Appendix 6. Downstream Western Toad and Gartersnake Monitoring Program – 2020

Site C Vegetation and Wildlife, Downstream Western Toad and Gartersnake Monitoring Program – 2020

Prepared for:

BC Hydro
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March 23, 2021

EXECUTIVE SUMMARY

Surveys for western toad (*Anaxyrus boreas*), common gartersnake (*Thamnophis sirtalis*), and terrestrial gartersnake (*Thamnophis elegans*) were conducted downstream of the Site C Clean Energy Project in 2020, as part of an on-going study initiated in 2018. The study was designed to assess Project-related changes in suitable habitat and the distribution and relative abundance of western toad and gartersnake. Suitable habitat was assessed in 2018, 2019, and 2020, which represent the pre-operation time period, and is planned to be reassessed during operations in 2030 and 2035. Surveys for presence and relative abundance are being conducted using a before-after, control-impact (BACI) study design framework and targeting all available suitable habitat within the area of potential impact.

Transect surveys of western toad in 2020 were conducted at six sites in the impact study area and 11 in the control study area. Standing water was observed during at least one survey event at 83% (5/6) of sites in the impact study area and 91% (10/11) of sites in the control study area. Sites that were dry were not surveyed. Western toads occupied 80% of sites in the impact study area and 90% of sites in the control study area in 2020. The total number of western toad eggs in the impact study was 300,747 eggs, and in the control was 47,104. The total number of tadpoles was estimated to be 1,350 tadpoles in the impact study area, and 1,111 tadpoles in the control area. The total number of juvenile toads in the impact study area was nine toads, and in the control was eight toads. There were four adult western toads detected in the impact study area wand seven in the control area.

Artificial covered object (ACO) surveys of gartersnakes conducted in 2019 were found to be ineffective for gathering gartersnake observations (one detection over 118 ACOs) and were replaced with time constrained visual encounter surveys in 2020. Using the visual encounter method, gartersnakes were observed at 50% (2/4) of survey sites in the impact study area and 60% (3/5) of survey sites in the control study area. A total of seven gartersnakes were observed in the impact study area and 12 in the control study area. The relative abundance of gartersnakes was 0.15 snakes per person-hour in the impact study area and 0.26 snakes per person-hour in the control study area.

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1.0 INTRODUCTION

This report describes the results of the Downstream Western Toad and Gartersnake Monitoring Program in 2020. This program is being conducted to evaluate whether there will be a change in the distribution and relative abundance of western toads and gartersnakes downstream of the dam site in areas where surface water hydrology will be most affected by the Site C Clean Energy Project (the Project).

2.0 METHODS

The program is based on a BACI (before-after-control-impact) study design in which monitoring is to be conducted in the control and treatment (i.e., impact) areas during the pre-operations (2018 through 2020) and operations periods (2025 through 2034). Sample sites in suitable habitat within the impact study area (i.e., from the Project downstream to the Pine River) and the control study area (i.e., from the Pine River downstream to the Beatton River) were established in 2018 for monitoring of western toads and gartersnakes as per the workplan (BC Hydro 2018).

In accordance with best management practices (BC MWLAP 2004), all surveys incorporated standard hygiene protocols (BC MoE 2017) to minimize the potential for spreading amphibian and other aquatic diseases as well as non-native plants and animals.

2.1 Study Area

The study area includes wetlands adjacent to the Peace River from the Site C dam to the Beatton River (**Figure 2.1**). The wetlands between the Site C dam and the Pine River confluence represent the impact study area and the wetlands adjacent to the Peace River downstream of the Pine River to the Beatton River represent the control study area.

Downstream Western Toad and
Gartersnake Monitoring 2019
Site C, Peace River, BC

Western Toad and Gartersnake
Study Area and Habitat Availability

Charlie Lake
Fort St. John
Beatton River
Old Fort
Moberly River
Taylor
Pine River
Peace River
Kiskatinaw River

Legend

- Site C Local Assessment Area (LAA)
- Proposed Dam Site
- Transmission Line Right-of-Way

Study Zones

- Pine River east to Beatton River
- West of Pine River

Habitat Type (TEM)

- Wetland
- Wet Forest

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

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2.2 Habitat Suitability Assessment

Surveys were focussed in suitable western toad breeding habitat and gartersnake foraging habitat. In 2018, Terrestrial Ecosystem Mapping (TEM) provided by BC Hydro, and aerial imagery from iMap were used to identify suitable wetlands within the bounds of the study area. Habitat identified as suitable was ground-truthed by biologists in 2018 to confirm habitat type and determine the area that is accessible (**Table 2.1**).

During the breeding season (i.e., early-May to early-June), western toads congregate in shallow water zones or vegetated habitat around wetland shorelines. After breeding, they disperse widely to upland foraging and over-wintering habitats. Suitable habitat during these surveys consisted of shallow wetlands.

Gartersnake habitat selection is related to the location of dominant prey species (amphibians and earthworms), and to a lesser degree, freshwater fish and leeches (Matsuda et al. 2006). Their suitable foraging habitat was considered to be shallow open water, willow sedge, sedge habitats, vegetated floodplain, and non-forested floodplain wetland (**Figure 2.1**).

Table 2.1 Wetland Habitat Based on TEM and Field Data in the Downstream Impact and Control Study Area

Habitat Type	Impact Area [ha]	Accessible Impact Area [ha]	Control Area [ha]	Accessible Control Area [ha]
Shallow open water	7.9	7.3	19.3	15.9
Willow sedge	7.2	6.4	0.7	0.2
Sedge	1.2	-	2.4	2.4
Vegetated floodplain	466.0	-	923.8	-
Non-forested floodplain wetlands	60.8	3.7	248.3	4.0
Total	**543.1**	**17.4**	**1,192.0**	**22.5**

Note: " - " indicates not accessible or used

In 2020, there were 17 survey sites considered suitable (shallow water wetlands) and accessible for western toads, with all sites, six sites in the impact study area and 11 sites in the control study area, chosen for surveys. There were 17 survey sites considered suitable and accessible for gartersnakes; four sites in the impact study area and five sites in the control study area were chosen for surveys (**Appendix A**). The total area and accessible area of suitable habitat will be reassessed in 2030 and 2035 and analyzed for change as per the workplan (BC Hydro 2018). Total area will be assessed using TEM mapping and aerial imagery; and accessible area will be field assessed by qualified biologists.

2.3 Western Toad Distribution and Relative Abundance

2.3.1 Systematic Visual Searches

Survey methods followed the protocol for systematic visual searches described in Inventory Methods for Pond-Breeding Amphibians and Painted Turtle (RIC 1998a), and were conducted by qualified biologists with experience in amphibian surveys. Parallel transects, approximately 10 m apart, at three different depths/habitat types were conducted in suitable habitat (as described in **Section 2.2**) for western toad. The three habitats were waist deep water, ankle to knee deep water, and terrestrial shoreline. Transects

followed wetland edges and were a maximum of 100 m in length. If the shoreline of the wetland was less than or equal to 100 m long, transects followed the wetland edge until the entire perimeter of the wetland was surveyed. The total distance surveyed was recorded. All amphibian species development stages (i.e., eggs, tadpole, juvenile, adult), and numbers observed during sampling were recorded for each transect and summarized for the site. Relative abundance was recorded as detections per 100 m and estimated either by direct count or extrapolation. Extrapolation was done by dividing transects into 1 m wide segments over which the abundance of eggs/tadpoles was approximately consistent. For each segment, the number of individuals in a 1 m x 1 m square was estimated by counting a 10 cm x 10 cm area and extrapolating to the larger 1 m square, and further extrapolating to the length of the segment. The estimates of number of eggs was then considered in the context of the number of breeding females likely to be supported by the waterbody surveyed using the assumption of ~16,000 eggs laid per female. Sites were visited up to three times in May, as recommended after the first year of surveys (Hemmera 2019), when adults are congregating and eggs are being laid (Kinsey 2009).

2.3.2 Environmental DNA

Environmental DNA (eDNA) was used to determine the distribution of western toads at sites where no toads were observed during visual encounter surveys and water was present.

2.4 Gartersnake Distribution and Abundance

2.4.1 Time Constrained Visual Encounter Surveys

Surveys for gartersnakes were conducted using time constrained visual encounter surveys as described by Joppa (2009) and RIC (1998b). Visual encounter surveys were adopted in 2020 in response to a lack of observations collected from artificial covered object (ACO) monitoring. Two qualified biologists walked along transects 5 to 10 m apart through habitat where previously placed ACOs were located (Hemmera 2020). Natural cover objects, such as, logs, tufts of grass, wood debris piles, and the placed ACOs, when encountered, were searched. The transects were used as a guide for the biologist to follow through the gartersnake foraging habitat to maintain consistency among survey events, but searchers were directed to focus on optimal habitat over following a specific route. Survey times were recorded to calculate a relative abundance of snakes detected per hour of searching**.**

Site selection in 2020 was focused on areas where snake detection was considered to be most likely. The following features were used to identify optimal sites:

- within 600 m of potential hibernacula (as interpreted on air photos i.e., close to eroding cliffs, rocky features, or rip-rap);
- habitat similar to historic snake observations (Bachmann et al. 2012, BC Hydro 2013, Hemmera 2020, Hilton et al. 2013); and
- suitable foraging habitat.

Focusing on sites nearer hibernacula, which were in habitat similar to historic snake observations, allowed greater search effort in optimal habitats. Using these metrics resulted in nine sites in the impact study area and five in the control study area (**Figure 2.2**) compared to eight sites in the impact area and nine sites in the control area in 2019.

Table 2.2 Gartersnake survey sites and transect lengths

Study Area	Site	Survey length (m)
Impact	OW01	284
	OW11	223
	OW20	237
	OW04	354
	Average Length (m)	**274.5**
Control	OW05	275
	OW06	328
	OW09	287
	TS	199
	WS02	268
	Average Length (m)	**271.4**

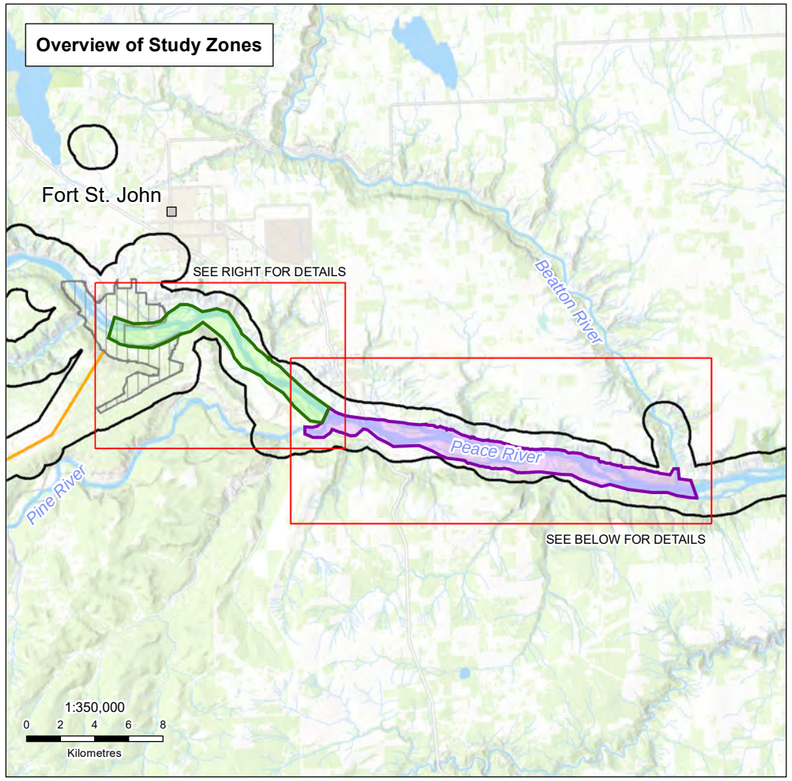
Through discussions with Mike Sarrell, herpetologist, previously placed ACOs were considered unlikely to attract snakes due to the small size and material used. Newly constructed ACOs were placed at each of the original nine sites near the original ACOs to improve the chances of snakes using these structures. Three 2’ x 2’ - 3/8” plywood were placed and flagged throughout each site close to the transect. These will be checked during the operation phase (2025 to 2034).

Two surveys were conducted in each of June, July, and August of 2020 (i.e., two surveys in each of the three survey periods).

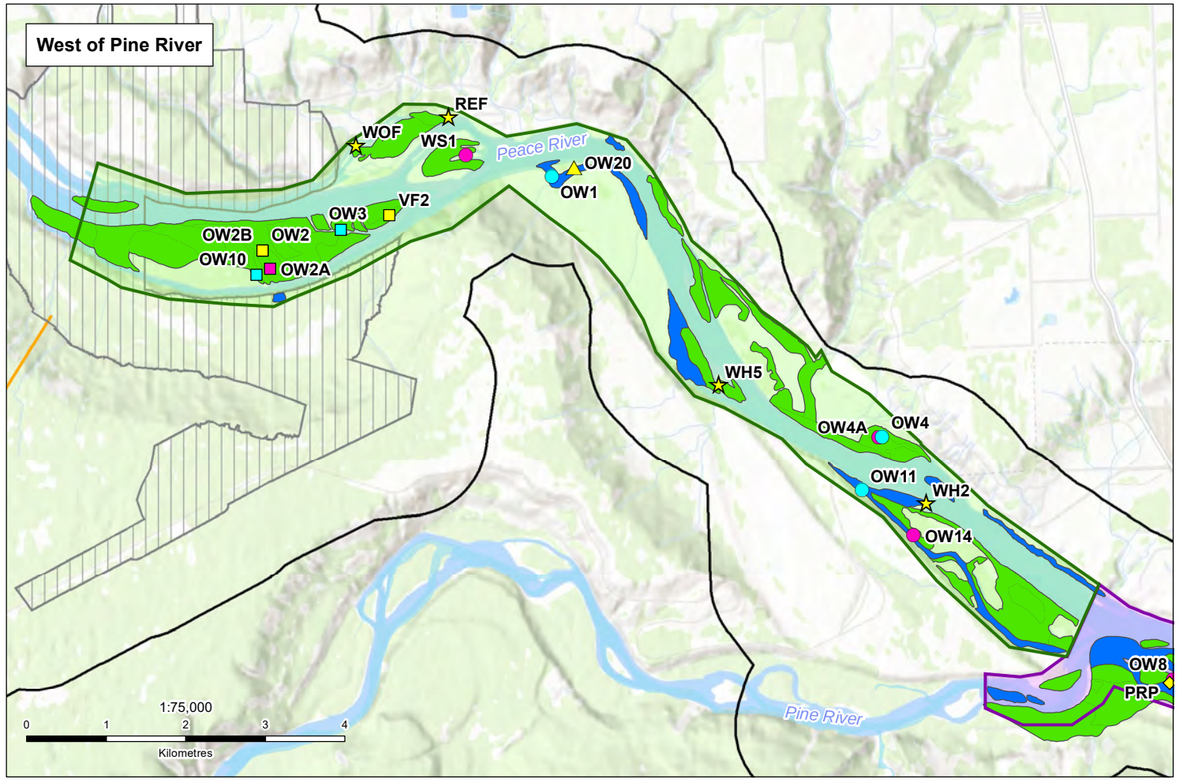
Downstream Western Toad and Gartersnake Monitoring 2019
Site C, Peace River, BC

Western Toad and Gartersnake Monitoring Sites

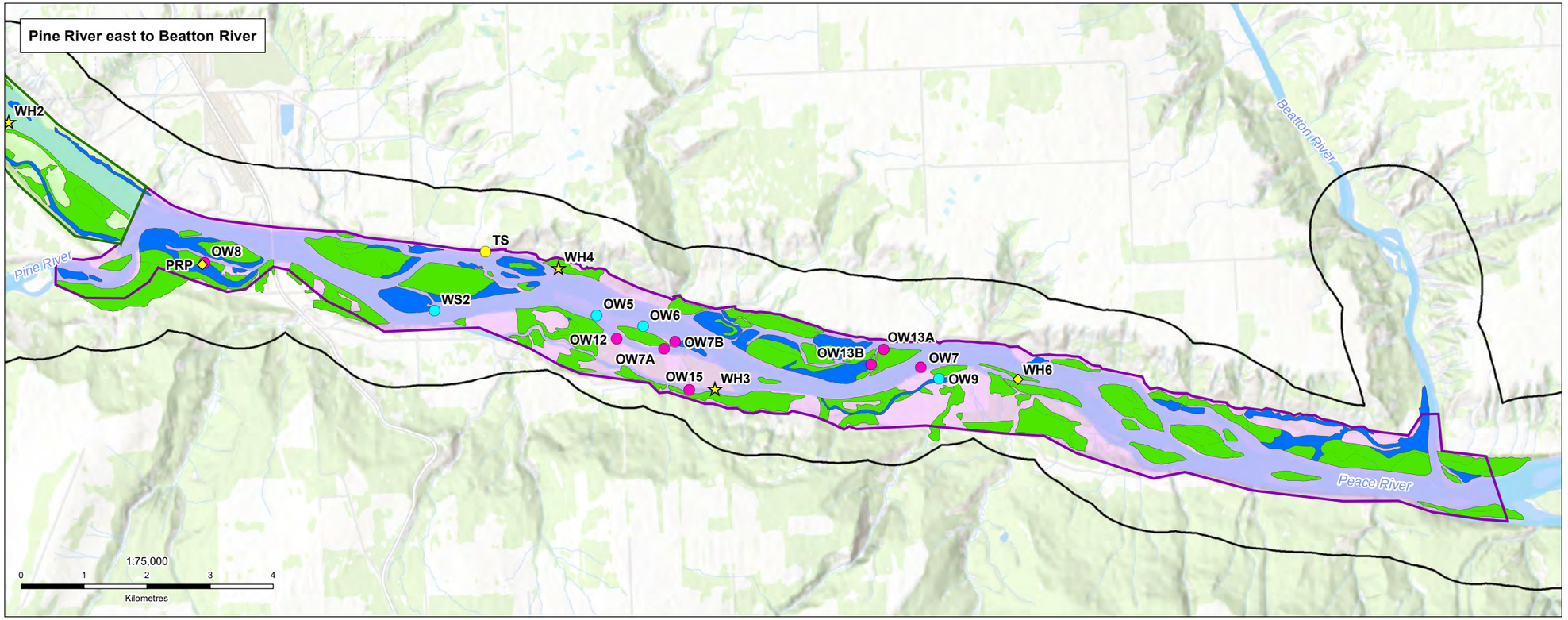
Overview of Study Zones



West of Pine River



Pine River east to Beatton River



Legend

- Site C Local Assessment Area (LAA)
- Proposed Dam Site
- Transmission Line Right-of-Way

Monitoring Sites

Site Status

- Active since 2018
- Added in 2019
- Removed (Construction)
- Removed (Private Property)
- Removed in 2020 (Site Reduction/ Protocol Change)

Species Surveyed

- Snakes
- Toads
- Snakes and Toads

Study Zones

- Pine River east to Beatton River
- West of Pine River

Habitat Type (TEM)

- Wetland
- Wet Forest

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

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2.5 Environmental Monitoring

During each site visit for both gartersnake and western toad monitoring, field crews collected environmental information: air temperature, water depth from a fixed location, and water quality (i.e., water temperature, pH, dissolved oxygen, and conductivity) using an Oakton PCSTestr 35. These data were used to inform intra-seasonal changes that might be affecting presence or relative abundance. Turbidity estimates were recorded using a LaMotte 2020we turbidity meter.

2.6 Data Analysis

Western toad and gartersnake observations from all surveys were collected via electronic (iPad) forms and compiled in a database. Data were reviewed to check for anomalous records (i.e., quality control), and questionable species identification or count data were queried with field staff.

The total number of western toads per life stage and gartersnake species detected by each survey method was recorded for each of the three survey periods. Relative abundance data are expressed as the number of toads detected per 100 m and the number of gartersnakes detected per person hour (RIC 1998b). True abundance would require either a complete census or an estimate of the individuals not detected during surveys to provide a total count of all toads that were present, and neither is feasible.

Annual reports summarize results from each year, and multi-year analysis will occur after five years and ten years of operation. Multi-year analysis will follow a BACI design to assess the project-related changes while accounting for background variation. To determine if there is an effect, the sample means (in these cases, mean counts for each site) for both Impact and Control, Before and After the impact are compared (Swartz 2015). A generalized linear mixed effects model will be used to determine if the number of western toad and gartersnake detections in the treatment area differ significantly ($\alpha < 0.05$) between the pre-construction and operations periods relative to the same periods at the control site:

$$Abundance \sim Treatment\ (control|impact) + Period(before|after) + Treatment * Period + Site + Year + environmental\ variables$$

Random effects will include Site, Year, and relevant environmental variables such as temperature and precipitation as measured at BC Hydro meteorological station 11 (Taylor) or 7B (North Camp) to control for the influence of weather conditions on observations. The interaction term "*Treatment * Period*" is the BACI effect, the non-parallel response where magnitude of change between treatment areas and time is estimated. Using an analysis of variance (ANOVA), the model will determine the level of significance (p-value) of the interaction of Treatment and Period. The BACI contrast estimates the magnitude of differences using least square means. This will indicate the magnitude and direction of the differences. Additionally, variation can be estimated within sites (sub-samples), between sites within a treatment, between treatments, and between periods.

3.0 RESULTS

The Downstream Western Toad and Gartersnake Monitoring Program plan originally specified sampling at 30 sites in the impact area and 30 sites in the control area for both western toads and gartersnakes to achieve sufficient statistical power. However, field assessments in 2018 found that access to and availability of suitable and discrete wetland habitat (**Table 2.1**) limited the application of the study design. In 2018, ten sites were sampled in the impact study area and 13 in the control study area (**Table 3.1**).

In 2019, sites available for survey were further reduced due to construction activities to prevent fish stranding in ephemeral ponds, such that only six sites in the impact study area and 11 sites in the control study area were available for western toad surveys. These sites were available for surveys in 2020 (**Table 3.1**, **Figure 2.2**).

In 2020, variation in precipitation resulted in some western toad survey sites in each study area not having appropriate breeding habitat for western toads. One site in each of the impact and control study areas did not contain water and were not surveyed. Further, one site in the impact study area and one in the control study area contained water during only one of the survey periods. Four of six sites in the impact area and nine of eleven sites in the control study area had standing water during all three survey periods (**Table 3.1**, **Figure 2.2**).

3.1 Western Toad Distribution and Relative Abundance

In 2020, field crews visited the six sites in the impact study area and 11 sites in the control study area to conduct transect surveys. Five out of six (83%) sites in the impact area and 10 out of 11 (91%) sites in the control area contained water during at least one survey period and were surveyed (**Table 3.1**). Surveys took place over three survey periods: 1) May 13, 14, and 15; 2) May 19 and 21; 3) May 27, 28, and 29.

In 2020, the percentage of western toads present at sites that had water during at least one survey period was 80% (4/5) in the impact study area and 90% (9/10) in the control study area (this included results of eDNA assessment of site OW13a). In 2019, western toads were detected in 100% (4/4) of sites in the impact study area and 83% (5/6) of sites in the control study area. In 2018, western toads were detected at 56% (5/9) of sites in the impact area and at 77% (10/13) of sites in the control study area (**Table 3.1**; **Figure 3.1**).

The number of sites with surveyable habitat (i.e., sites with water) as a percent of the total has changed among years. In 2018, 100% (9/9) of sites in the impact study area and 100% (13/13) of sites in the control study area contained surveyable habitat. This decreased in 2019 to 67% (4/6) of sites in the impact study area and 54% (6/11) of sites in the control study area. In 2020, there were more sites with surveyable habitat relative to 2019, with 83% (5/6) of sites surveyable in the impact study area and 91% (10/11) of sites surveyable in the control study area (**Table 3.1**).

Table 3.1 Western Toad Survey Sites, Habitat, and Presence, 2018 to 2020

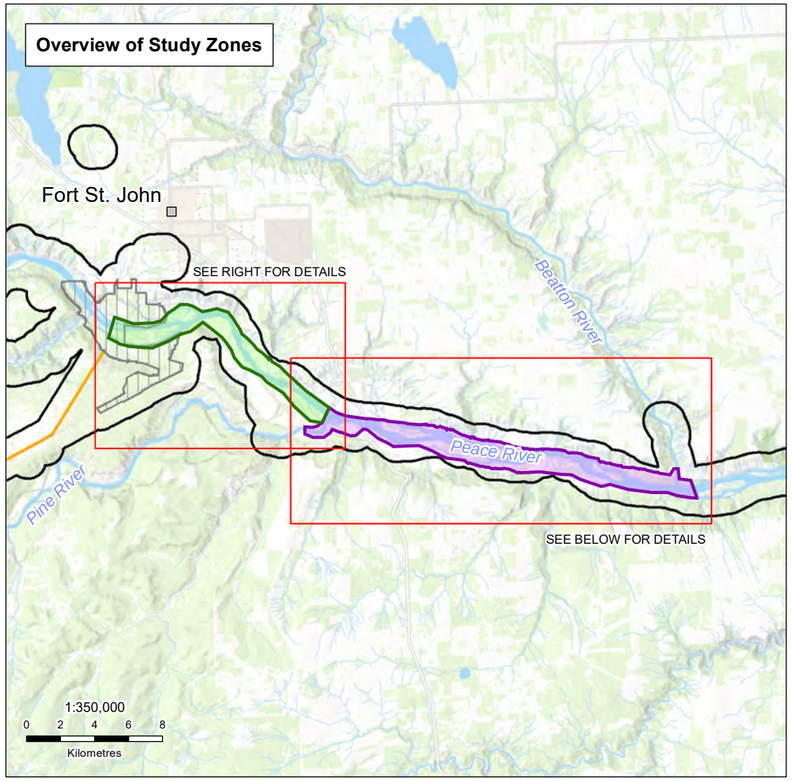
Study Area	Habitat	Site	2018	2019	2020
Impact	Shallow open water	OW1	P	P	P
		OW10	P	R	R
		OW11	A	P	P
		OW14	P	P	P
		OW3	A	R	R
		OW4	P	NS	A
		OW4a	P	P	P
	Sedge	OW2a	A	R	R
		OW2b	A	R	R
	Willow sedge	WS1	A	NS	NS
	Total Occupied Sites		**4**	**4**	**4**
Control	Shallow open water	OW12	P	P	P
		OW13a	A	NS	A
		OW13b	A	NS	P
		OW14	P	R	R
		OW15	P	P	P
		OW5	P	NS	P
		OW6	P	P	P
		OW7	P	P	P
		OW7a	P	P	P
		OW8	A	A	P
		OW9	P	R	R
	Sedge	OW7b	A	NS	P
	Willow sedge	WS2	A	NS	NS
	Total Occupied Sites		**8**	**5**	**9**

Note: Yellow cells with P – toads present
Light grey cells with A – toads absent
Light grey cells with NS – not surveyed due to lack of water.
Dark grey cells with R – site removed due to construction (impact) or removed to balance study (control)

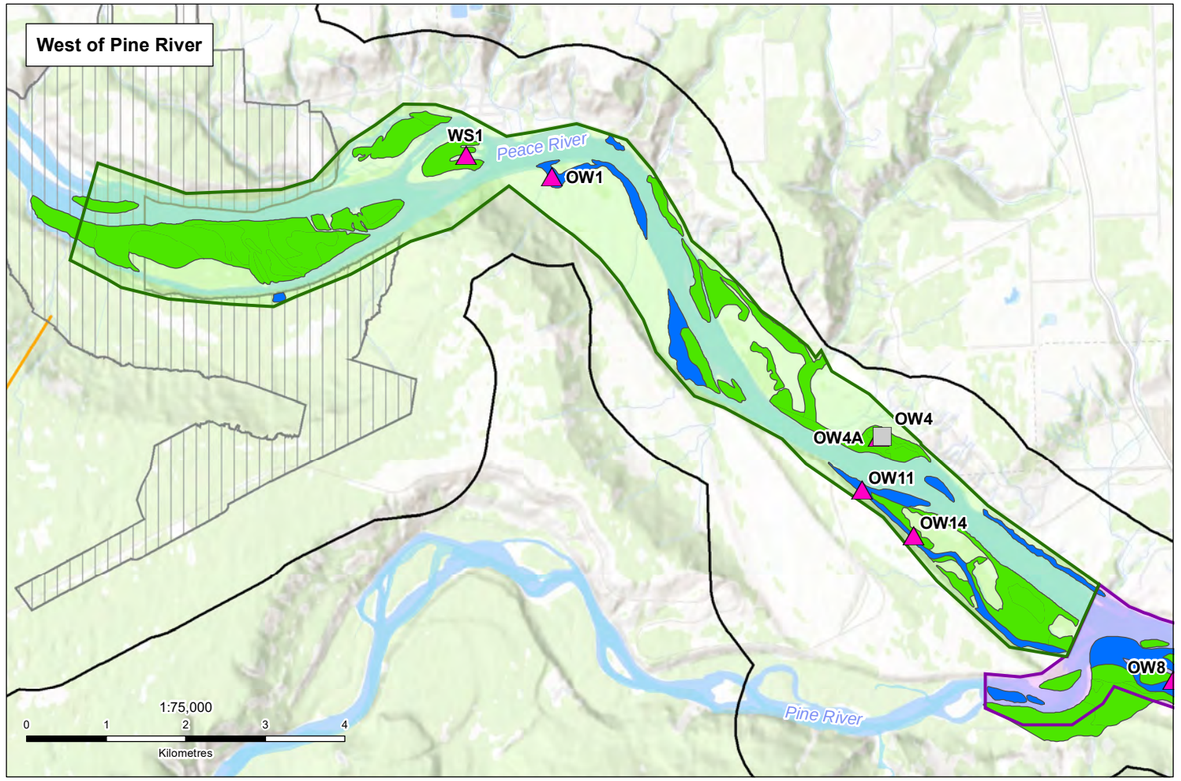
Downstream Western Toad and Gartersnake Monitoring 2019
Site C, Peace River, BC

Western Toad Presence / Not Detected

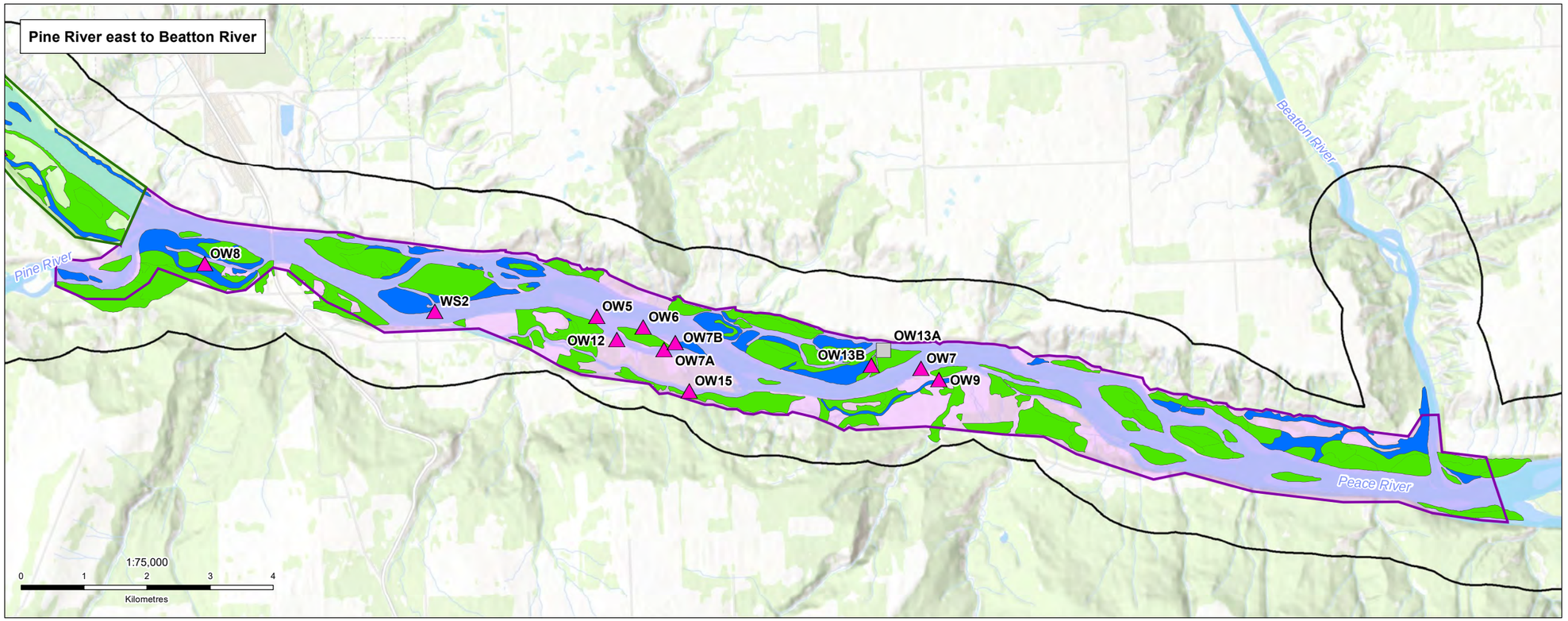
Overview of Study Zones



West of Pine River



Pine River east to Beatton River



Legend

- Site C Local Assessment Area (LAA)
- Proposed Dam Site
- Transmission Line Right-of-Way
- Western Toad Present
- Western Toad Not Detected

Study Zones

- Pine River east to Beatton River
- West of Pine River

Habitat Type (TEM)

- Wetland
- Wet Forest

Notes

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The relative abundance of western toad varied between study areas in 2020 and between years (**Table 3.2; Table 3.3; Figure 3.2**).

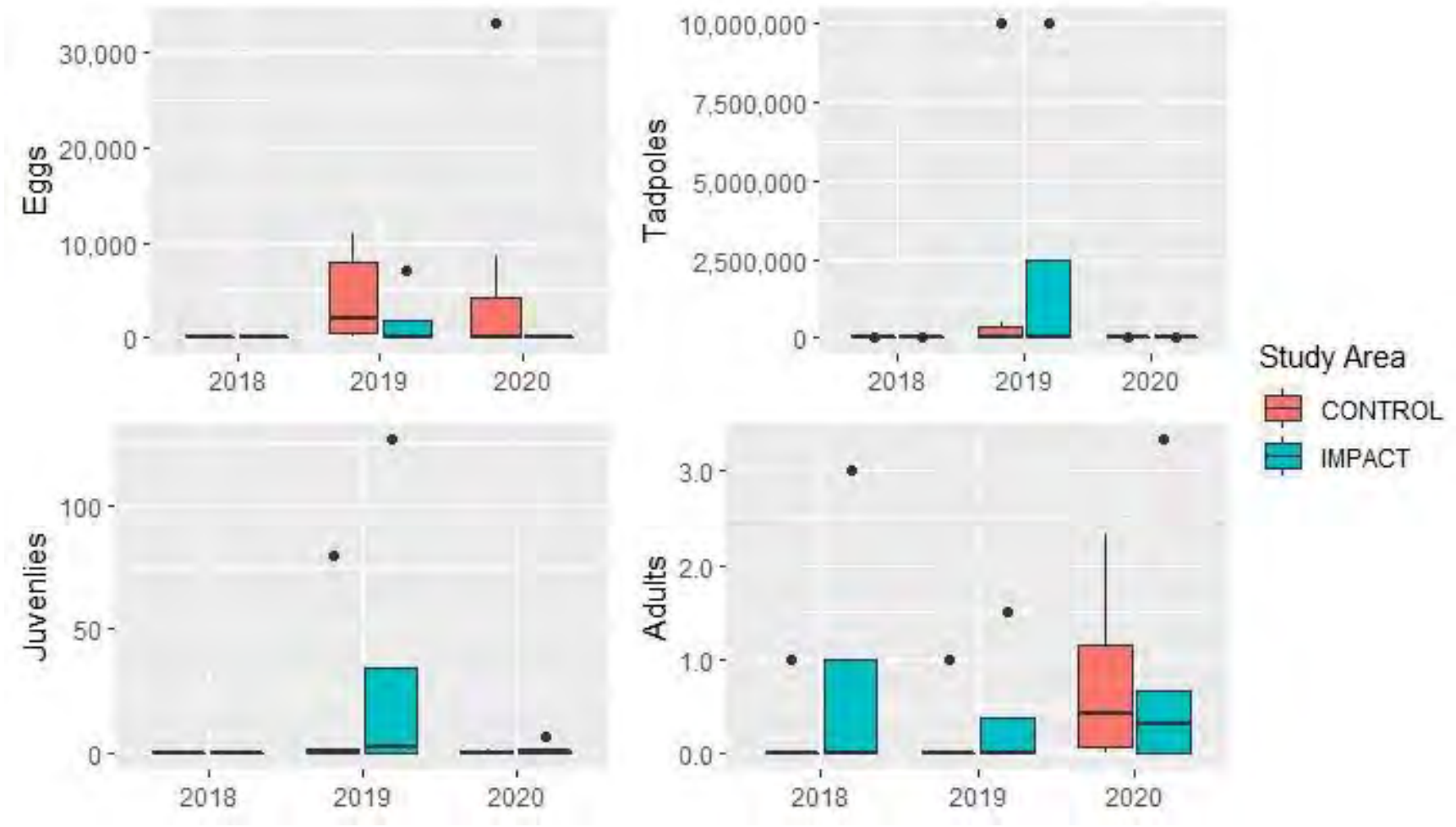
Table 3.2 Western Toad Relative Abundance per 100 m transect per site, 2020

Study Area	Site	Eggs	Tadpole	Juvenile	Adult
Impact	OW01	300,747	1,349	1	3.33
	OW11	0	0	1	0
	OW14	0	0	7	0.67
	OW04	0	0	0	0
	OW04a	0	0	0	0.32
Control	OW12	8,549	0	1.33	1.33
	OW13a	0	0	0	0
	OW13b	0	0	1.03	0
	OW15	0	2.33	0.67	2.33
	OW05	5,617	1,100	0	0.33
	OW06	0	8.33	1.67	0.67
	OW07	0	0.33	2	1.33
	OW07a	32,938	0	0.76	0.51
	OW07b	0	0	0.36	0.36
	OW08	0	0	0.33	0

Table 3.3 Western Toad Relative Abundance per 100 m transect per Study Area, 2018 through 2020

Year	Study Area	Summary	Life Stage			
			Eggs	Tadpole	Juvenile	Adult
2018	Impact (n = 8)	Avg Relative Abundance	0	25.2	0	1
		Median Relative Abundance	0	0	0	1
		SE	0	25.2	0	0.55
		Min	0	0	0	0
		Max	0	126	0	3
		Sum	0	126	0	5
	Control (n = 7)	Avg Relative Abundance	0	616	0	0
		Median Relative Abundance	0	1	0	0
		SE	0	596	0	0
		Min	0	0	0	0
		Max	0	3,000	0	1
		Sum	0	3,081	0	1

Year	Study Area	Summary	Life Stage			
			Eggs	Tadpole	Juvenile	Adult
2019	Impact (n = 4)	Avg Relative Abundance	1,750	2,500,001	32.88	0.38
		Median Relative Abundance	0	3	3	0
		SE	1,750	2,500,000	31.06	0.38
		Min	0	0	0	0
		Max	7,000	10,000,00	126	2
		Sum	7,000	10,000,005	131	1.5
	Control (n = 6)	Avg Relative Abundance	4,167	1,753,334	14	0.17
		Median Relative Abundance	2,000	10,001	1	0
		SE	2,041	1,651,316	13	0.17
		Min	0	0	0	0
		Max	11,000	10,000,000	80	1
		Sum	25,000	10,520,003	84	1
2020	Impact (n = 5)	Avg Relative Abundance	60,149	270	2	1
		Median Relative Abundance	0	0	1	0.32
		SE	60,149	270	1	1
		Min	0	0	0	0
		Max	300,747	1,350	7	3
		Sum	300,747	1,350	9	4
	Control (n = 10)	Avg Relative Abundance	4,710	111	1	1
		Median Relative Abundance	0	0	1	0
		SE	3,279	110	0	0
		Min	0	0	0	0
		Max	32,938	1,100	2	2
		Sum	47,104	1,111	8	7



Note: Eggs panel does not include one outlier observation of 300,000 eggs to focus on the finer scale variability of the data.

Figure 3.2 Western Toad Life Stage Relative Abundance per 100 m transect, 2018 through 2020

In 2020 the total number of eggs in the impact study area was greater than the control study area, with 300,747 eggs per 100 m transect and 47,104 eggs per 100 m, respectively. However, in 2019 the total number of eggs in the impact study area was less than the control study area, with 7,000 eggs per 100 m in the impact study area and 25,000 in the control study area. In 2020, there was a total of 1,350 tadpoles per 100 m in the impact study area with a similar amount, 1,111 tadpoles per 100 m, found in the control study area. In 2019, the number of tadpoles was greater than observations in 2020, with a estimated total of 10,000,005 tadpoles per 100 m in the impact area and 10,520,003 tadpoles per 100 m in the control study area. The total number of juveniles found in 2020 was similar between the impact study area (9 juveniles per 100 m) and the control study area (8 juveniles per 100 m). This was much less than observations in 2019, when 131.5 juveniles per 100 m were detected in the impact study area and 84 juveniles per 100 m in the control study area. The total number of adults found in 2020 was less in the impact study area (4.3 adults per 100 m) than the control study area (7 adults per 100 m). These adult observations were greater than observations in 2019, when 1.5 adults per 100 m were detected in the impact study area and 1 adult per 100 m transect in the control study area.

3.2 Gartersnake Distribution and Relative Abundance

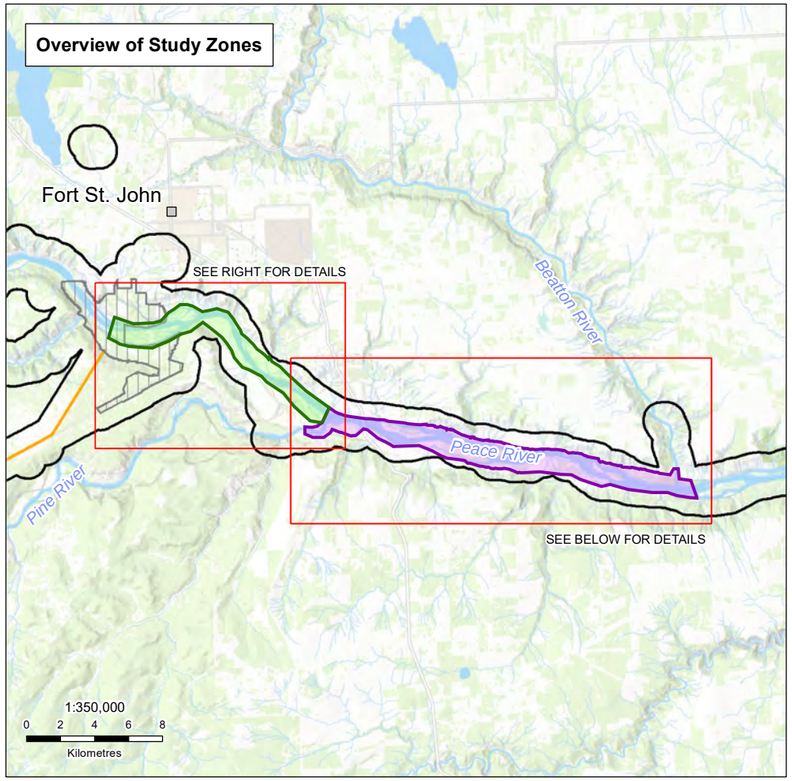
Field crews visited four sites in the impact area and five sites in the control area over three survey periods: 1) June 19 and 20; 2) July 22 and 23; and 3) August 10 and 11. Each site was surveyed twice during each survey period.

Gartersnakes were detected in 50% (2/4) of sites in the impact study area and 60% (3/5) of sites in the control study area (**Table 3.4**).

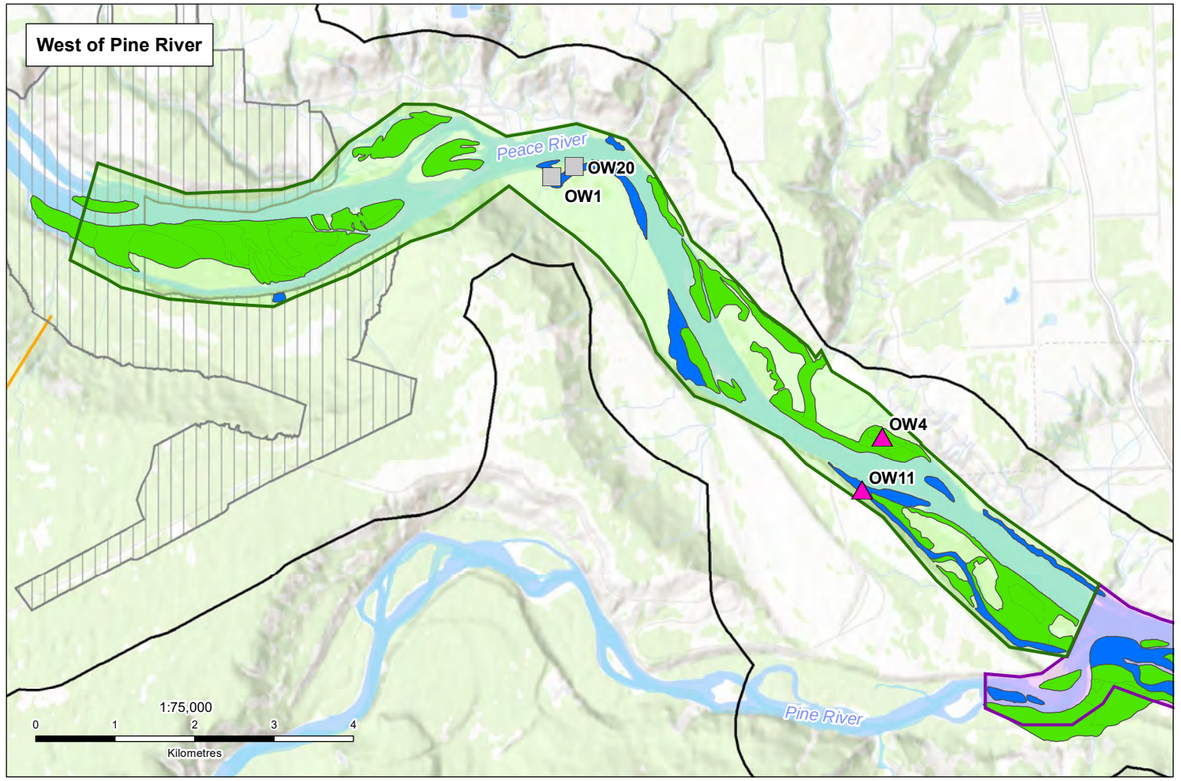
Table 3.4 Gartersnake Distribution, 2020

Study Area	Site	Common Gartersnake	Western Gartersnake	Unknown Gartersnake	Site Total
Impact (50% Occupancy)	OW01	0	0	0	**0**
	OW04	0	0	1	**1**
	OW11	0	0	6	**6**
	OW20	0	0	0	**0**
	Study Area Total	***0***	***0***	***7***	***7***
Control (60% Occupancy)	OW05	0	0	1	**1**
	OW06	0	0	0	**0**
	OW09	3	2	2	**7**
	TS	1	2	1	**4**
	WS02	0	0	0	**0**
	Study Area Total	***4***	***4***	***4***	***12***

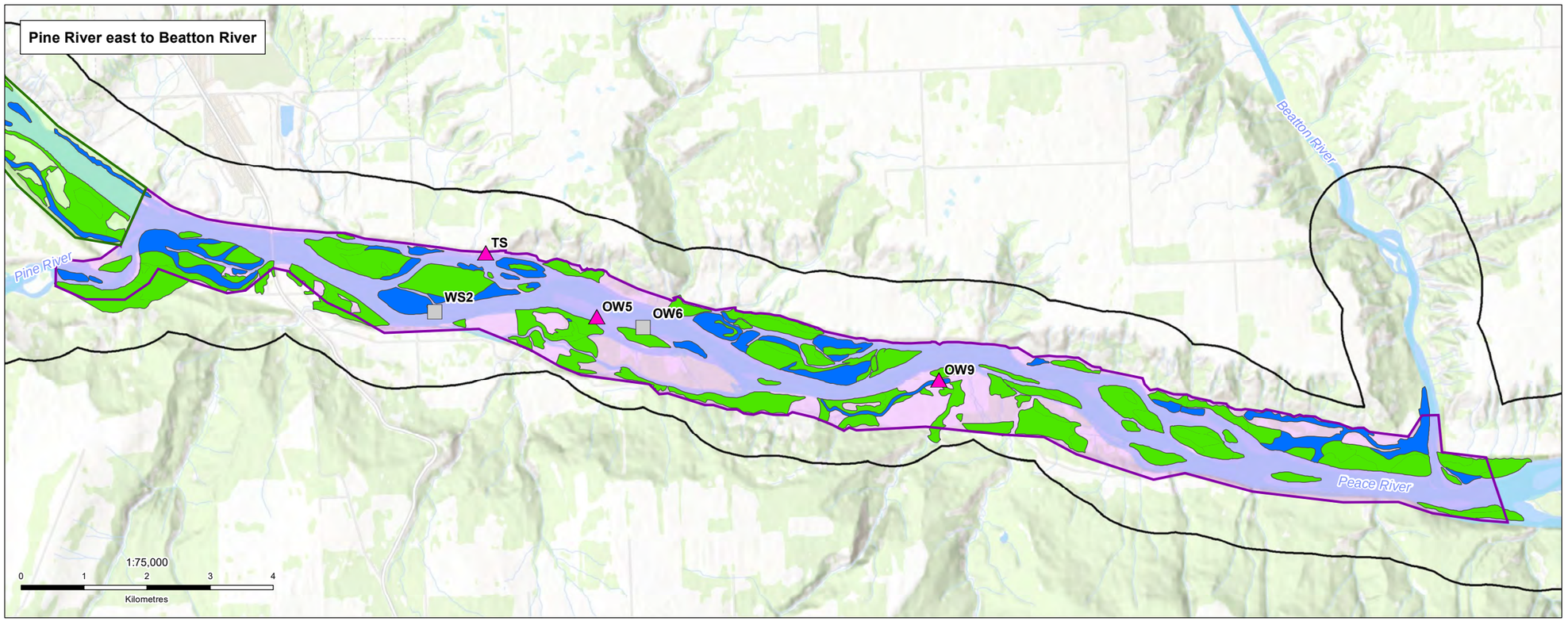
Overview of Study Zones



West of Pine River



Pine River east to Beatton River



Downstream Western Toad and Gartersnake Monitoring 2019
Site C, Peace River, BC

Gartersnake Presence / Not Detected

Legend

- Site C Local Assessment Area (LAA)
- Proposed Dam Site
- Transmission Line Right-of-Way
- Gartersnake Present
- Gartersnake Not Detected

Study Zones

- Pine River east to Beatton River
- West of Pine River

Habitat Type (TEM)

- Wetland
- Wet Forest

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

NAD 1983 UTM Zone 10N

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989619-09	Production Date: 2-Oct-2020	Figure 3.3

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The relative abundance of gartersnakes was 0.12 snakes per person-hour in the impact study area, and 0.26 snakes per person-hour in the control study area was. The average time per site spent surveying for snakes was 0:59:12 in the impact area and 0:50:32 in the control area was (**Table 3.5**).

Table 3.5 Gartersnake Search Time and Relative Abundance, 2020

Study Area	Site	Average search time over three survey periods	Snakes per person-hour
Impact	OW01	0:52:40	0.00
	OW04	1:01:00	0.16
	OW11	1:09:47	0.42
	OW20	0:53:20	0.00
	Study Area Average	**0:59:12**	**0.15**
Control	OW05	0:56:51	0.13
	OW06	0:39:20	0.00
	OW09	0:34:24	0.93
	TS	1:01:07	0.23
	WS02	1:01:00	0.00
	Study Area Average	**0:50:32**	**0.26**

Gartersnake distribution and relative abundance cannot be directly compared between 2020 and 2019 due to changes in survey methods and site selection. The methodology was changed in 2020 to focus on visual encounter surveys, in which surveyors walked through suitable snake foraging habitat looking for gartersnakes under natural cover objects rather than focussing on ACOs. The 2019 results were suboptimal, with one of 118 ACOs harbouring a snake (the other three observations were recorded as incidental). In 2020, sites were reduced to four from eight in the impact study area, and to five from nine in the control study area. Overall, there were four snakes found across 16 sites in 2019 while there were 19 snakes found across nine sites in 2020.

3.3 Environmental Monitoring

Environmental parameters varied between study areas and years. The lower pH in 2020 compared to 2018 and 2019 may have been due to a recent rain fall, and likely related to an increase in conductivity observed in 2020. The elevated average air and water temperature in 2018 were due to the surveys conducted through May, June, and July. In 2019 and 2020 surveys were conducted exclusively in May. There were no dissolved oxygen or water depths taken in 2018 (**Table 3.6**; **Figure 3.4**).

Table 3.6 Environmental Parameters, 2018 through 2020

Study Area	2018		2019		2020	
	Impact (n=9)	Control (n=13)	Impact (n=4)	Control (n=6)	Impact (n=5)	Control (n=10)
Average Water Temp (ºC) (SE)	20.33 (3.35)	19.6 (3.15)	12.25 (0.96)	13.50 (1.11)	13.29 (0.89)	15.21 (0.68)
Average Air Temp (ºC) (SE)	22.5 (2.39)	19.7 (2.51)	15.2 (1.25)	14.9 (1.01)	13.0 (1.17)	16.3 (0.80)
Average pH (SE)	8.68 (0.89)	7.85 (0.28)	8.34 (0.13)	8.61 (0.16)	7.80 (0.04)	7.46 (0.12)
Average Conductivity (s/cm) (SE)	300.4 (140)	399.8 (157)	388 (78.8)	526 (184)	614 (126)	748 (54.4)
Average Turbidity (NTU) (SE)	14.74* (5.62)	66.35* (22.83)	25.7 (3.55)	41.4 (6.92)	9.9 (2.43)	15.6 (6.02)
Dissolved Oxygen (mg/L) (SE)	NA	NA	13.7 (1.15)	13.7 (1.52)	13.0 (1.59)	9.42 (1.14)
Water Depth (cm) (SE)	NA	NA	32.6 (2.3)	22.9 (1.5)	41.4 (7.94)	33.5 (5.44)

Note: SE = standard error; NA = Not applicable: dissolved oxygen not collected, and water depth not standardized for comparison
* turbidity taken with LaMotte 2020we, or similar, were Impact = 5 and Control = 4 and are comparable

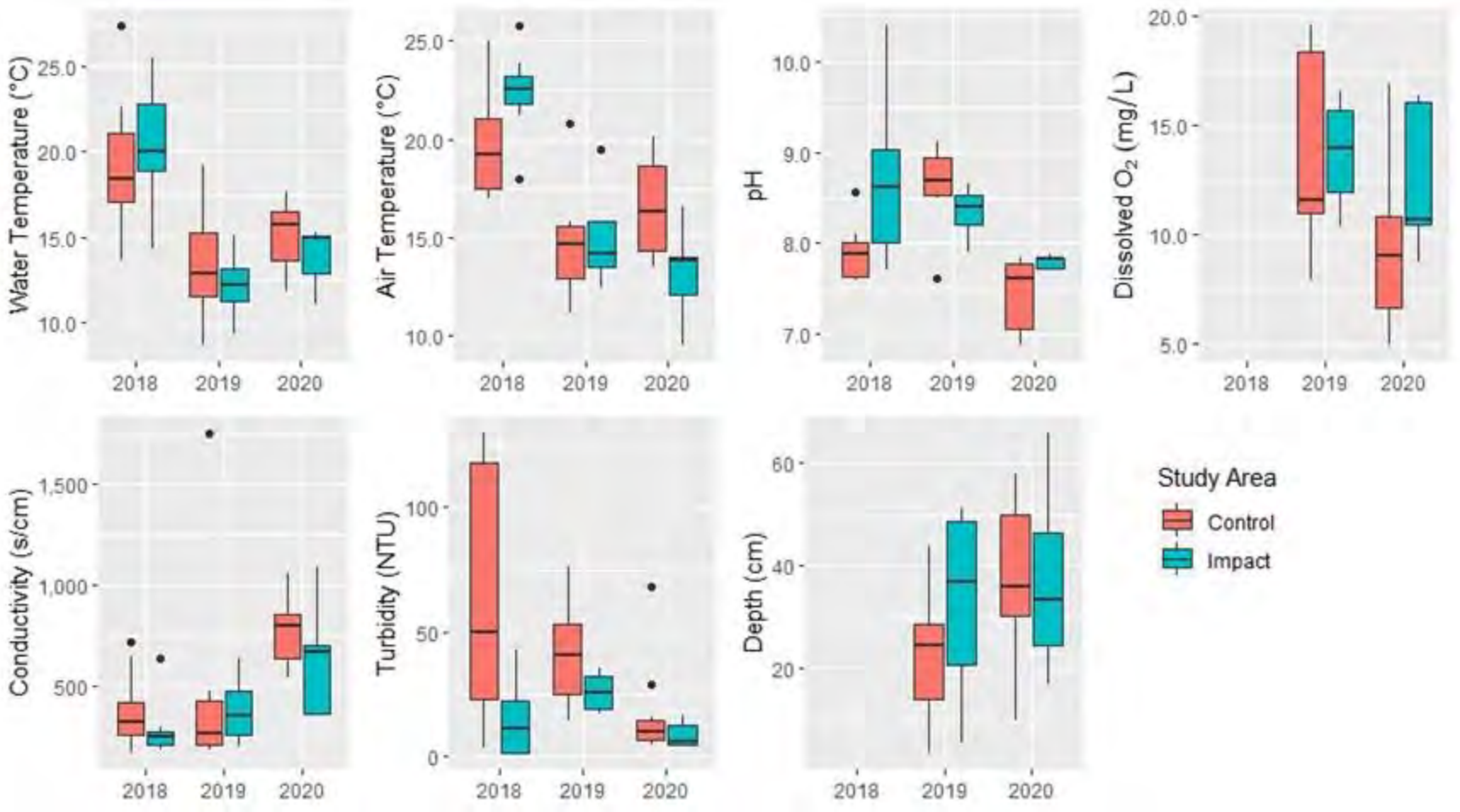

Figure 3.4 Environmental Parameters, 2018 through 2020

4.0 DISCUSSION

4.1 Western Toad Abundance

Population fluctuations are inherent to western toad, and amphibian populations in general are sensitive to stochastic events (Marsh and Trenham 2001). The data collected between 2018 and 2020 are highly variable among years, with no consistent pattern between each life stage. For example, the estimated number of tadpoles is not consistent with the expected rate of mortality of 0.6 between eggs and tadpoles (Crockett et al. 2020). Far more tadpoles than eggs were found in 2018 and 2019, and far fewer tadpoles than expected in 2020. There is also no apparent pattern in abundance related to water levels. For example, in 2019 there were more sites without water than in 2020, but also more observed tadpoles than in 2020.

The variability (and uncertainty) of tadpoles observed during 2019 suggests that it is difficult to make reliable inferences based on tadpole relative abundances. Although data on all life stages of western toad is valuable for gaining a holistic community ecology perspective, tadpoles and juveniles are generally poor indicators of successful breeding due to their high mortalities (COSEWIC 2012). Therefore, counts of tadpoles are expected to be excluded from future trend analysis. The timing of surveys in May has successfully captured estimates of all life stages, therefore egg and adult relative abundances will be used to compare trends among years and between impact and control sites.

4.2 Gartersnake Abundance

The adapted gartersnake survey protocols resulted in 19 snakes found in 2020 versus four in 2019 using the ACO methods. The 2020 protocols will be followed in the operational monitoring period (2024-2034).

The relative abundances of gartersnakes between 2019 and 2020 are not directly comparable. In 2019, one snake was detected under an ACO and three were observed incidentally. Unlike in 2020, the observations gathered away from ACOs were along direct paths from one ACO to another, rather than the focussed transects within suitable gartersnake foraging habitat conducted in 2020, Also, gartersnake populations are not likely to fluctuate to the extent observed from the 2019 surveys to the 2020 surveys (M. Sarrell, pers. comm.). Therefore, the increase in snake observations is likely a direct result of the change in protocol to a more effective approach for determining presence and relative abundance.

4.3 Environmental Monitoring

At the sites with water, there were no apparent meaningful differences in the water quality or environmental variables beyond normal annual variations (**Table 3.6**).

5.0 CLOSING

This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

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APPENDIX A

Western Toad and Gartersnake Site and Habitat Area

Table A.1 Western Toad and Gartersnake Site and Habitat Area

Site Name	Study Area	Habitat Type	Site Area (ha)	Species
OW1	Impact	Shallow-open Water	3.13	toad and snake
OW11	Impact	Shallow-open Water	0.39	toad and snake
OW4	Impact	Shallow-open Water	1.51	toad and snake
OW4a	Impact	Shallow-open Water	1.44	toad
OW20	Impact	Shallow-open Water	0.81	snake
WH2	Impact	Non-forested Floodplain	1.77	snake
WH5	Impact	Non-forested Floodplain	1.46	snake
WS1	Impact	Willow-Sedge	6.41	toad and snake
WOF	Impact	Non-forested Floodplain	0.47	snake
OW12	Control	Shallow-open Water	1.55	toad
OW13a	Control	Shallow-open Water	1.6	toad
OW13b	Control	Shallow-open Water	2.21	toad
OW14	Control	Shallow-open Water	1.24	toad
OW15	Control	Shallow-open Water	2.15	toad
OW5	Control	Shallow-open Water	0.75	toad and snake
OW6	Control	Shallow-open Water	0.53	toad and snake
OW7	Control	Shallow-open Water	2.98	toad and snake
OW7a	Control	Shallow-open Water	0.54	toad
OW7b	Control	Sedge	2.44	toad
OW8	Control	Shallow-open Water	0.86	toad and snake
OW9	Control	Shallow-open Water	1.47	toad and snake
WH3	Control	Non-forested Floodplain	3.21	snake
WH4	Control	Non-forested Floodplain	0.53	snake
TS	Control	Non-forested Floodplain	0.29	snake
WS2	Control	Willow-Sedge	0.18	toad and snake

Appendix 7. Downstream Vegetation Monitoring Project 2020 Status Update

ECOLOGIC CONSULTANTS LTD.
UNIT 4 - 252 EAST 1ST STREET
NORTH VANCOUVER BC V7L 1B3
PHONE: 604 836 2273

MEMORANDUM

DATE:	September 4, 2020 (updated November 16, 2020)
TO:	Brock Simons, M.Sc., R.P.Bio. – Terrestrial Biodiversity Specialist, Site C Clean Energy Project
FROM:	Claudia Houwers, B.Sc., R.P. Bio, P. Biol. – Terrestrial Biologist, EcoLogic
SUBJECT:	Downstream Vegetation Monitoring Project 2020 Status Update

1. PROGRAM BACKGROUND AND OBJECTIVES

In accordance with Condition 16.3.6 of the federal Decision Statement for the Site C Clean Energy Project (the Project), BC Hydro has committed to the monitoring of measures implemented to mitigate the Project's effects on species at risk, at-risk and sensitive ecological communities, and rare plants. One aspect of this monitoring is the development and execution of a Downstream Vegetation Monitoring Program.

The primary objectives of the Downstream Vegetation Monitoring, as laid out in Part of D of Section 7.4.7 of the Project's Vegetation and Wildlife Mitigation and Monitoring Plan, are to use long-term monitoring plots to document the following:

- the response of downstream riparian vegetation to changes in the surface water regime during construction and operations of the Site C dam;
- the response of downstream at-risk and sensitive ecosystems (hereafter, sensitive ecosystems) to changes in the surface water regime during construction and operations;
- the response of downstream plant species at risk occurrences to changes in the surface water regime during construction and operations; and
- the establishment of new populations of plant species at risk between the dam and the Pine River confluence.

The following questions will be addressed under this program:

- What are the effects of changes to the downstream surface water regime on riparian vegetation?

- What are the effects of changes to the downstream surface water regime on sensitive ecosystems?
- What are the effects of changes to the downstream surface water regime on known occurrences of plant species at risk?
- Have the changes to the downstream surface water regime resulted in the establishment of new occurrences of plant species at risk?

A memorandum summarizing the results of the 2019 field season was submitted on November 27, 2019, and was updated on May 14,2020, based on comments from the Vegetation and Wildlife Technical Committee. This memorandum is an expansion of the 2019 effort that summarizes the 2020 field work that completes the baseline assessment for the monitoring program. All raw data have been submitted to the B.C. Conservation Data Centre.

2. PROGRAM PROTOCOLS

2.1. SELECTION OF POLYGONS FOR SAMPLING

2.1.1. Pre-field

Protocols presented in the Downstream Vegetation Monitoring Workplan (Tables 1 and 2 in EcoLogic and Tetra Tech 2018) were used as the basis for selection of plant species and ecosystems at risk in the Downstream Vegetation Monitoring study area. The tables were cross-referenced with the most current data from the B.C. Conservation Data Centre (B.C. CDC 2020) to confirm the listings had not changed in the interim and to determine whether any other plant or ecosystems at risk had the potential to occur in the Downstream Vegetation Monitoring study area.

Plant species at risk with the potential to occur within the Project area were identified prior to field surveys by reviewing literature and online sources such as Douglas et al. (2002), eFlora BC (2019), and the BC Species and Ecosystem Explorer (B.C. CDC 2019). All plant species Red- and Blue-listed in BC (i.e., species at risk) with mapped known occurrences or the potential for occurrence (based on ecological and biogeographic considerations) were subsequently identified as targets for survey. There are no federally listed plant species at risk with potential to occur in the Project area.

Table 2.1-1 represents Table 2 from the EcoLogic and Tetra Tech (2018) work plan with the addition of Map Code and Site Series columns. Fifteen ecosystems have been identified in the downstream vegetation monitoring area. Ecosystems at risk within the Project area were identified by reviewing the most current B.C. CDC database (2019). The search criteria for potentially occurring at-risk ecosystems included those that are Red- or Blue-listed, within the BWBSmw and the Peace Forest District.

Table 2.1-1. Distribution of site series in Downstream Vegetation Monitoring study area

ID #	Map Code	Site Series	Site Series Name	CDC Status	Spatial Area (ha)
1	ATcp	101$6B.1	$At – Rose – Creamy peavine	Yellow	812
2	Fm02	112	AcbSw – Mountain alder – Dogwood	Blue	307
3	SW	103	SwPl – Soopolallie – Fuzzy-spike rye	Yellow	179
4	SH	111	Sw – Currant – Horsetail	Blue	133
5	ATsw	103$6B.1	$At – Rose – Fuzzy-spiked wildrye	Yellow	107
6	GB	00	Gravel Bar	n/a	75
7	Fl06	00	Pacific willow – Red-osier dogwood – Horsetail	Red	74
8	AM	101	Sw – Trailing raspberry – Step moss	Yellow	57
9	Gb51	00	Saskatoon – Blue wildrye	Yellow	41
10	Gg51	00	Slender wheatgrass – Pasture sage	Yellow	37
11	SHac	111$6B.1	$At – Highbush cranberry – Oak fern	Yellow	35
12	SO	110	Sw – Oak fern – Sarsaparilla	Blue	30
13	ATsk	102$6B.1	$At – Soopolallie – Kinnikinnick	Yellow	26
14	Wf02	00	Scrub birch – Water sedge	Blue	5
15	Wf01	00	Beaked sedge – Water sedge	Yellow	1

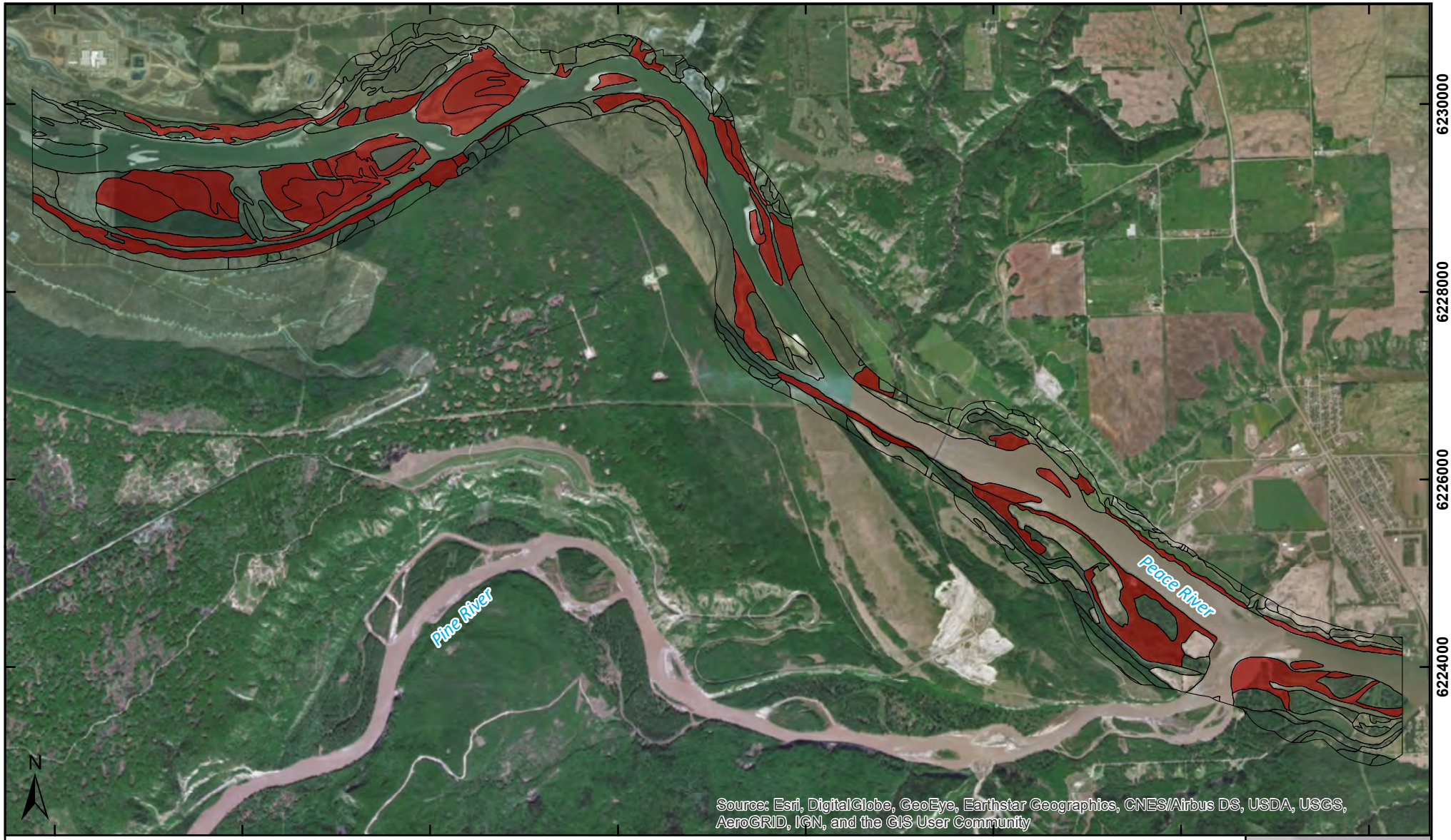
Note: dbase = attribute database; $ = seral; Acb = balsam poplar; At = trembling aspen, Sw = white spruce, Pl = lodgepole pine.

A sampling plan was prepared in Excel showing a matrix of the 15 ecosystems in Table 2.1-1 along with at-risk listings, proximity to river, and land ownership (Appendix A). The TEM ecosystems that occurred in the Downstream Vegetation Monitoring study area (Table 2.1-1) were spatially analyzed to determine which ecosystems abut the Peace River. Those ecosystems that did abut the river were retained and all other ecosystem units were dropped from consideration. Those ecosystem units remaining were spatially cross-referenced using ArcGIS to determine land ownership by polygon. In total, 44 polygons were identified as sampling targets in 2019 (Appendix A, Figure 2.1-1). In 2020, proximity to the Peace River was assessed spatially using imagery and knowledge of the topography of the study area based on the previous year's field season. Priority was given to polygons that were riparian, on Crown land, and accessible by boat. In total, 27 polygons were identified as sampling targets in 2020 (Appendix A, Figure 2.1-2).

2.1.2. In the Field

The objective of the sampling plan was to document the response of downstream vegetation, including ecosystems at risk and known rare plant occurrences, to changes in the surface water regime between the dam and the confluence of the Peace and Pine rivers. All else being equal, areas on BC Hydro or Crown land were preferentially selected because of their greater ease of access and a lower likelihood of land use changes or development. In 2019, 14 polygons were sampled out of the targeted 44 polygons, all but

one of which were on Crown land (Appendix A). To maximize the likelihood of detecting changes that may occur, preference was given to those polygons most likely to be affected by river activities (10 polygons), along with 4 polygons outside the river's influence for comparison. Land access and the timing of the 2019 field work (i.e., limited polygon selection that could be effectively sampled due to plant senescence) placed limitations on the number of polygons that could be effectively sampled.



Site C Downstream Monitoring

Polygons selected for potential sampling 2019

Figure 2.1-1

0 1 2 3

1:57,500 km

Date: 11/19/2019

Map Number: BCHD-002

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

Legend

- Potential sampling target
- Terrestrial Ecosystem Mapping (TEM)

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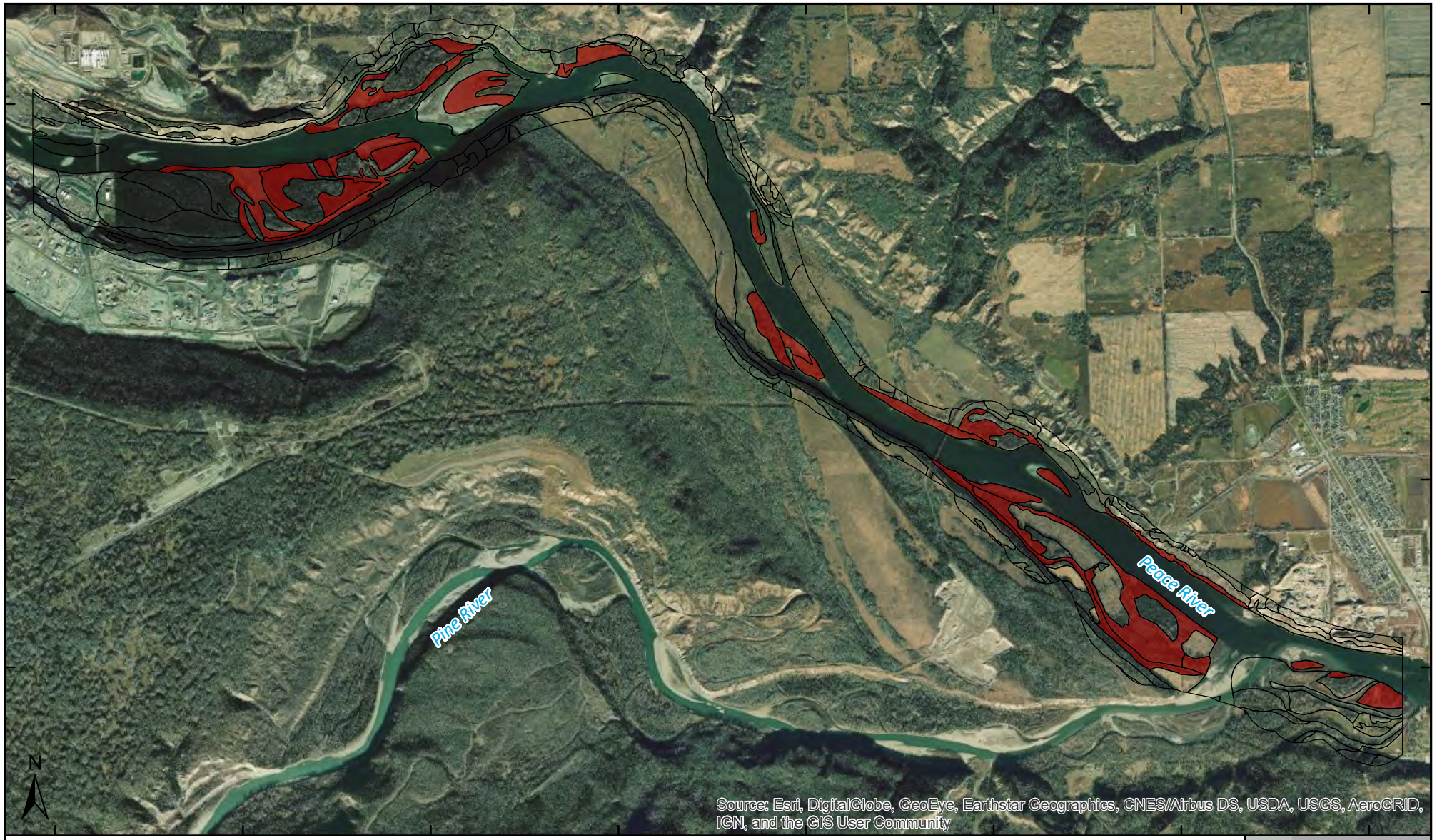


Site C Downstream Monitoring

Polygons selected for potential sampling 2020

Figure 2.1-2

Date: 8/12/2020

Map Number: BCHD-004

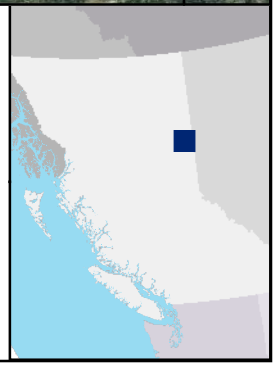
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

0 1 2 3
1:57,500 km

Legend

- Potential Sampling Target (2020)
- Terrestrial Ecosystem Mapping (TEM)



In 2020, 20 of the 27 target polygons were sampled. The majority of the polygons were on Crown land with a few exceptions that were categorized as unknown land-ownership status. These were either islands in the river or along the shoreline; for those along the shoreline that were in close proximity to private land, the owners were contacted prior to the site visit. Extremely high water levels placed limitations on the number of polygons that could be effectively sampled or reduced the number of plots that could be completed along transects. Several islands were completely under water and those that were not were covered with wet silt anywhere from a few centimeters up to 40 cm, making walking conditions hazardous and identifying vegetation impossible. Photos were collected at each location to document these conditions (Appendix C).

2.2. Sampling Design

Selected polygons were sampled using ecosystem classification plots (10-m radius) placed along two parallel 50-m transects set 25 m apart. One pair of transects, oriented approximately parallel to and in increasing distance from the shoreline, was established for each polygon, with three plots completed along each of these transects (Figure 2.2-1). This resulted in the completion of six sampling plots in each polygon. Exceptions to this sampling design occurred when the polygon was limited in size and unable to accommodate six plots or where sediment made sampling ineffective, as well as the very first polygon where nine plots were located as a pilot trial. All plot centres were georeferenced, and photographs were obtained for each plot.

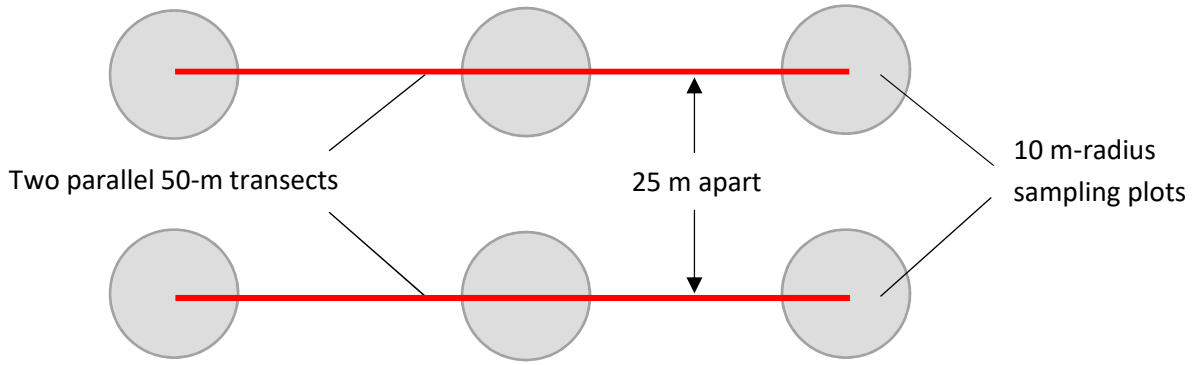


Figure 2.2-1. Sampling design for ecosystem classification used in Downstream Vegetation Monitoring Program

2.3. Ecosystem Classification/Verification

Ecosystem classification protocols followed provincial standards, as prescribed by the Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2010). Ecosystem characteristics specific to the Peace River region (e.g., site series) were informed by reference to the regional ecosystem identification guide for the Boreal White and Black Spruce Biogeoclimatic (BGC) Zone of British Columbia (BC MOFR 2011).

Three categories of information were recorded in each sampling plot in the field: (i) site characteristics, (ii) soils, and (iii) vegetation characteristics (Table 2.3-1).

Table 2.3-1. Ecosystem data collected at each sampling plot

Site Characteristics	
Site series	Soil moisture regime
Seral association (where applicable)	Soil nutrient regime
Map code	Surface shape
Slope	Mesoslope position
Aspect	Substrate/ground cover types (%)
Soils	
Drainage code	Depth of mottling (when present)
Humus form	Presence of seepage
Humus thickness	Depth of seepage (when present)
Presence of gleying	Presence of root restrictive layer
Depth of gleying (when present)	Depth of root restrictive layer (when present)
Presence of mottling	Type of root restrictive layer (when present)
For each soil horizon, the following data were collected:	
Horizon depth	% stones
Horizon colour	Total coarse fragments
Horizon texture	Root abundance
% gravels	Root size
% cobbles	
Vegetation	
Structural stage	% shrub cover
Successional stage	% herb cover
Canopy composition	% moss/lichen cover
Canopy closure	% cover of each vascular plant species in each layer
% tree cover	

2.4. PLANT SPECIES AT RISK

Each polygon sampled was assessed for the presence of plant species at risk by using the 'intuitive meander' protocol described in BC MOECCS (2018). This protocol prescribes that the surveying botanist relies on his or her knowledge of the ecology of plant species at risk within the region of interest to guide the surveys. This approach seeks to maximize the probability of detection of rare species that often exist at low densities on the landscape, particularly in habitats that have low potential for rare plant occurrences. Where high-potential habitats are located, the survey botanist conducts formal, plot-based

surveys of the high-potential area, as described in Section 4.3.2 of the Downstream Vegetation Monitoring Plan. Incidental collecting of bryophytes, particularly from within unusual microsites or habitats, was completed to broaden the survey scope beyond vascular plants. These bryophyte collections were reviewed and identified after the field session with the assistance of standard identification literature (primarily Morin et al. 2015).

3. FIELD WORK

3.1. SITE VISIT DETAILS

Field sampling was conducted August 11 to 15, 2019, and July 4 to 10, 2020. The 2019 field sampling included 14 polygons and a total of 86 plots (Figure 3.1-1). The 2020 sampling included 20 polygons and a total of 104 plots (Figure 3.1-2). This resulted in the completion of 190 sampling plots for both years combined. All polygons were accessed through the use of a jet boat.

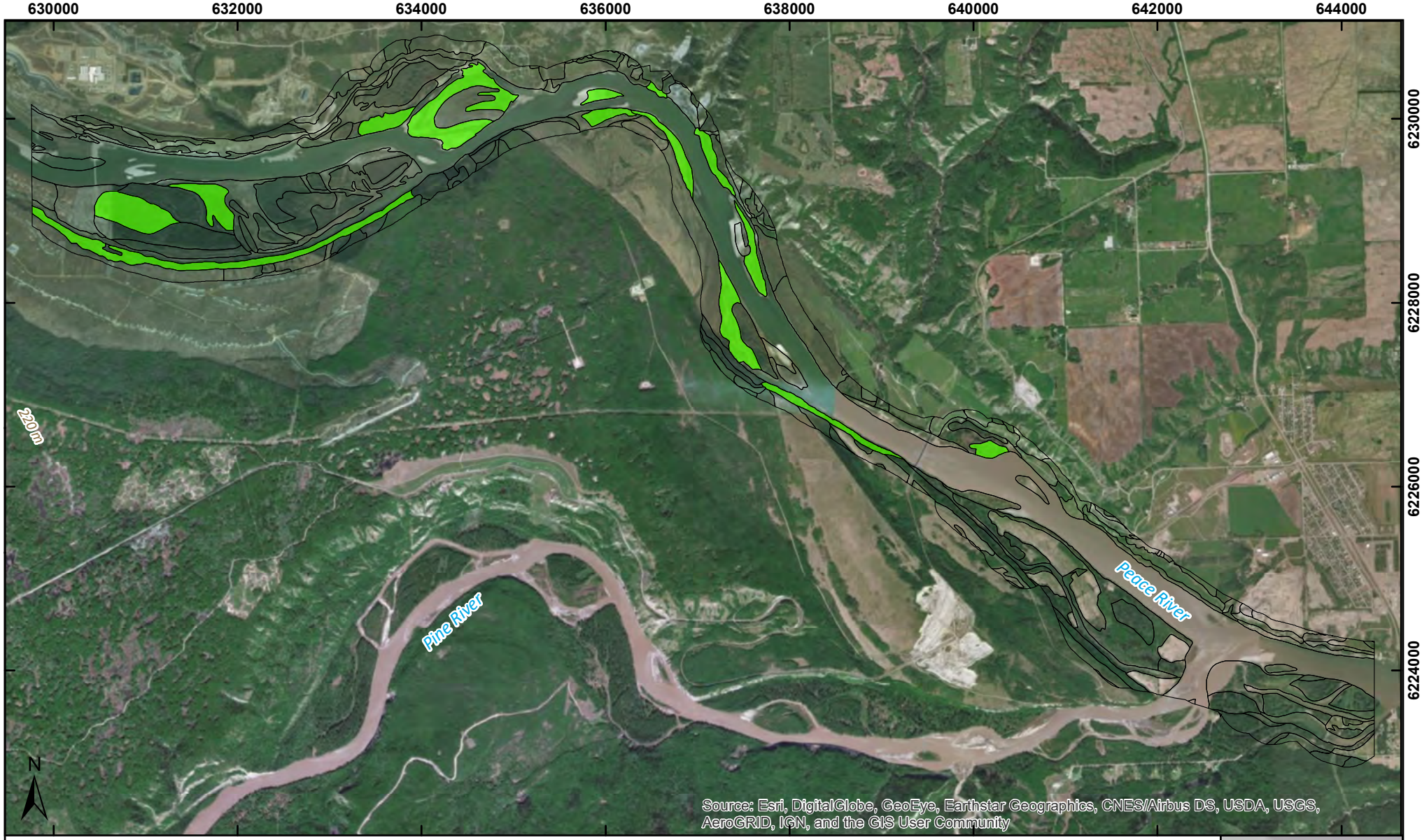
3.2. RESULTS

3.2.1. Ecosystem Classification

Twenty-four of the 34 sampled polygons had been classified as ecosystems at risk (i.e., Red- or Blue-listed by the B.C. CDC) based on TEM mapping prior to the field sampling. Following revision of the ecosystem classifications during the field sampling, the classifications within 11 of these polygons were revised and their conservation status downgraded or partially downgraded to reflect that all or part of the ecosystems actually present in each polygon are not considered at risk in the province (i.e., Yellow-listed by the B.C. CDC; Table 3.2-1). Four polygons that were not classified as ecosystems at risk based on TEM mapping prior to the field sampling were upgraded or partially upgraded to reflect that all or part of the ecosystems actually present are classified as at-risk in BC (Table 3.2-1). See Appendix B for a more detailed summary of the site, soil, and vegetation data that were collected for each polygon.

3.2.2. Rare Plants

Only a single plant species at risk was encountered during either the 2019 or 2020 field surveys. In 2019, a robust population of the provincially Blue-listed (S3?) Davis's locoweed (*Oxytropis campestris* var. *davisii*) was documented at all six sampling plots within Polygon 3059. This population was already known to the B.C. CDC, however, and did not constitute a new occurrence. In 2020, additional populations of this species were documented within Polygon 3034 (detected in three of six plots) and Polygon 3409 (detected in three of six plots); both of these populations were also known to the B.C. CDC. A third population was detected in 2020 that appears to represent a previously undocumented occurrence detected in Polygon 42 *en route* to the sampling transects of Polygon 3254, but was not detected within any of the sampling plots of that polygon (Figure 3.2-1; Photos 1 and 2).



Site C Downstream Monitoring

Polygons sampled in 2019

Figure 3.1-1

0 1 2 3

1:57,500 km

Date: 11/19/2019

Map Number: BCHD-003

Coordinate System: NAD 1983 UTM Zone 10N

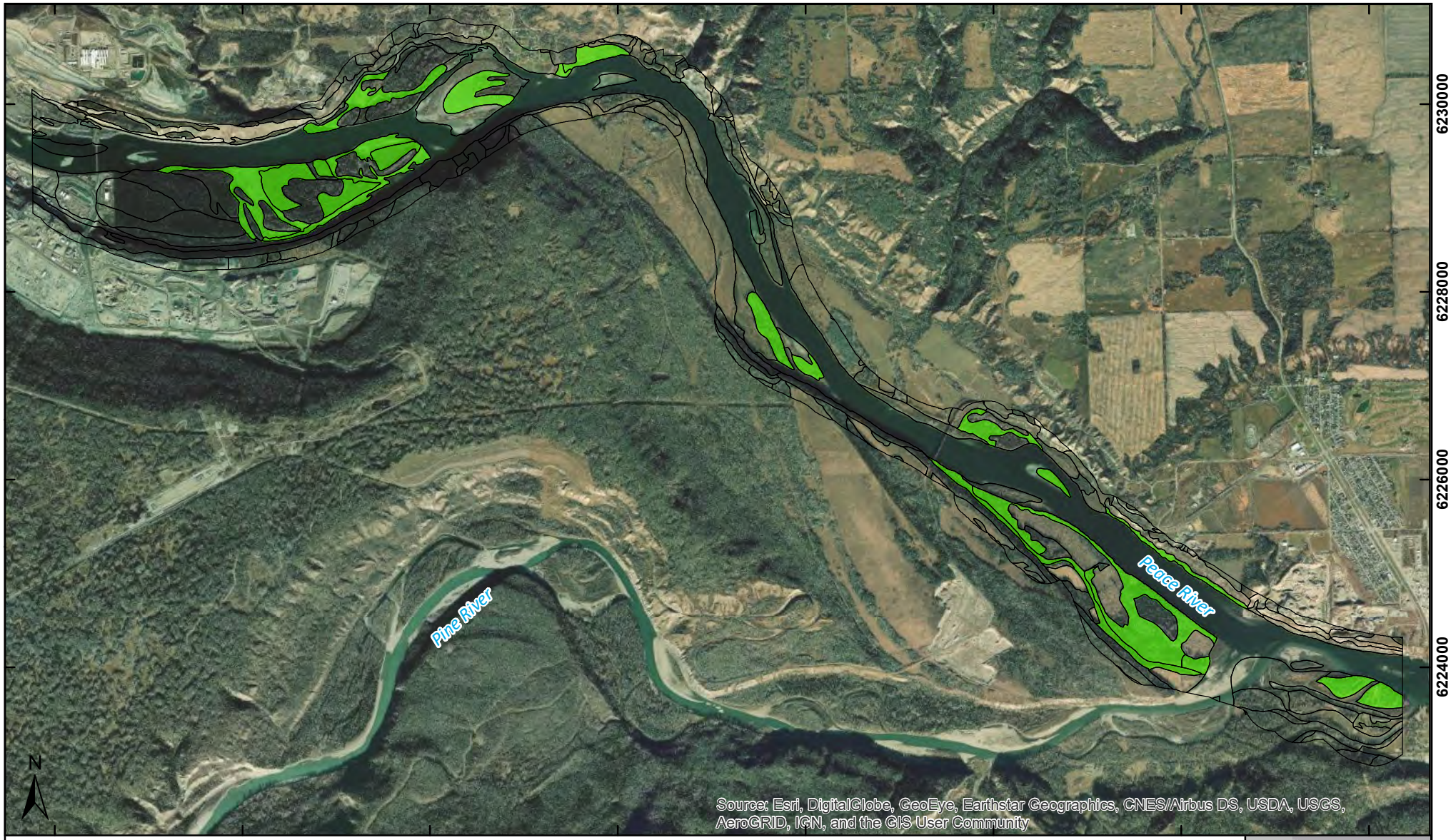
Projection: Transverse Mercator

Datum: North American 1983

Legend

- Sampled polygons (2019)
- Terrestrial Ecosystem Mapping (TEM)

ECOLOGIC



Site C Downstream Monitoring

Polygons sampled in 2020

Figure 3.1-2

Date: 8/12/2020

Map Number: BCHD-005

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC

0 1 2 3

1:57,500 km

Legend

- Sampled polygons (2020)
- Terrestrial Ecosystem Mapping (TEM)

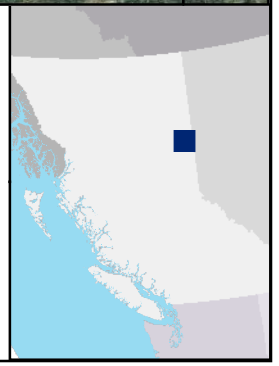
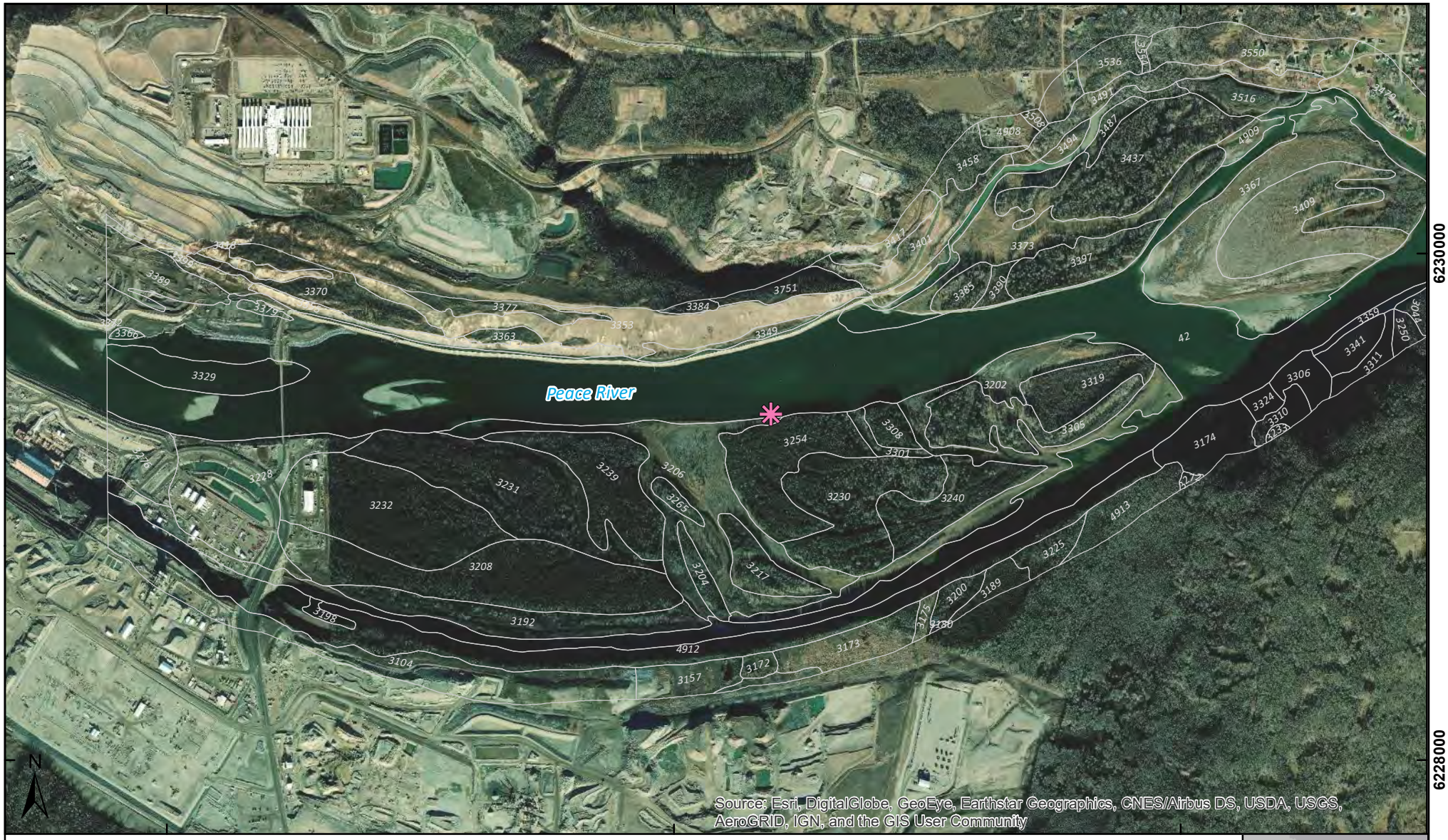


Table 3.2-1. Sampling summary and ecosystem classification for polygons visited during the August 2019 and July 2020 field survey. Note that some polygons contained more than one ecosystem type.

Year	POLY_NBR	# of Plots	Map Code	BC List	Actual Ecosystem	BC List	Change in Conservation Status due to Ecosystem Re-classification
2019	2950	6	SW	Yellow	SH/AM/SW	Blue/Yellow/Yellow	Partially Upgraded
	2951	6	Fm02	Blue	SHac	Blue	No change
	3059	6	Fl03/Fl06	Red	Fm	n/a	Downgraded
	3148	6	Fm02	Blue	Fm	n/a	Downgraded
	3232	9	SH	Blue	AM	Yellow	Downgraded
	3239	6	SH	Blue	SHac	Blue	No change
	3284	6	Fl03/Fl06	Red	Fl	n/a	Downgraded
	3291	6	SHac	Blue	SHac/AMap	Blue/Yellow	Partially downgraded
	3367	6	GB	n/a	GB	n/a	No change
	3397	6	AMap	Yellow	SHac	Blue	Upgraded
	3413	6	AMap	Yellow	AM/AMap	Yellow/Yellow	No change
	3448	6	GB	n/a	GB	n/a	No change
	3459	5	Fl03/Fl06	Red	Fl03/Fl06	Red/Red	No change
	4912	6	SW	Yellow	AM/SH/Fm02	Yellow/Blue/Blue	Partially upgraded
2020	2447	6	Fm02	Blue	SHac	Blue	No change
	2479	5	Fm02	Blue	Fm02	Blue	No change
	2562	4	Fl03/Fl06	Red	SHac	Blue	Downgraded
	2565	3	Fm02	Blue	SH	Blue	No change
	2582	6	Fm02	Blue	SHac	Blue	No change
	2703	3	Wf02	Blue	Fm02	Blue	No change
	2877	3	Fl03/Fl06	Red	Fl	n/a	Downgraded
	2953	6	Fm02	Blue	Fm02	Blue	No change
	3034	6	Fm02	Blue	Fl	n/a	Downgraded
	3051	6	Fm02	Blue	Fm02	Blue	No change
	3202	6	GB	n/a	GB	n/a	No change
	3206	6	Fm02	Blue	Fm02	Blue	No change
	3240	6	Fm02	Blue	AM (SHac)	Yellow (Blue)	Partially downgraded
	3254	6	Fm02	Blue	AM (SHac)	Yellow (Blue)	Partially downgraded
	3308	6	SH	Blue	SH	Blue	No change

Year	POLY_NBR	# of Plots	Map Code	BC List	Actual Ecosystem	BC List	Change in Conservation Status due to Ecosystem Re-classification
	3319	6	Fm02	Blue	Fm02	Blue	No change
	3373	4	GB	n/a	Fl	n/a	No change
	3409	6	Fm02	Blue	Fl	n/a	Downgraded
	3470	4	GB	n/a	Fl	n/a	No change
	3488	6	CF	n/a	SHac	Blue	Upgraded

Photos 1 and 2. New population of Davis' locoweed documented adjacent to survey transects within Polygon 3254 on July 4, 2020.



Site C Downstream Monitoring

Rare Plant: Davis's Locoweed
(Oxytropis campestris var. davisii)
Figure 3.2-1

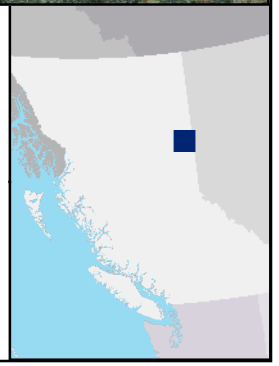
Date: 8/13/2020
Map Number: BCHD-006
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

0 250 500 750
1:21,250 m

Legend

- Rare Plant Observation (*Oxytropis campestris var. davisii*)
- Terrestrial Ecosystem Mapping (TEM)



3.2.3. Invasive Plants

Five species that are tracked as invasive plants by the Invasive Species Council of British Columbia (ISCBC) were documented during the 2020 field surveys (Table 3.2-2). In addition, a very large infestation of the invasive (Provincially Noxious) Dalmatian toadflax (*Linaria genistifolia ssp. dalmatica*) was documented in Polygon 3353 (Figure 3.2-2; Photos 3 and 4); this was not sampled in 2020 and is located along the left bank of the river downstream of the dam site and adjacent to the bridge access road. This population has been observed since at least 2017, and appears to have grown in size substantially since it was first detected. EcoLogic's understanding is that BC Hydro is currently implementing biocontrol treatment measures at this location (Pathfinder Endeavours Ltd. 2020).

Table 3.2-2. Invasive plants documented within polygons sampled in 2020

Species	Scientific Name	Status (ISCBC)	Polygon No.
Canada Thistle	*Cirsium arvense*	Provincially Noxious	3206, 2447, 2562, 3373, 3470, 2877, 3488, 3202
Perennial Sow-thistle	*Sonchus arvensis*	Provincially Noxious	3206, 3373, 3470, 2877, 3488, 3202
Burdocks	*Arctium* sp.	Regionally Noxious (Peace)	2565
Oxeye Daisy	*Leucanthemum vulgare*	Regionally Noxious (Peace)	3206, 3373, 3470
Quackgrass	*Elymus repens*	Regionally Noxious (Peace)	3206, 3254, 3034, 3373, 3051, 3470, 2877, 3409, 3488, 2703, 3308

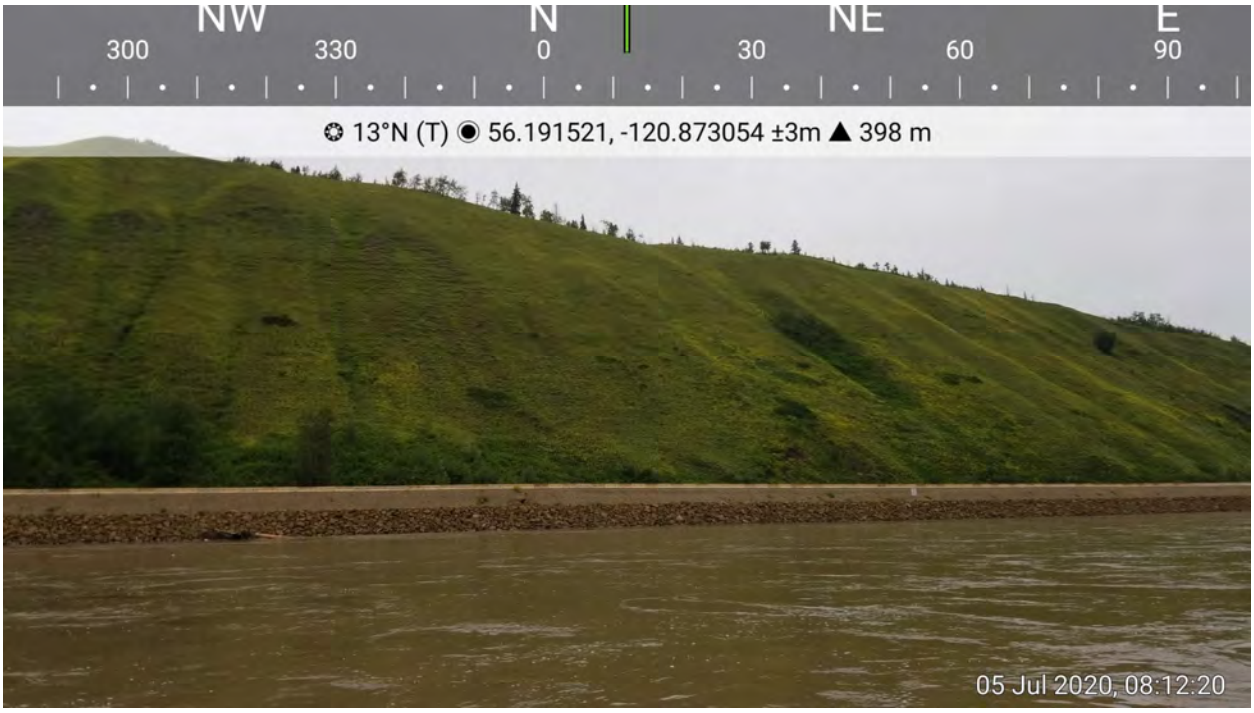


Photo 3. Hillside infested with Dalmatian toadflax.

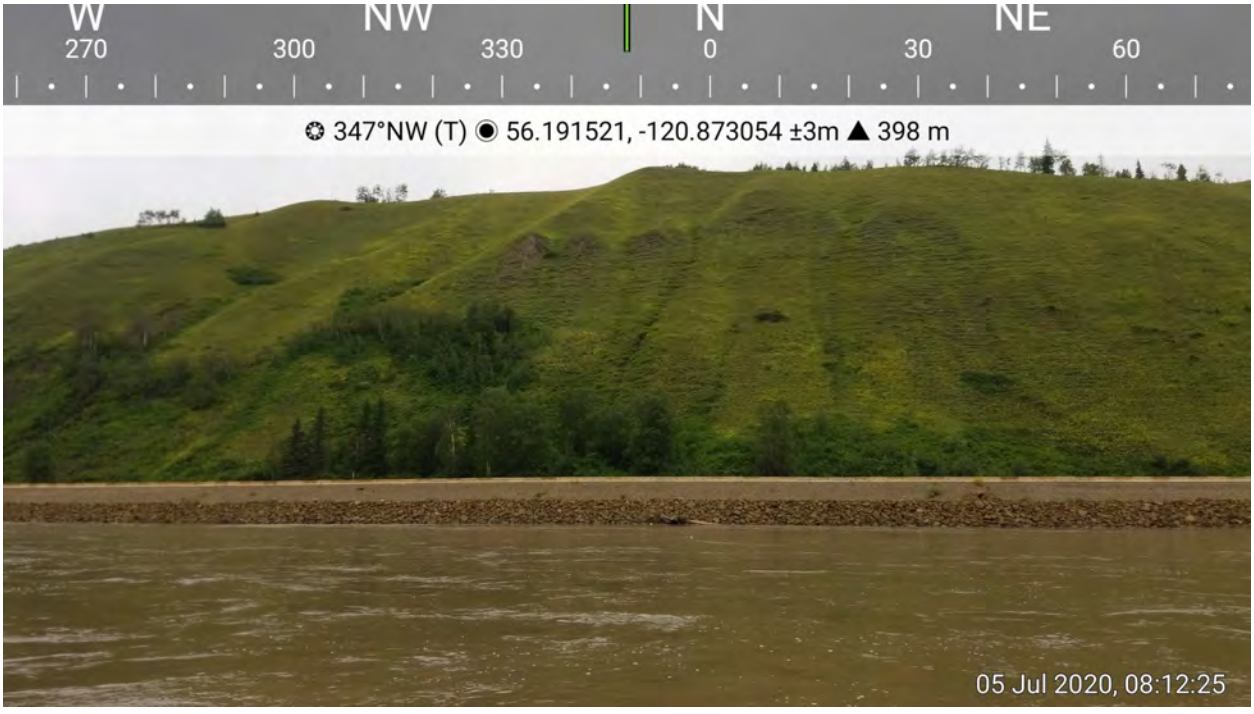
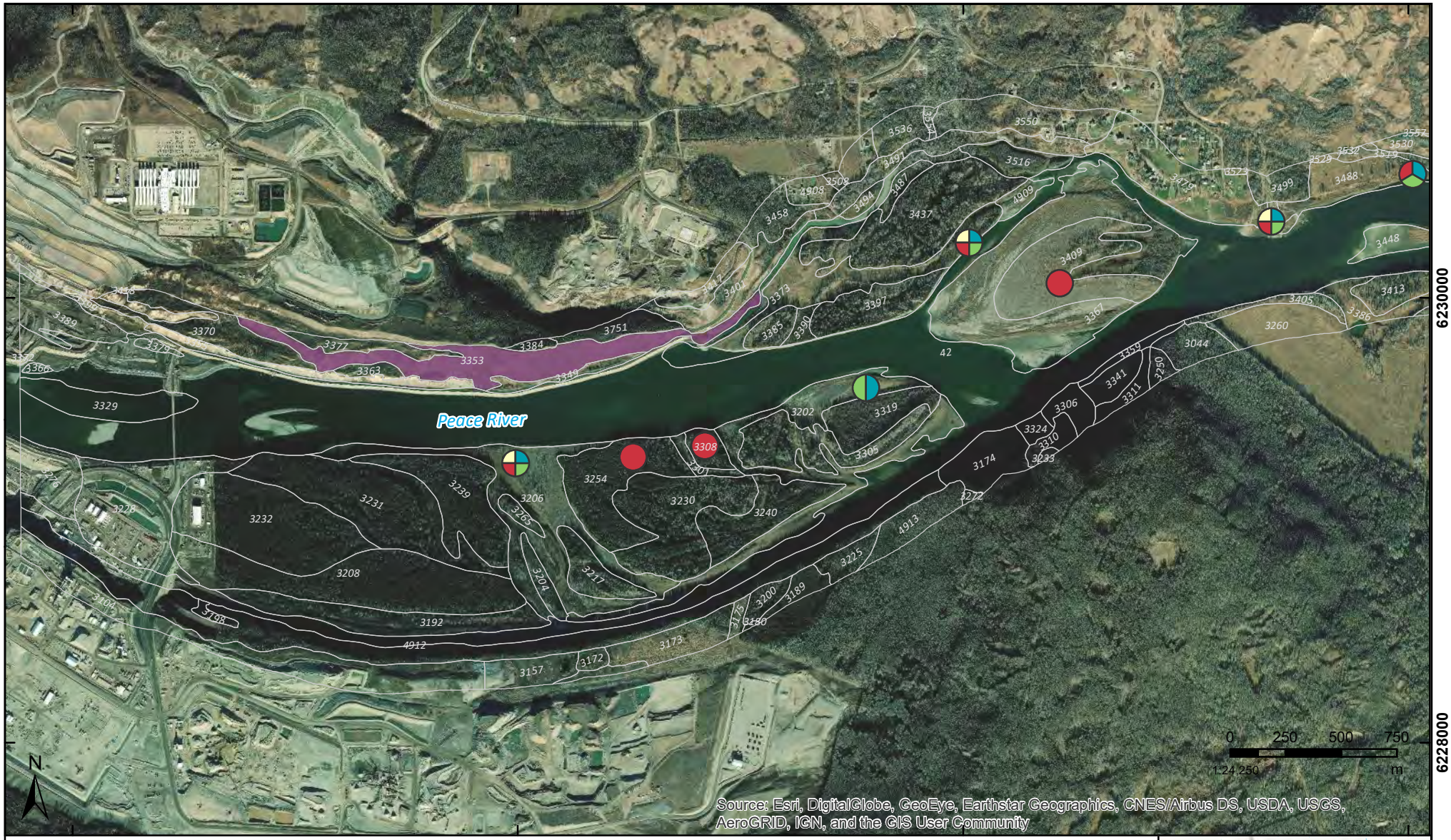


Photo 4. Alternate view of hillside infested with Dalmatian toadflax.



Site C Downstream Monitoring

Invasive Plants - Map 1

Figure 3.2-2

Date: 8/14/2020

Map Number: BCHD-007a

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC

Legend

Terrestrial Ecosystem Mapping (TEM)

Invasive Plant - Polygons

Dalmation toadflax (*Linaria genistifolia ssp. Dalmatica*)

Invasive Plant - Points

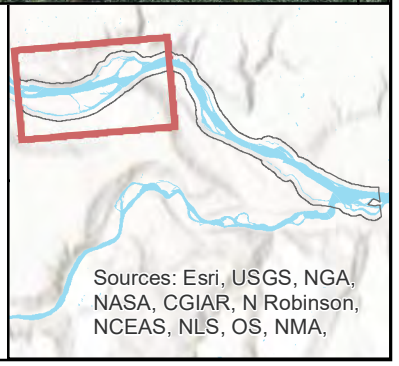
Canada thistle (*Cirsium arvense*)

Perennial sow thistle (*Sonchus arvensis*)

Quackgrass (*Elymus repens*)

Burdocks (*Arctium* sp.)

Oxeye daisy (*Leucanthemum vulgare*)



4. SUMMARY

The primary objectives of the Downstream Vegetation Monitoring, as laid out in Part of D of Section 7.4.7 of the Project's Vegetation and Wildlife Mitigation and Monitoring Plan, are to use long-term monitoring plots to document the following:

- the response of downstream riparian vegetation to changes in the surface water regime during construction and operations of the Site C dam;
- the response of downstream at-risk and sensitive ecosystems (hereafter, sensitive ecosystems) to changes in the surface water regime during construction and operations;
- the response of downstream plant species at risk occurrences to changes in the surface water regime during construction and operations; and
- the establishment of new populations of plant species at risk between the dam and the Pine River confluence.

In order to capture a picture of current conditions downstream of the dam site, a total of 34 polygons were surveyed between the 2019 and 2020 field sessions, with surveys focused on sampling riparian habitats and sensitive and at-risk ecosystems downstream of the Site C dam. This program represents an assessment of the current ecological conditions within these polygons prior to the large-scale effects that will follow the completion of the Site C dam. Sampling sites were spatially distributed throughout the study area, and extended from the dam site downstream to the Pine River confluence. Sensitive and at-risk plant populations and ecosystems that were characterized as part of this program may be subject to adverse impacts from dam completion, such as changes in soil erosion rates, changes in sediment deposition, changes in the abundance of invasive plant species, declines of populations of plant species at risk, and increases or decreases in soil moisture and nutrient regimes that could drive changes in the existing ecosystems. As such, future monitoring of these polygons will be necessary for the tracking of any changes in these ecological conditions that may occur from the resulting changes to the downstream hydrologic and surface water regimes of the Peace River.

5. REFERENCES

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APPENDIX A. Sampling Plans, 2019 and 2020

Table 1. 2019 Downstream Vegetation Monitoring Sampling Plan

ID #	Map Code	Site Series	BC Status	TEM_Site Series Name	Abut River Dec1	TEM_Dec1	Abut River Dec2	TEM_Dec2	Abut River Dec3	TEM_Dec3
1	Atcp	101$6B.1		$At - Rose - Creamy peavine	Yes	43 polygons; 17 abut river	Yes	7 polygons; 6 abut river	No	1 polygon; 0 abut river
2	Fm02	112/Fm02	Blue	AcbSw - Mountain alder - Dogwood	Yes	36 polygons; 36 abut river	Yes	15 polygons; 14 abut river	Yes	1 polygon; 1 abuts river
3	SW	103		SwPl - Soopolallie - Fuzzy-spiked rye	Yes	7 polygons; 2 abut river	No	0 polygons	No	0 polygons
4	SH	111	Blue	Sw-Currant-Horsetail	Yes	8 polygons; 5 abut river; 1 cleared	Yes	2 polygons; 2 abut river	No	0 polygons
5	Atsw	103$6B.1		$At-Rose-Fuzzy-spiked wildrye	Yes	19 polygons; 5 abut river	Yes	2 polygons; 1 abuts river	No	0 polygons
6	GB	GB		Gravel bar	Yes	12 polygons; 12 abut river	Yes	5 polygons; 5 abut river	Yes	1 polygons; 1 abuts river
7	Fl06	Fl03/Fl06	Red	Pacific willow - Red osier dogwood - Horsetail	Yes	9 polygons; 7 abut river	Yes	8 polygons; 7 abut river	Yes	1 polygons; 1 abuts river
8	AM	101		Sw - Trailing Raspberry - Stepmoss	No	8 polygons; 0 abut river	No	0 polygons	No	0 polygons
9	Gb51	Gb51		Saskatoon - Blue wildrye	No	7 polygons; 0 abut river	Yes	7 polygons; 2 abut river	No	0 polygons
10	Gg51	Gg51		Slender wheatgrass - Pasture sage	Yes	1 polygon; 1 abuts river	Yes	9 polygons; 2 abut river but very steep	No	2 polygons; 0 abut river
11	SHac	111$6B.1		$At - Highbush cranberry - Oakfern	Yes	4 polygons; 3 abut river	Yes	5 polygons; 3 abut river	No	0 polygons
12	SO	110	Blue	Sw - Oakfern - Sarsaparilla	No	6 polygons; 0 abut river	No	1 polygon; 0 abut river	No	0 polygons
13	Atsk	102$6B.1		$At - Soopolallie - Kinnickinnick	No	5 polygons; 0 abut river	No	0 polygons	No	0 polygons
14	Wf02	Wf02	Blue	Scrub birch - Water sedge	Yes	7 polygons; 1 abuts river	No	0 polygons	No	0 polygons
15	Wf01	Wf01		Beaked sedge - Water sedge	No	1 polygon; 0 abut river	Yes	2 polygons; 1 abuts river	No	0 polygons

Notes: shaded cells = completed; TBC = Land tenure to be confirmed

Table 1. 2019 Downstream Vegetation Monitoring Sampling Plan

ID #	Polygon_1	Ownership_1	Polygon_2	Ownership_2	Polygon_3	Ownership_3	Polygon_4
1	3192-7AMa:ap3-3AMa:ap5	Crown/5.7	3397-10AMa:ap5	Crown/2.31	3385-10AMa:ap5	Crown/2.31	3413-8AMa:ap5-2SHa:6
2	3254-10Fm02a4	Crown/2.11	3409-10Fm02ab:3	Crown/2.41/2.8/2.7	3148-10Fm02a:3	TBC	2951-10Fm02a5
3	3174-10SWk:6	Crown/2.7	4912-10SWgk:6	Crown/5.8			
4	3231-8SHa:6-2Fm02a:3	Crown/5.4	3308-10SHa:7	Crown/2.11	3230-8SH:6-2SO:3	Crown/5.8	3305-7SHa:5-3Fm02a:3
5	3324-10SWk:as5	Crown/2.7	3359-10SWk:as5	Crown/2.8	2950-8SWq:as5-2CB:1	TBC	2880-7SW:as5-3SW:as4
6	3367-8GB1-2WHac2	Crown/2.41/2.7/2.8	3202-5GB:1-5Fm02ab:3a	Crown/5.5/2.7	3448-10GB:1	TBC	3470-10GB:1
7	3284-9WHa:3a-1RI	Private/014-684-152	3059-8WH:af2-2GB:1	TBC	2877-10WHaf:3a	Unknown	2866-8WHaf:2-2WHaf:3
8	does not abut river						
9	3263-5Amw:4-5AS:3	Private/014-545-951	2587-6AMw:ap4-4AS:3b	Private/410.1			
10	3353-5WWgq:2-3WW:3a-2CBw:1	BCH/2.1					
11	3291-7SH:ac6-3AMw:ap3	Private/464.4	3090-7SH:ac4-3SHt:ac3	TBC	4920-10SHt:ac6	Private/464	3232-7SH:6-3SHac4
12	does not abut river						
13	does not abut river						
14	2703-6WS:3b-4SH:ac6	Partial on Private/410.2					
15	does not abut river						

Notes:

Table 1. 2019 Downstream Vegetation Monitoring Sampling Plan

ID #	Ownership_4	Polygon_5	Ownership_5	Polygon_6	Ownership_6	Polygon_7	Ownership_7	Total Transects to be Sampled
1	TBC	3495:10AMh:ap4	Private/464.3					5
2	Crown	2582-8Fm02a:3-2WHa:3	Crown / Private	2575-10Fm02ab:3b	TBD	3240-6Fm02a:3-4Fm02a:5	Crown/5.8	7
3								2
4	Crown/5.5	3239-10SHa:6	Crown/5.4					5
5	TBC	2682-10SWh:as5	Private/410-410.2					5
6	TBC	3197-10GB:1	TBC					5
7	TBC	2421-5WHac:3b-5Fm02ab:3	TBC	2553-10WHac:3	TBC	3459-8WHaf:3-2RI	TBC	7
8								0
9								2
10								1
11	Crown/5.4/5/7							4
12								0
13								0
14								1
15								0

Notes:

Table 2. 2020 Downstream Vegetation Monitoring Sampling Plan

FID	POLY_NBR	ECO_SEC	BGC_ZONE	BGC_SUBZONE	BGC_VRT	TEM_Label2	2017_S_MC1	2017S1Name	Status_MC1	POLY_NBR	2020 Sampling Comments	Ownership	Sample
6	2562	PEL	BWBS	mw	1	2562-10WHa:3b	Fl03/Fl06	Pacific willow – Red-osier dogwood – Horsetail	Red	2562	20-01; not likely Fl03/Fl06; poss SH	Crown land	OK
10	2866	PEL	BWBS	mw	1	2866-8WHaf:2-2WHaf:3	Fl03/Fl06	Pacific willow – Red-osier dogwood – Horsetail	Red	2866	20-02; possibly fl03/Fl06, underwater in imagery	Unknown	OK
142	2553	PEL	BWBS	mw	1	2553-10WHac:3	Fl03/Fl06	Pacific willow – Red-osier dogwood – Horsetail	Red	2553	20-03; maybe Fl03/Fl06; poss Fm02 or SH/111	Crown land	OK
167	2877	PEL	BWBS	mw	1	2877-10WHaf:3a	Fl03/Fl06	Pacific willow – Red-osier dogwood – Horsetail	Red	2877	20-04, maybe Fl03/Fl06; underwater in imagery	Unknown	OK
48	3409	PEL	BWBS	mw	1	3409-10Fm02ab:3	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	3409	20-09; maybe Fm02	Unknown	OK
79	3319	PEL	BWBS	mw	1	3319-8Fm02a:3-2WHa:2	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	3319	20-10; maybe Fm02 (could be Fl03/Fl06)	Crown land	OK
93	3308	PEL	BWBS	mw	1	3308-10SHa:7	111	Sw - Currant - Horsetail	Blue	3308	20-15; poss 111	Crown land	OK
96	3254	PEL	BWBS	mw	1	3254-10Fm02a:4	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	3254	20-16; poss Fm02 or 111 or AM/101	Crown land	OK
97	3206	PEL	BWBS	mw	1	3206-8Fm02ab:3-2GB:1	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	3206	20-17; poss Fl03/Fl06	Crown land	OK
104	3240	PEL	BWBS	mw	1	3240-6Fm02a:3-4Fm02a:5	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	3240	20-19; poss Fm02	Crown land	OK
132	3051	PEL	BWBS	mw	1	3051-10Fm02a:6	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	3051	20-26; poss Fm02 or SH/111	Unknown	OK
141	3034	PEL	BWBS	mw	1	3034-10Fm02ab:3a	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	3034	20-27; not likely Fm02 poss Fl03/Fl06	Unknown	OK
149	2958	PEL	BWBS	mw	1	2958-10Fm02ab:3	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	2958	20-28; poss Fm02	Unknown	OK
159	2953	PEL	BWBS	mw	1	2953-5Fm02a:3-4Fm02a:6-1OW	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	2953	20-29; poss Fm02	Crown land	OK
172	2582	PEL	BWBS	mw	1	2582-8Fm02a:3-2SHa:6	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	2582	20-31; maybe Fm02 or 111	Crown land	OK
175	2703	PEL	BWBS	mw	1	2703-6WS:3b-4SH:ac6	Wf02	Scrub birch – Water sedge	Blue	2703	20-32; not likely WS, maybe Fl 3a	Crown land	OK
199	2565	PEL	BWBS	mw	1	2565-10Fm02a:6	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	2565	20-34; not likely Fm02, poss SH/111	Crown land	maybe
200	2575	PEL	BWBS	mw	1	2575-10Fm02ab:3b	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	2575	20-35; poss Fm02	Unknown	OK
204	2447	PEL	BWBS	mw	1	2447-5Fm02a:6-5Fm02a:3	112/Fm02	AcbSw - Mountain alder - Dogwood	Blue	2447	20-37; poss Fm02, poss SH/111	Crown land	OK
3	4909	PEL	BWBS	mw	1	4909-10GB:1	GB	Gravel Bar		4909	20-41; poss GB - under water in imagery	Crown land	maybe
30	3516	PEL	BWBS	mw	1	3516-10AMay:ap4	101$6B.1	$At - Rose - Creamy peavine		3516	20-43; not 101$ poss Fl03/Fl06	Unknown	maybe
31	3488	PEL	BWBS	mw	1	3488-8CFt:2-2AMt:ap3				3488	20-44; not likelly AM poss SH/11	Unknown	OK
43	3470	PEL	BWBS	mw	1	3470-10GB:1	GB	Gravel Bar		3470	20-45; poss GB	Unknown	maybe
44	3373	PEL	BWBS	mw	1	3373-8GB:1-2WHac:2	GB	Gravel Bar		3373	20-46; not GB poss Fl03/Fl06	Crown land	OK
115	3197	PEL	BWBS	mw	1	3197-10GB:1	GB	Gravel Bar		3197	20-~~48~~ 50; poss GB	Unknown	OK
74	3202	PEL	BWBS	mw	1	3202-5GB:1-5Fm02ab:3a	GB	Gravel Bar		3202	20-48; GB	Crown land	OK
138	3058	PEL	BWBS	mw	1	3058-5GB:1-5Fm02ab:3a	GB	Gravel Bar		3058	20-49; GB	Unknown	OK

Notes: excluded non priority polygons such as upland sites
excluded private land as much as possible
excluded hard to access such as side channels

Table 2. 2020 Downstream Vegetation Monitoring Sampling Plan

FID	Need landowner permission?	BCH Comments
6	no, but close to private land 265.32 009-622-624; near railroad bridge, will be able to access via boat without trespassing on private land	Crown lands
10	no, suspect Crown land, gap in shapefiles	Crown lands
142	no	Crown lands
167	no, island in river, suspect Crown land	Crown lands
48	no, suspect Crown land, island in river	Crown lands
79	no	From what I can see this site straddles Crown and private lands that belongs to Tod and Kelly Ann Pratt. You can contact directly if required.
93	no	Crown lands
96	no	I am going to call this private as it is very close to private lands. The owner of the adjacent private lands may consider that portion as theirs. You can contact directly if required. Owner is Sheena Pratt.
97	no	From what I can see this site straddles Crown and private lands that belongs to Nels Ostero Ltd. You can contact directly if required.
104	no	From what I can see this site straddles Crown and private lands that belongs to George Bouffioux. You can contact directly if required.
132	no, suspect Crown, no facilities or houses nearby	From what I can see this site straddles Crown and private lands that belongs to George Bouffioux. You can contact directly if required.
141	no, suspect Crown, island in river	Crown lands
149	no, transect along river's edge, private land upslope, no need to go there	Crown lands
159	no	Crown lands
172	no, transect in Crown portion, close to private land but can stay away from it. PID 025547097, Parcel Description: BK A DL 2724 Peace River	Crown lands
175	no	Crown lands
199	no	Crown lands
200	no, low bench floodplain site, suspect Crown land	Crown lands
204	no	Crown lands
3	no	Crown lands
30	no, island in river suspect Crown Land	Crown lands
31	no, suspect Crown land, - private property upslope, no need to go there - 464.3 PID 003-636-640	Crown lands
43	no, suspect Crown land, alluvial fan into river	Crown lands
44	no	From what I can see this site straddles Crown and private lands that belongss to the City of Fort St. John. You can contact directly if required.
115	no, suspect Crown land, island in river	I am going to call this private as it is very close to private lands. The owner of the adjacent private lands may consider that portion as theirs. You can contact directly if required. Owner is George Bouffioux.
74	no	I am going to call this private as it is very close to private lands. The owner of the adjacent private lands may consider that portion as theirs. You can contact directly if required. Owners are Julie and Kelly Ziebart.
138	no, suspect Crown land	Crown lands

APPENDIX B. Data Summary by Polygon, 2019 and 2020

Appendix B. Data Summary by Polygon - 2019

Polygon:	2950	TEM Code: SH / AM / SW	
TEM Name:	Sw – Currant - Horsetail / Sw - Trailing Raspberry - Stepmoss / Sw-Pl - Soopolallie - Fuzzy-spiked rye		
Plot #s	46–51		
	Ecosystem 1	**Ecosystem 2**	**Ecosystem 3**
	Sw-Currant-Horsetail (SH)	**Sw - Trailing Raspberry – Stepmoss (AM)**	**SwPl - Soopolallie - Fuzzy-spiked rye (SW)**
Slope (%)	8	10–35	65–77
Aspect (deg)	30	40,320	40
SMR	Subhygric (5)	Mesic (4)	Submesic (3)
SNR	Very Rich (E)	Rich (D)	Medium (C)
Mesoslope	Gully	Gully, Lower	Middle
Structural Stage*	6	6	6
Humus Form	Moder	Moder	Mor (Moder)
Ah present	Yes	Yes	No
Soil Texture	Silt–Loam	Silt–Loam	Sandy Loam – Loamy Sand
Coarse Fragments (%)	40	45	51-55
Drainage	Imperfect	Moderate	Well - Rapid
Seepage	No	No	No
Mottling	Yes	No	No
Gleying	Yes	No	No
Dominant Vegetation			
Trees	*Picea glauca* *Betula papyrifera*	*Picea glauca* *Betula papyrifera* *Populus balsamifera*	*Picea glauca* *Betula papyrifera*
Shrubs	*Cornus sericea* *Viburnum edule* *Alnus incana*	*Rosa acicularis* *Cornus sericea* *Viburnum edule* *Rubus idaeus*	*Viburnum edule* *Rosa acicularis* *Populus tremuloides* *Cornus sericea*
Herbs	*Cornus canadensis* *Gymnocarpium dryopteris* *Rubus pubescens* *Equisetum arvense*	*Cornus canadensis* *Rubus pubescens* *Circaea alpina* *Mitella nuda* *Linnaea borealis* *Galium triflorum*	*Rubus pubescens* *Linnaea borealis* *Aralia nudicaulis*

Note: Sw – White Spruce; Pl – Lodgepole Pine

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Poly 2950 - Plot 46: Sw-Currant-Horsetail (SH)

Poly 2950 - Plot 47: Sw - Trailing Raspberry – Stepmoss (AM)

Poly 2950 - Plot 51: SwPl - Soopolallie - Fuzzy-spiked rye (SW)

Appendix B. Data Summary by Polygon - 2019

Polygon:	2951	TEM Code:	SHac
TEM Name:	$At - Highbush Cranberry - Oakfern		
Plot #s	81–86		
	Ecosystem		
	$At - Highbush cranberry – Oakfern		
Slope	0–5		
Aspect	999, 166, 205		
SMR	Subhygric (5)		
SNR	Rich (D)		
Mesoslope	Level (lower)		
Structural Stage*	3b/5		
Humus Form	Mull		
Ah	No		
Soil Texture	Fine Sandy Loam – Silt Loam		
Coarse Fragments	0		
Drainage	Well		
Seepage	No		
Mottling	No		
Gleying	No		
Dominant Vegetation			
Trees	*Betula papyrifera*		
	Populus balsamifera		
Shrubs	*Cornus sericea*		
	Salix scouleriana		
	Salix bebbiana		
	Rubus idaeus		
	Rosa acicularis		
	Elaeagnus commutata		
Herbs	*Astragalus cicer*		
	Aralia nudicaulis		
	Calamagrostis canadensis		
	Bromus inermis		

Poly 2951 -Plot 86: $At - Highbush Cranberry - Oakfern

Note: $= seral; At = Trembling Aspen

**Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon: 3059		TEM Code: Fm
TEM Name:	**Mid bench floodplain**	
Plot #	**16–21**	
	Ecosystem	
	Mid bench floodplain (Fm)	
Slope	0–2	
Aspect	999, 300	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Level–Lower	
Structural Stage*	3b	
Ah	No	
Humus Form	None	
Soil Texture	Fine Sandy Loam	
Coarse Fragments	90-95	
Drainage	R	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	-	
Shrubs	*Populus balsamifera*	
Herbs	*Oxytropis campestris* var. *davisii* *Medicago lupulina* *Poa pratensis* *Bromus inermis* *Medicago sativa*	

Poly 3059 -Plot 18: Mid bench floodplain (Fm)

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon: 3148	TEM Code: Fm
TEM Name:	**Mid bench floodplain**
Plot #s	**34–39**
	Ecosystem
	Mid bench floodplain (Fm)
Slope	0
Aspect	999
SMR	Subhygric (5)
SNR	Very poor (A)–Poor (B)
Mesoslope	Level
Structural Stage*	3b
Humus Form	None
Ah	None
Soil Texture	Sand–Silty Loam
Coarse Fragments	0–90
Drainage	Well–Rapid
Seepage	No
Mottling	No
Gleying	No

Dominant Vegetation

Trees	-
Shrubs	*Populus balsamifera*
Herbs	*Astragalus cicer* *Bromus inermis* *Poa pratensis*

Poly 3148 – Plot 39: Mid bench floodplain (Fm)

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon: 3232		TEM Code: AM
TEM Name:	**Sw - Trailing Raspberry - Stepmoss**	
Plot #s	**1–9**	
	Ecosystem	
	Sw - Trailing Raspberry – Stepmoss (AM)	
Slope	0–3	
Aspect	999, 200–300	
SMR	Mesic (4) (Subhygric (5))	
SNR	Medium (C) (Medium (D))	
Mesoslope	Level, Lower, Toe, Middle	
Structural Stage*	5 - 6	
Humus Form	Moder	
Ah	No	
Soil Texture	Fine Sandy Loam–Silt Loam	
Coarse Fragments	0	
Drainage	Moderate	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Picea glauca*	
	Populus balsamifera	
Shrubs	*Rosa acicularis*	
	Picea glauca	
	Alnus incana	
	Cornus sericea	
	Viburnum edule	
	Rubus idaeus	
Herbs	*Linnaea borealis*	
	Aralia nudicaulis	

Poly 3232 – Plot4: Sw – Trailing Raspberry – Stepmoss (AM)

Note: Sw = White Spruce

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon: 3239		TEM Code: SHac
TEM Name:	**$At - Highbush cranberry - Oakfern**	
Plots #s	**28–33**	
	Ecosystem	
	$At - Highbush cranberry – Oakfern (SHac)	
Slope	0–6	
Aspect	999, 165, 190	
SMR	Subhygric (5)	
SNR	Medium (C) (Poor (B))	
Mesoslope	Level	
Structural Stage*	6 (4)	
Humus Form	Moder	
Ah	No	
Soil Texture	Fine Sandy Loam–Silt Loam–(Sand)	
Coarse Fragments	0	
Drainage	Moderate	
Seepage	No (yes @15 cm in plot 32)	
Mottling	No (yes in plot 32)	
Gleying	No	
Dominant Vegetation		
Trees	*Picea glauca* *Populus balsamifera*	 *Poly 3239–Plot 32: $At - Highbush cranberry – Oakfern (SHac)*
Shrubs	*Alnus incana* *Rubus idaeus* *Rosa acicularis* *Cornus sericea* *Symphoricarpos albus*	
Herbs	*Maianthemum canadense* *Aralia nudicaulis* *Maianthemum stellatum*	

Note: At = Trembling Aspen

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon: 3284	TEM Code: Fl
TEM Name:	**Low Bench Floodplain**
Plot #s	**22–27**
	Ecosystem
	Low Bench Floodplain (Fl)
Slope	0
Aspect	999
SMR	Subhygric (5)
SNR	Medium (C), (Poor (B))
Mesoslope	Level
Structural Stage*	3b
Humus Form	None
Ah	None
Soil Texture	Silt–Fine Sandy Loam
Coarse Fragments	0
Drainage	(Well)–Medium–(Imperfect)
Seepage	No
Mottling	No (yes @15cm for plot 27)
Gleying	No

Dominant Vegetation (in decreasing order)

Trees	-
Shrubs	*Salix interior* *Populus balsamifera* *Salix prolixa*
Herbs	*Trifolium hybridum* *Bromus inermis* *Astragalus cicer* *Melilotus albus* *Medicago sativa*

Poly 3284 – Plot 24: Low Bench Floodplain (Fl)

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon:	3291	TEM Code: SHac / AMap
TEM Name:	$At - Highbush cranberry - Oakfern / $At - Rose - Creamy peavine	
Plot #s	58–63	
	Ecosystem 1	**Ecosystem 2**
	$At - Highbush cranberry - Oakfern	$At - Rose - Creamy peavine
Slope	12–40	0–20
Aspect	225–268	999, 258
SMR	Subhygric (5)	Submesic (3)
SNR	Very Rich (E)	Rich (D)
Mesoslope	Toe	Crest
Structural Stage*	3b	4
Humus Form	Mull	
Ah	None	None
Soil Texture	Silty Clay	Silty Clay
Coarse Fragments	0–2	0
Drainage	Poor	Moderate
Seepage	No	No
Mottling	Yes	No
Gleying	No	No
Dominant Vegetation		
Trees	*Betula papyrifera* *Picea glauca*	*Populus tremuloides*
Shrubs	*Salix bebbiana* *Salix scouleriana* *Elaeagnus commutata* *Cornus sericea* *Rosa woodsii* *Prunus virginiana*	*Populus tremuloides* *Shepherdia canadensis* *Cornus sericea* *Amelanchier alnifolia* *Salix scouleriana* *Rosa acicularis* *Betula papyrifera* *Salix lasiandra* *Picea glauca*
Herbs	*Astragalus cicer* *Trifolium hybridum*	*Astragalus cicer* *Eurybia conspicua*

Note: At – Trembling Aspen

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Poly 3291 – Plot59: $At - Highbush cranberry - Oakfern / $At - Rose - Creamy peavine

Poly 3291 – Plot 62: $At - Rose - Creamy peavine

Appendix B. Data Summary by Polygon - 2019

Polygon: 3367	TEM Code: GB
TEM Name:	**Gravel Bar**
Plot #s	**10–15**
	Ecosystem
	Gravel Bar (GB)
Slope	0
Aspect	999
SMR	Hygric (6)
SNR	Poor (B)
Mesoslope	Level
Structural Stage*	3a (1a)
Humus Form	None
Ah	None
Soil Texture	Sand
Coarse Fragments	85–100
Drainage	Rapid (Moderate)
Seepage	No
Mottling	No
Gleying	No

Dominant Vegetation

Trees	-
Shrubs	*Populus balsamifera* *Salix prolixa*
Herbs	*Deschampsia cespitosa* *Allium schoenoprasum* *Agrostis gigantea*

Poly 3367 – Plot 11: Gravel Bar (GB)

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon: 3397	TEM Code: SHac
TEM Name:	**$At - Highbush cranberry - Oakfern**
Plot #s	**52–57**
	Ecosystem
	$At - Highbush cranberry–Oakfern (SHac)
Slope	0–12
Aspect	999, 345–20
SMR	Subhygric (5)
SNR	Mesic (C)
Mesoslope	Depression (Level, Lower)
Structural Stage*	6 (3b)
Humus Form	Mull
Ah	No
Soil Texture	Silt
Coarse Fragments	0
Drainage	Moderate
Seepage	No
Mottling	No
Gleying	No

Dominant Vegetation

Trees	*Populus balsamifera*
Shrubs	*Rosa acicularis* *Alnus incana* *Prunus virginiana* *Rubus idaeus* *Prunus virginiana* *Cornus sericea* *Symphoricarpos occidentalis* *Picea glauca*
Herbs	*Aralia nudicaulis*

Poly 3397 – Plot 52: $At - Highbush cranberry – Oakfern (SHac)

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon: 3413		TEM Code: AM / AMap
TEM Name:	**Sw - Trailing Raspberry - Stepmoss / $At - Rose - Creamy peavine**	
Plot #s	**75–80**	
	Ecosystem 1	**Ecosystem 2**
	Sw - Trailing Raspberry – Stepmoss (AM)	$At - Rose – Creamy peavine (AMap)
Slope	0	0
Aspect	999	999
SMR	Mesic (4)	Mesic (4)
SNR	Medium (C)	Medium (C)
Mesoslope	Level	Level
Structural Stage*	6	2a
Humus Form	Moder - Mull	Mull
Ah	No	No
Soil Texture	Sand–Silt Loam	Silt Loam
Coarse Fragments	0	0
Drainage	Well–Moderate	Moderate
Seepage	No	No
Mottling	No	No
Gleying	No	No
Dominant Vegetation		
Trees	*Picea glauca* *Populus balsamifera*	*Populus balsamifera*
Shrubs	*Symphoricarpos occidentalis* *Rubus idaeus*	*Cornus sericea* *Symphoricarpos occidentalis* *Rubus idaeus*
Herbs	*Aralia nudicaulis* *Bromus inermis*	*Bromus inermis* *Urtica dioica*

Note: Sw = White Spruce; At = Trembling Aspen; $ = Seral

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Poly 3413 -Plot 77: $At - Highbush cranberry – Oakfern (SHac)

Poly 3413 – Plot 80: $At - Rose - Creamy peavine (AMap)

Appendix B. Data Summary by Polygon - 2019

Polygon:	3448	TEM Code: GB
TEM Name:	Gravel Bar	
Plot #s	64–69	
	Ecosystem	
	Gravel Bar (GB)	
Slope	0	
Aspect	999	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Level	
Structural Stage*	2b (2a)	
Humus Form	Mull	
Ah	No	
Soil Texture	Loamy Sand–Fine Sandy Loam	
Coarse Fragments	0–10	
Drainage	Rapid	
Seepage	No	
Mottling	No	
Gleying	No	

Dominant Vegetation

Trees	-
Shrubs	*Salix prolixa*
	Alnus incana
	Elaeagnus commutata
Herbs	*Solidago altissima*
	Melilotus albus
	Symphyotrichum lanceolatum
	Arnica chamissonis
	Bromus inermis
	Trifolium hybridum
	Calamagrostis canadensis
	Agrostis gigantea
	Phalaris arundinacea
	Sonchus arvensis

Poly 3448 – Plot 68: Gravel Bar (GB)

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Appendix B. Data Summary by Polygon - 2019

Polygon:	3459	TEM Code: Fl03 / Fl06
TEM Name:	Pacific willow – Red-osier dogwood - Horsetail / Sandbar Willow	
Plot #s	70–74	
	Ecosystem 1	**Ecosystem 2**
	Pacific willow – Red-osier dogwood – Horsetail (Fl03)	Sandbar Willow (Fl06)
Slope	0	
Aspect	999	
SMR	Hygric (6)	Hygric (6)
SNR	Rich (D)	Rich (D)
Mesoslope	Level	Level
Structural Stage*	3b	3b (3a)
Humus Form	Mull	Mull
Ah	No	No
Soil Texture	Sand	Sand–Loamy Sand
Coarse Fragments	0	0
Drainage	Rapid	Rapid
Seepage	No	No
Mottling	No	No
Gleying	No	No
Dominant Vegetation		
Trees	-	-
Shrubs	*Populus balsamifera* *Populus balsamifera* *Salix interior* *Alnus incana* *Salix lasiandra* *Salix prolixa*	*Salix interior* *Salix interior* *Populus balsamifera* *Salix prolixa* *Salix lasiandra*
Herbs	*Sonchus arvensis* *Bromus inermis* *Sympohyotrichum lanceolatum* *Poa palustris* *Equisetum arvense*	*Equisetum arvense* *Symphyotrichum lanceolatum* *Phalaris arundinacea* *Medicago lupulina* *Trifolium hybridum* *Astragalus cicer* *Bromus inermis* *Agrostis gigantea*

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Poly 3459 -Plot 70: Pacific willow – Red-osier dogwood – Horsetail (Fl03)

Poly 3459 -Plot 74: Sandbar Willow (Fl06)

Appendix B. Data Summary by Polygon - 2019

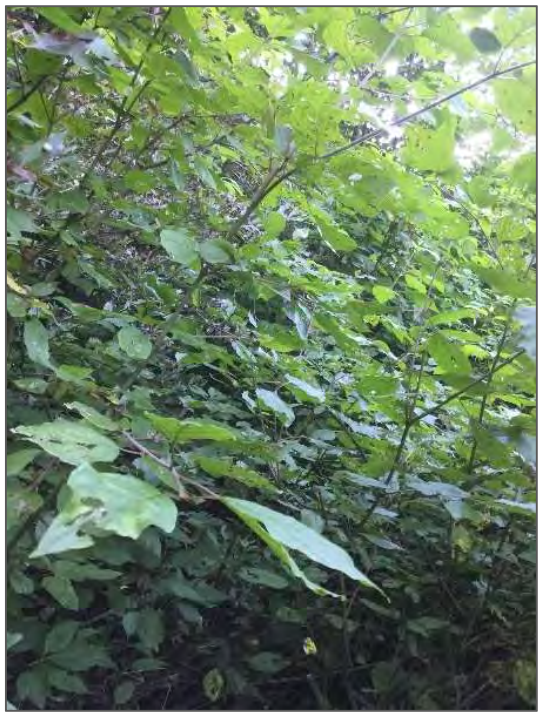
Polygon:	4912	TEM Code: AM / SH / Fm02	
TEM Name:	Sw – Trailing Raspberry – Stepmoss / Sw – Currant – Horsetail / Acb – Sw – Mountain alder – Dogwood		
Plot #s	40–45		
	Ecosystem 1	**Ecosystem 2**	**Ecosystem 3**
	Sw – Trailing Raspberry – Stepmoss (AM)	Sw-Currant-Horsetail (SH)	AcbSw – Mountain alder – Dogwood (Fm02)
Slope	65–72	5–25	14
Aspect	335–344	310–331	330
SMR	Mesic (4)	Subhygric (5)	Hygric (6)
SNR	Medium (C)	Rich (D)	Very Rich (E)
Mesoslope	Middle (Level)	Lower–Toe	Toe
Structural Stage*	5	4, 3b	3b
Humus Form	Mull	Mull	None
Ah	No	No	Yes (24 cm)
Soil Texture	Silt Loam	Silt – Loam	Silt Loam
Coarse Fragments	16–46	0–30	0
Drainage	Well	Imperfect – Moderate	Imperfect
Seepage	No	No	Yes (46 cm)
Mottling	No	Yes (6 cm)	No
Gleying	No	No	Yes (28cm)
Dominant Vegetation			
Trees	*Betula papyrifera* *Picea glauca* *Populus balsamifera*	*Betula papyrifera* *Picea glauca*	*Betula papyrifera*
Shrubs	*Picea glauca* *Cornus sericea* *Shepherdia canadensis* *Viburnum edule* *Alnus viridis*	*Alnus incana* *Picea glauca* *Cornus sericea* *Viburnum edule*	*Cornus sericea* *Ribes triste* *Salix scouleriana* *Alnus incana* *Picea glauca*
Herbs	*Pyrola asarifolia* *Orthilia secunda*	*Equisetum arvense* *Circaea alpina* *Rubus pubescens* *Mitella nuda* *Galium triflorum*	*Equisetum arvense* *Galium triflorum* *Circaea alpina*

Note: Sw = White Spruce; Acb = Balsam Poplar

** Structural Stage: 3 = shrub/herb; 3a = low shrub; 3b = tall shrub; 4 = pole/sapling; 5 = young forest; 6 = mature; 7 – old-growth forest*

Poly 4912 – Plot 43: Sw – Trailing Raspberry – Stepmoss (AM)

Poly 4912 – Plot 4: Sw-Currant-Horsetail (SH)



Poly 4912 – Plot 40: AcbSw – Mountain alder – Dogwood (Fm02)

Appendix B. Data Summary by Polygon - 2020

Table 1

Polygon:	3206	TEM Code:	Fm02
TEM Name:	Acb – Sw – Mountain alder – Dogwood		
Plot #s	20-17-1 - 20-17-6		
	Ecosystem		
	AcbSw – Mountain alder – Dogwood (Fm02)		
Slope	0		
Aspect	999		
SMR	Subhygric (5)		
SNR	Rich (D)		
Mesoslope	Level		
Structural Stage*	3b		
Humus Form	None, Mull, Mullmoder		
Ah	No		
Soil Texture	Silty Loam, Sand		
Coarse Fragments	0–85		
Drainage	Moderate–Well		
Seepage	No		
Mottling	No		
Gleying	No		
Dominant Vegetation			
Trees	*Populus balsamifera* *Picea glauca*		
Shrubs	*Salix interior* *Alnus incana* *Amelanchier alnifolia* *Symphoricarpos occidentalis* *Salix prolixa*		
Herbs	*Melilotus alba* *Medicago lupulina* *Bromus inermis* *Taraxacum officinale* *Poa pratensis* *Trifolium hybridum* *Calamagrostis canadensis*	*Poly 3206 -Plot 20-17-3: AcbSw – Mountain alder – Dogwood (Fm02)*	

*Note: Acb = Balsam Poplar, Sw = White Spruce; * Structural Stage: 3b = tall shrub*

Appendix B. Data Summary by Polygon - 2020

Table 2

Polygon: 3254		TEM Code: AM / SHac
TEM Name:	**Sw - Trailing Raspberry - Stepmoss / $At - Highbush cranberry - Oakfern**	
Plot #s	**20-16-1 – 20-16-6**	
	Ecosystem 1	**Ecosystem 2**
	Sw - Trailing Raspberry – Stepmoss (AM)	$At - Highbush cranberry – Oakfern (SHac)
Slope	0-3	2-3
Aspect	90, 270, 999	180, 232,240
SMR	Mesic (4)	Mesic (4)
SNR	Poor (B), Medium (C)	Medium (C)
Mesoslope	Level	Level
Structural Stage*	4	4, 5
Humus Form	Mormoder	MorModer
Ah	No	No
Soil Texture	Silty Loam – Sand	Silty Loam - Sand
Coarse Fragments	0	0
Drainage	Moderate - Well	Moderate
Seepage	No	No
Mottling	No	No
Gleying	No	No
Dominant Vegetation		
Trees	*Picea glauca*	*Picea glauca* *Populus balsamifera* *Betula papyrifera*
Shrubs	*Cornus sericea* *Alnus incana* *Elaeagnus commutata* *Rosa acicularis* *Amelanchier alnifolia* *Viburnum edule*	*Cornus sericea* *Rosa acicularis* *Alnus incana* *Ribes triste* *Ribes oxyacanthoides* *Viburnum edule*
Herbs	*Pyrola asarifolia* *Vicia americana* *Petasites frigidus var. palmatus* *Equisetum hyemale* *Maianthemum stellatum*	*Apocynum androsaemifolium* *Symphyotrichum ciliolatum* *Pyrola asarifolia* *Pyrola chlorantha* *Orthilia secunda* *Prosartes trachycarpa*

Note: Sw = White Spruce; $ = Seral, At = Trembling Aspen;

** Structural Stage: 4 = pole/sapling; 5 = young forest*

Appendix B. Data Summary by Polygon - 2020

Poly 3254 – Plot 20-16-1: Sw - Trailing Raspberry – Stepmoss (AM)

Poly 3254 – Plot 20-16-3: $At - Highbush cranberry – Oakfern (SHac)

Appendix B. Data Summary by Polygon - 2020

Table 3

Polygon: 2582		TEM Code: SHac
TEM Name:	**$At - Highbush cranberry - Oakfern**	
Plot #s	**20-31-1 – 20-31-6**	
Ecosystem		
	$At - Highbush cranberry – Oakfern (SHac)	
Slope	0-8	
Aspect	999, 79, 166, 182, 260	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Level	
Structural Stage*	5	
Humus Form	Moder, Mullmoder	
Ah	No	
Soil Texture	Silty Loam/Sand - Silt	
Coarse Fragments	0	
Drainage	Moderate	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Populus balsamifera*	
	Betula papyrifera	
Shrubs	*mountain alder*	
	Rosa acicularis	
	Symphoricarpos occidentalis	
	Rubus idaeus	
	Viburnum edule	
	Ribes triste	
	Lonicera dioica	
Herbs	*Aralia nudicaulis*	
	Actaea rubra	
	Rubus pubescens	
	Dryopteris carthusiana	
	Maianthemum canadense	

Poly 2582 -Plot 20-31-2: $At - Highbush cranberry – Oakfern (SHac)

*Note: $= seral; At = Trembling Aspen, * Structural Stage: 5 = young forest*

Appendix B. Data Summary by Polygon - 2020

Table 4

Polygon:	2447	TEM Code:	SHac
TEM Name:	$At - Highbush cranberry - Oakfern		
Plot #s	20-37-1 – 20-37-6		
	Ecosystem		
	$At - Highbush cranberry – Oakfern (SHac)		
Slope	0		
Aspect	999		
SMR	Hygric (6)		
SNR	Rich (D)		
Mesoslope	Level		
Structural Stage*	6		
Humus Form	MullModer		
Ah	No		
Soil Texture	Silt, Silt/Sand		
Coarse Fragments	0		
Drainage	Imperfect - Moderate		
Seepage	No (yes @ 38 cm in plot 20-37-3)		
Mottling	No		
Gleying	No		
Dominant Vegetation			
Trees	*Picea glauca*		
	Populus balsamifera		
	Betula papyrifera		
	Acer negundo		
Shrubs	*Alnus incana*		
	Rubus idaeus		
	Cornus sericea		
	Symphoricarpos occidentalis		
	Rosa acicularis		
	Sambucus racemosa		
Herbs	*Vicia americana*		
	Equisetum arvense		
	Galium triflorum		
	Calamagrostis canadensis		
	Bromus inermis		

Poly 2447 -Plot 20-37-5: $At - Highbush cranberry – Oakfern (SHac)

*Note: $= seral; At = Trembling Aspen, * Structural Stage: 6 = mature forest*

Appendix B. Data Summary by Polygon - 2020

Table 5

Polygon: 2562		TEM Code: SHac
TEM Name:	**$At - Highbush cranberry - Oakfern**	
Plot #s	**20-01-1 – 20-01-4**	
	Ecosystem	
	$At - Highbush cranberry – Oakfern (SHac)	
Slope	0, 11	
Aspect	999, 142	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Level	
Structural Stage*	3b, 5	
Humus Form	Mullmoder	
Ah	No	
Soil Texture	Silt (Fin Sandy Loam)	
Coarse Fragments	0	
Drainage	Imperfect	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Betula papyrifera*	
	Populus balsamifera	
Shrubs	*Amelanchier alnifolia*	
	Cornus sericea	
	Rosa acicularis	
	Lonicera dioica	
	Rubus idaeus	
	Symphoricarpos occidentalis	
	Alnus incana	
	Prunus virginiana	
Herbs	*Geum aleppicum*	
	Aralia nudicaulis	
	Equisetum arvense	
	Maianthemum canadense	
	Bromus inermis	

Poly 2562 -Plot 20-01-4: $At - Highbush cranberry – Oakfern (SHac)

*Note: At = Trembling Aspen; $ = Seral, * Structural Stage: 3b = tall shrub; 5 = young forest*

Appendix B. Data Summary by Polygon - 2020

Table 6

Polygon: 3034		TEM Code: Fl
TEM Name:	**Low Bench Floodplain**	
Plot #s	**20-27-1–20-27-6**	
	Ecosystem	
	Low Bench Floodplain (Fl)	
Slope	1–8	
Aspect	90, 171, 185, 281, 291, 300	
SMR	Subhygric (5)	
SNR	Poor (B) - Rich (C)	
Mesoslope	Level	
Structural Stage*	3b	
Humus Form	N/A, Mull	
Ah	No	
Soil Texture	Silt/Sand, Sand	
Coarse Fragments	0 - 95	
Drainage	Well - Rapid	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*balsam poplar* *balsam poplar* *Picea glauca*	 *Poly 3034-Plot 20-27-3: Low Bench Floodplain (Fl)*
Shrubs	*Amelanchier alnifolia* *Symphoricarpos occidentalis* *Salix interior* *Spiraea lucida*	
Herbs	*Astragalus cicer* *Medicago lupulina* *Dryas drummondii* *Bromus inermis* *Oxytropis campestris var. davisii* *Solidago altissima* *Medicago lupulina* *Medicago sativa* *Oxytropis splendens*	

** Structural Stage: 3b = tall shrub*

Appendix B. Data Summary by Polygon - 2020

Table 7

Polygon: 3373		TEM Code: Fl
TEM Name:	**Low Bench Floodplain**	
Plot #s	**20-46-1–20-46-4**	
	Ecosystem	
	Low Bench Floodplain (Fl)	
Slope	0-9	
Aspect	999, 71, 280	
SMR	Subhygric (5)	
SNR	Poor (B) - Rich (C)	
Mesoslope	Level	
Structural Stage*	3b, 4	
Humus Form	Mull	
Ah	No	
Soil Texture	Silt/Sand, Sand	
Coarse Fragments	0	
Drainage	Moderate - Well	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Acer negundo* *Populus balsamifera* *Picea glauca*	
Shrubs	*Salix prolixa* *Salix interior* *Rosa acicularis* *Alnus incana* *Cornus sericea* *Rubus idaeus*	
Herbs	*Sonchus arvensis* *Vicia americana* *Trifolium hybridum* *Bromus inermis* *Cirsium arvense* *Solidago altissima* *Poa palustris*	

Poly 3373-Plot 20-46-4 Low Bench Floodplain (Fl)

** Structural Stage: 3b = tall shrub; 4 = pole/sapling*

Appendix B. Data Summary by Polygon - 2020

Table 8

Polygon:	3240	TEM Code: AM / SHac
TEM Name:	Sw - Trailing Raspberry - Stepmoss / $At - Highbush cranberry - Oakfern	
Plot #s	20-19-1–20-19-6	
	Ecosystem 1	**Ecosystem 2**
	Sw - Trailing Raspberry – Stepmoss (AM)	$At - Highbush cranberry – Oakfern (SHac)
Slope	2- 8	9
Aspect	134, 136, 148, 292	90, 172
SMR	Subhygric (5)	Subhygric (D)
SNR	Rich (D)	Rich (D)
Mesoslope	Level	Level
Structural Stage*	4	3b, 5
Humus Form	Moder	Moder
Ah	No	No
Soil Texture	Silt (Silty Loam)	Silt
Coarse Fragments	0	0
Drainage	Imperfect	Imperfect - Moderate
Seepage	No	No
Mottling	No	No
Gleying	No	No
Dominant Vegetation		
Trees	*Picea glauca* *Betula occidentalis* *Betula papyrifera*	*Populus balsamifera* *Betula papyrifera*
Shrubs	*Amelanchier alnifolia* *Rosa acicularis* *Ribes oxyacanthoides* *Cornus sericea*	*Salix lasiandra* *Rosa acicularis* *Cornus sericea* *Symphoricarpos occidentalis* *Rubus idaeus* *Lonicera dioica* *Ribes oxyacanthoides*
Herbs	*Pyrola asarifolia* *Aralia nudicaulis* *Maianthemum canadense* *Galium triflorum* *Rubus pubescens*	*Maianthemum stellatum* *Aralia nudicaulis* *Galium triflorum* *Calamagrostis canadensis* *Actaea rubra*

Note: Sw = White Spruce; $ = Seral, At = Trembling Aspen;

** Structural Stage: 3b = tall shrub; 4 = pole/sapling; 5 = young forest*

Appendix B. Data Summary by Polygon - 2020

Poly 3240 – Plot 20-19-3: Sw - Trailing Raspberry – Stepmoss (AM)

Poly 3240 – Plot 20-19-6: $At - Highbush cranberry – Oakfern (SHac)

Appendix B. Data Summary by Polygon - 2020

Table 9

Polygon 3051		TEM Code: Fm02
TEM Name:	**Acb – Sw – Mountain alder – Dogwood**	
Plot #s	**20-26-1 – 20-26-6**	
	Ecosystem	
	AcbSw – Mountain alder – Dogwood (Fm02)	
Slope	0 (12)	
Aspect	999 (242)	
SMR	Mesic (4) – Subhygric (5)	
SNR	Medium (C) – Rich (D)	
Mesoslope	Level (Lower)	
Structural Stage*	5	
Humus Form	Moder (Mull)	
Ah	No	
Soil Texture	Sand/Silt, Silt/Sand/Silt, Silty Loam	
Coarse Fragments	0	
Drainage	Moderate	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Populus balsamifera*	
Shrubs	*Symphoricarpos occidentalis* *Elaeagnus commutata* *Amelanchier alnifolia* *Alnus incana* *Salix prolixa* *Rubus idaeus* *Cornus sericea* *Clematis occidentalis* *Prunus virginiana*	
Herbs	*Astragalus cicer* *Pyrola asarifolia* *Solidago altissima* *Taraxacum officinale* *Lathyrus ochroleucus* *Maianthemum canadense* *Bromus inermis*	

Poly 3051-Plot 20-26-6 AcbSw – Mountain alder – Dogwood (Fm02)

*Note: Acb = Balsam Poplar, Sw = White Spruce; * Structural Stage: 5 – Young Forest*

Appendix B. Data Summary by Polygon - 2020

Table 10

Polygon:	3470	TEM Code:	Fl
TEM Name:	Low Bench Floodplain		
Plot #s	20-99-1–20-99-4		
	Ecosystem		
	Low Bench Floodplain (Fl)		
Slope	0		
Aspect	999		
SMR	Subhygric (5) – Hygric (6)		
SNR	Medium (C) – Rich (D)		
Mesoslope	Level		
Structural Stage*	3b		
Humus Form	N/A		
Ah	No		
Soil Texture	Silt (Sand/Silt)		
Coarse Fragments	0 - 85		
Drainage	Imperfect - Well		
Seepage	No		
Mottling	No		
Gleying	No		
Dominant Vegetation			
Trees	*Acer negundo* *Populus balsamifera*		
Shrubs	*Salix interior* *Shepherdia canadensis* *Salix prolixa* *Cornus sericea*		
Herbs	*Caragana arborescens* *Bromus inermis* *Medicago sativa* *Trifolium hybridum* *Bromus inermis* *Astragalus cicer*		

Poly 2479-Plot 20-100-1: Low Bench Floodplain (Fl)

** Structural Stage: 3b = tall shrub*

Appendix B. Data Summary by Polygon - 2020

Table 11

Polygon	2479	TEM Code: Fm02
TEM Name:	Acb – Sw – Mountain alder – Dogwood	
Plot #s	20-100-1 – 20-100-5	
	Ecosystem	
	AcbSw – Mountain alder – Dogwood (Fm02)	
Slope	0 (7)	
Aspect	999 (240, 304)	
SMR	Subhygric (5)	
SNR	Medium (C)–Rich (D)	
Mesoslope	Level	
Structural Stage*	5	
Humus Form	Moder (Mull)	
Ah	No	
Soil Texture	Sand/ Silt/Sand, Silt/ Sand/ Silt, Silty/Silty Loam	
Coarse Fragments	0	
Drainage	Moderate (Well)	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Populus balsamifera*	
	Picea glauca	
	Acer negundo	
Shrubs	*Alnus incana*	
	Cornus sericea	
	Symphoricarpos occidentalis	
	Elaeagnus commutata	
	Rubus idaeus	
	Amelanchier alnifolia	
	Rosa acicularis	
	Ribes oxyacanthoides	
Herbs	*Aralia nudicaulis*	
	Lathyrus ochroleucus	
	Galium boreale	
	Maianthemum stellatum	
	Equisetum hyemale	
	Solidago altissima	

Poly 3051-Plot 20-100-5 AcbSw – Mountain alder – Dogwood (Fm02)

*Note: Acb = Balsam Poplar, Sw = White Spruce; * Structural Stage: 5 – Young Forest*

Appendix B. Data Summary by Polygon - 2020

Table 12

Polygon:	2565	TEM Code: SH
TEM Name:	Sw–Currant - Horsetail	
Plot #s	20-34-1 – 20-34-3	
	Ecosystem	
	Sw-Currant-Horsetail (SH)	
Slope	5-8	
Aspect	20, 120,216	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Level (Microcrest)	
Structural Stage*	6	
Humus Form	Mull (Moder)	
Ah	No	
Soil Texture	Silty Loam/Silt, Silt, Silty Loam	
Coarse Fragments	0	
Drainage	Imperfect (Moderate)	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Picea glauca* *Betula papyrifera*	
Shrubs	*Rubus idaeus* *Cornus sericea* *Rosa acicularis* *Ribes oxyacanthoides* *Ribes triste* *Ribes glandulosum* *Viburnum edule* *Salix scouleriana* *Lonicera dioica* *Viburnum edule* *Prunus virginiana*	
Herbs	*Galium triflorum* *Maianthemum canadense* *Arctium lappa* *Equisetum arvense* *Mitella nuda* *Aralia nudicaulis*	

Poly 2565-Plot 20-34-3 Sw-Currant-Horsetail (SH)

*Note: Sw = White Spruce; * Structural Stage: 6 = mature*

Appendix B. Data Summary by Polygon - 2020

Table 13

Polygon 2877		TEM Code: Fl
TEM Name:	**Low Bench Floodplain**	
Plot #s	**20-04-1 – 20-04-3**	
	Ecosystem	
	Low Bench Floodplain (Fl)	
Slope	0	
Aspect	999	
SMR	Hygric (6)	
SNR	Rich (D)	
Mesoslope	Level	
Structural Stage*	2b (3b)	
Humus Form	N/A	
Ah	No	
Soil Texture	Silt/Cobble, Silt/Gravels	
Coarse Fragments	0, 100	
Drainage	Moderate	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Populus balsamifera*	 *Poly 2877-Plot 20-04-1 Low Bench Floodplain (Fl)*
Shrubs	*Salix prolixa* *Salix interior* *Alnus incana* *Symphoricarpos occidentalis* *Elaeagnus commutata*	
Herbs	*Melilotus alba* *Achillea millefolium* *Poa pratensis* *Astragalus cicer* *Phalaris arundinacea* *Bromus inermis* *Cirsium arvense*	

** Structural Stage: 2b = herb; 3b = tall shrub*

Appendix B. Data Summary by Polygon - 2020

Table 14

Polygon: 3409		TEM Code: Fl
TEM Name:	**Low Bench Floodplain**	
Plot #s	**20-09-1 – 20-09-6**	
	Ecosystem	
	Low Bench Floodplain (Fl)	
Slope	0 (7)	
Aspect	999 (322)	
SMR	Subhygric (5)	
SNR	Poor (B)	
Mesoslope	Level	
Structural Stage*	3b	
Humus Form	N/A	
Ah	No	
Soil Texture	Silty Loam/ Sand (Sand/Silt)	
Coarse Fragments	82 – 85 (0)	
Drainage	Rapid (Well)	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Populus balsamifera*	
Shrubs	*Rosa acicularis*	
	Juniperus communis	
	Amelanchier alnifolia	
	Symphoricarpos occidentalis	
Herbs	*Bromus inermis*	
	Medicago lupulina	
	Medicago sativa	
	Astragalus australis	
	Melilotus alba	
	Artemisia campestris	
	Bromus inermis	
	Oxytropis campestris var. davisii	
	Hieracium canadense	
	Oxytropis sericea	
	Poa pratensis	

Poly 3409-Plot 20-09-5 Low Bench Floodplain (Fl)

** Structural Stage: 3b = tall shrub*

Appendix B. Data Summary by Polygon - 2020

Table 15

Polygon:	3488	TEM Code:	SHac
TEM Name:	**$At - Highbush cranberry - Oakfern**		
Plot #s	**20-44-1 – 20-44-6**		
	Ecosystem		
	$At - Highbush cranberry – Oakfern (SHac)		
Slope	0 - 14		
Aspect	100, 147, 152, 153, 164		
SMR	Subhygric (6)		
SNR	Rich (D) – Very Rich (E)		
Mesoslope	Lower (Level)		
Structural Stage*	3b, 5		
Humus Form	Mull		
Ah	No		
Soil Texture	Silt/Silty Loam, Silty Clay		
Coarse Fragments	0		
Drainage	Imperfect		
Seepage	No		
Mottling	Yes (10 – 25 cm)		
Gleying	No		
Dominant Vegetation			
Trees	*Populus balsamifera*		
Shrubs	*Cornus sericea* *Alnus incana* *Symphoricarpos occidentalis* *Salix prolixa* *Rosa woodsii* *Rubus idaeus* *Salix bebbiana*		
Herbs	*Astragalus cicer* *Maianthemum stellatum* *Bromus inermis* *Hackelia deflexa* *Equisetum arvense* *Sanicula marilandica* *Erigeron philadelphicus* *Sonchus arvensis* *Galium triflorum*		

Poly 3488 -Plot 20-44-5: $At - Highbush cranberry – Oakfern (SHac)

Note: At = Trembling Aspen; $ = Seral, Structural Stage: 5 = young forest*

Appendix B. Data Summary by Polygon - 2020

Table 16

Polygon: 3202		TEM Code: GB
TEM Name:	**Gravel Bar**	
Plot #s	**20-48-1 – 20-48-6**	
	Ecosystem	
	Gravel Bar (GB)	
Slope	0	
Aspect	999	
SMR	Subhgric (5)	
SNR	Medium (C) (Rich (D))	
Mesoslope	Level	
Structural Stage*	2a	
Humus Form	N/A	
Ah	No	
Soil Texture	Silt, Sand	
Coarse Fragments	81- 85	
Drainage	Well, Rapid	
Seepage	No	
Mottling	Np	
Gleying	No	
Dominant Vegetation		
Trees		
Shrubs		
Herbs	*Persicaria maculosa* *Hordeum vulgare* *Melilotus alba* *Cirsium arvense* *Medicago lupulina* *Polygonum aviculare* *Sonchus arvensis* *Lolium perenne* *Tripleurospermum inodorum* *Chenopodium album* *Veronica anagallis-aquatica* *Artemisia biennis* *Crepis tectorum*	

Poly 3202 -Plot 20-48-2: Gravel Bar (GB)

** Structural Stage: 2a = herbaceous*

Appendix B. Data Summary by Polygon - 2020

Table 17

Polygon:	3319	TEM Code:	Fm02
TEM Name:	Acb – Sw – Mountain alder – Dogwood		
Plot #s	20-10-1 - 20-10-6		
	Ecosystem		
	AcbSw – Mountain alder – Dogwood (Fm02)		
Slope	0		
Aspect	999		
SMR	Subhygric (5)		
SNR	Rich (D)		
Mesoslope	Level		
Structural Stage*	3b		
Humus Form	Moder		
Ah	No		
Soil Texture	Silt/Silty Loam (Silty Loam)		
Coarse Fragments	0		
Drainage	Moderate (Imperfect)		
Seepage	No		
Mottling	Yes (10 – 28 cm)		
Gleying	No		
Dominant Vegetation			
Trees			
Shrubs	*Cornus sericea*		
	Symphoricarpos occidentalis		
	Rubus idaeus		
	Rosa acicularis		
	Alnus incana		
	Prunus virginiana		
	Salix prolixa		
	Ribes oxyacanthoides		
Herbs	*Aralia nudicaulis*		
	Equisetum arvense		
	Galium triflorum		
	Actaea rubra		
	Urtica dioica		
	Stachys palustris ssp. pilosa		
	Calamagrostis canadensis		

Poly 3319 -Plot 20-10-5: AcbSw – Mountain alder – Dogwood (Fm02)

*Note: Acb = Balsam Poplar, Sw = White Spruce; * Structural Stage: 5 – Young Forest*

Appendix B. Data Summary by Polygon - 2020

Table 18

Polygon: 2953		TEM Code: Fm02
TEM Name:	**Acb – Sw – Mountain alder – Dogwood**	
Plot #s	**20-29-1 – 20-29-6**	
	Ecosystem	
	AcbSw – Mountain alder – Dogwood (Fm02)	
Slope	0 - 10	
Aspect	999 (62, 246,300, 322)	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Lower	
Structural Stage*	5 (4, 6)	
Humus Form	Moder	
Ah	No	
Soil Texture	Silt/Silty Loam (Silty Loam)	
Coarse Fragments	0	
Drainage	Moderate	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Populus balsamifera* *Betula papyrifera* *Picea glauca*	 *Poly 2953 -Plot 20-29-2: AcbSw – Mountain alder – Dogwood (Fm02)*
Shrubs	*Cornus sericea* *Rubus idaeus* *Prunus virginiana* *Rosa acicularis* *Symphoricarpos occidentalis* *Ribes oxyacanthoides* *Alnus incana*	
Herbs	*Equisetum arvense* *Aralia nudicaulis* *Astragalus cicer* *Equisetum hyemale* *Maianthemum stellatum* *Calamagrostis canadensis* *Galium boreale*	

Note: Acb = Balsam Poplar, Sw = White Spruce; Structural Stage: 5 – Young Forest*

Appendix B. Data Summary by Polygon - 2020

Table 19

Polygon: 2703		TEM Code: Fm02
TEM Name:	**Acb – Sw – Mountain alder – Dogwood**	
Plot #s	**20-32-1 – 20-32-3**	
	Ecosystem	
	AcbSw – Mountain alder – Dogwood (Fm02)	
Slope	11 - 15	
Aspect	160, 208, 220	
SMR	Subhygric (5)	
SNR	Mesic (C)	
Mesoslope	Toe	
Structural Stage*	3b	
Humus Form	N/A, Mull	
Ah	No	
Soil Texture	Silty Loam/Sand, Sand	
Coarse Fragments	35 - 70	
Drainage	Well	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Populus balsamifera* *Picea glauca*	 *Poly 2703 -Plot 20-32-3: AcbSw – Mountain alder – Dogwood (Fm02)*
Shrubs	*Viburnum edule* *Amelanchier alnifolia* *Juniperus communis* *Symphoricarpos occidentalis* *Cornus sericea* *Elaeagnus commutata*	
Herbs	*Medicago sativa* *Bromus inermis* *Achillea millefolium* *Astragalus cicer* *Linnaea borealis* *Taraxacum officinale* *Medicago sativa* *Galium boreale* *Vicia americana*	

*Note: Acb = Balsam Poplar, Sw = White Spruce; * Structural Stage: 5 – Young Forest*

Appendix B. Data Summary by Polygon - 2020

Table 20

Polygon:	3308	TEM Code: SH
TEM Name:	Sw – Currant - Horsetail	
Plot #s	20-15-1 – 20-15-6	
	Ecosystem	
	Sw-Currant-Horsetail (SH)	
Slope	0	
Aspect	999	
SMR	Subhygric (5)	
SNR	Rich (D)	
Mesoslope	Level	
Structural Stage*	5	
Humus Form	Moder	
Ah	No	
Soil Texture	Silt/Sand, Silt/Silty Loam, Sand	
Coarse Fragments	0	
Drainage	Moderate−Well	
Seepage	No	
Mottling	No	
Gleying	No	
Dominant Vegetation		
Trees	*Picea glauca*	
	Populus balsamifera	
Shrubs	*Ribes oxyacanthoides*	
	Alnus incana	
	Cornus sericea	
	Viburnum edule	
	Rosa acicularis	
	Elaeagnus commutata	
	Symphoricarpos occidentalis	
	Lonicera dioica	
	Ribes triste	

Appendix B. Data Summary by Polygon - 2020

Herbs	*Apocynum androsaemifolium* *Vicia americana* *Maianthemum stellatum* *Corallorhiza trifida* *Petasites frigidus var. palmatus* *Pyrola chlorantha* *Galium boreale* *Pyrola asarifolia* *Lathyrus ochroleucus*	 *Poly 3308-Plot 20-15-3 Sw-Currant-Horsetail (SH)*

*Note: Sw = White Spruce; * Structural Stage: 5 = young forest*

APPENDIX C. Flooded Sites

Appendix C. Flooded Sites

DVM: Sites not sampled due to flooding.

2553 (20-03)

2575 (20-35)

2866 (20-02)

2958 (20-28)

3058 (20-49)

3197 (20-50)

Appendix C. Flooded Sites

4909 (20-41)

Appendix 8. Experimental Rare Plant Translocation Program 2020 Annual Report

Experimental Rare Plant Translocation Program
2020 Annual Report

Date: February 16, 2021

PRESENTED TO:

BC Hydro
1111 West Georgia St, 9th Floor
Vancouver, BC V6E 4G2

PRESENTED BY:

EcoLogic Consultants Ltd.
Unit 4 - 252 East 1st Street
North Vancouver, BC V7L 1B3
Phone: 604 803-7146

and

Tetra Tech Canada Incorporated
on behalf of Saulteau EBA Environmental Services Joint Venture (SEES JV)
885 Dunsmuir Street, Suite 1000
Vancouver, BC V6C 1N5
Phone: 604 685-0275

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ACRONYMNS & ABBREVIATIONS

Term	Definition
B.C. CDC	B.C. Conservation Data Centre
EIL	Erosion Impact Line
ERPT	Experimental Rare Plant Translocation
ENSCONET	European Native Seed Conservation Network
PAZ	Potential Activity Zone
PRS	Potential Recipient Sites
QA/QC	Quality Assurance and Quality Control
spp.	The abbreviation "spp." (plural) indicates "several species".
sp.	The abbreviation "sp." Refers to a single species.

1. INTRODUCTION

As part of the federal and provincial regulatory approvals of the Site C project, BC Hydro committed to the creation of an Experimental Rare Plant Translocation program (ERPT) to support the viability of target rare plant species affected by the project.

The ERPT program is designed to establish new populations of target rare plant species in areas that are secure, contain analogous habitat to the source populations, and are within the Peace Region. This program uses an experimental approach to identify critical factors affecting germination, establishment, growth, and survival of the target species, the results of which inform the scope of the design such that informed variations on salvage, propagation, and transplant methods can be employed. The ERPT program is updated on an ongoing basis to incorporate relevant information related to target rare plant species and translocation methods as it emerges.

The program is founded on positive working relationships with First Nation-owned and local businesses as well as other consultants such that the program benefits from shared knowledge and experience. The knowledge acquired and lessons learned can be employed to maximize the success of the program.

This report summarizes the measures and activities undertaken in 2020. Included is a summary of species additions to the program, relevant updates to the conservation ranks of species of conservation concern, and the general methods and activities completed for the four phases of the program: Phase 1 - propagule collection; Phase 2 - *ex-situ* propagation; Phase 3 - translocation implementation; and Phase 4 - post-translocation care, maintenance, and monitoring.

1.1 SPECIES ADDITIONS TO THE PROGRAM

Two species were added to the ERPT program in 2020: Canada mountain-ricegrass (*Piptatheropsis canadensis*) and rock selaginella (*Selaginella rupestris*).

Canada mountain-ricegrass is a perennial grass that is widely distributed across North America; however, it was only recently rediscovered in BC after a prolonged absence of voucher specimens from the province (B.C. CDC 2019). It is primarily a species of eastern Canada and is much rarer in western portions of its range (B.C., Alberta; Barkworth 2007). It is Red-listed (i.e., endangered, or threatened) by the B.C. Conservation Data Centre (B.C. CDC), with several recent (2018, 2020) collections of the species in the province, all from the Peace River region (B.C. CDC 2020; R. Krichbaum, pers. comm.). This is a species of grasslands and open woods (Barkworth 2007), and British Columbia populations occur in small, remnant patches of natural grassland. It is likely highly susceptible to disturbance in B.C. given the tiny population sizes and reliance on natural grassland habitats.

Rock selaginella is a perennial spikemoss that occurs widely across Canada, from B.C. east to Nova Scotia. However, it is known from few populations within B.C., all of which occur in the vicinity of the Peace River (B.C. CDC 2020). This species is also Red-listed in British Columbia. In the Peace River region, this species

occurs primarily on fine-textured mineral soil substrates (occasionally rocks) among patches of herbaceous vegetation on dry, south-facing grassland slopes; habitat associations are more diverse elsewhere in its Canadian range (e.g., cliffs, granite outcrops, gravelly soils; Valdespino 1993). This species is likely moderately tolerant of disturbance, as it typically colonizes patches of bare mineral soil; however, the isolated nature of individual populations renders them susceptible to localized effects, and it has been reported as rare or absent in Peace River grasslands that have been exposed to high levels of disturbance from cattle (R. Krichbaum, pers. comm.).

1.2 CONSERVATION RANK UPDATES

The B.C. Conservation Data Centre (B.C. CDC) annually assesses the provincial conservation ranks of vascular plants and bryophytes in the province This annual assessment incorporates new information about the abundance and distribution of the province's flora, as well as newly recognized threats (or lack of threats) to known populations. The ranking update published by the B.C. CDC in 2020 (B.C. CDC 2020) changed the conservation status rank of 127 species in the province relative to their status in 2019. No changes to the conservation status rank of species included in the ERPT program were made in 2020 (Table 1.2-1).

Table 1.2-1. Species included in the Experimental Rare Plant Translocation Program

Scientific Name	Common Name	B.C. CDC Provincial Rank	NatureServe Provincial Status	NatureServe Global Status
Carex sprengelii	Sprengel's sedge	Blue	S3 (2019)	G5 (2016)
Carex torreyi	Torrey's sedge	Blue	S3? (2019)	G4G5 (2016)
Carex xerantica	dryland sedge	Blue	S3 (2019)	G5(2016)
Epilobium saximontanum	Rocky Mountain willowherb	Blue	S3 (2019)	G5 (1984)
Oxytropis campestris var. *davisii*	Davis' locoweed	Blue	S3? (2019)	G5T3 (2015)
Penstemon gracilis	slender penstemon	Blue	S3 (2019	G5 (2016)
Piptatheropsis canadensis	Canada mountain-ricegrass	Red	S1 (2019)	G4G5 (2016)
Ranunculus rhomboideus	prairie buttercup	Blue	S2S3 (2019)	G5 (2016)
Selaginella rupestris	rock selaginella	Red	S2 (2019)	G5 (2016)

2. GENERAL METHODS

2.1 PHASE 1. PROPAGULE COLLECTION

The standards for collecting and storing propagules for *ex-situ* conservation (e.g., timing, sampling, labelling, cleaning, processing, stratification, sowing, provenance) incorporate guidance outlined in Maslovat (2009) and by the European Native Seed Conservation Network (ENSCONET 2009).

The 2020 propagule collection phase included a combination of the following collection strategies:

- collection of seed from existing populations and sowing of seeds at nurseries, with the resulting seedlings targeted for out-planting at recipient sites;
- collection of mature plants and plant cuttings from existing populations, followed by *ex-situ* propagation and eventual planting of propagated material at recipient sites;
- collection of mature plants or seedlings from existing populations and direct transplantation to recipient sites; and
- collection of seed from existing populations and direct sowing of seeds at suitable recipient sites.

2.1.1 *In-situ* Seed Collection

The 2020 propagule collection efforts focused predominantly on augmenting existing seedbank resources for future propagation and for insurance against stochastic events (e.g., floods), human disturbance, and year-to-year climatic variability. Additional collection efforts focused on salvaging plants from within the project footprint and replanting them to areas outside of the footprint or sending them to the native plant nurseries for care and future propagation.

Field botanists aimed to capture a range of genetic variability; however, sampling options were limited due to small population sizes and the timing of the collection for some species, which were in areas slated for immediate clearing due to changes in the Hwy 29 realignment. Seeds were stored in a cool, dry location and plant cuttings were kept moist until they were shipped to the nursery for care.

2.1.2 *Ex-situ* Seed Collection

Nursery staff collected seeds from the nursery stock derived from the 2018 seed collection efforts. Nursery staff sorted the seeds to remove non-viable seeds (i.e., empty or poorly developed), and the remaining seeds were cleaned and dried (where necessary) to maximize viability. Cleaning included the removal of waste material from around the seed capsule, and the use of sieves, hand separation, and air separation. Seeds were then placed in cold storage at the nursery to maintain seed quality and longevity. The provenance, seed collection procedures, and quantity collected were recorded.

2.2 PHASE 2. *EX-SITU* PROPAGATION

Ex-situ propagation involved stratification and propagation for each individual target species in a nursery environment. Curation protocols and recommendations (ENSCONET 2009) and professional horticultural experience were used to inform the methods for this aspect of the program.

Through the pre-treatment process, seeds were treated to simulate the natural conditions for breaking seed dormancy and initiating germination. Seeds were scarified and/or stratified as relevant. Scarification treatments included a short hot-water bath or sandpaper, while stratification included immersing the seeds into cold temperatures with moisture to simulate natural germination conditions. Seeds that were not intended for planting in the subsequent year were not treated and are being stored as insurance for potential future use.

Propagation methods were developed based on the ecological conditions observed at the source populations, and included several measures and considerations (Vallee et al. 2004; Maslovat 2009) such as:

- examination of the ecological and, if available, translocation literature to determine experimental trials, including optimum founder plant size for sufficient genetic diversity, reproductive status relevant to propagation for each rare plant species, and out- planting requirements;
- review of common garden experiments as a potential source of horticultural information for a specific target species;
- exploration and implementation of a range of techniques (e.g., varying soil substrate) to determine the most effective propagation options for each target species;
- multiple germination trials to determine viability; and
- holding back source propagules in an *ex-situ* collection as material for future propagation.

All utilized *ex-situ* propagation methods have been documented including the following:

- provenance (i.e., origin of material collected);
- type of material collected (e.g., seed, live plant);
- location and date of collection; and
- growing conditions such as potting media, temperature of propagation area, watering and treatment of seeds.

2.3 PHASE 3. TRANSLOCATION

Translocation implementation included four components: 1) recipient site selection; 2) transport and plant preparation; 3) selection of planting locations with the habitat matrix; and 4) translocation at recipient sites.

2.3.1 Recipient Site Selection

Selection of suitable recipient sites, based on the species-specific preferred habitat characteristics, was informed by the extensive existing information collected for Site C along with the expert knowledge of qualified botanists who performed the field verification work (Appendix A: Eagle Cap 2021). Selected sites contained habitat analogous to the source occurrences and were situated in areas that are unlikely to be developed in the foreseeable future. In some cases, sites also contained one or more target rare plant occurrences. All sites selected are located within the Peace Region.

The stated goal of recipient site selection was to locate two suitable recipient sites for each target rare plant species, with the exception of prairie buttercup and Rocky Mountain willowherb.

Dedicated surveys to find additional recipient sites for prairie buttercup were not completed in 2020 as two recipient sites were identified in 2019 that have yet to be utilized for the out-planting trials. Plants resulting from the 2018 and 2019 seed collections were not fully rooted in 2020 and thus not available for planting. A subset of these individuals will be planted at suitable recipient sites in 2021; the remainder will be retained as insurance against stochastic events.

Dedicated surveys to find recipient sites for Rocky Mountain willowherb were also not completed in 2020 as efforts remain focused on trying to locate this species. The most recent attempt occurred in 2020 but no individuals of the species nor suitable habitat were observed.

In 2020, six target species were selected as priority species requiring recipient sites for translocation. In addition, recipient sites for Canada mountain-ricegrass were selected in response to salvage and subsequent translocation efforts resulting from changes to the Hwy 29 realignment.

Before verifying and selecting recipient sites in the field, a desktop review was conducted to identify potential locations. The desktop review included literature reviews for each priority species to evaluate current and relevant species information such as habitat and translocation requirements. Aerial imagery and GIS attributes were also visually evaluated for the following ideal site characteristics:

1. accessible by road or boat and outside of the Site C Potential Activity Zone (PAZ);
2. not be located below the reservoir preliminary Erosion Impact Line (EIL - a precautionary estimate of the amount of erosion that could occur over a 100-year period);
3. located on Crown land or BC Hydro land near the Peace River and within range of cell service;
4. contained appropriate habitat for priority species;
5. contained low levels of non-native plants;
6. illustrated low levels of disturbance;
7. had planting areas greater than one kilometre from known sites of the same taxon;
8. were not already occupied by other rare plant species; and
9. located close to a water source.

It is recognized that the list of desirable recipient site qualities describes a hypothetical ideal site. No site will fulfill all the listed criteria and trade-offs will always have to be made.

Potential recipient sites (PRS) were selected partially based on distance to other planting sites, with the aim of distributing them over a wide geographical extent. In some instances, a site was found to contain suitable habitat for several ERPT target species in close proximity, and so separate PRS plots were completed for each target species. While this does provide the option to plant multiple species at the same site, with the consequent increased risk of a single disturbance event impacting multiple species, the limited number of suitable sites available for some of the target species necessitated using one site for several species in some cases. In addition, several of the target species occur together in wild populations.

Forty-four PRS were identified during this desktop exercise, of which 17 received field verification and were ranked for suitability using weighted desirable site characteristics. The 27 PRS not field-verified were either too difficult to access or are under consideration as future PRS (see Appendix A). Of the sites that were checked, six PRS were considered to be worth investigating further and 12 PRS plots were completed. At each PRS plot, vegetation composition and cover data were recorded for the overall site, as well as for three one-metre-square plots placed in representative locations. Despite challenges with avoiding sites in the vicinity of other rare plant populations and finding areas with water sources, the six best PRS met the majority of the stated requirements. Two of the PRS contain a variety of habitats and are suitable for multiple species translocation (See Sites 1 and 2 in Appendix A). The remaining four PRS were specifically selected for a single taxon. Where possible, supplemental planting areas (i.e. specific microsites) were marked within suitable habitat to provide increased planting options.

Four PRS plots were completed for rock selaginella at three of the six selected planting areas; these plots did not possess the substrate typical of sites where this species is known to occur in the B.C. Peace region. Further review and field verification is required to select sites that are better suited to this species. In addition to the six best PRS, two sites were selected to receive 12 Canada mountain-ricegrass plants salvaged from within the Highway 29 construction footprint. Details of these recipient sites are provided in Appendix A.

Field botanists attempted to avoid occupied sites when reviewing potential planting locations; however, this was only partially successful because suitable planting sites often hosted target rare plant species.

2.3.2 Transport and Plant Preparation

Nursery seedlings (i.e., plugs) were transported on June 8 and 28, 2020, from NATS nursery to Dunvegan garden centre in Fort St. John. The plants were picked up from the garden centre and moved to a private residence in Fort St. John until transplant at recipient sites in the following days. Plants were stored outside in June with a tarp protecting them from inclement weather, and were stored inside in August at a temperature of 15° Celsius.

2.3.3 Selection of Planting Locations within the Habitat Matrix

Planting locations within the larger habitat matrix at a recipient site were identified as those that were relatively easy to access, correspond with known ecological conditions that support the species, support plant diversity that is similar to the source populations, are on stable substrates that are not expected to undergo erosion or deposition, and are not accessible to cattle or used intensely by native herbivores. There was limited variability in the planting patterns within species, thereby minimizing constraints on comparability across sites within species. Within species, the planting plans sought to:

- establish plant groupings such that there were similar conditions in terms of microsite conditions (e.g., soils, slope, aspect);
- create plant groupings to encourage pollinator visitation; and
- space individuals to minimize potential trampling during planting and monitoring and to minimize inter-individual resources (i.e., minimize density-dependent effects on survival).

2.3.4 Translocation at Recipient Sites

The specific timing windows for planting were determined based on past years' experience regarding the average first and last frost-free days for Fort St. John, as well as plant phenology, the development stage of the propagated plants, the local weather, and soil moisture conditions.

The initial out-planting occurred on June 10 to 13, 2020, and a subsequent planting occurred on August 29 and 30, 2020. Some plant stock was withheld from planting as insurance should inclement conditions negatively affect the initial out-planting stock. Implementation of the translocation planting included the following:

- placement of plants into optimal microhabitats at the recipient sites, and in a spatial pattern suitable to the rare plant's biology as observed at the source populations or otherwise known;
- installation of durable, long-lasting tags or markers to label individual plants and plant groupings;
- code systems to differentiate various experimental treatments (e.g., plants grown in various soil media during *ex-situ* propagation efforts) as needed to retain as much information as possible on the pathway of a given plant (e.g., from seed collection to planting) to facilitate annual assessments of success;
- marked boundaries for plants, plant groupings, and translocation site boundaries using GPS points and imported into the project GIS system;
- care and maintenance at the time of planting, such as watering and creation of microhabitat as necessary;
- documentation of each translocation effort (including time spent on each phase), which includes the methods used to prepare and transport the material from the nursery to the recipient site, day of pre-translocation site preparation, environmental conditions, method of re-introduction, care and maintenance activities, planting density, and spatial pattern; and

- post-translocation follow-up to assess the health and status of a sample of individuals following translocation and to check for other possible problems, such as desiccation, pest insects, trampling, or vandalism at a translocation site.

2.4 PHASE 4. MONITORING

The monitoring program documented a suite of parameters designed to evaluate the efficacy of translocation methods in relation to the stated objectives of the program (IUCN/SSC 1998; Sutter 1996 as cited in Monks and Coates 2002; Austin 2004; Vallee et al. 2004; Maslovat 2009; Vaino 2011). Monitoring activities were initiated in 2019 and continued again in 2020 to assess the survival of individuals translocated. Key metrics included:

- number of live/dead individuals;
- individual plant health; and
- reproductive success markers (% individuals flowering/fruiting, seed production per individual, recruitment [i.e., germination of second generation]).

Monitoring activities also re-evaluated sites for the one or more of the following:

- invasive species presence, especially those in close proximity to the translocated plants, and/or any species that may have inadvertently been introduced to the site during the translocation;
- herbivory or other possible problems (e.g., pest insects, trampling);
- human disturbance; and
- microsite habitat preferences.

2.5 QUALITY CONTROL AND ASSURANCE – DATA CAPTURE METHODS

For comparability of results across sites and species, numerous field personnel were required to perform field activities, make observations, and record data annually using standard and consistent methods. Quality assurance and quality control (QA/QC) measures were used for capturing data within the field program so that methods were consistently replicated across all trials and years, and so that pertinent variables or any variations in methodology were recorded.

The 2019 data-capture forms, which had used both DoForm and Excel platforms, were consolidated in the 2020 field season to a single hardcopy form (Appendix B). This allowed the form to be used by a wider range of individuals as it did not require access to a tablet. To safeguard data, photographs of the data sheets were taken before leaving the field. These photographs were uploaded at the end of each field day to a cloud server.

Each individual data-capture form was tracked using a unique informative identifying code built of the components indicating the species, the nursery of origin, and the full date of the transplant. The sheet was designed to accommodate data capture at all levels of study: transect, plot, or individual plant.

3. RESULTS

3.1 PHASE 1. PROPAGULE COLLECTION

3.1.1 *In-situ* Seed Collection

The 2020 *in-situ* collection efforts focused on acquiring additional propagules for five species: Sprengel's sedge, Torrey's sedge, prairie buttercup, Canada mountain-ricegrass, and rock selaginella (Table 3.1-1). No *in-situ* collections were made for Davis's locoweed and slender penstemon as previous collection efforts have resulted in sufficient quantity for the translocation efforts. Additionally, no collections were made for Rocky Mountain willowherb; there have been a number of attempts in recent years to locate this species in and around the reported location but no individuals or suitable habitat have been observed (Eagle Cap 2020).

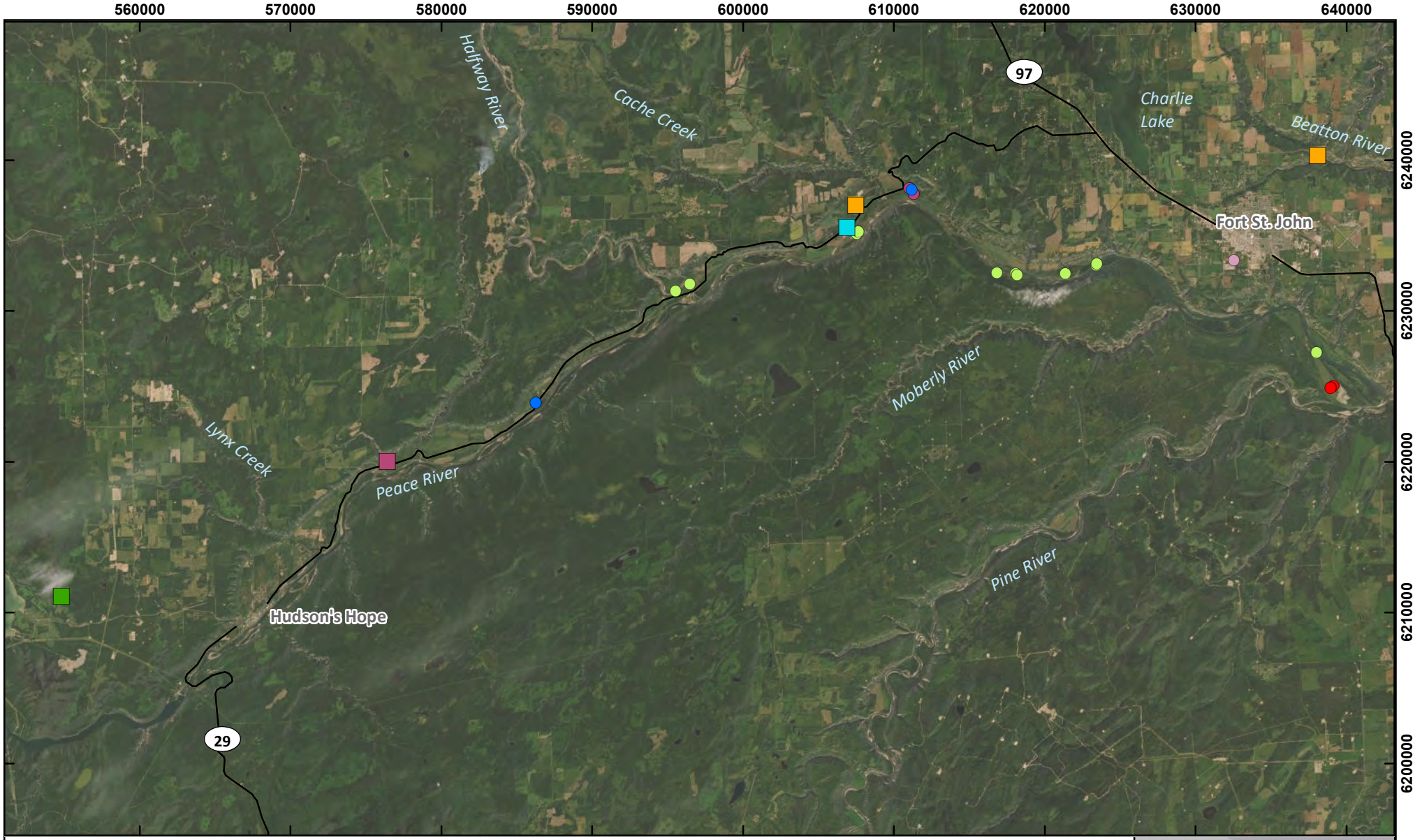
Table 3.1-1. Summary of 2020 Propagule Collection Efforts

Common Name	Species Name	Propagule Amount * and Type	Collection Timing	Collection Type	Collection Location
Sprengel's sedge	*C. sprengelii*	100 seeds	August 7, 2020	*in-situ*	Dry Creek
		400 seeds	July 3, 2020	*ex-situ*	NATS nursery
Torrey's sedge	*C. torreyi*	99 seeds	August 03, 2020	*in-situ*	Fish Creek
Dryland sedge	*C. xerantica*	32,000 seeds	August, 2020	*ex-situ*	NATS nursery
Davis' locoweed	*O. campestris* var. *davisii*	20,600 seeds	June through August, 2020	*ex-situ*	NATS nursery
Canada mountain-ricegrass	*P. canadensis*	8 seeds	August 03, 2020	*in-situ*	Fish Creek
		11 seeds	October 7,2020	*in-situ*	Cache Creek
Prairie buttercup	*R. rhomboideus*	12 seeds	August 02, 2020	*in-situ*	Watson's Slough
Rock selaginella	*S. rupestris*	Two large clumps of plants	August 08, 2020	*in-situ*	Bullhead Mountain

* Quantities provided from the nursery are estimates based on seed weight.

Seeds were collected from existing populations for three species: Sprengel's sedge, Torrey's sedge, and prairie buttercup from Dry Creek, Fish Creek, and Watson's slough, respectively (Figure 3.1-1; Eagle Cap 2020). These species were targeted for further collection to augment the existing seedbank housed at one of the two native plant nurseries participating in the program. The nursery will sow these seeds with the intent of generating future plant stock for transplant at recipient sites.

Mature plants and seeds from existing populations were collected for Canada mountain-ricegrass from Fish Creek and Cache Creek. Mature plants were salvaged and directly transplanted to two separate recipient sites; seeds were submitted to the nursery for the purpose of growing plants for transplant.



Site C Project

Experimental Rare Plant Translocation
Propagule Collection Locations
Figure 3.1-1

Date: 11/30/2020

Map Number: BCH-048

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC environmental consulting

2017-2019	2020	Target Species
●	■	*Carex sprengelii*
●	■	*Carex torreyi*
●		*Carex xerantica*
●		*Oxytropis campestris var. davisii*
●		*Penstemon gracilis*
	■	*Piptatheropis canadensis*
●	■	*Ranunculus rhomboideus*
	■	*Selaginella rupestris*

0 3 6 9

1:350,000 km

N

Plant cuttings and whole plants were collected for rock selaginella from Bullhead Mountain. Two large clumps of rock selaginella from one occurrence were collected and submitted to NATS Nursery team, who are working to develop propagation protocols for this species.

3.1.2 *Ex-situ* Seed Collection

Seed collections were taken from June through August 2020 from NATS nursery stock for Sprengel's sedge, dryland sedge, and Davis' locoweed. Seeds were processed according to the methods outlined in Section 2.1.2.

3.2 PHASE 2. *EX-SITU* PROPAGATION

Propagation efforts focused primarily on determining the stratification and germination requirements for three species for which no stock existed (Table 3.2-1): slender penstemon (Plate 3.2-1), Torrey's sedge (Plate 3.2-2), and prairie buttercup (Plate 3.2-3). Each of these species provided its own unique challenges. For example, it was difficult to acquire viable seeds for Torrey's sedge and slender penstemon because seed-ripening times were difficult to ascertain in the field and required multiple visits to acquire viable seeds. There were also challenges with prairie buttercup, which required a long stratification period, and Torrey's sedge, which had very low germination success (less than 2%) in the first year. Additional efforts focused on augmenting the existing plant stock for Sprengel's sedge (Plate 3.3-4), Davis' locoweed, and, to a lesser degree, dryland sedge (Plate 3.3-5).

Table 3.2-1. Ex- situ Propagation Results from the 2019 Seed Collection Efforts

Common Name	Scientific Name	Nursery of Origin	Seeds Stratified Weight	Germination Percentage	Quantity and Size Produced in 2020
Sprengel's sedge	*C. sprengelii*	NATS	<0.1 g	~ 46%	7 seedlings
Torrey's sedge	*C. torreyi*	NATS	0.2 g	2%	2 seedlings
Dryland sedge	*C. xerantica*	NATS	1.0 g	> 90%	100 seedlings
Davis' locoweed	*O. campestris* var. *davisii*	NATS	3.6 g	~ 0.5%	56 seedlings
Slender penstemon	*P. gracilis*	NATS	0.3 g	> 10%	150 seedlings
Prairie buttercup	*R. rhomboideus*	NATS	0.45g	~ 27%	13 adult plants and 53 seedlings
Total					**381**

Plate 3.2-1. Slender penstemon produced in 2020.

Plate 3.2-2. Torrey's sedge seedlings produced in 2020.

Plate 3.2-3. Prairie buttercup stock produced in 2020.

Plate 3.2-4. Sprengel's sedge seedlings produced in 2020.

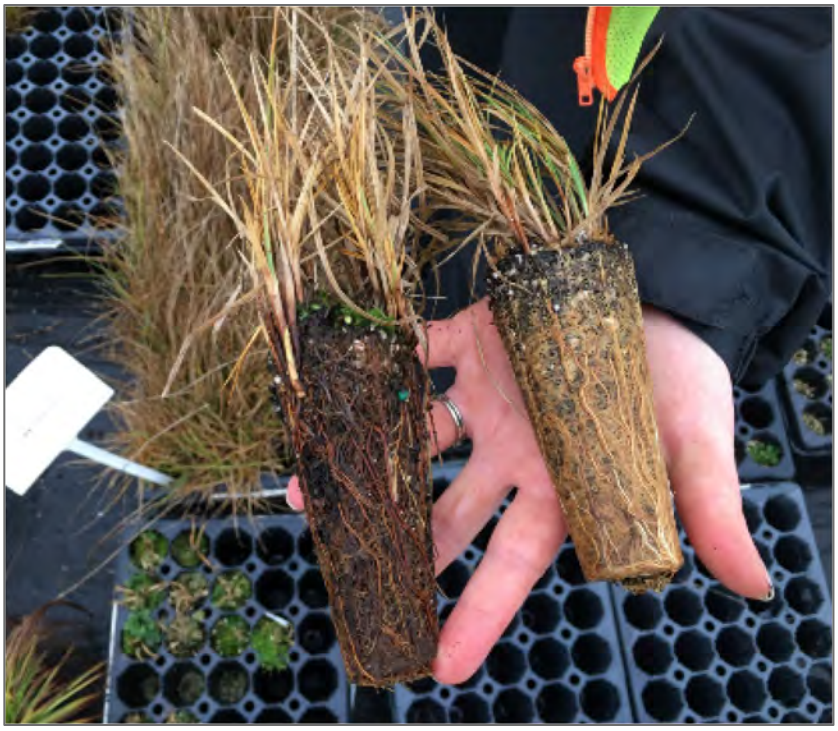


Plate 3.2-5. Dryland sedge seedlings produced in 2018 (left) and 2020 (right).

3.3 PHASE 3. TRANSLOCATION IMPLEMENTATION

Translocation implementation focused on planting trials at recipient sites that have greater long-term security than the locations of the source material. The recipient sites are within the known distribution range for the target plant within the Peace Region and have similar habitat to the location of the source material.

Four priority species were translocated in June and August 2020, including slender penstemon plants that had not been translocated in previous years. Trials were completed in June and August 2020. A total of 396 plants were planted at five recipient sites (Figures 3.3-1 and 3.3-2; Table 3.3-1).

Table 3.3-1. 2020 Species and Translocation Sites

Species	Site ID	No. of plants and type	Translocation Date 2020	Total
Dryland sedge	CAREXER-2020-D-50P	99 seedlings *	June 11	154
	CAREXER-2020-D-1G	5 adults**	August 30	
	CAREXER-2020-E-50P	50 seedlings	June 12	
Sprengel's sedge	CARESPR-2020-B-1G	5 adults	June 11	5
Davis' locoweed	OXYTCAM3-2020-B-1G	11 adults	June 13	190
	OXYTCAM3-2020-B-50P	90 seedlings	June 13	
	OXYTCAM3-2020-C-1G	14 adults	August 29	
	OXYTCAM3-2020-C-50P	75 seedlings	August 29	

Species	Site ID	No. of plants and type	Translocation Date 2020	Total
Slender penstemon	PENSGRA-2020-A-50P	25 seedlings	August 30	50
	PENSGRA-2020-B-50P	25 seedlings	August 30	
Total				**399**

* Seedlings are provided in 50P plug size containers which are 5" deep by 2" square

**Adults are provided in 1-gallon pots.

600000 610000 620000 630000 640000

6240000

CARESPR-2020-B
PENSGRA-2020-B
CAREXER-2020-D
CAREXER-2018-B
CAREXER-2018-A
PENSGRA-2020-A
CAREXER-2020-E
CAREXER-2019-C
OXYTCAM3-2018-A

Cache Creek
Charlie Lake
Beatton River
Peace River
Moberly River
Pine River
Fort St. John

29
97

6230000

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Site C Project

Experimental Rare Plant Translocation
Recipient Site Locations
Figure 3.3-1

Date: 2/16/2021
Map Number: BCH-047a
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC environmental consulting

Legend

2020 Recipient Sites

- *Carex sprengelii*
- *Carex xerantica*
- *Oxytropis campestris var. davisii*
- *Penstemon gracilis*

2018-2019 Recipient Sites

- *Carex xerantica*
- *Oxytropis campestris var. davisii*
- Highway

0 2 4 6
km
1:110,000

N

Sources: Esri, USGS, NOAA

640000 645000 650000 655000 660000 665000 670000 675000

6230000 6225000 6220000 6215000

OXYTCAM3-2018-A

Taylor

Beatton River

Pine River

OXYTCAM3-2020-B

OXYTCAM-2019-As

OXYTCAM3-2020-C

Peace River

97

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Site C Project

Experimental Rare Plant Translocation
Recipient Site Locations
Figure 3.3-2

Date: 2/16/2021
Map Number: BCH-047b
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC environmental consulting

Legend

2018-2019 Recipient Sites

Oxytropis campestris var. davisii

2020 Recipient Sites

Oxytropis campestris var. davisii

Highway

0 2 4 6
km
1:100,000

N

Sources: Esri, USGS, NOAA

3.3.1 *Dryland sedge (Carex xerantica)*

Two dryland sedge planting trials were established in June and August 2020: one within a Crown parcel on the north side of Highway 29 above Bear Flat (ID: CAREXER-2020-D; Figure 3.3-1) and one within a Crown parcel on the south side of Hwy 29 near the Peace River Valley Viewpoint (ID: CAREXER-2020-E, Figure 3.3-1). These two sites were trialed with the expectation of having greater plant survival due to lower browsing potential and soil conditions that are more favourable to the survival and growth of the species compared to the conditions at the 2018 and 2019 recipient sites.

A total of 154 seedlings were planted within these two grassland areas: 99 seedlings and 5 adults at CAREX-2020-D (Plates 3.3-1 to 3.3-4; Figures 3.3-3 to 3.3-7) and 50 seedlings at CAREXER-2020-E (Plates 3.3-5 to 3.3-8; Figure 3.3-8 and 3.3-9). The plants were placed within a small (5 cm width x 10 cm depth) or larger hole excavated for the plug or 1-gallon pot. The roots for each plug and pot were gently loosened before planting. Soil removed from the excavations were mixed with wetted nursery soil and then used to fill gaps within the holes. Excess plant roots and leaves as a result of excavation were placed around each plant to serve as a mulch. Individual plants were systematically tagged with numbered yellow or orange plastic tags fixed to the ground using 6-inch ground staples. Additional site preparation at site CAREXER-2020-D-50P included removal of goat's beard (*Tragopogon dubius*), an invasive plant species that could potentially outcompete dryland sedge. When translocation and data collection were complete, surrounding vegetation that was compacted by foot traffic was gently raked in an attempt to return the site to an undisturbed state. Some evidence of disturbance due the translocation efforts was noted at CAREXER-2020-E due to the highly erodible nature of the soils (i.e., predominantly silts; Plate 3.3-8).

Plate 3.3-1. Westward view of the recipient site – CAREXER 2020-D.

Plate 3.3-2. Eastward view of the recipient site – CAREXER-2020-D.

Plate 3.3-3. Dryland sedge- seedling plant installed at– CAREXER-2020-D.

Plate 3.3-4. Dryland sedge- adult plant installed at CAREXER-2020-D.

Plate 3.3-5. Westward view of the recipient site – CAREXER-2020-E.

Plate 3.3-6. Eastward view of the recipient site – CAREXER-2020-E.

Plate 3.3-7. Dryland sedge- seedling plant installed at–CAREXER-2020-E.

Plate 3.3-8. Evidence of low-level disturbance at CAREXER-2020-E due to trampling.

3.3.1.1 Sites CAREXER-2020-D-50P and CAREXER-2020-D-1G

In June 2020, four transects were established at the CAREXER-2020-D-50P location. Forty-five individuals were translocated to the first transect (Figure 3.3-3) with 15 individuals per row. Eleven individuals were translocated to the second transect in a single row (Figure 3.3-4). Twenty-seven individuals were translocated to the third transect (Figure 3.3-5) in two rows. Sixteen individuals were translocated to the fourth transect (Figure 3.3-6) with 7 plants in the top row and 9 plants in the bottom row. All plugs were planted approximately 50 cm apart. A post-translocation follow-up visit in October confirmed that all plants were alive and remained in good health.

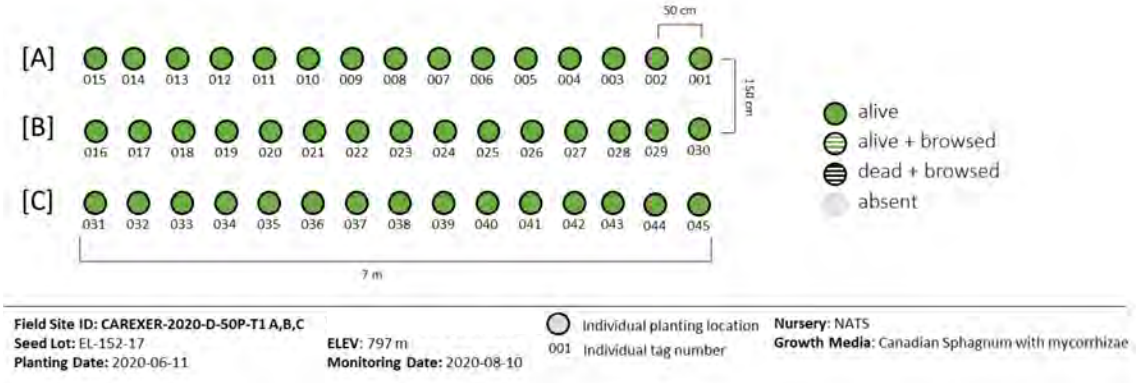


Figure 3.3-3. Planting Grid and 2020 Post-translocation Follow-up Results for Dryland Sedge at Site Id: CAREXER-2020-D-50P-Transects 1A, 1B, 1C

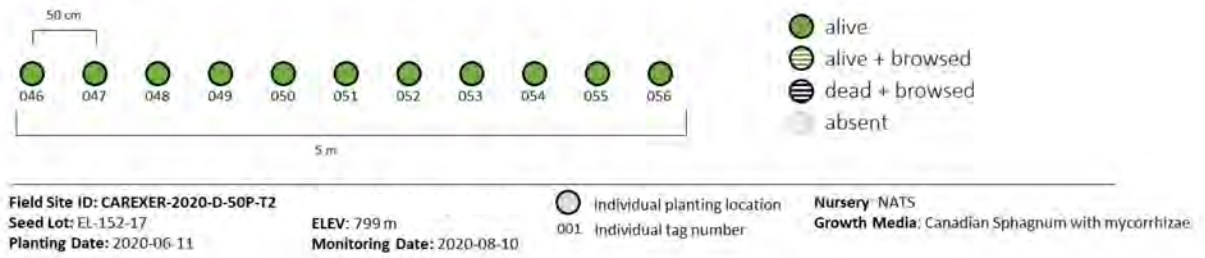


Figure 3.3-4. Planting Grid and Post-translocation Follow-up Results for Dryland Sedge at Site Id: CAREXER-2020-D-50P-Transect 2

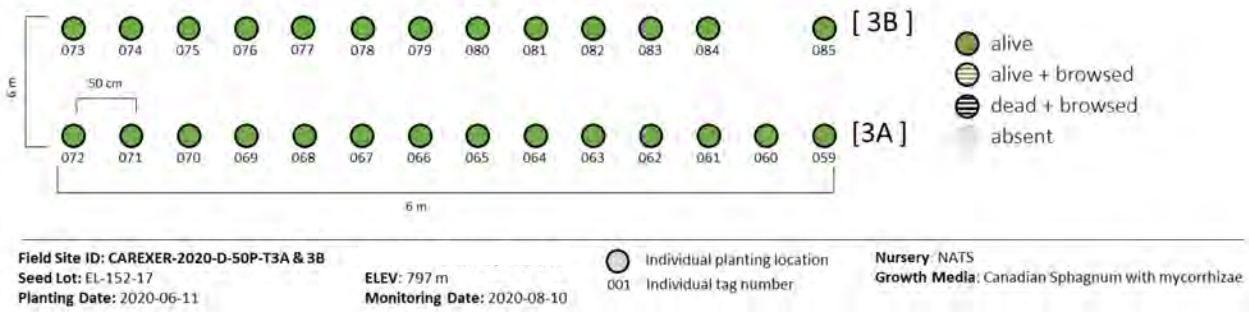


Figure 3.3-5. Planting Grid and Post-translocation Follow-up Results for Dryland Sedge at Site Id: CAREXER-2020-D-50P-Transect 3A & 3B

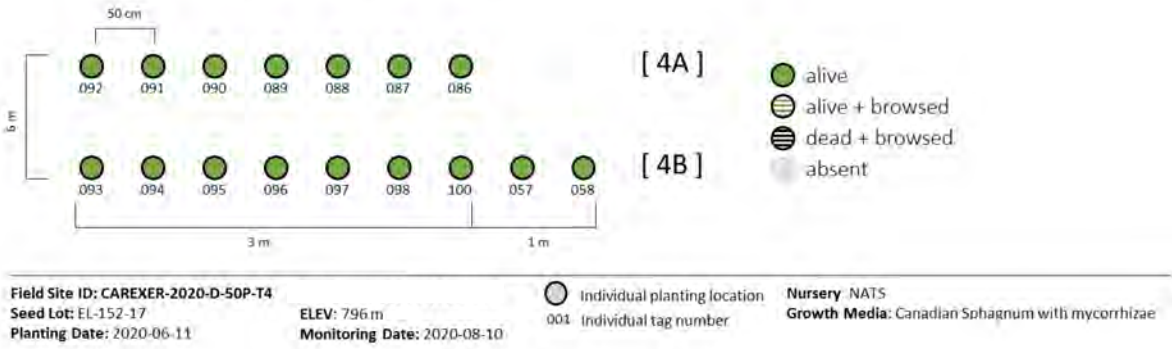


Figure 3.3-6. Planting Grid and Post-translocation Follow-up Results for Dryland Sedge at Site Id: CAREXER-2020-D-50P-Transect 4

In August 2020, five individuals in 1-gallon pots were translocated to site CAREXER-2020-D (Figure 3.3-7). These individuals were planted approximately 1-2 m apart in a somewhat linear pattern.

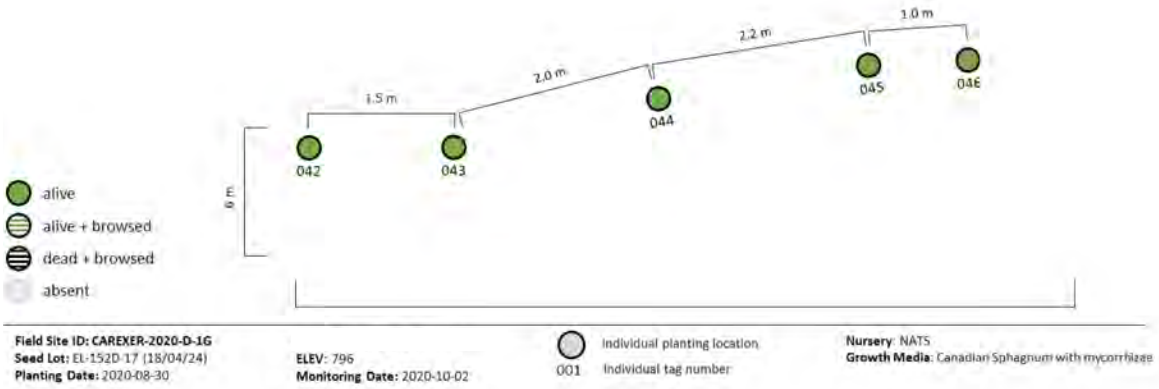


Figure 3.3-7. Planting Grid and Post-translocation Follow-up Results for Dryland Sedge at Site Id: CAREXER-2020-D-1G

3.3.1.2 Site CAREXER-2020-E-50P

In June 2020, two transects were established with a total of 50 individuals at the second 2020 Bear Flat location (site ID: CAREXER-2020-E-50P). Thirty individuals were planted in transect one (Figure 3.3-8), with 15 individuals per row, and 20 individuals were planted in transect two (Figure 3.3-9) with 10 individuals per row. Each individual was planted approximately 50 cm apart.

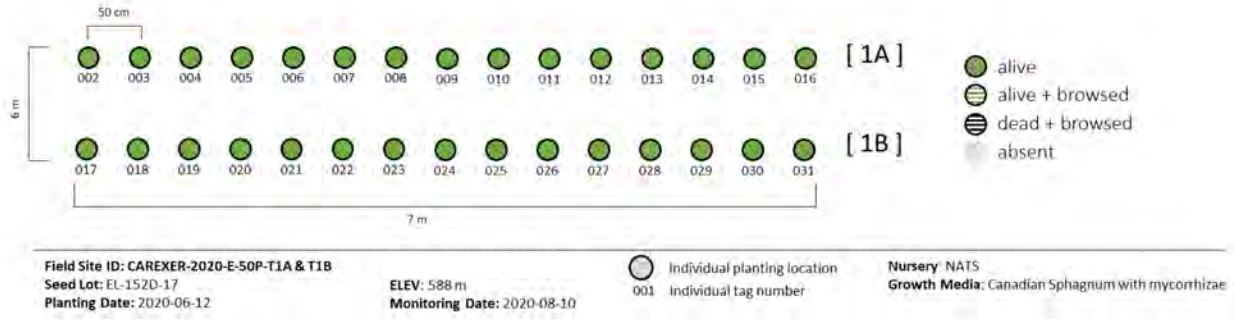


Figure 3.3-8. Planting Grid and Post-translocation Follow-up Results for Dryland Sedge at Site Id: CAREXER-2020-E-50P-Transect 1A & 1B

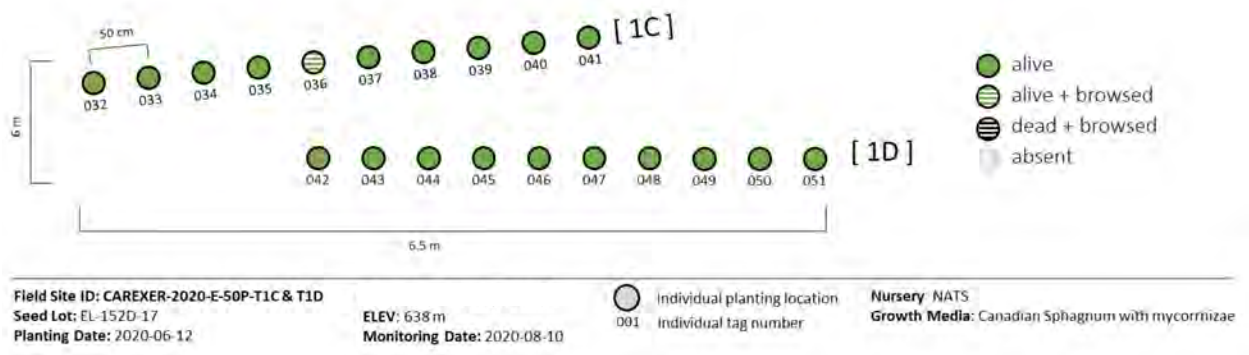


Figure 3.3-9. Planting Grid and Post-translocation Follow-up Results for Dryland Sedge at Site Id: CAREXER-2020-E-50P-Transects 1C & 1D

3.3.2 Sprengel's sedge (Carex sprengelii)

3.3.2.1 Sites CARESPR-2020-B-1G-1A and CARESPR-2020-B-1G-1B

One planting trial for Sprengel's sedge was established on the north side of Highway 29 above Bear Flat (Figure 3.3-10) on June 11, 2020. A total of five adult plants were planted in a moist open willow thicket in two groups separated by 100 m: Site ID: CARESPR-2020-B-1G-1A (Plates 3.3-9 and 3.3-10); Site ID: CARESPR-2020-B-1G-1B (Plates 3.3-11 and 3.3-12). The roots of each plant were gently loosened before placing each individual into excavated holes. Each hole was backfilled with the existing excavated soil that did not require additional water, as the natural soil held sufficient moisture. Each plant was systematically tagged with a numbered yellow plastic tag fixed to the ground using 6-inch ground staples.

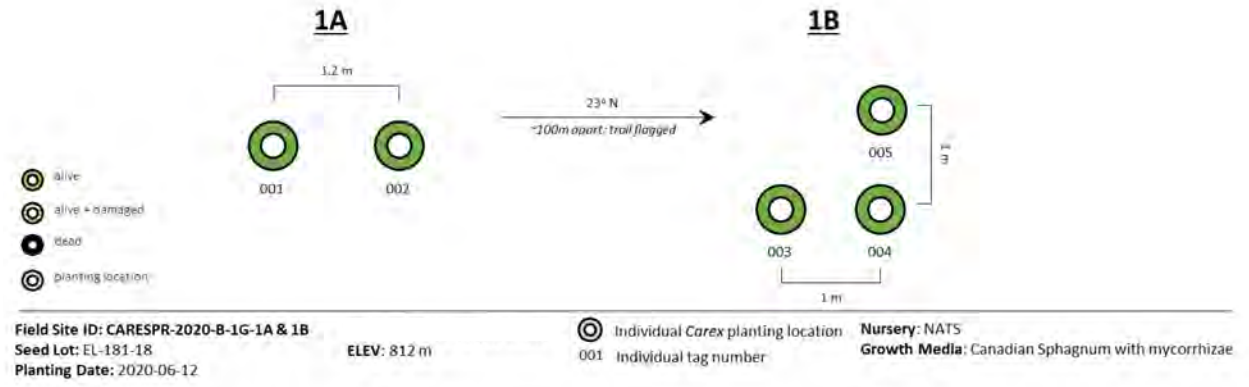


Figure 3.3-10. Planting Grid and Follow-up Results for Sprengel's Sedge at Site Id: CARESPR-2020-B-1G-1A & 1B

Plate 3.3-9. Planting site for *Sprengel's sedge* – CARESPR-2020-B-1G-1A.

Plate 3.3-10 Installed *Sprengel's sedge* and identification tag.

Plate 3.3-11. Planting site for *Sprengel's sedge* – CARESPR-2020-B-1G-1B.

Plate 3.3-12. Installed *Sprengel's sedge* and identification tag.

3.3.3 *Davis' locoweed (Oxytropis campestris var. davisii)*

Two planting trials for Davis' locoweed seedling (i.e., plugs) and adults were completed in June and August 2020 within areas downstream of the town of Taylor, BC (Figure 3.3-2): OXYTCAM3-2020-B and OXYTCAM3-2020-C.

3.3.3.1 Site OXYTCAM3-2020-B

Translocation occurred at OXYTCAM3-2020-B on June 13, 2020. For ease and efficiency of planting within the challenging substrate (predominantly cobbles with some sand), trenches were pre-excavated instead of creating individual holes for each plant (Plates 3.3-13 to 3.3-16). Plugs were lined up within the trenches

before back-filling (Plate 3.3-15). Using a sieving method, the excavated sandy soil was separated from the cobble and mixed with wetted nursery soil to be used as back-fill. The cobble was then used to fill in gaps and was placed around each plant to be flush with the existing grade. Any mosses that existed in the designated planting areas were carefully removed before excavation and replaced after planting.

Prior to planting, a few plants from the June 2020 translocation showed signs of stress (i.e., wilting:). While the cause is unknown, the wilting may have occurred as a result of the plants being covered with a tarp the night before to protect them from heavy rains. Damage and extent of damage to these individuals were noted. Seeds collected from several plants as a result of dead-heading at the nursery were scattered around the adult plants at the planting sites.

Plate 3.3-13. Pre-planting trench for Davis' locoweed at SITE ID: OXYTCAM3-2020-B.

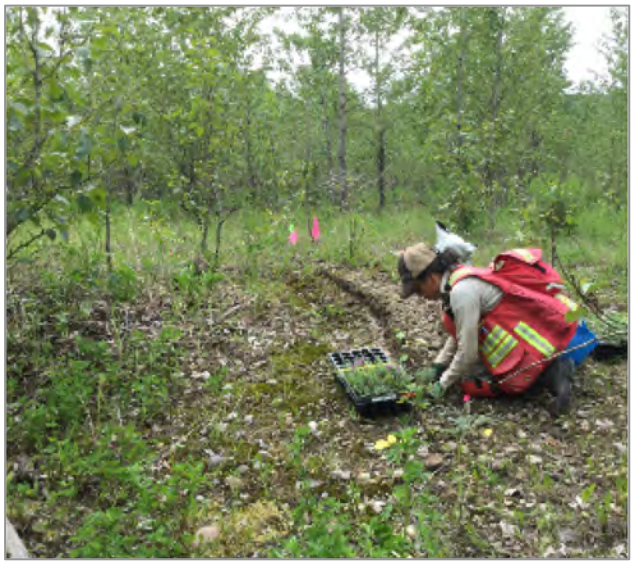


Plate 3.3-14. Davis' locoweed being planted within the trench at SITE ID: OXYTCAM3-2020-B.

Plate 3.3-15. Example of seedling (50P) Davis' locoweed transplanted.

Plate 3.3-16. Example of an adult Davis'(1G) transplanted at Site Id OXYTCAM3-2020-B.

In June 2020, six transects were established at site OXYTXAM3-2020-B-50P, with a total of 90 seedling plugs (individuals planted approximately 15 cm apart) and 11 adults. Single rows of 10 plants were translocated to transects 1, 2, and 3 (Figure 3.3-11), with four adult individuals planted as a group in a 1 x 1-m configuration between transects 1 and 2. Transects 4 and 5 (Figure 3.3-12) were established with a total of 30 plugs (10 plugs in transect 4 and 20 plugs in transect 5), with a row of four adult individuals planted in between the two transects, spaced approximately 50 cm apart. In transect 6 (Figure 3.3-13), a total of 30 plugs were translocated and established in a curved "T" configuration. Three adult individuals were also planted approximately 5 m NE from these transects.

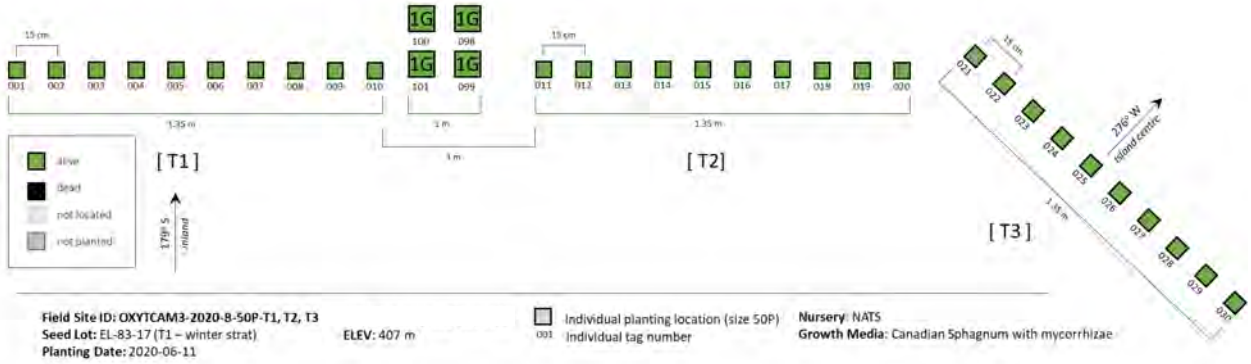


Figure 3.3-11. Planting Grid for Davis' Locoweed at Site Id: OXYTCAM3-2020-B-50P-Transects 1, 2, 3

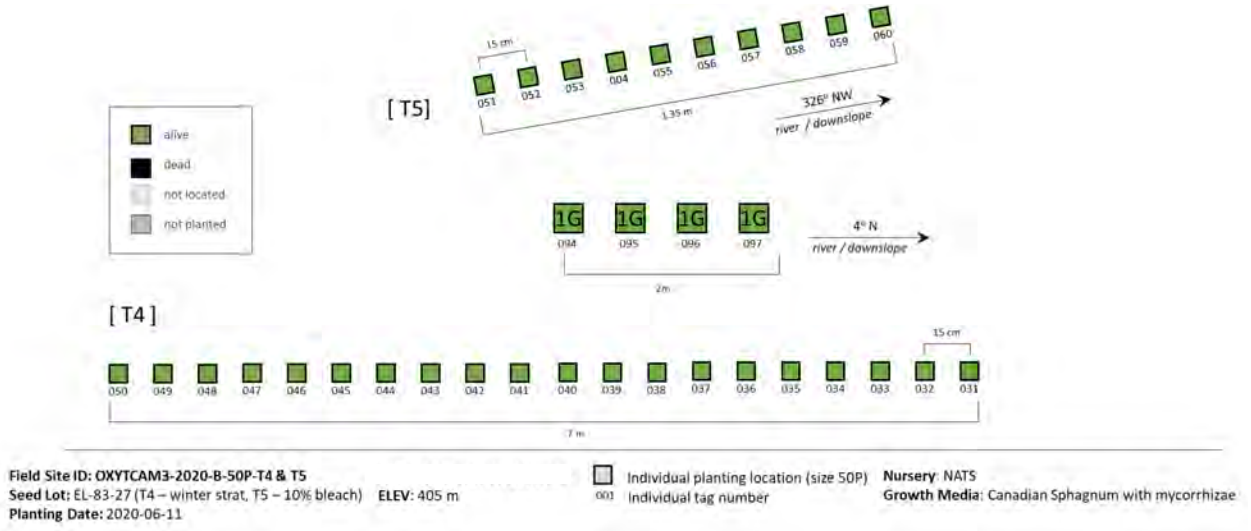


Figure 3.3-12. Planting Grid for Davis' Locoweed at Site Id: OXYTCAM3-2020-B-50P-Transects 4 & 5

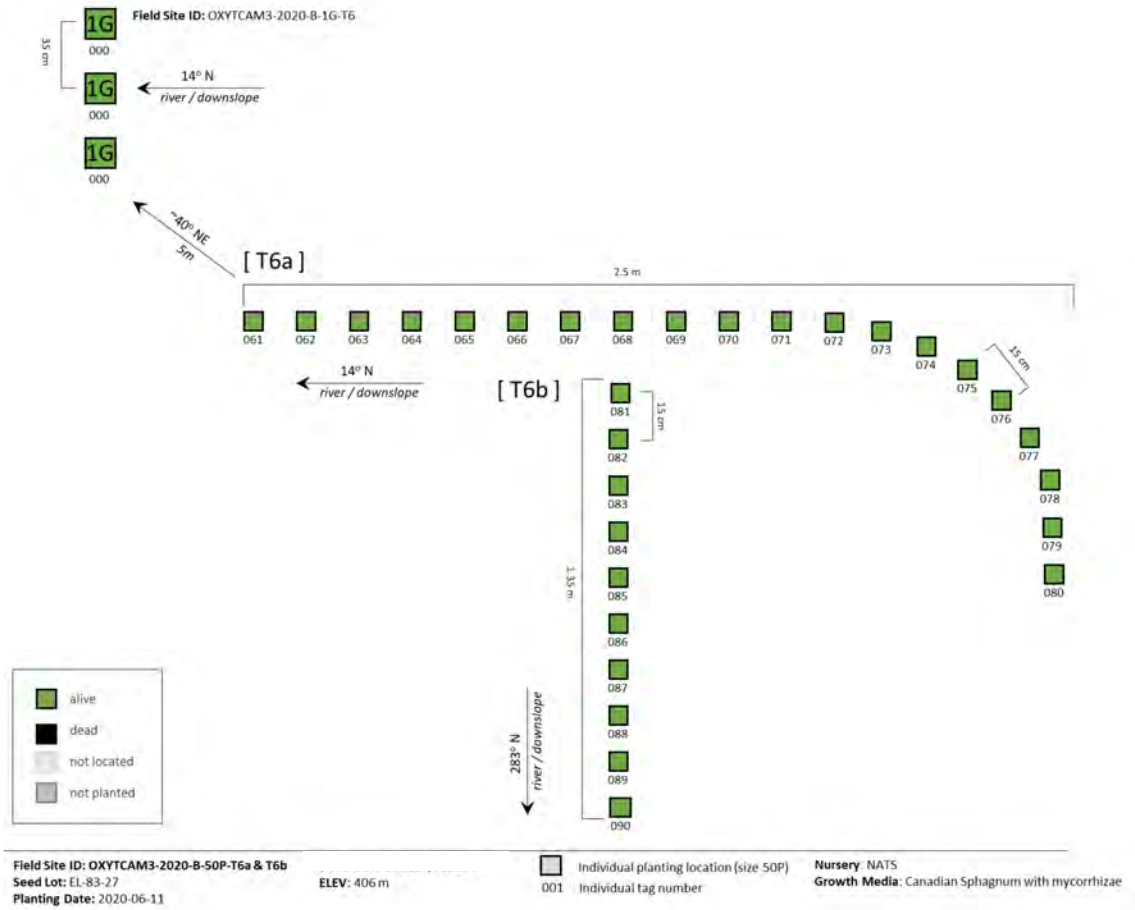


Figure 3.3-13. Planting Grid for Davis' Locoweed at Site Id: OXYTCAM3-2020-B-50P-Transects 6a & 6b

3.3.3.2 Site OXYTCAM3-2020-C

In August 2020, two plots were established at OXYTCAM3-2020-C, with one plot (Figure 3.3-14) consisting of a total of 75 translocated seedlings clustered in three groups of 23, 25, and 27 individuals, respectively (Plate 3.3-17 and 3.3-18). The second plot consisted (Figure 3.3-15) of a total of 17 translocated adult individuals (Plate 3.3-19 and 3.3-20) clustered in one group of 5 individuals and two groups of 6 individuals.

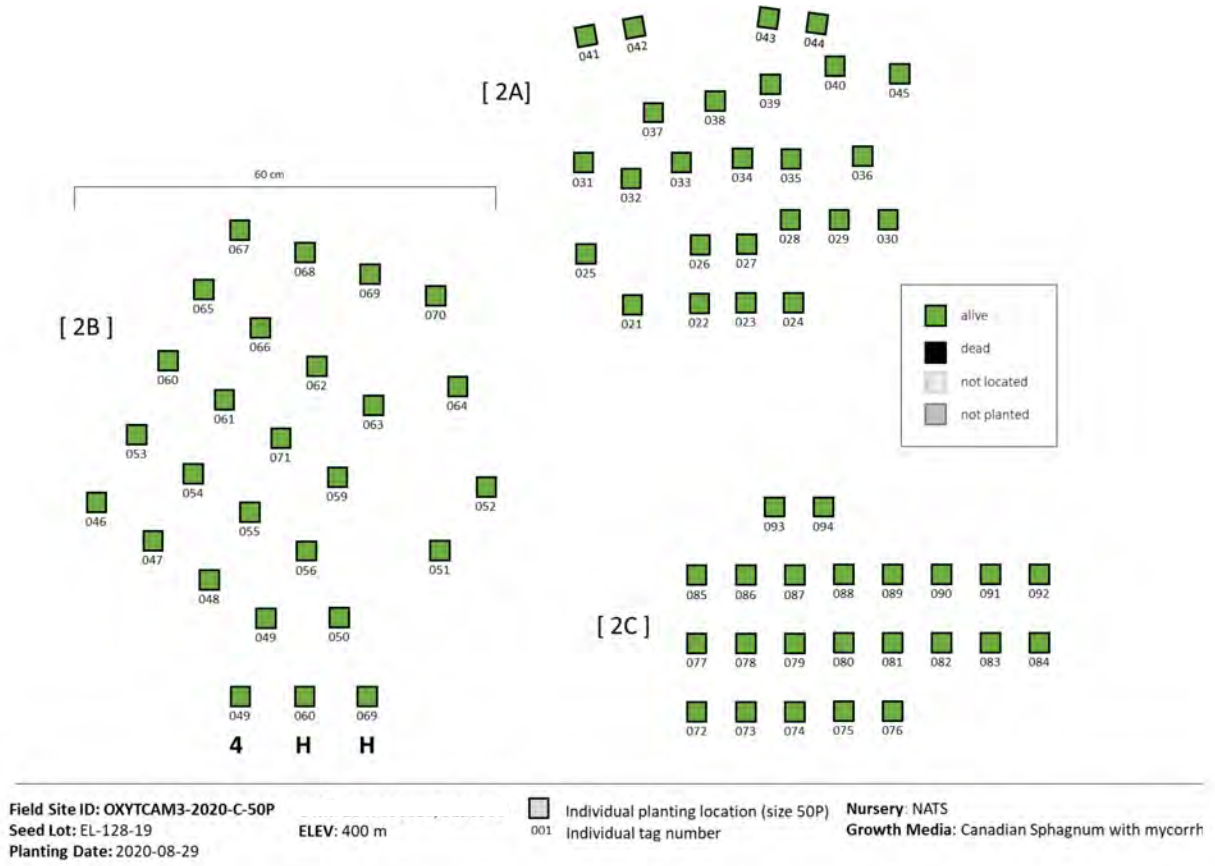


Figure 3.3-14. Planting Grid for Davis' Locoweed at Site ID: OXYTCAM3-2020-C-50P

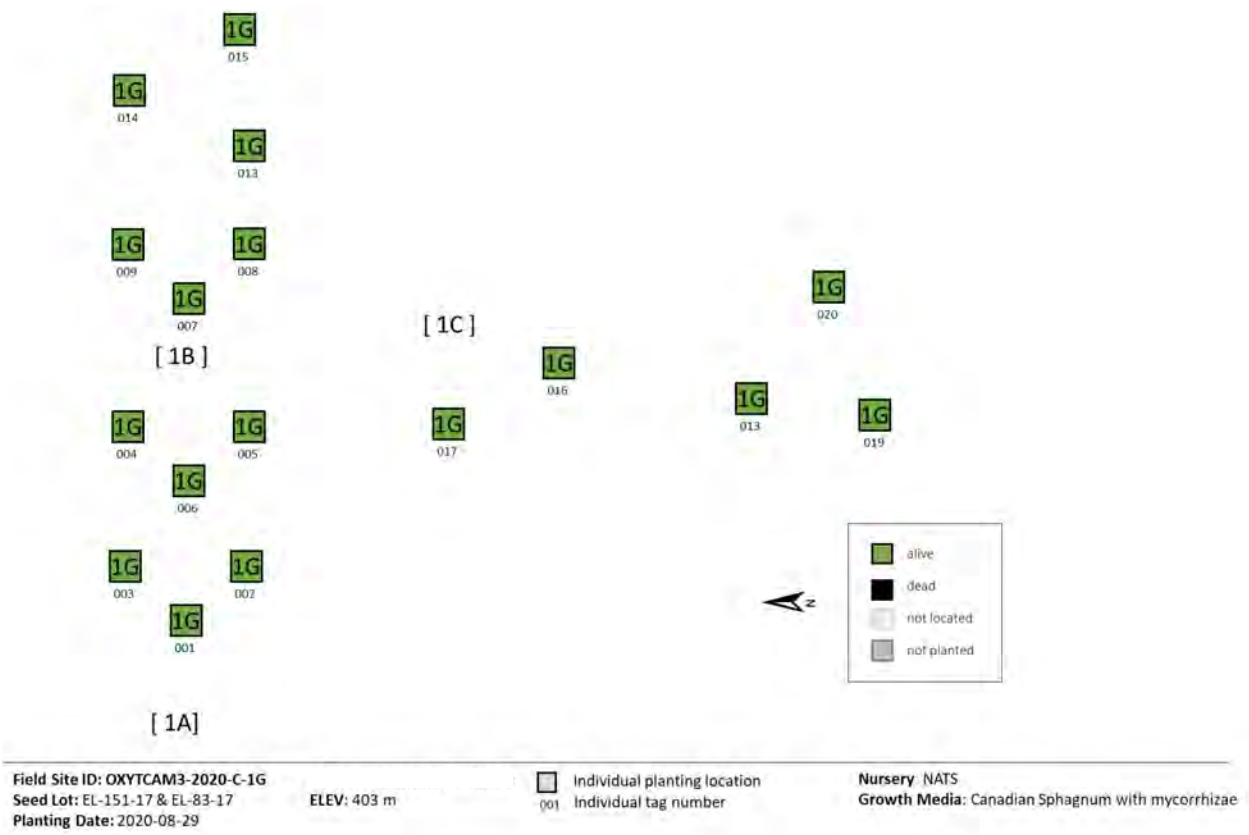


Figure 3.3-15. Planting Grid for Davis' Locoweed at Site ID: OXYTCAM3-2020-C-1G

Plate 3.3-17. Example of a Davis' locoweed seedling planted at Site Id:OXYTCAM3-2020-C.

Plate 3.3-18. Close up on Davis' locoweed seedling planted in the ground at Site Id: OXYTCAM3-2020-C.

Plate 3.3-19. Example of the trench dug for the Davis' locoweed adult plants at Site Id: OXYTCAM3-2020-C.

Plate 3.3-20. Davis' locoweed adults planted and tagged at Site Id: OXYTCAM3-2020-C.

In total, 190 Davis' locoweed plants were translocated in 2020. The status of the individuals planted in June at Site: OXYTCAM3-2020-B were assessed in August to determine if recent flooding events on the Peace River had affected the survival of the plants. Although there was clear evidence of flooding over portions of the site (e.g., tags partially covered in silt; Plate 3.3-21), most of the plants survived this event (Plate 3.3-22).

Plate 3.3-21. Tag partially covered in silt at Site ID OXYTCAM3-2020-B.

Plate 3.3-22. A Davis' locoweed seedling that survived the flood event.

3.3.4 Slender penstemon (Penstemon gracilis)

Slender penstemon was planted at two sites alongside the dryland sedge transplants (Figure 3.3-1; see also Section 3.3-1). In total, 50 plants were translocated in August 2020: 25 individuals at Site ID: PENSGRA-2020-A-50P (Figure 3.3-23 and Plates 3.3-24) and 25 individuals planted at Site ID: PENSGRA-2020-B-50P (Figure 3.3-25; and Plate 3.3-26). At the first site (Figure 3.3-16), a total of 25 individuals were translocated in distinct rows or clusters of five individuals adjacent to rows C and D of CAREXER-2020-E50P.

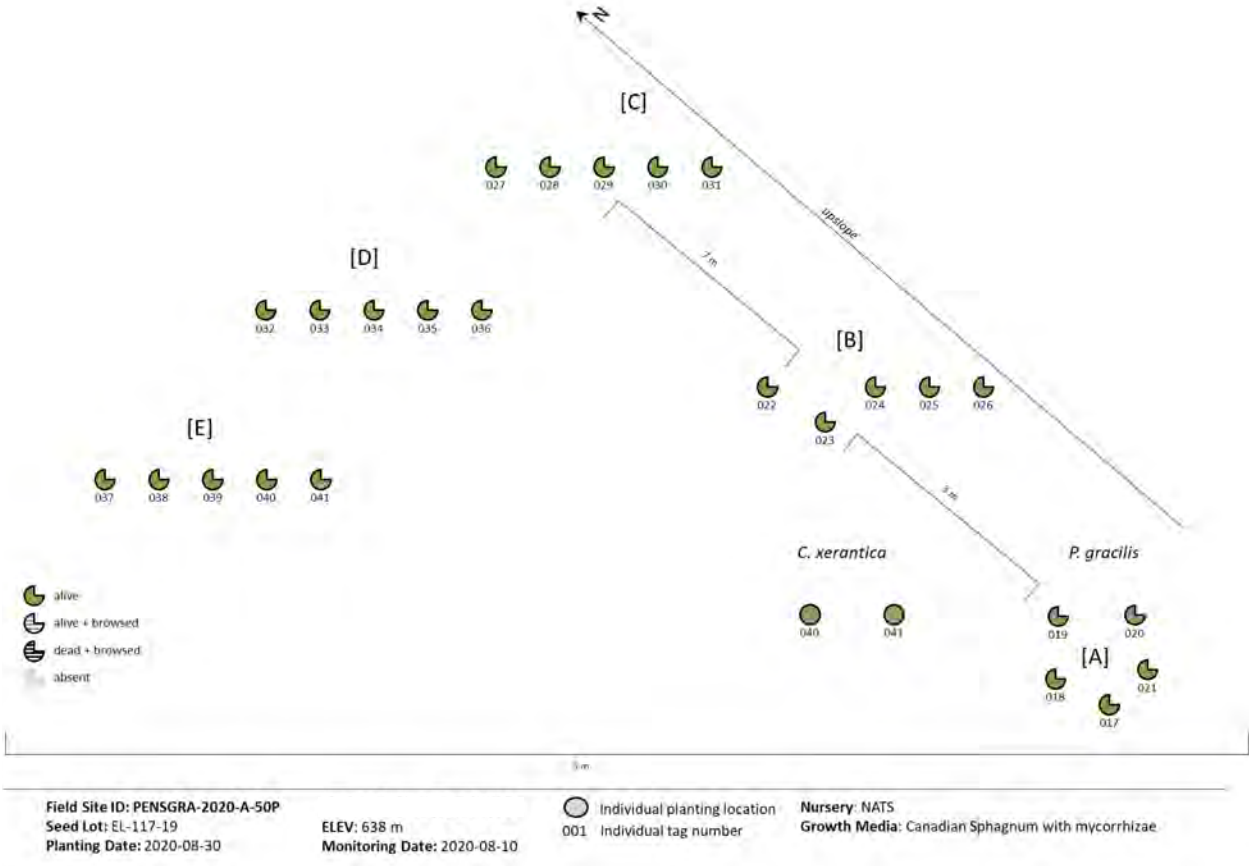


Figure 3.3-16. Planting Grid and Follow-up Results for Slender Penstemon at Site Id: PENGRA-2020-A-50P

Plate 3.3-23. Translocated slender penstemon with identification tags – PENSGRA-2020-A-50P.

Plate 3.3-24. Translocated slender penstemon with identification tags – PENSGRA-2020-B-50P.

At the second site (Figure 3.3-17), a total of 25 individuals were planted in two distinct transects. The first transect consisted of three rows of 5 individuals and the second transect consisted of one row of 10 individuals.

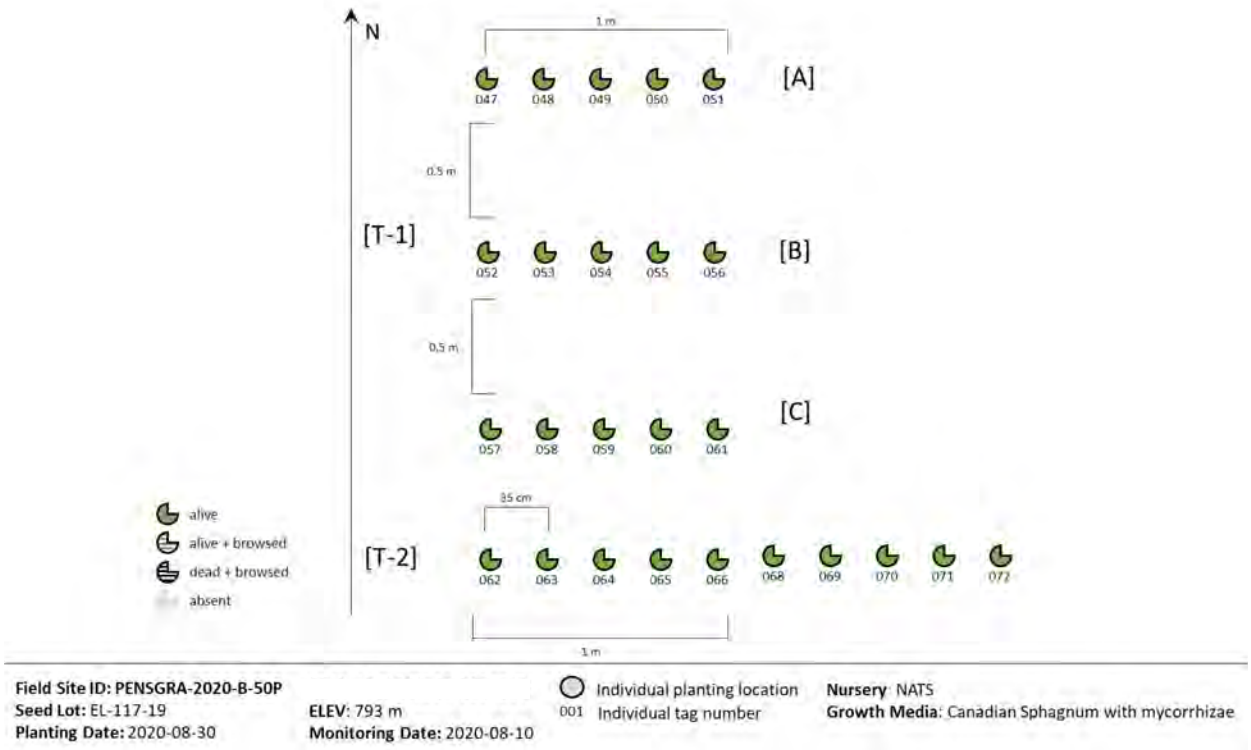


Figure 3.3-17. Planting Grid and Follow-up Results for Slender Penstemon at Site Id: PENGRA-2020-B-50P

3.4 MONITORING

Translocated and seeded populations were monitored two to three times each in 2020 to correspond with seasonal changes in the life history of each species (Table 3.4-1). An early spring visit determined

overwintering survival, a visit during the summer (targeted to correspond with the potential flowering period) assessed vigour, and a visit during the fall assessed survival after transplant for those species planted in August. Monitoring frequency was increased following any interventions to address population or health declines.

Two levels of monitoring were conducted in 2020. A more complete assessment was conducted to determine the survival and health of the population in June or August, whereas interim monitoring efforts (general observations, check-up, and intervention) were conducted in July, September, and/or October (Table 3.4-1). Data collected from monitoring activities since 2019 have been used to identify successes and failures in order to improve the survival of future plantings. Preliminary outcomes of management prescriptions in response to declines in survival or fitness of translocated individuals have been addressed in the sections below, where applicable.

Table 3.4-1. 2020 Species and Monitoring Sites

Species	Site ID	Monitoring Date(s) 2020
Dryland Sedge (*C. xerantica*)	CAREXER-2018-A-50P	June 12 and August 14
	CAREXER-2018-B-50P	June 12
	CAREXER-2019-C-50P	June 10 and August 10
	CAREXER-2020-D-50P	July 30, August 10, September 10, October 2
	CAREXER-2020-D-1G	September 10, October 2
	CAREXER-2020-E-50P	July 30, August 10, September 10, October 2
Slender penstemon (*P. gracilis*)	PENSGRA-2020-A-50P	September 10, October 2
	PENSGRA-2020-B-50P	September 10, October 2
Sprengel's sedge (*C. sprengelii*)	CARESPR-2020-B-1G	July 30, August 10, September 10, October 2
Davis' locoweed (*O. campestris* var. *davisii*)	OXYTCAM3-2018-A-50P	August 12
	OXYTCAM3-2018-As	July 31 and August 13
	OXYTCAM3-2020-B-50P	July 31

3.4.1 Dryland sedge (Carex xerantica)

Dryland sedges that were planted in September 2018 at Bear Flat (ID: CAREXER-2018-A-50P) were monitored for the first time in June 2019 and again in August 2020. Of the 42 individuals planted, 13 were alive (2 had been browsed), 14 were dead, and 15 were absent (Figure 3.4-1). In 2019, the seven plants that were alive were generally in good health; however, three of the seven were declared dead or absent in 2020. Eight individuals that were considered dead or absent in 2019 were observed to be alive in 2020. Possible explanations for the increase in survival of transplants from 17% in 2019 to 31% in 2020 include misidentifying individuals and mistaking plant dormancy for death. To improve future identification of planted individuals, wooden circles were placed on several plants on site ID CAREXER-2020-E-50P. The

efficacy of this technique will be confirmed during monitoring in 2021. Detecting herbivory in previous years may not substantiate mortality of an individual in the following year. In 2019, individuals that were alive and browsed were observed to be dead, absent, or alive in 2020. The extent of herbivory may influence the survivability of an individual, in conjunction with other factors contributing to plant health and resiliency. Individuals will continue to be monitored in follow-up years.

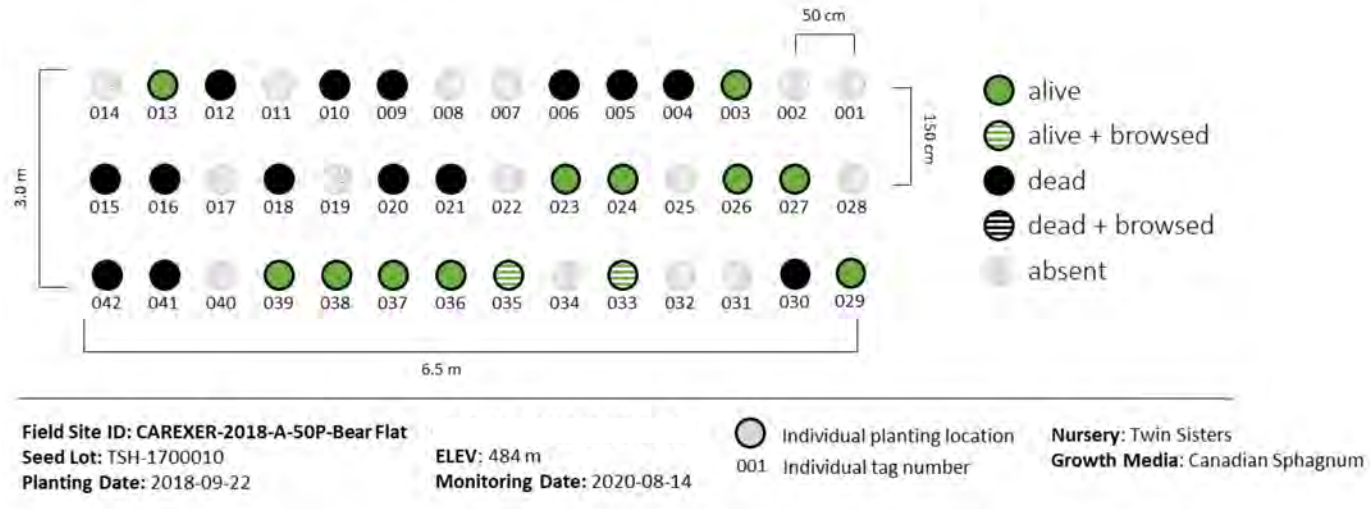


Figure 3.4-1. Planting Grid and 2020 Monitoring Results for Dryland Sedge at Field Site ID: CAREXER-2018-A-50P-Bear Flat

Dryland sedges that were planted in September 2018 at the second Bear Flat location (ID: CAREXER-2018-B-50P) and monitored for the first time in 2019 were monitored again in August 2020. Of the 45 individuals planted, 17 were alive, 5 were dead, and 23 were absent (Figure 3.4-2). Although the same number of plants survived in both 2019 and 2020, a few plants that were alive in 2019 were observed to be dead or absent in 2020. Similar to what was observed at the other occurrence at Bear Flat (Figure 3.4-1), a few plants that were considered dead or absent in 2019 were noted as alive in 2020. As well, individuals that showed signs of herbivory in 2019 had either survived or died in 2020. Signs of herbivory were prevalent in 2019, whereas herbivory was not observed in the remaining individuals in 2020. Individuals will continue to be monitored in follow-up years.

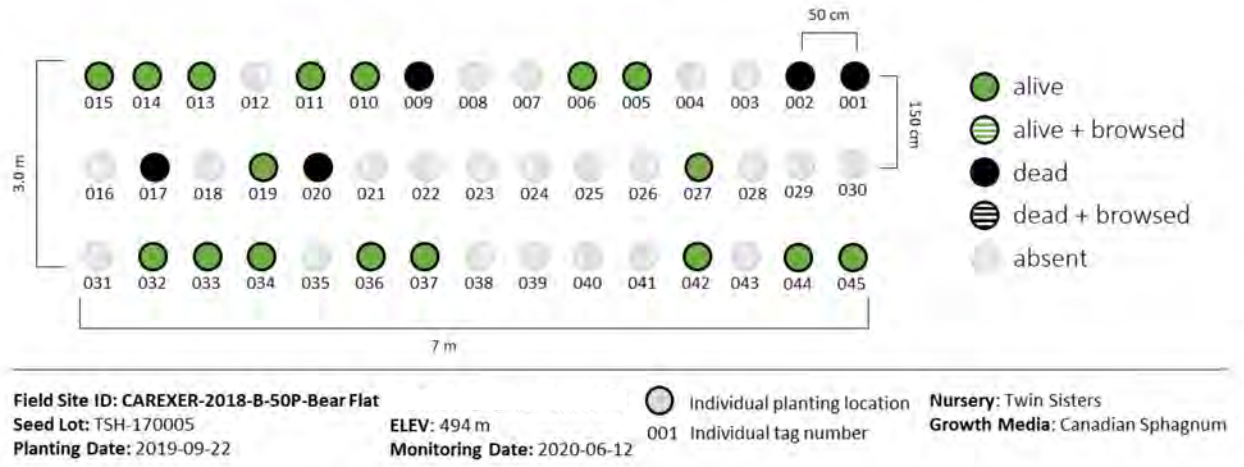


Figure 3.4-2. Planting Grid and 2020 Monitoring Results for Dryland Sedge at Field Site ID: CAREXER-2018-B-50P-Bear Flat

Dryland sedges that were planted in June 2019 at location ID CAREXER-2019-C-50P were monitored for the first time in July 2019 and monitored again in June and August 2020. Of the 50 individuals planted, 35 were alive, 3 were dead, and 12 were absent in the final monitoring in August 2020 (Figure 3.4-3). In 2020, 70% of individuals survived, compared to 78% that survived in 2019. Overall plant condition was observed to range between moderate and very poor. Most individuals appeared to show signs of drought stress and poor growth. Signs of herbivory were observed in only three individuals (Figure 3.4-3). Individuals will continue to be monitored in follow-up years.

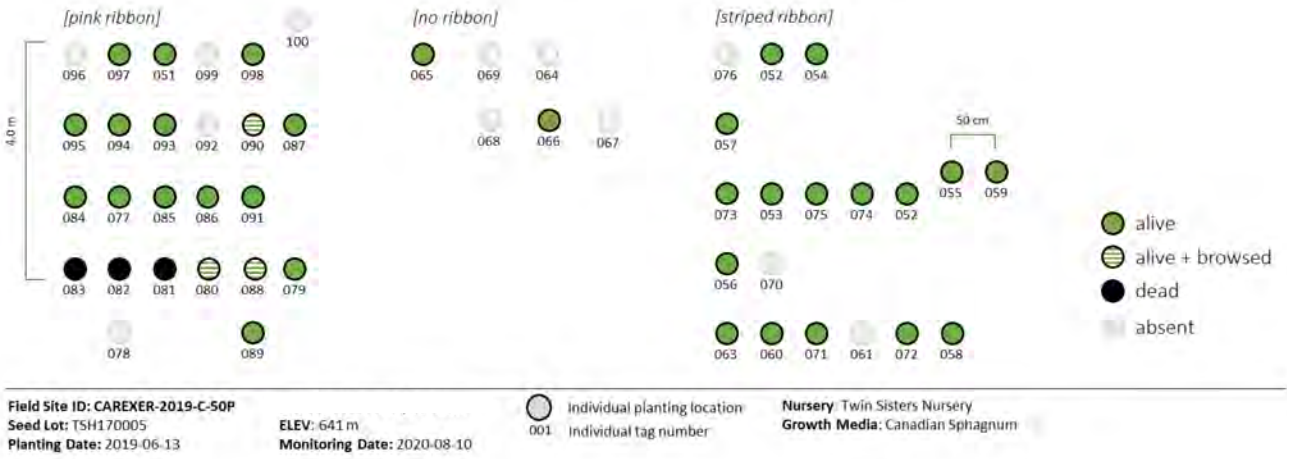


Figure 3.4-3. Planting Grid and 2020 Monitoring Results for Dryland Sedge at Field Site ID: CAREXER-2019-C-50P

In response to high herbivory observed at dryland sedge sites in 2018 and 2019 (Figures 3.4-1 to 3.4-3), two new recipient sites with lower grazing potential (ID: CAREXER-2020-D-50P-T1-4, Figures 3.3-2 to 3.3-6, and CAREXER-2020-E-50P-T1, Figures 3.3-7 to 3.3-8) were established in 2020.

These individuals, which were planted in June 2020, underwent a monitoring assessment for the first time in August, with follow up monitoring occurring in September and/or October.

Based on preliminary monitoring observations, all transplants at both sites were alive and found to be in good condition, with little to no herbivory observed. Signs of herbivory were only detected in one individual at site CAREXER-2020-E-50P-T1C (Figure 3.3-8). In September, site conditions at CAREXER-2020-D-50P were observed to be quite dry and each individual was watered to mitigate for drought stress. According to October interim monitoring efforts, sites CAREXER-2020-D-50P and CAREXER-2020-E-50P (Figures 3.3-3 to 3.3-9) had evidence of wildlife activity in the area (e.g., animal trails, tracks); however, all plants had avoided browsing and significant trampling. Final interim monitoring results indicated that all individuals at both sites were alive and in good condition (Plates 3.4-1 and 3.4-2).

Adult dryland sedges transplanted in August (Figure 3.3-6) were monitored in September and October 2020. In September, two of the individuals had been pulled from the ground, possibly by a bear. These individuals were thoroughly watered and re-planted. In October, all plants, including those that had been re-planted, appeared to be in good condition and not subject to herbivory or trampling (Plate 3.4-3).

Plate 3.4-1. Dryland sedge during July monitoring – CAREXER-2020-D-50P.

Plate 3.4-2. Dryland sedge during October monitoring – CAREXER-2020-D-50P.

Plate 3.4-3. Adult Dryland sedge monitored in October – CAREXER-2020-D-1G.

3.4.2 Sprengel's sedge (Carex sprengelii)

Sprengel's sedges transplanted in June 2020 (Figure 3.3-9) were monitored in July, August, September, and October 2020. The last monitoring assessment in October revealed that all five plants were in good condition (Plate 3.4-4). The two plants in site 1A showed no signs of herbivory during all monitoring sessions. In September, site 1B showed signs of significant moose activity including browsing, bedding, rubbing, and droppings in the area. Individual 004 was slightly browsed (Plate 3.4-5) and 003 had been flattened by bedding. Despite these impacts, all individuals were alive and healthy in October. Site 1B was fortified with branches in August and October to deter ungulates from bedding and browsing in the area. Success of this intervention and condition of plants will continue to be monitored in future years.

Plate 3.4-4. Sprengel's sedge in July - at Site Id: CARESPR-2020-1B.

Plate 3.4-5. Sprengel's sedge in October at Site Id: CARESPR-2020-1B.

3.4.3 Davis' locoweed (Oxytropis campestris var. davisii)

Davis' locoweed translocated in September 2018 along the Peace River west of Taylor, BC (ID: OXYTCAM3-2018-A-50P), were monitored four times during the course of the field season. Three reconnaissance trips were completed. The first site visit was completed on July 14, 2020, in conjunction with the Downstream Monitoring Program. During this visit, the botanist reported that a portion of the planting site was under water. The portions that were not under water were covered in silt and sand from an earlier flood event (Plate 3.4-6). The second visit was conducted on July 25, 2020, by a local boat operator who passed by the site to evaluate the water levels while conducting work in the area. He indicated that a portion of the site was underwater. The third site visit was completed on July 31, 2020. During this visit, the botanists reported that numerous plants were visible and thus additional monitoring was likely warranted. The final site visit was completed on August 12, 2020. During the final trip, several tags were visible; however, few target plants were detected, none of which could be positively confirmed as those that had been transplanted (Plate 3.4-7).

Plate 3.4-6. Example of silt and sand that covered the planting location nearest to the Peace River (photo taken on July 14, 2020).

Plate 3.4-7. Example of a visible tag but no identifiable plant along Transect 30 at subplot 25 (photo taken on August 12, 2020).

Seeding trials that had commenced in June 2019 (ID: OXYTCAM3-2019-As) were monitored for the first time in September 2019 and monitored again in August 2020. In September 2019, 24 of 900 seeds had germinated (Plates 3.4-8 and 3.4-9). Of the 24 that had germinated in 2019, 19 had survived to the August 2020 monitoring session, with an additional 49 seeds germinating from the remaining 876 seeds. Although 2019 yielded a low germination rate, the number of seeds germinating in the second year had doubled. Monitoring of germination rates and seedling survival will continue in future years.

Plate 3.4-8. Example of seeding quadrat for Davis' locoweed at Site Id: OXYTCAM3-2019-As.

Plate 3.4-9. Example of Davis' locoweed seedling at Site Id: OXYTCAM3-2019-As.

3.4.4 *Slender penstemon (Penstemon gracilis)*

Interim assessments were conducted in September and October for both sites (ID: PENSGRA-2020-A-50P and PENSGRA-2020-B-50P). In September, the individuals at site A (same site as CAREXER-2020-E-50P) were observed to be dry. All individuals were watered to mitigate dry conditions. Site B (same site as CAREXER-2020-D-50P) was observed to be less dry, with all individuals appearing to be in relatively good health. In September, all individuals at both sites were found to be present and had avoided herbivory and trampling despite evidence of wildlife activity in the area (e.g., wildlife trails, tracks; Plates 3.4-10 and 3.4-11).

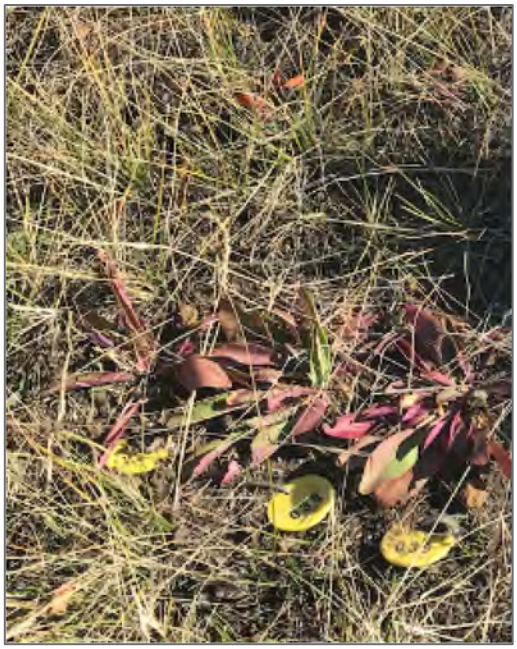


Plate 3.4-10. Slender penstemon monitored in October at Site id: PENSGRA-2020-A.

Plate 3.4-11. Slender penstemon monitored in October at Site id: PENSGRA-2020-B.

3.4.5 Summary of Monitoring Results

Table 3.4-2 provides a summary of the monitoring results from 2019 and 2020. The table is organized by site and provides the number of translocated and seeded individuals, as well as the corresponding percent survival calculated for each monitoring year, where applicable.

Table 3.4-2. Summary of Monitoring Results in 2019 and 2020.

Site	# Planted/Seeded	% Survival (2019)	% Survival (2020)
CAREXER-2018-A-50P	42	17	31
CAREXER-2018-B-50P	45	38	38
OXYTCAM3-2018-A-50P	163	38	-*
OXYTCAM3-2018-As	900	2.7	7.6
CAREXER-2019-C-50P	50	78	70
CAREXER-2020-D-50P	99	-	100
CAREXER-2020-D-1G	5	-	100
CAREXER-2020-E-50P	50	-	100
PENSGRA-2020-A-50P	25	-	100
PENSGRA-2020-B-50P	25	-	100
CARESPR-2020-B-1G	5	-	100

* Unable to determine % survival due to flooding of the site.

3.5 PLAN FORWARD

Information gained from the 2020 program will inform improvements to project methods and management in 2021. The propagation of seeds collected in 2017 through 2020 has resulted in varying degrees of success, with nurseries continuously assessing the efficacy of existing propagation methods and developing improved protocols for the experimental out-planting trials. Specifically, propagation protocols are being developed for species new to the 2020 program (i.e., Canada mountain-ricegrass, rock selaginella) and are being refined for species with longer stratification periods (e.g., slender penstemon) and lower germination rates (e.g., Torrey's sedge). Future efforts will continue to focus on additional propagule collection, as well as recipient site selection for Canada mountain-ricegrass and rock selaginella. Augmentation of existing recipient sites for Davis' locoweed, Sprengel's sedge, and slender penstemon will also occur in 2021 to boost populations at sites with environmental conditions that are known to be suitable for these species.

In conjunction with enhancing existing populations, future efforts will also be dedicated to understanding population dynamics of each species using ongoing monitoring data. However, at this early stage of program implementation, it difficult to predict which analytical approaches will be appropriate to address questions related to population dynamics. For example, constraints imposed by small sample sizes or cohort sizes will limit analytical options for many target species. For species with larger potential sample sizes both within and across occupied sites (e.g., Davis' locoweed), standard vital rate regression-based analyses based on counts of individuals will be conducted. In addition, the program will evaluate whether analyses-based population-level data (e.g., percent cover), which are simpler to apply over broader spatial areas, may have value as a rapid assessment tool (e.g., Tredennick et al. 2017). In addition, increasing monitoring efforts will provide opportunities to improve upon the efficacy of these monitoring activities. For example, difficulties in detecting translocated individuals of dryland sedge in 2020 will result in alterations to the marking of translocated plants and may also include using protective cages in 2021. As all phases of the program work concurrently, the 2021 program will continue to identify opportunities for improvement within an adaptive management framework throughout the remaining lifespan of the program.

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APPENDIX A. SITE C EXPERIMENTAL TRANSLOCATION PROJECT: POTENTIAL RECIPIENT SITE SELECTION METHODS & RESULTS MEMO

EAGLE CAP CONSULTING
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MEMO

Date: February 12, 2021

To: Natasha Bush (EcoLogic)

From: Randy Krichbaum (Eagle Cap), Margaret Krichbaum (Eagle Cap)

Subject: Site C Experimental Translocation Project: Potential Recipient Site Selection Methods & Results

INTRODUCTION

An important component of the Site C Experimental Rare Plant Translocation (ERPT) program is the selection of suitable recipient sites for planting of propagules collected from the project activity zone. Program planning in the spring of 2020 identified a need for eight recipient sites to accommodate the propagules collected (or planned for collection). Furthermore, as a result of rare plant field work conducted during the summer of 2020, a new rare species, *Piptatheropsis canadensis* (Canadian ricegrass), was added to the target list for the ERPT program. Salvage work for the species in October created a last-minute need for several *P. canadensis* recipient sites. This memo outlines the methods and results of the potential recipient site selection work performed in 2020.

The goal of this work was to locate and document suitable recipient sites for planting of rare plant propagules (seeds, achenes, spores, and started plants). The sites needed to meet a number of criteria regarding habitat (both biotic and abiotic components), accessibility, and geographic location.

METHODS

Prefield Review

A prefield review was conducted to identify and delineate potential recipient sites for later verification in the field. The review followed a structured workflow designed to locate the optimal planting locations based on the desired site characteristics.

A team of two qualified botanists completed the majority of the prefield and field portions of this work, in consultation with the ERPT project manager. The botanists have performed extensive rare plant work in the BC Peace River area, and as such are familiar with both the habitat requirements of rare species and the logistics of working in the Peace region.

Six taxa were chosen by the ERPT project manager as priority species in need of recipient sites for translocation (the final taxon was newly added to the translocation program as of May 2020):

- *Carex sprengelii* (Sprengel's sedge)
- *Carex torreyi* (Torrey's sedge)
- *Carex xerantica* (dry-land sedge)
- *Oxytropis campestris* var. *davisii* (Davis' locoweed)
- *Penstemon gracilis* (slender penstemon)
- *Selaginella rupestris* (rock selaginella)

The project botanical team met in May 2020 to review the priority species list and define desired recipient site characteristics. Each desired site characteristic was also assigned a weighting to reflect its relative importance to successful propagule establishment. This allowed for the potential recipient sites to be ranked for suitability following the field visits.

The prefield review identified thirteen desirable characteristics of the potential recipient sites. While no potential recipient site can meet all of the listed criteria, the intent of the work was to locate the best possible sites given the limitations present. An ideal site would have the following characteristics:

- contain suitable good-quality habitat for the specific rare plant taxon
- be located in the Peace River region of BC
- be located on land owned by BC Hydro or on Crown land
- not be located on lands requiring access through a locked gate or other owner permission
- not be located in the Site C Project Activity Zone (PAZ)
- not be located below the reservoir preliminary Erosion Impact Line (EIL - a precautionary estimate of the amount of erosion that could occur over a 100 year period)
- be accessible by road or boat during the entire growing season
- have a low likelihood of future disturbance
- have a low percentage of non-native plants
- have good cell service
- be more than one kilometre from known occurrences of the same taxon
- not contain known occurrences of other rare plant taxa
- be close to a source of water

A literature review was conducted for each of the six priority species to evaluate any new information relevant to the translocation work. This included checks of recent BC Conservation Data Centre (BCCDC) information to uncover any new element occurrences or changes to rare status, and a Google Scholar search for literature on the priority species (and *Ranunculus rhomboideus*) published since 2019. The review supplemented literature searches conducted in previous years for the translocation project. Queries were also run on the project rare plant database to uncover apparent habitat associations for the six priority species based on updated field data.

The habitat needs for the six priority taxa were then reviewed and delineated into five types, in order to aid in the visual evaluation of aerial imagery:

1. river or large stream, with level, open, non-active cobble bar; shading open to partial; sparsely vegetated; sandy, well drained soil

2. dry, steep, open south-facing hillside; relatively sparse low shrub, xeric grassland vegetation with a tan-coloured appearance

3. dry, steep, open south-facing hillcrest/hillside in close proximity to a gravel pit; relatively sparse low shrub, xeric grassland vegetation with a tan-coloured appearance

4. mesic to dry, open, south-facing hillcrest or gentle slope; relatively dense low-shrub, mesic grassland vegetation with a green-coloured appearance

5. moist to mesic; level to moderate slope; shading open to full; aspect variable; densely vegetated, tall shrubs present; may dry out later in season; relatively rich clay/silt soil

Using the list of desired site characteristics, the five habitat grouping types, and other collected information, Geographic Information System (GIS) layers were visually examined and potential recipient sites were selected. Primary GIS layers used for this phase of the prefield review were:

- aerial imagery of the BC Peace River region;
- property ownership provided by BC Hydro;
- known element occurrences of the priority taxa;
- potential recipient sites documented in previous years;
- the Site C Project Activity Zone; and
- the preliminary Erosion Impact Line.

The need for *Piptatheropsis canadensis* recipient sites was not identified until the salvage work was conducted in October. Therefore, the extensive prefield selection methods described above for the other six target species could not be completed for *P. canadensis*. Instead, the botanists used a field-based GIS to scan and classify potential *P. canadensis* recipient sites, and then visited the sites on the ground to confirm suitability.

Field Verification

Once the potential recipient sites had been identified, selected sites were inventoried in the field to determine suitability. Each suitable Potential Recipient Site (PRS) was evaluated and documented, with the data entered into a digital form for later analysis. Data elements collected included all those typically required by the BCCDC to document rare vascular plant element occurrences, as well as ratings for each of the thirteen desired site characteristics.

In addition, vegetation composition and cover data were recorded for the overall site, and three one-metre-square plots placed in representative locations. Species codes, with their associated percent covers, were recorded on a paper form for later analysis.

Potential Recipient Sites were selected partially based on distance to other planting sites, with the aim of distributing them over a wide geographical extent. In some instances, a site was found to contain suitable habitat for several ERPT target species in close proximity, and so separate PRS plots were completed for each target species. While this does provide the option to plant multiple species at the same site, with the consequent increased risk of a single disturbance event impacting multiple species, the limited number of suitable sites available for some of the target species necessitated using one site for several species in some cases. In addition, several of the target species occur together in wild populations.

Results

Prefield Review

The literature search uncovered six recent references containing information potentially relevant to the translocation of the priority species.

- *Smaller future floods imply less habitat for riparian plants along a boreal river (Jansson et al. 2019)*
- *Alberta Penstemon USFS Northern Region Seed Transfer Zone: Technical Report UMREL-NPM-10 (Gibson et al. 2019)*
- *Rough soil surface lessens annual grass invasion in disturbed rangeland (Johnston 2019)*
- *Changes in subarctic vegetation after one century of land-use and climate change (Kapfer & Popova 2019)*
- *An illustrated key to the Fabaceae of Alberta (Kershaw & Allen 2020)*
- *Comparative leaf morphology and anatomy of six Selaginella species (Selaginellaceae, subgen. Rupestrae) with notes on xerophytic adaptations (Adame-González et al. 2019)*

The queries run on the Site C rare plant database to identify habitat associations for the six priority species returned four helpful correlations that may have not been otherwise noted:

- For *Carex xerantica*: crown closure is listed as “open” for all occurrences where that variable was recorded (13)
- For *Oxytropis campestris* var. *davisii*: 0-5° slope for all occurrences where slope was recorded (28 occurrences)
- For *Penstemon gracilis*: most occurrences (20) are on steeper slopes (15–30°) that are south facing (all aspects are S, SW, or SE where aspect is recorded)
- For *Selaginella rupestris*: all occurrences are on steep slopes (20–31°) where slope is recorded (4); aspect is recorded as south facing and crown closure is listed as “open” for all occurrences (5)

A total of 44 planting areas that appeared to have a high likelihood of meeting the requirements for recipient sites were selected from the examination of the GIS layers (these included 24 newly-selected areas and 20 areas selected in the 2019 prefield review that were still under consideration). The most weight was given to appropriate habitat types and ease of legal access. Some planting areas appeared to contain habitat specific to only one rare taxon, and other areas were thought to contain habitat for multiple rare taxa. Not all potential planting areas in the BC Peace region were considered; rather the review focussed on areas that appeared to be easily accessible by road from Fort St. John, and on areas that were known to be easily accessible by boat on the Peace, Halfway, and Pine Rivers. Therefore, if additional potential recipient sites are required in the future, the as-yet unreviewed portions of the BC Peace region remain to be analyzed.

A unique PRS point was then generated for each planting area microsite thought to have suitable habitat for translocation of one of the six priority species. These points were intended to speed the field verification work by directing the surveyors' effort on the ground towards microsites of the best quality habitat. There was no expectation that every PRS point would be field checked, and the exact location for each actual PRS plot was to be decided in the field after a cursory area survey.

A total of 290 PRS points were generated for each of the six priority taxa: 30-38 points each for *Carex sprengelii, C. torreyi, C. xerantica, Oxytropis campestris* var. *davisii,* and *Penstemon gracilis,* and 118 points for the newly-added plant *Selaginella rupestris*. In addition, certain 2019-generated PRS points remained available for field evaluation.

Field Verification

The team of two botanists performed the field verification work from June 4 to 12 and July 30 to August 6, 2020. In preparation, the 44 selected planting areas were grouped according to the general access route to allow for efficient survey days. Of the 44 planting areas delineated, 17 received either complete or partial field checks (Table 1). Fifteen areas were reached by road from Fort St. John, with the closest area located approximately 9 km and the farthest area approximately 100 km from the town. The 16th and 17th areas consisted of boat access sites along an approximately 26 km stretch of the Pine River and an approximately 40 km stretch of the Peace River below Taylor, BC.

The 27 planting areas not yet field verified consist of 12 that present difficult access situations for work crews, and 15 that are still considered to be of possible use if additional potential recipient sites are required in the future.

Table 1: ERPT Potential Planting Areas Considered in 2020

Planting Area ID	Field Checked in 2020?	Field Check Date	Details
3	no		Access Issues
4	yes	2020-06-07	Plots Completed in 2020
5	no		Possible for Future Evaluation
9	no		Possible for Future Evaluation
10	no		Access Issues
14	yes	2020-06-05	No Habitat for Target Species
15	no		Access Issues
16	no		Access Issues
17	yes	2020-07-30	Set Aside for Future Consideration
18	no		Access Issues
19	no		Access Issues
20	no		Access Issues
21	no		Access Issues
22	yes	2020-06-12	Plots Completed in 2020
23	no		Access Issues
24	no		Access Issues
28	yes	2020-06-05	Plots Completed in 2020
29	no		Access Issues
30	yes	2020-06-04	Set Aside for Future Consideration
31	no		Possible for Future Evaluation
32	no		Possible for Future Evaluation
34	yes	2020-06-05	Plots Completed in 2020
35	no		Possible for Future Evaluation
36	no		Possible for Future Evaluation
37	no		Possible for Future Evaluation
38	no		Possible for Future Evaluation
39	yes	2020-06-07	Set Aside for Future Consideration
40	yes	2020-06-07	Plots Completed in 2020
41	no		Possible for Future Evaluation
42	no		Possible for Future Evaluation
43	yes	2020-08-03	Set Aside for Future Consideration

44	yes	2020-06-07	Plots Completed in 2020
45	yes	2020-06-08	Set Aside for Future Consideration
46	yes	2020-06-07	No Legal Access
47	yes	2020-06-11	No Habitat for Target Species
48	yes	2020-06-04	Set Aside for Future Consideration
49	yes	2020-08-02	Set Aside for Future Consideration
50	no		Possible for Future Evaluation
51	no		Possible for Future Evaluation
52	yes	2020-08-02	Set Aside for Future Consideration
53	no		Access Issues
54	no		Possible for Future Evaluation
55	no		Possible for Future Evaluation
56	no		Possible for Future Evaluation

The 17 field checks produced the following results:

- one planting area was found to be not easily accessible due to legal access issues;
- two planting areas did not contain appropriate habitat for the target species;
- eight planting areas were deemed to be not currently suitable for various reasons, but worth setting aside for future consideration; and
- six planting areas were considered to be worth investigating further.

A survey of each of the six “best choice” planting areas was performed, and a total of 12 PRS plots were completed in the spring (Table 2). Supplemental planting locations were also marked in suitable habitat near the PRS plots, where possible, to provide options for the planting crew.

It should be noted that during the course of the field verification surveys, 24 new rare plant sites were discovered: 7 patches of *Oxytropis campestris* var. *davisii*, 5 patches of *Penstemon gracilis,* 3 patches each of *Piptatheropsis canadensis* and *Selaginella rupestris,* 2 patches each of *Carex xerantica* and *Ranunculus rhomboideus*, and 1 patch each of *Carex torreyi* and *Atriplex gardneri* var. *gardneri*.

For the late-season *Piptatheropsis canadensis* work, six potential recipient sites were identified in four different planting areas. These six sites were field checked: two did not contain appropriate habitat, two were deemed to be worth setting aside for future consideration, and two were found to be suitable and were documented by the botanical team in October (Table 2). These two sites were sufficient to receive all 12 of the *P. canadensis* plants salvaged during the October work, but additional recipient sites will likely be needed in subsequent years.

Table 2: Potential Recipient Site Plots 2020

PRS Site ID	*Taxon*	Habitat	Survey Date	Area (sq m)	Elevation (m)
PRS-CARESPR-014	*Carex sprengelii*	Moist open willow thicket	2020-06-05	2,500	795
PRS-CARETOR-015	*Carex torreyi*	Open shrub grass area	2020-06-05	5,625	806
PRS-CARETOR-023	*Carex torreyi*	Open grassland low shrub	2020-06-05	200	630
PRS-CAREXER-011	*Carex xerantica*	Open grassland and shrub slopes	2020-06-05	1,000	784
PRS-CAREXER-019	*Carex xerantica*	Open grassland low shrub slope	2020-06-05	500	625
PRS-OXYTCAM3-025	*Oxytropis campestris var. davisii*	Young POPUBAL on cobble soil	2020-06-12	1,600	383
PRS-OXYTCAM3-051	*Oxytropis campestris var. davisii*	Low POPUBAL regrowth on cobble bars	2020-06-12	2,000	371
PRS-PENSGRA-014	*Penstemon gracilis*	Dry grassland shrub slope	2020-06-05	100	622
PRS-SELARUP-001	*Selaginella rupestris*	Dry grassland shrub slope	2020-06-05	100	622
PRS-SELARUP-013	*Selaginella rupestris*	Steep south facing grassland slopes with bare soil	2020-06-07	200	543
PRS-SELARUP-019	*Selaginella rupestris*	Open grassland slope	2020-06-07	5,000	508
PRS-SELARUP-028	*Selaginella rupestris*	Open grassland slopes	2020-06-07	100	547
PRS-PIPTCAN-001	*Piptatheropsis canadensis*	Forest opening	2020-10-08	200	489
PRS-PIPTCAN-002	*Piptatheropsis canadensis*	Open shrub grass area	2020-10-09	100	809

Discussion

The goal of the work was to locate two suitable recipient sites for most of the priority taxa based on the 13 criteria listed in the Methods section above. During the course of the field verification, it became clear that the first 10 criteria were relatively easy to meet (that is, accessible planting areas outside of the Site C PAZ and EIL, on Crown land near the Peace River, which contain appropriate rare plant habitat, low levels of both non-native plants and disturbance, and that have good cellular coverage).

However, the final three criteria proved much more challenging (i.e., planting areas greater than one kilometre from known sites of the same taxon, not already occupied by other rare plant species, and close to a source of water). While the prefield review specifically avoided known rare plant sites in choosing potential planting areas to evaluate, it was anticipated that new rare plant occurrences would be discovered since the goal was to target high-quality rare plant habitats. Thus, 24 new rare plant sites were documented by the survey team during the field verification process. The surveyors attempted to avoid these new sites when placing PRS plots and marking supplemental planting locations, but this was only partially successful: at two of the six recommended planting sites, PRS plots had to be placed in the vicinity of other rare plant populations. In addition, one of the new rare plant patches discovered in 2020 was located less than one kilometre from a 2019 recommended recipient site for the same species, consequently lowering the desirability of that particular site. However these compromises were accepted as reasonable considering that naturally-occurring multi-species rare plant sites are frequently found in the BC Peace region.

The final compromise for PRS plot placement, as anticipated, was that only the *Oxytropis campestris* var. *davisii* plots along the Peace River could be said to have a source of water. The remaining five priority taxa require mesic to xeric habitats generally found on dry slopes well above the river, and only rarely near year-round streams or springs.

Therefore, given the above caveats, the six planting areas where PRS plots were completed in 2020 do meet the majority of the requirements of an ideal recipient site. The first two of these planting areas contain a variety of habitats and are suitable for multiple species translocation. The remaining planting areas were specifically selected for a single taxon.

The first area chosen for multiple species translocation is a Crown parcel above Bear Flat on the north side of Highway 29. Three PRS plots were completed, for *Carex sprengelii, C. torreyi,* and *C. xerantica.* An additional 25 potential planting sites were marked for all three species.

The second multi-species translocation area is a Crown parcel on the south side of Highway 29 at the junction of Upper Cache Road. Four PRS plots were completed, for *Carex torreyi, C. xerantica, Penstemon gracilis,* and *Selaginella rupestris.* An additional 14 potential planting sites were marked for all four species.

For *Oxytropis campestris* var. *davisii*, which requires a specific type of riparian habitat, two PRS plots were completed on islands in the Peace River, downstream of Taylor, BC. The first is located approximately 4.5 km below the confluence of the Beatton River, and the second is approximately 1.5 km upstream of the Clayhurst Bridge near the Alberta border.

At the remaining three planting areas, PRS plots were completed for the single taxon *Selaginella rupestris* (added to the ERPT program in May of 2020). All three locations are on Crown parcels along Cecil Lake Road north of Fort St. John, BC. Additional planting sites were also marked at each location.

It should be noted that the four PRS plots completed for *Selaginella rupestris* are not considered to be ideal habitat for the species due to differences in substrate compared to known occurrences in the BC Peace region. More time is required for prefield review and field verification in order to find better quality recipient sites for this taxon.

In early October the botanical team surveyed a rare plant occurrence in the Highway 29 construction footprint, finding 12 live *Piptatheropsis canadensis* plants in 10 clumps. After evaluating 6 potential recipient sites, two were chosen for salvage planting. The first of these sites is located approximately 40 metres from other *P. canadensis* individuals in the same occurrence. However, the site is situated in a road allowance that is not expected to be disturbed the Site C work. Five plants were moved to this location.

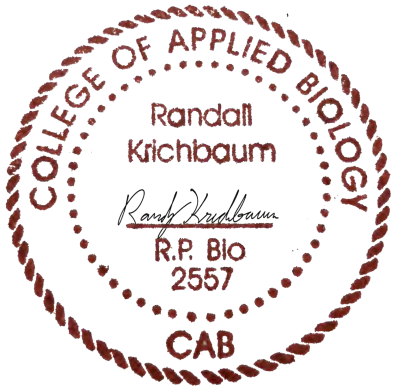
The second *P. canadensis* salvage planting site is on a Crown parcel above Bear Flat on the north side of Highway 29; no natural rare plant occurrences are known from this parcel, however this site is being actively used for ERPT program planting of other rare species. Seven plants in five clumps were planted at this location.

CLOSURE

Reviewed and approved:

Randy Krichbaum M.Sc., R.P. Bio., P. Biol.
Senior Ecologist
Eagle Cap Consulting Ltd.

<Original signed and sealed February 12, 2021 at Calgary, Alberta>



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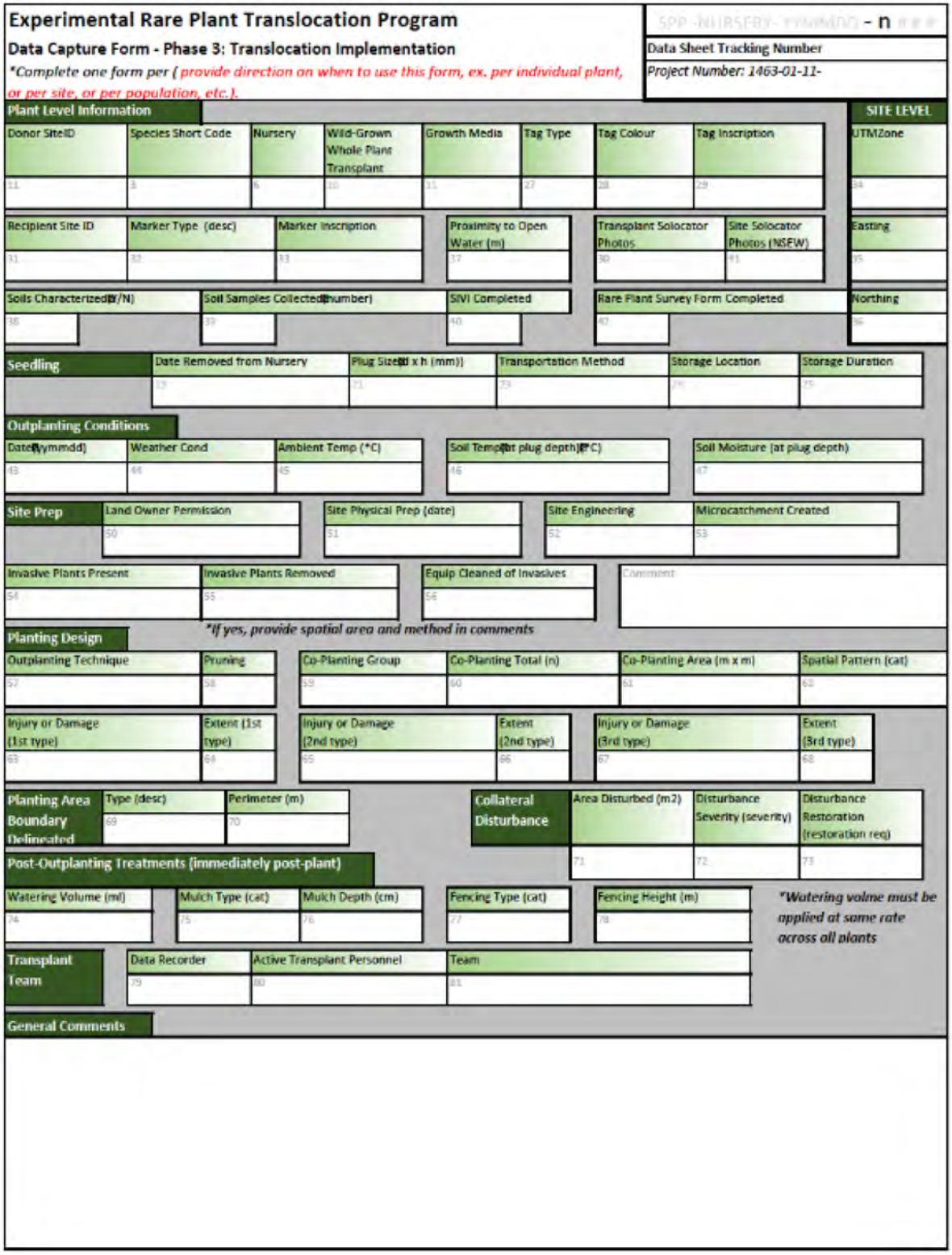
APPENDIX B. DATA CAPTURE FORM – TRANSLOCATION



Experimental Rare Plant Translocation Program

Data Capture Form - Phase 3: Translocation Implementation

**Complete one form per (provide direction on when to use this form, ex. per individual plant, or per site, or per population, etc.).*

SPP -NURSERY- YYMMDD - n # #

Data Sheet Tracking Number

Project Number: 1463-01-11-

Plant Level Information

Donor SiteID	Species Short Code	Nursery	Wild-Grown Whole Plant Transplant	Growth Media	Tag Type	Tag Colour	Tag Inscription
11	3	6	10	11	27	28	29

SITE LEVEL

UTMZone
34

Recipient Site ID	Marker Type (desc)	Marker Inscription	Proximity to Open Water (m)	Transplant Solocator Photos	Site Solocator Photos (NSFW)
31	32	33	37	30	41

Easting
35

Soils Characterized (Y/N)	Soil Samples Collected (number)	SIVI Completed	Rare Plant Survey Form Completed
38	39	40	42

Northing
36

Seedling

Date Removed from Nursery	Plug Size (d x h (mm))	Transportation Method	Storage Location	Storage Duration
70	71	73	74	75

Outplanting Conditions

Date (yymmdd)	Weather Cond	Ambient Temp (°C)	Soil Temp (at plug depth) (°C)	Soil Moisture (at plug depth)
43	44	45	46	47

Site Prep

Land Owner Permission	Site Physical Prep (date)	Site Engineering	Microcatchment Created
50	51	52	53

Invasive Plants Present	Invasive Plants Removed	Equip Cleaned of Invasives	Comment
54	55	56	

**If yes, provide spatial area and method in comments*

Planting Design

Outplanting Technique	Pruning	Co-Planting Group	Co-Planting Total (n)	Co-Planting Area (m x m)	Spatial Pattern (cat)
57	58	59	60	61	62

Injury or Damage (1st type)	Extent (1st type)	Injury or Damage (2nd type)	Extent (2nd type)	Injury or Damage (3rd type)	Extent (3rd type)
63	64	65	66	67	68

Planting Area Boundary Delineated	Type (desc)	Perimeter (m)
	69	70

Collateral Disturbance	Area Disturbed (m2)	Disturbance Severity (severity)	Disturbance Restoration (restoration req)
	71	72	73

Post-Outplanting Treatments (immediately post-plant)

Watering Volume (ml)	Mulch Type (cat)	Mulch Depth (cm)	Fencing Type (cat)	Fencing Height (m)
74	75	76	77	78

**Watering volme must be applied at same rate across all plants*

Transplant Team	Data Recorder	Active Transplant Personnel	Team
	79	80	81

General Comments

Appendix 9. Cavity Nesting Mitigation and Monitoring Program – 2020 Annual Report

MEMORANDUM

Date:	September 30, 2020
To:	BC Hydro
From:	Hemmera Envirochem Inc.
File:	989619-08
Re:	Cavity Nesting Mitigation and Monitoring Program – 2020 Annual Report

1.0 INTRODUCTION

BC Hydro assessed the potential effects of the Site C Clean Energy Project on Wildlife Resources in the Site C Environmental Impact Statement (EIS) using key species groups (BC Hydro 2013). Cavity-nesting species were assessed in the EIS as part of migratory birds (passerines [songbirds], northern flicker, and waterfowl) and raptors (hawks and owls; BC Hydro 2016). In 2017, a mitigation and monitoring plan for cavity-nesting birds was developed with input from the Vegetation and Wildlife Technical Committee (VWTC), which is comprised of representatives of the Canadian Wildlife Service (CWS), the BC Ministry of Environment and Climate Change Strategy (MoECCS) and the Ministry of Forests, Lands, Natural Resources Operations and Rural Development (FLNRORD).

The purpose of the Cavity Nesting Mitigation and Monitoring Program is to mitigate habitat loss for cavity-nesting bird species associated with Site C reservoir vegetation clearing, and to monitor the effectiveness of that mitigation (BC Hydro 2018). Mitigating the impacts of habitat loss for cavity-nesting birds is focused on areas that will be retained and currently have a low concentration of suitable trees for cavity-nesting species (i.e., structural stage 4 [pole-sapling] and/or 5 [young forest] habitats[1]). This will be achieved using different measures depending on the time period for which they are intended to mitigate (i.e., short-, medium-, or long-term). Nest box installation for cavity nesting species fulfills short-term mitigation, the results of which are the focus of this memo.

2.0 METHODS

2.1 Nest Box Construction

Cavity-nesting birds differ in their habitat requirements and selection of cavities. Therefore, a variety of nest box designs were constructed to mitigate impacts on nesting habitat for cavity-nesting birds due to the Project (**Figure 1**). Thirteen different nest box designs were constructed to accommodate 21 species of cavity nesting birds, with some box designs intended to support multiple species (BC Hydro 2018).

[1] Structural Stage 4 (pole-sapling forest): Trees >10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually >10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually <40 years for normal forest succession; up to 100+ years for dense (5000–15 000+ stems per hectare) stagnant stands.
Structural Stage 5 (young forest): Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions; from Standards for Terrestrial Ecosystems Mapping in British Columbia. 1998. Ecosystems Working Group of the Terrestrial Ecosystems Task Force, Resources Inventory Committee.

Figure 1 Nest box designs built for the Cavity Nesting Mitigation and Monitoring Program

2.2 Nest box installation

The selection of sites followed specifications described in the Cavity Nesting Species Mitigation and Monitoring Program (BC Hydro, 2018). The selection of habitat and placement of nest boxes was guided based on information from James (1984) and Terrestrial Ecosystem Mapping data along the anticipated reservoir, collected in 2016. Boxes were placed on lands owned or leased by BC Hydro or Crown land, in areas outside of planned clearing boundaries, above the high water mark, and in areas of suitable but suboptimal habitat (i.e., areas of suitable age class but with a low number of cavity trees). Box installation was specifically focussed on habitat with a low proportion of suitable cavity-nesting trees (i.e., structural stages 4 to 6), but which have the greatest potential to develop into suitable habitat over the short term (see **Figure 2** for an example of nest box installation). Additional information based on literature and expert knowledge were also considered for the installation of nest boxes:

- Proximity to a food source for all species (e.g., wetlands, water sources)
- Bird distribution and abundance information from Site C baseline studies in the area
- Known habitat associations
- Appropriate nest heights (**Table 1**)
- Density of nest boxes within an area (i.e., spacing between nest boxes) (**Table 1**).

Figure 2 **Nest box design 'A', built to provide additional habitat to Black- capped chickadee (*Poecile atricapillus*), boreal chickadee (*Poecile hudsonicus*), red-breasted nuthatch (*Sitta canadensis*), white-breasted nuthatch (*Sitta carolinensis*), house wren (*Troglodytes aedon*), and brown creeper (*Certhia americana*)**

Table 1 Installation guide table showing minimum distance between boxes and height of installation for the different types of boxes used in the mitigation plan

Species Group	Species	Minimum Spacing Between Boxes (m)	Nest Box Height (m)
Passerines	Black-capped Chickadee	150-200	1.5 - 4.5
	Boreal Chickadee	150-200	1.5 - 3
	Brown Creeper	150	1.0 - 10
	Red-breasted Nuthatch	50	1.5 - 4.5
	White-breasted Nuthatch	300	1.5 - 6
	Tree Swallow	10-30	1.5 - 1.8
	Violet-green Swallow	10-30	2.75 - 4.5
	House Wren	30	1.5 - 3
	Mountain Bluebird	90	1.2 – 1.8
Waterfowl	Barrow's Goldeneye	150-200	1.8 - 6
	Bufflehead	50-150	1.5 - 3
	Common Goldeneye	1,000	1.8 - 9
	Common Merganser	100	2.4 - 5.2
	Hooded Merganser	30	1.8 - 7.6
Raptors and Owls	Barred Owl	1,000	4.5 - 9
	Boreal Owl	150	≥3
	Northern Saw-whet Owl	400-500	≥3
	Northern Pygmy-owl	400-500	≥3
	Northern Hawk-owl	500-700	≥3
	American Kestrel	500-800	3.5 – 6

2.3 Nest Box Monitoring and Maintenance

Monitoring

The monitoring schedule for nest boxes will continue to be staggered biennially through Project construction and the first ten years of operations (**Appendix A**). Boxes installed in 2017 were monitored in 2020 and will again be monitored in 2022 and every two years after that through the first 10 years of Project operations. Boxes installed in 2019 and 2020 are planned to be monitored in 2021 and again in 2023.

Monitoring was conducted by a qualified environmental professional in a manner that minimizes disturbance to active nests. Using the breeding period information provided in **Appendix B**, nest box visits were timed to coincide with nest stages that maximize the likelihood of detecting use. The dates described in **Appendix B** fall within the range of dates for each species when nests are likely to be at either late incubation or have young nestlings. Visits timed to coincide with nests at a stage with older nestlings are more likely to have their status determined, as parents are more likely to be feeding older nestlings more frequently. However, due to variation in brood timing within and among species, attempting to time surveys to coincide with the presence of older nestlings would increase the chance of arriving too late for direct

observations of breeding activity for some breeding pairs. Therefore, a conservative estimate of the nesting window was applied to maximize the likelihood of observing active use and determining the species using each box.

During the monitoring work, surveyors approached the box discretely, watching and listening for activity. When adults were attending a box, surveyors observed from a distance, recorded species, and attempted to determine stage (if nestlings were present, food delivery and fecal sac removal confirmed stage). If no use was evident from nest box observation, surveyors approached the nest box structure (tree or otherwise) and tapped lightly on it to elicit a response (Dudley and Saab 2003). If no bird appeared at the cavity entrance, a pole mounted camera was used to examine the nest box contents.

During each nest box visit surveyors recorded the following data electronically on a field iPad:

- Date and time
- Coordinates
- Surveyors
- Weather conditions
- Nest box ID
- Detection methods:
  - Adult behaviour
  - Audible nestlings
  - Food delivery
  - Pole camera examination
- Is box being used
- Species detected
- Notes informing environmental context, such as disturbance in the area

Maintenance

With regular maintenance, nest boxes have a 10 to 15-year lifespan. Nest boxes in need of repair (e.g., broken boxes, loose lids or covers, attachment failure) were flagged during the monitoring season and repaired during the post-breeding season (mid-August). Maintenance and repair included replacing nesting material if necessary, and performing any replacement or repair of broken boxes.

3.0 RESULTS

3.1 Nest Box Installation

Between 2017 and 2020, 266 nest boxes were installed on trees and structures on BC Hydro owned and managed lands, and on private lands where permission was granted (**Table 2**, **Figure 3**). Twenty (20) boxes have been installed near the lower reservoir, 77 near the eastern reservoir, 38 near the middle reservoir and 131 near the western reservoir.

In 2017, a total of 97 nest boxes were installed on the north side of the Peace River. In 2019, 83 additional nest boxes were installed on the south side of the Peace River, and the remaining 86 nest boxes were installed in spring 2020 on the north and south sides of the Peace River. The locations of the 2020 nest boxes were selected based on areas not covered on previous installations (2017 and 2019) and complementing habitat and species assemblage within the proposed reservoir following the same criteria for habitat selection (see **Section 2.2**).

The installation of cavity boxes is now complete except for the reinstallation of the boxes that were damaged or removed. **Table 2** describes the target species, habitat type and number of boxes of each design installed to date.

Table 2 Target species, habitat preferences, and number total nest boxes installed in 2017 and 2020

Species Group	Habitat Preference	Box Type	Species Support	Number of Boxes Installed to Date
Passerine	Prefer a variety of habitat types, from dry to wet forests and in most structural stages Brown creeper and nuthatches prefer more mature forested habitats Swallows use wetland and cultivated field habitat Mountain bluebird require open field habitat	A / BC / B1	black-capped chickadee boreal chickadee red-breasted nuthatch white-breasted nuthatch house wren brown creeper	43
		A2 / B2	mountain bluebird tree swallow violet-green swallow	57
Waterfowl	Need an unobstructed flight path from suitable forage habitat to nesting features	E1	bufflehead	8
		F	Barrow's goldeneye common goldeneye hooded merganser	47
		D / G	common merganser	18
Raptors and Owls	Typically found in mesic to moist forests smaller species found in younger forests American kestrel requires open field habitat	E2	boreal owl northern saw-whet owl	27
		E3	American kestrel	17
		C	northern pygmy- owl	26
		B3	northern hawk-owl	20
		H	barred owl	3
			Total	**266**

Note: 264 boxes were proposed to be installed (BC Hydro, 2018)

Site C Clean Energy Project
Peace River, BC

Nest Box Locations

Charlie Lake

Site C Dam

Peace River

Moberly River

Pine River

Legend

- Proposed Dam Site
- 5 Year Beach Line
- Eastern Reservoir
- Lower Reservoir
- Middle Reservoir
- Western Reservoir

Nest Box Types

2017	2019	2020
○	△	A
●	▲	A2
○	△	B1
●	▲	B2
●	▲	B3
●	▲	BC
○	△	C
		D
○		E1
●	▲	E2
○	△	E3
●	▲	F
●	▲	G
	△	H

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basemap: ESRI World Topographic Base

N

1:210,000

0 2 4 6 8 10
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-08	Production Date: 28-Sep-2020	Figure 3

Hemmera An Ausenco Company

BC hydro

Path: S:\Geomatics\Projects\989619\08_cavity_nest\mxd\Fig3_989619_08_CavityNest_NestBoxLocations\2020_20200928.mxd

3.2 Monitoring and Maintenance of Nest Boxes Installed in 2017

Monitoring

From May 20 to May 22, 2020 monitoring was conducted for the 97 boxes installed in 2017. The status of each box at the time of monitoring can be found in **Appendix C**. Twenty-one (21) boxes showed signs of use such as nesting material, feathers, and adults fluttering next to the entrance (**Figure 4**). One American Kestrel (*Falco sparverius*) was recorded nesting at the box E3-14 (**Figure 5**) installed on a trembling aspen (*Populus tremuloides*) adjacent to an open field. Also, two adult American kestrels were observed fluttering next to the entrance of box E3-13, installed at the edge of a cultivated field in a small patch of forest approximately 1 km west from E3-14.

Figure 4 Example of nest observed during the 2020 monitoring period at one of the nest boxes installed in 2017 (B2-06)

Figure 5 American Kestrel recorded nesting inside one of the installed nest boxes (E3-14)

Signs of rodent use, such as droppings, or teeth marks, were observed at eight boxes during monitoring. One flying squirrel (*Glaucomys sabrinus*) was observed exiting the B3-17 box during the maintenance period on August 13, 2020. Additionally, wasp nests were observed in five boxes. The wasp nests were removed during the maintenance period (August 12 to 14, 2020).

Since installation, eighteen (18) boxes, installed in 2017 were damaged or completely removed due to livestock rubbing against the trees where the boxes were installed, logging activity, strong winds, and one case of potential vandalism (**Appendix C**). Also, due to updated linework for the Highway 29 realignment, five nest boxes (E1-05, F-07, F-08, F-32, and G-07) were within 50 m of highway activities and were deactivated on April 16, 2020 to prevent potential impact from work in the area on nesting birds. These boxes were assessed for occupancy, and when found to be unused, the entrances were blocked with a piece of wood to prevent birds from accessing the nest box during this time. These boxes will be reactivated once BC Hydro confirms that Highway 29 road work in the area is complete.

Maintenance

Maintenance was completed between August 12 and 14, 2020 for all boxes installed in 2017. Details of the maintenance completed can be found in **Appendix C**. Maintenance requirements were noted during the monitoring visit conducted between May 20 and 22, 2020. Minor repairs (e.g., tightening screws, readjusting loose doors, and readjusting boxes to trees) were performed on ten boxes while nesting material was cleaned and replaced with new wood shavings. Additionally, wire was installed to secure the maintenance door from opening inadvertently (**Figure 6**).

Figure 6 Latching system installed on nest boxes to prevent rodents or predators from coming inside the box

4.0 DISCUSSION AND RECOMMENDATIONS

Of the 97 boxes installed in 2017, 79 were available for nesting and 18 were either damaged by clearing, livestock, winds and probable vandalism, or deactivated to prevent their use during nearby construction activities (**Appendix C**). These boxes will be reinstalled and reactivated during future monitoring visits once nearby construction activities are complete. Of the 79 available boxes, 21 were occupied or had evidence of occupation by birds in 2020 (i.e., nesting material, nests, and feathers), for an occupancy rate of 27%. This occupancy percentage is similar to other studies of artificial nests conducted on multiple species (Milligan and Dickinson 2016). Rodent activity and wasp nests were observed in 13% of the monitored nest boxes, likely precluding their use by the target species. During monitoring, it was noted that some box doors had loosened and opened. To rectify this, wire fastened with screws was used in 2020 to better secure the doors.

Data from Highway 29 realignment and clearing boundaries received in August 2020 suggest that additional boxes may be within 50 m from the Highway 29 realignment construction boundary or within planned clearing boundaries. Discussions are currently ongoing to determine which, if any boxes may need to be moved or covered prior to the breeding season.

5.0 CLOSURE

This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this Work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and Project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

If there are any questions, please do not hesitate to contact the undersigned.

Memo prepared by:
Hemmera Envirochem Inc.

ORIGINAL SIGNED

Felix Martinez Nunez, M.Sc., R.P.Bio.
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Memo reviewed by:
Hemmera Envirochem Inc.

ORIGINAL SIGNED

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6.0 REFERENCES

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APPENDIX A
Monitoring and Maintenance Schedule

Table A Monitoring and maintenance schedule for nest boxes installed in 2017, 2019 and 2020

Nest box ID	Nest box type	Year installed	Monitoring and maintenance schedule until 2027 (10 years after initial installation)							
			2020	2021	2022	2023	2024	2025	2026	2027
A-002	A	2017	X		X		X		X	
A-010	A	2017	X		X		X		X	
A-011	A	2017	X		X		X		X	
A-014	A	2017	X		X		X		X	
A-017	A	2017	X		X		X		X	
A-020	A	2017	X		X		X		X	
A-021	A	2017	X		X		X		X	
A-025	A	2017	X		X		X		X	
A2-35	A2	2017	X		X		X		X	
A2-36	A2	2017	X		X		X		X	
A2-37	A2	2017	X		X		X		X	
A2-44	A2	2017	X		X		X		X	
A2-45	A2	2017	X		X		X		X	
A2-51	A2	2017	X		X		X		X	
A2-55	A2	2017	X		X		X		X	
A2-58	A2	2017	X		X		X		X	
A2-59	A2	2017	X		X		X		X	
A2-62	A2	2017	X		X		X		X	
A2-66	A2	2017	X		X		X		X	
A2-72	A2	2017	X		X		X		X	
A2-74	A2	2017	X		X		X		X	
A2-75	A2	2017	X		X		X		X	
A2-76	A2	2017	X		X		X		X	
A2-79	A2	2017	X		X		X		X	
B1-01	B1	2017	X		X		X		X	
B1-02	B1	2017	X		X		X		X	
B1-03	B1	2017	X		X		X		X	
B1-06	B1	2017	X		X		X		X	
B2-03	B2	2017	X		X		X		X	
B2-06	B2	2017	X		X		X		X	
B3-02	B3	2017	X		X		X		X	
B3-03	B3	2017	X		X		X		X	
B3-05	B3	2017	X		X		X		X	
B3-06	B3	2017	X		X		X		X	
B3-07	B3	2017	X		X		X		X	
B3-10	B3	2017	X		X		X		X	
B3-11	B3	2017	X		X		X		X	

Nest box ID	Nest box type	Year installed	Monitoring and maintenance schedule until 2027 (10 years after initial installation)							
			2020	2021	2022	2023	2024	2025	2026	2027
B3-12	B3	2017	X		X		X		X	
B3-13	B3	2017	X		X		X		X	
B3-14	B3	2017	X		X		X		X	
B3-16	B3	2017	X		X		X		X	
B3-17	B3	2017	X		X		X		X	
B3-20	B3	2017	X		X		X		X	
BC-01	BC	2017	X		X		X		X	
BC-02	BC	2017	X		X		X		X	
BC-03	BC	2017	X		X		X		X	
BC-05	BC	2017	X		X		X		X	
C-01	C	2017	X		X		X		X	
C-02	C	2017	X		X		X		X	
C-03	C	2017	X		X		X		X	
C-08	C	2017	X		X		X		X	
C-12	C	2017	X		X		X		X	
C-13	C	2017	X		X		X		X	
C-15	C	2017	X		X		X		X	
C-18	C	2017	X		X		X		X	
C-22	C	2017	X		X		X		X	
E1-02	E1	2017	X		X		X		X	
E1-05	E1	2017	X		X		X		X	
E2-01	E2	2017	X		X		X		X	
E2-02	E2	2017	X		X		X		X	
E2-03	E2	2017	X		X		X		X	
E2-06	E2	2017	X		X		X		X	
E2-10	E2	2017	X		X		X		X	
E2-13	E2	2017	X		X		X		X	
E2-17	E2	2017	X		X		X		X	
E2-20	E2	2017	X		X		X		X	
E2-21	E2	2017	X		X		X		X	
E2-27	E2	2017	X		X		X		X	
E2-28	E2	2017	X		X		X		X	
E3-01	E3	2017	X		X		X		X	
E3-02	E3	2017	X		X		X		X	
E3-02	E3	2017	X		X		X		X	
E3-03	E3	2017	X		X		X		X	
E3-04	E3	2017	X		X		X		X	
E3-05	E3	2017	X		X		X		X	
E3-05	E3	2017	X		X		X		X	

Nest box ID	Nest box type	Year installed	Monitoring and maintenance schedule until 2027 (10 years after initial installation)							
			2020	2021	2022	2023	2024	2025	2026	2027
E3-07	E3	2017	X		X		X		X	
E3-09	E3	2017	X		X		X		X	
E3-11	E3	2017	X		X		X		X	
E3-12	E3	2017	X		X		X		X	
E3-13	E3	2017	X		X		X		X	
E3-14	E3	2017	X		X		X		X	
E3-15	E3	2017	X		X		X		X	
E3-16	E3	2017	X		X		X		X	
F-03	F	2017	X		X		X		X	
F-07	F	2017	X		X		X		X	
F-08	F	2017	X		X		X		X	
F-11	F	2017	X		X		X		X	
F-17	F	2017	X		X		X		X	
F-18	F	2017	X		X		X		X	
F-29	F	2017	X		X		X		X	
F-31	F	2017	X		X		X		X	
F-32	F	2017	X		X		X		X	
F-42	F	2017	X		X		X		X	
G-07	G	2017	X		X		X		X	
G-08	G	2017	X		X		X		X	
G-13	G	2017	X		X		X		X	
G-15	G	2017	X		X		X		X	
A-004	A	2019		X		X		X		X
A-006	A	2019		X		X		X		X
A-007	A	2019		X		X		X		X
A-008	A	2019		X		X		X		X
A-013	A	2019		X		X		X		X
A-015	A	2019		X		X		X		X
A-016	A	2019		X		X		X		X
A-019	A	2019		X		X		X		X
A-022	A	2019		X		X		X		X
A-023	A	2019		X		X		X		X
A-024	A	2019		X		X		X		X
A-026	A	2019		X		X		X		X
A2-27	A2	2019		X		X		X		X
A2-28	A2	2019		X		X		X		X
A2-29	A2	2019		X		X		X		X
A2-30	A2	2019		X		X		X		X
A2-32	A2	2019		X		X		X		X

Nest box ID	Nest box type	Year installed	Monitoring and maintenance schedule until 2027 (10 years after initial installation)							
			2020	2021	2022	2023	2024	2025	2026	2027
A2-33	A2	2019		X		X		X		X
A2-34	A2	2019		X		X		X		X
A2-38	A2	2019		X		X		X		X
A2-39	A2	2019		X		X		X		X
A2-40	A2	2019		X		X		X		X
A2-42	A2	2019		X		X		X		X
A2-46	A2	2019		X		X		X		X
A2-47	A2	2019		X		X		X		X
A2-53	A2	2019		X		X		X		X
A2-56	A2	2019		X		X		X		X
A2-57	A2	2019		X		X		X		X
A2-60	A2	2019		X		X		X		X
A2-63	A2	2019		X		X		X		X
A2-64	A2	2019		X		X		X		X
A2-65	A2	2019		X		X		X		X
A2-67	A2	2019		X		X		X		X
A2-68	A2	2019		X		X		X		X
A2-69	A2	2019		X		X		X		X
A2-71	A2	2019		X		X		X		X
A2-73	A2	2019		X		X		X		X
A2-80	A2	2019		X		X		X		X
B1-04	B1	2019		X		X		X		X
B1-05	B1	2019		X		X		X		X
B1-06b	B1	2019		X		X		X		X
B2-01	B2	2019		X		X		X		X
B2-02	B2	2019		X		X		X		X
B2-04	B2	2019		X		X		X		X
B2-05	B2	2019		X		X		X		X
B3-01	B3	2019		X		X		X		X
B3-04	B3	2019		X		X		X		X
B3-08	B3	2019		X		X		X		X
B3-15	B3	2019		X		X		X		X
B3-18	B3	2019		X		X		X		X
BC-04	BC	2019		X		X		X		X
C-07	C	2019		X		X		X		X
C-21	C	2019		X		X		X		X
E2-11	E2	2019		X		X		X		X
E2-18	E2	2019		X		X		X		X
E2-26	E2	2019		X		X		X		X

Nest box ID	Nest box type	Year installed	Monitoring and maintenance schedule until 2027 (10 years after initial installation)							
			2020	2021	2022	2023	2024	2025	2026	2027
E3-20	E3	2019		X		X		X		X
F-02	F	2019		X		X		X		X
F-04	F	2019		X		X		X		X
F-05	F	2019		X		X		X		X
F-06	F	2019		X		X		X		X
F-09	F	2019		X		X		X		X
F-10	F	2019		X		X		X		X
F-12	F	2019		X		X		X		X
F-14	F	2019		X		X		X		X
F-15	F	2019		X		X		X		X
F-16	F	2019		X		X		X		X
F-19	F	2019		X		X		X		X
F-20	F	2019		X		X		X		X
F-22	F	2019		X		X		X		X
F-23	F	2019		X		X		X		X
F-24	F	2019		X		X		X		X
F-25	F	2019		X		X		X		X
F-28	F	2019		X		X		X		X
F-30	F	2019		X		X		X		X
F-37	F	2019		X		X		X		X
F-39	F	2019		X		X		X		X
F-40	F	2019		X		X		X		X
F-47	F	2019		X		X		X		X
G-03	G	2019		X		X		X		X
G-05	G	2019		X		X		X		X
G-11	G	2019		X		X		X		X
OWL-1	H	2019		X		X		X		X
A-001	A	2020		X		X		X		X
A-003	A	2020		X		X		X		X
A-005	A	2020		X		X		X		X
A-009	A	2020		X		X		X		X
A-012	A	2020		X		X		X		X
A-018	A	2020		X		X		X		X
A2-31	A2	2020		X		X		X		X
A2-41	A2	2020		X		X		X		X
A2-48	A2	2020		X		X		X		X
A2-49	A2	2020		X		X		X		X
A2-50	A2	2020		X		X		X		X
A2-52	A2	2020		X		X		X		X

Nest box ID	Nest box type	Year installed	Monitoring and maintenance schedule until 2027 (10 years after initial installation)							
			2020	2021	2022	2023	2024	2025	2026	2027
A2-61	A2	2020		X		X		X		X
A2-70	A2	2020		X		X		X		X
A2-81	A2	2020		X		X		X		X
B1-00	B1	2020		X		X		X		X
B3-09	B3	2020		X		X		X		X
B3-19	B3	2020		X		X		X		X
BC-01S	BC	2020		X		X		X		X
BC-02b	BC	2020		X		X		X		X
BC-03b	BC	2020		X		X		X		X
BC-04b	BC	2020		X		X		X		X
C-04	C	2020		X		X		X		X
C-05	C	2020		X		X		X		X
C-06	C	2020		X		X		X		X
C-09	C	2020		X		X		X		X
C-10	C	2020		X		X		X		X
C-11	C	2020		X		X		X		X
C-14	C	2020		X		X		X		X
C-16	C	2020		X		X		X		X
C-17	C	2020		X		X		X		X
C-19	C	2020		X		X		X		X
C-20	C	2020		X		X		X		X
C-23	C	2020		X		X		X		X
C-X1	C	2020		X		X		X		X
C-X2	C	2020		X		X		X		X
C-X3	C	2020		X		X		X		X
D-01	D	2020		X		X		X		X
D-02	D	2020		X		X		X		X
D-03	D	2020		X		X		X		X
E1-01	E1	2020		X		X		X		X
E1-03	E1	2020		X		X		X		X
E1-04	E1	2020		X		X		X		X
E1-06	E1	2020		X		X		X		X
E1-07	E1	2020		X		X		X		X
E1-09	E1	2020		X		X		X		X
E2-04	E2	2020		X		X		X		X
E2-05	E2	2020		X		X		X		X
E2-07	E2	2020		X		X		X		X
E2-08	E2	2020		X		X		X		X
E2-12	E2	2020		X		X		X		X

Nest box ID	Nest box type	Year installed	Monitoring and maintenance schedule until 2027 (10 years after initial installation)							
			2020	2021	2022	2023	2024	2025	2026	2027
E2-14	E2	2020		X		X		X		X
E2-15	E2	2020		X		X		X		X
E2-16	E2	2020		X		X		X		X
E2-19	E2	2020		X		X		X		X
E2-22	E2	2020		X		X		X		X
E2-23	E2	2020		X		X		X		X
E2-25	E2	2020		X		X		X		X
E2-27b	E2	2020		X		X		X		X
E3-01b	E3	2020		X		X		X		X
E3-08	E3	2020		X		X		X		X
F-01	F	2020		X		X		X		X
F-13	F	2020		X		X		X		X
F-21	F	2020		X		X		X		X
F-26	F	2020		X		X		X		X
F-27	F	2020		X		X		X		X
F-33	F	2020		X		X		X		X
F-34	F	2020		X		X		X		X
F-35	F	2020		X		X		X		X
F-36	F	2020		X		X		X		X
F-38	F	2020		X		X		X		X
F-41	F	2020		X		X		X		X
F-43	F	2020		X		X		X		X
F-45	F	2020		X		X		X		X
F-46	F	2020		X		X		X		X
F-49	F	2020		X		X		X		X
G-01	G	2020		X		X		X		X
G-02	G	2020		X		X		X		X
G-04	G	2020		X		X		X		X
G-06	G	2020		X		X		X		X
G-09	G	2020		X		X		X		X
G-10	G	2020		X		X		X		X
G-12	G	2020		X		X		X		X
G-14	G	2020		X		X		X		X
OWL-2	H	2020		X		X		X		X
OWL-3	H	2020		X		X		X		X

Note: X: indicates the scheduled year for monitoring and maintenance; no boxes were installed in 2018.

APPENDIX B

Breeding Periods for Survey Timing

Table B Species specific breeding periods

Focal Species	Breeding Window Date Range
northern saw-whet owl	April 1 to June 15
American kestrel	April 1 to July 15
hooded merganser	May 1 to July 1
brown creeper	May 1 to June 15
violet-green swallow	May 1 to July 15
Barrow's goldeneye	
common goldeneye	
house wren	May 1 to August 15
bufflehead	June 1 to July 15
black-capped chickadee	March 15 to July 15
boreal owl	April 15 to May 30
barred owl	
common merganser	April 15 to June 30
tree swallow	May 15 to August 10
white-breasted nuthatch	May 15 to Jun 15
northern pygmy owl	
northern hawk-owl	
red-breasted nuthatch	May 15 to June 20
mountain bluebird	May 15 to July 30
boreal chickadee	May 20 to July 15

References:

Campbell et al., 1990, Campbell et al. 1990b, Campbell et al., 1997

APPENDIX C

2017 Monitoring: Nest Box Status

Table C 2020 Monitoring and maintenance results

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
2017	2020-05-20	2020-08-14	A-002	A	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Lichens inside with sawdust
2017	2020-05-20	2020-08-13	A-010	A	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-13	A-011	A	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-13	A-014	A	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-14	A-017	A	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	2020-08-12	A-020	A	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Grass/moss/lichen nest inside, might be from last year or just being constructed
2017	2020-05-20	2020-08-14	A-021	A	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-13	A-025	A	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
2017	2020-05-20	2020-08-13	A2-35	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Rodent activity
2017	2020-05-21	2020-08-13	A2-36	A2	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	2020-08-13	A2-37	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	2020-08-13	A2-44	A2	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Was knocked down by livestock. Reinstalled.
2017	2020-05-21	2020-08-13	A2-45	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	2020-08-13	A2-51	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Was knocked down by livestock. Reinstalled.
2017	2020-05-21	2020-08-12	A2-55	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	2020-08-13	A2-58	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-12	A2-59	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and	-

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
									maintenance door secured with wire.	
2017	2020-05-21	2020-08-13	A2-62	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Rodent activity
2017	2020-05-21	N/A	A2-66	A2	N/A	No	-	Gone	N/A	Knocked down by livestock
2017	2020-05-21	N/A	A2-72	A2	N/A	No	-	Gone	N/A	Knocked down by livestock
2017	2020-05-20	2020-08-13	A2-74	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Rodent activity
2017	2020-05-20	2020-08-12	A2-75	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	2020-08-14	A2-76	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Was knocked down by livestock. Reinstalled.
2017	2020-05-21	2020-08-13	A2-79	A2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Rodent activity (Chewed entrance)
2017	2020-05-20	N/A	B1-01	B1	N/A	No	-	Gone	N/A	Recently mulched/logged trail through woods passes beside nest box

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
2017	2020-05-20	2020-08-12	B1-02	B1	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Rodent activity (Chewed entrance)
2017	2020-05-20	2020-08-12	B1-03	B1	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Wasp nest removed.
2017	2020-05-20	2020-08-13	B1-06	B1	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Wasp nest removed. Rodent activity (chewed entrance)
2017	2020-05-20	2020-08-12	B2-03	B2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-13	B2-06	B2	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Grass/lichen cup nest inside
2017	2020-05-20	2020-08-12	B3-02	B3	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Lichens, grasses and twigs inside
2017	2020-05-21	2020-08-12	B3-03	B3	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Lichens in bottom with sawdust
2017	2020-05-21	N/A	B3-05	B3	N/A	No	-	Gone	N/A	Box could not be located. Presumed to be cleared.
2017	2020-05-21	2020-08-12	B3-06	B3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and	Flagged but not removed. Wasp nest removed.

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
									maintenance door secured with wire.	
2017	2020-05-20	2020-08-13	B3-07	B3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Bear scratch marks up tree below nest box
2017	2020-05-21	2020-08-14	B3-10	B3	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Filled with sticks and grass
2017	2020-05-21	2020-08-12	B3-11	B3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-12	B3-12	B3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-14	B3-13	B3	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Was used in previous year - grass/lichen up nest inside
2017	2020-05-20	2020-08-12	B3-14	B3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	N/A	B3-16	B3	N/A	No	-	Gone	N/A	Tree fallen - lots of wind throw in this area
2017	2020-05-21	2020-08-12	B3-17	B3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Rodent activity
2017	2020-05-20	2020-08-14	B3-20	B3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and	-

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
									maintenance door secured with wire.	
2017	2020-05-20	2020-08-13	BC-01	BC	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Recent clearing of beetle kill pine in area surrounding nest box
2017	2020-05-20	2020-08-14	BC-2	BC	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-12	BC-3	BC	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Recently cleared track running close to nest box
2017	2020-05-20	2020-08-14	BC-5	BC	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	2020-08-14	C-01	C	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Flagged but not removed. Wasp nest removed.
2017	2020-05-20	2020-08-13	C-02	C	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust on bottom
2017	2020-05-20	2020-08-12	C-03	C	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust on bottom
2017	2020-05-21	2020-08-13	C-08	C	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust on bottom

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
2017	2020-05-20	2020-08-12	C-12	C	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-13	C-13	C	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	N/A	C-15	C	N/A	No	-	Gone	N/A	Nest box has been removed, flagging placed on tree. Nails holding box can be observed on the tree.
2017	2020-05-20	2020-08-12	C-18	C	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-20	2020-08-12	C-22	C	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Recent clearing of beetle kill pine in area near nest box
2017	2020-05-20	2020-08-12	E1-02	E1	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Some sawdust on bottom, side swing door not latched but is closed.
2017	2020-04-16	N/A	E1-05	E1	N/A	No	-	Deactivated	Deactivated to prevent impact from construction on highway 29	-
2017	2020-05-20	2020-08-12	E2-01	E2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
2017	2020-05-20	2020-08-12	E2-02	E2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust on bottom, swing door hanging open a crack
2017	2020-05-21	2020-08-13	E2-03	E2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Grass on bottom inside
2017	2020-05-20	2020-08-13	E2-05	E2	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Large grass mound with small cup nest inside - probably HOWR from previous year
2017	2020-05-20	2020-08-13	E2-10	E2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust on bottom
2017	2020-05-20	2020-08-13	E2-13	E2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust on bottom
2017	2020-05-20	2020-08-14	E2-17	E2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	-
2017	2020-05-21	2020-08-14	E2-20	E2	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Large pile of grass inside- maybe HOWR from envious year
2017	2020-05-21	2020-08-14	E2-21	E2	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Grass in bottom and fallen wasp nest

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
2017	2020-05-21	N/A	E2-27	E2	N/A	No	-	Gone	N/A	The area was cleared,
2017	2020-05-21	2020-08-14	E2-28	E2	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Large grass nest inside
2017	2020-05-21	2020-08-13	E3-01	E3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Side swing door is pushed inward. Rodent activity
2017	2020-05-21	2020-08-13	E3-02	E3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Rodent activity. Swing on hanging open a bit.
2017	2020-05-21	2020-08-13	E3-03	E3	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Grass cup nest inside
2017	2020-05-21	2020-08-13	E3-04	E3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Swing door hanging open - Box on an angle. Front panel is split (not stained).
2017	2020-05-21	2020-08-13	E3-05	E3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust on bottom, fallen wasp nest
2017	2020-05-21	N/A	E3-07	E3	N/A	No	-	Gone	N/A	Nest has been removed, flagging placed on tree. Can see where nails holding box were.
2017	2020-05-21	N/A	E3-09	E3	N/A	No	-	Gone	N/A	Nest has been removed, flagging placed on tree.

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
										Can see where nails holding box were.
2017	2020-05-21	2020-08-13	E3-11	E3	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Bird droppings and some grass on inside
2017	2020-05-22	N/A	E3-12	E3	N/A	No	-	Gone	N/A	Nest fallen down. Backing board still on tree was cracked in half, and box was apparently shot by shotgun with bird shot.
2017	2020-05-22	2020-08-14	E3-13	E3	Adult behaviour	Yes	AMKE	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Adult briefly fluttered up to entrance and looked out when we arrived at base of tree. Another flying nearby.
2017	2020-05-21	2020-08-14	E3-14	E3	Pole camera examination	Yes	AMKE	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Female sitting on nest, likely eggs given timing. Photo with pole cam, did not flush.
2017	2020-05-22	2020-08-14	E3-15	E3	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Squirrel popped out of Box when we tapped on it. Front marked with bird shot from shotgun.
2017	2020-05-22	2020-08-14	E3-16	E3	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Grass and leaves inside on bottom. Back of box is split, swing door

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
										hanging inward a bit.
2017	2020-04-19	N/A	F-03	F	N/A	No	-	Salvaged by Eco-Web	N/A	Removed during logging in the area
2017	2020-04-16	N/A	F-07	F	N/A	No	-	Deactivated	N/A	Deactivated to prevent impact from construction on highway 29
2017	2020-04-16	N/A	F-08	F	N/A	No	-	Deactivated	N/A	Deactivated to prevent impact from construction on highway 29
2017	2020-05-20	2020-08-13	F-11	F	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust and a feather on bottom
2017	2020-05-20	2020-08-13	F-17	F	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust and wasp nest pieces on bottom
2017	2020-05-20	2020-08-13	F-18	F	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Some sawdust on bottom, side swing door not latched but is closed.
2017	2020-05-20	2020-08-13	F-29	F	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Side door was hanging open to right on arrival
2017	2020-05-21	2020-08-12	F-31	F	Pole camera examination	Yes	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Debris and feathers on bottom

Year installed	Monitoring Date	Maintenance Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use?	Species Observed	Box Status	Maintenance Completed	Comments
2017	2020-04-16	N/A	F-32	F	N/A	No	-	Deactivated	N/A	Deactivated to prevent impact from construction on highway 29
2017	2020-04-16	N/A	F-42	F	N/A	No	-	Gone	N/A	Removed during logging in the area
2017	2020-04-16	N/A	G-07	G	N/A	No	-	Deactivated	N/A	Deactivated to prevent impact from construction on highway 29
2017	2020-04-19	N/A	G-08	G	N/A	No	-	Salvaged by Eco-Web	N/A	Removed during logging in the area
2017	2020-05-20	2020-08-13	G-13	G	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Some sawdust on bottom, side swing door not latched but is closed.
2017	2020-05-20	2020-08-13	G-15	G	Pole camera examination	No	-	Operational	Box cleaned out, nesting material added and maintenance door secured with wire.	Sawdust on bottom

Note: N/A - box was not available for monitoring because it was damaged by clearing, livestock, winds, and probably vandalism, or deactivated to prevent their use during construction activities; '-' – species was not present and could not be identified

Appendix 10. Bald Eagle Nest Surveys – Summary for 2020

MEMORANDUM

Date:	March 16, 2021
To:	Brock Simons, Terrestrial Biodiversity Specialist, Site C Clean Energy Project
From:	Jason Brogan, M.Sc., R.P.Bio. Hemmera
File:	989619-05
Re:	Bald Eagle Nest Surveys – Summary of 2020

1.0 INTRODUCTION

This memo summarizes the findings of the bald eagle (*Haliaeetus leucocephalus*) nest surveys on the Peace River conducted in May and June 2020. The purpose of the surveys was to document the status of known and newly constructed bald eagle nests along the Peace River, at wetlands near the Site C transmission line, and at artificial (mitigation) nest platforms. This is a continuation from the surveys that were completed in 2016 through 2019 (Hemmera 2016, 2018a, 2018b, 2019) and during baseline studies for the Site C Clean Energy Project (Keystone Wildlife Research 2009).

Bald eagle nest surveys were conducted with two objectives:

1. Determine the status (active/not active) and productivity of known and newly constructed bald eagle nests in the study area (the Peace River between Hudson's Hope and the Alberta border, including areas encompassed by the Site C reservoir footprint); and
2. Provide the data to BC Hydro to inform Site C construction mitigation.

Data collected during this survey provide information on the spatial distribution, timing and productivity of bald eagle nests in the study area.

2.0 METHODS

Known bald eagle nest locations (Hemmera 2019) along the Peace River and at natural wetlands adjacent to the Site C transmission line right-of-way were surveyed by helicopter on 29 May and 6 June 2020, following the methods outlined by the Resources Inventory Committee (RIC 2001). The surveys were conducted with a two-person crew consisting of a crew lead and a technician.

Previously identified nest locations from past aerial surveys (Hemmera 2019) were visited. In addition to known nests, a search was conducted simultaneously for new nests, which were then added to the database with unique identification designations starting with 900 for the 2020 surveys. Bald eagle nests reported by other crews working for BC Hydro were also visited. Nests that were known to be destroyed in 2018 (e.g., nest disintegrated, host tree failed naturally, or host tree was felled) were not visited in 2020, but searches were conducted in these areas for newly constructed nests.

The observations recorded at each known or new bald eagle nest (or stick nests constructed by other species) were the status of “active”, “inactive”, “not detected” or “tree gone”, or “unknown”, the associated species assigned to each nest, and the number of nestlings.

Status was determined by the presence of attending adults or evidence of nestlings. Productivity was estimated by counting the number of nestlings in each nest with the assumption that most nestlings reach fledging (Bruehler 2020). Annual productivity was calculated as the sum of estimated productivity from active nests divided by the number of active nests. The following assumptions were used to determine nest status and productivity:

- Active nests included those with evidence of adults attending a nest at any one of the field surveys;
- The number of chicks in a nest at the last observation reflects the number fledged, except nests with three chicks which were only assumed to fledge two chicks; and
- No second clutches.

Nestlings grow quickly in the first days and weeks after hatching causing drastic size differences between each sibling (Bortolotti 1986a). A third hatched chick is at a great disadvantage and will likely starve due to being out competed by its larger siblings. (Gerrard and Bortolotti 1988, as cited in Buehler 2020). In two chick broods, both chicks generally survive (e.g., only two chicks from 37 two-chick broods in Saskatchewan died [Bortolotti 1986b]).

Second clutches in natural populations of bald eagle are not observed (Buehler 2020), likely due to the long duration of breeding, as speculated by Newton (1977). Exceptions are known when eggs or nestlings are artificially removed as part of captive breeding programs (Morrison and Walton 1980, Wood and Collopy 1993), or eggs are lost early in the season (Steenhof and Newton 2007). No second clutches have been observed in the study area.

Survey results were provided to BC Hydro in Excel (.csv) format, including applicable comments and coordinates for each nest.

3.0 SURVEY RESULTS

Constraints from the COVID-19 outbreak, and measures to reduce transmission resulted in fewer surveys conducted in 2020 than in previous years. Timing of, and the fewer surveys reduced the ability of surveyors to accurately determine per nest productivity due to the inability to capture nests that failed during early stages.

A total of 55 potential bald eagle nests and artificial nesting platforms were monitored in 2020 (**Appendix A**). Of the 55 nests, 25 were active, 19 were inactive, and 11 nests were not detected or the host tree was gone (**Table 3.1**). The number of chicks observed at active nests ranged from one to three at the time of fledging, for a total of 46 assumed fledged chicks (**Table 3.1; Appendix B**). The estimated number of young fledged per nest could not confidently be calculated with only two mid-late season surveys. Four new bald eagle nests were found in 2020 (nest IDs 901 – 904). Three of those nests were active (IDs 901, 902, and 904) and one was inactive (IDs 903). Given the close proximity to other active and/or inactive nests, these newly identified nests may be alternate or new nests. Alternate nests are common; data show an average of 1.5 nests per pair across the range of bald eagles with some eagles reportedly having up to five nests (Buehler 2000).

Table 3.1 Bald Eagle Nest Activity and Productivity on the Peace River (2016-2020)

Nest Status	2016	2017	2018	2019	2020
Active	NEI	34	28	29	25
Inactive	8	7	15	22	19
Not Detected/Tree Gone	-	18	4	6	11
Unknown	52*	-	1	0	0
Total	**60**	**59**	**48**	**57**	**55**
Estimated productivity (total chicks)	**NEI**	**39**	**34**	**42**	**46**
Estimated young fledged per active nest (fledging success rate)	**NEI**	**1.15**	**1.21**	**1.45**	**NEI**

Note: unknown – incidental observation from third party, nest status unconfirmed by Hemmera
NEI = not enough information due to survey timing
*37 of the 52 unknown nests in 2016 were considered potentially active

BC Hydro erected three artificial nesting platforms (p32, p39, and p37) in 2015. In previous surveys, no use had been observed, and there was no evidence of bald eagle use during the 2020 surveys. The nest platforms are placed near the periphery of the future reservoir, and are therefore likely too far from water to be attractive for bald eagle nesting prior to reservoir filling.

There were eleven undetected nests (Nest IDs 101, 147, 218, 302, 400, 604, 703, 801, and 807 due to the nest tree no longer present; these nests will not be included in future surveys, but searches of suitable nesting habitat nearby will continue to be conducted. Four of the nests (101, 147, 302 and 400) likely fell due to natural causes, while the other nests were removed by BC Hydro.

All nests, whether active or inactive in 2020, will be surveyed again in 2021 except for nests where the nest tree was known to be removed or naturally fell.

4.0 DISCUSSION

The 2020 surveys represent the fifth year of annual productivity monitoring of bald eagle nests in the study area (2016 through 2020). In comparison to previous years of the study, 2020 had the highest estimated productivity; 46 chicks (**Table 3.1**). However, the number of chicks successfully fledged per active nest (i.e., the fledging success rate) in 2020 can not be directly compared to estimates from previous years because measures put in place to limit the spread of COVID-19 resulted in only the last two of three planned surveys being conducted. Surveys conducted later in the breeding season do not capture nests that were active but failed early in the incubation period (i.e. zero fledged chicks). Therefore, the fledging success rate would be an overestimate in 2020 and not comparable to other years.

Among years (excluding 2020), the year-to-year variation from surveys on the Peace River in this study is within the natural range because the observed productivity is comparable with other areas where pesticides have not affected productivity in bald eagles (Elliott and Norstrom 1998). Examples from other studies include 0.88 to 1.24 young produced per active nest in the Aleutian archipelago, Alaska (Anthony et al 1999), 0.72-1.18 young fledged per active nest in Oregon (Isaacs et al 1983), and 1.56 eggs or downy young per nest in Alaska (Hodges 1982).

Bald eagle nesting phenology in the Peace is asynchronous; some bald eagles were observed incubating eggs on nests at the same time as other nests were at the nestling stage, or had chicks that had already fledged. Some bald eagles were observed establishing nests very late in the nesting season (February 5 – June 25) as described by MOE (2013). This asynchronous nesting, combined with few surveys makes conclusions of productivity difficult, particularly during late spring surveys when tree leaves obscure nests and the precise numbers of chicks is difficult to discern.

Surveys using the methods described here will continue in 2021 as per the commitments in the bald eagle management plan for the project (BC Hydro 2016). Newly adopted protocols to prevent the transmission of COVID-19 are not expected to impact the timing and frequency of future surveys.

5.0 CLOSING

This Work was performed in accordance with BCO95055 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Canada Inc. (Ausenco), and BC Hydro (Client), dated 21 June 2016 (Contract). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this Work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

We have appreciated the opportunity of working with you on this project and trust that this report is satisfactory to your requirements. Please feel free to contact the undersigned regarding any questions or further information that you may require.

Report prepared by:
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APPENDIX A

Nest Survey Results for 2020

Nest Survey Results for 2020

Nest ID	Year first observed*	29-May-20	06-June-20	Comments
6	pre-2014	Active	Active	2 chicks
8	pre-2014	Inactive	Inactive	No activity. OK condition.
13	pre-2014	Active	Active	2 chicks
22	pre-2014	Inactive	Inactive	Nest ageing.
29	pre-2014	Inactive	Inactive	Inactive. Adult nearby. Nest condition declining.
38	pre-2014	Inactive	Not detected	Inactive
100	pre-2014	Active	Active	2 chicks and 2 adults nearby
101	pre-2014	Not Detected	Tree Gone	Tree appears to have broken causing the nest to fall
104	pre-2014	Active	Active	2 chicks and adult on nest
127	pre-2014	Inactive	Inactive	Adult nearby
128	pre-2014	Inactive	Inactive	Adult in vicinity but no activity on nest
132	pre-2014	Active	Active	2 chicks
133	pre-2014	Active	Active	2 chicks
138	pre-2014	Active	Active	3 large chicks
144	pre-2014	Active	Active	2 chicks
146	pre-2014	Active	Active	2 large chicks
147	pre-2014	Tree Gone	Tree Gone	Tree gone
155	pre-2014	Active	Active	1 chick
203	pre-2014	Active	Active	1 chick present though hard to see through leaves
218	pre-2014	Tree Gone	Tree Gone	
219	pre-2014	Active	Active	2 chicks adult flushed
222	pre-2014	Active	Active	2 chicks
223	pre-2014	Not Detected	Not detected	Nest not detected
224	pre-2014	Active	Active	1 chick
225	pre-2014	Inactive	Inactive	Inactive but adults in vicinity. Tried to find nest elsewhere at Boucher Lk but no luck.
302	2014	Tree Gone	Tree Gone	
400	2016	Tree Gone	Tree Gone	
600	2017	Active	Active	1 chick
601	2017	Inactive	Inactive	Nest a bit lopsided
602	2017	Active	Active	2 chicks
604	2017	Tree Gone	Tree Gone	
607	2017	Active	Active	2 chicks. Adult left nest.
608	2017	Inactive	Inactive	Nest ok
610	2017	Not Detected	Not Detected	Not detected
701	2018	Inactive	Inactive	Inactive. Good condition.
702	2018	Active	Active	2 chicks
703	2018	Tree Gone	Tree Gone	

Nest ID	Year first observed*	29-May-20	06-June-20	Comments
705	2018	Active	Active	2 chicks adult protective
707	2018	Active	Active	2 chicks
801	2019	Tree Gone	Tree Gone	
802	2019	Active	Active	2 chicks
803	2019	Inactive	Inactive	Inactive
804	2019	Inactive	Inactive	Nest ok
805	2019	Inactive	Inactive	Inactive. Good condition.
806	2019	Active	Active	2 chicks and one adult in nest
807	2019	Tree Gone	Tree Gone	
901	2020	Active	Active	2 chicks
902	2020	Active	Active	2 chicks
903	2020	Inactive	Inactive	Not active
904	2020	Active	Active	2 chicks
62c	pre-2014	Inactive	Inactive	Eggs still present no adult - not eagle eggs maybe unsuccessful goose
Common Raven				
611	2017	Active	Inactive	CORA seems to have fledged
Platform Structures				
p32	2018	Inactive	Inactive	
p39	2018	Inactive	Inactive	
p47	2018	Inactive	Inactive	

Notes:

'*' - Year first observed for nests recorded before 2014 is not known as the Site C EIS does not provide this detail, but rather only that that BAEA nest surveys were conducted and the nests found in 2006, 2008, and 2011. Surveys were conducted in 2012, but no nests were detected.

Active – nest present and BAEA in area or using nest; Inactive – nest present but unused; Not Detected - nest not detected; Tree Gone - the nest tree is no longer standing.

APPENDIX B

Active bald eagle nests and assumed productivity, May 19 and June 6, 2020

Nest ID	May 29	June 6	Estimated Productivity (# fledged)
6	Adult, Chicks (2)	Chicks (2)	2
13	Adult, chicks (2)	Chicks (2)	2
100	Adult, Chicks (2)	Adult, Chicks (2)	2
104	Chicks (2)	Chicks (2)	2
132	Adult, Chicks (2)	Chicks (2)	2
133	Adult, Chicks (2)	Chicks (2)	2
138	Adult, Chicks (3)	Chicks (3)	2
144	Chicks (2)	Chicks (2)	2
146	Chicks (2)	Chicks (2)	2
155	Chick (1)	Chick (1)	1
203	Adult	Chick (1)	1
219	Adult, Chick (1)	Adult, Chicks (2)	2
222	Adult, Chicks (2)	Chicks (2)	2
224	Adult, Chick (1)	Chick (1)	1
600	Adult, Chick (1)	Chick (1)	1
602	Chicks (2)	Chicks (2)	2
607	Adult, Chicks (2)	Adult, Chicks (2)	2
702	Chicks (2)	Chicks (2)	2
705	Adult, Chick (1)	Adult, Chicks (2)	2
707	Adult, Chicks (2)	Chicks (2)	2
802	Adult, Chicks (2)	Chicks (2)	2
806	Adult, Chick (1)	Adult, Chicks (2)	2
901	Adult, Chicks (2)	Chicks (2)	2
902	Adult, Chicks (2)	Chicks (2)	2
904	Chicks (2)	Chicks (2)	2
		Total Chicks	**46**

Note: Active – nest present and BAEA using nest; Inactive – nest present but unused

Appendix 11. Ground-Nesting Raptor Monitoring 2020 Annual Report

Site C Clean Energy Project
Ground-Nesting Raptor Monitoring
2020 Annual Report



PRESENTED TO

BC Hydro and Power Authority

DECEMBER 17, 2020
ISSUED FOR USE
FILE: 704-ENW.PENW03042-01.GNRM

Saulteau EBA Environmental Services Joint Venture.
Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

Site C Clean Energy Project Ground-Nesting Raptor Monitoring 2020 Annual Report

FILE: 704-ENW.PENW03042-01.GNRM
December 16, 2020

PRESENTED TO

Site C Clean Energy Project
BC Hydro and Power Authority
P.O. Box 49260
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Elyse Hofs, B.Sc., Dipl.T. **2020-12-17**
Junior Environmental Scientist

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Jeff Matheson, M.Sc., R.P.Bio. **2020-12-17**
Senior Biologist

EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors (i.e., Short-eared Owl [*Asio flammeus*] and Northern Harrier [*Circus hudsonius*]) in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2020. The surveys were part of BC Hydro's Ground-Nesting Raptor Follow-up Monitoring Program. This report describes the methods used to conduct the surveys and provides a summary of the results.

The 2020 ground-nesting raptor surveys were conducted using two methods: (1) Field surveys were conducted along transects and at standwatch stations to detect Northern Harrier and Short-eared Owl, and (2) Autonomous Recording Units (ARUs) were established at select standwatch stations with the purpose of detecting Short-eared Owl through human-listening.

The ground-nesting raptor field surveys were completed within six cleared portions of the Site C reservoir: Lynx Creek, Halfway River, Highway 29 near Watson Slough, Cache Creek, Bear Flats, and along the Peace River between the Halfway River and Moberly River. The surveys were conducted either through transects or through stationary standwatches. Ground-nesting raptor surveys were completed at each transect and standwatch station up to four times over May and June 2020 (three daytime visits and one evening survey for select sites). The cleared portions near Bear Flats, Cache Creek, Lynx Creek and Highway 29 were accessed on foot and the areas along the Peace River and Halfway River were accessed by boat.

ARUs were deployed at seven stations throughout the survey area that were assessed as having the highest habitat potential for Short-eared Owl. These seven stations were located along transects or at standwatch stations in the Bear Flats, Cache Creek, Halfway River and Peace River survey areas in locations that had experienced between one to three growing seasons since clearing. The ARUs were retrieved after a month of recording and three audio recordings taken near sunset were randomly selected from separate nights at each station and analyzed and interpreted for Short-eared Owl through human listening.

No Short-eared Owls were detected during the field surveys or through human listening of the ARU recordings. Northern Harriers were observed in the Bear Flats, Highway 29 and Peace River areas during the late May (May 21 – May 24) and early June (June 3 – June 9) surveys, but were not observed during any surveys completed during the third visit in late June (June 19 – 24). A breeding pair of Northern Harriers and their nest was observed within the footprint though not in a location that had been cleared during reservoir preparation. Surveys in 2021 will continue in all cleared areas within the headpond.

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1.0 INTRODUCTION

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2020. The surveys were part of BC Hydro's Ground-Nesting Raptor Follow-up Monitoring Program (BC Hydro 2016). Ground-nesting raptor surveys have occurred annually since 2016. This report describes the methods used to conduct the surveys and provides a summary of the results from 2020.

The Ground-Nesting Raptor Follow-up Monitoring Program is specifically focused on two ground-nesting raptor species: Short-eared Owl (*Asio flammeus)* and Northern Harrier (*Circus hudsonius)* (Table 1).

Table 1: Species Covered in the Ground Nesting Raptor Follow-up Monitoring Program

Common Name	Scientific Name	BC List	COSEWIC [1] Status	SARA [2] Status
Short-eared Owl	*Asio flammeus*	Blue	Special Concern	Schedule 1 – Special Concern
Northern Harrier	*Circus hudsonius*	Yellow	-	-

[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada.
[2] SARA – *Species at Risk Act*.

The objectives of the ground-nesting raptor monitoring program are to determine:

- The number of Northern Harrier and Short-eared Owl nesting in areas cleared within the construction headpond during construction prior to reservoir filling;
- The effects of seasonal headpond flooding on Northern Harrier and Short-eared Owl nests; and
- The use of open fields within mitigation properties by Northern Harrier and Short-eared Owl as nesting habitat.

2.0 METHODS

The 2020 ground-nesting raptor surveys were conducted using two methods:

1. Field surveys were conducted along transects and at standwatch stations to detect Northern Harrier and Short-eared Owl; and
2. Autonomous Recording Units (ARUs) were deployed at select standwatch stations as a pilot study to determine if acoustic recordings could be used to detect Short-eared Owl in late-evening hours when sites cannot be surveyed by human observers.

Surveys were conducted in cleared portions of the reservoir between the dam site and the Halfway River. Surveys of the mitigation properties were conducted in 2016 and 2017. Use of the mitigation properties in their current conditions (i.e., in the absence of any land-use changes or habitat modification) by ground-nesting raptors has been well documented and further surveys would likely not provide new information. Surveys of the mitigation properties were therefore not conducted in 2020. Surveys of these areas will be performed again when the reservoir has been inundated or when there are land use changes or habitat modifications in the mitigation properties, whichever occur first.

2.1 Field Surveys

Surveys were conducted at 48 standwatch stations within the six areas outlined in Table 2 and in Figures 1 through 10. Appendix B provides a full list of the standwatch stations surveyed in 2020 and the survey history of each station surveyed from 2016 – 2020.

The Bear Flats area had a single transect with 5 standwatch stations located along its length (Figure 2). The Cache Creek area consisted of one transect with five standwatch stations, and an additional standwatch station, CCSW06, that was newly established this year (Figure 3). Surveys were not conducted at CCSW01 this year because water levels in Cache Creek remained too high and the watercourse could not be safely crossed to access the survey point.

A number of standwatch stations in the Halfway River and Highway 29 areas that were surveyed in 2019 could not be surveyed in 2020 due to active construction in the area; HRSW02, HRSW03, H29SW01, H29SW04, and H29SW05. Only one standwatch station remained in the Halfway River area, and the Highway 29 area consisted of two standwatch stations (Figures 4 & 5). Since H29SW05 had been disturbed by construction, a new station H29SW06 was established nearby so that the general area could still be surveyed. A new survey area was established at Lynx Creek and two standwatch stations were established in cut areas (Figure 6).

The Peace River area was the largest survey area, with 5 transects (for a total of 25 standwatch stations) between the Moberly River and Cache Creek and eight standwatch stations located between Cache Creek and the Halfway River (Figures 7 to 10). A number of single standwatch stations and two transects (the Peace River Transect #4 and the Peace River Transect #5) were established this year, for a total of 22 new standwatch stations. PRSW13 was not surveyed during the first visit in May due to active logging that was occurring nearby but was surveyed during the second and third round of visits. The standwatch stations PRSW10 and PRSW01 were not surveyed this year because these areas could be adequately viewed and surveyed from nearby standwatch stations and were considered to be redundant. Surveys were not conducted in the Moberly River area due to construction activity at the confluence with the Peace River and high water upstream making it inaccessible.

Within these six areas, ground-nesting raptors were surveyed up to four times over May and June 2020 to capture earlier, middle, and later stages of their breeding season. The fourth visit was an evening survey conducted at select sites. The first survey in May began later in the month than in previous years due to travel complications and restrictions associated with the COVID-19 pandemic. The surveys were conducted using a combination of transects and stationary standwatches. The cleared Bear Flats, Cache Creek, Highway 29, and Lynx Creek areas were accessed by foot and the cleared Peace River and Halfway River areas were accessed by boat. Surveys were completed by two teams of two observers. Each team was composed of a biologist with raptor survey experience and an assistant (Appendix C).

Table 2: Survey Areas with Dates and Times

Survey Location	First Visit	Second Visit	Third Visit	Fourth Visit
Bear Flats	May 21, 2020 13:15 – 16:10	June 6, 2020 04:30 – 07:00	June 20, 2020 07:50 – 10:30	June 26, 2020 21:00 – 21:20 (Only surveyed BFSW01)
Cache Creek	May 20, 2020 15:15 – 15:55 & May 21, 2020 10:20 – 11:55	June 6, 2020 04:10 – 06:00	June 19, 2020 15:10 – 15:15 & June 20, 2020 08:05 – 09:30	June 26, 2020 21:35 – 21:55 (Only surveyed CCSW05)
Halfway River	May 24, 2020 9:30 – 9:50	June 9, 2020 11:35 – 11:55	June 19, 2020 16:00 – 16:20	-
Highway 29	May 20, 2020 14:15 – 15:00	June 6, 2020 07:50 – 08:10 & June 9, 2020 10:50 – 11:10	June 19, 2020 14:05 – 15:00	June 26, 2020 21:30 – 21:50 (Only surveyed H29SW02)
Lynx Creek	May 20, 2020 11:30 – 12:20	June 6, 2020 07:45 – 08:30	June 19, 2020 14:40 – 15:25	-
Peace River	May 20, 2020 13:20 – 13:40 & May 22, 2020 08:40 – 15:20 & May 23, 2020 08:35 – 15:30 & May 24, 2020 10:10 – 14:25	June 3, 2020 06:35 – 14:20 & June 5, 2020 10:10-10:35 & June 7, 2020 11:35 – 11:55 & June 9, 2020 11:35 – 11:55	June 19, 2020 16:00 – 16:20 & June 21, 2020 06:30 – 14:20 & June 23, 2020 09:45 – 10:40 & June 24, 2020 10:50 – 11:10	June 26, 2020 20:55 – 21:15 (Only surveyed PRSW36)

Northern Harrier are diurnal, and research suggests they are generally active between 05:30 and 21:30 (Smith et al. 2011). Short-eared Owl are a crepuscular species and optimal survey timing is in the evening just prior to civil twilight (Wiggins at al. 2006). While most surveys were conducted during daytime hours, evening surveys were conducted at four select sites to enhance the possibility of detecting Short-eared Owl (the fourth visit column in Table 2). The evening surveys were limited to areas that could be safely accessed by truck due to the logistical and safety considerations that come with conducting surveys in cleared portions of the reservoir that require boat access. Evening surveys would require boating in very low light or dark conditions after surveys are complete and boat use at night on the Peace River is not considered a safe work practice by BC Hydro.

2.1.1 Transect Survey Protocol

The transect surveys were conducted by walking at a speed of 0.5 – 2 km/hr, looking and listening for birds. Surveyors stopped whenever required to confirm identification and record data. The walking transects were located only in cleared portions of the reservoir. Surveyors selected walking paths to ensure visual coverage of the entire portion of suitable habitat in each area. During the transect, surveyors stopped at each established standwatch station to complete a standwatch survey. From each standwatch station the surveyors had a view from the previous standwatch station to the next station in the transect. Adding these standwatches into the transect surveys allowed surveyors to observe areas for longer periods to increase the potential to observe bird activity and to monitor potential nesting behaviour for the purpose of locating ground-nesting raptor nests. Standwatches were conducted by observing from a stationary position for approximately 20 minutes.

Surveys were not completed during periods of high wind (greater than Beaufort 3, 12 - 19 km/hr), rain or fog, when bird activity and detectability are likely to be low. The order that the stations were visited was different on each of the survey days.

For all raptor observations, species, sex, age, activity, distance and compass direction were recorded. Other species were recorded as incidental observations (Appendix A). For Northern Harrier or Short-eared Owl observations, if a pair was observed or there was evidence of nesting behaviour, a nest search was conducted to attempt to locate any nest that might be present in the area. Since ground-nesting raptor nests can easily be destroyed by human traffic, surveyors were instructed to observe for behaviour suggesting a nest was nearby (e.g., one or both of the pair returning to the same location with nesting materials or food, a pair of Northern Harriers exchanging prey or nesting materials through aerial passes, or a male Short-eared Owl defending a nest with distraction displays) rather than conduct intensive foot searches to locate a nest.

2.1.2 Standwatch Survey Protocol Without Transects

Standwatch surveys in the absence of associated transects were conducted in cleared portions of the reservoir that (1) could not be visited by foot due to impassible terrain and/or (2) could not be linked with other standwatch stations to form a transect. Standwatches were conducted by observing from a stationary position for approximately 20 minutes.

Surveys were not completed during periods of high wind (greater than Beaufort 3, 12 - 19 km/hr), rain or fog. The order that the stations were visited were different on each of the survey days.

Ground-nesting raptor observations were collected following the same protocol as described in Section 2.1.1 for transect surveys.

2.2 Autonomous Recording Unit Surveys

An ARU is a standalone audio recording device that can be deployed and left for a period of time to record vocalizations or other sounds. The audio recordings are analyzed and interpreted once the recording units have been retrieved. ARUs are a commonly used tool to survey birds (Shonfield and Bayne 2017). The benefit of using ARUs for bird surveys is that the units can be deployed during daylight hours in areas that cannot be easily or safely accessed in the evening/night (i.e. along the Peace River) when species such as Short-eared Owl are active, allowing for monitoring in areas that would otherwise be difficult to survey.

Short-eared Owl are not especially vocal (Wiggins et al. 2020) and surveys for this species are best conducted using visual ground surveys. However, ARUs could be a useful supplement to visual surveys if Short-eared Owl vocalizations can be reliably detected by a human listener in recordings. This would allow for listening of recordings at locations that could not otherwise be surveyed in evening hours.

To informally test the utility of ARUs for detecting Short-eared Owls and determine if ARUs could be a useful addition to supplement the ongoing visual ground surveys at Site C, an experimental trial was conducted in 2020. ARUs were deployed at select standwatch stations with the intent that Short-eared Owl would be detected by visual survey and recordings could then be reviewed to identify Short-eared Owl vocalizations. Ideally, ARUs would be deployed at locations where Short-eared Owls are known to occur; however, previous surveys have not identified any Short-eared Owl in or adjacent to the reservoir area.

ARUs (Song Meter SM4 from Wildlife Acoustics Inc.) were deployed at seven stations that were assessed as having the highest habitat potential for Short-eared Owl. These seven stations were located along transects or at standwatch stations in the Bear Flats, Cache Creek, Halfway River and Peace River survey areas in locations that had experienced between one to three growing seasons since clearing (Table 3). These sites were abundant in low vegetation, grasses, shrubby regrowth, and had abundant coarse woody debris. A description of the habitat at each ARU survey station can be found in Section 3.1.

Table 3. ARU Survey Station Locations

ARU Survey Station	Location Reference	UTM Zone	UTM Easting	UTM Northing
BF01	Along the Bear Flats transect, between standwatch stations BFSW02 and BFSW03	10V	611747	6237385
CC01	Along Cache Creek transect at standwatch station CCSW04	10V	609092	6238402
PR01	Along PR Transect #2 at standwatch station PRSW07	10V	626622	6232619
PR02	Along PR Transect #1 at standwatch station PRSW03	10V	624354	6233276
PR03	Along PR Transect #3 at standwatch station PRSW14	10V	622906	6232754
PR04	Along PR Transect #3 at standwatch station PRSW15	10V	622119	6232808
HR01	At standwatch station HRSW01	10V	595517	6231367

The ARUs were installed from May 21 to May 24, 2020 and were collected from June 20 to June 24, 2020. The ARUs were installed based on the deployment protocol of Lankau (2015). Each unit was mounted on a wooden stake or affixed to a tree approximately 1 m from the ground. The ARUs were set to record for 10 minutes every half hour each evening for the duration of deployment. The evening recordings were collected between 20:00 to 00:10 (i.e., midnight). The ARUs recorded 2-channel stereo, compressed W4V-8 files at 24 KHz.

To increase the probability of Short-eared Owl detection, recordings that could be selected for human listening were restricted to those taken as close to sunset (approximately 21:55 in June) as possible, when Short-eared Owls are likely to be most active. Three 10-minute recordings, taken at either 21:30 or 22:00, were randomly selected from each station for human listening, for a total of 21 recordings. The three recordings were selected from different nights during the ARU deployment period. If a selected recording had persistent wind or rain, a new recording was randomly selected to avoid periods of low Short-eared Owl activity or decreased ability to detect sounds. The

compressed W4V files were converted to uncompressed WAV files using the Kaleidoscope software (version 5.3.8) by Wildlife Acoustics. The uncompressed WAV files were then imported into Audacity (version 2.4.2) for human listening. The trained human listener played back each recording and was instructed to record Short-eared Owl calls, including barks, screams, bill snaps and male courtship hoots detected in 1-minute intervals; replay any section needed to accurately track and count Short-eared Owl detections; and estimate perceived distance to each individual (near, mid and far). Human listening was conducted by the same trained human listener for all recordings.

3.0 RESULTS

3.1 Habitat at Survey Areas

Habitat information for each survey station was noted during surveys to determine the quality of the cleared area as hunting and nesting habitat for ground-nesting raptors. Table 4, below, describes the habitat at each survey station. Photographs of the habitat at each station are presented in Figures 2-10.

Table 4: Habitat at Peace River Standwatch Stations and Transects during the 2020 Surveys

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
Bear Flats Survey Area – Transect Only			
Bear Flats Transect ▪ BFSW01 ▪ BFSW02 ▪ BFSW03 ▪ BFSW04 ▪ BFSW05	Winter 2018/2019	1	The cleared area was experiencing vegetation regrowth with high percent cover (80-90%) of grasses, forbs and shrubs. Shrubs were approximately 1 m high. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.
Cache Creek Survey Area – Transect and Standwatch			
Cache Creek Transect ▪ CCSW02 ▪ CCSW03	Winter 2018/2019	1	Reestablished vegetation now covers approximately 90% of the cleared area and is dominated by grasses and forbs. Low shrubs reach heights of up to 1.0 m. The cleared area is in a steep-sided drainage in an agriculturally-dominated area with some remnant forest patches on the eastern side and bounded by Highway 29 to the south.
Cache Creek Transect ▪ CCSW04 ▪ CCSW05	Winter 2016/2017	3	Reestablished vegetation consisting of a patchwork of balsam poplar saplings, shrubs, grasses and horsetails covering 90% of the cleared area. In some areas, vegetation reached heights of over 1 m tall. Located in a steep-sided drainage in an agriculturally-dominated area with some remnant forest patches on the eastern side and bounded by Highway 29 to the south.
CCSW06	Partial clearing in Winter 2016/2017 Partial clearing in Winter 2018/2019	3 1	Reestablished vegetation is dominated by grasses and patches of low shrubs (1.0 m in height). The area is oriented south towards Cache Creek, bounded by Highway 29 to the north and surrounded by deciduous riparian forests.
Halfway River Survey Area – Standwatch Only			
HRSW01	Winter 2018/2019	1	Mulched trees, slash piles and some exposed soils remain, but the majority of the area has abundant vegetation regrowth, with shrub, grass, and weed regrowth covering 95% of the area by June. The area is adjacent to the Halfway River, agricultural land, and remnant riparian forest.

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
Highway 29 Survey Area – Standwatch Only			
H29SW02	Winter 2016/2017	3	The cleared area is adjacent to pastureland to the east and Watson Slough to the west, being reestablished by trembling aspen saplings.
H29SW06	Winter 2016/2017	3	Vegetation regrowth consists of a dense cover of grasses, weeds, forbs, and shrubs under 1 m tall with trembling aspen saplings growing to up to 2 m tall on the western side. The Peace River and riparian balsam poplar forest lies to the south.
Lynx Creek Survey Area – Standwatch Only			
LCSW01	Winter 2019/2020	0	The cleared area lies along the left bank of Lynx Creek and is surrounded by agricultural pasture and open mixed-wood forest. There is abundant grass cover (80%) and scattered small woody debris, but no shrub or tree regrowth. Slash piles remain.
LCSW02	Winter 2019/2020	0	A small cleared area along the left bank of Lynx Creek south of Highway 29 and near the confluence of Lynx Creek and the Peace River. Surrounding intact forest is mainly deciduous. Some cleared areas are completely devoid of vegetation, but other areas have moderate grass cover (50%). There is no shrub or tree regrowth. Slash piles remain.
Peace River Survey Area – Transect and Standwatch			
Peace River Transect #1 ▪ PRSW02 ▪ PRSW03 ▪ PRSW04	Winter 2017/2018	2	A cleared and mulched bench in the river channel with thick herbaceous and shrubby regrowth (some greater than 1.0 m tall) covering 90% of the cleared area. It is bounded on the northern and southern sides by intact strips of open riparian forest between the cleared area and the Peace River.
Peace River Transect #2 ▪ PRSW05 ▪ PRSW06 ▪ PRSW07 ▪ PRSW08	Winter 2017/2018	2	A cleared stretch of coniferous forest on a north-facing slope with abundant, grass, herb and shrub regrowth (some greater than 1 m tall) covering 90% of the area. It is bounded to the south by the Peace River, and to the north and west by coniferous forest.
Peace River Transect #3 ▪ PRSW11 ▪ PRSW12 ▪ PRSW13 ▪ PRSW14 ▪ PRSW15	Winter 2018/2019 (except PRSW15 which was cleared 2019 / 2020)	1 0	A large cleared and mulched area encompassing Tea Island. The eastern end of the transect has moderate low vegetation regrowth of forbs, grasses and low shrubs (<1 m) covering about 50% of the ground. The western half of the transect has a higher percentage of vegetation cover (70-80 %), and shrubs over 1 m in height are abundant. It is bounded by dry south-facing slopes to the north and an intact strip of riparian forest along the Peace River to the south.
Peace River Transect #4 ▪ PRSW16 ▪ PRSW17 ▪ PRSW18 ▪ PRSW19 ▪ PRSW20 ▪ PRSW21 ▪ PRSW22 ▪ PRSW23	Winter 2019/2020	0	The flat floodplain areas and the southern slopes were cleared and mulched. Cleared areas consist of exposed soils, small and large woody debris, and have very little vegetation regrowth (<5%). It is bounded to the north by the Peace River, and to the south by coniferous forest. Riparian buffers were left around the perimeters of the clear-cut areas.
Peace River	Winter 2019/2020	0	The area has been cleared and mulched; slash piles, logging road and log piles still remain. Cleared areas consist of exposed soils,

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
Transect #5 ▪ PRSW24 ▪ PRSW25 ▪ PRSW26 ▪ PRSW27 ▪ PRSW28			small and large woody debris, and have very little vegetation regrowth (<5%). It is bounded to the north by the Peace River, and to the south by coniferous forest. Riparian buffers were left around the perimeters of the clear-cut areas.
PRSW29	Winter 2019/2020	0	The cleared area is dominated by large and small woody debris and exposed soils. Slash and debris piles remain. Vegetation regrowth is minimal (<10%) and consists of grasses and some low shrubs that survived the clearing activities, less than 1 m in height. It is bounded by the Halfway River and Peace River to the west and south, respectively, and agricultural fields to the north.
PRSW30	Winter 2019/2020	0	The area has been previously cleared and some woody debris remains. Vegetation regrowth is substantial (>70%) and consists of grasses, herbs and shrubs under 1 m in height. It is bounded by the Peace River to the southeast and agricultural fields to the north.
PRSW31	Winter 2019/2020	0	The area has been cleared and mulched; slash piles remain. Vegetation regrowth is minimal (>5%) and consists of grasses, herbs and low shrubs under 0.5 m in height. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW32	Winter 2019/2020	0	The area has been cleared and mulched; slash piles remain. Vegetation regrowth is minimal (>5%) and consists of grasses, herbs and low shrubs under 0.5 m in height. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW33	Winter 2019/2020	0	The area has been cleared and mulched; slash piles remain. Vegetation regrowth is minimal (>10%) and consists of grasses, herbs and low shrubs under 1.0 m in height. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW34	Winter 2019/2020	0	A small cleared area surrounded by mainly deciduous trees. The cleared and grubbed area has minimal vegetation regrowth (<20%) and consists mostly of grasses, herbs and low shrubs. Slash piles remain. It is bounded to the east and south by the Peace River and to the north by floodplains, and Highway 29.
PRSW35	Winter 2019/2020	0	A small cleared area surrounded by mainly deciduous trees. The cleared and grubbed area has minimal vegetation regrowth (<20%) and consists mostly of grasses, herbs and low shrubs. Slash piles remain. It is bounded to the east and south by the Peace River and to the north by floodplains, and Highway 29.
PRSW36	Natural regrowth after burn. Nearby areas cleared in Winter 2019 / 2020	10+ 0	A small open area near a logging road, between Highway 29 and a logging camp. This area is naturally non-forested and is a remnant of an old burned floodplain bench that has naturally regenerated. Vegetation regrowth was substantial and consisted of grasses and low shrubs such as prickly rose. No clearing related to the project has occurred in this particular area. Nearby project-related clearing occurred in winter of 2019/2020 in areas along the slope to the north and some tree clearing roughly 200-300 m upstream and 200-300 m downstream of PRSW36 (near the Frost-Halfway logging office and equipment storage). Slash piles remain.

3.2 Transect Results

Northern Harriers were observed along one transect. Two (2) Northern Harrier observations were recorded during the transect surveys along Bear Flats at BFSW01 and BFSW02 (Table 5). These two observations were recorded during the late May surveys (i.e., first visit) and Northern Harriers were not observed during subsequent visits. No nests or potential nests were observed along any of the transects surveyed.

3.3 Standwatch Results

Four (4) Northern Harriers were observed at standwatch stations within the Highway 29 and Peace River survey areas (Table 5). During the May surveys (i.e. first visit) in the Peace River survey area at PRSW36, a pair of Northern Harriers were observed displaying nesting / courtship behavior and their nest was located. While this observation was within the Project footprint, it was not located in a cleared area, but rather in a naturally non-forested area that is a remnant of a previously burned floodplain bench (Figure 5). Two other Northern Harrier observations in the Highway 29 survey area at H29SW02 and Peace River survey area at PRSW30 were documented in early June during the second visit. No Northern Harrier were observed at any of the stations during the third visit in late June.

3.4 Incidental Observations

In addition to the six (6) Northern Harrier observations recorded during the transect and standwatch surveys, three Northern Harriers were observed incidentally when transiting between transect or standwatch locations (Table 5). One of these three incidentally observed individuals was male while the other two were of unknown sex. All three incidental observations were documented in late May and early June during the first and second visits.

3.5 ARU Survey Results

Three 10-minute recordings from near sunset at each station were analyzed through human listening, for a total of 21 recordings. No Short-eared Owls were detected through human listening.

Table 5: Northern Harrier Observations during the May/June 2020 Field Surveys.

Transect	Station	Date	Time	Count	Activity	Sex	Age Class	Observation Location			Comments[1]
								UTM Z	UTM E	UTM N	
Observations from Transects											
Bear Flats Transect	BFSW01	May 21	13:19	1	Hunting	F	Adult	10V	611077	6237965	First spotted flying over the agricultural fields to the west and appeared to be hunting on the slopes north of Bear Flats. Continued to fly east along Peace River Valley.
	BFSW02		14:03	1	Flying, Perching	M	Adult	10V	611561	6237465	Spotted flying south of the survey transect closer to the river, and then perched on a snag for a while within the cleared area.
Observations from Standwatches											
Peace River	PRSW36	May 20	13:18	2	Nesting / Hunting	M/F	Adult	10V	598278	6232689	Male and Female NOHA were displaying courtship behavior. Male was observed giving the female food via air transfer and the female landed on a nearby slope to eat the prey. Male and female NOHA landed approximately 83m south of the road and a nest with eggs was observed. The nest was located within the Project footprint at the following coordinates: 10V 598342, 6232636. The nest was in hip-high prickly rose and grass habitat, with no trees and no tall shrubs. This area is naturally non-forested and is a remnant of an old burned floodplain bench that has naturally regenerated (i.e., this area was not cleared as a result of the Project). Photos of the grass nest can be found on Figure 5.
	PRSW30	June 5	10:15	1	In Transit	U	Adult	10V	598190	6222248	Observed flying above the slope along the hill to the halfway lookout.
Highway 29	H29SW02	June 6	07:51	1	In Transit	U	Adult	10V	607618	6236690	Observed flying over the open agricultural field next to the standwatch station and then flew out of view.

Transect	Station	Date	Time	Count	Activity	Sex	Age Class	Observation Location			Comments[1]
								UTM Z	UTM E	UTM N	
Incidental Observations											
-	-	May 23	13:45	1	In transit	M	Adult	10V	613324	6235589	Flying downstream along right bank of Peace River; flying low along riparian area.
-	-	June 3	14:30	1	In transit	U	Adult	10V	606654	6234377	Flying over the riparian area along the banks of the Peace River.
-	-	June 6	06:25	1	Hunting	U	Adult	10V	609345	6237997	NOHA observed foraging along the slopes north of Highway 29, between Cache Creek and Bear Flats.

[1] NOHA = Northern Harrier

4.0 DISCUSSION

The 2020 ground-nesting raptor surveys detected Northern Harrier in and adjacent to the Project footprint, primarily displaying hunting behavior. Northern Harriers were only observed during the late May and early June surveys, and not during the late June surveys. The majority of these Northern Harrier observations were associated with agricultural fields and along ridges and slopes north of the Peace River. One Northern Harrier nest was found in the Project footprint in a naturally non-forested area that was a remnant of an old burned floodplain bench that had naturally regenerated over time. This nest was the first nest observed within the survey areas since the ground-nesting raptor surveys began in 2016.

No Short-eared Owls were detected during the 2020 ground-nesting raptor surveys, which is consistent with the previous years' findings. Short-eared Owl has not been observed in or adjacent to the Project footprint since surveys began in 2016. The experimental use of ARUs to detect Short-eared Owl using audio recordings was inconclusive since no Short-eared Owl were detected in 2020. The ARU trial will be conducted again in 2021.

Areas surveyed within the headpond area in 2016 through 2020 will be surveyed again in 2021 in addition to any newly cleared areas within the headpond. Surveys in the headpond will continue until the reservoir has been filled. This year, the first survey was conducted about two weeks later than in previous years due to COVID-19 pandemic restrictions and complications with travel. The first surveys in 2021 are expected to occur in the first week of May, consistent with previous years.

5.0 REFERENCES

BC Hydro. 2016. Ground Nesting Raptor Follow-up Monitoring Program Plan. Prepared for BC Hydro's Site C Clean Energy Project.

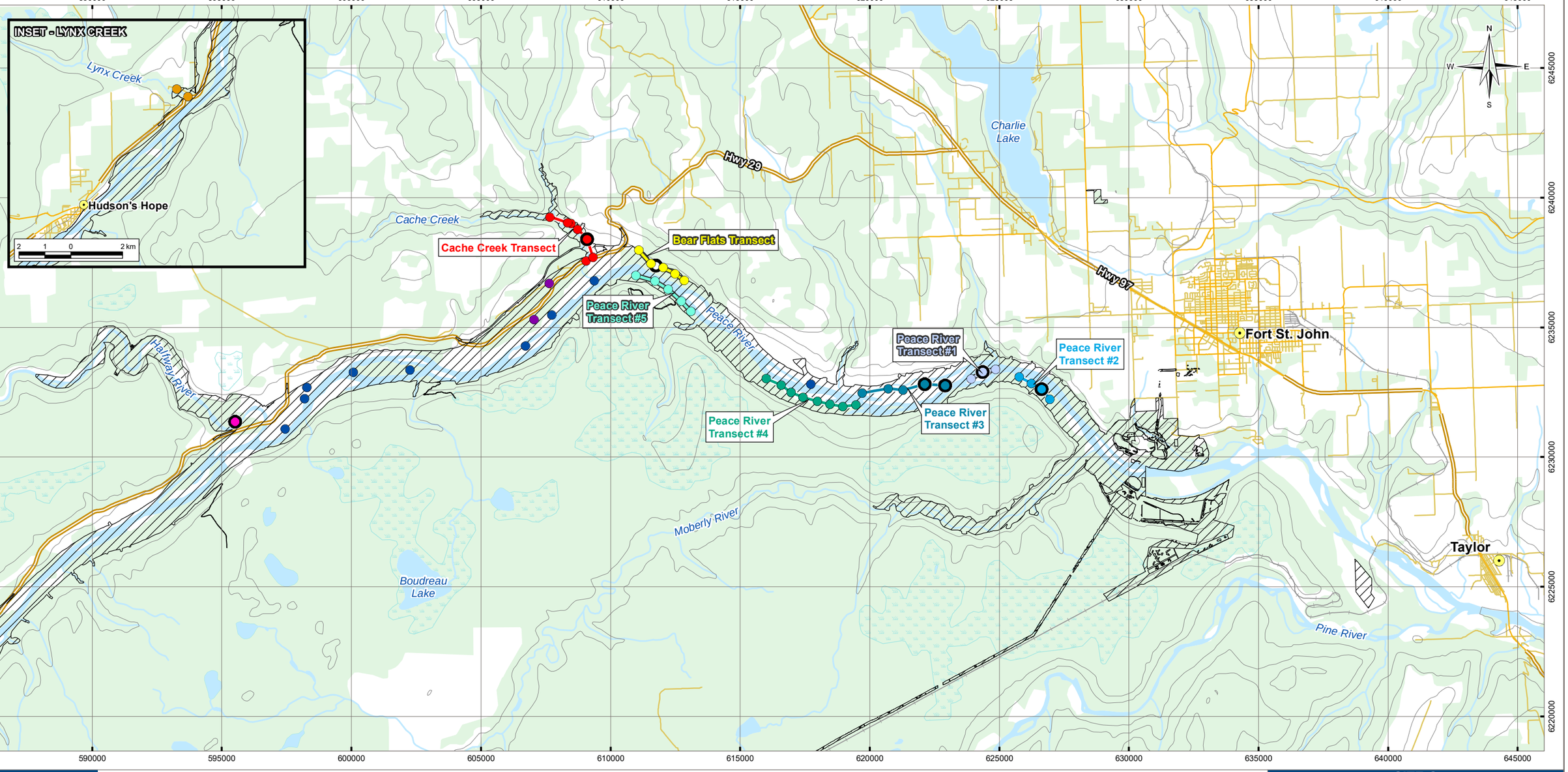
Resources Inventory Committee. 2001. Inventory Methods for Raptors. Standards for Components of British Columbia's Biodiversity No. 11. BC Ministry of Sustainable Resource Management, Environment Inventory Branch, Victoria, BC.

Lankau, H.E., MacPhail, A., Knaggs, M. and Bayne, E. 2015. Acoustic recording analysis protocol. BioAcoustic Unit, University of Alberta and Alberta Biodiversity Monitoring Institute. Edmonton, Alberta.

Shonfield, J. and E.M. Bayne. 2017. Autonomous recording units in avian ecological research: current use and future applications. Avian Conserv. Ecol. 12(1).

Siddle, C. 2010. Birds of North Peace River (Fort St. John and Vicinity), British Columbia, 1975-1999: Part 1 (Introduction and Nonpasserines: waterfowl through woodpeckers). Wildlife Afield 7(1):12–123.

FIGURES



LEGEND

- Project Footprint
- ARU Station

Standwatch Station

- Halfway River
- Highway 29
- Lynx Creek
- Peace River

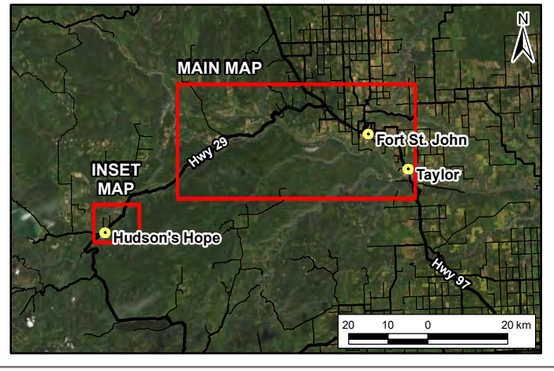
Transect Standwatch Station

- Bear Flats
- Cache Creek
- Peace River #1
- Peace River #2
- Peace River #3
- Peace River #4
- Peace River #5

Transect

- Bear Flats
- Cache Creek
- Peace River #1
- Peace River #2
- Peace River #3
- Peace River #4
- Peace River #5

- Populated Place
- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Railway
- Residential Area
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Wooded Area



NOTES
Base data source: CanVec 1:250,000 (2019).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Project Overview

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OFFICE: Tt-VANC	DWN: SL	CKD: RG	APVD: EH	REV: 0
DATE: December 16, 2020	PROJECT NO.: ENW.PENW03042-01			Figure 1

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610500 611000 611500 612000 612500 613000 613500 614000

6238000 6237500 6237000 6236500

Hwy 29

BF-SW01

Bear Flats Transect

BF-SW02

BF01

BF-SW03

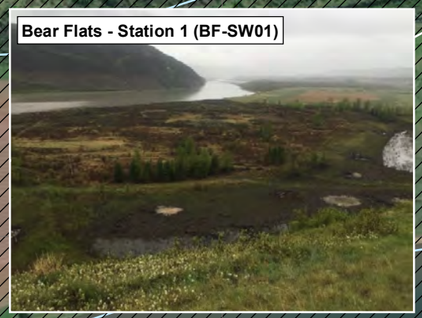
BF-SW04

BF-SW05

Peace River

N W E S

Bear Flats - Station 1 (BF-SW01)

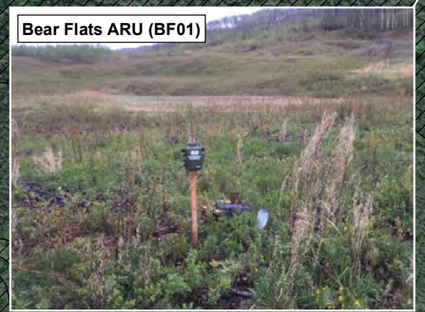


Bear Flats - Station 2 (BF-SW02)

Bear Flats - Station 3 (BF-SW03)

Bear Flats - Station 4 (BF-SW04)

Bear Flats ARU (BF01)

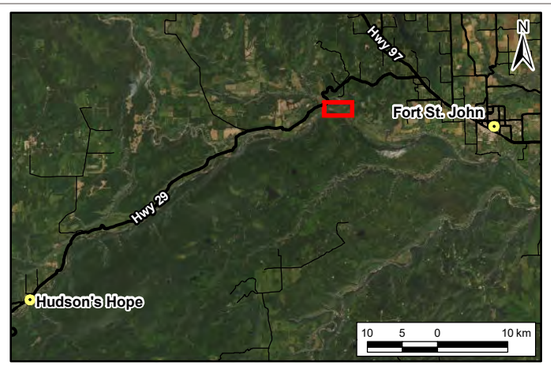


Bear Flats - Station 5 (BF-SW05)

610500 611000 611500 612000 612500 613000 613500 614000

LEGEND

- Northern Harrier Observation
- ARU Station
- Bear Flats Transect Standwatch Station
- Bear Flats Transect
- Project Footprint
- Highway
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2016).

STATUS
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SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Bear Flats Transect Stations

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DATE: December 16, 2020	PROJECT NO.: ENW.PENW03042-01			Figure 2

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606000 606500 607000 607500 608000 608500 609000 609500 610000 610500 611000 611500

6239500 6239000 6238500 6238000 6237500 6237000

Cache Creek

CC-SW01
(No access/
Not surveyed)

Cache Creek Transect

CC-SW02
(No Access,
Relocated Point
to CCSW02B)

CC-SW02B

CC-SW03

CC01

CC-SW04

CC-SW05

CC-SW06

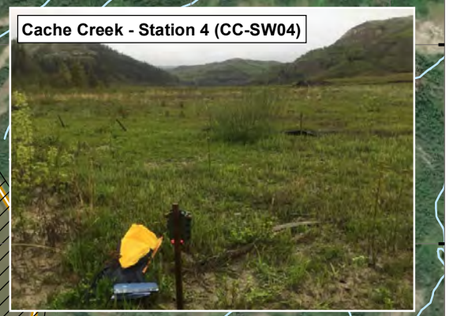
Hwy 29

Peace River

N W E S

Cache Creek - Station 2B (CC-SW02B)

Cache Creek - Station 4 (CC-SW04)



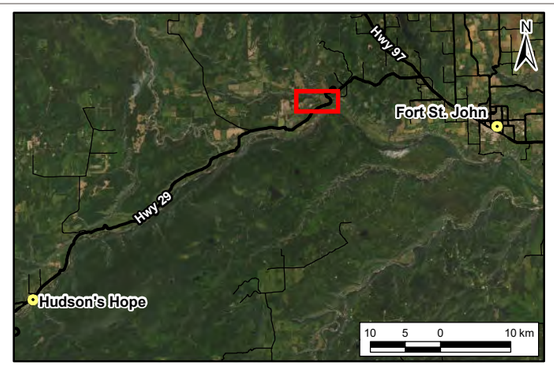
Cache Creek - Station 3 (CC-SW03)

Cache Creek - Station 6 (CC-SW06)

Cache Creek - Station 5 (CC-SW05)

LEGEND

- Northern Harrier Observation
- ARU Station
- Cache Creek Transect Standwatch Station
- Cache Creek Transect
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



NOTES
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Imagery from ESRI; Maxar (2016).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Cache Creek Transect and Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:15,000
200 100 0 200
Metres

TETRA TECH

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Tt-VANC	SL	RG	EH	0
DATE	**PROJECT NO.**			
December 16, 2020	ENW.PENW03042-01			

Figure 3

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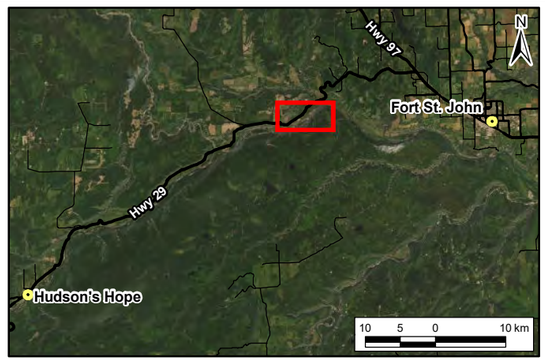
604000 605000 606000 607000 608000 609000 610000 611000

6237000 6236000 6235000 6234000

H29-SW02
PR-SW35
H29-SW06
PR-SW34
PR-SW33
Watson Rd
Hwy 29
Peace River
N
W
E
S

LEGEND

- Northern Harrier Observation
- Highway 29 Standwatch Station
- Peace River Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



NOTES
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Imagery from ESRI; Maxar (2016).

STATUS
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SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Highway 29 and Peace River Standwatch Stations

PROJECTION: UTM Zone 10	DATUM: NAD83				CLIENT: BC hydro
Scale: 1:20,000 (400 200 0 400 Metres)					TETRA TECH
FILE NO.: PENW03042-01_Fig04_Hwy29_PeaceR.mxd					
OFFICE: TI-VANC	DWN: SL	CKD: RG	APVD: EH	REV: 0	Figure 4
DATE: December 16, 2020	PROJECT NO.: ENW.PENW03042-01				

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595000 596000 597000 598000 599000 600000 601000 602000

6234000 6233000 6232000 6231000

Peace River - Station 29 (PR-SW29)

Peace River - Station 36 (PR-SW36)

Peace River - Station 31 (PR-SW31)

Halfway River - Station 1 (HR-SW01)

Peace River - Station 32 (PR-SW32)

Peace River - Station 30 (PR-SW30)

Northern Harrier Nest

N W E S

PR-SW31

PR-SW32

PR-SW36

PR-SW30

PR-SW29

HR01

HR-SW01

Halfway River

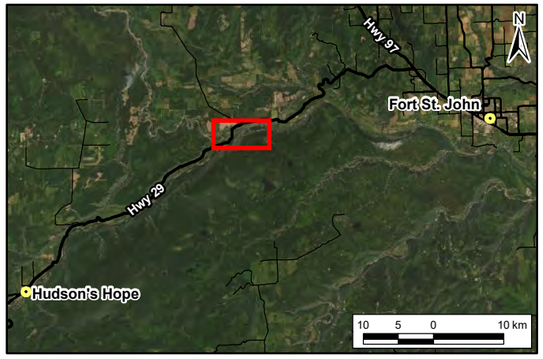
Hwy 29

Peace River

595000 596000 597000 598000 599000 600000 601000 602000

LEGEND

- Northern Harrier Nest
- Northern Harrier Observation
- ARU Station
- Halfway River Standwatch Station
- Peace River Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



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Imagery from ESRI; Maxar (2018).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Halfway River and Peace River Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:20,000
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Metres

TETRA TECH

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OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	RG	EH	0

DATE	PROJECT NO.
December 16, 2020	ENW.PENW03042-01

Figure 5

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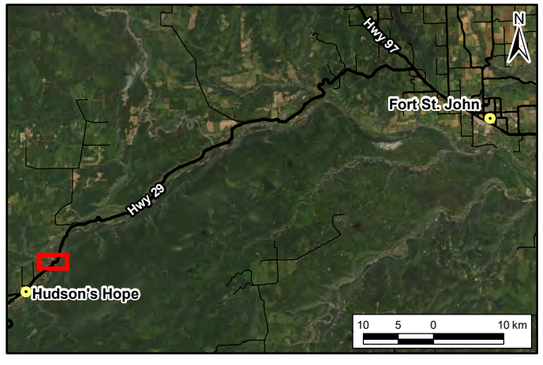
LEGEND

- Lynx Creek Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



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Imagery from ESRI; Maxar (2016).

STATUS
ISSUED FOR USE

SITE C
GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Lynx Creek Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:10,000
200 100 0 200
Metres

TETRA TECH

FILE NO.
PENW03042-01_Fig06_LynxCreek.mxd

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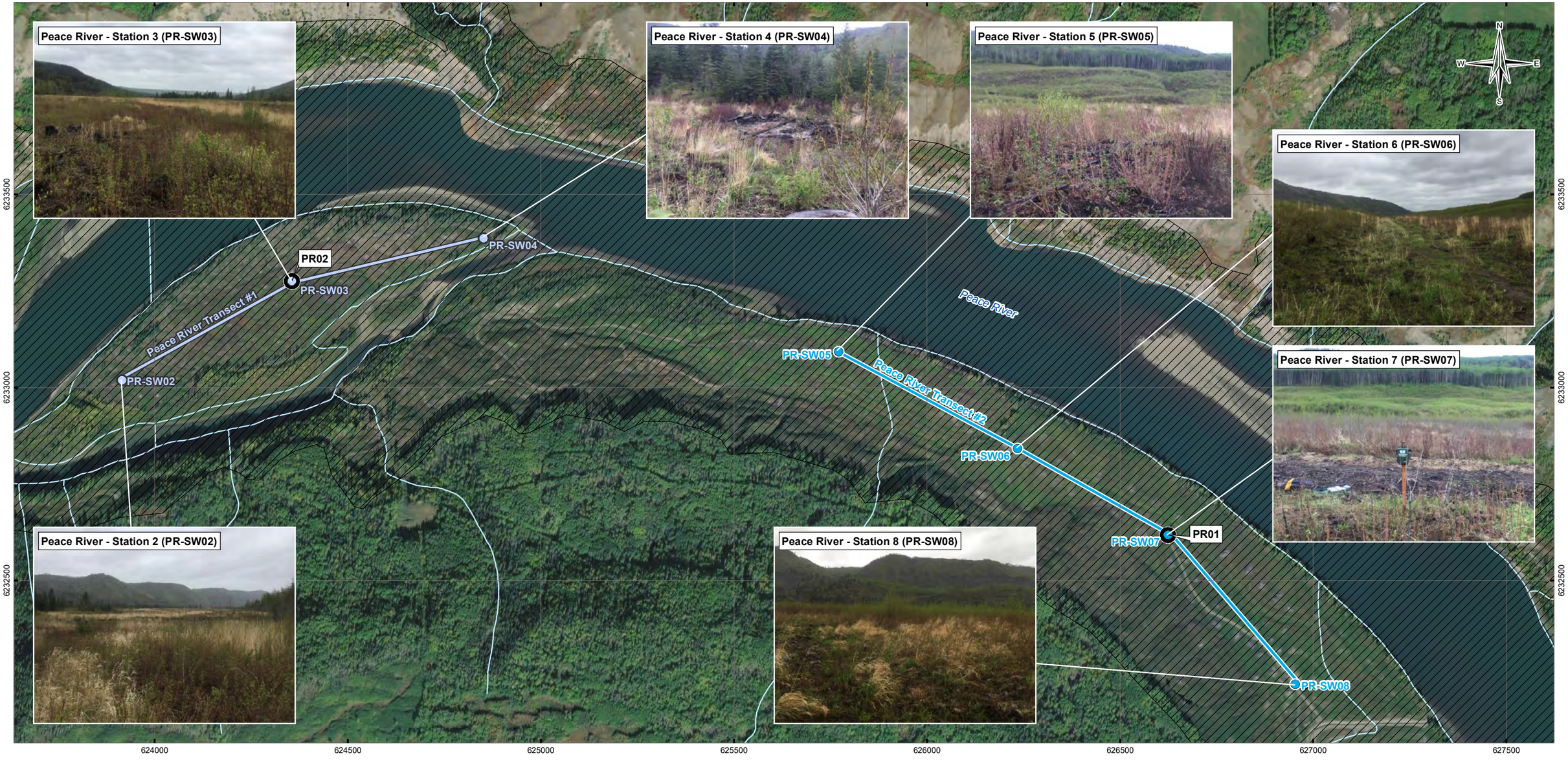
Tt-VANC	SL	RG	EH	0

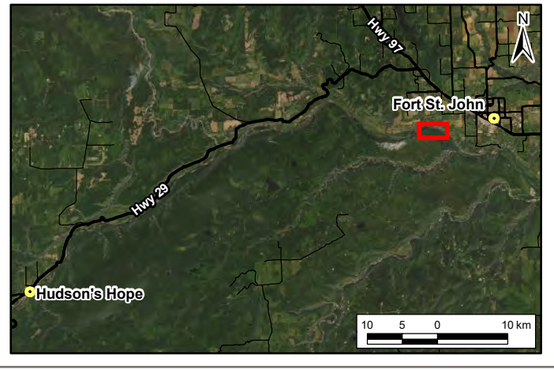
DATE	PROJECT NO.
December 16, 2020	ENW.PENW03042-01

Figure 6



LEGEND

- ARU Station
- Peace River Transect #1 Standwatch Station
- Peace River Transect #2 Standwatch Station
- Peace River Transect #1
- Peace River Transect #2
- Project Footprint
- Watercourse
- Waterbody



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Imagery from ESRI; Maxar (2018).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Peace River Transect #1 and Transect #2 Standwatch Stations

PROJECTION: UTM Zone 10	DATUM: NAD83				CLIENT: BC hydro
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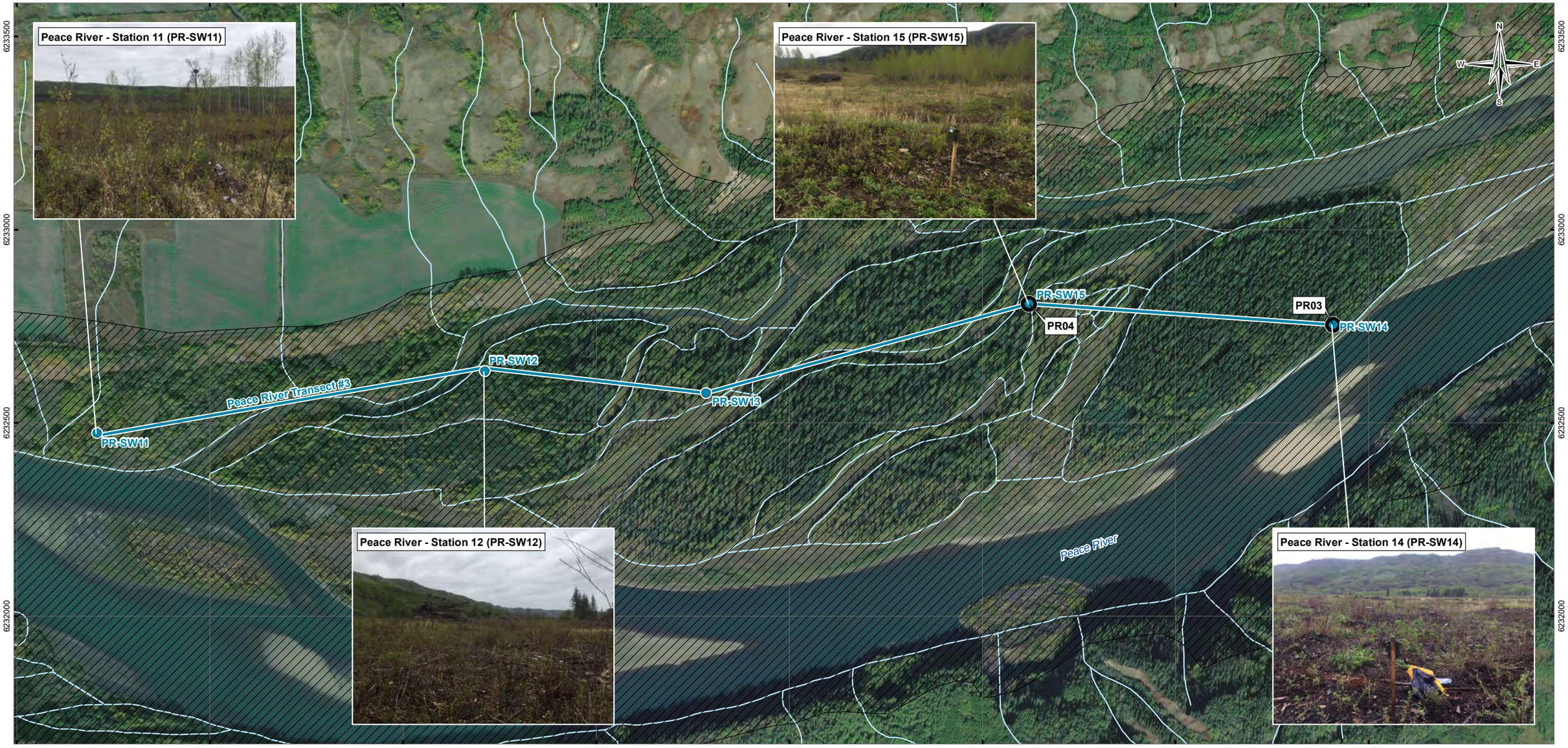

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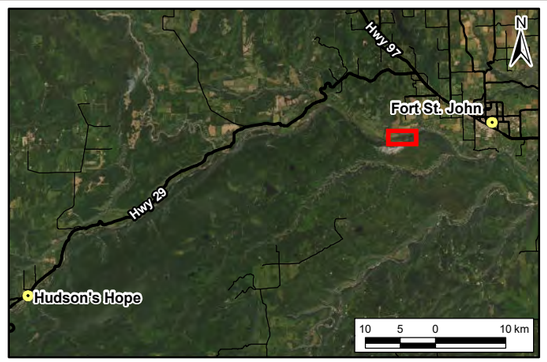
LEGEND

- ARU Station
- Peace River Transect #3 Standwatch Station
- Peace River Transect #3
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2017/2018).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Peace River Transect #3 Standwatch Stations

PROJECTION UTM Zone 10			**DATUM** NAD83	**CLIENT** BC hydro
Scale: 1:10,000 — 200 100 0 200 — Metres				TETRA TECH
FILE NO. PENW03042-01_Fig08_PeaceR_T3.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** RG	**APVD** EH	**REV** 0
DATE December 16, 2020	**PROJECT NO.** ENW.PENW03042-01			**Figure 8**

615000 615500 616000 616500 617000 617500 618000 618500 619000 619500 620000 620500

6233500 6233000 6232500 6232000 6231500

PR-SW23 Peace River Transect #4 PR-SW22 PR-SW21 PR-SW20 PR-SW19 PR-SW18 PR-SW16 PR-SW17

PR-SW10

Peace River

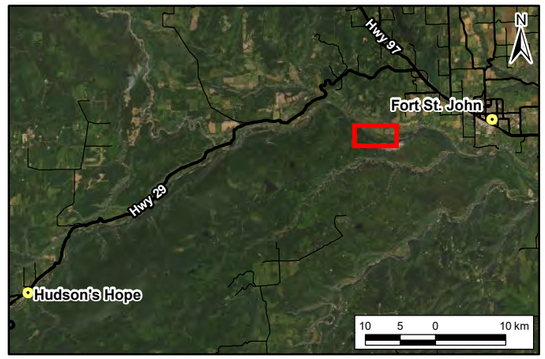
N W E S

615000 615500 616000 616500 617000 617500 618000 618500 619000 619500 620000 620500

6233500 6233000 6232500 6232000 6231500

LEGEND

- Peace River Standwatch Station
- Peace River Transect #4 Standwatch Station
- Peace River Transect #4
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2017/2018).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Peace River Transect #4 Standwatch Stations

PROJECTION: UTM Zone 10	DATUM: NAD83			CLIENT: BC hydro
Scale: 1:15,000 (200 100 0 200 Metres)				TETRA TECH
FILE NO.: PENW03042-01_Fig09_PeaceR_T4.mxd				
OFFICE: Tt-VANC	DWN: SL	CKD: RG	APVD: EH	REV: 0
DATE: December 16, 2020	PROJECT NO.: ENW.PENW03042-01			Figure 9

Q:\Vancouver\GIS\ENVIRONMENTAL\PENW\PENW03042-01\Maps\Raptor_2020\PENW03042-01_Fig09_PeaceR_T4.mxd modified 2020-12-16 by stephanie.leusink

610500 611000 611500 612000 612500 613000 613500 614000

6237000 6236500 6236000 6235500

PR-SW28

Peace River Transect #5

PR-SW27

PR-SW26

PR-SW25

PR-SW24

Peace River

N W E S

Peace River - Station 28 (PR-SW28)

Peace River - Station 26 (PR-SW26)

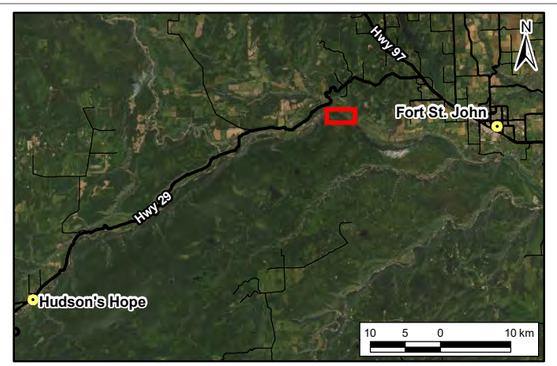
Peace River - Station 25 (PR-SW25)

Peace River - Station 27 (PR-SW27)

Peace River - Station 24 (PR-SW24)

LEGEND

- Northern Harrier Observation
- Peace River Transect #5 Standwatch Station
- Peace River Transect #5
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2017/2018).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2020 ANNUAL REPORT

Peace River Transect #5 Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:10,000
200 100 0 200
Metres

FILE NO. PENW03042-01_Fig10_PeaceR_T5.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	RG	EH	0

DATE	PROJECT NO.
December 16, 2020	ENW.PENW03042-01

TETRA TECH

Figure 10

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APPENDIX A
INCIDENTAL WILDLIFE OBSERVATIONS

Table A.1: Incidental Observation of Other Raptors During Ground-Nesting Raptor Surveys

Common Name	Scientific Name	BC List	COSEWIC/SARA [1]	Number Observed					
				Bear Flats	Cache Creek	Halfway River	Hwy 29	Moberly River	Peace River
Red-tailed Hawk	*Buteo jamaicensis*	Yellow	Not at Risk (May 1995)	1	1	-	-	-	6
Merlin	*Falco columbarius*	Yellow	Not at Risk (April 1985)	-	-	-	-	-	3
American Kestrel	*Falco sparverius*	Yellow	-	1	1	2	-	1	1
Bald Eagle	*Haliaeetus leucocephalus*	Yellow	Not at Risk (May 1984)	1	-	2	1	1	20
Unknown Raptor	-	-	-	1	-	-	-	-	-

APPENDIX B
SURVEY STATION HISTORY 2016 - 2020

Survey Area	Station	Accompanying Transect	UTM Coordinates			Survey Year				
			Zone	Easting	Northing	2016	2017	2018	2019	2020
Compensation Sites	Wilder Creek Lands	No	-	-	-	Established	Surveyed	-	-	-
	Ruttledge Property	No	-	-	-	Established	Surveyed	-	-	-
	Marl Fen Property	No	-	-	-	Established	Surveyed	-	-	-
Highway 29	H29SW01	No	10	604838	6234918		Established	Surveyed	Surveyed	Active Haul Road
	H29SW02	No	10	607633	6236693		Established	Surveyed	Surveyed	Surveyed
	H29SW03	No	10	609150	6237937		Established	Surveyed	Renamed CCSW05 and included in the CC Transect	Renamed CCSW05 and included in the CC Transect
	H29SW04	No	10	606078	6234708			Established	Active Construction (Gravel Pit)	Active Construction (Gravel Pit)
	H29SW05	No	10	606918	6235242			Established	Surveyed	Disturbed by construction - soil piles, grading etc. Established H29SW06 nearby as replacement
	H29SW06	No	10	607050	6235314					Established to replace H29SW05
Peace River	PRSW01	No	10	623128	6232853		Established	Surveyed	Surveyed	Redundant
	PRSW02	Peace River Transect 1	10	623914	6233025		Established	Surveyed	Surveyed	Surveyed
	PRSW03		10	624359	6233273		Established	Surveyed	Surveyed	Surveyed
	PRSW04		10	624854	6233389		Established	Surveyed	Surveyed	Surveyed
	PRSW05	Peace River Transect 2	10	625768	6233094		Established	Surveyed	Surveyed	Surveyed
	PRSW06		10	626233	6232844		Established	Surveyed	Surveyed	Surveyed
	PRSW07		10	626635	6232616		Established	Surveyed	Surveyed	Surveyed
	PRSW08		10	626969	6232228		Established	Surveyed	Surveyed	Surveyed
	PRSW09		10	627381	6231920		Established	Surveyed	Active Construction	Active Construction
	PRSW10	No	10	617729	6232813				Established	Redundant
	PRSW11	Peace River Transect 3	10	619709	6232467				Established	Surveyed
	PRSW12		10	620706	6232643				Established	Surveyed
	PRSW13		10	621282	6232572				Established	Surveyed
	PRSW14		10	622910	6232747				Established	Surveyed
	PRSW15		10	622118	6232805					Established
	PRSW16	Peace River Transect 4	10	619462	6232003					Established
	PRSW17		10	618963	6231942					Established
	PRSW18		10	618468	6232038					Established
	PRSW19		10	617978	623215					Established
	PRSW20		10	617429	6232291					Established
	PRSW21		10	616965	6232496					Established
	PRSW22		10	616559	6232794					Established
	PRSW23		10	616002	6233031					Established
	PRSW24	Peace River	10	613099	6235624					Established
	PRSW25		10	612727	6236012					Established

Survey Area	Station	Accompanying Transect	UTM Coordinates			Survey Year				
			Zone	Easting	Northing	2016	2017	2018	2019	2020
	PRSW26	Peace River Transect 5	10	612220	6236478					Established
	PRSW27		10	611697	6236730					Established
	PRSW28		10	610982	6236991					Established
	PRSW29	No	10	597439	6231064					Established
	PRSW30	No	10	598178	6232247					Established
	PRSW31	No	10	600081	6233281					Established
	PRSW32	No	10	602255	6233351					Established
	PRSW33	No	10	606725	6234293					Established
	PRSW34	No	10	607721	6235469					Established
	PRSW35	No	10	609368	6236803					Established
	PRSW36	No	10	598278	6232689					Established - Called HRSW04 in the field.
Moberly River	MRSW01	No	10	628328	6230312				Established	Active Construction
Bear Flats	BFSW01	Bear Flats Transect	10	611077	6237965				Established	Surveyed
	BFSW02		10	611561	6237465				Established	Surveyed
	BFSW03		10	612031	6237301				Established	Surveyed
	BFSW04		10	612483	6237076				Established	Surveyed
	BFSW05		10	612839	6236812				Established	Surveyed
Cache Creek	CCSW01	Cache Creek Transect	10	607653	6239245				Established	No Access due to high water levels
	CCSW02 / CCSW02B		10	608345	6239034				Established	Surveyed
	CCSW03		10	608729	6238798				Established	Surveyed
	CCSW04		10	609093	6238402				Established	Surveyed
	CCSW05		10	609318	6237699				Established	Surveyed
	CCSW06	No	10	609057	6237557					Established
Halfway River	HRSW01 / HRSW01-2	No	10	595783	6231568				Established	Surveyed
	HRSW02	No	10	596262	6231237				Established	Active Construction
	HRSW03	No	10	595800	6231049				Established	Active Construction
Lynx Creek	LCSW01	No	10	571702	6214556					Established
	LCSW02	No	10	572132	6214265					Established

APPENDIX C
PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project manager, report reviewer
Elyse Hofs, B.Sc., Dipl.T. Tetra Tech Canada Inc.	Field data collection, data entry, report author
Claudio Bianchini, R.P.Bio. Bianchini Biological Services	Field data collection

APPENDIX D
LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

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