Enhancing Waterfowl Nesting Opportunities in the Parsnip Arm

Fish and Wildlife Compensation Program

Blackbird Environmental Ltd.

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Executive Summary

During the fall of 2020, Blackbird Environmental Ltd. (Blackbird) completed usage assessments and maintenance activities on artificial nesting structures aimed to enhance waterfowl habitat within the Fish and Wildlife Compensation Program's (FWCP's) Parsnip Arm sub-region of the Williston reservoir. These structures were initially installed in the early 1990s as part of the Peace/Williston Fish & Wildlife Compensation Program. Target waterfowl species within the region include common and Barrow's goldeneye (*Bucephala clangula, Bucephala islandica*), common and hooded merganser (*Mergus merganser, Lophodytes cucullatus*), bufflehead (*Bucephala albeola*), Canada goose (*Branta canadensis*), common loon (*Gavia immer*), and mallard (*Anas platyrhynchos*).

The subject project was completed under the guidance of the FWCP's 2014 Peace Region Action Plans. Specifically, the project has been completed under the Peace Basin Riparian and Wetlands Action Plan Objective 2 and Priority Action 2b-2:

- Objective 2: Conserve or enhance the ecological integrity of riparian and wetland ecosystems,
- Sub-objective 2b-2: Install artificial nesting or roost structures for wildlife species (FWCP 2014a).

Blackbird inspected 74 artificial nesting structures as part of this program, which included floating islands, nest boxes, nesting tunnels, and a floating log.

Fifty-three nest boxes were historically installed, of those, fifty were successfully maintained during 2020 maintenance. Fifty-six percent of nest boxes were deemed functional at the time of the inspection. Of the total nest boxes, only 51 % showed signs of use by waterfowl. However, of the functional nest boxes, 89 % were used specifically by waterfowl and this number increases to 93 % when considering use by all wildlife. Thirteen new nest boxes were deployed as replacements for historic nest boxes in poor condition. Two nest boxes are recommended to be removed from the monitoring program due to low historical use and maintenance feasibility.

In addition, Blackbird attempted to locate 17 floating islands that were previously installed within the project area. 15 islands could be located, five of which showed obvious sign of use by wildlife (i.e., 33 %). Eleven floating islands with signs of significant deterioration were removed, ten of which were replaced with a novel floating island design. The remaining four floating islands were found to be structurally and functionally sound and were left in place.

Additional nesting structure maintenance and monitoring occurred on one floating log and three nesting tunnels.

This report provides a summary of the wildlife use observations at these artificial nesting structures, an overview of maintenance activities performed, as well as specific recommendations for the design and implementation of future maintenance and follow-up programs.

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Revision No.	Date	Reason/Type of Revision
Rev. 0	February 4, 2021	Final report issued

1 Introduction

The Fish and Wildlife Compensation Program (FWCP), a partnership between the BC Hydro and Power Authority (BC Hydro), the Province of BC, Fisheries and Oceans Canada, First Nations, and Public Stakeholders provides annual funding to projects aimed at conserving and enhancing fish and wildlife in watersheds impacted by exiting BC Hydro dams.

Under the FWCP's Peace Region Action Plans, waterfowl habitat in the FWCP's Parsnip Arm sub-region watershed has successfully been augmented for 30 years. Between 1991 and 1998, FWCP-Peace staff completed inventory and assessment studies of several wetlands along the southern reach of Williston Reservoir and installed a total of 74 enhancement structures at 17 distinct sites (Corbould 1991, Corbould 1991a, Corbould 1992, Corbould 1993, Jeulfs and Corbould 2008). Structures include floating islands to provide additional habitat for nesting and loafing, nest boxes to provide nesting sites for cavity nesting species, nesting tunnels to provide secure ground nesting habitat, and floating logs to provide stationary loafing or resting areas (Clark 2000, Martin 1992).

Following the installation of the artificial nesting structures, maintenance, monitoring, and replacement activities took place between 1991 and 2011; however, not all years were well documented (Ecofor 2015). In 2008, a report summarized the use and maintenance of nesting structures from 1992-2006 (Juelfs and Corbould 2008). This report found that overall, the nesting structure program was successful and made several site-specific recommendations.

In 2014, Ecofor Consulting Ltd. (Ecofor) received FWCP grant funding to maintain artificial nesting structures in the Parsnip Arm and assess their utilization by target species, which resulted in a comprehensive project report detailing structure conditions and recommendations for the next maintenance program (Ecofor 2015).

The subject report provides a summary of Blackbird Environmental Ltd.'s (Blackbird's) 2020 usage assessments, conducted maintenance and repairs, removals, and replacements of the 74 historically installed waterfowl enhancement structures.

2 Goals and Objectives

The subject project was completed under the FWCP's 2014 Peace Region Action Plans. Specifically, the project has been completed under the Peace Basin Riparian and Wetlands Action Plan Objective 2 and Priority Action 2b-2:

- Objective 2: Conserve or enhance the ecological integrity of riparian and wetland ecosystems,
- Priority Action 2b-2: Install artificial nesting or roost structures for wildlife species (FWCP 2014a).

Suitable nesting and roosting habitat for waterfowl species is limited in the Parsnip Arm, as illustrated by high historic utilization rates of the artificial nesting structures.

We designed this project to enhance nesting opportunities and increase the reproductive success of waterfowl in the watershed by conducting maintenance of artificial nesting structures established in riparian and wetland areas throughout the FWCP's Parsnip Arm sub-region. Through this project, we aimed to accomplish the following habitat enhancement goals and objectives:

- enhance the number and availability of suitable nesting sites for cavity and island-nesting waterfowl (e.g., bufflehead, merganser spp., goldeneye spp., Canada geese) within the Parsnip Arm, and ultimately
- increase waterfowl presence and population sizes.

3 Study Area

This project took place within the Parsnip sub-region of the FWCP's Peace Region.

More specifically, the project area included 16 enhancement sites at wetlands, lakes, and rivers within the Parsnip Arm of the Williston Reservoir watershed (see Appendix C, Figure 1). One historical site (i.e., Tutu B) is no longer included in the program.

Eight sites are located along the Highway 97 corridor, including Neilson Lake, Old Mill Pond, Tudyah North, Crooked River # 1 and # 2, Kerry Lake, 42 Mile Marsh, and Misinchinka. In addition, six sites are located on the east side of the Williston Reservoir near Mackenzie, BC: Rocky Marsh, Mugaha A and B (Mugaha Bay), Mugaha G, Tutu Bay, and Dina Lake. Finally, two enhancement sites are located on the west side of the Williston Reservoir (i.e., 60 Km Marsh and Robert's Pond).

4 Methods

Fieldwork was scheduled based on the identified breeding bird window for the Parsnip region (ECCC 2018) to avoid any disturbances to nesting wildlife and to ensure structure availability during the 2021 avian breeding season. Initial scouting to assess the condition and integrity of the floating islands occurred in late August, while maintenance activities occurred on all structures between September 14 and October 18 and on November 5, 2020.

A Blackbird field crew led by a qualified environmental professional registered with the BC College of Applied Biology travelled to the identified enhancement sites with land monitors from McLeod Lake Indian Band. Enhancement sites and nesting structures were located using a Global Positioning System unit and accessed on foot, via vehicle, or by boat.

Maintenance visits included an assessment of wildlife use, structure condition, and site suitability.

4.1 Nest Boxes

Between September 14 and November 5, 2020, we completed maintenance activities and usage assessments on a total of 53 accessible nest boxes. Nest box maintenance included the removal of old nesting material and old wood shavings, the addition of new shavings, as well as minor repairs to boxes where required. Most damaged boxes were replaced if they were beyond repair; however, some were not replaced due to environmental conditions or based on the discretion of the qualified environmental professional. Project activities also included minor vegetation maintenance where branches could potentially infringe on flight paths to nest boxes.

Usage assessments classified wildlife to species or taxonomic groups, as much as feasible, based on feathers, eggs, eggshells, droppings, and other signs (e.g., food caches).

Where nest boxes required replacement and the previous location was unavailable (e.g., where trees had fallen over), new box locations were selected based on habitat requirements for cavity nesting waterfowl and to ensure box longevity, in accordance with DUC recommendations (DUC 2008, DUC date unknown). We preferentially selected live, healthy deciduous trees (e.g., trembling aspen, balsam poplar, or white birch) within 50 m of the water's edge and with minimal undergrowth for box placement as these sites offer minimal flight path obstructions and minimal risk for fledging ducklings (Martin 1992). Boxes were placed no closer than 100 m together to avoid concerns of crowding, given that nesting barrow's goldeneye and buffleheads can be highly territorial (Gauthier and Smith 1987, Savard 1985). We installed replacement nest boxes with the entrance hole facing the water and located approximately 2.5 m above the ground (DUC 2008). Where deciduous trees were unavailable, conifer trees lacking low branches and with limited undergrowth were used for box placement. In some instances, we removed lower and/or overhanging branches to enable suitable access and egress for nesting ducks.

We utilized DUC duck box designs for this project (DUC date unknown). New pressure-treated lumber was used for the nest boxes, with construction of the boxes occurring away from the deployment locations to avoid releasing treated sawdust to the natural environment (Lebow and Tippie 2001, Government of Canada 2019). A wood screw was used to close the right-side cleanout access door, rather than a pin and wire, to improve box security (please note: a # 2 Robertson screw bit will be required for conducting future box maintenance). As cavity-nesting waterfowl do not carry nesting material with them, the boxes were lined with 10 to 15 cm of fresh softwood shavings to serve as nesting material (DUC date unknown; DUC 2008).

We attached the boxes to mounting trees using two structural screws: one at the top and one at the bottom. As predator guards had not been installed below nest boxes regionally in the past, predator guards were similarly not installed beneath the newly installed boxes (Blackbird, personal observation).

The per-box cost to construct and install the nest boxes based on the DUC design was approximately $25 excluding labour and tools. However, please note that the cost per nest box is based on the material market prices encountered at the time of purchase. For the complete cost breakdown, please refer to Appendix D.

4.2 Floating Islands

We conducted preliminary scouting of the floating islands in late August 2020 (prior to maintenance fieldwork) to assess access and site logistics for islands removal, where required. Fieldwork and maintenance activities took place in two phases: the initial phase (September) involved collecting wildlife use data and removing floating islands, and the second phase (October) involved the deployment of new floating islands.

Maintenance activities for floating islands were focused on the removal and disposal of non-functional historic islands, as well as their subsequent replacement where further waterfowl habitat enhancement was deemed appropriate. We removed islands that were found to be insufficiently buoyant/waterlogged and/or damaged beyond repair. Islands that passed the initial integrity assessments were left in place with no additional maintenance activities outside of repairs to the anchoring system. Following removal of the non-functional historic islands, they were replaced with a new floating island design.

Usage assessments of floating islands were focused on obvious signs of waterfowl presence (e.g., feathers, droppings, trampling). We focused on general observations; wildlife use of the floating islands was not generally classified to the species level.

Where island removal was required, the entire island structure was removed except for the anchoring system. The original anchor structures had become embedded in the waterbody substrates making initial removal efforts unsuccessful and potentially unsafe. As a result, we cut the floating islands from their anchoring cables using an angle grinder and then pulled them to shore where they were carefully disassembled and transported to the Mackenzie Regional Landfill/Recycling Centre for disposal. As severe flotation foam degradation had occurred around many of the historic islands, we used dip nets to retrieve and dispose of as much Styrofoam as possible during the island removal.

Based on the results of our scouting efforts, we developed a novel design for the replacement floating islands to enable the continued provision of functional loafing and/or nesting habitat for waterfowl. The novel design is intended to provide enhanced longevity with minimal risks of potential detrimental environmental impacts.

Buoyancy for each island is provided by a manufactured dock float. The dock floats included a wood board along two top edges to serve as mounting points, with the floatation foam and the board encapsulated in high density polyethylene to provide longevity and prevent foam degradation and dispersion into the surrounding environment.

An aluminum punch plate, with sanded edges and corners to reduce any risk of wildlife injury, was wrapped in heavy-duty woven coconut matting and bolted to the top of the float. The coconut matting is intended to thermally decouple the surface of the platform from the aluminum sheet, reduce the platform's shine, provide traction for wildlife, retain supplemental platform substrate, and provide footing for any future vegetative cover. The aluminum sheet, as it extends beyond the underlying float, arches into the water on either side to improve waterfowl access and moisture wicking. If required, the sheet ends were further hand-bent during island deployment to ensure they rested below the water level on either side.

We attached eye bolts to opposite corners of the wooden support frame of each island for anchoring and used aviation-grade stainless steel cable to attach the eye bolts to concrete anchors. The cable was measured and cut on-site to ensure it was of an adequate length for each island's deployment location and to take into consideration the anticipated seasonal water level fluctuations.

At each deployment location, we sourced local materials (soil, organic material, and vegetative matter) and placed in on the top of the island to allow for vegetation establishment in future growing seasons.

The floating islands are intended for all regional shoreline and island-nesting waterfowl including Canada goose (*Branta canadensis*) and, as island vegetation becomes established and provides cover, common loons (*Gavia immer*) and mallards (*Anas platyrhynchos*). The islands may also be used by all roosting waterfowl and by additional resting aquatic wildlife (e.g., beavers, muskrats, river otters, etc.).

The per-island cost for materials to construct the islands and anchoring system was approximately $900, excluding labour and final transportation costs. Please note that the cost per island and anchoring system is based on the market prices encountered at the time of purchase. Refer to Appendix D for the complete cost breakdown.

4.3 Additional Structures

Maintenance activities for nesting tunnels included removing the wire mesh tunnel, thus allowing the remaining support structure to act as a perching platform (see Appendix A, Photo 3). Tunnels were removed using a cordless angle grinder, and the sides of the remaining metal were bent down near the edges to eliminate potential harm to wildlife.

Floating log maintenance included an assessment of use, noting any obvious signs of use by waterfowl (e.g., droppings or feathers).

4.4 Community and First Nations Participation

Due to COVID-19 and both provincial and federal social distancing guidelines, Blackbird's community engagement, education, and outreach initiatives were adapted to ensure the health and safety of both staff and participants.

Environmental community groups in the Mackenzie area were contacted to determine their interest and availability in volunteering to assist with the field program.

Local First Nations who had expressed an interested in participating in the field program were contacted to determine availability for joining Blackbird's field crew during nesting structure maintenance. McLeod Lake Indian Band provided two members to participate in the field program.

A final copy of this report will be provided to each of the First Nations communities who had requested a copy during the initial Notice of Intent discussions.

5 Results and Outcomes

Waterfowl nesting structure maintenance took place between September 14 and November 5, 2020. Maintenance and usage assessments were performed on a total of 74 artificial nesting structures, including, nest boxes, floating islands, nesting tunnels, and floating logs.

McLeod Lake Indian Band provided two land monitors to participate in the field program.

Local community groups were unable to participate during the maintenance program due to the COVID-19 pandemic.

5.1 Nest Boxes

Within the FWCP's Parsnip sub-region, cavity-nesting waterfowl may include common and Barrow's goldeneye (*Bucephala clangula, Bucephala islandica*), common and hooded merganser (*Mergus merganser, Lophodytes cucullatus*), and bufflehead (*Bucephala albeola*) (Cornell University 2019). Cavity-nesting waterfowl are unable to excavate their own tree cavities; they are considered among the secondary cavity users, making use of existing tree cavities (e.g., previously created by woodpeckers, through natural branch break-off, lightning strikes, etc.) for nesting or roosting (Fenger et al. 2006).

Ducks are receptive to using artificial cavities and nest boxes can be used as an effective means to supplement waterfowl habitat, when lacking, provided the features receive regular maintenance (Fenger et al. 2006, DUC 2008, DUC date unknown). This historic waterfowl nesting habitat enhancement program implemented within the FWCP's Parsnip Arm sub-region has shown nest boxes provide viable waterfowl nesting habitat (Ecofor 2015, Juelfs and Corbould 2008).

We monitored and maintained 50 nest boxes out of a total of 53 between all sites in the FWCP's Parsnip sub-region. Field assessments determined that only 56 % of the monitored nest boxes were functional during 2020 maintenance.

Usage assessments determined that of the total nest boxes, 51 % showed signs of use by waterfowl. However, of the functional nest boxes, 89 % were used specifically by waterfowl; this number increases to 93 % when considering use by all wildlife (see Table 1).

We installed a total of thirteen replacement boxes, based on the recommendations made from the last round of maintenance activities and the discretion of the qualified professional completing the field assessment (Ecofor 2015).

Three of the nest boxes were not monitored or maintained and, as such, were excluded from the nest box function and use analyses. We were unable to assess one of two nest boxes at Robert's Pond due its height of installation. Similarly, we were unable to access two of the six boxes at Kerry Lake due to fall ice-up on the lake, which restricted safe access.

On average, nest box users in the Parsnip Arm consisted of 70 % waterfowl with the remaining 30 % consisting of other wildlife species (Table 2).

Table 1: Nest Box Status Summary

		Nest Box Status		
Location	**Monitored**	**Functional**	**Waterfowl Use**	**Wildlife Use**
Crooked River	4	3	3	3
Dina Lake	8	4	4	4
Kerry Lake[1]	4	2	2	2
Mugaha Bay	6	0	0	0
Neilson Lake	5	3	3	3
Old Mill Pond	3	1	1	1
Rocky Marsh	6	5	3	4
Tudyah North	3	3	2	2
Tutu Bay	4	3	3	3
42 Mile Marsh	2	1	1	1
Robert's Pond[1]	1	0	0	0
60 km Marsh	4	3	3	3
Total	50	28 (56 % of monitored)	25 (89 % of functional)	26 (93 % of functional)

[1] Three nest boxes were not assessed during 2020 maintenance. Only the monitored nest boxes were included in the nest box status and wildlife use analysis.

Where boxes were found to be in a poor condition, it was typically due to the box having poor structural integrity (e.g., detached nails, warping, or minor rot) or significant undergrowth restricting flight access/egress. We completed maintenance activities to improve boxes' structural integrity if necessary (e.g., added reinforcement screws) and completed minor vegetation management at nest box sites where required, to ensure a clear flight path for potential users.

On occasion, a nest box condition was found to be poor due to excessive beaver activity on the nest box mounting tree (notably, to trees at the Crooked River site). Nest box trees at Crooked River are predicted to not last more than five years, and nest boxes at this site should be considered for relocation or tree protection measures. Where beaver activity put the midterm viability of a nest box at risk, future monitoring/replacement recommendations were made but the box was not replaced. Please refer to Section 7.2 and Appendix B for site specific maintenance recommendations for nest boxes observed to be in poor condition.

Nest boxes that were not functional were often located on fallen trees. We noticed significant damage to lodgepole pine due to mountain pine beetle kill at Mugaha Bay. At this site, three out of six boxes were located on fallen trees. Boxes attached to fallen trees were of poor structural integrity (e.g., fallen apart or wet/rotten) and were not suitable for relocation. Site specific maintenance recommendations are provided in Appendix B.

Table 2: Wildlife Use of Functional Nest Boxes within the Parsnip Arm (in %)

		Waterfowl Use					Non-Waterfowl Use		
Location	**n**	**BUFF**[2]	**COGO**[3]	**COME**[4]	**HOME**[5]	**unknown**	**NOFL**[6]	**m-TAHU**[7]	**other**[8]
Crooked River	3	1	2	0	1	0	0	0	0
Dina Lake	4	2	1	0	0	1	0	0	0
Kerry Lake[1]	2	0	0	2	0	0	1	1	0
Mugaha Bay	0	0	0	0	0	0	0	0	0
Neilson Lake	3	1	1	1	0	0	0	1	0
Old Mill Pond	1	0	0	1	0	0	0	1	1
Rocky Marsh	5	2	0	0	1	0	1	2	0
Tudyah North	3	1	1	1	0	0	0	1	0
Tutu Bay	3	0	2	1	0	0	0	1	0
42 Mile Marsh	1	0	0	0	0	1	0	0	1
Robert's Pond[1]	0	0	0	0	0	0	0	0	0
60 km Marsh	3	2	3	0	0	0	0	1	0
Total		9 (22 %)	10 (24 %)	6 (15 %)	2 (5 %)	2 (5 %)	2 (5 %)	8 (20 %)	2 (5 %)

[1] Three nest boxes were not assessed during 2020 maintenance. Only the monitored nest boxes were included in the nest box status and wildlife use analysis.
[2] Bufflehead (*Bucephala albeola).*
[3] Barrow's goldeneye (*Bucephala islandica*) and/or common goldeneye (*Bucephala clangula*).
[4] Common mergansers (*Mergus merganser*).
[5] Hooded merganser (*Lophodytes cucullatus*).
[6] Northern flicker (*Colaptes auratus*).
[7] Red squirrel (*Tamiasciurus hudsonicus*) and/or northern flying squirrel (*Glaucomys sabrinus*).
[8] "Other" non-waterfowl wildlife include passerines and unknown non-waterfowl species.

Please note that the reported nest box use data is representative of utilization by several species over multiple years (up to six), as the last maintenance was completed in 2014. Values in Tables 1 and 2 do not necessarily equal the sum of individual species because multiple species may have used the same nest box over the given time period. Please note that the fact that we may have not detected sign of any particular species at a site does not support the conclusion that the species does not utilize the nesting structure.

5.2 Floating Islands

Floating islands (also known as artificial nesting islands) have been used historically to provide shoreline and island-nesting waterfowl with nesting habitat to reduce mammalian predation risk, reduce the impacts of flooding where water levels fluctuate regularly, and/or to supplement habitat where natural islands are sparse (Brenner and Mondok 1979, Desorbo et al. 2006, Maggiulli and Dugger 2011, Maxson and Riggs 1996). Floating islands within the FWCP Parsnip sub-region and throughout BC have historically been used mainly as loafing sites and have seen high use by Canada geese (*Branta canadensis*; Harrison, B. 2019. Personal Communication. October 24, 2019).

Preliminary scouting results indicated that four floating islands were in better structural condition than initially anticipated. As a result, two out of three floating islands at Rocky Marsh and one island at Tudyah North were left in place. Similarly, one island at Dina Lake (D1-Isl-2014) was in good condition; however, it had become detached from its original anchoring system and had floated to a nearby shore. Field crews towed the island to a more desirable location and attached it to newly installed cables and anchors (see Appendix A, Photo 6). A summary of the floating island maintenance activities has been provided in Table 3. Please note that Table 3 outlines the maintenance completed on the historic floating islands, see Appendix B for the locations of the new floating islands.

Table 3: Summary of Floating Island Maintenance Activities Completed at Historic Locations

Site	Island ID	Maintenance Summary
Dina Lake	Disl1-2014	removed in 2011, replaced in 2020
	Disl2-2014	replaced
	DI-Isl-20114	left in place, anchoring system fixed
Old Mill Pond	Mill-I-2014	removed and replaced
Misinchinka	Mis1-Isl-2020	replaced
Mugaha Bay	Mug-i1-2014	removed and replaced
	Mug-i2-2014	removed and replaced
	Mug-i3-2014	removed and replaced
Mugaha G	MugG-i-2014	removed
Neilson Lake	Nisl1-2014	removed
	Nisl2-2014	removed and replaced
	Nisl3-2014	removed
Rocky Marsh	Rock-I1-2014	left in place
	Rock-I2-2014	removed and replaced
	Rock-I3-2014	left in place
Tudyah North	Tudi-2014	left in place
Tutu Bay	Tutu-i-2014	removed
60 Km Marsh	60kmi-2014	removed and replaced

At Mugaha G and Tutu Bay, we removed and did not replace the floating islands based on a variety of factors. Mugaha G is directly connected to the Williston Reservoir and initial scouting assessments concluded that regularly fluctuating water levels likely significantly reduce the lifespan of the floating islands, due to excessive wear on the subframe and anchoring system. The historic island from this site showed no evidence of use by waterfowl. A new floating island was not deployed at Tutu Bay based on the previous maintenance recommendations to remove and not replace (Ecofor 2015), paired with no evidence or signs of use during the 2020 assessment.

At Neilson Lake, we removed three floating islands and only replaced one. During the initial site visit, we noted that an abundance of naturally vegetated islands surrounding the open waterbody. These natural islands showed extensive evidence of waterfowl use, primarily by Canada Geese (i.e., feathers and droppings). Due to the observed availability of natural nesting, roosting, and loafing habitat at Neilson Lake, only one new floating island was deployed.

We were unable to locate two floating islands (Disl-2-2014, located in Dina Lake, and Mis1-Isl-2020, located in Misinchinka) during preliminary scouting. Field crews searched the respective waterbodies extensively using watercrafts and UAVs but deemed the islands irretrievable. These structures could be missing due to excessive water logging (resulting in sunken islands) or may have become detached from their anchoring systems and drifted away. Both islands were replaced with new floating islands in similar locations.

Floating islands identified for removal following the preliminary scouting often had Styrofoam exposed on the top and sides or floating in the water nearby (see Appendix A, Photo 5). Islands of poor structural integrity were also frequently severely water-logged or detached from anchoring systems.

The deployed islands were of new construction, as detailed in the project methods, and were double anchored. At each deployment location, we sourced local materials (soil, organic material, and vegetative matter) and placed in on the top of the islands to allow for vegetation establishment in future growing seasons.

Of the floating islands, 33 % showed obvious signs of wildlife use, including droppings, feathers, signs of trampling, and visual observations. Note that floating islands that could not be located (i.e., Mis1-Isl-2020 and Disl-2-2014) were not included in the analysis.

Table 4: Summary of Floating Island Use by Wildlife

Location	Monitored	Sign of Use
Dina Lake	1	0
Old Mill Pond	1	1
Mugaha Bay	3	0
Mugaha G	1	0
Neilson Lake	3	2
Rocky Marsh	3	1
Tudyah North	1	1
Tutu Bay	1	0
60 Km Marsh	1	0
Total	15	5 (33 %)

Heavily vegetated floating islands generally showed few signs of wildlife use, while the most significant signs of use were observed on islands with less dense vegetative growth (i.e., the islands at Neilson Lake and Old Mill Pond). Floating islands which showed the most use were also generally the islands in the worst structural condition, requiring removal and replacement. Notable, the island at Old Mill Pond showed the most use, with soil exposed and minimal vegetation present.

During preliminary scouting at Tudyah North on July 29, 2020, we installed a remote camera on the floating island as part of a reconnaissance survey to gain a better understanding of species use of the island. This island was characterized by heavy vegetative growth including alder and grass species (see Photo 8). During the twelve-week monitoring period, species using the island included goldeneye spp. (either *Bucephala clangula* or *Bucephala islandica*), wood duck (*Aix sponsa*), beaver (*Castor canadensis*), and river otter (*Lontra canadensis*).

5.3 Nesting Tunnels and Floating Log

Three nesting tunnels were installed at Rocky Marsh in 1999 to provide additional nesting habitat to ground-nesting waterfowl (e.g., mallards [*Anas platyrhynchos*]). We could only locate two of these structures during preliminary field scouting. These two located tunnels and their nesting materials were heavily weathered and showed no signs of use. Based on previous recommendations by Ecofor (2015) and the high maintenance frequency required for the tunnels to provide adequate habitat (i.e., annual straw placement prior to the breeding season), we converted the two located tunnels (Rock-t2-2014 and RT-3-2014) to perching platforms (see Table 5). The third nesting tunnel (RT-T1-2014) was presumed to have fallen or been removed and it was not replaced.

Table 5: Converted Perching Platform Locations

Platform ID	Site	UTM Coordinates (10U)
Rock-t2-2014	Rocky Marsh	6121685N 493569E
RT-3-2014	Rocky Marsh	6122109N 493308E

A floating log was initially installed as a habitat enhancement feature to supplement resting and loafing habitat for waterfowl. One floating log was installed at 60 Km Marsh as part of the initial habitat enhancement program and it was identified for removal in 2014 (Ecofor 2015). However, during the 2020 monitoring and maintenance program we were unable to locate the floating log. This feature was not replaced due to an abundance of available natural trees and areas for perching and resting at the marsh.

5.4 First Nations Communities

Through the FWCP First Nations community engagement process, we had the opportunity to collaborate with interested First Nations during the implementation of this project. Two land monitors with McLeod Lake Indian Band assisted with nest box and floating island maintenance and were asked to provide feedback on the perceived project experience and value.

The McLeod Lake Indian Band monitors believed that enhancing waterfowl nesting habitat aligned with their Nation's priorities and values. Monitors were able to join the monitoring and maintenance project phases, and they expressed satisfaction with being able to participate from start to finish in the removal of historic floating islands and the deployment of new ones. Similarly, monitors stated both they and their Nation would like to continue to be involved in this project and in participating on similar projects with Blackbird in the future.

6 Discussion

During the previous round of maintenance activities in 2014, 53 % of total nest boxes showed sign of use by waterfowl (Ecofor 2015).

We observed approximately 51 % use by waterfowl. However, 44 % of the boxes were found to be non-functional, likely due to the age of the nest boxes, many of which had greatly exceeded their predicted 7 to 10-year lifespan (Juelfs and Corbould 2008). Of the functional nest boxes within the FWCP's Parsnip sub-region in 2020, very high usage rates by waterfowl (i.e., 89 %) were observed.

The overall observed use of total nest boxes by waterfowl during the 2020 monitoring period is comparable to 2014, while the proportion of non-functional nest boxes had increased by 15 % and sites that showed low to no sign of use during the last maintenance period showed significantly increased use.

Use of nest boxes by waterfowl had significantly increased at sites including Tutu Bay, Rocky Marsh, and Tudyah North. These sites saw low to no utilization by waterfowl during the 2014 round of maintenance activities but were found to have high use over the subsequent six-year period based on our observations. The reason for the observed increase in nest box use is not clear based on the historic and recently acquired monitoring and evaluation data. Sites that have historically seen high use and continue to see high use include Crooked River, Neilson Lake, and 60 Km Marsh.

We noted that nest boxes were primarily used by goldeneyes (24 %), buffleheads (22 %), and common mergansers (15 %). Other users included hooded mergansers, northern flickers, squirrels, and passerine species.

We observed evidence of waterfowl nesting in at least one of the established nest boxes at each of the locations during the 2020 monitoring period with the exception for Mugaha Bay and Robert's Pond.

All six nest boxes at Mugaha Bay were deemed non-functional, with mounting trees for some fallen since the previous 2014 monitoring period and the others decayed beyond use. We only replaced four of the six Mugaha Bay nest boxes due to a lack of suitable candidate trees and habitat requirements. At Robert's Pond, one nest box was found on a fallen tree, and the other was located at an unsafe height for the field crew to access. Nest boxes were not replaced at Robert's Pond, and monitoring at this site is recommended to be discontinued based on low historical use and higher maintenance effort requirements, based on the remote location and undesirable access to the site (Ecofor 2015).

Sites that showed beaver damage to nest box mounting trees during the 2020 maintenance program (i.e., Crooked River) may require more extensive maintenance during the next round of monitoring. Tudyah North required nest box replacement in 2014 due to downed trees from beaver activity. At the time of the 2020 maintenance program, however, all nest boxes at Tudyah North were on healthy, stable trees which showed no signs of beaver damage.

Historic floating islands that were removed during 2020 fieldwork showed signs of deterioration including waterlogging, exposed Styrofoam, and detachment from anchoring systems. The replacement islands have been designed to have an extended life expectancy relative to the traditional wooden islands and to avoid any waste being released into the surrounding environment.

Thirty-three percent of existing floating islands within the Parsnip Arm displayed signs of use by wildlife. However, this value is based on obvious signs of use by waterfowl (e.g., feathers and droppings) and utilization rates of floating islands by wildlife and waterfowl are likely underestimated.

Although all three floating islands at Mugaha Bay showed no obvious signs of use, members from the Mackenzie Nature Observatory noted that waterfowl use the floating islands every spring (Mackenzie Nature Observatory. Personal Communication. September 19, 2020). Similarly, the floating island at Tudyah North (Tudi-2014) showed no obvious sign of use by waterfowl during the site visit although remote camera footage showed that the floating island is used by a wide range of waterfowl and wildlife species.

Trail camera monitoring results at Tudyah North included a resting juvenile female wood duck. Historically, the wood duck's natural range does not extend as far north as the project area (Cornell University 2019). However, more recent observations suggest that their range is shifting further north (Davidson et al. 2020). Juelfs and Corbould (2008) noted that wood ducks have been known to nest in the Prince George area and could be potential users of the nesting structures at the southern enhancement sites (e.g., Neilson Lake and Crooked River).

Structures such as nesting tunnels can be effective at providing habitat to ground-nesting waterfowl. However, they require annual maintenance to be used as feasible nesting habitat and as such, were deemed to be impractical for the project and were removed from the project area.

7 Recommendations

7.1 Nesting Structure Monitoring and Maintenance Recommendations

Both traditional and novel enhancement structure designs were a part of this project. We adopted a traditional nest box design for new box installations which, if constructed well, has a reported life expectancy of up to 25 years (DUC 2008, DUC Date Unknown). We developed a novel design for the floating islands. Based on the selected product specifications, the anticipated life expectancy for the floating islands is approximately 30 years with coir replacement expected approximately every 10 years.

We recommend long-term monitoring of the nesting structures and floating islands to ensure their continued function and value, and to evaluate their continued effectiveness (DUC 2008, DUC Date Unknown, Fenger et al. 2006, Juelfs and Corbould 2008, May 2004, Nelms 2007).

As a novel floating island design was deployed within the project area, and as waterfowl have historically been shown to use floating islands within one year of deployment, we recommend that the floating islands be evaluated one year after deployment following the end of the breeding bird season (i.e., autumn 2021). The purpose of the one-year monitoring review is to determine island integrity and efficacy and to identify any potential future maintenance needs. This monitoring can be accomplished by consultants, community groups, First Nations, etc. who are knowledgeable and trained in the function and value of floating islands as well as how to safely navigate wildlife encounters.

Similarly, we recommend that all structures, including the nest boxes, be maintained and monitored in at least 3-year intervals to determine location suitability, structure efficacy, and to conduct structural and nesting material maintenance when/where required.

Although annual nest box maintenance is recommended to promote the highest use rate (DUC Date Unknown, DUC 2008, Fenger et al. 2006, May 2004, Nelms 2007), maintenance and monitoring can occur less frequently depending on climatic conditions and the type of use boxes receive during the winter (DUC 2008, Nelms 2007).

The 3-year minimum recommendation considers that newly installed nest boxes are unlikely to be used within the first year following deployment (B. Harrison, DUC, Personal Communication; Clark, 2000; DUC 2008; Juelfs and Corbould 2008). Regular maintenance programs should continue at all sites except Robert's Pond, which historically had been enhanced with two nest boxes.

Based on 2020 fieldwork, the next round of maintenance is predicted to cost approximately $ 28,100. Please refer to Appendix D for a full cost breakdown of the anticipated costs for maintenance programs going forward.

Nest boxes found to be in poor condition in 2020 should be replaced during the next round of maintenance (see Appendix B).

Future maintenance programs should consider adding chicken wire or a suitable alternative material around the base of nest box trees at sites which show frequent or increased beaver activity (i.e., Crooked River and Tudyah North). The chicken wire is intended to discourage beaver foraging on the nest box trees to aid in nest box longevity and ultimately reduce maintenance efforts (i.e., replacement and relocation) required in the future.

Due to the high maintenance requirements of nesting tunnel structures, they are not recommended to be installed at future enhancement sites without a commitment from local volunteer groups to conduct the necessary annual maintenance.

Subsequent monitoring and maintenance programs should include:

- Evaluation of enhancement structure use by both target and non-target species.
- Evaluation of waterfowl use on the floating islands using a remote camera deployment program.
- Evaluation of enhancement structure integrity.
- Enhancement structure maintenance such as
    - Replenishing nest box nesting material with fresh wood shavings (please note: a #2 Robertson screw bit will be required to open the nest box cleanout access doors),
    - Relocating structures to more effective locations when little signs of use are evident,
    - Re-anchoring any floating islands that have become detached from their anchoring system,
    - Repairing minor damage to enhancement structures, and
    - Removing or replacing enhancement structures which have experienced significant damage.
- Evaluation of surrounding natural habitat availability to determine feature necessity.

Separate from the regular nesting feature monitoring and maintenance program, additional monitoring can be completed under the direction of a qualified professional to quantitatively evaluate the impacts the installed artificial nesting structures are having on regional waterfowl population numbers. This will allow for researchers to evaluate not only waterfowl use of artificial features, but also whether the features are having the intended impacts on local waterfowl populations (i.e., an increase in population size).

7.2 Community Engagement, Education, and Outreach

Community engagement and support opportunities were limited in 2020 due to the COVID-19 pandemic and social distancing guidelines. Volunteers from local community groups were unable to participate in the field program.

During enhancement feature deployment, safety procedures were adapted to ensure the continued health and safety of the Blackbird team and First Nations participants, which allowed for the planned participation of available First Nation monitors to continue.

Should social interactions remain restricted during future monitoring and/or maintenance programs, broader community engagement can be continued through digital presentations (e.g., an interactive webinar with participating classrooms or for interested community clubs) or through publicly accessible print materials (e.g., signs or laminated posters throughout Mackenzie and other nearby communities).

We consider Neilson Lake a potential candidate site for further enhancement, such as a board walk. An information board already exists at the site, summarizing enhancement work that has been done at Neilson lake, including information on the weir construction and artificial nesting structures. The lake is easily accessible from Highway 97N and the road to Teapot Mountain receives a lot of recreational traffic, potentially making it a great opportunity to educate people about the Fish and Wildlife Compensation Program, local waterfowl, and waterfowl nesting requirements.

The inclusion of First Nations monitors in project implementation has been valuable for both our project team and the involved Nations. We recommend that First Nation participation continue through future maintenance and monitoring activities.

It would likewise be valuable to include local environmental clubs and community groups in the program, if feasible, to raise broader awareness on enhancement options, opportunities, and maintenance requirements. Community involvement helps to increase community awareness and interest in waterfowl habitat requirements and can aid in volunteer recruitment for future maintenance requirements.

We were unable to collaborate with the members of the Mackenzie Nature Observatory due to COVID-19 during the 2020 monitoring and maintenance program. We recommend to continue engaging this group for potential participation in future monitoring of the enhancement structures.

8 Acknowledgements

The Enhancing Nesting Opportunities in the Parsnip Arm project was completed within the traditional territory of the Dunne-za, Cree, and Sekani speaking peoples.

Blackbird Environmental Ltd. gratefully acknowledges the financial support of the Fish and Wildlife Compensation Program for its contribution to the Enhance Waterfowl Nesting Opportunities in the Parsnip Arm. www.fwcp.ca

Blackbird Environmental Ltd. would also like to gratefully acknowledge the support of the following communities, organizations, and businesses who assisted with the *Enhancing Waterfowl Opportunities in the Parsnip Arm* project:

- Ducks Unlimited Canada, who generously provided in-kind support through nesting structure and floating platform construction designs and advice.
- McLeod Lake Indian Band, whose enthusiastic and hard working field monitors provided meaningful assistance during maintenance work of the nest boxes and islands.
- Ken Latreille at Mesa Environmental for providing design and deployment input and for supporting the field crew, notably while removing historic floating islands (which was no small feat).

9 Statement of Limitations

Services provided by Blackbird for this report have been conducted in a manner consistent with the level of skill, care and competence ordinarily exercised by registered members of the profession of biology currently practicing under similar conditions and like circumstances in the same jurisdiction in which the services were provided.

The evaluations contained in this report are based on professional judgement, calculations, and experience. They are inherently imprecise. Biological, physical, and hydrological conditions other than those indicated may exist on the sites.

The recommendations and conclusions contained in this report pertain only to the site conditions observed by Blackbird at the time of the inspection. Since site conditions may change over time, this report is intended for immediate use.

The conclusions of this report are based in part on information provided by others. Blackbird believes this information to be accurate but cannot guarantee or warrant its accuracy or completeness.

If you have questions with regards to this report, feel free to contact the authors at your convenience by email at matthias@blackbird.ca or by phone at (250) 793-7262.

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Appendix A Photos

Photo 1: Photo of new floating island Mug1-Isl-2020 deployed at Mugaha Bay.

Photo 2: View of newly installed nest box D2-2020 at Dina Lake.

Photo 3: View of a metal perching platform at Rocky Marsh, which has been converted from a historic nesting tunnel.

Photo 4: View of a newly installed floating island at Misinchinka marsh in the Pine Pass.

Photo 5: View of a historic floating island removed from Tutu Bay in 2020, which had detached from its anchoring system and drifted to shore. Note the Styrofoam floating in the surrounding water.

Photo 6: View of floating island D1-Isl-2014 at Dina Lake. Assessed to be in good condition, aside from having drifted to shore. The island was anchored at a new location with a new anchoring system.

Photo 7: View of beaver damage to the nest box tree at Crooked River site C#1-31-2014.

Photo 8: View of floating island Tudi-2014 at Tudyah North. The historic island was assessed as being in good condition. A trail camera documented wildlife use of the island and it was left in place.

Appendix B Structure Locations and Maintenance Recommendations

Nest Boxes

Site	Nest Box ID	Box Condition	Tree Species	Box Ht (m)	Aspect	UTM Coordinates (10U)	Last Maintenance	Maintenance Recommendations
Crooked River	C#1-30-2014	Fair	Cottonwood	5.2	SW	6061856N 513381E	October 2020	Regular maintenance. Assess health of mounting tree, potential replacement required
	C#1-31-2014	Fair	Cottonwood	2.6	SW	6061685N 513349E	October 2020	Regular maintenance. Assess health of mounting tree, potential replacement required
	C#2-2-2014	Fair	Spruce	3.3	SW	6053943N 517665E	October 2020	Regular maintenance
	C1-2020	Good	Poplar	3.7	S	6055777N 516201E	October 2020	Regular maintenance
	C#2-1-2014	Removed	-	-	-	6055759N 516222E	-	-
Dina Lake	D1-2014	Fair	Birch	3	SE	6153706N 481067E	October 2020	Regular maintenance
	D4-2014	Poor	Spruce	2.5	S	6153256N 479571E	October 2020	Remove and replace
	D5-2014	Fair	Birch	2.8	N	6203045N 561117E	October 2020	Regular maintenance
	D8-2014	Fair	Birch	3.5	NW	6153775N 480015E	October 2020	Regular maintenance
	D1-2020	Good	Birch	2.5	E	6153561N 479382E	October 2020	Regular maintenance
	D2-2020	Good	Birch	3.5	SW	6153692N 481014E	October 2020	Regular maintenance
	D2-2014	Removed	-	-	-	6153705N 480969E	-	-
	D3-2014	Removed	-	-	-	6153359N 480957E	-	-
	D6-2014	Removed	-	-	-	6153544N 479535E	-	-
	D7-2014	Removed	-	-	-	6152235N 479974E	-	-

Site	Nest Box ID	Box Condition	Tree Species	Box Ht (m)	Aspect	UTM Coordinates (10U)	Last Maintenance	Maintenance Recommendations
Kerry Lake	K1-2014	Poor	Birch	3.5	N	6057982N 513383E	November 2020	Remove and replace
	K2-2014*	-	Unknown	Unknown	-	6058820N 514195E	-	Regular maintenance
	K3-2014*	-	Unknown	Unknown	-	6058404N 514666E	-	Regular maintenance
	K4-2014	Poor	Spruce	4.5	W	6058877N 513653E	November 2020	Remove and replace
	K1-2020	Good	Birch	2.8	S	6059594N 513403E	November 2020	Regular maintenance
	K2-2020	Good	Spruce	2.5	SE	6058790N 513812E	November 2020	Regular maintenance
	K5-2014	Removed	-	-	-	6059542N 513456E	-	-
	K6-2014	Removed	-	-	-	6058791N 513814E	-	-
Old Mill Pond	Mill27-2014	Fair	Birch	3.6	NW	6037985N 521031E	October 2020	Regular maintenance
	Mill1-2020	Good	Birch	2.5	W	6038062N 521083E	October 2020	Regular maintenance
	Mill2-2020	Good	Birch	3.3	SE	6038055N 520838E	October 2020	Regular maintenance
	Mill28-2014	Removed	-	-	-	6038053N 520835E	-	-
	Mill29-2014	Removed	-	-	-	6038052N 521070E	-	-
Mugaha Bay	Mug1-2020	Good	Pine	2.4	SE	6139029N 486361E	October 2020	Regular maintenance
	Mug2-2020	Good	Birch	2.5	S	6139343N 486925E	October 2020	Regular maintenance
	Mug3-2020	Good	Birch	2.6	S	6139381N 486800E	October 2020	Regular maintenance
	Mug4-2020	Good	Aspen	3.7	NE	6138437N 486407E	October 2020	Regular maintenance
	Mug5-2014	Removed	-	-	-	6138353N 486489E	-	-
	Mug6-2014	Removed	-	-	-	6138409N 486423E	-	-

Site	Nest Box ID	Box Condition	Tree Species	Box Ht (m)	Aspect	UTM Coordinates (10U)	Last Maintenance	Maintenance Recommendations
	Mug7-2014	Removed	-	-	-	6138933N 486257E	-	-
	Mug8-2014	Removed	-	-	-	6139046N 486380E	-	-
	Mug9-2014	Removed	-	-	-	6139341N 486942E	-	-
	Mug10b-2014	Removed	-	-	-	6139362N 486831E	-	-
Neilson Lake	N1-2014	Fair	Spruce	4.5	N	6018692N 522774E	September 2020	Regular maintenance
	N2-B-2014	Fair	Spruce	3	NW	6018748N 523115E	September 2020	Regular maintenance
	N4-2014	Fair	Spruce	3.1	SW	6019218N 523168E	September 2020	Regular maintenance
	N1-2020	Good	Spruce	2.8	SE	6019223N 522914E	September 2020	Regular maintenance
	N2-2020	Good	Fir	3	S	6019061N 523157E	September 2020	Regular maintenance
	N3-2014	Removed	-	-	-	6019078N 523133E	-	-
	N5-2014	Removed	-	-	-	6019253N 522920E	-	-
Rocky Marsh	R2-2014	Fair	Pine	2.7	NW	6121534N 493784E	September 2020	Regular maintenance
	R3-2014	Fair	Pine	2.6	W	6121676N 493806E	September 2020	Regular maintenance
	R4-2014	Fair	Pine	3.0	SE	6121720N 493643E	September 2020	Regular maintenance
	R5-2014	Fair	Spruce	2.5	N	6122055N 493260E	September 2020	Regular maintenance
	R6-2014	Fair	Pine	2.5	S	6122141N 493286E	September 2020	Regular maintenance
	R7-2014	Removed	-	-	-	6121769N 493331E	-	-
Robert's Pond	Rob20-2014*	Poor	Cottonwood	10	NW	6170085N 445372E	-	Discontinue monitoring
	Rob19-2014	Removed	-	-	-	6170305N 445260E	-	-

Site	Nest Box ID	Box Condition	Tree Species	Box Ht (m)	Aspect	UTM Coordinates (10U)	Last Maintenance	Maintenance Recommendations
Tutu Bay	T1b-2014	Poor	Cottonwood	2.8	E	6144077N 485027E	September 2020	Remove and replace
	T2-2014	Poor	Birch	3.2	SE	6144133N 484986E	September 2020	Remove and replace
	T3-2014	Poor	Birch	3.5	SE	6144181N 484922E	September 2020	Remove and replace
	T4-2014	Removed	-	-	-	6144189N 485108E	-	-
Tudyah North	Tud1-2014	Fair	Birch	3.1	SW	6108846N 498555E	September 2020	Regular maintenance
	Tud2-2014	Fair	Birch	3.5	E	6108845N 498165E	September 2020	Regular maintenance
	Tud3-2014	Fair	Birch	3.5	S	6108480N 498642E	September 2020	Regular maintenance
42 Mile Marsh	42mi-25-2014	Fair	Spruce	3.4	NE	6071858N 510985E	October 2020	Regular maintenance
	42mi26-2014	Removed	-	-	-	6072158N 511000E	-	-
60 Km Marsh	60km15-2014	Fair	Birch	5	E	6149159N 475017E	October 2020	Regular maintenance
	60km16b-2014	Fair	Spruce	6	S	6148927N 475122E	October 2020	Regular maintenance
	60km17-2014	Fair	Pine	6.2	E	6148951N 474794E	October 2020	Regular maintenance
	60km18-2014	Removed	-	-	-	6149209N 474982E	-	-

*Nest boxes not assessed during 2020 maintenance.

Floating Islands

Site	Island ID	Anchor Depth (m)	UTM Coordinates (10U)	Maintenance Recommendations
Dina Lake	D1-Isl-2014	4.9	6153220N 479166E	Monitor
	D1-Isl-2020	3.4	6153484N 479391E	Monitor
	D2-Isl-2020	3.2	6154055N 480877E	Monitor
Old Mill Pond	Mill1-Isl-2020	3.9	6038137N 521017E	Monitor
Misinchinka	Mis1-Isl-2020	1.9	6116586N 516449E	Monitor
Mugaha Bay	Mug1-Isl-2020	4.9	6139338N 486740E	Monitor
	Mug2-Isl-2020	4.5	6139288N 486961E	Monitor
	Mug3-Isl-2020	3.9	6138995N 486877E	Monitor
Neilson Lake	N1-Isl-2020	3.9	6018753N 523003E	Monitor
Rocky Marsh	Rock-I1-2014	Unknown	6121710N 493784E	Monitor
	Rock-I3-2014	Unknown	6122035N 493374E	Monitor
	Rock1-Isl-2020	1.7	6121180N 493733E	Monitor
Tudyah North	Tudi-2014	11	6108194N 498512E	Monitor
60 Km Marsh	60km-Isl-2020	3.9	6149012N 474895E	Monitor

Additional Enhancement Structures

Site	Platform ID	Feature Type	UTM Coordinates (10U)	Maintenance Recommendations
Rocky Marsh	Rock-t2-2014	Perching Platform	6121685N 493569E	Monitor
	RT-3-2014	Perching Platform	6122109N 493308E	Monitor

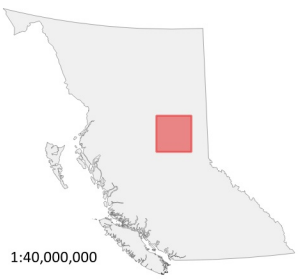
Appendix C Figures

List of Figures

Figure 1: Project Overview Map

Legend

- Floating Island
- Nest Box
- Roads - Paved
- FWCP Peace Region
- Lakes & Reservoirs
- Wetlands/Riparian



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Disclaimer

UTM Zone 10, NAD 83
Date of data acquisition: Unknown
Data Credit: Blackbird Environmental Ltd., BC Geodata Warehouse
For representational purposes only, all locations are approximate.

Fish & Wildlife Compensation Program

Enhancing Waterfowl Nesting Opportunities
Parsnip Arm Region
Project Overview Map

Horizontal Scale 1:1,000,000

0 10 20 30 40 50 km

Map to scale when plotted on a page 216 mm x 279 mm (Letter)

Our File:	20011	Appl. #:	PEA-F21-W-3193	Revision #:	0
Client File:	n/a	GIS:	EM	Date:	Jan. 25, 2021

Blackbird Environmental
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Figure 1

Appendix D Nest Box, Floating Island and Maintenance Cost Breakdown

Cost Breakdown 1: Nest Box

Component	Cost per Nest Box (including taxes)
Lumber, plywood (treated 3/4") assuming 4 boxes per sheet	$ 15.96
Deck Screws (1 ½", 16 total)	$ 5.20
Wooden Dowel Pins (5/16", 9 total)	$ 0.90
Wood Chips (approximately 4 L)	$ 0.25
Total Cost Per Nest Box*	**$ 22.30**

Cost Breakdown 2: Floating Island

Component	Cost per Island (including taxes and shipping, where applicable)
Islands	
4x10' Aluminum Sheet	$ 402.08
Coir Matting (1 roll for 14 islands)	$ 41.27
Float: 1 Enviro Float, 4'x4'x6"	$ 264.15
Lumber (2x4", 18' total length)	$ 25.19
Nuts (galvanized, 4 total)	$ 1.79
Washers (galvanized, 4 total)	$ 0.54
Structural Screws (¼" x 1 ½", 6 total)	$ 1.95
Structural Screws (5/16" x 3-1/8", 6 total)	$ 19.49
Carriage Bolts (galvanized, 1" x 5", 2 total)	$ 4.70
Eye Bolts (galvanized, 1/2" x 6", 2 total)	$ 11.69
Miscellaneous Supplies (Loctite, 4 large zip ties, etc.)	$ 5.60
	$ **778.45**
Anchors	
1/4" cable (approximately 20' total per island)	$ 31.36
5-gallon Plastic Buckets (2 total)	$ 8.89
8" Piling Ring (2 total)	$ 5.78
Concrete (10 gallons)	$ 40.32
Clamps, galvanized (12 total)	$ 7.80
	$ **94.15**
Total Cost Per Island*	**$ 872.60**

**Note: These prices are based on the encountered 2020 market prices and include bulk order discounts as well as any applicable shipping costs to Fort St. John, BC.*

*** Enviro Dock Floats were manufactured by Enviro Float Manufacturing (2002) Ltd.*

Cost Breakdown 3: Projected Future Maintenance Costs

Component	Description	Item Cost
Labour	Project Administration	$2,500
	Fieldwork	$12,500
	Analysis, Mapping & Reporting	$4,000
Equipment	Accommodations & Per-Diem	$4,200
	Vehicles, Boats, Equipment	$4,600
	Replacement Nest Boxes	$300
Total Projected Maintenance Cost*		**$ 28,100**

**Notes/Assumptions:*

1. *Pricing is based on 2020 field season applied research rates and actual 2020 material costs.*
2. *Assumed participation in the program of one First Nations land monitor, based on 2020 rates.*
3. *Potential cost of floating island removal is not included (it is not anticipated to be required for the next round of maintenance).*
4. *Anticipated total cost does not include applicable taxes.*