

Ducks Unlimited Canada FWCP Columbia Region Partnership

COL-F21-W-3268



Prepared for: Fish & Wildlife Compensation Program

Prepared by: Ducks Unlimited Canada

Prepared with Financial support from Fish & Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and Public Stakeholders

April 28 2021

Executive Summary

This report summarizes the accomplishments of the first year of the Ducks Unlimited Canada (DUC) FWCP Columbia Region Partnership project. Appendix 1 reports on detailed biological surveys completed at DUC's highest priority projects in the Columbia Region (Mayook and Moberly Marshes).

Objective 1: Complete all preconstruction steps at Mayook Marsh

In addition to biological surveys at Mayook Marsh, DUC has completed hydrological modelling and preliminary engineering designs for rebuilding water control infrastructure at Mayook Marsh. At the time of this report, drafting is not yet complete. Negotiations are underway to complete a new Crown Protocol Agreement between DUC and the Province of BC at Mayook Marsh, and the BC Ministry of FLNRORD has indicated intent to continue its agreement with DUC at Mayook. An Archaeological Preliminary Field Reconnaissance (PFR) was completed at Mayook, indicating no archaeological concerns with works proposed.

Objective 2: Complete all preconstruction steps at Moberly Marsh

In addition to biological surveys at Moberly Marsh, an archaeological PFR has now been completed and indicates no archaeological concerns with breaching dikes at the site. DUC completed an engineering design for Moberly Marsh previously, and Adama (2021) confirms that the proposed design would successfully restore connectivity between the Columbia River and marsh habitats at Moberly. Restoration works at Moberly hinge on a land-swap agreement between BC Parks (the landowner) and a neighbouring private landowner. Although BC Parks is confident this land swap will be successful, the timeline for completing it has now extended by a full year in response to covid19.

Objective 3: Build relationships with conservation partners in the Columbia region

The covid19 pandemic complicated the 2020 field season for everyone. Since no DUC staff reside in the Columbia region, our biggest constraint was on our ability to travel to the region to reconnect with conservation partners and meet with new partners. As a result, we were unable to reconnect with the Kootenay Conservation Program. DUC staff were able to meet with Lower Kootenay Band land-use planner and wetland restoration practitioner Norm Allard Jr in October 2020. Norm gave us a tour of his ongoing floodplain wetland restoration works on the Lower Kootenay Band reserve. We were very impressed with Norm's work, and Norm has agreed to advise us on upcoming restoration planning for our Bummers Marsh project.

Objective 4: Prioritize Columbia Region projects to rebuild or re-design

We reviewed the status of our Columbia Region projects and identified our top 10 highest priorities for rebuild or re-design. We completed field visits to these projects and identified a further five projects to prioritise for future grant applications to the FWCP. These four projects, Bummers Marsh, Wolf Creek Marsh, Suzanne Creek Marsh, Spring and Bronze Lakes, and Pickering Lakes show potential for enhancement to align with several of FWCP's Action Plan priorities.

Contents

Executive Summary.....	2
Tables	4
Figures.....	4
Introduction	5
Goals and Objectives and Linkage of FWCP Action Plans	5
Study Area	5
Methods	6
Biological surveys.....	6
DUC Kootenay Region Project Prioritization.....	6
Desktop Review.....	7
Field Visits	7
Results and Outcomes	8
Field Visit Summary.....	13
Moberly Marsh.....	13
Mayook Marsh	14
Saugum Lake	14
South Bummers Marsh	14
Wolf Creek.....	15
Suzanne Creek Marsh	17
Pickering Lake	18
Spring and Bronze Lakes	20
Dunbar Creek	22
Westside 43.....	23
Discussion.....	24
Recommendations	25
Acknowledgements.....	25
References	25
Appendix 1	26

Tables

Table 1: Objective 1 Deliverables and Progress.....	8
Table 2: Objective 2 Deliverables.....	9
Table 3: Objective 3 Deliverables and Progress.....	10
Table 4: Objective 4 Deliverables.....	11
Table 5: Desktop Prioritization of DUC Kootenay Region Wetland Projects	11
Table 6: Summary Results from Field-level prioritization.....	12

Figures

Figure 1: DUC projects in the Columbia Region denoted by red stars	6
Figure 2: Map of DUC Columbia Region projects. Priority projects circled and numbered according to rank from Table 7.....	13
Figure 3: South Bummers Marsh. Looking west from highway 95	15
Figure 4: Upper Wolf Creek Marsh. Upper photo faces northeast from the southwestern edge of the wetland; lower photo faces southwest from the northwestern edge of the wetland.....	16
Figure 5: Aerial imagery of Suzanne Creek Marsh showing the emergent vegetation cover	17
Figure 6: Water control structure (clogged with beaver debris) and emergent vegetation at Suzanne Creek Marsh; most emergent vegetation is <i>Typha latifolia</i> ; a stand of <i>Thule</i> is visible looker's right of the control structure	18
Figure 7: Columbia spotted frog observed at Suzanne Creek Marsh	18
Figure 8: Pickering Lake facing north from the southern edge	19
Figure 9: Turtles observed basking at Pickering Lake	20
Figure 10: Aerial imagery showing Spring and Bronze Lakes.....	21
Figure 11: Trumpeter swans observed on Spring Lake.....	21
Figure 12: Dunbar Creek wetland; emergent cover visible at the far end of the wetland	22
Figure 13: Dunbar Creek downstream of weir.....	23
Figure 14: Westside 43 wetland, facing west from the east edge.....	24

Introduction

For over 50 years, Ducks Unlimited Canada (DUC) has secured, restored and maintained over 180,000 Ha of wetlands and associated upland habitat in BC by leveraging international, national, and regional funding from government, industry, and foundations. DUC's restoration and securement priorities cascade from international planning developed under the North American Waterfowl Management Plan, which sets broad population and landscape-level habitat goals for waterfowl and wetlands. In this manner, DUC allocates conservation resources to continental priority areas so that benefits extend far beyond individual projects.

DUC manages 29 wetland projects in the East Kootenay sub-region, totalling 1678 Ha of wetland and associated upland habitats, and two wetland projects in the North Columbia sub-region, totalling a further 710.5 Ha of wetland and associated upland habitats. Most of our Columbia Region projects are Category 2 wetlands; maintained by engineered water control infrastructure. All projects include long-term securement, such as agreements with private landowners, crown conservation agreements, or fee-simple ownership by DUC or a partner NGO (i.e. the Nature Conservancy of Canada (NCC) or Nature Trust of BC (NTBC)).

Of our projects in the Columbia, 25 are at or nearing securement agreement renewal term (30 years). For DUC, renewing securement agreements means re-investing in the water control infrastructure maintaining the wetland, and in the long-term maintenance of the habitat. In 2019-2020, we received funding from FWCP to begin assessing our wetland projects in the Columbia. This included detailed assessment of two previously identified high priority projects, and prioritization of the remaining 25 projects.

Goals and Objectives and Linkage of FWCP Action Plans

Our year 1 objectives included:

1. Complete all pre-construction steps for Waterfowl Oxbows
2. Complete all pre-construction steps for Moberly Marsh
3. Build relationships with conservation partners in the Columbia region
4. Prioritize Columbia Region projects to rebuild or re-design

Please refer to the accompanying report, Adama (2021) Table 2-1, for alignment of project objectives with FWCP Action Plans.

Study Area

Our broad study area included all of our 25 Kootenay region projects which are due for re-securment (Figure 1). Detailed studies of our two highest priority projects (Mayook and Moberly Marshes) were completed by Adama (2021). These study areas are defined in Adama (2021) Figures 3-1 and 4-1.

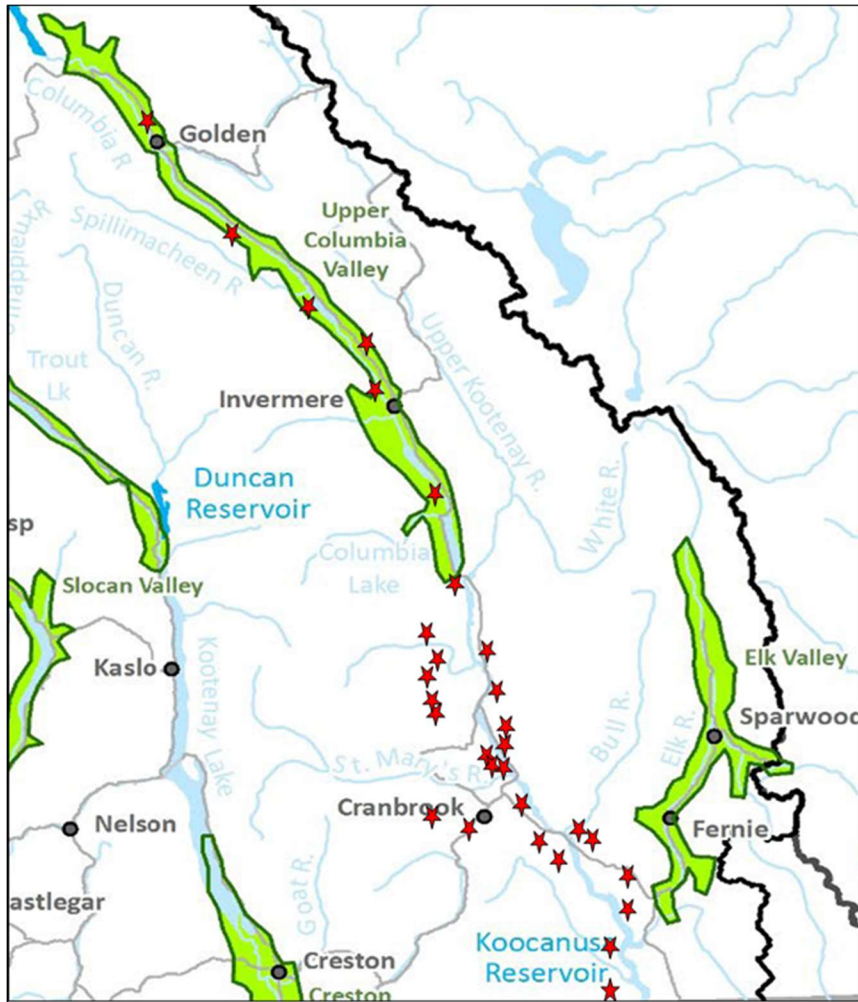


Figure 1: DUC projects in the Columbia Region denoted by red stars

Methods

Biological surveys

Methods associated with fish, wildlife and vegetation surveys at Mayook and Moberly Marsh are detailed in Adama (2021). Archaeological Preliminary Field Reconnaissance methodology is described in the accompanying PFR Reports completed by Wayne Choquette.

DUC Kootenay Region Project Prioritization

Our three highest priority projects in the Kootenay Region were identified prior to 2020. These include Moberly and Mayook Marshes, and Saugum Lake. We prioritized Saugum Lake for rebuild and transfer based on engineering concerns. Presence of invasive bass make Saugum Lake a poor candidate for future grant applications to the FWCP. We prioritized our remaining projects using a Desktop Review of our project information. We completed field visits to the seven highest priorities identified in the desktop review to assess next steps for these projects over the next three years.

Desktop Review

The purpose of the desktop review was to prioritize projects for field visits. To do this, we reviewed our existing project information on biological value, infrastructure condition, and infrastructure risk. We followed the steps outlined below to establish priorities for field visits in 2020:

1. Infrastructure risk: any projects with high or moderate infrastructure risk were assigned highest priority (rank of 1) for field visit in 2020.
2. Project age: all projects less than 30 years old (minimum infrastructure life expectancy) with low infrastructure risk were eliminated
3. Waterfowl habitat quality rating: based on previously collected biological data, we rank our projects “high”, “moderate”, “low”, or “uncertain” based on past waterfowl observations and a variety of habitat characteristics. All projects ranked “high” or “uncertain” were assigned a rank of 1.
4. Other Species: here, we refer to the potential relative value of the project for other wetland-dependent species (e.g. species at risk). All projects ranked “high” or “uncertain” were assigned a value of 1.
5. All projects ranked low on infrastructure risk, waterfowl habitat quality, and other species were ranked 3 – these are non-urgent, low quality, and likely to be decommissioned.
6. All remaining projects were ranked 2. These projects were not prioritized for field visits in 2020, but will become priorities once rank 1 projects are complete.

Results are presented in Table 5.

Field Visits

No DUC staff reside in the Kootenay region. As such, conducting field visits to selected projects was challenging given the covid19 pandemic. To minimize travel in response to public health guidelines, biological field visits by staff were conducted in early October (October 4 – 7 2020), at which time travel to that region was essential to deliver a construction project at Creston Valley Wildlife Management Area. Exceptions were Moberly and Mayook Marshes, which were rigorously surveyed by a consultant based in the Kootenays due to their age, value, and interest by other stakeholders. Engineering inspections happened at regular intervals throughout freshet as required by dam safety regulations. Table 6 summarizes the results of the early October field visits, and further details on each site are provided subsequently.

Results and Outcomes

Table 1: Objective 1 Deliverables and Progress

Deliverable	Progress
Preliminary Field Reconnaissance for archaeology; determine archaeological requirements for construction	Complete (please refer to Appendix 2). No archaeological concerns were identified with the proposed activities at Mayook; however vehicles must be confined to access road to minimize any potential disturbance.
Complete fish, wildlife and vegetation surveys including recommendations to restore habitat for Western screech owl (if practicable), and other focal species	Complete (Please refer to Appendix 1)
Finalize restoration objectives and restoration plan, including monitoring plan	Complete (Please refer to Appendix 1)
Negotiate new securement agreement with land owners	Partially complete: DUC is negotiating a new Crown Protocol Agreement with the Province of BC; province has indicated will to remain in partnership with DUC at Mayook
Finalize engineering design	Partially: calculations are complete; drafting is underway
Submit permit applications	Partially Complete: Amphibian salvage permit has been submitted Section 11/26 permit will be submitted once engineering plans are complete

Table 2: Objective 2 Deliverables

Deliverable	Progress
Complete land-owner negotiations	Delayed: At Moberly Marsh, landowner negotiations are proceeding slowly. Part of the securement process involves a land-swap between BC Parks and an adjacent private landowner. This land-swap requires approvals from senior levels within BC Parks. BC Parks anticipates receiving approval, however this process has delayed restoration works in Moberly Marsh by a year.
Archaeology Preliminary Field Reconnaissance	Complete: the conclusion of the PFR is that the restoration plan for Moberly Marsh poses no threat to archaeological values. Please refer to Appendix 3 for details.
Final field work to determine restoration objectives (focus on amphibian, fish, and riparian).	Partially Complete: Adama (2021) concludes that breaches proposed in DUC's preliminary design would restore hydrological connectivity between the marsh and the Columbia river. Given the timeline delays due to the land-swap negotiations, Adama (2021) recommends further vegetation and wildlife surveys in 2021 prior to finalizing the plan.
Finalize restoration objectives and restoration plan	Delayed: Final plan has been delayed by one year.
Complete securement agreement with land owners	Delayed: This deliverable has been delayed by one year due to approvals required by BC Parks to finalize a land-swap agreement with a private landowner.
Finalize engineering design	Delayed: Final plan has been delayed by one year
Submit permit applications	Delayed by one year

Table 3: Objective 3 Deliverables and Progress

Deliverable	Progress
Engage with the Ktunaxa Nation to ensure cultural values are included in our restoration plans	Complete: In October 2020, DUC met with Norm Allard Jr., land-use planner from the Lower Kootenay Band. Over two days, Norm gave DUC staff a tour of extensive wetland restoration projects that he is currently managing on the Lower Kootenay Band Reserve. The Lower Kootenay Band projects are excellent examples of wetland restorations where natural flooding regimes have been restored by reconnecting diked wetlands to river floodplain, and Mr. Allard himself shows significant skill as a project designer and manager. We wish to initiate a new partnership with the Lower Kootenay Band by hiring Mr. Allard to help guide restoration designs for Moberly Marsh. For Fiscal 2022, we hope to obtain funds from FWCP to hire Mr. Allard to visit Moberly Marsh on at least two occasions (low and high water conditions) and to discuss restoration methods and objectives with us. Our vision is to increase Mr. Allard's involvement in and control over our restoration works in the Kootenays over the span of our funding agreement with FWCP.
Re-Engage with the Kootenay Conservation Program to identify opportunities to partner on conservation program delivery (project design, stewardship)	Incomplete: Due to covid 19, we were unable to meet with the Kootenay Conservation Program in 2020. In early 2021, our habitat securement specialist began attending KCP meetings to re-invigorate this past partnership.
Re-engage with NTBC and NCC on securement and restoration plans in the Columbia Region	Complete: DUC discussed projects in the Kootenay region with NTBC and NCC on several occasions throughout 2020. Both agencies continue to invest in managing projects in the region.

Table 4: Objective 4 Deliverables

Deliverable	Progress
Review existing project data and begin initial project ranking	Complete: Further details provided below
Conduct field visits to at least 15 projects according to review of existing information	Partially Complete: Due to travel and time constraints related to covid 19 we reduced this to a top 10 highest priority projects in the Columbia Region.
Summarize new information gathered from field visits and discussions with conservation partners	Complete: Further details provided below
Develop a short-list of priority projects to deliver by end of year five	Complete: Further details provided below

Table 5: Desktop Prioritization of DUC Kootenay Region Wetland Projects

Project name	Area (ha)	Infrastructure Risk	Waterfowl habitat Quality	Other Species	Desktop Priority
Moberly	377	Moderate	Low	High	1
Saugum Lake	37	High	Low	Moderate	1
Mayook Marsh	48	Low	High	High	1
Dunbar Creek	28	Low	Moderate	Uncertain	1
Westside 43	11	Low	Moderate	Uncertain	1
Pickering Lakes	9	Low	Moderate	Uncertain	1
Suzanne Creek	11	Low	Uncertain	Uncertain	1
South Bummers	120	Low	Low	High	1
Wolf Creek	15	Low	High	High	1
Spring Lakes/Bronze Lake	14	Low	Low	Uncertain	1
Hahas lake	72	Low	Low	Moderate	2
Lake Enid	20	Low	Moderate	Moderate	2
Findlay Marsh	15	Low	Moderate	Moderate	2
Lavington Creek	23	Low	Moderate	Moderate	2
Englishman Creek	28	Low	Moderate	Moderate	2
Echo Lakes	23	Low	Moderate	Moderate	2
Wasa Sloughs	303	Low	Moderate	Moderate	2
Edith Lake	19	Low	Moderate	Moderate	2
Reflection Lake	4	Low	Moderate	Moderate	2
Cranberry Marsh	333	Low	Moderate	High*	3
Tata Lakes	34	Low	Low	Low	3
Reed Lakes	22	Low	Low	Low	3

**while potential habitat value for other wildlife species is High at Cranberry Marsh, we assigned a low priority because a restoration project has already been initiated there by a conservation partner.*

Table 6: Summary Results from Field-level prioritization

Project name	2021 Priority	Next Steps*	rank
Moberly	High	Work with BC Parks, BC Wildlife Federation, and Norm Allard to finalize restoration plan by March 31 2022. Parks Canada to finalize land swap agreement; project construction planned for 2023	1
Mayook Marsh	High	Complete rebuild during summer 2021; Complete Western painted turtle nest survey and assess need to further protect nest sites in 2021; Install data loggers to monitor water temperature; Develop riparian restoration plan in 2022, implement in 2022 or 2023 pending funds.	2
Saugum Lake	High	Negotiate transfer agreement	3
South Bummers	High	Complete detailed fish and wildlife field program in 2021. Initiate process to re-design project; delivery planned for 2024.	4
Wolf Creek	Moderate	Complete wildlife surveys in 2021	4
Suzanne Creek	Moderate	Complete wildlife surveys in 2021	6
Pickering Lakes	Moderate	Complete wildlife surveys in 2021	7
Spring Lakes/Bronze Lake	Moderate	Complete wildlife surveys in 2021	8
Dunbar Creek	Low	No action in 2021	9
Westside 43	Low	No action in 2021	10

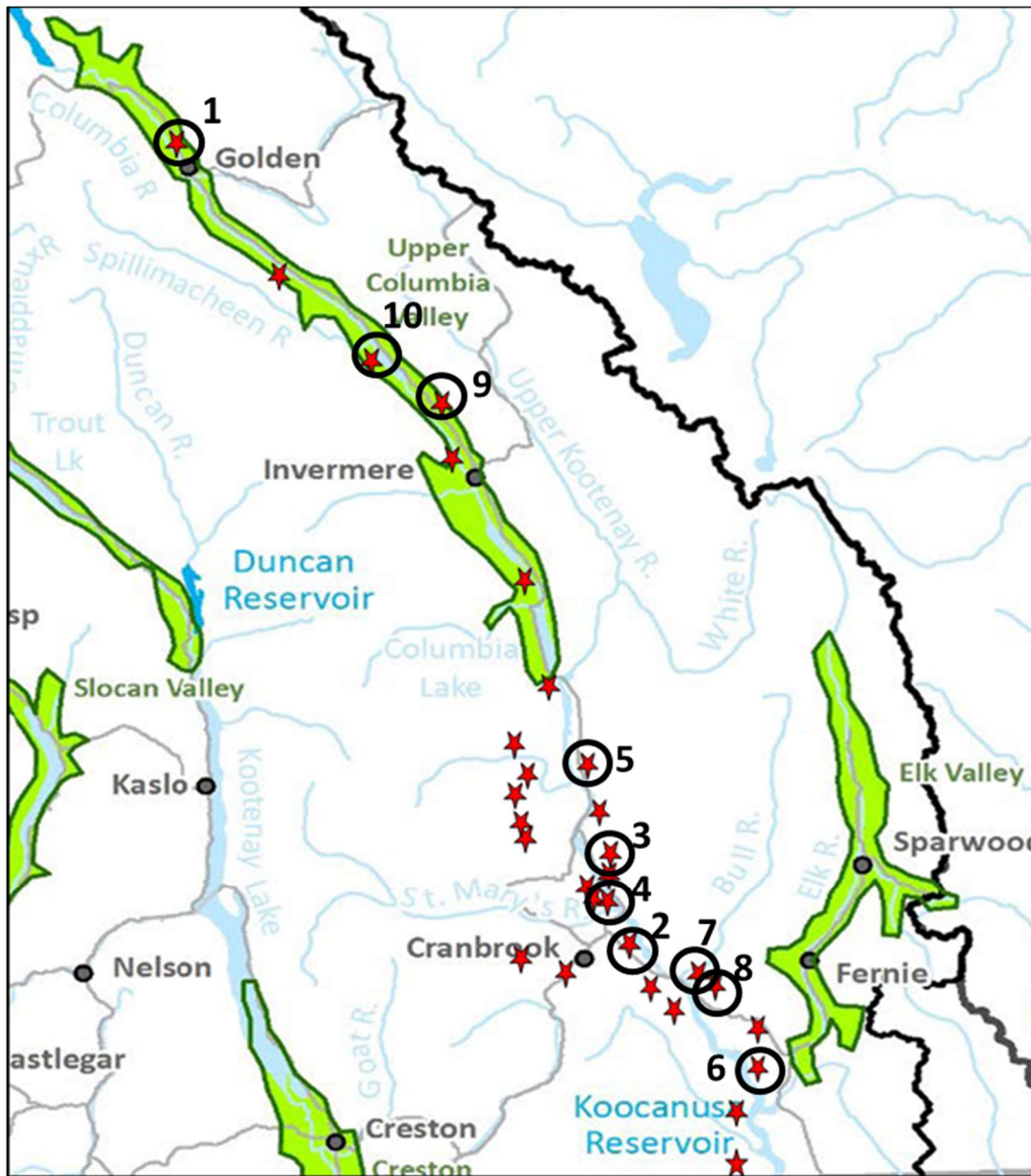


Figure 2: Map of DUC Columbia Region projects. Priority projects circled and numbered according to rank from Table 7.

Field Visit Summary

Moberly Marsh

Moberly Marsh is located approximately 11 km northwest of Golden in the Columbia River floodplain. This marsh was historically drained for agriculture in the early 1900s. In 1964, the land was donated to BC Parks, and DUC partnered to manage the habitat by building up the diking system, including water control infrastructure and nesting islands in the 1970s. This work isolated the marsh from the Columbia River in hopes of stabilizing water levels during waterfowl nesting season, which corresponds with freshet in the Columbia. However, insufficient water levels in the marsh have resulted in encroachment of vegetation and insufficient open water habitat to support waterfowl nesting.

DUC is working with BC Parks on plans to breach the dikes to reconnect the marsh to the Columbia. In 2020, DUC hired LGL Ltd. to conduct some preliminary monitoring at Moberly Marsh to assess the benefits of the proposed breaches. We anticipate completing project construction in fall 2022. Refer to Appendix 1 for further detail.

Mayook Marsh

LGL Ltd. completed detailed wildlife surveys at Mayook Marsh and provided restoration recommendations for DUC during the 2020 field season (Appendix 1). Key findings included a population of Western painted turtle in Mayook Marsh, Lewis's Woodpecker detections in the upland areas, and potential for Mayook Marsh to act as a reintroduction site for Northern leopard frog. In 2021, DUC will replace the water control structure to maintain Mayook Marsh. We will action additional recommendations, including western painted turtle nest site surveys and riparian habitat restoration over the next two years. Please refer to Adama (2021) for further detail.

Saugum Lake

To date, Saugum Lake has consistently performed poorly as waterfowl habitat. This relatively deep lake is not conducive to productive dabbling habitat, and the high abundance of fish attracts loons which predate on ducklings. Saugum is a freshwater fishing destination located on Provincial Crown land, and it has a high abundance of invasive bass. Because of these characteristics, we will work towards negotiating a transfer of the infrastructure to the Province to maintain the lake for fishing.

South Bummers Marsh

South Bummers Marsh is approximately 5km north of Fort Steele along highway 95. This is a 120ha diked marsh on Provincial Crown land in the Kootenay river floodplain. DUC constructed dikes in hopes of stabilizing water levels which fluctuate with freshet during waterfowl nesting season. However, substrate was too coarse to hold enough water outside of freshet, and the marsh is now dominated by dense stands of *Typha latifolia* and other emergent species (Figure 1). While this project has low value for waterfowl, other species (e.g. fish, amphibians) would likely benefit from building perched breaches to allow some influence from the Kootenay river without entirely losing the marsh habitat.

Shortly after visiting South Bummers, DUC staff met with Norm Allard, land-use planner from the Lower Kootenay Band. Norm has been working on a significant restoration project on Lower Kootenay Band reserve land with well-known wetland restoration practitioner Tom Beibighauser. This project involves restoring floodplain wetland on a failed diked wetland project initiated by DUC in the 1960s that was transferred back to the Lower Kootenay Band in the 1990s. Norm gave us a tour of the project, which is impressive in scope. We described similarities between this and South Bummers and Moberly Marshes, and Norm agreed to become involved in our efforts to complete floodplain restoration at both of those sites. As such, South Bummers is one of our highest priority projects for more detailed field assessment in the 2021 field season.



Figure 3: South Bummars Marsh. Looking west from highway 95

Wolf Creek

Wolf Creek Marsh is located approximately 10 km northeast of Wasa along Premier Ridge, one of BC's most important ungulate winter ranges. This marsh includes an upper and a lower compartment, separated by a dike and a water control structure. Our biological data indicates that the upper compartment performs well in supporting waterfowl broods; however the lower compartment has too much flow to be optimal for waterfowl nesting.

Wolf Creek marsh is a beautiful example of a hemi-marsh, a complex patchwork of emergent vegetation occupying approximately 50% of total wetland area (Figure 2). We observed 24 Mallards, seven Canada geese, four Wood ducks, and three Green-winged teals during our October 5th site visit. Uplands are a mix of grazing lands and coniferous forest (Figure 2). We did note some invasive vegetation (thistle) on the dam at the north end of the wetland. A large beaver lodge was visible near the middle of the wetland, and we observed woodpeckers on site.

Some uncertainty around the waterfowl values combined with its location within ungulate winter range, makes this site a priority for more detailed wildlife surveys during the 2021 field season.

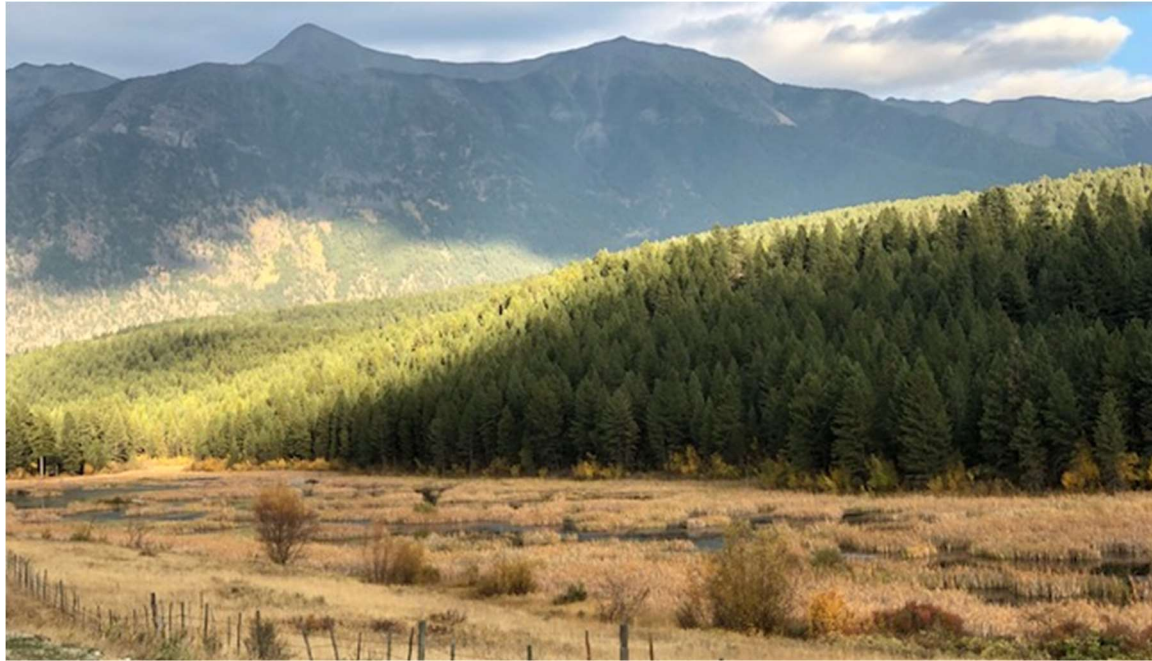


Figure 4: Upper Wolf Creek Marsh. Upper photo faces northeast from the southwestern edge of the wetland; lower photo faces southwest from the northwestern edge of the wetland

Suzanne Creek Marsh

Suzanne Creek marsh is located 10 km southeast of Jaffray. This is a shallow 11 ha marsh with approximately 75% emergent vegetation cover (Figure 3), of which the vast majority is *Typha latifolia*, though some Thule is present near the water control structure (Figure 4). Beaver activity is apparent at this wetland; the control structure was clogged with debris at the time of our visit (Figure 4) and we saw a large beaver lodge in the southern half of the marsh. We observed Columbia spotted frogs at this site (Figure 5). How much of the cattail cover is rooted in the bottom of the marsh versus floating cattail mat is uncertain. This uncertainty, the presence of amphibians, and the possibility of improving hydrology and habitat function on site (i.e. increasing flow through the system by re-designing the water control) make this a priority for more detailed studies in the 2021 field season.



Figure 5: Aerial imagery of Suzanne Creek Marsh showing the emergent vegetation cover



*Figure 6: Water control structure (clogged with beaver debris) and emergent vegetation at Suzanne Creek Marsh; most emergent vegetation is *Typha latifolia*; a stand of *Thule* is visible looker's right of the control structure*



Figure 7: Columbia spotted frog observed at Suzanne Creek Marsh

Pickering Lake

Pickering Lake is located approximately 5 km southeast of Bull River, and 2 km east of the Kootenay River. This 9 ha lake has a history of variable water levels; during the 2020 site visit, the lake was full.

This system is on marl substrate, likely driving the relatively low emergent cover (<10%) which restricted to shallow lake margins. Uplands include grazing range land to the south and east and coniferous forest to the west (Figure 6). We did not observe any waterfowl, other water birds, or amphibians on site, however we did see two turtles basking on an emergent stump (Figure 7). We were not able to see the plastron from shore and cannot confirm whether these were western painted turtles (Rocky Mountain population). This observation makes this a candidate site for more detailed wildlife surveys in the 2021 field season.



Figure 8: Pickering Lake facing north from the southern edge



Figure 9: Turtles observed basking at Pickering Lake

Spring and Bronze Lakes

Spring and Bronze Lakes are located approximately 6 km north of Jaffray. These two shallow lakes, which total 14 ha in area, are connected by a channel running northwest from Spring to Bronze Lakes (Figure 8). The lakes are within mixed forest and range land, with approximately 30% emergent vegetation cover. We observed a group of five Trumpeter swans on Spring Lake during our site visit (Figure 9). This site would likely benefit from fencing to exclude cattle from portions of the wetland so that vegetation can recover. We would like to pursue more detailed wildlife surveys at this site in 2021 to better characterize the benefits of such a fencing project.



Figure 10: Aerial imagery showing Spring and Bronze Lakes

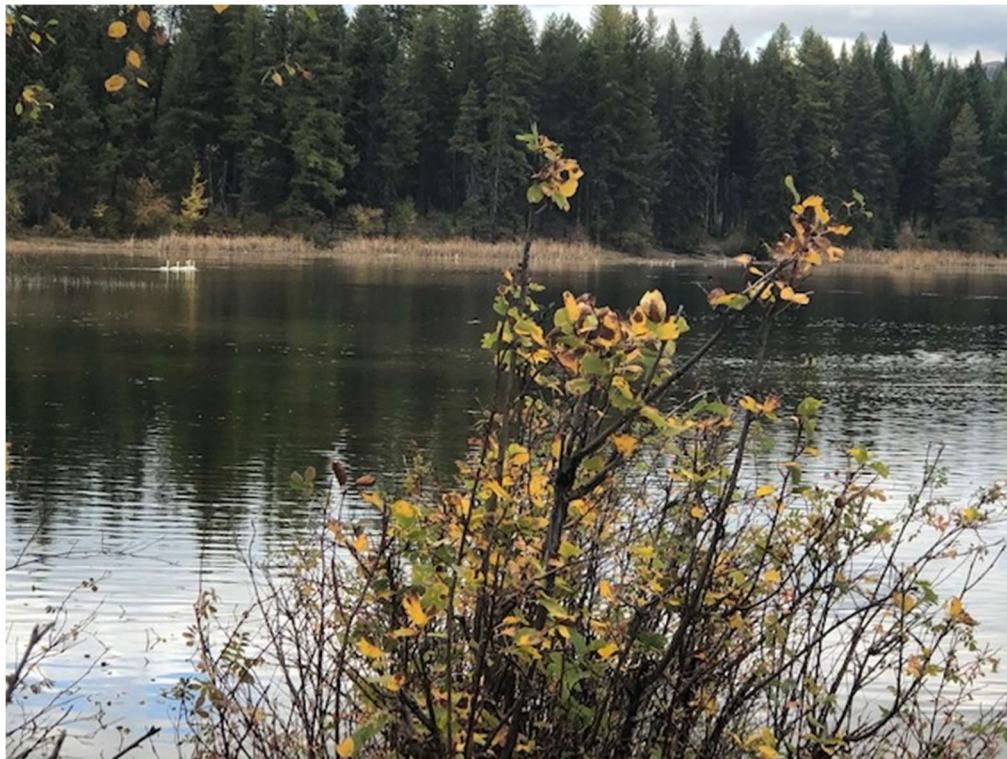


Figure 11: Trumpeter swans observed on Spring Lake

Dunbar Creek

Dunbar Creek is located along the Westside 43 Forest Service road, 7 km southwest of the town of Brisco (as the crow flies). DUC staff visited this site on October 4, 2020. Dunbar Creek wetland is 28 ha shallow open water lake with approximately 20% emergent vegetation cover (Figure 10). The wetland is controlled with a small weir, which is in good condition. Upland habitat is primarily coniferous, with few snags. Downstream of the weir, Dunbar Creek meanders through shrubby floodplain habitat (Figure 11). No amphibians or waterfowl were observed during the field visit.

This site is advertised as a fishing location on the BC Provincial Government's Recreation Sites and Trails BC website, fish presences is a major feature at this site. Fish abundance typically attracts loons; predators of waterfowl broods. Given these characteristics, despite its aesthetic appeal, this project is a relatively low priority for rebuild over the next five years.



Figure 12: Dunbar Creek wetland; emergent cover visible at the far end of the wetland



Figure 13: Dunbar Creek downstream of weir

Westside 43

The Westside 43 wetland is located approximately 2 km south of Dunbar Creek. Uplands surrounding the east side of this wetland have been logged within the last 10 years; upland areas are dominated by conifer saplings and deciduous shrubs including young alder and cottonwood. Uplands on the western edges are dominated by conifer forest. Emergent vegetation cover is approximately 60%, consisting of a mix of *Typha spp.*, *Carex spp.*, and *Juncus spp.* (Figure 12). Beaver activity is evident at the water control structure; however the control has not been compromised by this activity, and the structure is low risk. Given these characteristics, this project is a relatively low priority for rebuild over the next five years.



Figure 14: Westside 43 wetland, facing west from the east edge

Discussion

Our highest priorities remain our proposed works at Mayook and Moberly Marshes. We anticipate finalizing engineering plans for rebuilding water control infrastructure at Mayook Marsh in spring 2021. Adama (2021) indicates that this marsh provides very high quality wildlife habitat, in particular for western painted turtle, in addition to waterfowl. Moberly Marsh restoration work has met a major delay due to protracted negotiations between BC Parks and a neighbouring landowner. We have been assured that these negotiations will be successful. The advantage to this delay is that it creates an additional year for baseline data collection, which will better enable us to evaluate the benefits of the restoration work.

We have now identified a further five projects for more detailed biological assessments. These include Bummers Marsh, Wolf Creek Marsh, Suzanne Creek Marsh, Spring and Bronze Lake, and Pickering Lakes. Bummers Marsh, a diked wetland in the Kootenay River floodplain, would likely benefit from reconnection to the river. We intend to collaborate with Norm Allard Jr. to begin assessing wetland restoration design options. We intend to assess the remaining projects for opportunities to address FWCP Action Plan priorities through future restoration works.

Recommendations

Please refer to Appendix 1 Section 3.4.4 and 4.3.4 for detailed recommendations for Mayook and Moberly Marshes.

Acknowledgements

We are grateful for the financial support of the Fish & Wildlife Compensation Program, the Habitat Conservation Trust Foundation, and the North American Wetland Conservation Act, without which our work would not be possible.

References

Adama, D.A. 2021. Ducks Unlimited Canada East Kootenay Conservation Areas: Baseline Wildlife Surveys and Assessment for Mayook Marsh and Moberly Marsh. Unpublished report for Ducks Unlimited Canada, Surrey BC, 46 pp + Appendix

Appendix 1

Fish and Wildlife Compensation Program

Project # COL-F20-W-3118

Ducks Unlimited Canada East Kootenay Conservation Areas: Baseline
Wildlife Surveys and Assessment of Project Effects for Mayook Marsh
and Moberly Marsh



Draft Report

2020/2021

Prepared for

Ducks Unlimited

and

Fish and Wildlife Compensation Program: Columbia Basin

Prepared by

LGL Limited environmental research associates

Technical Contact: Douglas Adama, R.P.Bio.

dadama@gl.com; 1.250.656.0127

Mar 15, 2021

Suggested Citation

Adama, D. A. 2021. Ducks Unlimited Canada East Kootenay Conservation Areas: Baseline Wildlife Surveys and Assessment for Mayook Marsh and Moberly Marsh. Unpublished report for Ducks Unlimited Canada, Surrey, BC, 46 pp + Appendix.

Cover photos

Photos © LGL Limited: Image #1 and #3 Doug Adama. Image #2 and #4 Jeremy Gatten

EXECUTIVE SUMMARY

Ducks Unlimited Canada (DUC) manages 29 wetland conservation properties in the East Kootenay and Upper Columbia Valley, totalling 1678 ha. Over the next 10 years, it is anticipated that 25 of these properties will require reinvestment in water control infrastructure to maintain or restore wetland habitat. In April 2020, DUC was granted funding for year one of their multi-year project (April 1 2020 to March 31 2021). Under this agreement, ecological assessments will allow DUC to re-evaluate each property's management objectives in light of their conservation and wildlife habitat values. These assessments will help inform the need for reinvestments into water control infrastructure, assess project effects, and identify potential restoration or conservation actions that align with regional funders such as the FWCP.

In 2020, monitoring was initiated at two DUC management properties, Mayook and Moberly Marsh. Investments are anticipated for these projects over the next one to three years. Monitoring began in July of 2020, focusing initially on Mayook Marsh; monitoring commenced at Moberly Marsh in September 2020. The two projects are presented separately.

Mayook Marsh

Mayook Marsh is located 21 km east of Cranbrook, BC, in the Kootenay River Floodplain. The marsh is part of a larger wetland DUC project comprised of two large wetland compartments: Mayook Marsh and Waterfowl Oxbows. Mayook Marsh is 29.5 ha and consists of shallow open water, marshes, and riparian shrub habitats adjacent to stands of Douglas-fir, Ponderosa Pine, and Aspen. A water control structure was installed in 1976 to serve as the water source for a series of waterfowl oxbows. DUC intends to replace the water control at Mayook in 2021.

Assessments carried out in 2020 determined that Mayook Marsh provides habitat for waterfowl, marsh birds, bats, Columbia Spotted Frog, and a population of Western Painted Turtle. Lewis's Woodpeckers were also observed in an adjacent pasture utilizing Aspen snags as nesting sites. Other species of management concern observed included Elk, White-tailed Deer, Great Blue Heron, Bank Swallow, and Common Nighthawk.

An assessment of habitat conditions revealed that Reed Canarygrass has displaced mature Cottonwood and Aspen stands and shrub communities and is encroaching on marsh and shallow water communities. Air photos from 1988, 1994, and 2020 show a dramatic shift in habitat following a prescribed burn that destroyed the shrub, Cottonwood, and Aspen stands in the early 1990s, allowing Reed Canarygrass to establish. Now established, Reed Canarygrass occupies approximately a third of the entire marsh.

Project effects from replacing the water control are anticipated to be minimal and limited to the footprint of the construction site. The potential disturbance of Western Painted Turtle nests is the primary concern during construction. Before construction, the site and laydown areas should be surveyed for turtle nests to avoid disturbing or destroying them. Alternatively, installing drift fencing around the construction site during the nesting season (May – June) will prevent turtles from laying nests in the construction zone. However, the feasibility of this will need to be assessed.

An invasive plants survey of the construction site is recommended before construction. All noxious invasive species should be treated to reduce the risk of spreading during construction.

Post-construction surveys assessing erosion and invasive plants survey are recommended to ensure neither become problematic after the project has been completed.

The following restorations and conservation opportunities in Mayook Marsh were identified:

Western Painted Turtle nesting habitat conservation

The Western Painted Turtle in the East Kootenays is provincially blue and listed under SARA Schedule 1 as a Species of Special Concern. A population of Western Painted Turtles was observed in Mayook Marsh. Turtle nests ($n = 8$) were documented along the perimeter dike and on the terrace at the western end of the marsh. At both locations, nests may be vulnerable to vehicle and ATV traffic as well as trampling by cattle. As nest habitat and nest success can be limiting factors for turtle populations, we recommend nest surveys be carried out to identify the extent of nesting habitat around the Mayook Marsh, to assess threats to nesting habitat or nest success, and to assess whether habitat protection measures (e.g., fencing) are warranted.

Lewis's Woodpecker population and habitat assessment

Lewis's Woodpecker is provincially blue listed and listed under SARA Schedule 1 as Threatened. Several Lewis's Woodpeckers were documented using Aspen snags as potential nest trees in the pasture adjacent to Mayook Marsh. We recommend reporting this observation to the Regional Rare and Endangered Species Biologist to ensure they are aware of this population. If this population is undocumented, we recommend monitoring it more closely during future site visits to assess the population size and extent of nesting habitat. Riparian restoration (discussed below) could benefit Lewis's Woodpecker in the long-term by providing a future source of wildlife trees.

Northern Leopard Frog Reintroduction

The Northern Leopard Frog (NLF) is provincially Red Listed and listed under SARA Schedule 1 as Endangered. Historically, Northern Leopard Frogs occurred in floodplain wetlands along the Kootenay River but have been reduced to a single extant population in the Creston Valley Wildlife Management Area. Currently, recovery efforts are focusing on establishing additional populations in their historical range. Identifying potential reintroduction sites is an important step in this effort.

Based on our habitat assessment, we surmise that Mayook Marsh may be a suitable reintroduction site for Northern Leopard Frogs. We recommended further assessments of seasonal NLF habitats beginning with monitoring water temperatures (with temperature data loggers) to assess whether spring and summer water temperatures are suitable for NLF breeding and tadpole development.

Riparian Restoration

Re-establishing shrub, Cottonwood, and Aspen communities around the margin of Mayook Marsh would restore habitat degraded by Reed Canarygrass. The restoration of riparian habitats would increase the structural complexity and habitat diversity of the Mayook Marsh and benefit many species, including bats, waterfowl, songbirds, Lewis's woodpecker, and ungulates. An active approach to restoration that includes site preparation, planting and fencing of saplings is

recommended as passive approaches are generally unsuccessful in restoring habitats degraded by Reed Canarygrass. A small-scale trial is recommended to assess the feasibility of this restoration opportunity.

Moberly Marsh

Moberly Marsh is a large (304.5 ha) managed wetland complex located in the Columbia River floodplain 11km northwest of Golden, British Columbia. Constructed during the 1970s, the existing DUC project includes water control structures, 8km of dikes that separate three wetland compartments (Braul, Sime, and Bergenham) from the Columbia River. The land status of Moberly Marsh is complex. It includes approximately 270 ha of Burges and James Gadsden Provincial Park, 21.5 ha of the Columbia Wetlands Wildlife Management Area, and 13 ha of private land (Spike Elk Ranch).

DUC recently assessed the dikes and concluded that the dike's integrity has become compromised. In reviewing options, it was determined that the costs required to upgrade the dike outweigh the project benefits. Over the past four decades, Moberly Marsh has become overgrown, with Cattail, Bulrush, and Reed Canarygrass homogenizing much of the marsh habitat. To invigorate and restore the marsh, DUC intends to breach the dike at strategic locations, reconnecting Moberly Marsh with the Columbia River.

A desktop review was undertaken to summarize the conservation and wildlife values of Moberly Marsh and to assess project effects. LiDAR data acquired in 2016 and hydrometric data were used to assess the project effects. Water level monitoring was initiated, and two level-loggers were installed in Moberly Marsh (Braul and Sime compartments) and two in newly constructed wetlands on Spike Elk Ranch.

From modelling river levels, we conclude that breaching the dike at the proposed invert levels will restore the hydrological connection between Moberly Marsh to the Columbia River. Modelling hydrometric data from 2011 to 2019, we estimate that flooding will increase from less than one day per year to an average of 64 days per year (range 40 to 74 days). The average depth during the flood period was estimated to be 0.7 m above the average invert height (775.3m), with a maximum depth averaging 1.3m (range 0.6 to 1.9m) above the average invert height.

To assess the impacts on key valued ecosystem components, we recommended collecting baseline information on:

- Water depth and physicochemistry (pH, turbidity, conductivity, dissolved oxygen).
- Wetland communities: monitoring habitat extent and vegetation composition of wetland habitats
- Waterfowl habitat use (species richness and occupancy) and productivity
- Marsh bird and shorebird habitat use (species richness and occupancy)
- Habitat use by amphibians (species richness and occupancy)

No supplemental restoration actions are recommended at this time.

ACKNOWLEDGEMENTS

Ducks Unlimited Canada gratefully acknowledges the Fish and Wildlife Compensation Program's financial support for its contribution to Mayook and Moberly Marsh's Assessment.

www.fwcp.ca.

The following individuals are credited for their assistance in coordinating and/or conducting this study: Doug Adama, Stephen Roias, Jerney Gatten, Nathan Hentz, Dr. Micheal Miller, Julio Nova and Virgil Hawkes, with LGL Limited and Bryan Kelly-McAuthor (Wildsight Golden).

ACRONYMS

ASL	Above Sea Level
CDC	BC Conservation Data Centre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DUC	Ducks Unlimited Canada
DEM	Digital Elevation Model. Represents the bare-Earth surface, removing all-natural and built features.
IDF	Interior Douglas Fir
ICH	Interior Cedar Hemlock
MS	Montane Spruce
NLF	Northern Leopard Frog
NLFRT	Northern Leopard Frog Recovery Team
RMTERP	Rocky Mountain Trench Ecosystem Restoration Program
SARA	Species-at-Risk Act
VRI	Vegetation Resources Inventory Provincial dataset

TABLE OF CONTENTS

Executive Summary	2
Tables.....	4
Figures	4
Introduction.....	5
Goals and Objectives and Linkage of FWCP Action Plans	5
Study Area	5
Methods	6
Biological surveys	6
DUC Kootenay Region Project Prioritization	6
Desktop Review	7
Field Visits.....	7
Results and Outcomes.....	8
Field Visit Summary	13
Moberly Marsh	13
Mayook Marsh.....	14
Saugum Lake.....	14
South Bummers Marsh.....	14
Wolf Creek	15
Suzanne Creek Marsh	17
Pickering Lake	18
Spring and Bronze Lakes.....	20
Dunbar Creek.....	22
Westside 43	23
Discussion	24
Recommendations.....	25
Acknowledgements	25
References	25
Appendix 1.....	26
EXECUTIVE SUMMARY.....	xxviii
ACKNOWLEDGEMENTS	xxxii
ACRONYMS	xxxiii
TABLE OF CONTENTS	xxxiv

LIST OF TABLES	xxxvii
LIST OF FIGURES	xxxix
1.0 INTRODUCTION	1
2.0 LINKAGE OF PROJECT OBJECTIVES WITH FWCP PLANS AND ACTION(S).....	1
3.0 MAYOOK MARSH.....	3
3.1 Study Area	3
3.1.1 Biophysical Information.....	4
3.1.2 Hydrology	4
3.1.3 Land use.....	4
3.2 Methods	5
3.2.1 Desktop Review	5
3.2.2 Vegetation survey and habitat mapping	5
3.2.3 Bat Monitoring	6
3.2.4 Waterfowl Brood Survey	7
3.2.5 Fish Surveys	8
3.2.6 Water Level Monitoring	8
3.2.7 Wildlife cameras.....	9
3.2.8 Incidental observations	9
3.3 Results	9
3.3.1 Survey Effort	9
3.3.2 Vegetation and Habitat Mapping	9
3.3.3 Waterfowl Brood Survey	22
3.3.4 Fish Surveys	23
3.3.5 Water Physicochemistry.....	23
3.3.6 Amphibians, Turtles, and Reptiles.....	24
3.3.7 Bats	25
3.3.8 Wildlife Camera Data.....	26
3.3.9 Incidental observations and Desktop Review of Species at Risk.....	28
3.4 Discussion	30
3.4.1 Conservation Values	30
3.4.2 Assessment of Project Effects	31
3.4.3 Habitat Conditions	31
3.4.4 Conservation and Restoration Opportunities	32

3.5	Conclusion	34
4.0	MOBERLY MARSH.....	36
4.1	Study Area	36
4.1.1	Biophysical Information.....	36
4.1.2	Hydrology	38
4.1.3	Land use.....	38
4.1.4	Proposed Works	38
4.2	Methods	38
4.2.1	Desktop Review	38
4.2.2	Monitoring.....	39
4.3	Results and Discussion.....	40
4.3.1	Conservation Values	40
4.3.2	Habitats	42
4.3.3	Assessment of Project Effects	43
4.3.4	Conservation and Restoration Opportunities	45
4.4	Conclusion	45
5.0	Literature Cited.....	46
6.0	Appendix.....	50
6.1	Waterfowl Brood Aging Guide.	50
6.2	Vegetation Species Lists by Habitat Type	51
6.3	Waterfowl brood denistyWaterfowl Survey Data.	54
6.4	Fish Survey Data	55
6.5	Amphibian, Reptile, And Turtle Observations.....	56
6.6	Incidental wildlife observations from Mayook Marsh	57

LIST OF TABLES

Table 1: Objective 1 Deliverables and Progress	8
Table 2: Objective 2 Deliverables	9
Table 3: Objective 3 Deliverables and Progress	10
Table 4: Objective 4 Deliverables	11
Table 5: Desktop Prioritization of DUC Kootenay Region Wetland Projects.....	11
Table 6: Summary Results from Field-level prioritization	12
Table 2-1. Alignment of project objectives with FWCP Action Plans, actions, and priorities. Items in bold were addressed in this report. New actions identified following work carried in 2020 are identified with red text.	2
Table 3-1. Provincial and national status of ten bat species that potentially occur at Mayook Marsh.	7
Table 3-2. Field visits to Mayook Creek.....	9
Table 3-3. Vegetation communities delineated from ground surveys and satellite imagery.	10
Table 3-4. Composition and structure of adjacent forest stands to Mayook Marsh as characterized by the Vegetation Resource Inventory (VRI) database.	18
Table 3-5. Count data of fishes captured during a one-hour dip netting survey at two locations (Map 1) in Mayook Marsh on 23 July 2020.	23
Table 3-6. A summary of water physicochemistry data from 21 sample stations in Mayook Marsh, July 23, 2020.....	23
Table 3-7. The number of classified bats detections from four autonomous recording units (ARU) located at Mayook Marsh, July 23 to Oct. 1, 2020. See Table 3-1 for species codes and corresponding common and scientific names.	25
Table 3-8. Summary of capture data from 4 wildlife cameras set at Mayook Marsh from July 23 to Oct 1, 2020.	26
Table 3-9. Results of the BC Conservation Data Centre database query for at-risk species and ecosystems at risk for Mayook Wetlands.	28
Table 3-10. Summary of conservation values for Mayook Marsh.	30
Table 4-1. The total area of Moberly Marsh by jurisdiction and compartment*	36
Table 4-2. Location and elevation of data loggers installed in 2020.....	39
Table 4-3. Summary of conservation values for Moberly Marsh.....	41
Table 4-4. Results of the BC Conservation Data Centre database query for at-risk species and ecosystems for Moberly Marsh, updated with confirmed observations. Appendix Error!	
Reference source not found. lists the ecosystems and species.	42
Table 4-5. Incidental wildlife observations at Moberly Marsh and Spike Elk Ranch.....	42
Table 4-6. The estimated area of broad habitat types mapped by compartment for Moberly Marsh.	42
Table 4-7. Estimated elevations and dates above 775.3m for the Columbia River levels at Moberly Marsh from 2011 to 2019. Elevations are based on water levels observed at Donald Station and corrected for Moberly Marsh using the 2016 LiDAR data.	44
Table 6-1. Inventory Waterfowl brood aging guide (from Gollop and Marshall 1954).	50
Table 6-2. Macrophytes observed in the Shallow-water habitat of Mayook Marsh.	51
Table 6-3. Vegetation along the east dike, Mayook Marsh.	51
Table 6-4. Vegetation of sedge community located along Mayook Creek.	52

Table 6-5.	Vegetation associated with riparian shrub community in Mayook Marsh.	52
Table 6-6.	Vegetation associated with FI01a Water birch – Red-osier dogwood – Rose flood fringe community in Mayook Marsh.	53
Table 6-7.	Inventory of waterfowl observed in Mayook Marsh during the waterfowl brood survey on 22 July 2020.	54
Table 6-8.	Amphibian, Reptile, And Turtle observations in Mayook Marsh, 2020	56
Table 6-9.	All wildlife species observed incidentally and during surveys in Mayook Marsh, 2020.	57

LIST OF FIGURES

Figure 1: DUC projects in the Columbia Region denoted by red stars	6
Figure 2: Map of DUC Columbia Region projects. Priority projects circled and numbered according to rank from Table 7.	13
Figure 3: South Bummers Marsh. Looking west from highway 95	15
Figure 4: Upper Wolf Creek Marsh. Upper photo faces northeast from the southwestern edge of the wetland; lower photo faces southwest from the northwestern edge of the wetland	16
Figure 5: Aerial imagery of Suzanne Creek Marsh showing the emergent vegetation cover	17
Figure 6: Water control structure (clogged with beaver debris) and emergent vegetation at Suzanne Creek Marsh; most emergent vegetation is <i>Typha latifolia</i> ; a stand of <i>Thule</i> is visible looker's right of the control structure.....	18
Figure 7: Columbia spotted frog observed at Suzanne Creek Marsh.....	18
Figure 8: Pickering Lake facing north from the southern edge	19
Figure 9: Turtles observed basking at Pickering Lake.....	20
Figure 10: Aerial imagery showing Spring and Bronze Lakes	21
Figure 11: Trumpeter swans observed on Spring Lake	21
Figure 12: Dunbar Creek wetland; emergent cover visible at the far end of the wetland	22
Figure 13: Dunbar Creek downstream of weir	23
Figure 14: Westside 43 wetland, facing west from the east edge	24
Figure 3-1. Mayook Marsh and Waterfowl Oxbows located along the Kootenay River. ESRI Imagery date: August 18, 2020 (ESRI 2020).	4
Figure 3-2. Location of vegetation, waterfowl, fish, and surveys and monitoring stations (ARU, wildlife cameras, water level logger, and weather station) at Mayook Marsh.	6
Figure 3-3. Weather station (left) and water level logger assemble (right) installed in Mayook Marsh near the water control.	9
Figure 3-4. Map of vegetation communities in Mayook Marsh, 2020. Image Date: Aug 18, 2020.	11
Figure 3-5. Dense coverage of <i>Potamogeton pusillus</i> , <i>Ranunculus aquatilis</i> and <i>Myriophyllum verticilatum</i> in the shallow open-water areas of Mayook Marsh.	12
Figure 3-6. Trumpeter Swan (<i>Cygnus buccinator</i>) flying past a stand of Cattail (<i>Typha latifolia</i>) in Mayook Marsh. Deciduous trees and tall shrubs can be seen in the background and Reed Canarygrass (<i>Phalaris arundinacea</i>) in the foreground.....	13
Figure 3-7. A Bulrush (<i>Schoenoplectus tabernaemontani</i>) stand at the southeast corner of Mayook Marsh.....	13
Figure 3-8. A dense stand of Reed canarygrass along the eastern edge of Mayook Marsh, Sept 1, 2020. An Aspen stand occurs between Mayook Marsh dike, and the Kootenay River can be seen on the left side of the image.....	14
Figure 3-9. Reed Canarygrass was pervasive throughout Mayook Marsh, July 23, 2020.	14
Figure 3-10. Cattle grazing Reed Canarygrass at the east end of Mayook marsh, Image date: Oct. 1, 2020. Shrubs can be seen growing along the margin of the road.	15
Figure 3-11. A small edge marsh and alder-sedge flood community along Mayook Creek. Soil disturbance from cattle and native ungulates can be seen along the creek's edge.	16
Figure 3-12. The image showing a willow community and the sedge meadow in the foreground and the Ws02: Alder/Willow swamp community in the background (arrow).....	16

Figure 3-13. Evidence of shrub mortality due was widespread throughout Mayook Marsh. Much of the shrub community has been displaced by Reed Canarygrass.....	17
Figure 3-14. Sandbar willow (<i>Salix exigua</i>) community FI06 (indicated by the white arrow) growing along the water's edge. The tall willow (Ws03) community indicated (black arrow).....	17
Figure 3-15. Flood fringe riparian community along the southern margin of Mayook Marsh. The image shows the transition of habitats from shallow open-water and Reed Canarygrass to the riparian flood community. Large amounts of dead shrub can be seen in the foreground. ...	18
Figure 3-16. Douglas fir – Ponderosa pine open forest located along the northwest perimeter of the Mayook Marsh.	19
Figure 3-17. Reed Canarygrass meadows intermixed with Aspen, Cottonwood, and shrub on elevated sites extend northeast from the Mayook Marsh into Eagle Nest pasture.	19
Figure 3-18. The images above show a dramatic reduction in Cottonwood, Aspen and deciduous shrub across the sequence of images: July 8, 1988 (left), Jun22, 1994 (centre), and Aug 20, 2020 (right). Evidence of the prescribed fire undertaken in the early 1990's can be seen in the centre image (1994). The displacement of the Cottonwood, Aspen and shrub stands by Reed Canarygrass is clearly visible in the right-hand image (2020). The images also show an increase in flooding over time.....	21
Figure 3-19. The flooded remnants of an Aspen/Cottonwood stand. Image taken June 9, 2020. These stands were destroyed by a prescribed fire in the early 1990's.....	22
Figure 3-20. Trumpeter Swan (<i>Cygnus buccinator</i>) and nest with two eggs (June 9 th , 2020)...	23
Figure 3-21. Young-of-year A. Redside Shiner (<i>Richardsonius balteatus</i>), B. Pumpkinseed (<i>Lepomis gibbosus</i>).	23
Figure 3-22. Columbia Spotted Frog, Common Red-sided Garter Snake, Western Painted Turtle observations in Mayook Marsh, 2020. The size of the bubble indicates the relative number of individuals observed.....	25
Figure 3-23. The remains of turtle eggs near two Western Painted Turtle nests found on the terrace at the west end of Mayook Marsh (Figure 3-22).	25
Figure 3-24. The relative abundance of bat detections (recordings per hour) by species at Mayook Marsh, July 23 to Oct. 1, 2020.	26
Figure 3-25. Images of the four habitats and species sampled with wildlife cameras. Clockwise from top left, White-tailed Deer in Riparian forest, Coyote in grass meadow, Wild Turkey in the sedge meadow, and cow Elk in the dry open forest at Mayook Marsh.....	27
Figure 3-26. Wildlife cameras data showing the number of individuals of the four species detected per trap night and session. Session 1 = July 23 to Sept 2, 2020. Session 2 = Sept 2 to Oct 1, 2020. Camera locations are shown in Figure 3-2.	28
Figure 3-27. Image of Lewis's Woodpecker on an Aspen Snag in the pasture north of Mayook Marsh (Image by J. Gatten June 9, 2020).	29
Figure 4-1. Map showing the location of the wetland compartments of Moberly Marsh. The boundary of Burges and James Gadsden Provincial Park is marked in yellow. The location of proposed dike breaches are identified by the letter "B," and the existing water control structures are indicated by P (pump) and C (inlet/outlet control).	38
Figure 4-2. Location of the level logger and weather station installed in Moberly Marsh in 2020. Incidental wildlife observations from 2020 and proposed level logger locations for 2021 are also shown.....	40

Figure 4-3.	Digital elevation model of Moberly Marsh based on LiDAR data obtained in 2016. Most of the Braul compartment and approximately a third of the Sime compartment were flooded when the LiDAR data was acquired (June 6, 2016).....	44
Figure 4-4.	Distribution of 25 cm elevation bands in the three compartments of Moberly Marsh.	44
Figure 6-1.	Fork length of Redside Shiner (<i>Richardsonius balteatus</i>) and Pumpkinseed (<i>Lepomis gibbosus</i>) captured with a dipnet in Mayook Marsh.	55

1.0 INTRODUCTION

Ducks Unlimited Canada (DUC) manages 29 wetland conservation properties in the East Kootenay and Upper Columbia Valley, totalling 1678 ha. Over the next 10 years, it is anticipated that 25 of these properties will require reinvestment in water control infrastructure to maintain or restore wetland habitat. In April 2020, DUC was granted funding for year one of their multi-year project (April 1 2020 to March 31 2021). Under this agreement, base surveys and assessments of project effects will be conducted to evaluate each property's management objectives in light of their conservation and wildlife habitat values. This will allow DUC to evaluate rebuilding water control infrastructure and/or re-designing infrastructure to meet other conservation objectives.

In 2020, monitoring was initiated at two DUC management properties, Mayook and Moberly Marsh. Investments in these projects are anticipated in 2021 and 2023. Monitoring was initiated in July 2020, focusing initially on Mayook Marsh. Monitoring began at Moberly Marsh in September 2020.

The objectives of the assessment at Mayook Marsh in 2020 were to conduct fish, wildlife, and vegetation surveys, assess wildlife use and habitat conditions, assess project effects, and identify potential conservation and restoration actions to enhance for FWCP focal species.

The objectives for Moberly Marsh in 2020 were to assess project effects and recommend and initiate monitoring in light of the proposed decommissioning of the dike infrastructure to reconnect Moberly Marsh with the Columbia River. As the objectives differ between the two projects, each project is presented separately.

2.0 LINKAGE OF PROJECT OBJECTIVES WITH FWCP PLANS AND ACTION(S)

This project aligns with several actions in the FWCP Columbia Region: Riparian and Wetlands Action Plans (FWCP 2020; Table 2-1). Habitat-based actions are those actions that will conserve, restore, and enhance wetlands and riparian habitats; Research and Information Acquisition Actions are actions that will collect information necessary to evaluate, review, and implement subsequent wetland and riparian area conservation, restoration, and enhancement actions. (e.g., inventory, conservation, and restoration planning, and other activities to address data gaps and information needs to complete other actions); Monitoring and Evaluation Actions are actions that will monitor and evaluate FWCP-supported projects in wetlands and riparian areas to understand the effectiveness of habitat- or species-based actions; Species-based Actions are actions that aim to alleviate limiting factors for species of interest associated with wetlands and riparian areas (e.g., inventory, restoration planning, captive breeding/rearing, and reintroduction).

Several new action items emerged following our assessment of Mayook Marsh. These included species-based actions for Western Painted Turtle (*Chrysemys picta*) and Lewis's Woodpecker (*Merlanerpes lewis*) (Table 2-1).

Table 2-1. Alignment of project objectives with FWCP Action Plans, actions, and priorities.
Items in bold were addressed in this report. New actions identified following work carried in 2020 are identified with red text.

Action Category	Action #	FWCP Priority	Linkage to FWCP Actions
FWCP Riparian and Wetlands Action Plan			
Research and information acquisition	9	1	Inventory DUC projects and adjacent areas for old growth stands as part of project prioritization.
	10	2	Inventory DUC projects and adjacent areas for black cottonwood and popular stands as part of project prioritization.
	35	2	Conduct waterfowl surveys at DUC Columbia-region projects as part of project prioritization and liaise with other conservation organizations for the collection of species data
Habitat-based Actions	11	1	Prioritize projects in terms of wetland and riparian areas for ecosystem restoration plans. In cases where DUC projects have not fully met waterfowl objectives, they will be evaluated on their potential to restore areas to seasonal wetlands and/or riparian vegetation.
	12	1	Develop restoration plans for priority projects with the highest potential to meet waterfowl and/or other conservation objectives.
	13	1	Beginning in year 2, deliver restoration works at priority projects,
	15	1	Work with partners to identify opportunities to recruit cottonwood stands on our projects
	16	2	Beginning in year 2, implement habitat-based actions to conserve/restore/enhance water levels and water quality in wetland habitats.
	17	1	In year 2, implement works to improve habitat connectivity between wetland and river ecosystems (e.g., Moberly Marsh)
	20	1	Develop partnerships with the Ktunaxa Nation and other stewardship groups as well as re-engage with our existing partners in the Columbia region to prioritize our projects and explore new stewardship opportunities where possible.
	36	1	Evaluate and propose specific restoration methods to restore fish habitat at Moberly and Mayook Marsh
	37	1	Survey wildlife at Moberly and Mayook Marsh and recommend additional wildlife habitat features to include in project designs.
Monitoring and Evaluation	21	1	Include monitoring plans to determine if the project meets conservation objectives. We will share our monitoring data with collaborators and conservation partners.
	38	1	We will build monitoring and evaluation into management of restored projects
Land Securement	22	1	For all of our projects, we will negotiate new or maintain existing securement strategies.
Species-Based	23	1	Support strategies and initiatives outlined in the BC Recovery Plan for Northern Leopard Frog that relate to compensation for dam impacts. Where possible, link project work to the connectivity of this species across ecosystems and collaborate with recovery team specialists.
Species-Based	24	1	Incorporate habitat features for Western screech owl at Mayook Marsh and at other projects near known occurrences.
Species-Based	30	2	Contribute to habitat-based enhancement action items and priorities as identified in the Management Plan for the Western Painted Turtle as they relate to footprint impacts.
FWCP Upland and Dryland Action Plan			
Species-Based	22	1	Support strategies and initiatives outlined in the SARA Recovery Strategy for Lewis's Woodpecker that relate to compensation for dam impacts. Where possible, link project work to the connectivity of this species across ecosystems and collaborate with recovery team specialists.

3.0 MAYOOK MARSH

3.1 Study Area

Mayook Marsh is located 21 km east of Cranbrook BC in the Kootenay River Floodplain (Figure 3-1). The 29.5 ha marsh is part of a larger wetland DUC project that includes the Waterfowl Oxbows (29 ha) – a series of constructed oxbows designed to provide waterfowl habitat. The Waterfowl Oxbows are connected to Mayook Marsh by a water inlet control and backchannel. The water control structure was installed in 1976 to serve as the water source for the oxbows. Improvements to stabilize the water levels in Mayook Marsh were completed in 1983. These improvements included constructing a 900 m dike along the eastern perimeter of Mayook Marsh (Dam File # D310123-00), upgrading the water control structure, and creating an emergency spillway at the north end of the waterfowl oxbow perimeter dike.

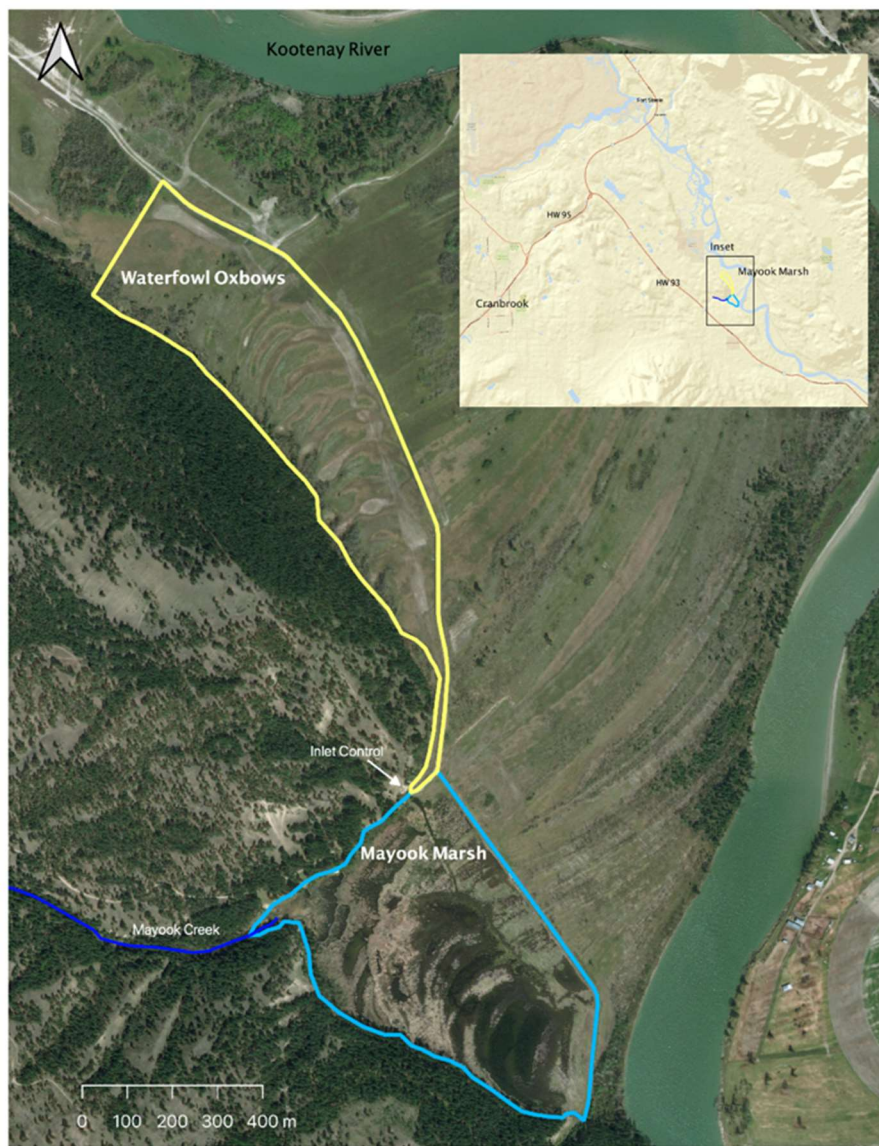


Figure 3-1. Mayook Marsh and Waterfowl Oxbows located along the Kootenay River. ESRI Imagery date: August 18, 2020 (ESRI 2020).

3.1.1 Biophysical Information

Mayook Marsh occurs in the Kootenay Very Dry – Very Hot Interior Douglas-fir biogeoclimatic subzone (IDFxx2). Seasons are characterized by very dry conditions, with June being the wettest month and July and August the driest (McKillop et al. 2018). Winter is cool, spring is warm, summer is very hot, and fall is hot. Snowpack depths are shallow (~ 25 cm) and often intermittent throughout the winter from late November to early March. As a result, soils often freeze to shallow depths. Extreme cold snaps in winter and extreme heatwaves in summer are important influences on climate and vegetation in this subzone.

Mayook Marsh is flanked by silty glaciolacustrine terraces characterized by incised gullies and unstable escarpments. Mineral soils along this stretch of the Kootenay River floodplain are comprised of cumulic regisols of calcareous silts (Lacelle 1990). Organic soils have developed within the wetland and consist of thick organic accumulations overlying strongly gleyed mineral material. The upper layers of organic soils generally consist of 10 to 40 cm of poorly decomposed plant matter (e.g., sedges and reeds).

3.1.2 Hydrology

Water levels in Mayook Marsh are influenced by spring with snowmelt, precipitation, and inflow from Mayook Creek. The perimeter dike protects the marsh from inundation by the Kootenay River. The water diversion control inlet is located in the northwest corner of the marsh. The outlet that feeds the Waterfowl Oxbows is located in a diversion ditch on the other side of the dike/access road. The spillway in Mayook Marsh is set at an elevation of 2741 FSL (753.2 m) and has a 2.5 ft (76 cm) drawdown capability.

3.1.3 Land use

Mayook Marsh occurs in the Cranbrook Landscape Unit (L.U.), and forest resources are managed by the Kootenay Timber Sales Business unit of BC Timber Sales (BCTS). Land use activities around Mayook Marsh are primarily related to timber harvesting and cattle grazing. Both Mayook Marsh and the Waterfowl Oxbows occur in the Rampart Mayook Range Unit. Mayook Marsh is located in Eagle Nest Pasture, and the Waterfowl Oxbows are located in Oxbow Pasture.

The Rocky Mountain Trench Ecosystem Restoration Program (RMTERP) supports forest and range ecosystem restoration to restore low-elevation grasslands and dry Ponderosa pine/Douglas-fir forests in the southern portion of the Rocky Mountain Trench. Restoration plans have been developed for Range Units from Radium to the U.S. border, including the Rampart/Mayook Range Unit (Ross 1998). Updated operational restoration plans are available on the RMTERP website (<https://www.trench-er.com/>).

Recreational activities around Mayook Marsh include hunting, all-terrain vehicle use, and horseback riding. Although Mayook Marsh is an ideal site for birdwatching, the terrible condition of the road and dike surface adjacent to the Waterfowl Oxbows limits access, resulting in limited use by the birding community.

3.2 Methods

The RFP requested fish, wildlife, and vegetation surveys focusing on the Mayook Marsh compartment. Our assessment of Mayook Marsh entailed the following components:

- desktop assessment of species-at-risk
- inventory of wetland/riparian vegetation
- mapping of wetland and riparian habitats
- the deployment of wildlife cameras to sample for midsize and large wildlife (e.g., bears, ungulates, furbearers)
- the deployment of high-frequency autonomous recording units (ARU) to sample for bats
- the deployment of a water level logger and an associated weather station to monitor water level data in Mayook Marsh for an entire hydrological cycle (July 2020 to July 2021)
- fish inventory
- visual encounter herpetological surveys
- waterfowl brood surveys

Locations of each survey/monitoring station are shown in Figure 2.

3.2.1 Desktop Review

The BC Conservation Data Centre (CDC) data was queried for potential species and ecosystems at risk that may occur in Mayook Marsh. Species and ecosystems were categorized as confirmed, possible, or unlikely occurring at Mayook Marsh and were assessed by LGL staff with expertise in each taxonomic group. Ebird (<https://ebird.org/home>) was also queried, but no records were available for Mayook Marsh.

3.2.2 Vegetation survey and habitat mapping

Vegetation surveys were conducted to describe the composition of vegetation communities occurring in Mayook Marsh and document rare plant occurrences where encountered. Survey methods entailed species identification along transects to describe the vegetation present in each habitat noting the dominant vegetation in each habitat type. The species composition along with site characteristics were used to type the vegetation communities to the provincial site associations (Mackenzie and Moran 2004; McKillop et al. 2018). Wetland, riparian, and upland habitats within Mayook Marsh were delineated in GIS using satellite imagery (ESRI 2020). Due to the 1.0 m resolution of this imagery, the estimated area and habitat boundary should be interpreted with caution as it was often not possible to discern habitat boundaries or identify small patches of habitats. Nevertheless, our results provide a sound basis for describing the pattern and distribution of vegetation throughout the wetland compartment. To gain insight into habitat change over the past four decades, we compared the recent imagery (2020) to air photos from 1982 and 1994.

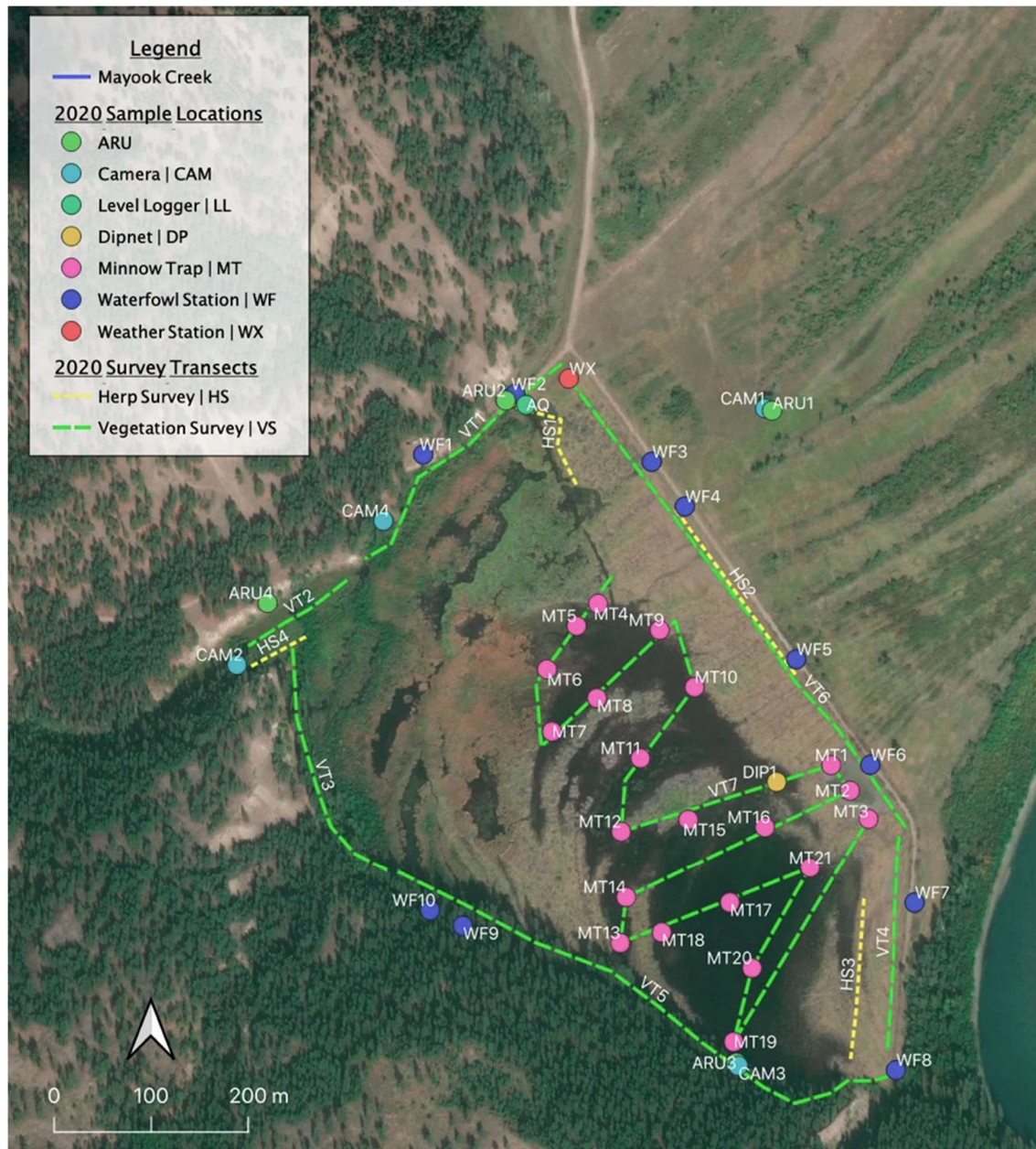


Figure 3-2. Location of vegetation, waterfowl, fish, and surveys and monitoring stations (ARU, wildlife cameras, water level logger, and weather station) at Mayook Marsh.

3.2.3 Bat Monitoring

To assess for the presence of bats, four Wildlife Acoustics Song Meter autonomous recording units (ARU) were deployed from July 23 to October 01, 2020. Each ARU was programmed to document bats during two periods: i) half an hour before sunset for 5.5 hours, and ii) an hour before sunrise for 1.5 hours, for a total of 7 hours per 24-hour period. Under ideal conditions, Wildlife Acoustics Song Meter detectors sample bats in an airspace of 30 to 100 m from the microphone, with bats emitting higher frequencies (e.g., *Myotis spp*) detected more often in the 30 m zone. Bats emitting lower frequencies (e.g., Silver-haired Bat - *Lasionycteris noctivagans*

and Hoary Bat - *Lasiurus cinereus*) can be detected up to ~100 m from the microphone. The microphones paired with each ARU were omnidirectional, meaning that they sample from almost all directions projecting out from the microphone. The microphones were set approximately 2 m above ground or higher. The microphone pitch was set at approximately 90° (horizontal).

Bat presence and activity were assessed by analyzing triggered recordings from Wildlife Acoustics Song Meter units using their automatic classification software (Kaleidoscope Pro v. 4.5.4). Kaleidoscope utilizes classifiers developed from libraries of species-verified recordings to generate complex algorithms used in the automated identification process. Species classifiers can be selected to match the expected bat fauna in an area; however, environmental (e.g., rain, wind, surface echoes, temperature changes, etc.), biological factors (e.g., number of bats present, the distance of bats to the microphone, etc.), and overlap in the acoustic signatures of many bat species can result in classification errors (Szewczak et al. 2011a,b). Consequently, we treat the classifications as indicative rather than definitive

Based on the known distribution of bats in British Columbia (e.g., E-fauna website and Holroyd et al. 1994), ten species were selected for automatic classification (Table 3-1). Data collected by autonomous recording devices do not indicate the number of individual bats present in a given area. Instead, these data indicate the relative activity of each of the bat species detected.

Table 3-1. Provincial and national status of ten bat species that potentially occur at Mayook Marsh.

Common Name	Scientific Name	Species Code	CDC Status	COSEWIC Status	SARA
Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>	COTO	Blue		
Big Brown Bat	<i>Eptesicus fuscus</i>	EPFU	Yellow		
Hoary Bat	<i>Lasiurus cinereus</i>	LACI	Yellow		
Silver-haired Bat	<i>Lasionycteris noctivagans</i>	LANO	Yellow		
California Myotis	<i>Myotis californicus</i>	MYCA	Yellow		
Long-eared Myotis	<i>Myotis evotis</i>	MYEV	Yellow		
Little Brown Myotis	<i>Myotis lucifugus</i>	MYLU	Yellow	Endangered	1-E (2014)
Fringed Myotis	<i>Myotis thysanodes</i>	MYTH	Blue	Data Deficient	3 (2005)
Long-legged Myotis	<i>Myotis volans</i>	MYVO	Yellow		
Yuma Myotis	<i>Myotis yumanensis</i>	MYYU	Yellow		

3.2.4 Waterfowl Brood Survey

Waterfowl brood surveys were conducted in the morning daylight hours on 22 July 2020 from shoreline vantage points following the provincial inventory methods for waterfowl and allied species (RIC 1999). All waterfowl taxa present were recorded, including members of the family Anatidae (swans, geese, and ducks), and extended to grebes and American Coot (*Fulica americana*). The number, age, sex (where possible), and species of all waterfowl observed were recorded. Waterfowl brood ageing followed Gollop and Marshall (1954; Appendix 6.1). Optics used in the survey included binoculars (10x by 42 mm) and a spotting scope (20x by 65 mm) mounted on a tripod. Sampling duration on each vantage point varied from one to 10 minutes, which depended on the size area surveyed (i.e., area of open water) and level of bird activity.

3.2.5 Fish Surveys

Fish sampling was conducted under the Ministry of Forests, Lands, Natural Resource Operations and Rural Development Fish Collection Permit: CB20-608487. Presence was determined from a combination of minnow trapping and dip netting and followed provincial standards (RIC 2001, RIC 1997). All captured fish were enumerated, identified to species, and released back into Mayook Marsh. A subset of 30 fish per species was measured to fork length at each sampling station/transect. Water depth, dissolved oxygen, water temperature and conductivity were measured at each minnow trapping transect using a hand-held YSI meter. A description of habitat (e.g., vegetation cover, substrate) was recorded at each sampling location.

Descriptions of the two sampling techniques:

- Minnow traps – Gee-style, dimensions 42 cm x 23 cm x 0.6 cm mesh, each trap baited with a 3 oz. can of Fancy Feast® wet cat food (Ocean Whitefish and Tuna flavour). Cans were punctured for slow release of scent. Three traps per transect were soaked overnight on 22 July 2020 for approximately an 18 to 19-hour period and retrieved the following day (23 July 2020). Minnow traps were deployed from a canoe, and water depth was measured at each trap position via a 2 m measuring pole.
- Dip netting – dimensions 40 cm net frame on a 1.8 m monorail pole and 0.5 cm mesh. This method was conducted in daylight hours on 23 July 2020 on canoe and from the shoreline. Each dip netting session was 60 minutes in duration and conducted by a single person.

3.2.6 Water Level Monitoring

An Onset™ level logger was deployed in Mayook Marsh on July 23rd, 2020 to record water depth and water temperature. The logger was programmed to collect data hourly and fastened to a 5/8" rebar near the water control. As ambient barometric pressure has a discernible influence on level logger measurement, an Onset weather station was installed to collect barometric pressure. The weather station also collects wind speed, air temperature, and photosynthetic active radiation (PAR). A 4 ft fence was installed around the weather station in September for protection from cattle. Data from the level logger will be collected and reported out following the 2021 field season.



Figure 3-3. Weather station (left) and water level logger assemble (right) installed in Mayook Marsh near the water control.

3.2.7 Wildlife cameras

Wildlife cameras are a cost-effective means of detecting wildlife including rare and/or elusive species that are otherwise difficult to systematically sample by conventional methods. Reconyx HyperFire professional wildlife research cameras were deployed on July 23, 2020 at four locations at Mayook Marsh (Figure 3-2). Cameras were mounted at a height between 75 and 125 centimetres. Images were collected on September 02, 2020, and again on October 01, 2020. The cameras will remain in place until the spring of 2021.

Images were processed using Camelot image management and classification software (Hendry and Mann 2017). Summaries of wildlife capture data were provided directly from Camelot.

3.2.8 Incidental observations

Incidental wildlife observations and sign were documented as encountered. Where possible, photographs were taken, and habitat information and GPS location data were recorded. These observations were used to confirm the presence of species at risk listed in the output of the BC Conservation Data Centre query (Section 3.2.1).

3.3 Results

3.3.1 Survey Effort

Four field visits were made to Mayook Marsh in 2020 (Table 3-2). An initial outing to the site occurred on June 9th. Waterfowl, fish and vegetation surveys occurred from July 21 to 24, 2020. The water level logger, weather station, four wildlife cameras, and four ARUs were deployed on July 23. In September and October, site visits were made to Mayook Marsh to maintain the wildlife cameras and weather station, retrieve the ARUs, and survey for reptiles and amphibians.

Table 3-2. Field visits to Mayook Creek

Date	Purpose
June 9, 2020	Site reconnaissance
Jul 21 to 24, 2020	Fish, Vegetation, and Waterfowl Surveys. Deployment of water level logger, Weather station, ARU and wildlife camera
Sept 02, 2020	Weather station maintenance, Herp Survey
Oct 1, 2020	Herp Survey, Camera maintenance, ARU retrieval

3.3.2 Vegetation and Habitat Mapping

Six wetland habitat types were identified within Mayook Marsh (Table 3-3 and Figure 3-4). An additional four habitat types were identified adjacent the marsh. In some cases (e.g., Reed Canarygrass), habitat types corresponded directly with vegetation communities (also called site associations) as defined by BC Site Series classification (McKenzie and Moran 2004; MacKillop et al. 2018). In other cases, more than one vegetation community was identified within the habitat type (e.g., Marsh included Wm05 [Cattail], Wm06 [Bulrush]), often intergrading with Reed Canarygrass) but were difficult to delineate in GIS.

Table 3-3. Vegetation communities delineated from ground surveys and satellite imagery.

Mayook Marsh Habitats	Area (ha)*	Comment
Reed Canarygrass (RC**)	7.2	Located along the north and east shoreline between the road and open-water. Intergrades with other marsh communities, including Cattail and Bulrush Marsh and shrub communities.
Sedge Marsh (SM)	0.6	Located at the western end of the marsh along Mayook Creek.
Marsh (M)	8.4	Includes stands of Cattail (<i>Typha latifolia</i>) and Bulrush (<i>Schoenoplectus tabernaemontani</i>) intergrading with Reed Canarygrass (<i>Phalaris arundinacea</i>) and shrubs. The Cattail marsh community corresponded with the WM05 Cattail site association (McKenzie and Moran 2004), a provincially blue-listed plant community. The bulrush community corresponded with the Wm06 Bulrush community (McKenzie and Moran 2004) and often intergraded with Cattail stands and the Reed Canarygrass (RC) and Shallow-water (OW) habitat.
Shrub (SH)	2.6	Located on raised areas and old beaver dams on the west side of the marsh. One community corresponded to the Ws03: Bebb's Willow – Bluejoint plant association Small patches of Sandbar Willow (<i>S. exigua</i>) correspond to the Sandbar willow flood association (FI06).
Shallow-waters (W)	10.6	Water depths less than 2 m a with less than 10% emergent vegetation. Dominated by submergent and floating pond vegetation. Intergrades with stands of Bulrush.
Flood-Riparian (RI)	0.5	A narrow band of riparian forest occurs at the toe slope along the southern edge of the marsh. Corresponded to the Ff01a: Water birch – Red-osier dogwood – Rose plant association (MacKillop et al. 2018).
Total Area	29.9	
Adjacent Habitats†		
Aspen	-	Aspen dominated stands that correspond with Fm07 Aspen – Dogwood – Water Birch (MacKillop et al. 2018).
Open Douglas-fir Ponderosa Pine Forest (OF)	-	Located along the northwest corner. Site of old turtle nests.
Closed Douglas Fir Forest (CF)	-	Located along the southern boundary of the marsh. Denotes as Cf in Figure 3-4.
Grass Meadow (GM)	-	Dominated by Reed Canary Grass with Aspen and shrub communities occurring on raised areas.

* Approximate

** Corresponding map code

† Area was not calculated for adjacent habitats

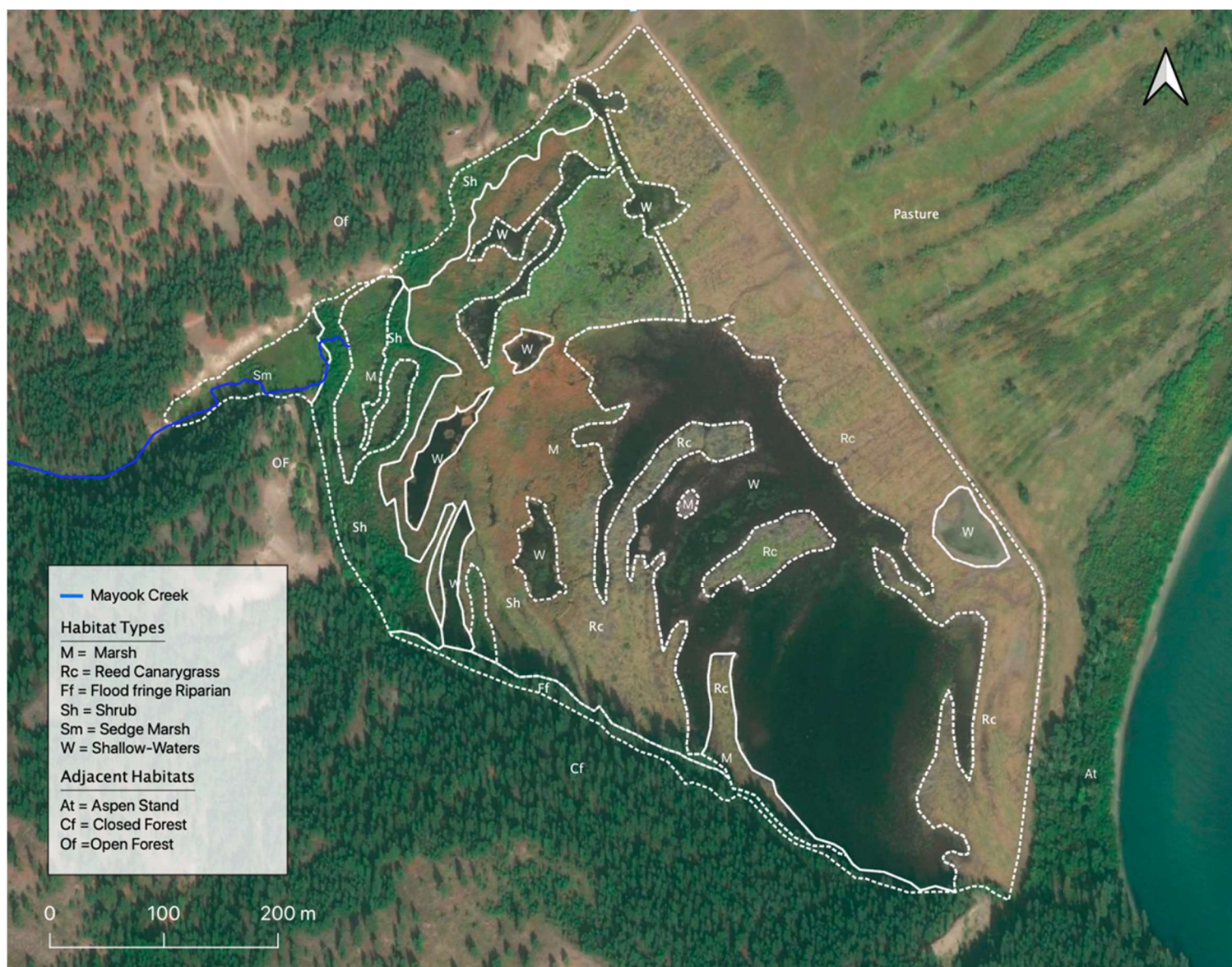


Figure 3-4. Map of vegetation communities in Mayook Marsh, 2020. Image Date: Aug 18, 2020.

Shallow-water Wetlands

Shallow-water wetlands comprised a third (36%; 10.6 ha) of Mayook Marsh (Table 3-3 and Figure 3-4). These wetlands include water bodies two meters or less and have less than 10% emergent cover (McKenzie and Moran 2004). The average depth of the shallow-water wetlands was 124.5 cm. Much of the open-water areas were dominated by a few prominent species (Figure 3-5), including submergent (e.g., *Chara vulgaris*, *Myriophyllum verticillatum*, *Potamogeton pusillus*, and *Ranunculus aquatilis*), and floating (e.g., *Potamogeton natans*, and *Persicaria amphibia*) macrophytes. In shallower areas, open water gave way to stands of Bulrush, Cattail Marsh, or Reed Canarygrass (*Phalaris arundinacea*). A species list is provided in the Appendix: Table 6-2.



Figure 3-5. Dense coverage of *Potamogeton pusillus*, *Ranunculus aquatilis* and *Myriophyllum verticillatum* in the shallow open-water areas of Mayook Marsh.

Cattail and Bulrush Marshes

Marsh habitat was a major component of the Mayook Marsh wetland complex, occupying 28 % (8.4 ha) of the compartment (Table 3-3 and Figure 3-4). This habitat included stands of Cattail (*Typha latifolia*) and Bulrush (*Schoenoplectus tabernaemontani*), often intergrading with Reed Canarygrass (*Phalaris arundinacea*) (Figure 3-6). The Cattail marsh communities correspond with the provincially blue listed wetland site association WM05: Cattail marsh and the Bulrush community correspond with the WM06: Great Bulrush site association (Makenzie and Moran 1004). Cattail stands mainly occurred in the western portion of the wetland complex. Bulrush occurred in several large stands in the central and eastern portions of the marsh and intermittently throughout with cattail along the edge of smaller openings (Figure 3-7).



Figure 3-6. Trumpeter Swan (*Cygnus buccinator*) flying past a stand of Cattail (*Typha latifolia*) in Mayook Marsh. Deciduous trees and tall shrubs can be seen in the background and Reed Canarygrass (*Phalaris arundinacea*) in the foreground.



Figure 3-7. A Bulrush (*Schoenoplectus tabernaemontani*) stand at the southeast corner of Mayook Marsh.

Reed Canarygrass

Reed Canarygrass (*Phalaris arundinacea*) occupied the entire north and eastern margins of Mayook Marsh, accounting for almost one-quarter of the total area (24.5 ha; Figure 3-4). Species richness was very low, consisting of little else other than *P. arundinacea* (Figure 3-8). Species richness increased along

the road edge where shrubs and several weedy species have been able to compete against Reed Canarygrass on drier soil (see Appendix: Table 6-3 for species list).



Figure 3-8. A dense stand of Reed canarygrass along the eastern edge of Mayook Marsh, Sept 1, 2020. An Aspen stand occurs between Mayook Marsh dike, and the Kootenay River can be seen on the left side of the image.

Reed Canarygrass extended out into shallow open waters displacing Cattail and Bulrush marsh communities (Figure 3-9). From ground surveys, habitat photos, satellite imagery, we estimate that at least 40% of the marsh habitat was comprised of Reed Canarygrass. Along the northeast dike, Reed Canarygrass stands were inundated in late-July. In September, lush new shoots and foliage provided excellent forage for cattle (Figure 3-10).



Figure 3-9. Reed Canarygrass was pervasive throughout Mayook Marsh, July 23, 2020.



Figure 3-10. Cattle grazing Reed Canarygrass at the east end of Mayook marsh, Image date: Oct. 1, 2020. Shrubs can be seen growing along the margin of the road.

Sedge Marsh

A small (0.5 ha) marsh dominated by sedges and rushes occurred along Mayook Creek at the west end of the marsh (Figure 3-4). Alder (*Alnus incana*) and willow (*Salix sp.*) encroach along the creek where the marsh transitions into a shrub/sedge community and conifers occupied the banks of the meadow (Figure 3-11). This community was difficult to classify using MacKenzie and Moran (2004). Unlike most sedge marshes with low species diversity, species richness in this community was relatively high (species list: Table 6-4)., reflecting the site's transitional position



Figure 3-11. A small edge marsh and alder-sedge flood community along Mayook Creek. Soil disturbance from cattle and native ungulates can be seen along the creek's edge.

During amphibian surveys in the fall of 2020, numerous juvenile Columbia Spotted Frogs (*Rana luteiventris*) were observed along the creek, indicating that the creek may be an overwintering site. As shown in Figure 3-11, an old jeep trail bisects the marsh. Although much of it appears to be growing over, a small area of exposed soil remains at the creek crossing.

Riparian Shrub Communities

Deciduous riparian shrub communities occurred on elevated sites in the marsh, predominantly along the marsh's southern and western margins (Figure 3-4). Four different shrub communities were identified from ground surveys; however, due to the resolution of the imagery, these communities could not be mapped separately. Given the preliminary nature of the sampling in 2020, these community types should be treated as tentative.

An Alder/Willow swamp community occurred at the west edge of the marsh downstream of the sedge meadow described previously (Figure 3-12). This community corresponded most closely with the Ws02: Mountain alder – Pink spirea – Sitka sedge site association (Mackenzie and Moran 2004), and due to the influence of Mayook Creek, was more hydrologically dynamic than the shrub communities located more centrally within the marsh.



Figure 3-12. The image showing a willow community and the sedge meadow in the foreground and the Ws02: Alder/Willow swamp community in the background (arrow).

A second riparian community occurred along old beaverdams and raised areas in the western portion of Mayook Marsh. This community was dominated by Bebb's Willow (*Salix bebbiana*), Red-Osier Dogwood (*Cornus sericea*), and Water Birch (*Betula papyrifera*) and corresponded most closely with Ws03: Bebb's willow – Bluejoint site association (MacKenzie and Moran 2004). Much of this community was burnt during a prescribed burn in the early 1990s, as evidenced by the extensive amount of burnt and dead shrub observed (Figure 3-13).



Figure 3-13. Evidence of shrub mortality due was widespread throughout Mayook Marsh. Much of the shrub community has been displaced by Reed Canarygrass.

A third shrub community dominated by Sandbar Willow (*Salix exigua*) occurred in isolated stretches along the edge of open water (Figure 3-14). This community corresponded with the flood community FI06 Sandbar Willow site association (MacKenzie and Moran 2004) and was only observed in the northwest corner of the marsh.



Figure 3-14. Sandbar willow (*Salix exigua*) community FI06 (indicated by the white arrow) growing along the water's edge. The tall willow (Ws03) community indicated (black arrow).

A fourth deciduous community occurred as a narrow strip along the marsh's southern shoreline (Figure 3-4). This community occurred between the shoreline and slope break, quickly transitioning from shallow open water to a closed Douglas-fir stand (Figure 3-15). This community was dominated by tall shrubs and trees, including Water Birch (*Betula papyrifera*), Aspen (*Populus tremuloides*), Bebb's Willow (*Salix bebbiana*), Red-Osier Dogwood (*Cornus sericea*), and Wild Rose (*Rosa woodsia*). This community

corresponded most closely with the provincially Red-listed Ff01a Flood fringe Water birch – Red-osier Dogwood – Rose site association (MacKillop et al. 2018)¹. This site association is confined to the margins of lakes, ponds, and wetlands where flooding is minimal, but the water table remains within the rooting zone for much of the year (MacKenzie and Moran 2004). As this community has not been identified in the East Kootenays (Deb MacKillop pers. comm), further investigation is required to confirm this classification. A species list is provided in Table 6-6.

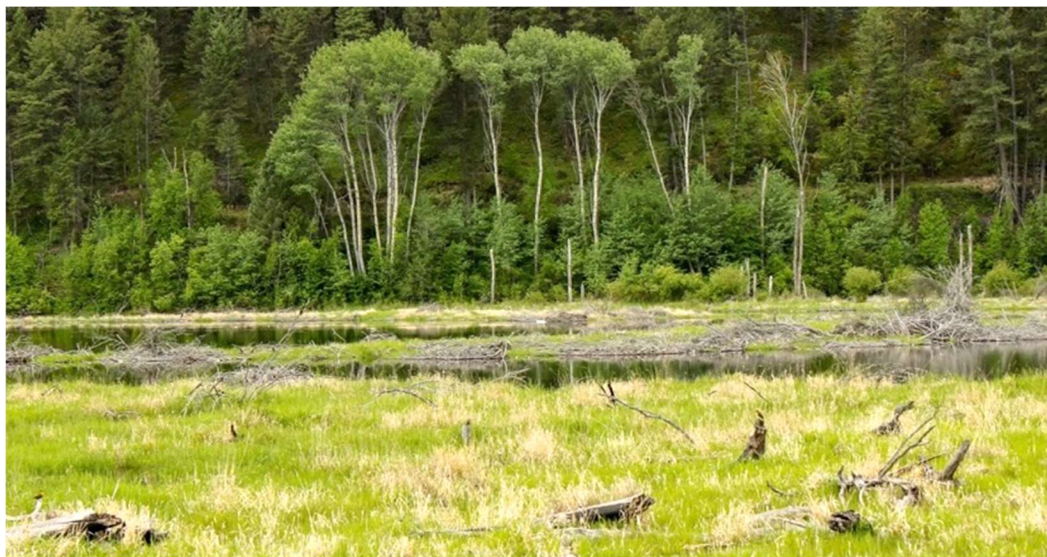


Figure 3-15. Flood fringe riparian community along the southern margin of Mayook Marsh. The image shows the transition of habitats from shallow open-water and Reed Canarygrass to the riparian flood community. Large amounts of dead shrub can be seen in the foreground.

Adjacent Habitats

Habitats adjacent to Mayook Marsh included: 1) an open dry Douglas-fir – Ponderosa Pine forest along the west side of the Marsh (Figure 3-16), 2) a closed mesic Douglas-fir forest along the south shore of the marsh above the flood fringe shrub community (Figure 3-15), 3) a stand of Aspen between Mayook Marsh and the Kootenay River (Figure 3-7; Figure 3-8), and 4) meadows of Reed Canarygrass broken by elevated sites with shrub and Aspen stands (Figure 3-17). The structure and composition of the adjacent forested stands are summarized in Table 3-4.

Table 3-4. Composition and structure of adjacent forest stands to Mayook Marsh as characterized by the Vegetation Resource Inventory (VRI) database.

Stand Type	Leading Species*	Secondary Species	Stand Age Class [†]	Stand Height Class ^{††}
Open Forest	Py FD	FD, Sx, Lw	6 and 7	2 and 3
Closed Forest	FD	Py	7 and 8	3
Aspen/Cottonwood	At/Act**	Sx	5	3

* Tree species codes: At = Aspen, FD = Douglas-fir, Py = Ponderosa Pine, Sx = Hybrid White Spruce, Lw = Western Larch.

** Typed as Act (Black Cottonwood) in the VRI database as Cottonwood

[†] Age classes: 5 = 81 -v100yrs, 6 = 101-120 yrs, 7 = 121-140 yrs, 8 = 141-250 yrs

^{††} Height classes: 2 = 10.5 – 19.4m, 3 = 19.5 – 28.4m

¹ This community was previously classified as FI07 in Wetlands of British Columbia (MacKenzie and Moran 2004).

The adjacent conifer stands ranged in age from mature to old-growth (trees over 140 years old are considered old growth in dry interior forests). The adjacent Aspen stand was classified as Black Cottonwood in the VRI database.



Figure 3-16. Douglas fir – Ponderosa pine open forest located along the northwest perimeter of the Mayook Marsh.



Figure 3-17. Reed Canarygrass meadows intermixed with Aspen, Cottonwood, and shrub on elevated sites extend northeast from the Mayook Marsh into Eagle Nest pasture.

A Retrospective Assessment of Habitats

A dramatic reduction in Aspen, Cottonwood, and deciduous shrub communities has occurred in Mayook Marsh over the past four decades, (Figure 3-18). The loss of these habitats was largely due to a prescribed fire in the early 1990s (Anna Fontanna, Pers. Comm.). Remarkably, these habitats have not recovered since and have instead been completely displaced by Reed Canarygrass. Grazing pressure from cattle and native ungulates on Aspen succours and shrub seedlings, and saturated soils from high-

water levels would have also contributed to the proliferation of Reed Canarygrass Mayook Marsh (Figure 3-19).



Figure 3-18. The images above show a dramatic reduction in Cottonwood, Aspen and deciduous shrub across the sequence of images: July 8, 1988 (left), Jun22, 1994 (centre), and Aug 20, 2020 (right). Evidence of the prescribed fire undertaken in the early 1990's can be seen in the centre image (1994). The displacement of the Cottonwood, Aspen and shrub stands by Reed Canarygrass is clearly visible in the right-hand image (2020). The images also show an increase in flooding over time.



Figure 3-19. The flooded remnants of an Aspen/Cottonwood stand. Image taken June 9, 2020. These stands were destroyed by a prescribed fire in the early 1990's.

3.3.3 Waterfowl Brood Survey

Twelve species of waterfowl were observed from 10 vantage points around Mayook Marsh (Figure 3-2, Table 6-7). Mallard (*Anas platyrhynchos*) was the most frequently observed species, followed by American Coot, Pied-billed Grebe (*Podilymbus podiceps*), and Wood Duck (*Aix sponsa*). No sensitive (i.e., at-risk) species were detected.

Twenty-one broods were observed from eleven species and brood stages varied from the earliest stage (Ia - "bright ball of fluff") to the last flightless stage (III - fully feathered - flightless). Brood sizes ranged from one to nine chicks, and 61 chicks were observed in total. However, only 13 (62%) of the broods were accompanied by an adult. Examples of broods without parents included several stage III Mallard and Wood Duck, and a few stage IIc (mostly feathered, last down) Pied-billed Grebe and Hooded Merganser (*Lophodytes cucullatus*). A pair of Trumpeter Swans (*Cygnus buccinator*) with eggs were observed by LGL staff in June 2020. Unfortunately, their nesting efforts appeared to have failed as no cygnets were observed during our July survey.



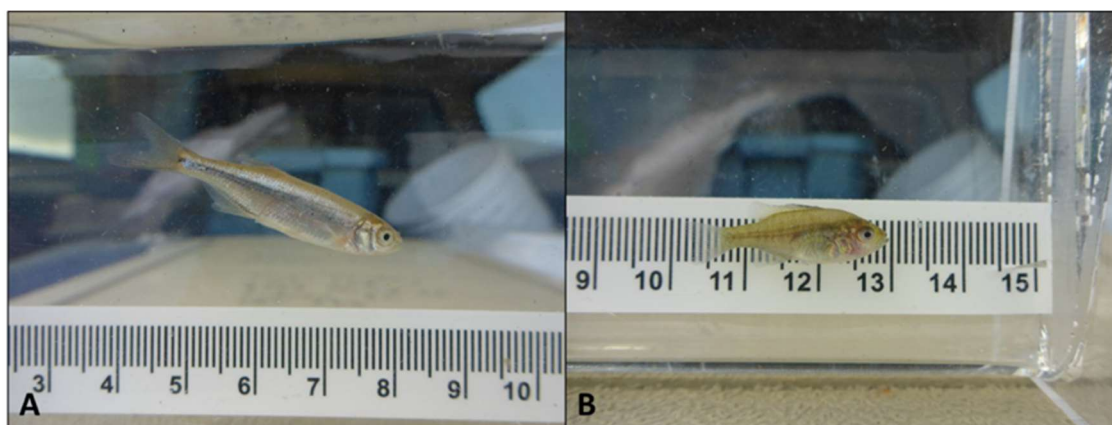
Figure 3-20. Trumpeter Swan (*Cygnus buccinator*) and nest with two eggs (June 9th, 2020).

3.3.4 Fish Surveys

A total of 21 minnow traps (Figure 3-2) were deployed in Mayook Marsh, ranging in water depths ranging from 81 to 192 cm. No fish were captured with this method. Dip netting occurred at two locations, out in the open shallow-water habitat (100 to 150 cm depth) and along the shoreline in water depths of 10 to 50 cm depth (Figure 3-2). A total of 281 fish of two species were captured between both locations: Redside Shiner (*Richardsonius balteatus*) and Pumpkinseed (*Lepomis gibbosus*) (Table 3-5; Figure 3-21). Aside from a single 65 mm Redside Shiner, all captured fish were young-of-year.

Table 3-5. Count data of fishes captured during a one-hour dip netting survey at two locations (Map 1) in Mayook Marsh on 23 July 2020.

Species	Location	
	DIPNET1 (canoe-based)	DIPNET2 (shore-based)
Redside Shiner (<i>Richardsonius balteatus</i>)	1	153
Pumpkinseed (<i>Lepomis gibbosus</i>)	74	53

Figure 3-21. Young-of-year A. Redside Shiner (*Richardsonius balteatus*), B. Pumpkinseed (*Lepomis gibbosus*).

3.3.5 Water Physicochemistry

Water physicochemistry data taken during fish sampling on July 23, 2020, are summarized in **Table 3-6**. Water temperature and water level data from the data loggers currently deployed in Mayook Marsh will be summarized in 2021 after the data loggers are retrieved.

Table 3-6. A summary of water physicochemistry data from 21 sample stations in Mayook Marsh, July 23, 2020.

Parameter	Mean	Min	Max
Depth (cm)	124.4	81	192
Conductivity (us/cm)	269.7	232	315

DO (mg/L)	10.4	8	18
Water temp (°C)	23.8	21.7	26.5

3.3.6 Amphibians, Turtles, and Reptiles

Columbia Spotted Frog (*Rana luteiventris*), Western Painted Turtle (*Chrysemys picta*; COSEWIC Special Concern, Provincial blue-list), and Red-sided Garter Snake (*Thamnophis sirtalis*) were observed in Mayook Marsh (Figure 3-22; Table 6-8). Columbia Spotted Frogs were only observed in the west end of the marsh; however, dense Reed Canarygrass and Cattail along the shoreline made surveying challenging, and they were likely more widespread than observed. Most Columbia Spotted Frog observations were of juveniles observed along Mayook Creek in October, where they likely overwintered.

Western Painted Turtles were remarkably abundant and were observed throughout Mayook Marsh, often floating on the water's surface or pond vegetation. Less frequently, turtles were observed basking on the large amounts of wood debris within the marsh or along the shoreline. A total of 73 turtles were observed.

Several remnant turtle nests were observed along the north dike and in the lacustrine terrace at the west end of the side marsh near Mayook Creek (Figure 3-22). A total of eight nest holes were observed, two along the dike and six at the crest of the terrace.

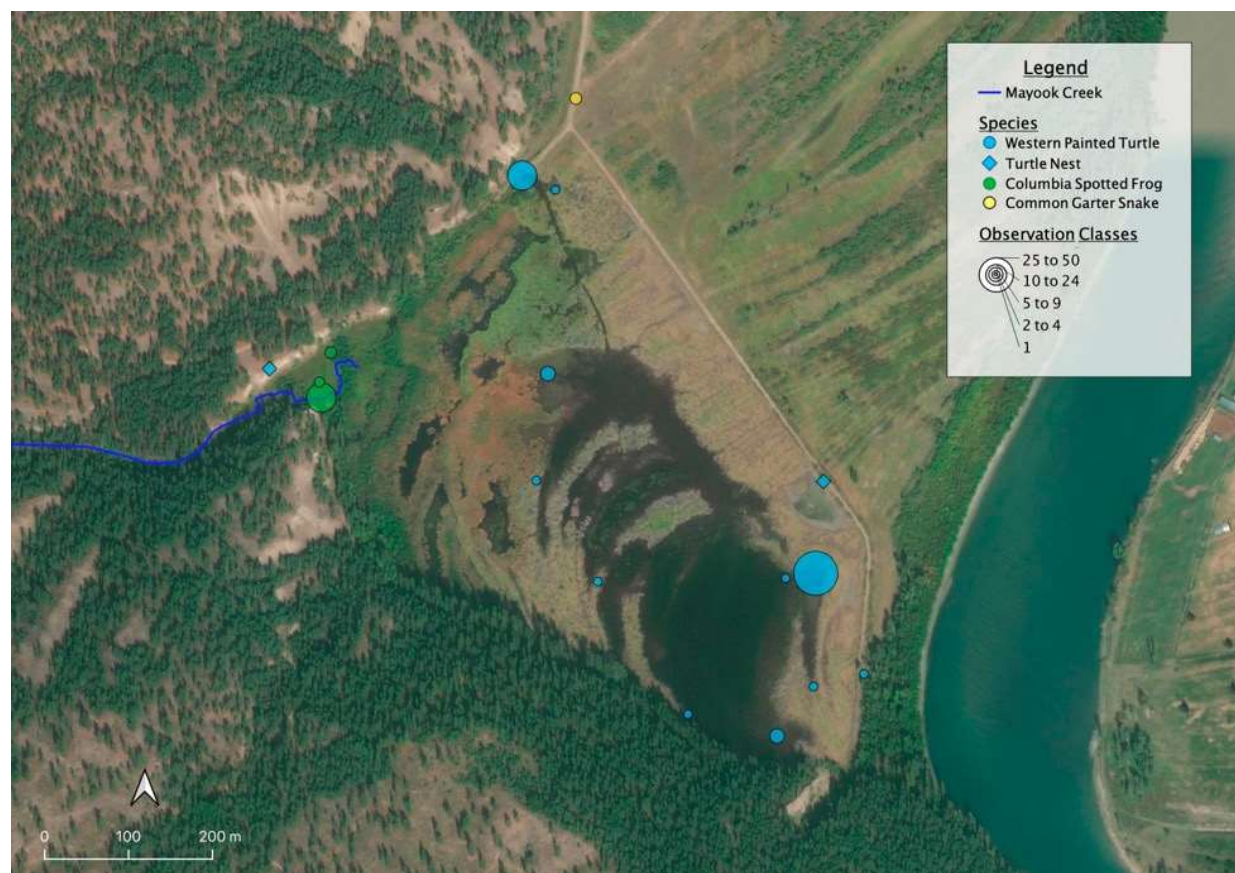


Figure 3-22. Columbia Spotted Frog, Common Red-sided Garter Snake, Western Painted Turtle observations in Mayook Marsh, 2020. The size of the bubble indicates the relative number of individuals observed.



Figure 3-23. The remains of turtle eggs near two Western Painted Turtle nests found on the terrace at the west end of Mayook Marsh (Figure 3-22).

A single Common Red-sided Garter Snake was observed along the main dike leading to Mayook. As with Columbia Spotted Frog, they are likely widespread throughout the marsh were but difficult to detect in the dense vegetation.

3.3.7 Bats

Bat detectors (n=4) were operated from July 23 to Oct 1, 2020, for a combined total of 2015 hours, capturing 55,319 recordings. Of these, 29,169 (52.7%) were classified as bat calls. The Kaleidoscope software classified all ten bat species that could occur in Mayook Marsh. Nine of the ten species all ten species were detected at each location (Table 3-7). Townsend's big-eared bat (*Corynorhinus townsendii*) was the exception and was not detected in ARU located in the pasture.

Table 3-7. The number of classified bats detections from four autonomous recording units (ARU) located at Mayook Marsh, July 23 to Oct. 1, 2020. See Table 3-1 for species codes and corresponding common and scientific names.

Habitat (ARU#)	COTO	EPFU	LACI	LANO	MYCA	MYEV	MYLU	MYTH	MYVO	MYYU	Total	# of Species
Pasture (ARU #1)	0	292	275	310	73	56	1812	29	9	1	2857	9
Marsh (ARU #2)	10	446	709	1387	948	1221	7123	159	353	75	12431	10
Riparian (ARU #3)	3	263	1572	1086	982	189	6640	4	83	36	10858	10
Sedge (ARU #4)	4	119	953	426	226	155	1057	5	71	7	3023	10

	17	1120	3509	3209	2229	1621	16632	197	516	119	29169
Total											

Little Brown Myotis (*Myotis lucifugus*) was the most prevalent species accounting for 57% of the recordings, while Townsends Big-eared bat was the least prevalent with only 17 recordings (0.1% of all recordings). Yuma and Fringe Myotis (*Myotis yumanensis* and *M. thysanodes*) were also infrequently detected (less than 1% of all detections).

Data were pooled by site, and the proportion of detections for each species was compared visually (Figure 3-24). The main pattern that emerges is the high prevalence of bat detections in the marsh and riparian habitats (ARU #2 and 3) in comparison to the adjacent meadow habitats (ARU #1 and #4).

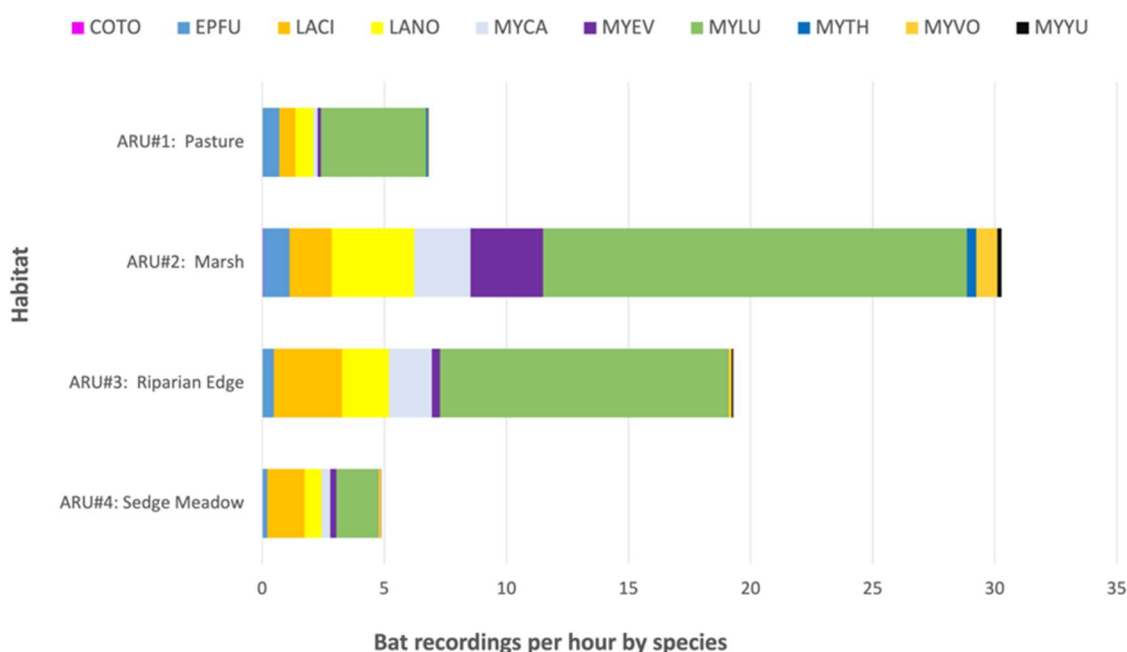


Figure 3-24. The relative abundance of bat detections (recordings per hour) by species at Mayook Marsh, July 23 to Oct. 1, 2020.

3.3.8 Wildlife Camera Data

Wildlife camera traps captured 11,059 images over 239 trap nights between July 23 to Oct 1, 2020. Excluding images of cattle and photographs of moving vegetation, 1726 images were of four wildlife species (Table 3-8, Figure 3-25): White-tailed Deer (*Odocoileus virginianus*), Elk (*Cervus canadensis*), Wild Turkey (*Meleagris gallopavo*), and Coyote (*Canis latrans*).

Table 3-8. Summary of capture data from 4 wildlife cameras set at Mayook Marsh from July 23 to Oct 1, 2020.

Species	Locations	# Images	# Est Individuals
White-tailed deer	4 (all)	1183	123
Elk	4 (all)	407	48

Turkey	1 (sedge marsh)	40	2
Coyote	1 (grass meadow)	4	1



Figure 3-25. Images of the four habitats and species sampled with wildlife cameras. Clockwise from top left, White-tailed Deer in Riparian forest, Coyote in grass meadow, Wild Turkey in the sedge meadow, and cow Elk in the dry open forest at Mayook Marsh.

The camera located in the open forest habitat at the west end of Mayook Marsh had the highest detection rates of the four sites. In contrast, the camera located in the riparian habitat along the south shore had the least (Figure 3-26). However, this camera malfunctioned and did not operate during the first sample session. Aside from differences in use among habitats, the data show that Elk detections declined across the two sample sessions ($p = 0.003$, $t = 5.203$, $\alpha = 5\%$, $df = 5$) while detection rates for White-tailed Deer remained consistent ($p = 0.145$, $t = 1.73$, $\alpha = 5\%$, $df = 5$) across the two-session (Figure 3-26). Although this difference in seasonal use by Elk corresponded with cattle presence (cattle were released for grazing in early Sept 2020) at Mayook Marsh, it could also reflect a shift in seasonal habitat use.

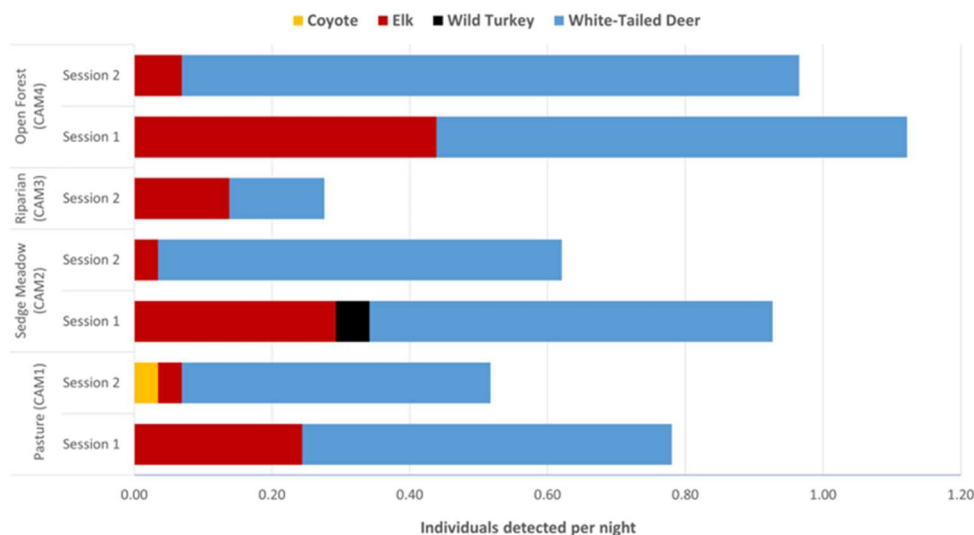


Figure 3-26. Wildlife cameras data showing the number of individuals of the four species detected per trap night and session. Session 1 = July 23 to Sept 2, 2020. Session 2 = Sept 2 to Oct 1, 2020. Camera locations are shown in Figure 3-2.

3.3.9 Incidental observations and Desktop Review of Species at Risk.

A total of 71 additional species were recorded incidentally at Mayook Marsh, of which 62 were birds (Table 6-9). Of the incidental observations, four bird species are designated as a species of conservation concern provincially or listed Federally under COSEWIC and SARA. These included the Common Nighthawk (*Chordeiles minor*; COSEWIC Special Concern/SARA Schedule 1), Great Blue Heron (*Ardea herodias herodias*; BC Blue list), Bank Swallow (*Riparia riparia*; COSEWIC Threatened/SARA Schedule 1), and Lewis's Woodpecker (*Melanerpes lewis*; BC Blue list and COSEWIC Threatened/SARA Schedule 1; Figure 3-27).

The query of the CDC database for the Mayook wetland complex yielded 12 ecosystems and 128 potential species at risk. Of these, we confirmed the presence of one ecosystem at risk, one turtle species (Western Painted Turtle), four bird species at birds (mentioned above), and two species of bats.

Table 3-9. Results of the BC Conservation Data Centre database query for at-risk species and ecosystems at risk for Mayook Wetlands.

Element Type	Count	Confirmed	Possible	Unlikely
Ecological Communities	12	1*	3*	7
Nonvascular Plant	1	-	1	-
Vascular Plant	21	-	5	16
Invertebrate	38	-	12	26
Amphibians	4	-	1	3
Bird	41	4	33	5
Fish	3	-	-	3
Mammal	19	2	4	5
Reptile	1	-	-	1
Turtle	1	1	-	-

*the Water birch – Red-osier Dogwood – Rose site community requires further confirmation.



Figure 3-27. Image of Lewis's Woodpecker on an Aspen Snag in the pasture north of Mayook Marsh (Image by J. Gatten June 9, 2020).

3.4 Discussion

3.4.1 Conservation Values

High, moderate, and low ratings were assigned to Valued Ecosystem Components identified for Mayook Marsh based on our findings from field surveys and desktop review (Table 3-10). The marsh provides high-value habitat for Western Painted Turtle, amphibians, waterfowl, bats, marsh birds and songbirds; moderate value for mammals; and low-value for fish. Recreational and education values vary by activity but are reduced due to access limitations.

Table 3-10. Summary of conservation values for Mayook Marsh.

Valued Ecosystem Components	Assigned Value	Rationale
Ecosystems	High	Mayook Marsh supports the Cattail Marsh (Blue listed) at-risk community and possibly a Flood-fringe community (Ff01a; field verification required). High-value marsh and shrub habitat compromised by the loss of mature stands of Aspen/Cottonwood and shrub communities displaced by Reed Canarygrass.
Fish	Low	Pumpkinseed and red-sided shiners. Likely supports other coarse or introduced species. Unlikely to support salmonoids.
Waterfowl	High	12 species were observed in total; 21 Broods were observed from 11 species. Diverse waterfowl community; many cavity-nesting species. Nesting Trumpeter Swans; Several are FWCP Inventory species (Bufflehead, Barrow's Goldeneye, Cinnamon Teal, Common Goldeneye, Hooded Merganser, Redhead, Wood duck)
Lewis's Woodpecker	High	Lewis's Woodpeckers were observed using cavities of dead Aspen in the adjacent pasture. Few snags left in the Mayook Marsh component. FWCP Upland Focal Recovery Species.
Other birds	High	High-value marsh bird habitat (Red-winged Black Birds, Yellow-headed Blackbird, Marsh Wren, Sora, American Coot, Pied-billed grebe). Sora, American Coot, Pied-billed grebe are FWCP Focal species. Unknown for American Bittern and Short-eared Owl. Unknown for shorebirds but likely low due to lack of exposed mudflats. Low to Moderate for shrub nesting songbirds (e.g., Yellow Warbler – FWCP Focal Species) relative to past conditions
Mammal	Moderate	Riparian and wetland margins provide moderate to high-value habitat for Elk, and White-tailed Deer; both are FWCP Focal Species. Unknown for Black, and Grizzly Bear, Beaver, River Otter, Badger and Wolf. Likely moderate for Muskrat.
Bats	High	Diverse bat population foraging at Mayook Marsh. Townsends Big-eared Bat are FWCP Focal Species; Big Brown Bat, California Myotis, Fringed Myotis, Little Brown Myotis, and Yuma Myotis are FWCP Inventory Species. The adjacent stand of mature Ponderosa Pine, Douglas fir, and Aspen likely provide roosting habitat.
Western Painted Turtle	High	Very abundant. Old, depredated nests observed. FWCP Focal Species.
Amphibians	High	Moderate to high potential as a Northern Leopard Frog (FWCP Focal Recovery Species) reintroduction site. All seasonal habitats appear to in suitable for this species. Further investigation is required. Columbia Spotted Frog present (FWCP Focal Species).
Recreation	Moderate	High values but limited access. Excellent birdwatching along the existing network of dikes. High-value as a recreational hunting area. Excellent primitive camping. Dikes and surrounding road network are moderate to high value for horseback riding and ATV.

3.4.2 Assessment of Project Effects

Impacts on wildlife and conservation values resulting from the planned infrastructure upgrades (replacing the water control structure) in Mayook Marsh are anticipated to be low and localized, provided the water levels remain unchanged. Soil disturbance is anticipated to be will be the primary impact. Turtle nest surveys should be conducted at the construction site and laydown areas to ensure turtle nests are not disturbed or destroyed. Alternatively, installing drift fencing around the construction site during the nesting period (May through July) may be an option to ensure nests are not laid in the construction zone (MFLNRO 2016).

Post-construction monitoring should include monitoring of exposed soils for erosion and invasive plants. Water level data should be collected before and after construction to ensure water level objectives are met in both the Mayook Marsh and the Waterfowl Oxbows.

3.4.3 Habitat Conditions

The shallow-water community appears to be in good condition, supporting a diverse community of resident waterfowl and what appears to be a healthy population of Western Painted Turtle. However, the conversion of Aspen/Cottonwood stands and deciduous shrub communities to Reed Canarygrass has degraded the overall habitat values of Mayook Marsh. The encroachment of Reed Canarygrass into the shrub and marsh communities continues to threaten the integrity of those habitats.

Reed Canarygrass degrades habitat values by forming dense monotypic stands that outcompeted native vegetation. Once established, Reed Canarygrass can alter the normal successional pathway of wetland and riparian communities by preventing shrubs and other native vegetation from establishing (Annen et al. 2008), resulting in a cascade of ecological impacts (Spyreas et al. 2010). Werner and Zedler (2002) found that dense stands of Reed Canarygrass supported one-ninth of the plant species found in a dense stand of cattails (*Typha* spp.) and native sedge communities. Negative associations with Reed Canarygrass have been reported in birds (Kirsch et al. 2007), garter snakes (Kapfer et al. 2013), amphibian populations (Northern Leopard Frog - Adama et al. 2004; Oregon Spotted Frog - Kapust et al. 2012), and arthropod communities (Weilhoefer et al. 2017).

The extent to which Reed Canarygrass has displaced Aspen/Cottonwood, shrub, and marsh communities in Mayook Marsh. Reed Canarygrass was pervasive throughout Mayook Marsh, absent only in deeper waters (>80 cm), dense stands of riparian shrubs, and in the dry upland forests. Reed Canarygrass was most pervasive on seasonally inundated low gradient areas that border the north and east shoreline, which historically supported stands of Aspen/ Cottonwood and deciduous shrub. The prescribed burn in the early 1990s eliminated Aspen, Cottonwood, and much of the shrub community. Grazing of Cottonwood and Aspen succours and shrub seedlings by cattle and native ungulates may have also prevented them from re-establishing. The maintenance of high-water levels throughout the summer months may have also contributed to the displacement of the Aspen and shrub communities by providing ideal soil moisture conditions for Reed Canarygrass to invade.

Unfortunately, while many of the ecological effects of Reed Canarygrass are understood, Reed Canarygrass is difficult to control (Apfelbaum and Sams 1987; Marc-Andre Beaucher, Pers. Comm 2021). An ecologically appropriate approach in addressing the habitat degradation caused by Reed Canarygrass is to restore the shrub communities, and Aspen/Cottonwood stands through active management. This approach is discussed in Section 3.4.4.

3.4.4 Conservation and Restoration Opportunities

Western Painted Turtle

The Western Painted Turtle is the only native turtle in British Columbia. They are a long-lived slow to mature species and have low reproductive rates and high egg/hatchling mortality. They are also dependent on a matrix of wetland and terrestrial habitat to complete their life history. The population in BC is estimated at 5000–10000 (COSEWIC 2016) and is distributed within the province's interior over three distinct regional genetic units: the Cariboo, the Thompson-Okanagan, and the Kootenays (Intermountain – Rocky Mountain Population). Western Painted Turtle Populations in the interior of BC are provincially Blue listed and listed under SARA Schedule 1 Species of Special Concern. The Fish and Wildlife Compensation Program identifies Western Painted Turtle as a Priority 2 Focal Inventory Species (FWCP 2019b).

Turtle nests were documented along the perimeter dike and on the terrace at the western end of the marsh. Nests along the dike were located near the road and may be susceptible to occasional vehicle traffic/ The nests on the terrace were located along an old Jeep road and may be exposed to ATV traffic. Nests at both locations may be susceptible to trampling by cattle. At least half of the nest detected had been destroyed by a predator, which is likely why they were easy to find. As nesting habitat is often cited as a limiting factor (COSEWIC 2016), we recommend nest surveys be conducted to identify additional nesting habitat, to identify potential risks to nests and nesting sites, and to assess whether habitat protection measures are warranted.

Lewis's Woodpecker

Lewis's Woodpecker is a semi-colonial nester that breeds in low-elevation habitats of south-central and southern interior British Columbia. Breeding habitats include dry, open Ponderosa Pine forests/grasslands, mature riparian Cottonwood stands, and recently burned Ponderosa Pine or Douglas-fir dominated forests. The population in BC is estimated to be at least 371 pairs (Environment and Climate Change Canada 2017), with 25% of the population occurring in the southern portions of the Rocky Mountain Trench. Lewis's Woodpecker is provincially Blue Listed and listed under SARA Schedule 1 as Threatened. The FWCP identifies Lewis's Woodpecker as Priority 1 Focal Inventory and Recovery Species in their Upland and Dryland Action Plan (FWCP 2019a).

Appropriate actions for Ducks Unlimited are to notify the FWCP and BC Ministry of Environment to ensure they are aware of this population. If FWCP and BC Ministry of Environment are unaware of this population, surveys to assess the number of breeding pairs and the breeding habitat's extent are recommended. Although we do not anticipate the proposed infrastructure upgrades at Mayook Marsh to affect Lewis's Woodpeckers or their habitat, the restoration of riparian habitat could benefit this population by recruiting nest trees over the long-term.

Northern Leopard Frog Reintroduction

The Northern Leopard Frog (NLF) is provincially Red Listed and listed under SARA Schedule 1 as Endangered. The FWCP lists the NLF as a Priority 1 Focal Inventory and Recovery Species.

Historically, NLF occurred in the southeast corner of BC from the U.S. border to Bush Lakes, north of Golden (Green and Campbell 1984). During the 1980s, widespread declines left a single endemic population in the Creston Wildlife Management Area (CVWMA; Waye and Cooper 2000). Over the past 20 years, recovery efforts have been attempting to re-establish populations in the East Kootenay and Upper Columbia with limited success (Randall and Stanton 2019). The recent appearance of Bullfrogs

(*Lithobates catesbeianus*) in the CVWMA increases the urgency to establish additional populations outside of the CVWMA.

Mayook Marsh appears to have the three seasonal habitats required by Northern Leopard Frogs. The shallow areas of Mayook Marsh with emergent Cattail and Bulrush vegetation appear to be suitable breeding and tadpole rearing habitat. Mayook Creek and the Kootenay River are likely suitable overwintering habitats. The surrounding marsh and meadows appear suitable as summer foraging habitats. Also, the wetland is secure (e.g., not prone to development), has a reliable water source and water levels, and provides connectivity to other reintroduction efforts along the Kootenay River (e.g., Bummer Flats). Finally, a review of a draft Habitat Suitability Index developed by the NLF Recovery Team indicated Mayook Marsh has high suitability based on the model criteria.

During a Recovery Team meeting in the fall of 2020, Mayook Marsh was suggested as a potential reintroduction site; however, an assessment of water levels and temperatures in the spring is required. We recommend DUC incorporate these surveys into the monitoring of Mayook Marsh in the spring of 2021.

Riparian Restoration

Riparian restoration is the most appropriate option for improving habitat values for wildlife in Mayook Marsh. Many of the valued ecosystem components identified in Table 3-10 (e.g., bats, waterfowl, songbirds, Lewis's woodpecker, and ungulates) would benefit from establishing Aspen, Cottonwood, and shrub communities long the margin of the marsh. By virtue of its rapid growth, Reed Canarygrass inhibits the establishment of native vegetation, preventing riparian communities from reestablishing on their own. However, Reed Canarygrass is shade intolerant and does not establish or grow well under an existing canopy, and it is possible to reduce its dominance by re-establishing an overstory by planting seedling/sapling of fast-growing trees and shrubs. This approach can result in reductions Reed Canarygrass biomass and cover and increases in understory diversity and habitat complexity, improving habitat for wildlife (Mathews et al. 2019; Kim et al. 2006). Fencing is recommended where grazing from native ungulates and cattle may damage and kill shrub saplings, which can delay or jeopardize restoration efforts (Jager et al. 2013; Jones et al. 2011).

We recommend DUC incorporate riparian restoration into the management plan for Mayook Marsh. The restoration of riparian habitats aligns with at least four actions in the FWCP Columbia Region's Wetland & Riparian Areas Action Plan, including: 1) the development of ecosystem restoration plans (Priority 1; COLWRA.ECO.HB.12.01); 2) restore and create wetland/riparian habitat (Priority 1; COLWRA.ECO.HB.13.01); 3) Cottonwood stand restoration/recruitment (Priority 1; COLWRA.ECO.HB.15.01); and 4) Improve habitat connectivity (Priority 1; COLWRA.ECO.HB.17.01).

Habitat Enhancement Features

Habitat enhancement features such as installing bat boxes or turtle loafing logs in Mayook Marsh were considered unnecessary.

The prescribed fire of the early 1990s created an abundance of logs and wood debris around the perimeter of the marsh. Along with dense mats of aquatic macrophytes in the shallow open water, there is an abundance of loafing habitat in the marsh.

Bat boxes were deemed unnecessary for two reasons. First, the older age stands of Douglas-fir, Ponderosa Pine stands, and Aspen (live and dead) surrounding Mayook Marsh likely provide natural roosting habitat for the arboreal roosting bats (species that utilize bat boxes). Second, the benefit of bat boxes is currently being reconsidered. Recent research indicates that bat boxes may be prone to overheating during the summer leading to direct mortalities and lower reproductive success (Irene Manley, pers. comm; Flaquer et al. 2014).

3.5 Conclusion

Our assessment indicates that Mayook Marsh provides important habitat for an interesting mix of wildlife species. Species observed/detected included:

- 63 bird species, including twelve species of waterfowl (11 with broods and 61 chicks), Lewis's Woodpecker, Great Blue Heron, Bank Swallow, and Common Nighthawk.
- A small colony of Lewis's Woodpecker was observed in the pasture adjacent to Mayook Marsh.
- Ten species of bats calls were recorded on 4 ARUs.
- Three species of herptiles were observed: Columbia Spotted Frogs, Common Garter Snake, and Western Painted Turtle. The Columbia Spotted Frogs were primarily observed along Mayook Creek. A population of Western Painted Turtle was observed utilizing the marsh (n = 71 turtle observed), and nests were documented at two locations.
- White-tailed Deer (n=1183), Elk (n=407), Wild Turkey (n=40), and Coyote (n =4) were documented with wildlife cameras (n = number of images for each species).
- Redsided-Shiner and Pumpkinseed were the only fish species captured.
- Twelve vegetation communities were documented and briefly described.

An assessment of habitat conditions revealed that a prescribed burn in the early 1990s destroyed the Aspen and Cottonwood stands and much of the riparian shrub communities that occurred in the marsh. Reed Canarygrass has displaced these communities and currently occupies approximately a third of the entire marsh encroaching on shallow-water, marsh, and remaining shrub habitats. The restoration of riparian communities is recommended as a priority action to restore Aspen and Cottonwood stands and improve habitat values for wildlife.

Project effects associated with replacing the water control are anticipated to be minimal and limited to the footprint of the construction site. Invasive plants, erosion, and turtle nesting were identified as potential concerns that may need to be assessed and mitigated.

Four restoration/ conservation opportunities were identified.

- **Western Painted Turtle:** Conduct nest surveys to identify additional nesting habitat, identify potential risks to nests and nesting sites, and assess whether habitat protection measures are warranted.
- **Lewis's Woodpecker:** Notify BC Ministry of Environment to ensure they are aware of this population. Conduct surveys to determine the size of the colony and extent of the breeding habitat to determine if habitat protection measures are warranted.

- **Northern Leopard Frog Reintroduction:** Monitor water temperatures with temperature data loggers to assess whether spring and summer water temperatures are suitable for NLF breeding and tadpole development.
- **Riparian Restoration:** Incorporate riparian restoration into DUC Mayook Marsh management plan. Assess soil conditions along the north and east margins of the marsh and collect more detailed information on the riparian shrub communities to support the preparation of a restoration plan.

4.0 MOBERLY MARSH

4.1 Study Area

Moberly Marsh is a managed wetland complex located 11km northwest of Golden, British Columbia, in the Columbia River floodplain (Figure 4-1). The marsh is bordered to the north by the Blaeberry River alluvial fan, to the east by the TransCanada Highway and CP Rail tracks, and to the south and west by the Columbia River.

The marsh has a long history of agriculture, providing pasture for cattle, horses, and buffalo as early as the mid-1800s (Hennan 1984). Agricultural improvements in the early 1900s attempted to drain the land and reduce flooding by constructing ditches and dams. In 1964, Burges James Gadsden donated 550 acres (which includes most of Moberly Marsh) to the BC Government. Recognized as primarily a wildlife management area, the land was designated as a "Class A" provincial park by Order-in-Council #1813 during the same year. In 1971, John and Caroline Bergenham donated an additional 30 acres of marshland to the Provincial Government to be integrated into the Park. Construction commenced the same year to enhance the marsh for waterfowl production with funding from the Northern California Ducks Unlimited Committee. By 1972, the initial dikes, ditches, and water control structures were in place, and 63 small nesting/loafing islands had been built from spoil piles. Further work was carried out in 1978 and 1979, raising the level of the dike above 776 m. This work also included installing a two-water control structure and constructing cross dikes, interior dikes (to protect the railroad), and 24 larger nesting islands (15 x 30 m).

The land status of Moberly Marsh is complicated as it incorporates portions of Burges and James Gadsden, Provincial Crown Land, and Private land (Table 4-1). The DUC Moberly Marsh project is approximately 304.6 ha and comprises three wetland compartments: the Bergenham, Braul, and Sime (Figure 4-1). A large marsh occurs to the west of the Braul compartment (approximately 12ha) outside the dike's perimeter.

Table 4-1. The total area of Moberly Marsh by jurisdiction and compartment*.

Jurisdiction	Compartment			Total (ha)
	Bergenham	Braul**	Sime	
CVWMA	21.5			21.5
Park	154.7	40.8	69.8	270.1
Private		13.0		13.0
Total	176.2	58.6	69.8	304.6

* Does not include marshes beyond the perimeter dike or upland forests.

**The northern boundary of the Braul compartment was estimated.

4.1.1 Biophysical Information

Moberly Marsh is located on the valley floor of the Rocky Mountain Trench between the western slopes of the Rocky Mountains and the eastern slopes of the Purcell Range. McKillop et al. (2018) classify Moberly Marsh within the Dry Cool Montane Spruce (MSdk) biogeoclimatic subzone. However, this area of the Rocky Mountain Trench is transitional between the Interior Cedar Hemlock (ICH), Interior Douglas-fir (IDF), and Montane Spruce (MS) zones. Seasons are characterized by dry, cold winters and dry, warm summers. Winter snowpacks are moderately deep and persist from December through March. Northern air masses with cold air bring frigid temperatures (< -20 °C), often extending several

weeks during the winter months. Precipitation is highest during June, July, and November and lowest in late winter and spring (Feb through April) (Environment Canada 2020).

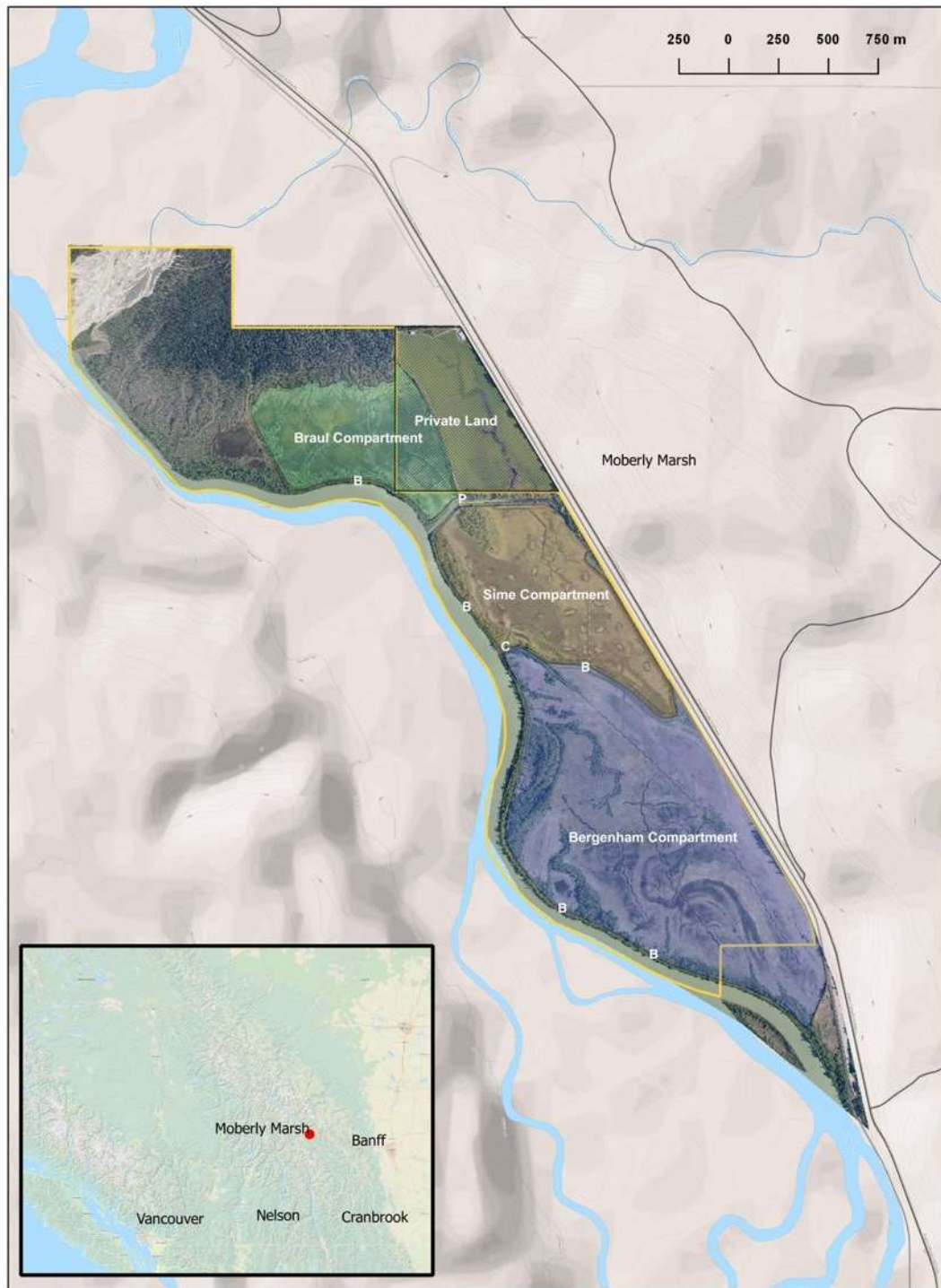


Figure 4-1. Map showing the location of the wetland compartments of Moberly Marsh. The boundary of Burges and James Gadsden Provincial Park is marked in yellow. The location of proposed dike breaches are identified by the letter “B,” and the existing water control structures are indicated by P (pump) and C (inlet/outlet control).

4.1.2 Hydrology

Historically, water inputs into Moberly Marsh came from snowmelt, spring runoff, precipitation, flooding from the Columbia River during the freshet, discharge from Moberly Creek, and through seepage channels from the alluvial fan of the Blaeberry River. However, over the past century, the hydrology of the Moberly Marsh has been altered. More recently, the construction of the railway and TransCanada Highway has resulted in the diversion of Moberly Creek directly into the Columbia River, reducing the upslope water flow into the marsh. The construction of dikes by DUC in the 1970s altered the hydrology further by isolating Moberly Marsh from the Columbia River.

4.1.3 Land use

Access to Burges and James Gadsden Provincial Park and Moberly Marsh is restricted to the boat access along the Columbia River, through private land – Spike Elk Ranch, or illegally crossing the CPR tracks. The lack of access and Provincial Park regulations restrict land use activities in the marsh. Ducks Unlimited Canada manages the marsh under their Land Use Occupancy permit (Authorization #103001). No other Park-use permits have been issued for grazing, recreation, or other uses. Shooting, Hunting or Trapping is not permitted in the Park.

4.1.4 Proposed Works

In 2015, DUC assessed the dikes in Moberly Marsh and concluded that the dike's integrity has become compromised and that significant upgrades to the dike are required to maintain it. In reviewing options, it was determined that the Moberly Marsh project was not meeting DUCs objectives for waterfowl productivity, and DUC concluded that the costs required to maintain the dike outweigh the project benefits. To reduce DUCs ongoing liability for maintaining the project's infrastructure, DUC proposes to breach the dike at strategic locations and decommission some of the existing water control structures (Figure 4-1). By breaching the dike, it is anticipated that Moberly Marsh will be restored, over time, to a seasonally flooded wetland.

4.2 Methods

4.2.1 Desktop Review

A desktop review of reports and data was undertaken to summarize the conservation and wildlife values of Moberly Marsh and to assess project effects.

The conservation assessment prepared in 2017 was updated with information from Darvill (2020), recent e-bird records, and data from the BC CDC Species and Ecosystem Explorer (CDC. 2020), E-fauna and E-flora (Klinkenberg 2020a and 2020b).

A Digital Elevation Model (DEM) of Moberly Marsh was prepared from bare ground LiDAR data acquired in 2016. Water level data from the Donald hydrometric station were used to model the elevation of the Columbia River at Moberly Marsh by correlating the LiDAR to the river levels at Donald Station. We used

data from 2011 to 2019 (the only years available for this station) to assess the potential timing and duration of flooding in Moberly Marsh based on the invert elevations of the proposed breaches.

4.2.2 Monitoring

Level loggers were installed in the Braul Compartment and Sime Compartments in October 2020 to collect baseline information on water levels (Table 4-2; Figure 4-2). For comparison, two level loggers were also installed in two recently created wetlands by Tom Beibighauser (BCWF 2020) on the adjoining private land (Spike Elk Ranch). A weather station was deployed to record barometric pressure for barometric compensation of water levels. Data from the level loggers will be retrieved and processed in 2021. Incidental wildlife observations were documented and, where possible, photographs were taken, and habitat information and GPS location data were recorded. No vegetation or habitat data were collected in 2020.

Table 4-2. Location and elevation of data loggers installed in 2020.

Description	Compartment	Easting	Northing	Elevation
Level Logger	Braul Compartment	496005	5696158	NA
Level Logger	Spike Ek 01	496298	5696210	775.8
Level Logger	Spike Ek 02	496476	5695786	775.4
Weather Station	Spike Elk	496258	5696279	775.9
Level Logger	Sime Compartment	496164	5695631	NA

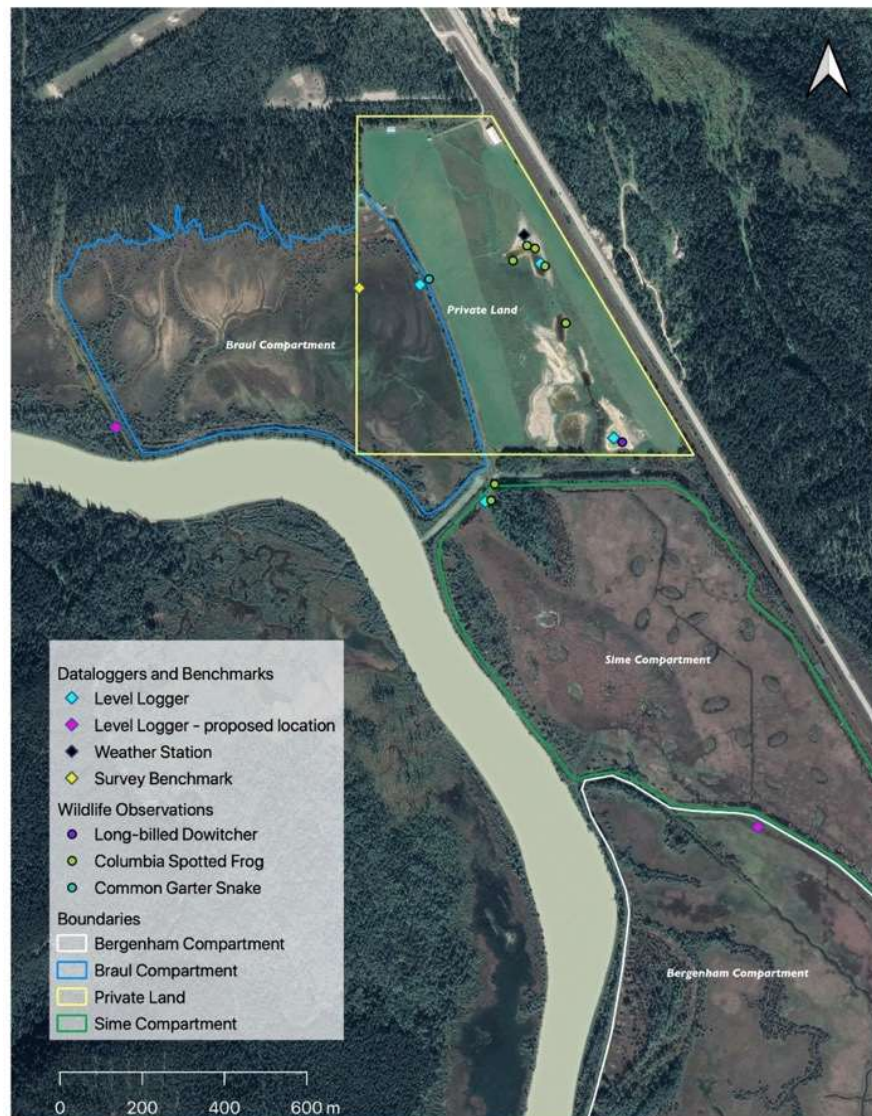


Figure 4-2. Location of the level logger and weather station installed in Moberly Marsh in 2020. Incidental wildlife observations from 2020 and proposed level logger locations for 2021 are also shown.

4.3 Results and Discussion

4.3.1 Conservation Values

Moberly Marsh has long been recognized as important habitat for wildlife, including amphibians, garter snakes, waterfowl, shorebirds, marsh birds, raptors, Great Blue-Heron, Grizzly and Black Bear, Elk, and deer. Table 4-3 provides a summary of conservation values for the marsh.

Records of the National Museum confirm the presence of Northern Leopard Frogs in the late-1960 (CMN 2021). Other notable observations included Sandhill Crane, which has been observed (often with young of the year) in the Marsh and adjacent private land for the past two decades (Leighton 2005; eBird 2020)

and the presence of several species at risk (Table 4-3). Incidental observations from 2020 included Common Red-Sided Garter Snake, Columbia Spotted Frog (*Rana luteiventris*), and a small flock of long-billed dowitchers (Table 4-5).

Table 4-3. Summary of conservation values for Moberly Marsh

Valued Ecosystem Components	Assigned Value	Project Rationale
Ecosystems	High	The overall habitat values of Moberly Marsh are high, particularly along the dikes, raised areas, and productivity habitats within the marsh. Hydrological alterations have resulted in a homogenous stand of Cattail, Bulrush, and Reed Canarygrass.
Waterfowl	High	Moderate value for Waterfowl, although habitat quality has declined with the ingrowth of Cattail and Bulrush. Values are enhanced by adjacent agricultural fields that flood in the spring providing high-value stopover habitat for migrants.
Marsh Birds	High	Extensive cattail marsh provided high-value marsh bird habitat.
Songbirds	High	Riparian habitat provides high-value neotropical migrant nesting and stopover habitat.
Other birds	Moderate	Limited use by Short-eared owl and American Bittern. Annual Sandhill Crane nesting.
Rare Plants	High	High-value rare plant habitat. Four species were observed in July 2016: <i>Carex crawei</i> (blue listed), <i>Eleocharis elliptica</i> (blue listed), <i>Gentianopsis macounii</i> (blue listed), and <i>Liparis loeselii</i> (red-listed).
Mammal	High	High-value habitat for Elk, Deer, Black and Grizzly Bear, Muskrat, Beaver, River Otter, and Wolf.
Amphibians	High	Shallow water and marsh communities provide high-value habitat for Columbia Spotted Frog (<i>Rana luteiventris</i>). Unknown for Pacific Chorus Frog <i>Pseudacris regilla</i> and Western Toad <i>Anaxyrus boreas</i> . Moderate to high potential value for Northern Leopard Frog (<i>Lithobates pipiens</i>) due to historic occurrence,
Recreation and Education	Moderate	Excellent birdwatching and educational opportunities along the existing network of dykes, Unfortunately, access is limited and is through private land or illegal crossing of CPR tracks. Moderate canoeing, snowshoeing, and cross-country skiing (classic) opportunities. Improved access would greatly enhance recreational and educational values. Shooting, Hunting or Trapping is not permitted in the Park.

Table 4-4. Results of the BC Conservation Data Centre database query for at-risk species and ecosystems for Moberly Marsh, updated with confirmed observations. Appendix Error! Reference source not found. lists the ecosystems and species.

Element Type	Count	Confirmed	Possible	Unlikely
Ecological Communities	4	1	1	2
Fungi and Nonvascular Plant	6	-	5	1
Vascular Plant	19	1	9	8
Molluscs	19	-	5	14
Invertebrate	23	1	8	14
Amphibians	4	2*	-	2
Bird	49	22 †	5	22
Fish	7	-	2	5
Mammal	12	2	5	7
Reptile	1	-	-	1
Turtle	1	-	1	-

* Includes Northern Leopard Frogs, which are now extirpated.

** Includes National Museum Record for Northern Leopard Frog (*Lithobates pipiens*)

†based on ebird records.

Table 4-5. Incidental wildlife observations at Moberly Marsh and Spike Elk Ranch.

Name	QTY	Compartment	Habitat	UTM_E	UTM_N	Elev (m)
Common Garter Snake	1	Spike Elk Ranch	Jeep Road	496027	5696172	775.7
Columbia Spotted Frog	1	Sime	Dike	496186	5695674	777.6
Columbia Spotted Frog	1	Sime	Shoreline Pond	496178	5695634	NA
Columbia Spotted Frog	1	Spike Elk Ranch	Pond Shoreline	496231	5696217	775.5
Columbia Spotted Frog	1	Spike Elk Ranch	Pond Shoreline	496265	5696253	775.9
Columbia Spotted Frog	1	Spike Elk Ranch	Pond Shoreline	496285	5696247	775.9
Columbia Spotted Frog	1	Spike Elk Ranch	Pond Shoreline	496309	5696203	775.4
Long-Bill Dowitcher	4	Spike Elk Ranch	Pond Shoreline	496497	5695776	775.5
Columbia Spotted Frog	1	Spike Elk Ranch	Pond Shoreline	496360	5696065	775.4

4.3.2 Habitats

Table 4-6 summarizes the distribution of general habitat types mapped in 2016 across the three compartments in Moberly Marsh (Adama 2017). Beibighauser (2019) estimated a 93% reduction (157 ha to 11 ha) in shallow open water wetlands between 1965 and 2017. Dense stands of Cattail and Bulrush now dominate the wetlands impounded by the dikes. A fulsome assessment of habitat conditions in Moberly Marsh was not completed in 2020.

Table 4-6. The estimated area of broad habitat types mapped by compartment for Moberly Marsh.

Habitat	Braul	Sime	Bergenham	Total
Marsh/Openwater	40.8	56	137.5	234.3
Shallow waters*	-	-	-	11
Marsh Communities				225.3
Riparian	5.6	7	29.2	41.8
Forest	8.6	.	.	8.6
Dike	3.6	6.8	9.5	19.9
Total	58.6	69.8	176.2	304.6

* estimated by Beibighauser (2019).

4.3.3 Assessment of Project Effects

A thematic map of a Digital Elevation Model shows the bare ground elevations of Moberly Marsh (Figure 4-3). The map shows that the Bergenham compartment is 25 to 50 cm lower than the Sime and Braul compartments. However, most of the Braul Compartments and approximately a third of the Sime compartment were already underwater when the LiDAR data was captured (Jun 06, 2016). The elevation of the Columbia River was estimated to be 775.6 m at that time. A plot of the terrain data shows a similar pattern with little terrain below 775.5 m in the Sime and Braul compartments (Figure 4-4).

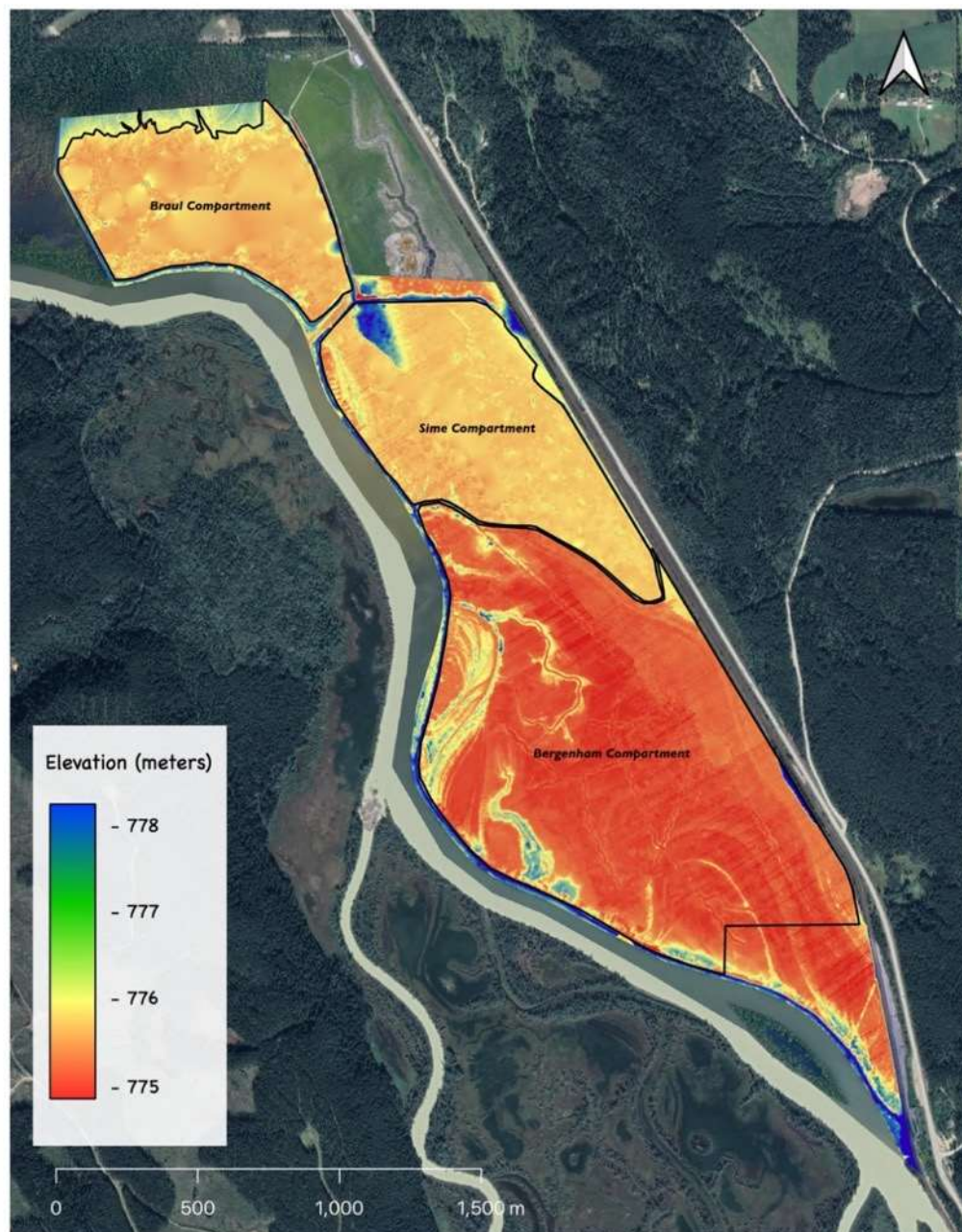


Figure 4-3. Digital elevation model of Moberly Marsh based on LiDAR data obtained in 2016. Most of the Braul compartment and approximately a third of the Sime compartment were flooded when the LiDAR data was acquired (June 6, 2016).

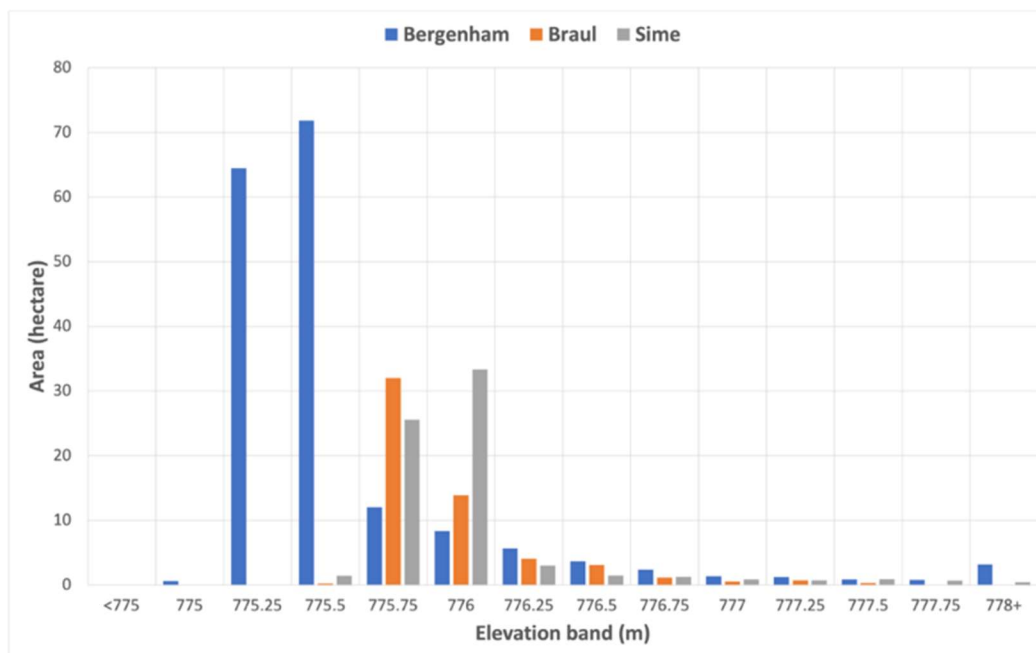


Figure 4-4. Distribution of 25 cm elevation bands in the three compartments of Moberly Marsh.

Using river elevation data from Donald Station, we estimated values on the timing, duration, and flooding depth to illustrate the effects of breaching the dike on the water levels in Moberly Marsh over a nine-year period (2011 to 2019; Table 4-7). A value of 775.3m was used for the average invert elevation of the proposed dike breaches. The lowest elevation of the dike currently is 777.1m, and this elevation was only attained on two days between 2011 and 2019. In contrast, the Columbia River exceeded 775.3 m for 577 days during the same period for an average of 64.1 days per year. During this period, water levels were 0.7 m higher than 775.3 m on average. The maximum elevation during this period was 777.2 m, which is 0.1 m above the current dike elevation. The average seasonal maximum height was 1.3m (range 0.6 to 1.9 m). During 2011–2019, the earliest and latest the Columbia River was above 775.3m at Moberly Marsh were estimated to be May 6 and August 15, respectively. On average, the earliest and latest days 775.3m at Moberly Marsh were May 19 and July 30.

Table 4-7. Estimated elevations and dates above 775.3m for the Columbia River levels at Moberly Marsh from 2011 to 2019. Elevations are based on water levels observed at Donald Station and corrected for Moberly Marsh using the 2016 LiDAR data.

Year	Days above 775.3m	Earliest Date above 775.3m	Last Date above 775.3m	Mean Elevation (m)	Mean Height (m) above 775.3m	Max Elevation (m)	Annual Max Height (m) above 775.3m
2011	74	26-May	12-Aug	775.8	0.5	776.5	1.2
2012	74	03-Jun	15-Aug	776.1	0.8	777.2	1.9
2013	74	13-May	29-Jul	776.3	1.0	776.9	1.6
2014	69	19-May	08-Aug	775.8	0.5	776.4	1.1
2015	54	23-May	15-Jul	776.0	0.7	776.4	1.1
2016	40	06-May	17-Jul	775.7	0.4	775.9	0.6

2017	61	24-May	24-Jul	776.2	0.9	777.0	1.7
2018	74	08-May	03-Aug	776.0	0.7	776.7	1.4
2019	57	10-May	22-Jul	775.8	0.5	776.1	0.8
Average	64.1	19-May	30-Jul	776.0	0.7	777.2	1.3

* 755.3 m is the average depth of the proposed breach inverts

These estimates indicate that breaching the dike at the proposed invert levels will restore the hydrological connection between Moberly Marsh to the Columbia River. However, as the inundation values and river elevations were estimated by cross-referencing the LiDAR data to river elevations at Donald Station, these estimates should be interpreted cautiously. Nevertheless, the results are instructive and help predict the hydrological changes in Moberly Marsh once the decommissioning is completed.

The planned decommissioning will affect wildlife and conservation values in the marsh as a new equilibrium is established. Waterfowl, marsh birds, amphibians, and vegetation communities are among those valued ecosystem components that will be likely be directly affected. However, while reconnecting Moberly Marsh with the Columbia River will restore the marsh's hydrology, the ecological outcomes are difficult to predict.

Further surveys of the wetland habitats and wildlife populations are required to fully assess the potential changes to wetland habitat, productivity and habitat use by wildlife.

We recommended collecting baseline information on:

- Water depth and physicochemistry (pH, turbidity, conductivity, dissolved oxygen).
- Wetland communities: monitoring habitat extent and vegetation composition of wetland habitats
- Waterfowl habitat use (species richness and occupancy) and productivity
- Marsh bird and shorebird habitat use (species richness and occupancy)
- Habitat use by amphibians (species richness and occupancy)

4.3.4 Conservation and Restoration Opportunities

No additional restoration actions are recommended until further assessments are completed and a decommissioning plan has been finalized. Following wildlife and habitat assessments, DUC or project partners may consider incorporating restoration actions into the decommissioning plan. Alternatively, it may be more prudent to assess project outcomes several years afterwards to see if additional restoration actions are warranted.

4.4 Conclusion

We used LiDAR data and river elevation at Donald bridge to model the hydrological effects of reconnecting Moberly Marsh to the Columbia River floodplain using hydrometric data from 2011 to 2019. We conclude that breaching the dike at the proposed invert levels will restore the hydrological connection between Moberly Marsh to the Columbia River. The increased flooding and residence time will affect marsh habitats, wetland productivity, and wildlife use of the marsh. As vegetation and wildlife assessments have not begun, the ecological outcomes are difficult to predict at this time.

To assess the impacts on key valued ecosystem components, we recommended collecting baseline information on:

- Water depth and physicochemistry (pH, turbidity, conductivity, dissolved oxygen).
- Wetland communities: monitoring habitat extent and vegetation composition of wetland habitats
- Waterfowl habitat use (species richness and occupancy) and productivity
- Marsh bird and shorebird habitat use (species richness and occupancy)
- Habitat use by amphibians (species richness and occupancy)

Water level-loggers were installed in 2020, and additional level loggers will be installed in 2021.

No supplemental restoration actions are recommended at this time.

5.0 Literature Cited

- Adama, D.B 2017. Moberly Marsh Habitat Restoration Seed Funding Report. COL-F17-W-1435. Report to the Fish and Wildlife Compensation Program: Columbia Region. Castlegar, BC. 22pp.
- Adama, D. B., K. Lansley, and M. A. Beaucher. 2004. Northern Leopard Frogs (*Rana pipiens*) Recovery: Captive rearing and reintroduction in southeast British Columbia, 2003. Report to the Columbia Basin Fish and Wildlife Compensation Program, Nelson, BC pp. 26.
- Annen CA, Kirsch EM, Tyser RW. 2008. Reed Canarygrass Invasions Alter Succession Patterns and May Reduce Habitat Quality in Wet Meadows. *Ecological Restoration* **26**:190–193.
- Apfelbaum, S.I., and C.E. Sams. 1987. Ecology and control of reed canarygrass (*Phalaris arundinacea* L.). *Natural Areas Journal* 7:69-74.
- BC Conservation Data Centre (CDC). 2020a. BC Species and Ecosystems Explorer. BC Ministry. of Environ. Victoria, BC Available: <http://a100.gov.bc.ca/pub/eswp/> (accessed Sep 4, 2020).
- BC Conservation Data Centre (CDC). 2020b. Ecological Community Summary: Typha latifolia Marsh. BC Ministry of Environment. Available: <https://a100.gov.bc.ca/pub/eswp/> (accessed Nov 17, 2020).
- BC Ministry of Environment (MOE). 2017. Management plan for the Painted Turtle – Intermountain– Rocky Mountain Population (*Chrysemys picta* pop. 2) in British Columbia. BC Ministry of Environment, Victoria, BC 31 pp
- Biebighauser T. R. 2019. Burges James Gadsden Provincial Park Wetland Restoration Design Plan. Unpublished report for BC Parks and the BC Wildlife Federation. 107 pp
- British Columbia Wildlife Federation (BCWF). 2020. Advancing Wetland Stewardship & Restoration in the Kootenays. COL-F19-W-2707. Unpublished report for the Fish and Wildlife Compensation Program. Castlegar, BC. 30pp.
- COSEWIC. 2016. In Press. COSEWIC assessment and status report on the Western Painted Turtle *Chrysemys picta bellii*, Pacific Coast population, Intermountain-Rocky Mountain population and Prairie/Western Boreal - Canadian Shield population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxi + 95 pp.
- Canadian Museum of Nature (CMN). 2016. Specimen data provided by the Canadian Museum of Nature. Record number 9876. Canadian Museum of Nature website: <http://nature.ca/collections-online>.
- Darvill, R. 2020a. Kootenay Connect: Columbia Wetlands Literature Review of Species at Risk in the Columbia Valley. Unpublished report for the Columbia Wetlands Stewardship Partners and Kootenay Conservation Program. 127 pp

- Darvill, R. 2020b. Columbia Wetlands Waterbird Survey. Unpublished report to Wildsight Golden. 127 pp
- eBird. 2020. eBird: An online database of bird distribution and abundance. Ithaca, New York. Available: <http://www.ebird.org> (accessed November 2020).
- Environment Canada. 2014. Management Plan for the Lewis's Woodpecker (*Melanerpes lewis*) in Canada. *Species at Risk Act Management Plan Series*. Environment Canada, Ottawa. iii + 23 pp
- Environment and Climate Change Canada. 2017. Recovery Strategy for the Lewis's Woodpecker (*Melanerpes lewis*) in Canada. *Species at Risk Act Recovery Strategy Series*. Environment and Climate Change Canada, Ottawa. vi + 40 pp.
- Environment and Climate Change Canada. 2017. Recovery Strategy for the Northern Leopard Frog (*Lithobates pipiens*), Rocky Mountain population in Canada. *Species at Risk Act Recovery Strategy Series*. Environment and Climate Change Canada, Ottawa. 2 parts, 24 pp. + 47 pp
- Environment Canada. 2020. Canadian Climate Normals 1981-2010 Station Data for Golden, BC.
- ERSI 2020. World Imagery. Attribution: GeoEye, Maxar | Esri, HERE, Garmin, iPC, NRCAN. Image Date Aug 18, 2020. URL: <https://www.arcgis.com/home/webmap/viewer.html>
- Fish and Wildlife Compensation Program (FWCP) 2019a. Columbia Region: Wetlands and Riparian Areas Action Plan (V1). Castlegar BC. URL: <https://fwcp.ca/app/uploads/2019/08/Action-Plan-Columbia-Region-Wetlands-Riparian-Areas-Aug-21-2019.pdf>
- Fish and Wildlife Compensation Program (FWCP) 2019b. Columbia Region: Upland and Dryland Areas Action Plan (V1). Castlegar BC. URL: <https://fwcp.ca/app/uploads/2019/08/Action-Plan-Columbia-Region-Upland-Dryland-Aug-21-2019.pdf>
- Flaquer, C., X. Puig, A. López-Baucells, I. Torre, L. Freixas, M. Mas, X. Porres and A. Arrizabalaga. 2014. Could overheating turn bat boxes into death traps? *Barbastella* 7:46–53.
- Gollop, J.B., and W.H. Marshall. 1954. A guide for aging duck broods in the field. *Miss.Flyway Counc., Tech. Sect.* 14 pp.
- Green, D.M. and R.W. Campbell. 1984. The amphibians of British Columbia. Royal B.C. Museum, Victoria, BC. RBCM Handbook No. 45.
- Hendry H, and C. Mann. 2017. Camelot – Intuitive Software for Camera Trap Data Management 7:1209–11. Available from <https://www.biorxiv.org/content/biorxiv/early/2017/10/18/203216.full.pdf> <https://gitlab.com/camelot-project/camelot>
- Holroyd, S.L., R.M Barclay, L.M. Merk and R.M. Brigham 1994. A survey of the bat fauna of the dry interior of B.C. Min. of Env't, Victoria, B.C. Wildlife Working Report No. WR 63.
- Jager NRD, Cogger BJ, Thomsen MA. 2013. Interactive effects of flooding and deer (*Odocoileus virginianus*) browsing on floodplain forest recruitment. *Forest Ecology and Management* 303:11–19.
- Jones BE, Lile DF, Tate KW. 2011. Cattle Selection for Aspen and Meadow Vegetation: Implications for Restoration. *Rangeland Ecology & Management* 64:625–632.
- Kapfer JM, Doehler K, Hay R. 2013. The Influence of Habitat Type and the Presence of an Invasive Wetland Plant (*Phalaris arundinacea*) on Capture Rates of Sympatric Rare and Common Gartersnake Species (*Thamnophis butleri* and *Thamnophis sirtalis*). *Journal of Herpetology* 47:126–130.

- Kapust, H. Q. W., K. R. McAllister, and M. P. Hayes. 2012. Oregon spotted frog (*Rana pretiosa*) response to enhancement of oviposition habitat degraded by invasive reed canary grass (*Phalaris arundinacea*). *Herpetological Conservation and Biology* 7: 358-366.
- Kidd SA, Yeakley JA. 2015. Riparian Wetland Plant Response to Livestock Exclusion in the Lower Columbia River Basin. *Natural Areas Journal* 35:504–514.
- Kim K. D, Ewing K, Giblin D. E. 2006. Controlling *Phalaris arundinacea* (reed canarygrass) with live willow stakes: A density-dependent response. *Ecological Engineering* 27:219–227.
- Kirsch, E. M., B. R. Gray, T. J. Fox, and W. E. Thogmartin. 2007. Breeding bird territory placement in riparian wet meadows in relation to invasive reed canary grass, *Phalaris arundinacea*. *Wetlands* 27: 644-655.
- Klinkenberg, Brian. (Editor) 2020a. E-Flora BC: Electronic Atlas of the Plants of British Columbia[eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver.
- Klinkenberg, Brian. (Editor) 2020b. E-Fauna BC: Electronic Atlas of the Fauna of British Columbia [www.efauna.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver.
- Lacelle, L. E. H. 1990. Biophysical resources of the East Kootenay area: soils. British Columbia Ministry of Environment Wildlife Technical Monograph TM-1.
- Leighton, D. 2005. Recent Range Expansion of Sandhill Cranes (*Grus Canadensis Tabida*) In Southeastern British Columbia. *Wildlife Afield* 2(2): 64 – 74
- MacKillop, D.J., A.J. Ehman, K.E. Iverson, and E.B. McKenzie. 2018. A field guide to site classification and identification for southeast British Columbia: the East Kootenay. Prov. B.C., Victoria, B.C. Land Manag. Handb. 71.
- Matthews JW, McIntyre S, Peralta AL, Rodgers C. 2020. Long-Term Assessment of Alternative Strategies for the Restoration of Floodplain Forest in the Presence of an Invasive Grass, *Phalaris arundinacea*. *Wetlands* 40:655–665.
- McPhail, J.D. 2007. The freshwater fishes of British Columbia. The University of Alberta Press. Canada Council for the Arts. First edition.
- Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO), 2016. Best Management Practices for Amphibian and Reptile Salvages in British Columbia. Version 1.0., June 2, 2016.
- Northern Leopard Frog Recovery Team. 2012. Recovery plan for the Northern Leopard Frog (*Lithobates pipiens*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 47pp.
- Peralta AL, Muscarella ME, Matthews JW. 2017. Wetland management strategies lead to tradeoffs in ecological structure and function. *Elem Sci Anth* 5:74.
- Randall, L. and R. Stanton. 2019. Reintroduction and monitoring of northern leopard frogs (*Lithobates pipiens*) in the Columbia marshes, 2019. Unpublished Report for the Columbia Basin Trust Kootenay Conservation Program.
- Resources Inventory Committee (RIC). 1997. Fish Collection Methods and Standards. Report prepared by the British Columbia Ministry of Environment, Lands, and Parks, Fish Inventory Unit for the Aquatic Ecosystems Task Force, Resources Inventory Committee. Version 4.0.

- Resources Inventory Committee (RIC). 1999. Inventory Methods for Waterfowl and Allied Species: Loons, Grebes, Swans, Geese, Ducks, American Coot, and Sandhill Crane. Standards for Components of BC's Biodiversity No. 18. Ministry of Environment, Lands and Parks, Victoria, BC. 82 pp
- Resources Inventory Committee (RIC). 2001. Reconnaissance Fish and Fish Habitat Inventory: Standards and Procedures. Report prepared by B.C. Fisheries Information Services Branch for the Resources Inventory Committee. Version 2.0.
- Richards DR, Moggridge HL, Warren PH, Maltby L. 2020. Impacts of hydrological restoration on lowland river floodplain plant communities. *Wetlands Ecology and Management* 28:403–417.
- Rooney, R. C., C. Carli, and S. E. Bayley. 2013. River Connectivity Affects Submerged and Floating Aquatic Vegetation in Floodplain Wetlands. *Wetlands* 33:1165–1177.
- Spyreas, G., B. W. Wilm, A. E. Plocher, D. M. Ketzner, J. W. Matthews, J. L. Ellis, and E. J. Heske. 2010. Biological consequences of invasion by reed canary grass (*Phalaris arundinacea*). *Biological Invasions* 12: 1253–1267.
- Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184:82–89.
- Szewczak, J.M., Corcoran, A.J., Kennedy, J.K., Ormsbee, P.C. & Weller, T.E. 2011a. Echolocation Call Characteristics of Western U.S. Bats. Humboldt State University Bat Lab, Arcata, California. http://www.sonobat.com/download/WesternUS_Acoustic_Table_Mar2011.pdf
- Szewczak, J.M., Corcoran, A.J., Kennedy, J.K., Ormsbee, P.C. & Weller, T.E. 2011b. Echolocation Call Characteristics of Eastern U.S. Bats. Humboldt State University Bat Lab, Arcata, California. http://www.sonobat.com/download/EasternUS_Acoustic_Table_Mar2011.pdf
- Waye, H.L. and J.M. Cooper. 2000. Status of the Northern Leopard Frog (*Rana pipiens*) in the Creston Valley Wildlife Management Area 1999. Columbia Basin Fish and Wildlife Compensation Program.
- Weilhoefer, C., D. Williams, I. Nguyen, K. Jakstis, and C. Fischer. 2017. The effects of reed canary grass (*Phalaris arundinacea* L.) on wetland habitat and arthropod community composition in an urban freshwater wetland. *Wetlands Ecology and Management* 25(2) 159–175
- Werner, K.J. and J.B. Zedler. 2002. How sedge meadow soils, microtopography, and vegetation respond to sedimentation. *Wetlands* 22(3):451–46

Pers. Comm

- Marc-Andre Beaucher. Area Manager, Creston Valley Wildlife Management Area. Creston B.C.
- Anna Fontana Pers. Comm. Range user. Rafter F Ranch.
- Irene Manley, pers. comm. Ministry of Forest, Lands, and Natural Resource Operations. Nelson, B.C.

6.0 Appendix

6.1 Waterfowl Brood Aging Guide.

Table 6-1. Inventory Waterfowl brood aging guide (from Gollop and Marshall 1954).

Plumage Class	Sub-Class	Description
I. Downy Young - No Feathers visible	A	"Bright ball of fluff". Down bright. Patterns distinct (except diving ducks). Body rounded; neck and tail are not prominent.
	B	"Fading ball of fluff". Down colour fading, patterns less distinct. Body still rounded; neck and tail are not yet prominent.
	C	"Gawky-downy". Down coloured and patterns faded. Neck and tail becomes prominent. Body itself becomes long and oval.
II. Partly Feathered - as viewed from the side	A	"First feathers". First feathers show on side under ideal field conditions. Stays in this class until side view shows one-half of side and flank feathered.
	B	"Mostly feathered". Side view shows one-half of side and flank feathered. Primaries break from sheaths. Stays in this class until side view shows down in one or two areas only (nape, back or upper rump).
	C	"Last down". Side view shows down in one or two areas only (nape, back or upper rump). Sheaths visible on erupted primaries through this class. Stays in this class until profile shows no down.
III. Fully Feathered – in profile		"Feathered-flightless". No down visible. Primaries completely out of sheath but not fully developed. Stays in the class until capable of flight.

6.2 Vegetation Species Lists by Habitat Type

Table 6-2. Macrophytes observed in the Shallow-water habitat of Mayook Marsh.

Form	Scientific Name	Common Name
Submergent	<i>Chara vulgaris</i>	Common Stonewort
	<i>Myriophyllum verticillatum</i>	Verticillate Water-Milfoil
	<i>Potamogeton pusillus</i>	Small Pondweed
	<i>Ranunculus aquatilis</i>	White Water-Buttercup
	<i>Utricularia sp.</i>	Bladderwort Sp.
Floating	<i>Najas flexilis</i>	Wavy Water Nymph
	<i>Lemna minor</i>	Common Duckweed
	<i>Persicaria amphibia</i>	Water Smartweed
	<i>Potamogeton natans</i>	Broad-leaved Pondweed
Emergent	<i>Hippuris vulgaris</i>	Common Mare's-tail
	<i>Schoenoplectus tabernaemontani</i>	Soft-Stemmed Bulrush

Table 6-3. Vegetation along the east dike, Mayook Marsh.

Form	Scientific Name	Common Name
Native Herbs	<i>Aralia nudicaulis</i>	Wild Sarsaparilla
	<i>Lysimachia thyrsiflora</i>	Tufted Loosestrife
	<i>Maianthemum stellatum</i>	Star-Flowered False Solomon's-Seal
	<i>Mitella nuda</i>	Common Miterwort
	<i>Galium trifidum</i>	Small Bedstraw
Exotics	<i>Cirsium vulgare</i>	Bull Thistle
	<i>Elymus condensatus</i>	Giant Wildrye
	<i>Medicago lupulina</i>	Black Medic
	<i>Phalaris arundinacea</i>	Reed Canarygrass
	<i>Ranunculus acris</i>	Meadow Buttercup
	<i>Thinopyrum intermedium</i>	Intermediate Wheat Grass
Native Shrubs	<i>Verbascum Thapsus</i>	Great Mullein
	<i>Clematis ligustifolia</i>	White Clematis
	<i>Cornus sericea</i>	Red-Osier Dogwood
	<i>Crataegus douglasii</i>	Black Hawthorn
	<i>Populus tremuloides</i>	Trembling Aspen
	<i>Ribes oxycanthoides</i>	Northern Gooseberry
	<i>Symphoricarpos occidentalis</i>	Western Snowberry

Table 6-4. Vegetation of sedge community located along Mayook Creek.

Form	Scientific Name	Common Name
Shrubs	<i>Alnus incana</i>	Speckled Alder
	<i>Salix sitchensis</i>	Stika Willow
Herbs	<i>Cicuta douglasii</i>	Douglas' Water-Hemlock
	<i>Erigeron philadelphicus</i>	Philadelphia Fleabane
	<i>Lathyrus nevadensis</i>	Purple Peavine
	<i>Petasites frigidus var sagittatus</i>	Arrow Leaved Coltsfoot
Graminoids	<i>Carex aurea</i>	Golden Sedge
	<i>Carex crawfordii</i>	Crawford's Sedge
	<i>Carex rostrata</i>	Swollen-Beaked Sedge
	<i>Carex stipata</i>	Awl-Fruited Sedge
	<i>Carex utriculata</i>	Beaked Sedge
	<i>Eleocharis palustris</i>	Common Spike-Rush
	<i>Juncus tenuis</i>	Slender Rush
	<i>Scirpus microcarpus</i>	Small-Flowered Bulrush
	<i>Schoenoplectus tabernaemontani</i>	Soft-Stemmed Bulrush
Equisetum	<i>Glyceria striata</i>	Fowl Manna Grass
	<i>Equisetum arvense</i>	Common Horsetail
	<i>Equisetum fluviatile</i>	Swamp Horsetail

Table 6-5. Vegetation associated with riparian shrub community in Mayook Marsh.

Form	Scientific Name	Common Name
Shrub	<i>Alnus incana</i>	Speckled Alder
	<i>Betula occidentalis</i>	Water Birch
	<i>Cornus sericea</i>	Red-Osier Dogwood
	<i>Cretaeus douglasii</i>	Black Hawthorn
	<i>Salix exigua</i>	Sandbar Willow
	<i>Salix bebbiana</i>	Bebbs Willow
Herb	<i>Cicuta douglasii</i>	Douglas' Water-Hemlock
	<i>Lathyrus nevadensis</i>	Purple Peavine
	<i>Petasites frigidus var sagittatus</i>	Arrow Leaved Coltsfoot
	<i>Ranunculus cymbalaria</i>	Shore Buttercup
Graminoid	<i>Veronica beccabunga</i>	American Brooklime
	<i>Calamagrostis canadensis</i>	Bluejoint Reedgrass
	<i>Carex rostrata</i>	Swollen-Beaked Sedge
	<i>Carex stipata</i>	Awl-Fruited Sedge
	<i>Carex utriculata</i>	Beaked Sedge
	<i>Equisetum arvense</i>	Common Horsetail
	<i>Glyceria striata</i>	Fowl Manna Grass
	<i>Phalaris arundinacea</i>	Reed Canarygrass
	<i>Scirpus microcarpus</i>	Small-Flowered Bulrush

Table 6-6. Vegetation associated with FI01a Water birch – Red-osier dogwood – Rose flood fringe community in Mayook Marsh.

Form	Scientific Name	Common Name
Shrub	<i>Alnus incana</i>	Speckled Alder
	<i>Betula occidentalis</i>	Water Birch
	<i>Betula papyrifera</i>	Paper Birch
	<i>Cornus sericea</i>	Red-Osier Dogwood
	<i>Cretaeus douglasii</i>	Black Hawthorn
	<i>Lonicera involucrata</i>	Black Twinberry
	<i>Populus tremuloides</i>	Quaking Aspen
	<i>Ribes oxycanthoides</i>	Northern Gooseberry
	<i>Rosa woodsia</i>	Wild Rose
	<i>Salix bebbiana</i>	Bebbs Willow
Herb	<i>Symphoricarpi occidentalis</i>	Western Snowberry
	<i>Aralia nudicaulis</i>	Wild Sarsaparilla
	<i>Lysimachia thyrsiflora</i>	Tufted Loosestrife
	<i>Maianthemum stellatum</i>	Star-Flowered False Solomon's-Seal
	<i>Cirsium vulgare</i>	Bull Thistle
	<i>Medicago lupulina</i>	Black Medic
Graminoids	<i>Ranunculus acris</i>	Meadow Buttercup
	<i>Calamagrostis canadensis</i>	Bluejoint Reedgrass
Equisetum	<i>Phalaris arundinacea</i>	Reed Canarygrass
	<i>Equisetum arvense</i>	Common Horsetail

6.3 Waterfowl brood denistyWaterfowl Survey Data.

Table 6-7. Inventory of waterfowl observed in Mayook Marsh during the waterfowl brood survey on 22 July 2020.

Species	Waypoint ^a	Adult Female (Count)	Adult Male (Count)	Adult Unknown (Count)	Brood Count	Brood Plumage Class ^b
Swans						
Trumpeter Swan (<i>Cygnus buccinator</i>)	WF1			2		
Perching Ducks						
Wood Duck (<i>Aix sponsa</i>)	WF1		1			
	WF1				1	III
	WF3	1			2	IIb
	WF5	2				
	WF6				1	III
Dabbling Ducks						
Cinnamon Teal (<i>Spatula cyanoptera</i>)	WF7				3	III
Mallard (<i>Anas Platyrhynchos</i>)	WF1	3	3			
	WF1				9	III
	WF1	1			6	Ib
	WF5	1				
	WF5	1			3	III
	WF10				1	III
Diving Ducks						
Bufflehead (<i>Bucephala albeola</i>)	WF6	1			2	IIc
	883	1			4	Ic
Common Goldeneye (<i>Bucephala clangula</i>)	WF1	1	1			
	WF2	1				
	WF4	1			2	IIc
Redhead (<i>Aythya americana</i>)	WF5	1			7	Ia
	WF8	1			8	Ic
Ring-necked Duck (<i>Aythya collaris</i>)	WF1	1				
Stiff-tailed Ducks						
Ruddy Duck (<i>Oxyura jamaicensis</i>)	WF5	1	1		4	Ia
	WF5	1				
Mergansers						
Hooded Merganser (<i>Lophodytes cucullatus</i>)	WF6				1	IIc
Grebes						
Pied-billed Grebe (<i>Podilymbus podiceps</i>)	WF1			2		
	WF5				1	IIc
	WF5			2	3	Ib
	WF5			1		
	883				1	IIc
Coots						
American Coot (<i>Fulica americana</i>)	WF1			2	5	Ic
	WF1			5		
	WF5			4		
	WF7			2	7	Ic
	WF8			2	2	Ic

^a See Figure 3-2 for the location of waterfowl brood survey stations.

^b See Appendix 6.1 on waterfowl brood aging guide.

6.4 Fish Survey Data

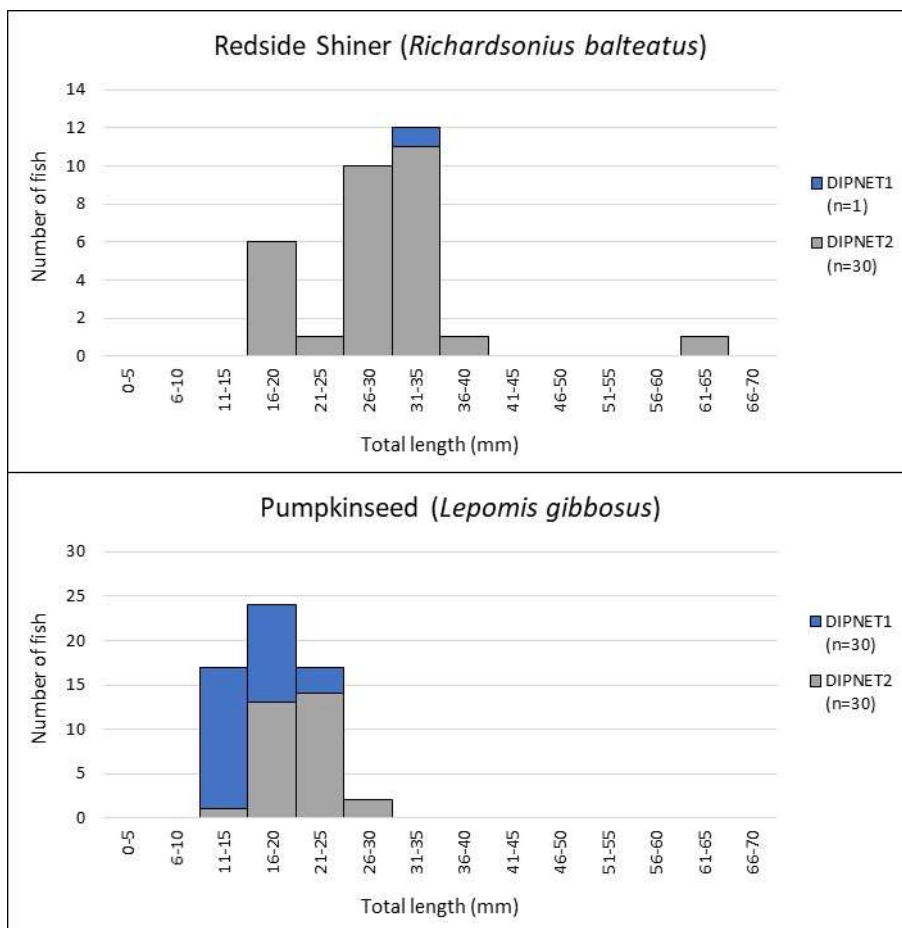


Figure 6-1. Fork length of Redside Shiner (*Richardsonius balteatus*) and Pumpkinseed (*Lepomis gibbosus*) captured with a dipnet in Mayook Marsh.

6.5 Amphibian, Reptile, And Turtle Observations

Table 6-8. Amphibian, Reptile, And Turtle observations in Mayook Marsh, 2020

Date	Species Code	Count	Stage	UTM Easting	UTM Northing	Comment
2020-06-09	CHPI	1	Adult	603854	5485993	Basking on log
2020-06-09	CHPI	1	Adult	603904	5485526	Basking on log
2020-07-23	CHPI	1	Adult	604222	5485416	On log in small pond to the east of the Mayook Marsh.
2020-07-23	CHPI	1	Adult	603831	5485647	Surface
2020-07-23	CHPI	1	Adult	604128	5485530	Surface
2020-07-23	CHPI	1	Adult	604012	5485368	Surface
2020-07-23	CHPI	2	Nest	604173	5485646	Old nest along the edge of the North dike.
2020-07-23	CHPI	2	Adult	603845	5485774	Surface
2020-07-23	CHPI	6	Nest	603513	5485780	Old nests above the sedge meadow on embankment
2020-07-23	CHPI	40	Adult	604164	5485536	Basking on veg. Counted by Steven R.
2020-07-23	RALU	1	Adult	603573	5485764	Along Mayook Creek
2020-09-02	CHPI	2	Adult	604161	5485401	Basking on log
2020-10-01	CHPI	3	Adult	604118	5485342	Basking on log
2020-10-01	RALU	3	Juvenile	603586	5485799	Small Pond
2020-10-01	RALU	15	Juvenile	603575	5485746	Along Mayook Creek
2020-10-01	THSI	1	Adult	603878	5486102	On Road
2020-10-15	CHPI	12	Adult	603814	5486010	Basking in pond near datalogger

* CHPI: Western Painted Turtle; RALU: Columbia Spotted Frog; THSI: Common Red-Sided Garter Snake

6.6 Incidental wildlife observations from Mayook Marsh

Table 6-9. All wildlife species observed incidentally and during surveys in Mayook Marsh, 2020.

Species	Habitat	B.C. List ^a	COSEWIC ^b
BIRDS			
Waterfowl			
Gadwall (<i>Mareca strepera</i>)	Marsh	Yellow	N/A
Lesser Scaup (<i>Aythya affinis</i>)	Marsh	Yellow	N/A
Grebes			
Mourning Dove (<i>Zenaida macroura</i>)	Grass Meadow	Yellow	N/A
Goatsuckers			
Common Nighthawk (<i>Chordeiles minor</i>)	Flyover	Yellow	Special Concern
Sandpipers			
Greater Yellowlegs (<i>Tringa melanoleuca</i>)	Marsh	Yellow	N/A
Rails			
Sora (<i>Porzana Carolina</i>)	Marsh	Yellow	N/A
Hérons			
Great Blue Heron (<i>Ardea Herodias</i>)	Marsh	Blue	N/A
New World Vultures			
Turkey Vulture (<i>Cathartes aura</i>)	Flyover	Yellow	N/A
Hawks and Eagles			
American Kestrel (<i>Falco sparverius</i>)	Flyover	Yellow	Not at Risk
Bald Eagle (<i>Haliaeetus leucocephalus</i>)	Flyover	Yellow	Not at Risk
Northern Harrier (<i>Circus hudsonius</i>)	Marsh	Yellow	Not at Risk
Red-tailed Hawk (<i>Buteo jamaicensis</i>)	Flyover	Yellow	Not at Risk
Woodpeckers			
Lewis's Woodpecker (<i>Melanerpes lewis</i>)	Aspen snags	Blue	Threatened
Northern Flicker (<i>Colaptes auratus</i>)	Not recorded	Yellow	N/A
Red-naped Sapsucker (<i>Sphyrapicus nuchalis</i>)	Upland Coniferous	Yellow	N/A
Tyrant Flycatchers			
Western Wood-Pewee (<i>Contopus sordidulus</i>)	Upland Coniferous	Yellow	N/A
Willow Flycatcher (<i>Empidonax traillii</i>)	Marsh	Yellow	N/A
Least Flycatcher (<i>Empidonax minimus</i>)	Broadleaf Riparian	Yellow	N/A
Eastern Kingbird (<i>Tyrannus tyrannus</i>)	Marsh	Yellow	N/A
Vireos			
Red-eyed Vireo (<i>Vireo olivaceus</i>)	Broadleaf Riparian	Yellow	N/A

Species	Habitat	B.C. List ^a	COSEWIC ^b
Warbling Vireo (<i>Vireo gilvus</i>)	Broadleaf Riparian	Yellow	N/A
Kinglets			
Ruby-crowned Kinglet (<i>Regulus calendula</i>)	Not recorded	Yellow	N/A
Swallows			
Bank Swallow (<i>Riparia riparia</i>)	Marsh	Yellow	Threatened
Northern Rough-winged Swallow (<i>Stelgidopteryx serripennis</i>)	Marsh	Yellow	N/A
Chickadees			
Black-capped Chickadee (<i>Poecile atricapillus</i>)	Broadleaf Riparian	Yellow	N/A
Nuthatches			
Red-breasted Nuthatch (<i>Sitta canadensis</i>)	Open Forest	Yellow	N/A
Wrens			
House Wren (<i>Troglodytes aedon</i>)	Not recorded	Yellow	N/A
Marsh Wren (<i>Cistothorus palustris</i>)	Marsh	Yellow	N/A
Thrushes			
American Robin (<i>Turdus migratorius</i>)	Upland Coniferous	Yellow	N/A
Swainson's Thrush (<i>Catharus ustulatus</i>)	Broadleaf Riparian	Yellow	N/A
Mimids			
Gray Catbird (<i>Dumetella carolinensis</i>)	Upland Coniferous	Yellow	N/A
Waxwings			
Cedar Waxwing (<i>Bombicilla cedrorum</i>)	Broadleaf Riparian	Yellow	N/A
Finches			
Cassin's Finch (<i>Haemorhous cassinii</i>)	Upland Coniferous	Yellow	N/A
Red Crossbill (<i>Loxia curvirostra</i>)	Upland Coniferous	Yellow	N/A
American Goldfinch (<i>Spinus tristis</i>)	Upland Coniferous	Yellow	N/A
Pine Siskin (<i>Spinus pinus</i>)	Upland Coniferous	Yellow	N/A
Wood-Warblers			
American Redstart (<i>Setophaga ruticilla</i>)	Broadleaf Riparian	Yellow	N/A
Common Yellowthroat (<i>Geothlypis trichas</i>)	Marsh	Yellow	N/A
Northern Waterthrush (<i>Parus noveboracensis</i>)	Marsh	Yellow	N/A
Magnolia Warbler (<i>Setophaga magnolia</i>)	Not recorded	Yellow	N/A
Yellow Warbler (<i>Setophaga petechia</i>)	Broadleaf Riparian	Yellow	N/A
Emberizine Sparrows			
Chipping Sparrow (<i>Spizella passerina</i>)	Upland Coniferous	Yellow	N/A

Species	Habitat	B.C. List ^a	COSEWIC ^b
Clay-coloured Sparrow (<i>Spizella pallida</i>)	Grass Meadow	Yellow	N/A
Vesper Sparrow (<i>Poocetes gramineus</i>)	Upland Coniferous	Yellow	N/A
Song Sparrow (<i>Melospiza melodia</i>)	Marsh	Yellow	N/A
Savannah Sparrow (<i>Passerculus sandwichensis</i>)	Meadow	Yellow	N/A
Spotted Towhee (<i>Pipilo maculatus</i>)	Not recorded	Yellow	N/A
Blackbirds			
American Crow (<i>Corvus brachyrhynchos</i>)	Flyover	Yellow	N/A
Common Raven (<i>Corvus corax</i>)	Flyover	Yellow	N/A
Western Meadowlark (<i>Sturnella neglecta</i>)	Marsh	Yellow	N/A
Bullock's Oriole (<i>Icterus bullock</i>)	Not recorded	Yellow	N/A
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	Marsh	Yellow	N/A
Yellow-headed Blackbird (<i>Xanthocephalus xanthocephalus</i>)	Marsh	Yellow	N/A
Brown-headed Cowbird (<i>Molothrus ater</i>)	Grass Meadow	Yellow	N/A
Grouse			
Ruffed Grouse (<i>Bonasa umbellus</i>)	Forest	Yellow	N/A
Cardinals/Grosbeaks			
Black-headed Grosbeak (<i>Pheucticus melanocephalus</i>)	Not recorded	Yellow	N/A
Starlings			
European Starling (<i>Sturnus vulgaris</i>)	Not recorded	Yellow	N/A

Species	Habitat	B.C. List ^a	COSEWIC ^b
MAMMALS			
Ungulate			
American Elk (<i>Cervus canadensis</i>)	Marsh/Meadow	Yellow	N/A
Sciurids			
Yellow-pine Chipmunk (<i>Neotamias amoenus</i>)	Upland Coniferous	Yellow	N/A
Red Squirrel (<i>Tamiasciurus hudsonicus</i>)	Upland Coniferous	Yellow	N/A

Turtles			
Western Painted Turtle (<i>Chrysemys picta</i>)	Marsh	Blue	Special Concern
Reptiles			
Common Red-sided Garter Snake (<i>Thamnophis sirtalis</i>)	Dike	Yellow	N/A

Species	Habitat	BC List ^a	COSEWIC ^b
Invertebrates			
Variegated Meadowhawk (<i>Sympetrum corruptum</i>)	Marsh	Yellow	N/A
Dreamy Dusty Wing (<i>Erynnis icelus</i>)	Marsh	Yellow	N/A
Common Ringlet (<i>Coenonympha californica</i>)	Marsh	Blue	N/A
Four-Spotted Skimmer (<i>Libellula quadrimaculata</i>)	Marsh/Shallow-waters	Yellow	N/A
Canadian Swallowtail (<i>Papilio canadensis</i>)	Marsh/Meadow	Yellow	N/A
Large Marble (<i>Euchloe ausonides</i>)	Marsh/Meadow	Yellow	N/A
Digger Bee (<i>Anthophora</i> sp.)	Open Forest	N/A	N/A