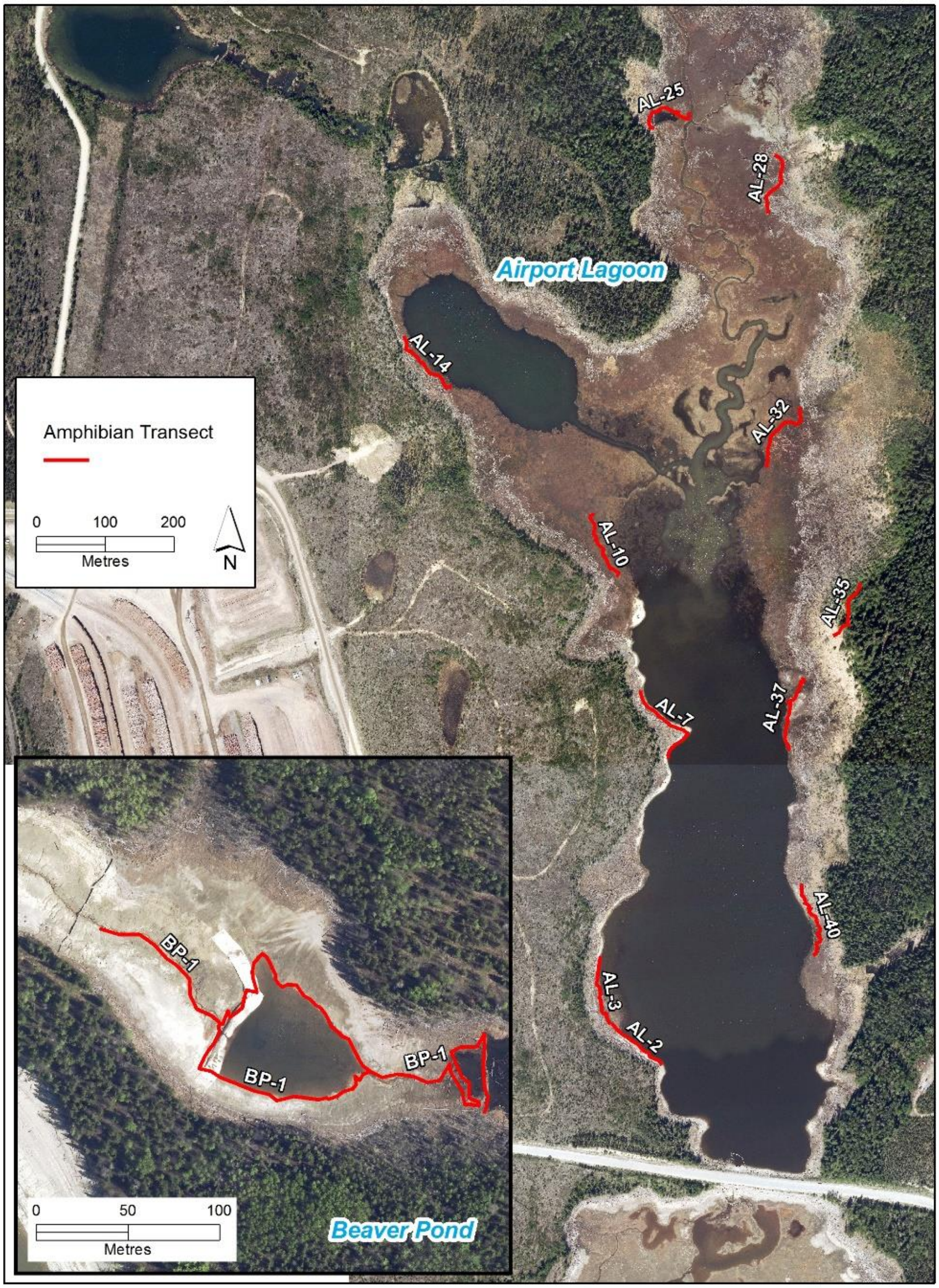

Figure 8. Amphibian survey transect locations at Airport Lagoon and Beaver Pond sampled in 2018.

4.6 Fish Surveys

Fish surveys were conducted to address the following management questions and hypothesis:

- **MQ1:** Are the enhanced (or newly created) wetlands used by fish?
- **MQ4:** Is the area and quality of fish and wildlife habitat created by the wetland enhancement maintained over time?
- **H_{01}:** Fish species composition and density of waterfowl changes following enhancement.

Fish survey methods and effort were consistent with the Terms of Reference (BC Hydro 2008), previous years of the project (McInnis et al. 2017), and provincial standards (RIC 2001; Figure 9). Two sampling sessions were completed, one in May 2018 and the second in July 2018. A combination of methods was used to sample both large and small fish.

At Airport Lagoon, 12 minnow traps were deployed, one reach was electrofished, and fyke nets were deployed – one in May and two in July (Figure 10). At the Beaver Pond site, sampling only occurred in May when six minnow traps were deployed. Insufficient water levels prevented effective electrofishing and fyke net deployment (Figure 11). The Beaver Pond site could not be accessed in July and was not sampled.

When catches were high for a species and method, the first 50 fish were measured for length (mm) and the remainder were enumerated without measurement. All salmonids, cyprinids, and suckers were measured for fork length and total length was recorded for sculpins and burbot.

Fish sampling was conducted under Scientific Fish Collection Permit #297655 issued by the Ministry of Forest, Lands and Natural Resource Operations.

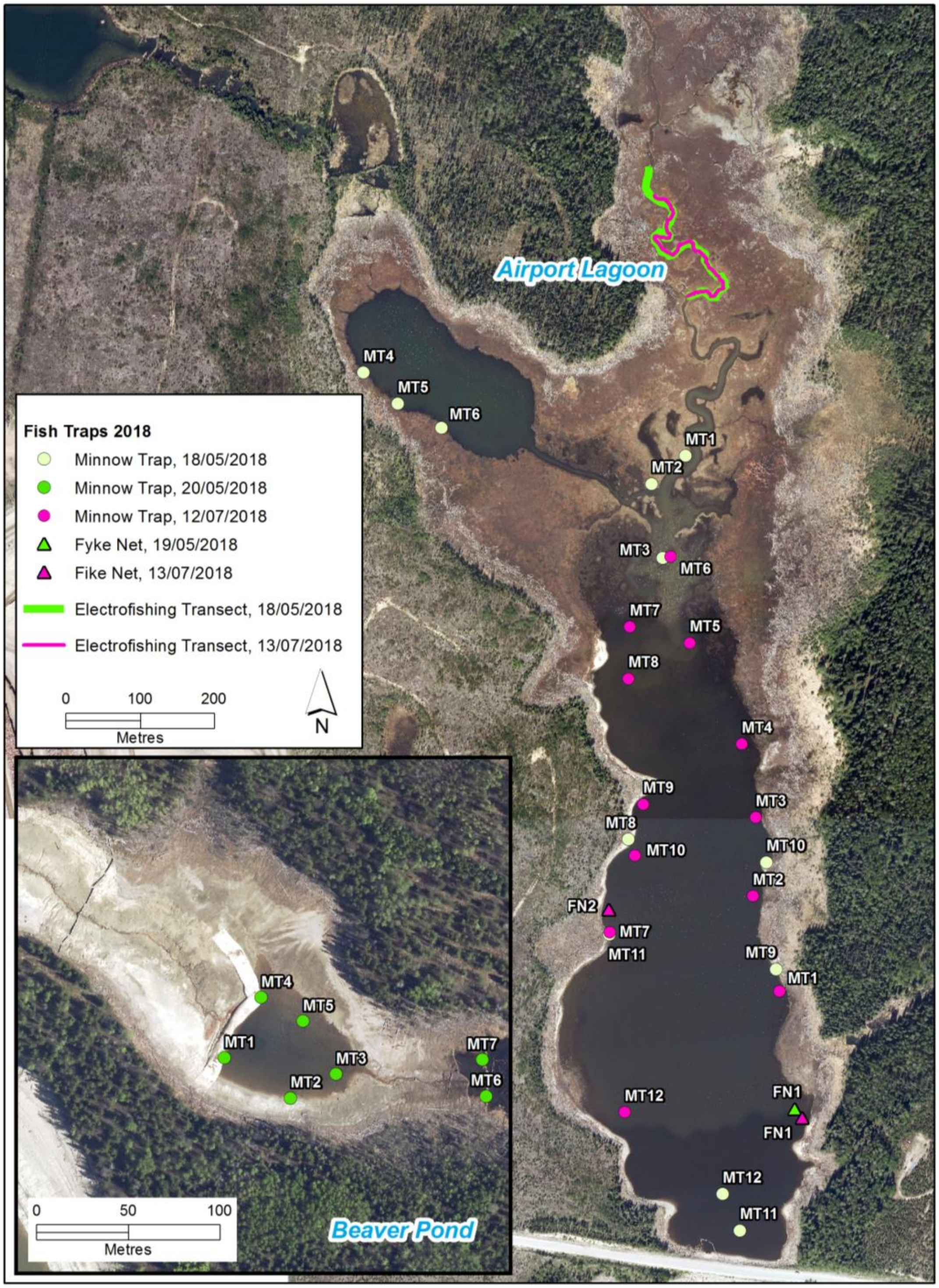

Figure 9. Fish sampling locations by data and method at the Airport Lagoon and Beaver Pond sites.

Figure 10. Conditions at Airport Lagoon for sampling fish in May 2018.

Figure 11. Conditions at Beaver Pond for sampling fish Upstream of Beaver Pond impoundment with insufficient flow for electrofishing in May 2018.

4.7 Data Entry and Analysis

Data was collected on printed data forms in the field and transcribed into Microsoft Excel. GPS waypoint and photographs were labelled accordingly. Other than the results of the habitat classification, data analysis presented in this report is for data that was collected in Year 8 only. The comprehensive report, prepared at the conclusion of Year 10 of the monitoring program, will test the null hypotheses of no effect or difference.

4.7.1 Vegetation

Presence/not detected data was used to assess the species diversity and abundance of terrestrial and aquatic plant species. The average percent cover of terrestrial species across the 10 quadrats in each transect was calculated. These averages were then used to calculate an average per cent cover by vegetation layer (e.g., moss, herb, shrub, tree) for each transect. Species richness (i.e., the number of species by vegetation layer) across each transect was calculated.

Aquatic macrophyte frequency (defined as the proportion of sample plots in which a species or group of species was detected) was compared across each site. Macrophyte frequency (a proxy for overall cover) was calculated as the number of sample points in which a species was detected divided by the total number of sample points. For analysis, macrophyte abundance was estimated for each species and sample point as volume multiplied by relative cover (Miller and Hawkes 2013).

Volume classes ranged from 1 through 3, and relative abundance classes ranged from 0.1 (for trace) to 1 through 5 (Table 1, Table 2). For each sample point, the values were averaged across two rake grabs. Thus, the minimum possible volume value was 0.5 and the minimum possible relative cover value was 0.05. The minimum possible (non-zero) value for the volume x cover metric was then 0.5 x 0.05 = 0.025, and the maximum possible value for the volume x cover metric was 3 x 5 = 15.

4.7.2 Waterfowl and Shorebirds

The total count of each species at a survey site, during each survey period, was used as the basic statistical unit. These data were used to infer relative abundance and species composition on a seasonal basis. Seasonal periods included early spring (i.e., April), mid-spring (i.e., May) and late spring (i.e., June). Specific locations and the relative abundance of each species was used to document the distribution of waterfowl and shorebird species in each study site.

4.7.3 Songbirds

Songbird analyses were limited to passerine (i.e., “songbirds”) and hummingbird detections within 100 m of the point count centre. Birds detected as fly-overs were excluded from analyses, as these individuals may not utilize the treatment area containing the point count; except for swallows, which were included as they are aerial foragers and are almost exclusively detected in flight, and hummingbirds. For most analyses, one sample (the experimental unit) was a point count station. At each point count station, the total number of detections and individuals was determined by taking the maximum count for a species over all visits during the field season (e.g., if there were three visits to a point count station in a year and 2, 4, and 2 American Robins were recorded during each visit respectively, the value used was 4). For comparisons involving habitat, detections per habitat type per point count station were averaged for all visits (e.g., if there were three visits to a point count station and there were 2, 4, and 2 American Robins detected in the "Forest", the value used was 2.7). Habitat was defined based on the micro-habitat that an individual bird was utilizing at the time of observation. Habitats classified as "Coniferous", "Deciduous", "Mature Mixedwood", or second-growth (coniferous, deciduous or mixed) were labelled as "Forest", habitats classified as "drawdown zone", "reservoir", or "sedge" were labelled as "DDZ", and habitats classified as "shrub" were labelled as "Shrub". Any observations with unknown habitat classifications were excluded.

Songbird richness was defined as the number of species present in a sample, meeting the above detection criteria, and calculated using the 'specnumber' function in the vegan package (Oksanen et al. 2017) in R statistical programming language (R Development Core Team 2014). Songbird diversity (Shannon's diversity index [H]) was determined using the 'diversity' function in the vegan package, and calculated as follows:

$$H = -\sum_{i=1}^{q} p_i \log p_i$$

where *q* is species richness and *pi* is the relative frequency or proportion (on a 0 to 1 scale) of observations of species *i*. For a given survey, *H* is maximum when the observations are equally distributed among the *q* species, *H* is lower when one or a few species exhibit stronger dominance, and *H*=0 when there is only one species detected. *H* increases with the number of species and thus, has no predefined maximum. That is, diversity is related to richness but accounts for species abundance. Using both richness and diversity indices together provides insight into the composition of the communities. Both songbird richness and diversity were examined through boxplots.

Data are summarized using box plots, since these display the differences between groups of data without making any assumptions about their underlying statistical distributions and show their dispersion and skewness (Massart et al. 2005). Boxes represent between 25 percent and 75 percent of the ranked data. The horizontal line inside the box is the median. The length of the boxes is their interquartile range (Sokal and Rohlf 1995). A small box indicates that most data are found around the median (small dispersion of the data). The opposite is true for a long box: the data are dispersed and not concentrated around the median. Whiskers are drawn from the top of the box to the largest observation within 1.5 interquartile range of the top, and from the bottom of the box to the smallest observation within 1.5 interquartile range of the bottom of the box. Outliers beyond the whiskers are plotted as hollow dots. "Notched" boxplots were used in Airport Lagoon boxplots allowing for direct comparisons of group differences with visual examination; where notches do not overlap between groups there is strong evidence that their medians significantly differ (Chambers et al. 1983). Notched boxplots were not used for Beaver Pond sites due to graphical anomalies resulting from a small sample size, and instead the distribution of data was explored using regular boxplots. Box plots are recommended for a sample size of at least five, which makes them useful for sampling designs with low replication (Krzywinski and Altman 2014).

The similarity of songbird communities was assessed using Venn diagrams, with the VennDiagram package in R. A three-way Venn diagram was used for Airport Lagoon. Due to the pattern of shared species a three-way diagram was not able to be computed for Beaver Pond, so pair-wise comparisons were graphed instead.

4.7.4 Amphibians

Total survey time per person was recorded to calculate detection rates (a proxy for catch per unit effort time or CPUE) for each survey site, field session and species. Detection rates were calculated for each site by dividing the total number of observations by the time spent searching the site. Comparisons of species richness (i.e., the number of species per study site) were made by standardizing capture data by correcting for total time surveyed per area (number of observations per hour). Finally, site occupancy was assessed by the presence of any life stage of a species at the site.

4.7.5 Fish

To assess fish composition and density, fish abundance data was standardized to the number of individuals per trap hour (CPUE), which accounts for slight differences in trap effort between the May and July replicates.

5.0 RESULTS

Our ability to observe possible effects of wetland enhancement depends upon the availability of robust occurrence data (i.e., multiple confirmations of species identifications over multiple years), which for this monitoring program relates to vegetation, waterfowl and shorebirds, passerines, amphibians and fish. In 2018, species from all groups were observed, the results of which are presented below.

5.1 Reservoir Conditions

During the 2018 field season, the elevation of Williston Reservoir ranged from a daily average low of 656.47 m ASL in late April to a daily average high of 667.11 m ASL in the middle of July (Table 3). Reservoir elevations reached the height of the enhancement structures on July 9, 2018 at Airport Lagoon and on July 20, 2018 at Beaver Pond.

Table 3. Dates and reservoir elevations of each 2018 field session.

	2018		Reservoir Elevation (m ASL)*		
Field Session	Start Date	End Date	Min	Max	Mean
Waterfowl / Amphibian	Apr 27	Apr 27	656.47	656.47	656.47
Waterfowl / Amphibian	May 18	May 19	660.17	660.44	660.31
Fish	May 18	May 21	660.17	661.01	660.59
Songbirds	Jun 2	Jun 8	663.35	664.00	663.67
Waterfowl / Amphibian	Jun 4	Jun 4	663.56	663.56	663.56
Vegetation	Jul 4	Jul 10	666.59	666.95	666.77
Fish	Jul 12	Jul 14	667.04	667.11	667.08

*elevations where the wetland features begin to get inundated: Airport Lagoon=666.99 masl; Beaver Pond = 667.25 masl.

Reservoir elevations in 2018 were lowest in April, hitting the lowest daily average (656.48 m ASL) on April 26, 2018 (Figure 12). Water levels increased after that, peaking on August 1, 2018 (667.65 m ASL). In 2018 the reservoir levels were lower than in most previous years, reaching minimum elevations earlier. The timing of maximum elevation in 2018 was comparable to previous years, but overall, the reservoir elevations were lower in 2018 compared to the previous years of the monitoring program (Figure) and was outside the range of variability of the long-term trends.

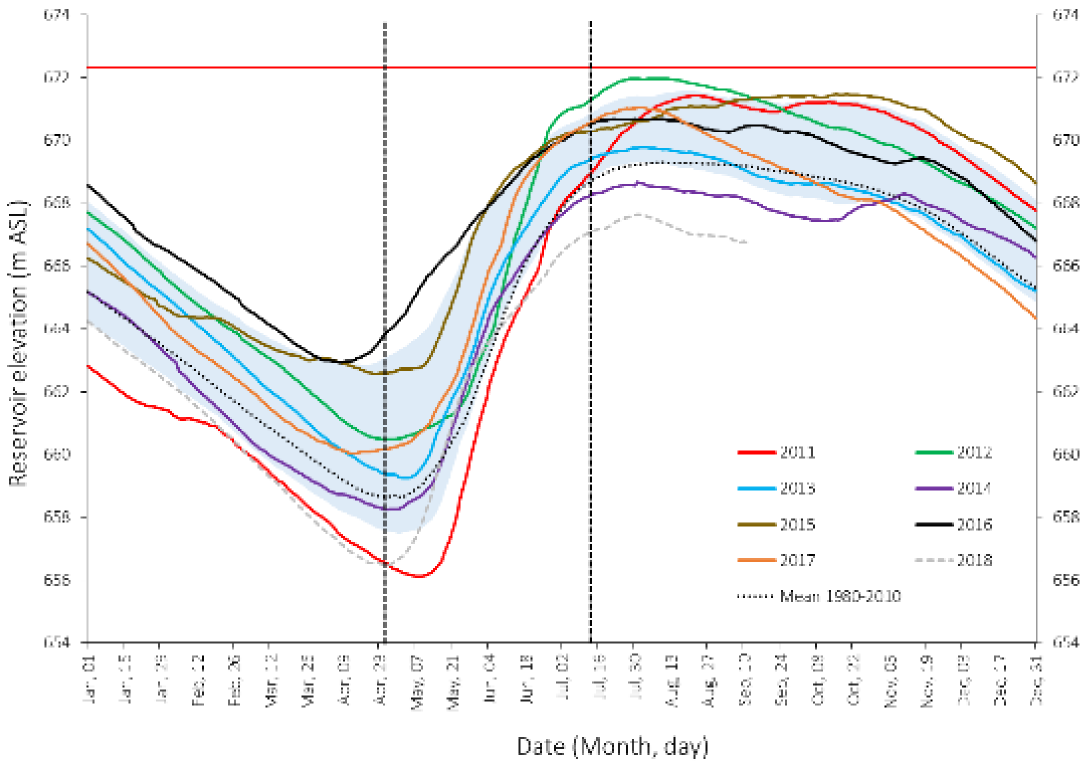

Figure 12. Williston Reservoir elevations for 2011 to 2018. The shaded area represents the 10th and 90th percentile for the period 2011 to 2017; the dashed horizontal red line is the normal operating maximum. Vertical dashed lines indicated start and end dates of sampling in 2018.

5.2 Environmental Conditions

The average daily temperatures in 2018 were within the range of variability of the daily mean temperatures during the previous years of monitoring (Figure 13). Daily mean temperatures were colder at the beginning of April 2018, compared to previous years, but rapidly increased in late April and May 2018. During June and July, average daily temperatures fluctuated within the range of variability of the previous monitoring period.

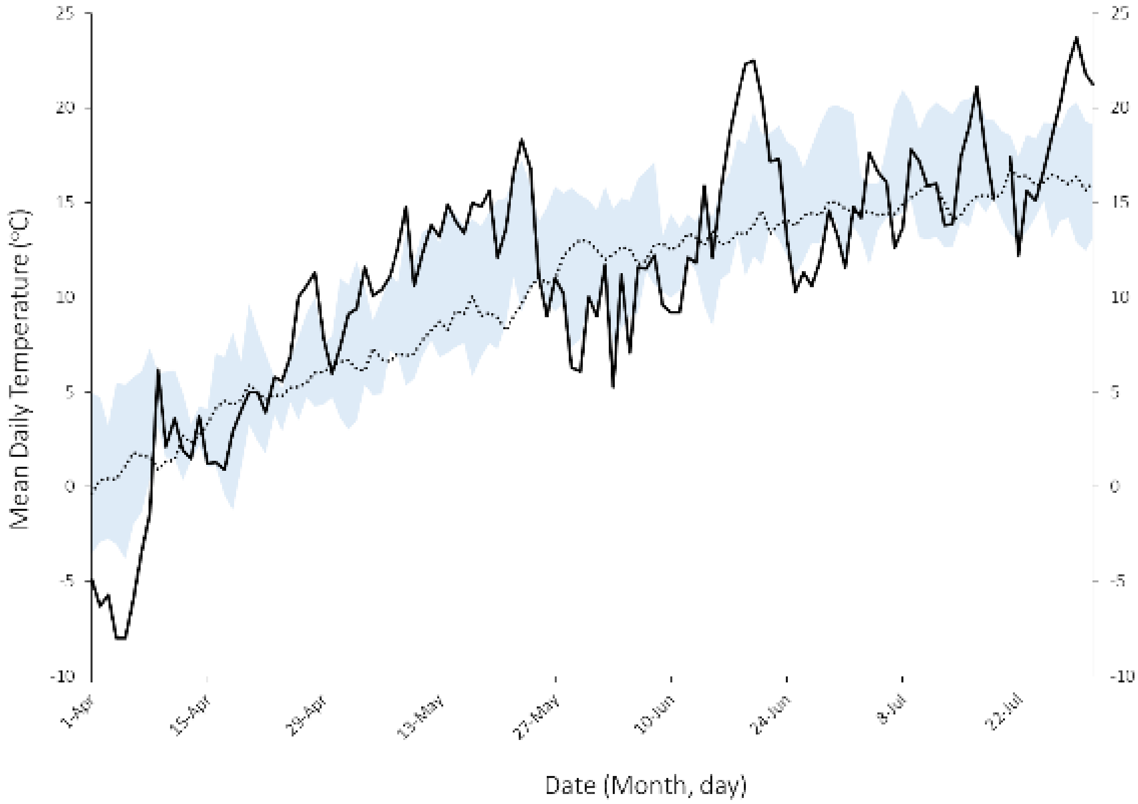

Figure 13. Daily mean air temperature for 2018 (black line) in the study region for the monthly periods when field surveys occurred. The shaded area represents the standard deviation (+/-) of the daily mean air temperatures for Years 1-7 (2011-2017) of the monitoring program. Dotted line represents the average mean temperature from 1980-2010.

Cumulative precipitation during the survey period in 2018 was typically within the range of variability measured during the previous years of monitoring (Figure 14). Conditions in April 2018 appeared to be average of what was experienced in previous years, whereas conditions in May and June of 2018 appeared to be drier than previous years. Likewise, conditions in July 2018 appeared to be consistent with cumulative precipitation in previous years.

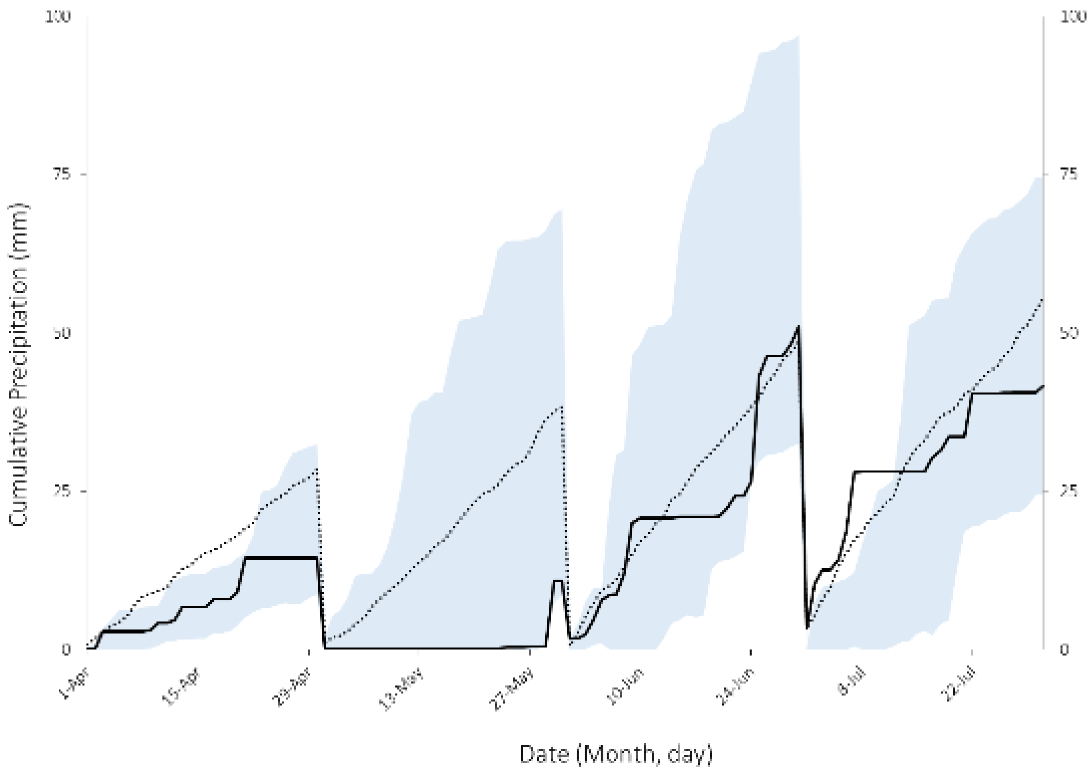

Figure 14. Cumulative monthly total precipitation for 2018 (black line) in the study region for the monthly periods when field surveys occurred. The shaded area represents the standard deviation (+/-) of the cumulative monthly total precipitation for Years 1-7 (2011-2017) of the monitoring program. The dotted line represents the average cumulative precipitation from 1980-2010.

In regard to accumulated degree days, Year 8 of the monitoring program was comparable to Year 7 (2017). While warmer than the long-term average, the accumulated degree days in 2018 were cooler than what as experienced in 2015 and 2016, but were warmer than the years at the beginning of the monitoring program (i.e., 2011-2013; Figure 15).

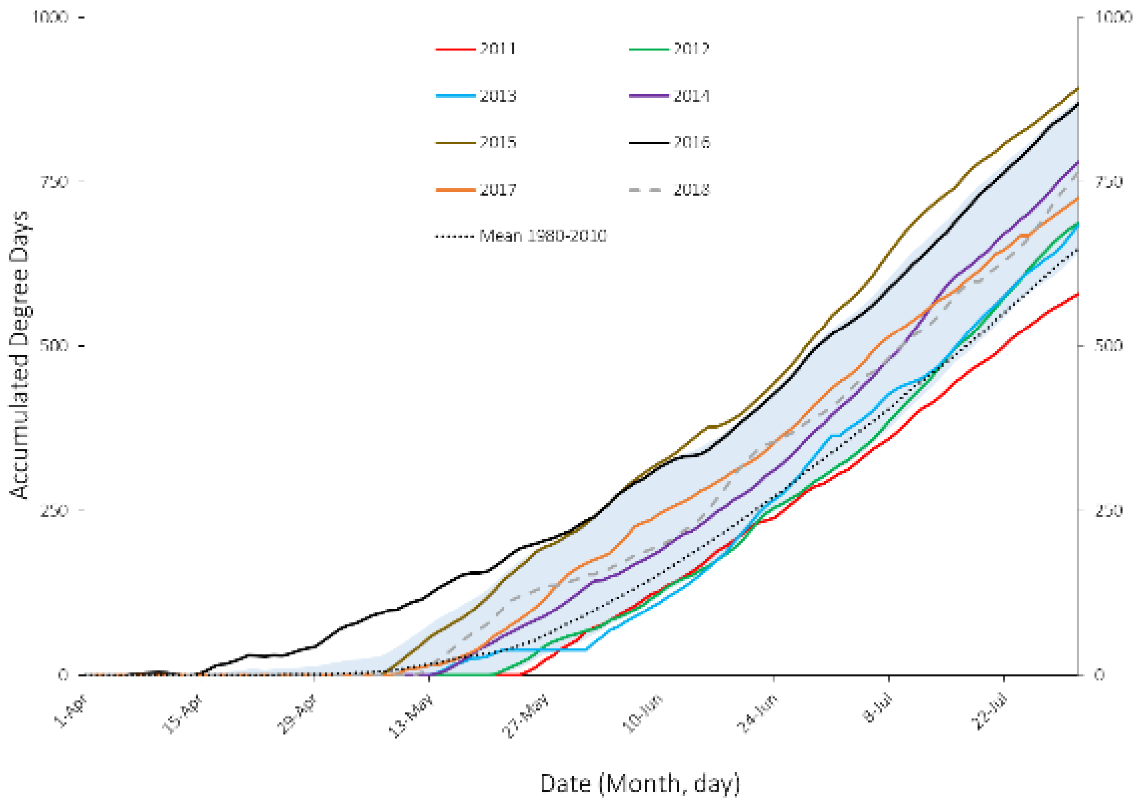

Figure 15. Accumulated degree days (5°C base temperature) and the long-term average (1980-2010) in the region. The shaded area represents the 10th and 90th percentile for the period 2011 to 2017. Calculated from Environment and Climate Change Canada daily maximum and minimum temperatures observed at the Mackenzie Airport (Station names: Mackenzie A and Mackenzie Airport Auto).

5.3 Vegetation

Plant species identified in Year 8 of the monitoring program are presented here. These results are used to update the distribution of habitat classes, characterize the vegetation coverage in the drawdown zone and characterize the dominant species in the aquatic macrophyte communities.

5.3.1 Habitat Classification

The vegetation data collected at each transect was used to determine whether the species composition of those communities changed over time. The classifications generated in 2016 at Airport Lagoon have remained relatively stable over time, with little change in species composition of each community (i.e., the same dominant species can be used to define each community); however, the area and coverage of these communities has changed in the past two year (Table 4).

Table 4. Habitat classification summary, area for habitat classes identified during photo interpretation for the Airport Lagoon site in Year 8 compared to the previous results from Year 6. Refer to Appendix 9 for detailed descriptions of the habitat classes

Habitat Class	Habitat Class Description	Year 8 Area (ha)	Year 8 Per cent of total area	Year 6 Area (ha)	Year 6 Per cent of total area	Difference between Year 8 and Year 6 (total area)	Difference between Year 8 and Year 6 (%)
BM	Basin Moss	14.6	22.3%	18.0	27.6%	-3.4	-5.3%
BS	Basin Smartweed	3.1	4.7%	4.8	7.4%	-1.8	-2.7%
FI	Floating Island	0.0	0.0%	0.1	0.1%	-0.1	-0.1%
SD	Shoreline Driftwood	11.0	16.8%	8.1	12.4%	2.9	4.4%
SG	Shoreline Grassland	2.2	3.3%	0.4	0.7%	1.8	2.7%
SP	Streams and Ponds	27.0	41.3%	26.1	40.0%	0.9	1.3%
SS	Shoreline Sand	0.7	1.1%	1.2	1.8%	-0.5	0.7%
SW	Shoreline Willow	3.9	6.0%	3.6	5.6%	0.3	0.4%
WD	Wetland Dead Trees	0.2	0.3%	0.2	0.3%	0.0	0.0%
WH	Wetland Horsetail	0.7	1.1%	0.8	1.2%	0.0	0.0%
WS	Wetland Sedge	1.1	1.6%	1.1	1.6%	0.0	0.0%
WW	Wetland Willow	0.9	1.4%	0.9	1.4%	0.0	0.0%

The biggest changes were a decreased in the area coverage for Basin Moss (BM) and Basin Smartweed (BS) and an increase in the coverage of Shoreline Driftwood (i.e., coarse woody debris; Figure 16).

5.3.2 Drawdown Zone Vegetation

At Airport Lagoon, terrestrial vegetation surveys were completed on July 4, 5, and 9, 2018. Seven belt transects that were surveyed in 2016 were also surveyed in 2018. As in previous years, transects AL-1 and AL-2 were not surveyed due to the water levels at Airport Lagoon. The location of AL-4 and AL-8 were moved to the nearest shoreline. In addition, four new transects were established (i.e., AL-13, AL-14, AL-15 and AL-16) to increase the survey coverage in the different habitat classes.

Five belt transects were surveyed on July 6, 2018 at Beaver Pond. Two transects (i.e., BP-1 and BP-2) established in previous years were underwater and were not surveyed. Instead a new transect (BP-1A) was established on the south side of the impoundment and a second new transect (BP-6) was established on the north side of the impoundment.

<u>Airport Lagoon</u>

Vegetation transects at the Airport Lagoon were generally located on moist, organic rich soils, with slight to gentle slopes and that are subject to annual flooding and are therefore dominated by graminoid species. Overall the surface substrate was dominated by organic matter; a subset of the transects were covered with a large proportion of mineral soil (sand) and coarse woody debris (driftwood). The amount of surface water was varied at the time of the survey from 0% on half of the transects to 48.3% on AL-4 (Table 5).

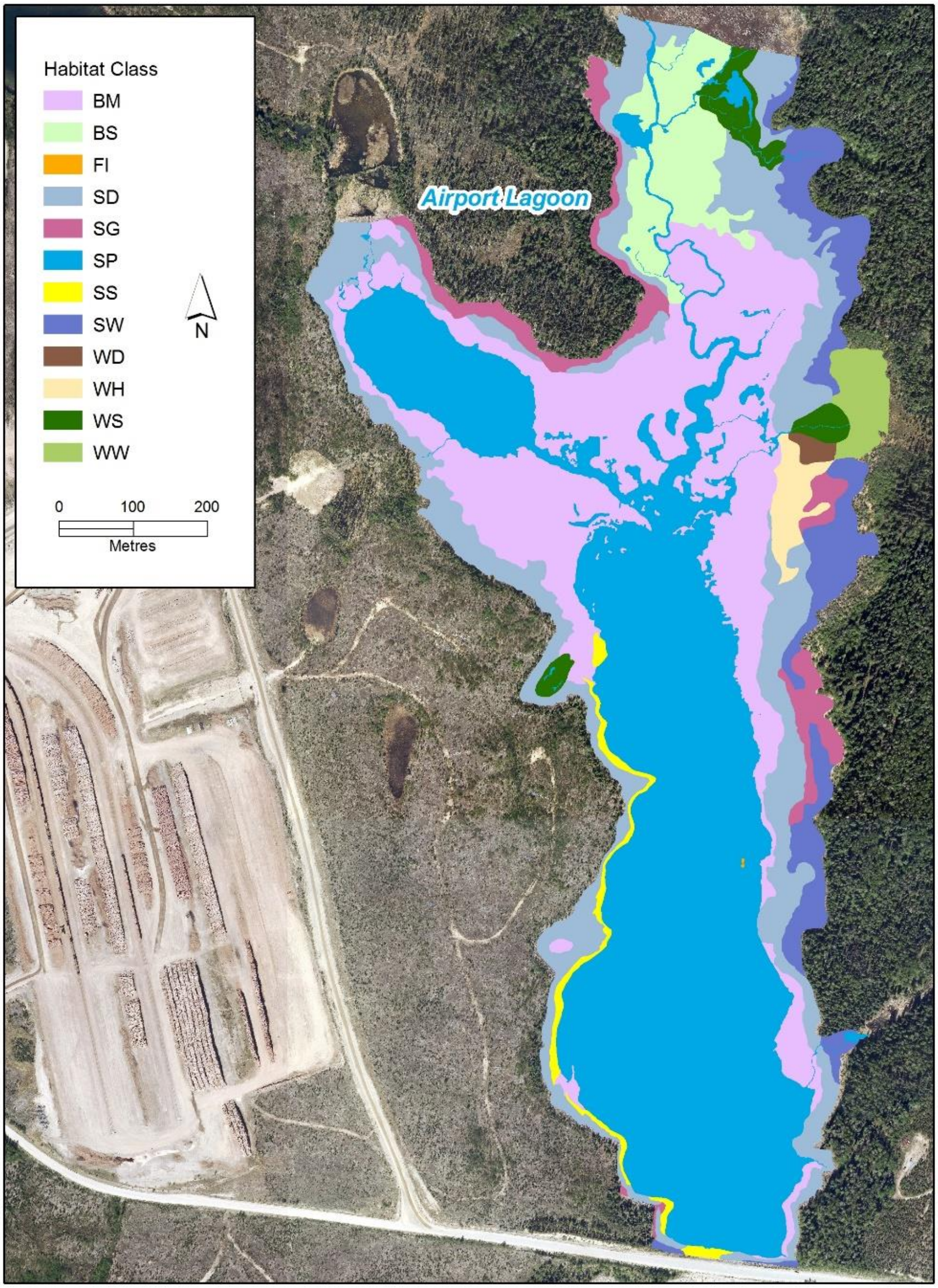

Figure 16. Spatial extent of habitat classes delineated based on updated orthophoto imagery acquired in May 2018 Pond sites.

Table 5. Site characteristics for vegetation transects sampled in Year 8 at the Airport Lagoon.

Transect	Water Source[1]	Soil Moisture Regime[2]	Soil Nutrient Regime[3]	Successional Status[4]	Structural Stage[5]	Elevation (m)[6]	Slope (%)	Aspect (°)	% Organic Matter	% Rocks	% Mineral Soil	% Course Woody Debris	% Surface Water[7]	Drainage[8]	Flood Regime[9]
AL-3	P	2	A	DC	2b	677	15	30	36.0	0.0	56.7	12.2	0.0	r	A
AL-4	-	-	-	-	-	-	-	-	69.4	0.0	10.0	-	48.3		
AL-5	P	3	B	DC	2b	679	15	169	55.0	0.0	22.2	25.0	0.0	r	A-F
AL-6	F	7	E	DC	2b	673	1	-	94.4	0.0	0.0	3.5	17.5	p	F
AL-7	F	7	E	DC	2b	676	3	260	95.5	0.0	0.0	15.0	0.0	v	F
AL-9	P	6	E	DC	2b	675	6	272	61.4	0.0	2.3	37.2	0.0	i	A
AL-10	F	7	E	DC	2b	675	2	284	85.1	0.0	0.0	14.3	2.0	v	A-F
AL-11	G	6	E	DC	2a	676	0	-	100.0	0.0	0.0	0.0	0.0	v	A
AL-12	G	6	E	DC	2a	666	0	-	99.0	0.0	0.0	2.0	0.0	-	-
AL-13	G	3	E	-	2b	-	-	-	97.0	0.0	0.0	-	6.0	p	-
AL-14	P	6	E	DC	2b	676	5	272	92.7	0.0	0.0	7.3	0.0	i	A
AL-15	-	-	-	-	-	-	-	-	99.7	0.0	0.0	3.0	0.0	-	-
AL-16	-	-	-	-	-	-	-	-	86.0	0.0	0.0	5.2	15.7	-	-

[1] P=Precipitation, G=Groundwater, S=Snowmelt, F=Stream sub-irrigation and flooding, M=Mineral spring, T=Tidal, freshwater, E=Tidal, saltwater, Z=Permafrost

[2] 0=Very Xeric, 1 = Xeric, 2 = Subxeric, 3= Submesic, 4= Mesic, 5= Subhygric, 6=Hygric, 7=Subhygric, 8=Hydric

[3] A=Very poor, B=Poor, C=Medium, D=Rich E=Very rich, F=Saline

[4] DC = Disclimax

[5] 2a= Forb dominated – includes non-graminoid herbs and ferns; 2b= Graminoid dominated – includes grasses, sedges, reeds, and rushes

[6] Values represent observations in 2016.

[7] Area of transect covered by surface water.

[8] v=very poorly drained, p=poorly drained, i=imperfectly drained, m=moderately well drained, w=well drained, r=rapidly drained, x = very rapidly drained

[9] A=annual flood, O=occasional flooding, F=frequent flooding

Tree cover was absent on all transects. Average per cent cover of herb species ranged from a low of 0.46% (AL-11) to a high of 79.91% (AL-4). A total of 56 herb species were recorded across the 14 transects. The most common species detected were *Drepanocladus aduncus* (common hook moss), *Persicaria amphibia* (water smartweed), *Calamagrostis canadensis* (bluejoint) and *Bidens cernua* (nodding beggarticks). Six species of moss were recorded on 11 of the transects with the highest coverage being present on transects AL-7 and AL-11. Shrubs species were predominantly willow (*Salix* sp.) and their coverage of the transects was relatively low (Table 6).

A summary of the terrestrial plant species and percent cover for each transect will be prepared for the final report.

Table 6. Vegetation cover summary for transects sampled in Year 8 at the Airport Lagoon.

Transect	No. herb species	Average % herb cover	No. moss species	Average % moss cover	No. shrub species	Average % shrub cover
AL-3	7	4.49	1	0.01	0	0.00
AL-4	17	79.91	1	0.01	0	0.00
AL-5	13	8.23	0	0.00	0	0.00
AL-6	16	35.40	1	1.51	0	0.00
AL-7	12	15.06	1	51.50	2	1.12
AL-9	10	7.94	1	7.81	0	0.00
AL-10	11	7.96	2	21.91	3	0.22
AL-11	7	0.46	2	90.03	0	0.00
AL-12	9	39.48	1	0.02	0	0.00
AL-13	5	2.53	3	5.18	2	3.40
AL-14	12	23.56	0	0.00	0	0.00
AL-15	7	13.01	1	14.00	0	0.00
AL-16	14	14.76	1	16.11	0	0.00
Average		***19.45***		***16.01***		***0.36***

Beaver Pond

The five vegetation transects at the Beaver Pond were located on clay rich soils with gentle to moderate slopes and frequent to annual flooding (Table 7). Overall the surface substrate was dominated by mineral soil matter, except for transect BP-5, which was dominated by organic matter. None of the transects were had any surface water at the time of the survey in 2018.

Table 7. Site characteristics for vegetation transects sampled in Year 6 at the Beaver Pond.

Transect	Water Source[1]	Soil Moisture Regime[2]	Soil Nutrient Regime[3]	Successional Status[4]	Structural Stage[5]	Elevation (m)[6]	Slope (%)	Aspect (°)	% Organic Matter	% Rocks	% Mineral Soil	% Course Woody Debris	% Surface Water[7]	Drainage[8]	Flood Regime[9]
BP-1A	P	4	D	DC	2b	673	-	-	0.4	0.9	98.8	0.0	0.0	m	A-F
BP-3	P	3	B	DC	2b	675	25	230	1.2	25.7	73.5	0.5	0.0	r	A-F
BP-4	G	7	D	DC	2a	673	5	227	1.4	0.8	93.0	6.2	0.0	m	A
BP-5	P	4	D	DC	2a	685	20	44	70.2	0.0	11.2	24.2	0.0	m	A-F
BP-6	P	3	B	DC	2b	675	-	-	1.3	99.1	0.2	-	0.0	r	A-F

[1] P=Precipitation, G=Groundwater, S=Snowmelt, F=Stream sub-irrigation and flooding, M=Mineral spring, T=Tidal, freshwater, E=Tidal, saltwater, Z=Permafrost

[2] 0=Very Xeric, 1 = Xeric, 2 = Subxeric, 3= Submesic, 4= Mesic, 5= Subhygric, 6=Hygric, 7=Subhygric, 8=Hydric

[3] A=Very poor, B=Poor, C=Medium, D=Rich E=Very rich, F=Saline

[4] DC = Disclimax

[5] 2a= Forb dominated – includes non-graminoid herbs and ferns; 2b= Graminoid dominated – includes grasses, sedges, reeds, and rushes

[6] Values represent observations in 2016.

[7] Area of transect covered by surface water.

[8] v=very poorly drained, p=poorly drained, i=imperfectly drained, m=moderately well drained, w=well drained, r=rapidly drained, x = very rapidly drained

[9] A=annual flood, O=occasional flooding, F=frequent flooding

Tree cover was absent on all transects. Average per cent cover of herb species on all transects was less than 5%, which was considerably less than Airport Lagoon. A total of 31 herb species were recorded across the five transects. The most common species detected were *Equisetum arvense* (common horsetail), *Cryptantha torreyana* (Torrey's cryptantha) and *Juncus bufonius* (toad rush). Three species of moss were recorded on the transects with the highest coverage being present on transect BP-6. No shrub species were recorded on the transects at Beaver Pond (Table 8).

Table 8. Vegetation cover summary for transects sampled in Year 8 at the Beaver Pond.

Transect	No. herb species	Average % herb cover	No. moss species	Average % moss cover	No. shrub species	Average % shrub cover
BP-1A	10	1.64	3	0.64	0	
BP-3	11	3.56	1	0.01	0	
BP-4	15	5.44	2	0.11	0	
BP-5	20	4.47	1	1.73	0	
BP-6	14	5.11	1	3.33	0	
Average		***4.04***		***1.16***		***0.00***

5.3.3 Aquatic Vegetation

Data on aquatic plants was collected at Airport Lagoon on July 7, 8 and 9, 2018. Beaver Pond was sampled on July 6, 2018.

Airport Lagoon

Fifteen species of aquatic plants were recorded at Airport Lagoon in 2018 (Table 9). The frequency ranged from 1.6% for a few species to a high of 64.5% for *Myriophyllum sibiricum* (Siberian water-milfoil). The other most commonly encountered species were *Potamogeton foliosus* (closed-leaved pondweed), *Drepanocladus aduncus* (common hook moss) and *Ceratophyllum demersum* (common hornwort). Sampling depths were between 20 cm and 240 cm.

Table 9. Per cent frequency and average volume:abundance metric of aquatic macrophyte species detected in random samples (rake grabs) at Airport Lagoon in 2018.

Scientific Name	Common Name	Frequency (%)	Average volume x Abundance
Bidens cernua	nodding beggarticks	1.61	0.20
Callitriche palustris	spring water-starwort	3.23	0.15
Ceratophyllum demersum	common hornwort	45.16	4.52
Chara sp.	stonewort	4.84	0.10
Drepanocladus aduncus	common hook moss	56.45	11.56
Hippuris vulgaris	mare's tail	1.61	0.10
Myriophyllum sibiricum	Siberian water-milfoil	64.52	6.13
Persicaria maculosa	lady's thumb	3.23	0.20
Potamogeton foliosus	closed-leaved pondweed	45.16	3.49
Potamogeton praelongus	long-stalked potamogeton	17.74	7.77
Ranunculus aquatilis	whitewater buttercup	1.61	0.10
Sparganium sp.	bur-reed	1.61	0.10
Stuckenia pectinata	fennel pondweed	37.10	2.05
Utricularia intermedia	flat-leaved bladderwort	3.23	3.05
Utricularia macrorhiza	greater bladderwort	20.97	3.45

Beaver Pond

Two aquatic plant species were recorded at Beaver Pond in 2018: *P. foliosus* and *R. aquatilis*. *P. foliosus* was recorded at five of the 17 sampling locations (29.4%), whereas *R. aquatilis* was only recorded at one location. Both species were relatively low in volume and abundance, except for *P. foliosus*, which was fairly dense at one sampling point near the southern edge of the impoundment. The majority of the aquatic vegetation samples were collected between 50 cm and 100 cm in depth.

5.4 Waterfowl and Shorebirds

In 2018, three replicates of waterfowl and shorebird surveys were completed at Airport Lagoon and only two replicates were completed at Beaver Pond (Table 10). Access to Beaver Pond at the end of April 2018 was not possible due to the ice conditions on Williston Reservoir at the time of the survey.

Table 10. Dates for the waterfowl and shorebird surveys at Airport Lagoon and Beaver Pond in 2018.

Site		Survey Dates	
Airport Lagoon	April 27, 2018	May 18, 2018	June 4, 2018
Beaver Pond		May 19, 2018	June 7, 2018

5.4.1 Airport Lagoon

At Airport Lagoon, all five of the survey stations were visited during each of the replicates. Survey effort (i.e., observation time) ranged from 15 minutes to 30 minutes at each observation station. A total of 29 individuals from the shorebird group were recorded for six species: Greater Yellowlegs (*Tringa melanoleuca*; n=15), Killdeer (*Charadrius vociferous*; n=5), Spotted Sandpiper (*Actitis macularius*; n = 5), Long-billed Dowitcher (*Limnodromus scolopaceus*; n=2), Lesser Yellowlegs (*Tringa flavipes*; n= 1), and Wilson's Snipe (*Gallinago delicata*; n=1). Eleven waterfowl species and a total of 221 individuals were recorded at Airport Lagoon. Waterfowl species observed at Airport Lagoon (Figure 17) included American Wigeon (AMWI, *Mareca americana*; n=58), Green-winged Teal (GWTA, *Anas crecca*; n=42), Canada Goose (CAGO, *Branta canadensis*; n=35), Bufflehead (BUFF, *Bucephala albeola*; n=24), Mallard (MALL, *Anas platyrhynchos*; n=20), Common Merganser (COME, *Mergus merganser*; n=15), Northern Shoveler (NOSL, *Spatula clypeata*; n=12), Trumpeter Swan (TRUS, *Cygnus buccinator*; n=6), Barrow's Goldeneye (BAGO, *Bucephala islandica*; n=5), Blue-winged Teal (BWTE, *Spatula discors*; n=3) and Northern Pintail (NOPI, *Anas acuta*; n=1).

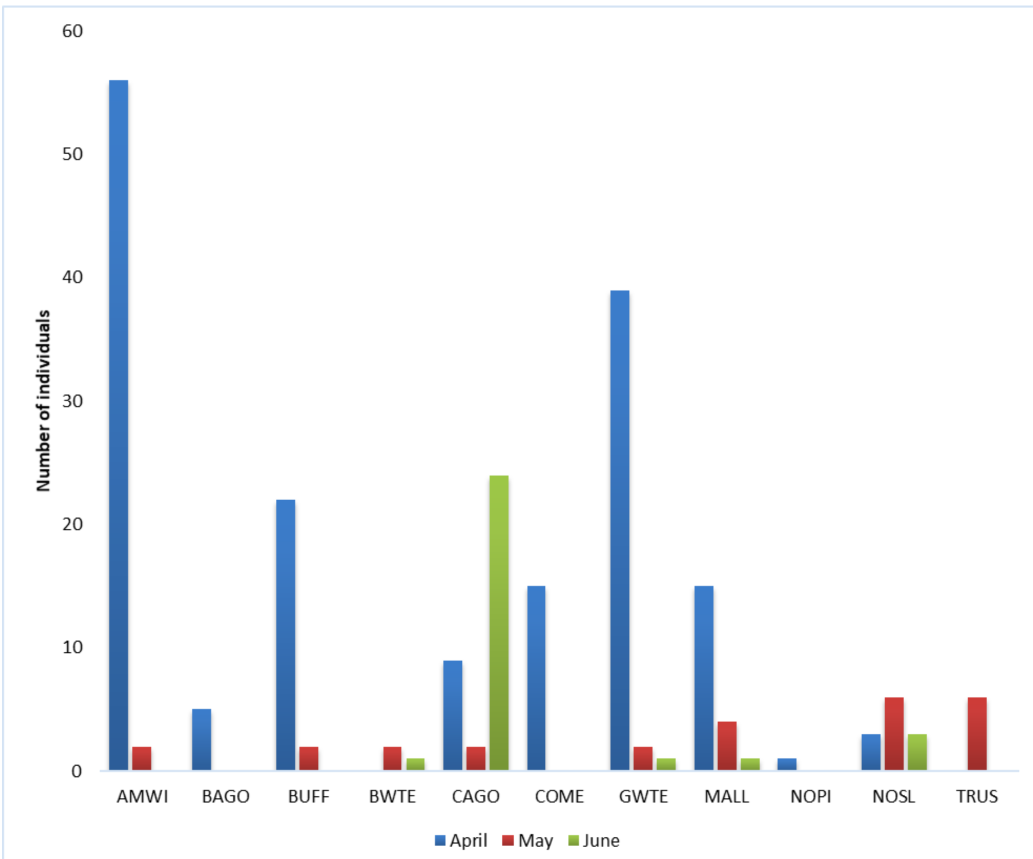

Figure 17. Species composition of waterfowl observed at Airport Lagoon during the surveys in April, May and June 2018.

Species diversity for shorebirds was highest in June, whereas it was highest for waterfowl in April. Likewise, for the number of individuals observed; more waterfowl were using the Airport Lagoon in April and numbers declined in May and June. Conversely, shorebird numbers were highest in June compared to the previous months.

Observation station WSP-03 and WSP-04 appear to consistently have the highest number of species and individuals across the three replicates (Table 11). The majority of shorebird and waterfowl observations were recorded in the northern half of the Airport Lagoon (Figure 18; Figure 19).

Table 11. Total numbers of species and individuals for shorebirds and waterfowl observed at Airport Lagoon during the replicate surveys in 2018.

	Date	WSP-01		WSP-02		WSP-03		WSP-04		WSP-06	
		# Sp.	Count	# Sp.	Count	# Sp.	Count	# Sp.	Count	# Sp.	Count
Shorebirds	April 27, 2018	1	1	1	2	1	2	2	3	1	1
	May 18, 2018	-	-	-	-	1	1	2	4	1	1
	June 4, 2018	1	2	2	3	4	5	1	2	2	2
	Date	**WSP-01**		**WSP-02**		**WSP-03**		**WSP-04**		**WSP-06**	
		# Sp.	Count	# Sp.	Count	# Sp.	Count	# Sp.	Count	# Sp.	Count
Waterfowl	April 27, 2018	1	2	2	3	9	112	7	26	2	22
	May 18, 2018	-	-	2	4	5	16	2	6	-	-
	June 4, 2018	-	-	-	-	3	5	2	25	-	-

Other water-associated birds recorded at Airport Lagoon during the replicate surveys were Belted Kingfisher (*Megaceryle alcyon*; n=1), Common Loon (*Gavia immer*; n=2), Bonaparte's Gull (*Chroicocephalus philadelphia*; n=2), California Gull (*Larus californicus*; n=2), Herring Gull (*Larus argentatus*; n=8) and Ring-billed Gull (*Larus delawarensis*; n=1). Three additional waterfowl species were recorded at Airport Lagoon during the Songbird Survey in June 2018. These included Lesser Scaup (*Aythya affinis*; n=8), Hooded Merganser (*Lophodytes cucullatus*; n=1) and Canvasback (*Aythya valisineria*; n=1).

5.4.2 Beaver Pond

Survey effort at Beaver Pond was 30 minutes in May and 12 minutes in June. A total of 10 individuals from the shorebird group were recorded for four species: Spotted Sandpiper (n = 3), Killdeer (n=5), Least Sandpiper (n= 1), and Wilson's Snipe (n=1). Only one waterfowl species was recorded at Beaver Pond: six Canada Geese were recorded in June 2018 (Table 12).

Table 12. Total numbers of species and individuals for shorebirds and waterfowl observed at Beaver Pond during the replicate surveys in 2018.

	Date	WSP-05	
		# Sp.	Count
Shorebirds	May 19, 2018	4	6
	June 7, 2018	2	4
	Date	WSP-05	
		# Sp.	Count
Waterfowl	May 19, 2018	-	-
	June 7, 2018	1	6

Other water-associated birds recorded at Beaver Pond during the replicate surveys included one Sandhill Crane flyover during the May survey. Three species of waterfowl were recorded at Beaver Pond during the Songbird Survey including Bufflehead (n=1), Mallard (n=1) and Blue-winged Teal (n=1).

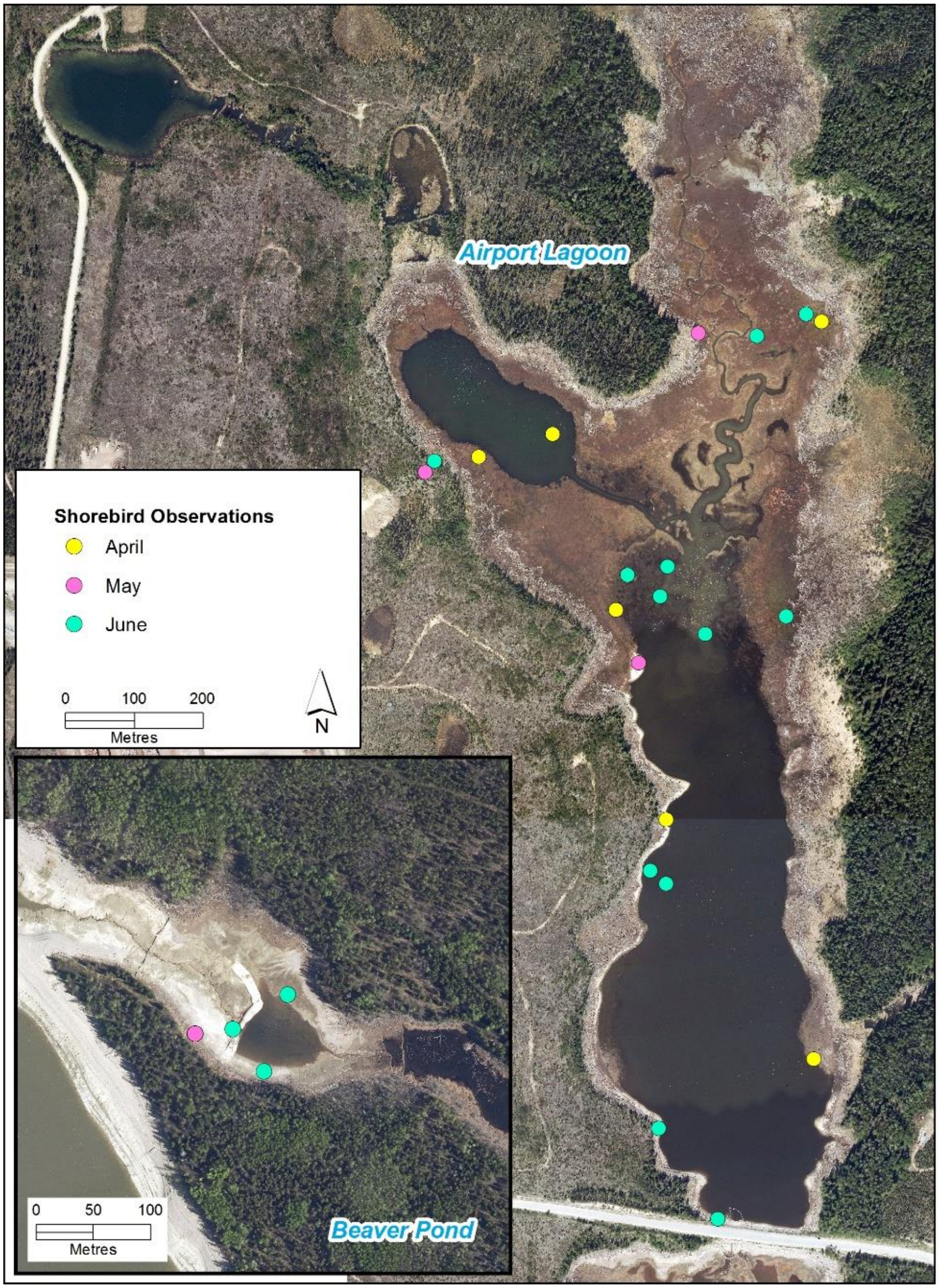

Figure 18. Distribution of shorebird detections by survey date at Airport Lagoon and Beaver Pond in 2018.

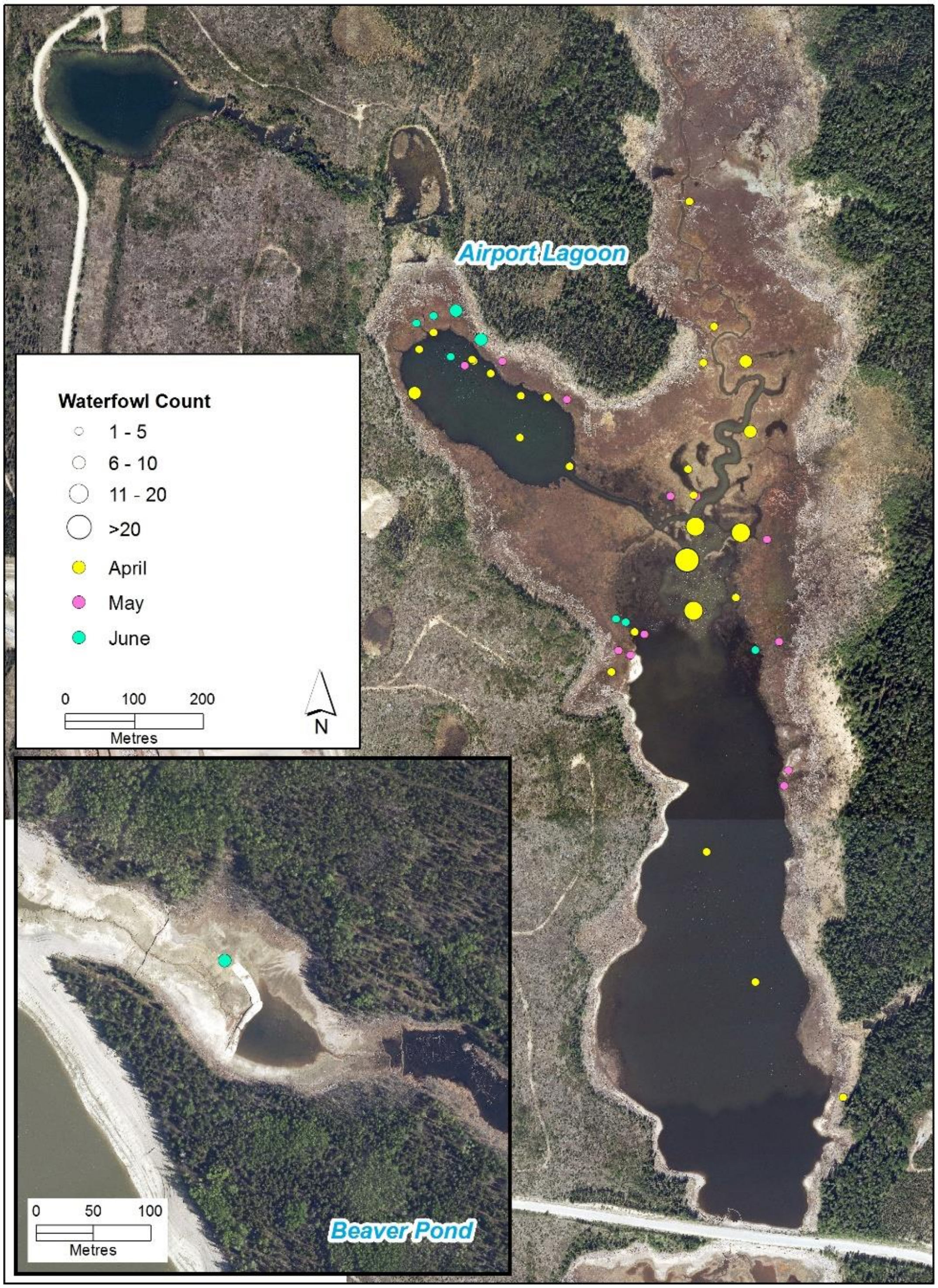

Figure 19. Distribution of waterfowl detections by survey date at Airport Lagoon and Beaver Pond in 2018. The different size circles represent the relative abundances observed during the surveys.

5.5 Songbirds

Point count surveys were completed at Airport Lagoon on June 2, 3, 5, 6 and 7, 2018. All 17 stations were sampled on three separate days. The one sampling session at Beaver Pond was conducted on June 8, 2018.

5.5.1 Airport Lagoon

At Airport Lagoon, a total of 77 species were documented in 2018 from all species groups during songbird point count surveys. This included four species on the provincial Blue list (a species of special concern): Barn Swallow (*Hirundo rustica*), California Gull, Long-billed Curlew (*Numenius americanus*), and Olive-sided Flycatcher (*Contopus cooperi*). The curlew and flycatcher are listed as Special Concern under Schedule 1 of the Species at Risk Act, respectively, while the flycatcher and swallow are both listed as Threatened. One other listed species was detected: Bank Swallow (*Riparia riparia*; Threatened).

For songbird species only, a total of 303 detections of 371 individuals resulted in data on 43 songbird species being recorded in 2018. Lincoln's Sparrow (*Melospiza lincolnii*) was the most frequently detected songbird (32 detections), followed by Tree Swallow (*Tachycineta bicolor*; 22 detections), and American Redstart (*Setophaga ruticilla*) and White-throated Sparrow (*Zonotrichia albicollis*; each with 19 detections). The ten most frequently detected species accounted for 57.4% of all detections and comprised representatives from five bird families: sparrows (3 species), swallows (1 species), warblers (4 species), thrushes (1 species) and vireos (1 species). In contrast 47.8% of all species were detected fewer than fives times and represented 13 songbird families.

Forest habitat types had higher richness and diversity than DDZ or Shrub habitats (Figure 20). Neither DDZ or Shrub habitats significantly differed from each other.

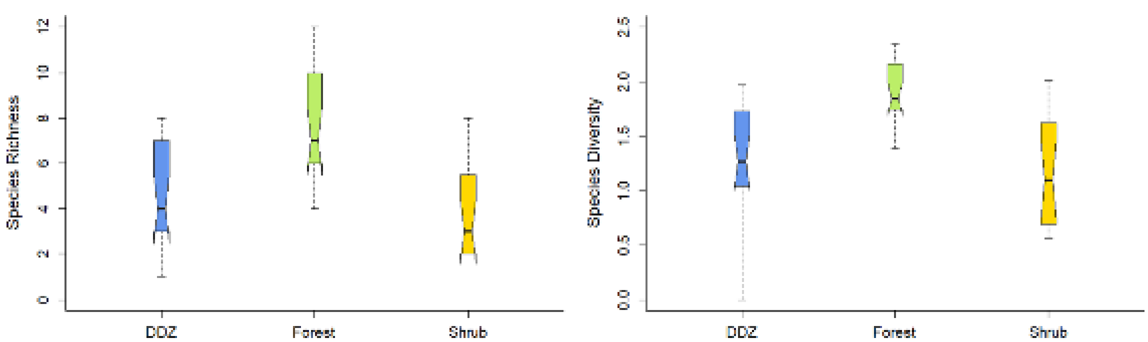

Figure 20. Boxplots showing species richness (left panel) and diversity (right panel) at three habitat types (drawdown zone (DDZ), forest, and shrub) at Airport Lagoon. Both richness and diversity were significantly higher in forest habitats, while no difference exists between DDZ and shrub habitats.

Approximately one-quarter of all bird species were detected at least once in all three habitat types. There were from 1 to 11 unique species in each habitat (Figure 21). The one species unique to Shrub habitats was the Alder Flycatcher (*Empidonax alnorum*). Those unique to DDZ habitats were predominantly aerial insectivores (i.e., swallows) and hummingbirds, as well as Common Yellowthroat (*Geothlypis trichas*). Species unique to forest habitat types included several woodland warblers (e.g., Black-and-white

Warbler [*Mniotilta varia*], Magnolia Warbler [*Setophaga magnolia*]), flycatchers (e.g., Olive-sided Flycatcher), and kinglets among others.

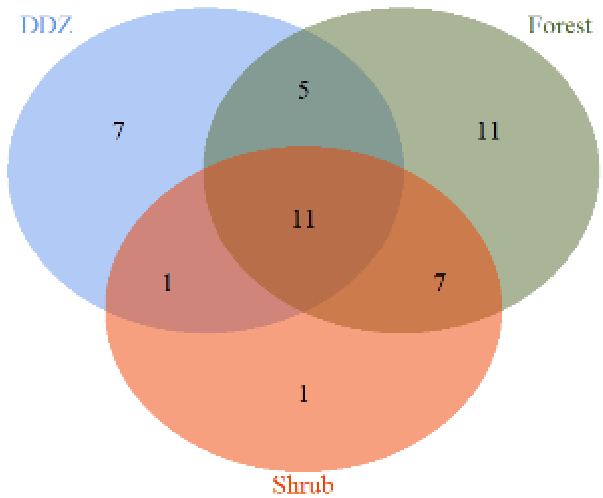

Figure 21. Venn diagram showing the number of species unique to each habitat type at Airport Lagoon, and the shared number of species between each pair-wise comparison of habitats as well as all habitats together.

In most cases unique species are in-part due to few detections of a given species. It is also informative to look at the dispersion of observations by habitat type within those species with a higher number of detections to visualize habitat preferences. For example, Lincoln's Sparrow was documented from all habitat types, though the majority were in DDZ habitats, while Tennessee Warbler (*Oreothlypis peregrina*) were more evenly detected in Forest and Shrub habitat around the Airport Lagoon (Figure 22).

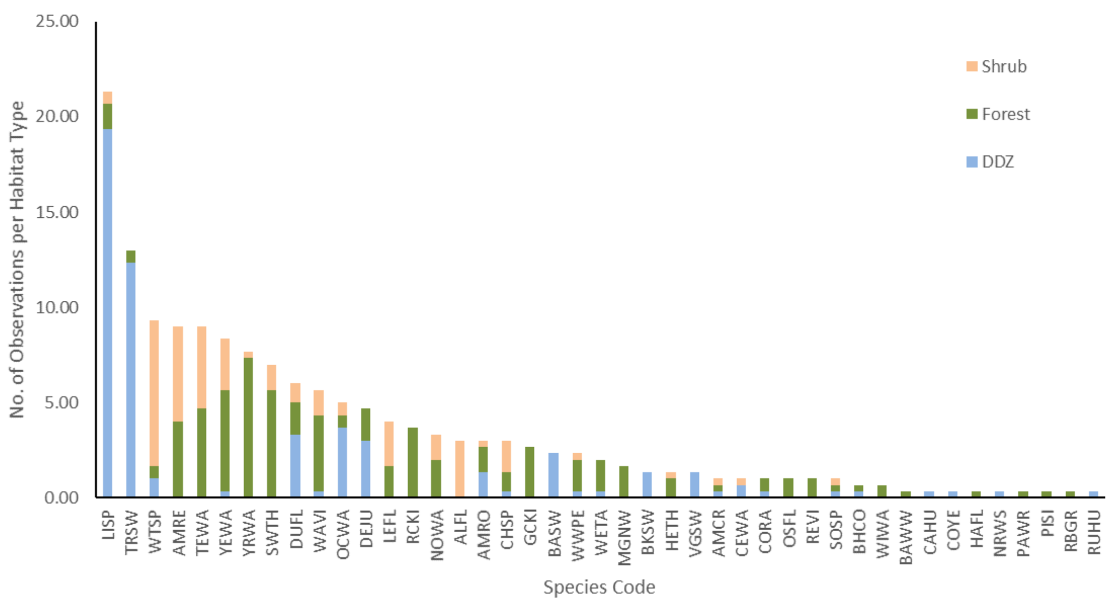

Figure 22. Total number of songbird observations of each species per habitat type at Airport Lagoon. Species associated with their respective codes are presented in Appendix 9-2

5.5.2 Beaver Pond

At Beaver Pond, a total of 27 species were documented in 2018 from all species groups during songbird point count surveys. No species of provincial or federal conservation concern were detected.

For songbird species only, a total of 43 detections of 46 individuals resulted in 17 songbird species being recorded in 2018. No species was particularly numerous; the four most frequently detected species (all with 4 or 5 detections) accounted for 39.5% of all detections, while the ten species with 1 or 2 detections also accounted for 39.5% of all detections. Six bird families were represented by observations at Beaver Pond including warblers (7 species), sparrows (4 species), thrushes (2 species), flycatchers (2 species), vireos (1 species), and swallows (1 species). Yellow-rumped Warbler (*Setophaga coronata*) was the most frequently detected songbird (5 detections).

Drawdown zone habitat types had lower richness and diversity than Forest or Shrub habitats (Figure 23). Neither Forest or Shrub habitats significantly differed from each other.

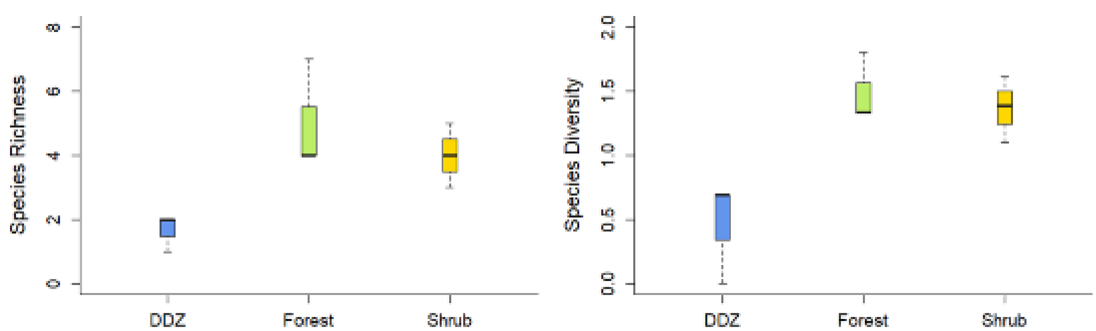

Figure 23. Boxplots showing species richness (left panel) and diversity (right panel) at three habitat types (drawdown zone (DDZ), forest, and shrub) at Beaver Pond. Both richness and diversity were significantly lower in DDZ habitats, while no difference exists between forest and shrub habitats.

Only one species (Dusky Flycatcher [*Empidonax oberholseri*]) was detected in all three habitat types. The greatest amount of habitat overlap among songbirds occurred between the Forest and Shrub habitats (5 shared species). There was only one shared species between Shrub and DDZ habitats, and two between Forest and DDZ (Figure 24). The species unique to DDZ habitats included an aerial insectivore (Tree Swallow) as well as Dark-eyed Junco (*Junco hyemalis*), and Lincoln's Sparrow. Shrub habitats alone hosted Alder Flycatcher, Northern Waterthrush (*Parkesia noveboracensis*) and White-throated Sparrow, while unique species in Forested habitats included warblers (Magnolia, Yellow-rumped, and Ovenbird [*Seiurus aurocapilla*]) and Swainson's Thrush (*Catharus ustulatus*).

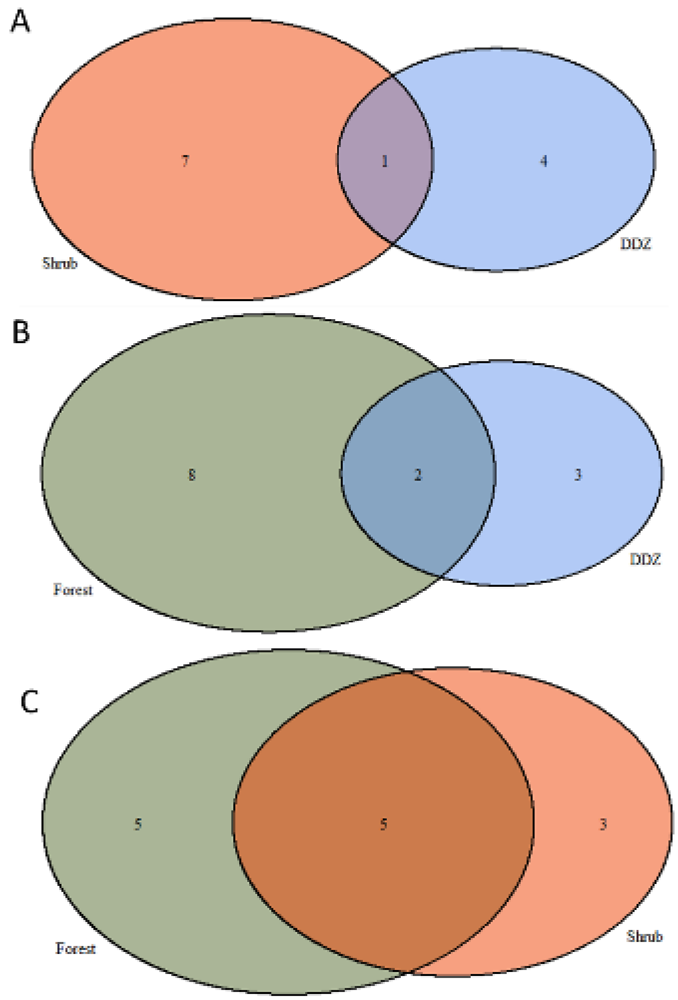

Figure 24. Venn diagrams showing the number of species unique to each habitat type at Airport Lagoon, and the shared number of species between each pair-wise comparison of habitat. Panel A compares Shrub to Drawdown Zone, Panel B compares Forest to Drawdown Zone, and Panel C compares Forest to Shrub. Circles are scaled proportionately by number of species within each panel, but not between them.

In most cases, unique species are in-part due to few detections. It is also informative to look at the dispersion of observations by habitat type within each species to visualize habitat preferences. For example, Dusky Flycatcher was evenly encountered in each habitat type, while American Robin (*Turdus migratorius*), with the same number of detections, was found predominantly in forested habitat (Figure 25).

Figure 25. Total number of songbird observations of each species per habitat type at Beaver Pond. Species associated with their respective codes are presented in Appendix 9.2.

5.6 Amphibians

In 2018, three replicates of amphibian surveys were completed at Airport Lagoon and only two replicates were completed at Beaver Pond (Table 13). Access to Beaver Pond at the end of April 2018 was not possible due to the ice conditions on Williston Reservoir at the time of the survey.

Table 13. Dates for the amphibian surveys at Airport Lagoon and Beaver Pond in 2018.

Site	Survey Date		
Airport Lagoon	April 27, 2018	May 18, 2018	June 4, 2018
Beaver Pond		May 19, 2018	June 7, 2018

5.6.1 Airport Lagoon

Across the three replicate surveys 14.8 person-hours were spent surveying for amphibians on the 11 transects. On average 13.5 minutes were spent on each transect by two observers. No amphibians were detected during the April survey. One group of >1000 Western Toad (*Anaxyrus boreas*) tadpoles was detected on transect 25 in May 2018. In June 2018, this group of tadpoles was re-sighted on transect 25 (Table 14).

Table 14. Amphibians detected and catch per unit effort at both enhancement sites on the Williston Reservoir during the surveys in 2018.

Site	Survey Date	# detections	Survey effort (min)	Catch per unit effort (CPUE)
Airport Lagoon	April 27, 2018	0	288	0
	May 18, 2018	1	336	0.003
	June 4, 2018	1	332	0.003
Beaver Pond	May 19, 2018	0	60	0
	June 7, 2018	2	60	0.03

5.6.2 Beaver Pond

A total of two person-hours was spent surveying at Beaver Pond over the two visits (i.e., 30 minutes per visit). No observations of amphibians were recorded during the first visit on May 19, 2018; however, egg masses were noted in the beaver pond to the immediate southeast of the engineered wetland habitat. During the second replicate on June 7, 2018, two observations of Western Toad tadpoles were recorded (Table 14).

5.7 Fish

Fish traps and nets were deployed at Airport Lagoon on May 18, 2019 and checked on May 19, 2018. The reach at Airport Lagoon was electrofished on May 18, 2018. During the second visit, minnow traps were deployed on July 12, 2018 and checked on July 13, 2018. The reach was electrofished on July 13, 2018 and two fyke nets were deployed on the same day. Captures from the fyke nets were processed on July 14, 2018.

At Beaver Pond, minnow traps were deployed on May 20, 2018 and checked on May 21, 2018. As mentioned above, water levels were too shallow to deploy the fyke net or electrofish. Beaver Pond could not be accessed in July 2018 for a second visit.

5.7.1 Airport Lagoon

Eleven fish species from five families were captured in Airport Lagoon in 2018 (Table 15). In total, 7,348 fish were captured, with most (77%; 5,682) sampled in May. Minnows (Cyprinidae) dominated catches, followed by suckers (Catostomidae), Rainbow trout (*Oncorhynchus mykiss*), Prickly sculpin (*Cottus asper*), and Burbot (*Lota lota*). Catch per unit effort (CPUE) was highest in May for both fyke nets and minnow traps, but for electrofishing, the CPUE in May and July were equal.

Redside shiner (*Richardsonius balteatus*) were the most common species captured for each method in each month. Brassy minnow (*Hybognathus hankinsoni*) and Lake chub (*Couesius plumbeus*) were also captured in high numbers. Largescale suckers

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(*Catostomus macrocheilus*) were only captured in May and Northern pikeminnow (*Ptychocheilus oregonensis*) were only captured in July.

Length measurements were collected from each of the 11 species sampled. Results for the two sampling periods were pooled and are presented in Table 16. Length histograms were produced for the three most abundant species: Brassy minnow, Lake chub, and Redside shiner (Figure 26).

Table 15. Summary of fish species captured, by method and sampling period, at Airport Lagoon, 2018.

	Species		Method[a] and Sampling Period[b]								Grand
			EF		MT		FN[c]		Totals		
Family	Scientific name	Common name	May	July	May	July	May	July	May	July	Total
Catostomidae	*Catostomus catostomus*	Longnose sucker	0	7	0	1	1	5	1	13	14
	C. commersoni	White sucker	0	0	7	0	155	36	162	36	198
	C. macrocheilus	Largescale sucker	0	0	0	0	23	0	23	0	23
		Subtotal	*0*	*7*	*7*	*1*	*179*	*41*	*186*	*49*	*235*
Cottidae	*Cottus asper*	Prickly sculpin	5	8	2	0	2	2	9	10	19
Cyprinidae	*Couesius plumbeus*	Lake chub	0	17	70	92	375	90	445	199	644
	Hybognathus hankinsoni	Brassy minnow	22	1	121	109	430	50	573	160	733
	Mylocheilus caurinus	Peamouth chub	0	0	0	0	1	5	1	5	6
	Ptychocheilus oregonensis	Northern pikeminnow	0	0	0	0	0	33	0	33	33
	Richardsonius balteatus	Redside shiner	40	62	624	340	2,588	795	3,252	1,197	4,449
		Subtotal	*62*	*80*	*815*	*541*	*3,394*	*973*	*4,271*	*1,594*	*5,865*
Gadidae	*Lota lota*	Burbot	1	0	0	1	0	0	1	1	2
Salmonidae	*Oncorhynchus mykiss*	Rainbow trout	0	0	0	0	2	12	2	12	14
Unknown[d]	*n/a*	n/a	0	0	0	0	1,213	0	1,213	0	1,213
		Airport Lagoon Totals	68	95	824	543	4,790	1,028	5,682	1,666	7,348
		Effort[e]	698	991	236.8	298.5	15.1	34.3			
		CPUE[f]	5.8	5.8	3.5	1.8	317.9	30.0			

[a] EF = backpack electrofisher; MT = minnow trap; FN = fyke net

[b] 18-21 May 2018; 12-14 July 2018

[c] One fyke net set in May; two fyke nets set in July.

[d] Due to the high number of fish captured in the fyke net and the prolonged processing time, these fish were simply enumerated and released to reduce handling-induced mortality.

[e] Electrofishing effort = seconds; minnow trap and fyke net effort = combined hours for all traps or nets fished during a sampling period.

[f] Catch per Unit Effort (CPUE): electrofishing CPUE = fish/minute; minnow trap and fyke net CPUE = fish/hour.

Table 16. Lengths of fish species captured in Airport Lagoon, 2018.

	Species		Length (mm)[a]			
Family	Scientific name	Common name	n	Average	Min	Max
Catostomidae	*Catostomus catostomus*	Longnose sucker	14	110	66	195
	C. commersoni	White sucker	140	170	44	285
	C. macrocheilus	Largescale sucker	23	135	101	185
Cottidae	*Cottus asper*	Prickly sculpin	19	81	51	113
Cyprinidae	*Couesius plumbeus*	Lake chub	252	68	34	120
	Hybognathus hankinsoni	Brassy minnow	266	63	32	101
	Mylocheilus caurinus	Peamouth chub	6	243	130	292
	Ptychocheilus oregonensis	Northern pikeminnow	33	190	49	345
	Richardsonius balteatus	Redside shiner	661	76	48	115
Gadidae	*Lota lota*	Burbot	2	211	194	228
Salmonidae	*Oncorhynchus mykiss*	Rainbow trout	14	283	234	425

[a] Total length for burbot and prickly sculpin and fork length for all other species.

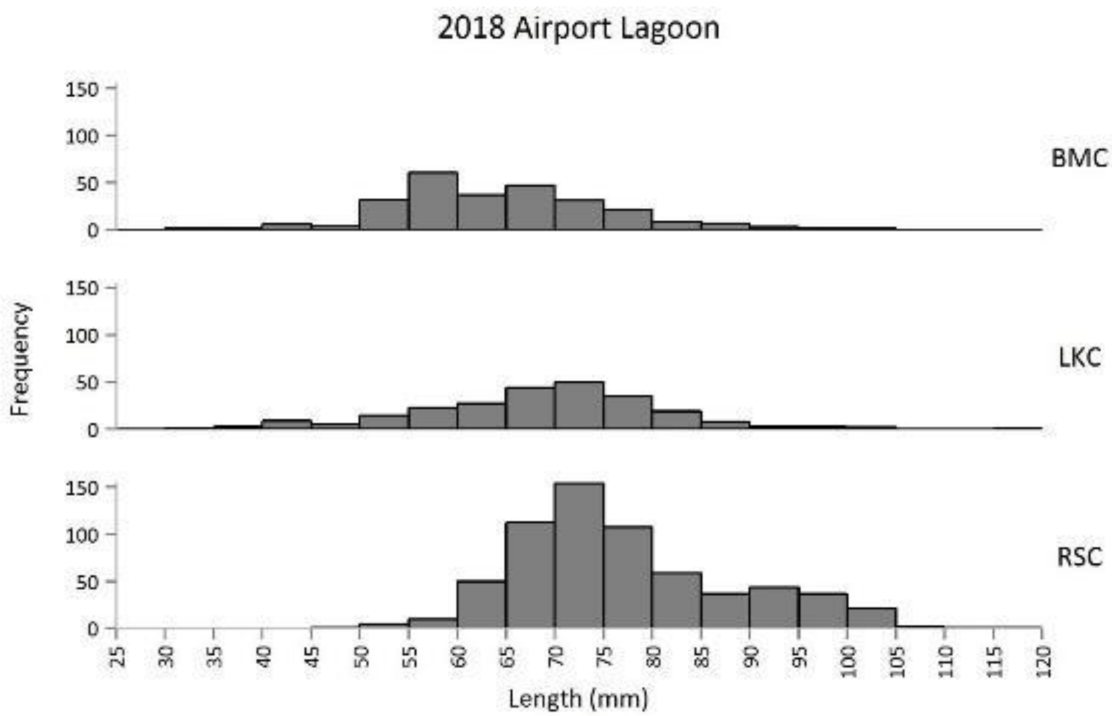

Figure 26. Length-frequency histograms for the three most abundant species captured at Airport Lagoon in 2018: Brassy minnow (BMC), Lake chub (LKC), and Redside shiner (RSC).

5.7.2 Beaver Pond

Two minnow species (Northern Pikeminnow and Lake Chub) were captured with minnow traps at the Beaver Pond site in May 2018 (Table 17). A third species, White sucker (*Catostomus commersonii*), was captured in the natural beaver pond upstream of the constructed pond. The 11 unidentified fish captured in minnow traps were either Northern Pikeminnow or Lake Chub. The captured minnows were all small juveniles, ranging from 23 mm to 42 mm. The White sucker was 62 mm.

Table 17. Summary of fish species captured, by method and sampling period, at the Beaver Pond site, 2018.

	Species		Method[a] and Sampling Period[b]							
			EF[c]		MT		FN[d]		Totals	
Family	Scientific name	Common name	May	July	May	July	May	July	May	July
Catostomidae	*C. commersoni*	White sucker	-	-	1	-	-	-	1	-
Cyprinidae	*C. plumbeus*	Lake chub	-	-	1	-	-	-	1	-
	P. oregonensis	Northern pikeminnow	-	-	1	-	-	-	1	-
		Unidentified minnow	-	-	11	-	-	-	11	-
		Beaver Pond Totals	-	-	14	-	-	-	14	-
		Effort	-	-	116.0	-	-	-		
		CPUE	-	-	0.1	-	-	-		

[a] EF = backpack electrofisher; MT = minnow trap; FN = fyke net

[b] 18-21 May 2018; no sampling at the Beaver Pond in July.

[c] Effective electrofishing could not be conducted due to insufficient water levels above and below the Beaver Pond berm.

[d] No habitat available to set a fyke net due to the low water levels behind the berm.

6.0 DISCUSSION

GMSMON-15, initiated in 2011, is a long-term monitoring program that aims to understand the effectiveness of the wetland demonstration projects in improving fish and wildlife habitat on the Williston Reservoir. Data collected in 2018 represents Year 8 of the 10-year monitoring. The Airport Lagoon enhancements were completed in May 2013, so data collected in Year 8 represents the fifth full year of post-construction monitoring. The Beaver Pond enhancements were completed in June 2014, so the data collected in Year 8 represents the fourth full year of post-construction monitoring for that site.

Year 8 also represents the first year that data was collected at the sites by LGL Limited. Previous data collection had been completed by Cooper Beauchesne and Associates Ltd. For the most part, the methods employed in previous years of the monitoring program were used in Year 8. Previous annual reports have provided qualitative assessments of changes observed in earlier years of the monitoring program. We have not taken that approach here and discuss the results of Year 8 only.

6.1 Environmental Conditions

Reservoir operations and annual environmental conditions can affect the availability and suitability of habitats in the drawdown zone; which can result in annual variability in the data collected for the target species. Fish and wildlife response variables (e.g., presence/not detected, relative abundance, species richness and diversity, presence and relative abundance of native versus non-native species), patterns of habitat use, and habitat suitability are expected to vary across the sampling years. Therefore, factors such as reservoir elevations and environmental conditions will be considered as covariates in the comprehensive analyses, conducted after data collection in Year 10, to account for possible confounding effects of these variables on response variables.

6.2 Vegetation

Vegetation species identified during the belt transect sampling can be classified as both terrestrial plant species and aquatic plant species, which provides evidence of annual and/or frequent flooding. This flooding likely influences the density, diversity and spatial extent of vegetation at the enhancement sites.

The habitat classes at both sites have responded to the wetland enhancements and the annual flooding. The amount of surface water (e.g., pond) has appeared to have increased at both sites leaving a varied shoreline/riparian area. At Airport Lagoon, the general pattern of riparian habitat from the water's edge starts with either mineral soil (sand) or mosses and perennials that transitions into a band of coarse woody debris (driftwood) followed by graminoid-dominated areas and then shrub habitats. At Beaver Pond, mud and clay remains present at the water's edge, but perennial species are becoming established. The partitioning of communities, observed in Year 8, along these gradients suggests that succession to stable wetland/riparian communities will require additional time.

Aquatic plant sampling was initiated in 2014 (Year 4) to monitor the development of aquatic plant communities at Airport Lagoon and Beaver Pond following completion of the wetland enhancement projects. The overall macrophyte community at Beaver Pond remains poorly developed. The same is not true at Airport Lagoon where macrophytes are relatively well developed in the shallower portions (i.e., near the shoreline) of the wetland.

Changes in the density and distribution of coarse woody debris (CWD) were not undertaken in 2018. The methods for describing and delineating CWD density classes were not clearly explained in MacInnis et al. (2017), therefore this task could not be repeated in Year 8. Upon visual inspection of the orthophoto imagery provided in 2018, the extent of CWD at Airport Lagoon closely aligns with the delineation of the Shoreline Driftwood habitat class.

6.3 Waterfowl and Shorebirds

Analysis of migratory waterfowl and shorebirds can be complicated by the highly variable nature of avian species. In 2018, most species of waterfowl appear to be using the Airport Lagoon during their northward migration. The highest numbers of waterfowl were observed at the end of April, but a large portion of the wetland was covered with ice as a result of the late spring (compared to previous years). At this time, the majority of waterfowl individuals were recorded at the northern end of Airport Lagoon where shallow water occurs and a higher prevalence of aquatic macrophyte species is present, compared to other areas of the wetland. Plus, the environmental conditions at the end of April may have influenced the higher prevalence of dabbling species. However, it is expected that waterfowl would use these areas as stopover habitat in subsequent years regardless of the climatic conditions. The reduction of waterfowl sightings in May and June was expected, given the onset of the breeding period during this time.

6.4 Songbirds

Songbird surveys in 2018 provided an indication of the species assemblage utilizing the study areas and a comparison of how birds are using different habitat types within the enhancement areas. A wide variety of species were documented during songbird surveys reflecting the variety of micro-habitats at both Airport Lagoon and Beaver Pond. These data show that songbirds, and other birds, are using enhanced wetlands and adjacent habitat.

The pattern of use was not the same at both study sites. At Airport Lagoon there was broad overlap in species use of the three major habitat types (i.e., forest, shrub and DDZ), with shrub being intermediate between the DDZ and forest habitats (as indicated by having only one unique species). There was no significant difference in richness or diversity between shrub and drawdown zone habitats, again suggesting overlap in the quality of these habitats for bird utilization. Forests had the most unique species, and also significantly higher richness and diversity, though this was expected given the greater structural heterogeneity and prevalence of migratory, forest-dwelling songbirds.

Only one visit was made to Beaver Pond in 2018, and only three point count stations exist there due to its smaller size. As such, habitat use was more difficult to quantify. Based on the 2018 data, the DDZ had significantly lower richness and diversity than either forest or shrub habitats (which did not differ from each other). This trend was also reflected in the number of shared species between habitats, with forest and shrub having more overlap than either did with the DDZ. Taken together this showed that the DDZ habitat at Beaver Pond was more distinct. Based on this one season of data the quality of wildlife habitat created at the Beaver Pond is limited for songbirds.

6.5 Amphibians

Since the inception of GMSMON-15, the five species of amphibians that were expected to occur at the study sites have been detected at Airport Lagoon and Beaver Pond. However, since amphibian abundances (detection rates) vary from year to year, more detections of individual species are required to confirm occupancy.

At Airport Lagoon, the most productive area for amphibians appears to be transects 25 and 28 in the northeastern section of the wetland. The Western Toad was the only amphibian species observed at Airport Lagoon in 2018, which is consistent with the previous two years (2016 & 2017) of data collection. Breeding was first confirmed on May 18, 2018 and tadpoles were still present during the survey in June 2018. In the past three years, Western Toads have only been recorded in the northeast bay of the wetland, along transects 25 and 28.

At Beaver Pond, Western Toad was also recorded in its tadpole form. Tadpoles were first observed here in early June. Tadpoles were still present in July when they were reporting incidentally by the vegetation survey crew. The detected species diversity was lower in 2018 compared to previous years.

Amphibian populations naturally exhibit large degrees of variation with the number detected a function of current environmental conditions, overwinter survival, and predation pressure (Hansen et al. 2012). Some species (e.g., Long-toed Salamander) are often difficult to locate because they have an early breeding period and are inconspicuous during the remainder of the year (Wilkinson and Hanus 2002).

Amphibian productivity has not been explicitly studied in Williston Reservoir. Qualitatively, it appears that the productivity of Western Toads is consistent between years, as egg masses and adults have been repeatedly detected at the same locations. However, in the absence of data from a suitable control site, we cannot know for certain how productivity is affected by the enhancements.

6.6 Fish

In Year 8 of the monitoring program, electrofishing, minnow traps, and fyke nets proved effective at capturing eleven species of fish with different life histories and habitat preferences (e.g. pelagic vs. benthic), including species with relatively very low abundance (e.g. Burbot), at Airport Lagoon. Past fish surveys here (e.g. MacInnis et al. 2017) found that the lagoon supported resident cyprinid, sculpin, and sucker populations. Our 2018 results add further support to this conclusion. Redside shiners were captured in very high (relative to other species) numbers and several were observed with spawning colours during May. Brassy minnows, Lake chub, and White suckers were also caught in relatively high numbers, which potentially indicates that the increased available habitat is being utilized by these species.

The Rainbow trout captured are likely resident in the Williston Reservoir and are taking advantage of the abundant prey available in the lagoon. These fish are likely accessing the lagoon through the upgraded culverts at the south end when the reservoir elevation exceeds 667 m, which was reached during the July sampling (Figure 12). The increase in the Rainbow trout catch during July supports this conclusion. Further, no salmonid spawning habitat was observed and no juvenile fish (<20 cm) were captured. The two Rainbow trout captured in during May sampling are expected to have overwintered in the lagoon.

Only minnow traps were set at the Beaver Pond site in May due to insufficient water levels for other sampling methods (i.e., electrofishing and fyke nets). The inlet and outlet streams from the impounded pond were nearly dry and could not be sampled. All captured fish at Beaver Pond site were from a single minnow trap located adjacent to the berm. All other traps were empty. Northern pikeminnow and Lake chub were captured in 2018 and both species have been previously captured at this site. From 2011 to 2016, five species (Peamouth chub, Northern pikeminnow, Redside shiner, Longnose sucker, and Prickly sculpin) have been sampled with minnow traps at the Beaver Pond site. No sculpins, suckers, or shiners were captured or observed. However, we did capture a White sucker with a minnow trap set in the natural beaver pond located upstream of the berm impoundment and suspect that the other species previously captured in the impounded area originate from the natural pond. At high water, these species could migrate into the impounded area. The presence of these species during past electrofishing in the stream between the two ponds supports this conclusion.

Recent post-construction sampling found that fish were using the outlet stream downstream of the berm. The lack of streamflow during our May sampling suggests that water levels at this site have changed from previous years. Sampling in 2019 and 2020 will help determine if our 2018 observations were atypical or if a longer-term change is occurring at the Beaver Pond site.

7.0 CONCLUSIONS

Data collected in 2018 for the GMSMON-15 project show that species from all indicator groups continue to be present at both wetland enhancement projects. The methods implemented to date will enable the collection of an adequate amount of data that can be used to address each management question and associated hypothesis. In particular, the time-series data can be linked to broader management questions and will be tested statistically.

Vegetation development and establishment can be a relatively slow ecological process, so the longer time series (i.e., 10 years) is necessary and the conditions under which the vegetation communities persist will become evident with the proceeding results. Likewise, the full understanding of how bird, amphibian and fish species composition and abundance has changed over time following wetland enhancement and will be addressed in the comprehensive report at the conclusion of the 10-year monitoring program. Two additional years of monitoring are planned for 2019 and 2020.

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9.0 APPENDICES

Appendix 9-1: Water quality data collected during fish sampling at Airport Lagoon and Beaver Pond in 2018.

Location	Date	Time	Zone	Easting	Northing	Depth (m)	Temp (°C)	DO (mg/L)	Conductivity (uS)	pH	Rel. Turbidity	Secchi Depth1 (cm)	Secchi Depth2 (cm)	Comment
Airport Lagoon	May 18, 2018	10:10	10U	492537	6126704	0.1	13	14.5	190	10.9	Clear	n/a	n/a	pH meter was stable, but value seems high
	May 19, 2018	8:30	10U	492586	6125494	2	14.1	4.5	140	n/a	n/a	148	120	Deep
	May 19, 2018	8:30	10U	492586	6125494	0.1	18	9.3	162	7.1	Clear	-	-	Surface
	July 13, 2018	17:32	10U	492664	6125780	0.5	20	17.1	209	8.4	Clear	n/a	n/a	
	July 13, 2018	18:58	10U	492562	6126621	0.5	18.1	14.5	245.8	7.86	Clear	-	-	
	July 14, 2018	15:05	10U	492586	6125494	2	19.1	17.3	209	8.04	Clear	150	-	Deep
	July 14, 2018	16:05	10U	492586	6125494	0.1	20.4	18	219	8.1	Clear	-	-	Surface
Beaver Pond	May 21, 2018	9:19	10U	479262	6148242	0.4	17.7	8.3	94	7.8	Clear	-	-	Mid-depth. Total depth ~1 m. Impounded area, measured at berm.
	May 21, 2018	9:49	10U	479405	6148221	0.2	17	9.6	67	7.5	Clear	-	-	Measured in natural beaver pond

Appendix 9-2: All bird species detected during songbird point counts at Airport Lagoon and Beaver Pond in 2018. Species are listed alphabetically.

Species Code	Common Name	Scientific Name	Species Group	Conservation Status		Study Area	
				COSEWIC	BC List	Airport Lagoon	Beaver Pond
ALFL	Alder Flycatcher	*Empidonax alnorum*	Songbirds	.	Yellow	✓	✓
AMCR	American Crow	*Corvus brachyrhynchos*	Songbirds	.	Yellow	✓	
AMRE	American Redstart	*Setophaga ruticilla*	Songbirds	.	Yellow	✓	✓
AMRO	American Robin	*Turdus migratorius*	Songbirds	.	Yellow	✓	✓
BAEA	Bald Eagle	*Haliaeetus leucocephalus*	Hawks, Eagles, and Allies	Not at Risk	Yellow	✓	
BAGO	Barrow's Goldeneye	*Bucephala islandica*	Waterfowl	.	Yellow		✓
BASW	Barn Swallow	*Hirundo rustica*	Songbirds	Threatened	Blue	✓	
BAWW	Black-and-white Warbler	*Mniotilta varia*	Songbirds	.	Yellow	✓	
BBWO	Black-backed Woodpecker	*Picoides arcticus*	Woodpeckers and Allies	.	Yellow	✓	
BEKI	Belted Kingfisher	*Megaceryle alcyon*	Kingfishers and Allies	.	Yellow	✓	
BHCO	Brown-headed Cowbird	*Molothrus ater*	Songbirds	.	Yellow	✓	
BKSW	Bank Swallow	*Riparia riparia*	Songbirds	Threatened	Yellow	✓	
BOGU	Bonaparte's Gull	*Chroicocephalus philadelphia*	Shorebirds, Gulls, Auks, and Allies	.	Yellow	✓	
BUFF	Bufflehead	*Bucephala albeola*	Waterfowl	.	Yellow	✓	✓
BWTE	Blue-winged Teal	*Spatula discors*	Waterfowl	.	Yellow	✓	✓
CAGO	Canada Goose	*Branta canadensis*	Waterfowl	.	Yellow	✓	
CAGU	California Gull	*Larus californicus*	Shorebirds, Gulls, Auks, and Allies	.	Blue	✓	
CAHU	Calliope Hummingbird	*Selasphorus calliope*	Swifts and Hummingbirds	.	Yellow	✓	
CANV	Canvasback	*Aythya valisineria*	Waterfowl	.	Yellow	✓	
CEWA	Cedar Waxwing	*Bombycilla cedrorum*	Songbirds	.	Yellow	✓	
CHSP	Chipping Sparrow	*Spizella passerina*	Songbirds	.	Yellow	✓	
COLO	Common Loon	*Gavia immer*	Loons	Not at Risk	Yellow	✓	
CORA	Common Raven	*Corvus corax*	Songbirds	.	Yellow	✓	
COYE	Common Yellowthroat	*Geothlypis trichas*	Songbirds	.	Yellow	✓	
DEJU	Dark-eyed Junco	*Junco hyemalis*	Songbirds	.	Yellow	✓	✓
DUFL	Dusky Flycatcher	*Empidonax oberholseri*	Songbirds	.	Yellow	✓	✓
EUST	European Starling	*Sturnus vulgaris*	Songbirds	.	Exotic	✓	

Species Code	Common Name	Scientific Name	Species Group	Conservation Status		Study Area	
				COSEWIC	BC List	Airport Lagoon	Beaver Pond
EVGR	Evening Grosbeak	*Coccothraustes vespertinus*	Songbirds	Special Concern	Yellow	✓	
GCKI	Golden-crowned Kinglet	*Regulus satrapa*	Songbirds	.	Yellow	✓	
GRYE	Greater Yellowlegs	*Tringa melanoleuca*	Shorebirds, Gulls, Auks, and Allies	.	Yellow	✓	✓
GWTE	Green-winged Teal	*Anas crecca*	Waterfowl	.	Yellow	✓	
HAFL	Hammond's Flycatcher	*Empidonax hammondii*	Songbirds	.	Yellow	✓	
HAWO	Hairy Woodpecker	*Dryobates villosus*	Woodpeckers and Allies	.	Yellow	✓	
HEGU	Herring Gull	*Larus argentatus*	Shorebirds, Gulls, Auks, and Allies	.	Yellow	✓	
HETH	Hermit Thrush	*Catharus guttatus*	Songbirds	.	Yellow	✓	
HOME	Hooded Merganser	*Lophodytes cucullatus*	Waterfowl	.	Yellow	✓	
KILL	Killdeer	*Charadrius vociferus*	Shorebirds, Gulls, Auks, and Allies	.	Yellow	✓	
LBCU	Long-billed Curlew	*Numenius americanus*	Shorebirds, Gulls, Auks, and Allies	Special Concern	Blue	✓	
LEFL	Least Flycatcher	*Empidonax minimus*	Songbirds	.	Yellow	✓	
LESC	Lesser Scaup	*Aythya affinis*	Waterfowl	.	Yellow	✓	
LEYE	Lesser Yellowlegs	*Tringa flavipes*	Shorebirds, Gulls, Auks, and Allies	.	Yellow	✓	
LISP	Lincoln's Sparrow	*Melospiza lincolnii*	Songbirds	.	Yellow	✓	✓
MALL	Mallard	*Anas platyrhynchos*	Waterfowl	.	Yellow	✓	✓
MGNW	Magnolia Warbler	*Setophaga magnolia*	Songbirds	.	Yellow	✓	✓
NOFL	Northern Flicker	*Colaptes auratus*	Woodpeckers and Allies	.	Yellow	✓	✓
NOSL	Northern Shoveler	*Spatula clypeata*	Waterfowl	.	Yellow	✓	
NOWA	Northern Waterthrush	*Parkesia noveboracensis*	Songbirds	.	Yellow	✓	✓
NRWS	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Songbirds	.	Yellow	✓	
OCWA	Orange-crowned Warbler	*Oreothlypis celata*	Songbirds	.	Yellow	✓	✓
OSFL	Olive-sided Flycatcher	*Contopus cooperi*	Songbirds	Special Concern	Blue	✓	
OSPR	Osprey	*Pandion haliaetus*	Hawks, Eagles, and Allies	.	Yellow	✓	
OVEN	Ovenbird	*Seiurus aurocapilla*	Songbirds	.	Yellow		✓
PAWR	Pacific Wren	*Troglodytes pacificus*	Songbirds	.	Yellow	✓	
PISI	Pine Siskin	*Spinus pinus*	Songbirds	.	Yellow	✓	
PIWO	Pileated Woodpecker	*Dryocopus pileatus*	Woodpeckers and Allies	.	Yellow	✓	

Species Code	Common Name	Scientific Name	Species Group	Conservation Status		Study Area	
				COSEWIC	BC List	Airport Lagoon	Beaver Pond
RBGR	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Songbirds	.	Yellow	✓	
RBGU	Ring-billed Gull	*Larus delawarensis*	Shorebirds, Gulls, Auks, and Allies	.	Yellow	✓	
RBSA	Red-breasted Sapsucker	*Sphyrapicus ruber*	Woodpeckers and Allies	.	Yellow	✓	
RCKI	Ruby-crowned Kinglet	*Regulus calendula*	Songbirds	.	Yellow	✓	
REVI	Red-eyed Vireo	*Vireo olivaceus*	Songbirds	.	Yellow	✓	
RTHA	Red-tailed Hawk	*Buteo jamaicensis*	Hawks, Eagles, and Allies	Not at Risk	Yellow	✓	
RUGR	Ruffed Grouse	*Bonasa umbellus*	Upland Game Birds	.	Yellow	✓	✓
RUHU	Rufous Hummingbird	*Selasphorus rufus*	Swifts and Hummingbirds	.	Yellow	✓	
SACR	Sandhill Crane	*Antigone canadensis*	Rails, Cranes, and Allies	.	Yellow	✓	
SOSA	Solitary Sandpiper	*Tringa solitaria*	Shorebirds, Gulls, Auks, and Allies	.	Yellow		✓
SOSP	Song Sparrow	*Melospiza melodia*	Songbirds	.	Yellow	✓	✓
SPSA	Spotted Sandpiper	*Actitis macularius*	Shorebirds, Gulls, Auks, and Allies	.	Yellow	✓	✓
SWTH	Swainson's Thrush	*Catharus ustulatus*	Songbirds	.	Yellow	✓	✓
TEWA	Tennessee Warbler	*Oreothlypis peregrina*	Songbirds	.	Yellow	✓	✓
TRSW	Tree Swallow	*Tachycineta bicolor*	Songbirds	.	Yellow	✓	✓
TRUS	Trumpeter Swan	*Cygnus buccinator*	Waterfowl	Not at Risk	Yellow	✓	
VGSW	Violet-green Swallow	*Tachycineta thalassina*	Songbirds	.	Yellow	✓	
WAVI	Warbling Vireo	*Vireo gilvus*	Songbirds	.	Yellow	✓	✓
WETA	Western Tanager	*Piranga ludoviciana*	Songbirds	.	Yellow	✓	
WISN	Wilson's Snipe	*Gallinago delicata*	Shorebirds, Gulls, Auks, and Allies	.	Yellow	✓	✓
WIWA	Wilson's Warbler	*Cardellina pusilla*	Songbirds	.	Yellow	✓	
WTSP	White-throated Sparrow	*Zonotrichia albicollis*	Songbirds	.	Yellow	✓	✓
WWPE	Western Wood-Pewee	*Contopus sordidulus*	Songbirds	.	Yellow	✓	
YEWA	Yellow Warbler	*Setophaga petechia*	Songbirds	.	Yellow	✓	
YRWA	Yellow-rumped Warbler	*Setophaga coronata*	Songbirds	.	Yellow	✓	✓
					Total	77	27

Appendix 9-3: Number of detections and individuals of all songbird and hummingbird species located within 100 m during point count surveys at Airport Lagoon and Beaver Pond sites in 2018. Species are listed in taxonomic order.

Code	Common Name	Airport Lagoon		Beaver Pond	
		Detections	Individuals	Detections	Individuals
RUHU	Rufous Hummingbird	1	1	0	0
CAHU	Calliope Hummingbird	1	1	0	0
OSFL	Olive-sided Flycatcher	1	1	0	0
WWPE	Western Wood-Pewee	5	5	0	0
ALFL	Alder Flycatcher	5	5	2	2
LEFL	Least Flycatcher	8	8	0	0
HAFL	Hammond's Flycatcher	1	1	0	0
DUFL	Dusky Flycatcher	11	11	4	4
WAVI	Warbling Vireo	13	14	2	2
REVI	Red-eyed Vireo	3	3	0	0
AMCR	American Crow	3	3	0	0
CORA	Common Raven	3	3	0	0
TRSW	Tree Swallow	22	66	2	5
VGSW	Violet-green Swallow	4	8	0	0
NRWS	Northern Rough-winged Swallow	1	1	0	0
BKSW	Bank Swallow	4	11	0	0
BASW	Barn Swallow	6	9	0	0
PAWR	Pacific Wren	1	1	0	0
GCKI	Golden-crowned Kinglet	5	5	0	0
RCKI	Ruby-crowned Kinglet	10	10	0	0
SWTH	Swainson's Thrush	14	14	3	3
HETH	Hermit Thrush	3	3	0	0
AMRO	American Robin	8	8	3	3
CEWA	Cedar Waxwing	2	9	0	0
PISI	Pine Siskin	1	1	0	0
CHSP	Chipping Sparrow	9	9	0	0
SOSP	Song Sparrow	3	3	1	1
LISP	Lincoln's Sparrow	32	32	1	1
WTSP	White-throated Sparrow	19	19	3	3
DEJU	Dark-eyed Junco	11	12	2	2
BHCO	Brown-headed Cowbird	2	3	0	0
OVEN	Ovenbird	0	0	1	1
NOWA	Northern Waterthrush	7	7	2	2
BAWW	Black-and-white Warbler	1	1	0	0
TEWA	Tennessee Warbler	15	15	2	2
OCWA	Orange-crowned Warbler	9	9	2	2
COYE	Common Yellowthroat	1	1	0	0
AMRE	American Redstart	19	19	4	4
MGNW	Magnolia Warbler	3	3	4	4
YEWA	Yellow Warbler	16	16	0	0
YRWA	Yellow-rumped Warbler	13	13	5	5
WIWA	Wilson's Warbler	2	2	0	0
WETA	Western Tanager	4	4	0	0
RBGR	Rose-breasted Grosbeak	1	1	0	0
	Total	303	371	43	46