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BUILDING NEST BOX HABITATS FOR CAVITY NESTING BIRDS IN THE CHRYSTAL CREEK WATERSHED

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Abstract

The Chrystal Creek watershed on Galiano Island is a wetland undergoing restoration and at this early stage of development lacks bird nesting habitats. Three target species of birds were chosen based on existing bird surveys of the watershed, acoustic monitoring, and their conservation status. Using existing blueprints for bird-nesting habitats, the team constructed 9 boxes for the hooded merganser (*Lophodytes cucullatus*), wood duck (*Aix sponsa*), and violet-green swallow (*Tachycineta thalassina*). To find suitable sites for the boxes, the watershed was scouted for requirements specific to each species in terms of proximity to water, orientation, shade, and height from the ground. The watershed early seral stage created challenges in finding suitable sites which form the basis of a discussion. Finally, a robust monitoring plan is recommended to assess the success of the bird boxes and allow for adaptive management of the restoration project.

Introduction

Our restoration design project, developed in partnership with the Galiano Conservancy Association (GCA), focuses on improving habitat for cavity-nesting birds in the Chrystal Creek watershed. Wetlands in the Coastal Douglas-fir moist maritime (CDFmm) biogeoclimatic zone are rare ecosystems and the Chrystal Creek Watershed seral stage does not provide adequate bird nesting habitats. Birds play a vital role in British Columbia's wetlands by supporting biodiversity, keeping populations in balance, and spreading seeds and nutrients. In return, wetlands will provide the food, shelter, and habitat birds need to survive and migrate (Morisette et al., 2013)

We began by researching which bird species are present on Galiano Island and cross-referenced this information with the BC Species and ecosystems explorer database to identify priority species for this site. From this process, we selected three main species: the hooded merganser (*Lophodytes cucullatus*),

wood duck (*Aix sponsa*), and violet-green swallow (*Tachycineta thalassina*), chosen for their presence on Galiano Island and their potential to benefit from providing cavity nesting structures. To support our species selection and provide the GCA with accurate data for future monitoring, we used a 24-hour acoustic monitoring device and the Merlin Bird ID app to confirm our chosen species presence in the watershed. Additionally, we used GPS mapping to add precise data points to GCA field maps, creating a clear reference for ongoing monitoring efforts.

This report explains why these species were chosen, how their habitats were built and their chosen placement, as well as a plan to provide the GCA with a long-term monitoring program that can be adapted as needed. These nest boxes will provide safe nesting opportunities and encourage these species to become more established in the watershed. Our goal is to provide the GCA with a clear and adaptable monitoring plan to guide long-term stewardship and ensure the success of the ongoing Chrystal Creek restoration project.

Background

In 2012, the GCA purchased a 76-hectare property for conservation, restoration, and educational purposes (GCA, 2023). Known today as the Millard Learning Centre, the property presented at the time a fragmented landscape consisting of old logging roads, drainage ditches, fences, and scattered structures across the Chrystal Creek watershed (GCA, 2023). The native vegetation had largely been replaced by invasive agronomic grasses and weeds, and the original creek channels had been altered into ditches, directing rainfall off the land and directly into Chrystal Cove (GCA, 2023). Since acquiring the property, the GCA dedicated significant resources to help restore the natural wetland ecosystem. The restoration of the watershed started in 2021 and in 2024 they celebrated the completion of primary restoration

treatments including ditch filling, soil decompaction, wetland excavation, woody debris incorporation, and native planting across 12 hectares of the Chrystal Creek watershed (GCA, 2023).

The Chrystal Creek watershed is around 26 ha and the GCA has carried out a long-term restoration of the watershed through the *"Cedars for the Next Century"* project, aiming to reverse decades of agricultural and logging impacts as well as reestablish natural wetland and forest systems. Our project took place in the mid section of the wetland between "Robins delight" and "Plug n Pond", ponds named by the GCA staff (*see figure 1*).

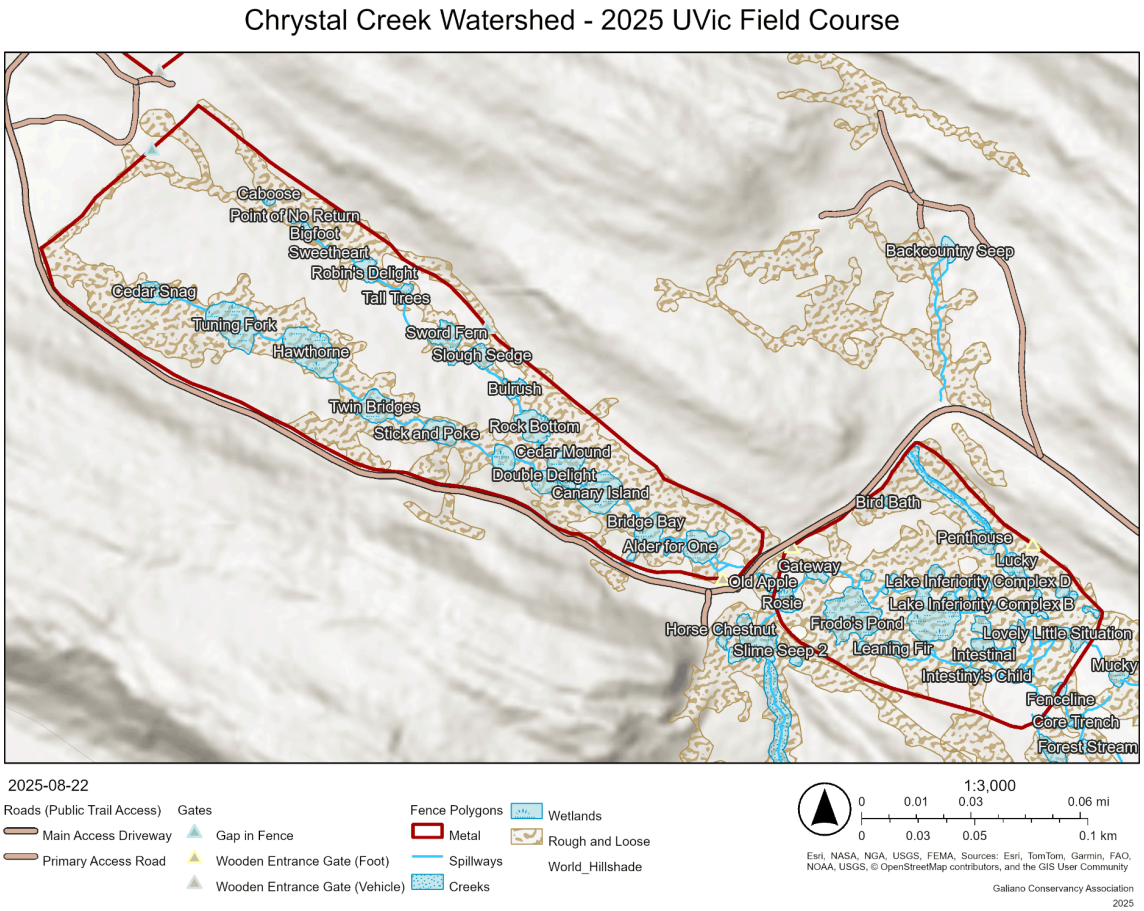

Figure 1 : Map of the Chrystal Creek watershed, courtesy of the Galiano Conservancy Association

Galiano Island (*see figure 2*) lies within the traditional and unceded territories of many Hul'qumi'num speaking peoples, including the Penelakut First Nation and the Lamalcha, Hwlitsum, Lelum Sar Augh Ta Naogh, Chemainus, Halalt, Lyackson, and Cowichan.

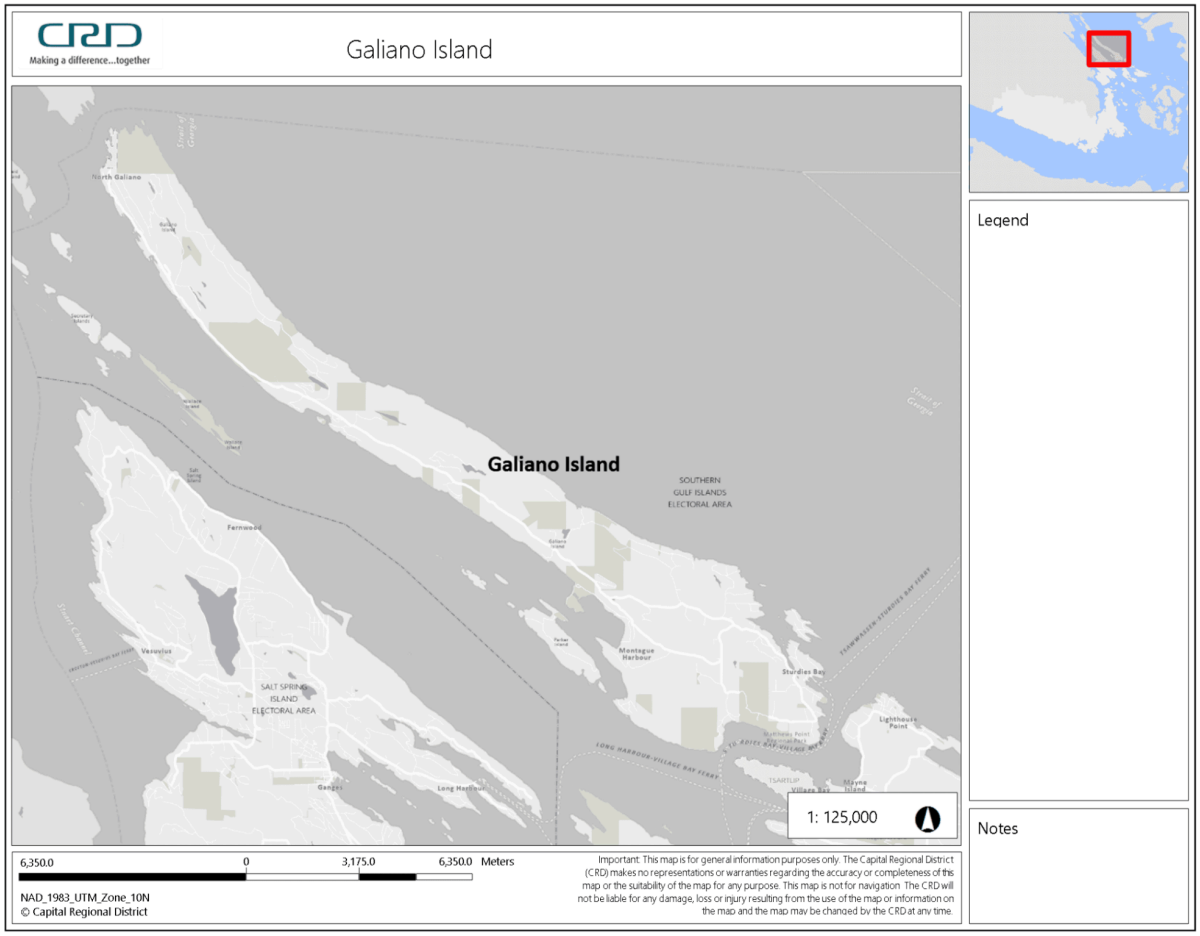

Figure 2 : Map of Galiano Island with inset showing its location within the Gulf Islands and Vancouver Island. Map courtesy of the Capital Regional District.

It also lies within the ceded territory of the Tsawwassen First Nation. While there is no evidence presently that suggests sustained cultural use of what is now the Millard Learning Centre, we recognize

that this land is part of a much broader cultural landscape. We honour all Indigenous peoples who may have had ties to this space in the past, as well as those who continue to maintain close relationships with Galiano Island today. Galiano Island is in the waterways of the Salish Sea that once served as a vital trade route for the Coast Salish Peoples and continues to be an essential part of daily life, providing food and other resources for Indigenous communities (Vo & Underwood, 2021).

Methods

Initially we wanted to determine what species were present in the Crystal Creek watershed. To gather data on species present we installed an acoustic monitoring device near one of the entrance gates of the wetland (see figure 3, Remote detection symbol) for 24 hours. This data was then processed through the BirdNet application for identification. We also used the Merlin smartphone application (Cornell Lab of Ornithology, 2024) to have faster results of calls at three locations in the watershed. We also consulted existing bird surveys done during previous restoration research (Cameron, 2021) to confirm that the results from the acoustic monitoring fell within a range of species already observed.

Once the target species were chosen, we identified blueprints for suitable bird boxes from the Cornell Lab of Ornithology website. These were designed to accommodate our species of interest. A GCA contractor, Erik Wilkinson, facilitated building the boxes.

The last step was to determine the location of the boxes. To do that, we walked throughout the wetland to find sites with adequate shade, water present, correct distance from a water source, while considering spacing between boxes, box height and attachment material. Once sites were chosen, we marked them using ArcGIS Field Maps and uploaded point photos to the software.

Findings

After analysis with BirdNET, the data recorded over 24 hours with the acoustic monitoring device showed 3,712 calls from 81 bird species. However, only the Violet-Green Swallow was recorded enough time to be able to confidently identify it, with a 95% confidence value (see Appendix 1 for the raw data). Using the Merlin Bird ID app, we recorded three observations of two minutes each and found multiple song birds present (Appendix 2) including the Spotted Towhee, American Goldfinch, and our species of interest, the Violet-green Swallow.

A 2021 bird survey conducted by UVic student Courtney Cameron also confirmed the presence of song birds in the watershed. In the report they indicated the presence of wildlife trees in various states of decay, which suggests the availability of nesting sites already in the watershed. After discussion with the GCA and Wilkinson, 9 bird boxes were built. The watershed scouting only resulted in 8 suitable locations. (*See Figure 3*).

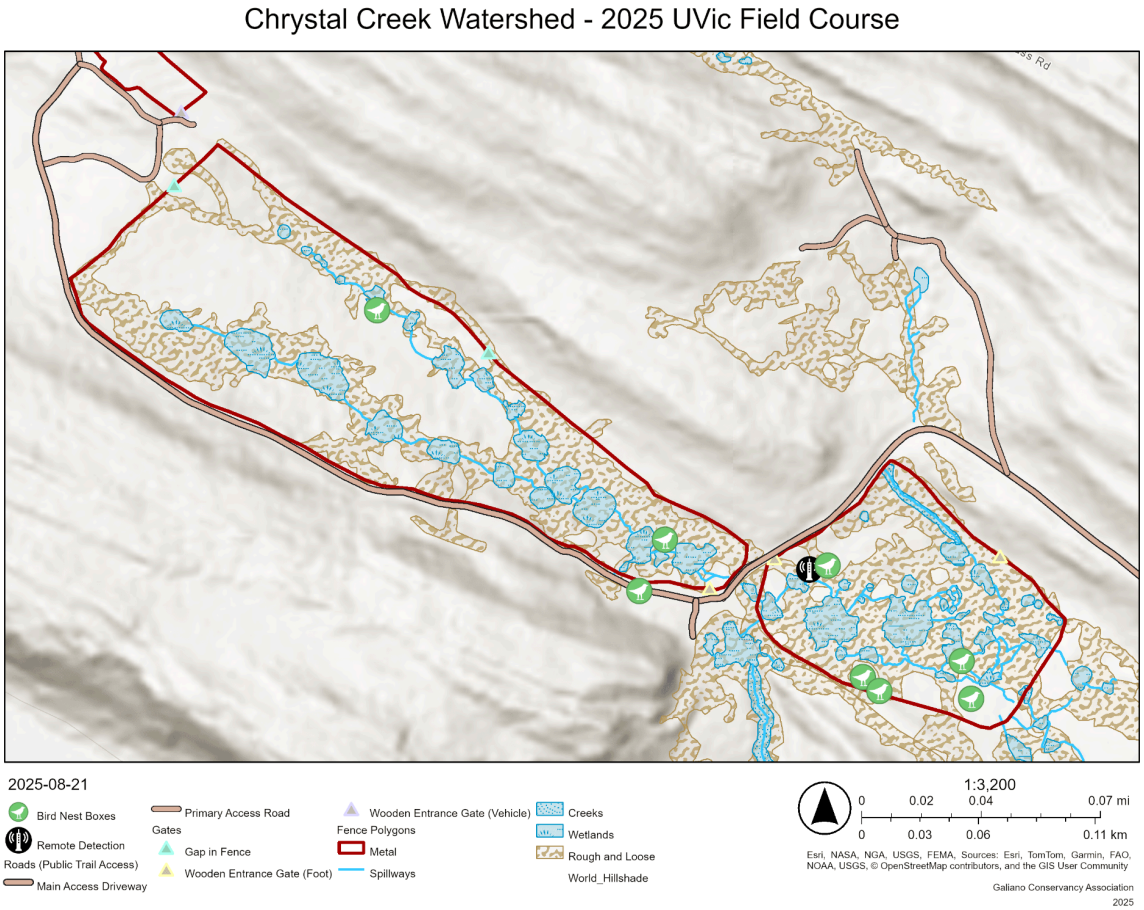

Figure 3: Field Map indicating proposed nest box locations (green bird icons).

Site Assessment

The Chrystal Creek watershed is primarily composed of open meadow habitat with a diverse mix of plant species. Vegetation observed includes sword fern (*Polystichum munitum*), Douglas-fir (*Pseudotsuga menziesii*), slough sedge (*Carex obnupta*), common rush (*Juncus effusus*), trailing blackberry (*Rubus ursinus*), western red cedars (*Thuja plicata*) and many others. The hydrology of this site has been heavily impacted by years of logging, compaction, frequent ditching and agriculture. Compacted soil often limits water infiltration and plant growth therefore much of the wetland has been transformed into ”rough and

loose" as highlighted by Adam Huggins, restoration coordinator at the GCA, during site visits. Rough and loose surface treatments are an effective method for reducing erosion and supporting site revegetation as well as ecological resilience (Polster, 2013). During our site visits in July, there was some stagnant water present indicating a high-water table which is ideal within wetland habitats. Although the site's hydrology has been heavily altered, which has in turn affected vegetation, the GCA has made significant restoration efforts by successfully converting much of the compacted soil into functional rough and loose terrain.

Species

For this project, the selected species include the hooded merganser (*Lophodytes cucullatus*), wood duck (*Aix sponsa*), and violet-green swallow (*Tachycineta thalassina*). While we would have liked to include more species including a red-list species, there was limited time and given the scope of the project we chose to focus on species that would likely be present, and with nest box plans already underway, there was limited flexibility to adjust the designs. These three species are 'yellow-listed' under the Canadian Species at Risk Act, meaning they are apparently secure and not at risk of extinction, though some subspecies may be of greater concern (BC Species & Ecosystem Explorer, 2024). Focusing on these native cavity-nest birds also aligns with the Galiano Conservancy Association's (2013) management principle to 'Protect intact ecosystems and native biodiversity first' (p.11). Their presence and use of the installed nest boxes will provide valuable insight into the health of the wetland ecosystem, as birds serve as important indicator species for biodiversity and habitat quality.

Nest Box Plans

The nest box design plans were chosen for three species of interest: the Wood Duck *Aix sponsa*, the Hooded Merganser *Lophodytes cucullatus,* and the Violet-green Swallow *Tachycineta thalassina*. We

chose one design for the two waterfowls and one for the songbird based on blueprints from the Cornell Lab of Ornithology (Cornell Lab Nest Watch, 2025).

Physical structure: the design of the waterfowl box is the larger of the two, with the back measuring 29” and a width of 9 ¼”. The entrance oval is roughly 4”x3” wide (*see figure 4*). There is an angle cut made

Figure 4 : Photo of a constructed nesting box for a waterfowl (Photo Carmen Davies).

on one side to create a door that opens outwards for access, and an overhanging roof to shed rain from all sides. A mesh hardware cloth was installed on the front of the box as a ladder.

Habitat: The nesting period for the Wood Duck is April to August and the Merganser is February to mid-June. Both the Wood duck and Hooded Merganser require nesting habitat facing the water at least 6 ft off the ground. The Hooded merganser requires 100 ft of spacing between boxes and the Wood Duck requires 600 ft. Boxes should be installed within 100 ft from the water with no branches blocking the entrance. Boxes intended for wood ducks should be angled forward to shed rain. It is suggested to add 2-3 inches of wood shavings in the bottom of the box as well as a predator guard. These boxes can be attached to posts or poles.

Physical structure: The box chosen for the Violet-green Swallow is a smaller rectangular design. The back of the box is13 ½" and 5 ½" wide. The mechanism used to open the side door is similar and uses a pivot nail, allowing it to swing out. The diameter for the entrance hole is 1 ⅜". The roof overhangs in the front to shed rain (*see figure 5*).

Figure 5 : Violet-green wallow boxes with a roof overhang (Photo Carmen Davies).

Habitat: The nesting period for the Violet-green Swallow is May to August. The placement for this box should be at least 9 ft off the ground and facing South or East. The distance required between boxes is 30 ft. It is suggested to add predator guards and a fledgling ladder on the interior to aid the nestling to climb out of the box. Feathers can be provided for Swallows to add to the bottom of the box. They can be attached to trees or poles.

Monitoring plan and recommendations

A core principle of ecological restoration is the need for clear goals and objectives and the use of measurable indicators (Gann et al., 2019). A rigorous monitoring plan of the bird boxes will inform the GCA on the efficiency of the design chosen and whether the objectives are being met.After the installation of the nest boxes, we recommend a detailed monitoring plan to observe bird activity with the newly established habitat. The USDA (Dudley & Saab, 2003) lays out a field protocol for monitoring cavity nesting birds based on the Breeding Biology Research and Monitoring Database (BBIRD) and provides nest cards (Figure. 3) for data entry. They note that occupied nests should be monitored every 3-4 days (increasing as fledgling dates approach) and last 1-30 minutes, depending on the time it takes to determine nesting stage. The nesting stages include courtship, nest building, egg-laying, incubation, nestling, and fledgling. They suggest documenting behavioural observations such as excavating, aggression, fecal sac removal, carrying nesting material, copulating, and size of prey delivered to offspring if unable to see the inside of the nest. These observations should be made with each visit until nest failure or the young fledge. The nest fate can be determined by searching for evidence of a failed nest such as claw marks on the nest tree, feathers or egg shells present near the nest, or changes in the cavity. Success is indicated when nestlings are observed at 80% or more of their mean fledgling age. Other causes of nest failure include abandonment due to human interference, storms, ectoparasites, or usurpation from other bird species. The Nestwatch program established by Cornell Lab of Ornithology is also based on the BBIRD field protocol. They indicate the difficulties of ensuring data quality in monitoring programs and how the frequent (3-4 days) nest checks can help estimate daily nest survival. The Nestwatch program run by Birds Canada is another citizen led monitoring program that provides information on the health of breeding bird populations and environmental change (Birds Canada, 2025). It is important to collect chronological data because it will tend to overestimate actual nesting success. Rather than just reporting final tallies of eggs, nestlings, or fledglings, multiple visits allow for scientists to estimate the ‘daily nest survival’ demographic (the likelihood that any nest will survive from one day to

the next) (Cornell Lab of Ornithology, 2013). Nests are often destroyed early on which leaves them undetected. This is called detection bias and can be mitigated by using daily nest survival statistics such as the Mayfield Method and the Logistic-Exposure Method (Cornell Lab of Ornithology, 2013).

Appendix B. Example of a Nest Card.

(Front)

Yr[1]:	Loc[2]:	Species[3]:	First Observer[4]:	Cavity ID#[5]:
Trt[6]:	Unit[7]:	Tasks Comp.[8]: GPS VEG FATE	Direction (°) BT-Nest[9]:	Distance (m) BT-Nest[10]:
Cavity Location/ Description[11]:				
Nest Status[12]:			UTM (NAD27)	
Find Method[13] (circle one): PB F SS NBC L PY YB			Northing[14]: Easting:	
Computer ID#[15]:	Nest Ht (m) [16]:		Cavity Age[17]:	Decay Class[18]:
Tree Sp[19]:	Tree Ht (m) [20]:		DBH (cm) [21]:	Orient (°)[22]:
Original Exc[23]:	OE Cert[24]: SURE UNSURE	Tree Top Condition[25]:	Previous Cavity ID#[26]:	Previous Cavity Sp[27]: / Previous Cavity Yr[28]:
Aspect[29]:	Deg Slope[30]:	Position on Slope[31]:	Multiple Cavity ID#[32]:	Multiple Cavity Sp[33]: / Multiple Cavity Yr[34]:

(Back)

Visit Date[35] Day	Mo	#Egg[36]	#Yng[37]	Beg-End Time[38]	Observations (parental behavior, nestling development, fate, etc)[39]	Cont.[40]	Stage[41]	Obs[42]
				-				
				-				
				-				
				-				
				-				
				-				
				-				

Nest Fate[43]: (circle one) 1-Successful Failed due to: 2-bear, 3-corvid, 4-squirrel, 5-chipmunk, 6-snake, 7-weather, 8-cavity destroyed, 9-unknown, 10-other _____ 11-Fate unknown

Initiation Date[45]:	Success/Failure Notes[44]: Record detailed information used to determine nest fate
Date Fated[46]:	
# Fledged[47]:	Fledge Conf.[48]: SURE UNSURE

Figure 6: USDA Nest Card example

Discussion & Challenges

a. Suitable sites

Assessing suitable sites for bird-nesting cavities in the Chrystal Creek watershed presented several challenges. While the wetland restoration is now coming up on its 5th year, the wetland itself is still in an early seral stage. That means that the wetland only has a small number of ponds that remain active throughout the summer. It also doesn't have a lot of shaded areas with structures to mount bird-nesting boxes.In addition, each bird species has specific nesting requirements: orientation, proximity to water, and spacing from other boxes. These factors complicated finding suitable sites.

b. Acoustic monitoring

The results from the acoustic monitoring only confirmed the presence of one of the three target species. After further discussions with the GCA team, the length of monitoring chosen - 24 hours - explained the discrepancy between the species identified in the literature and the species identified through acoustic monitoring. The very short timeline of the project prevented us from monitoring for a longer period, but future projects should try to monitor multiple locations over longer periods of time for increased accuracy.

c. Box design

While the Cornell Lab of Ornithology bird box designs saved the team a lot of time by offering free, detailed blueprints, they still required some refinements with GCA contractor Erik Wilkinson. For future projects we recommend allocating enough time to fully test out the viability of the designs - some minor issues during the building phase can not be anticipated when looking at the blueprints. For example the

groove to grip the door on the right side of the box proved more challenging that anticipated - a slightly different mechanism (nail) was used instead of the proposed attachment.

Conclusion

Supporting the restoration of a wetland through building bird nesting boxes requires in-depth research beforehand and robust monitoring plans afterwards. Special consideration should be placed on sufficient acoustic monitoring before deciding on target species. Some testing is recommended when building the boxes to account for local specificities. Wetlands early in their restoration trajectory present added challenges because of lower water availability and lack of shaded structures to host bird boxes.

Acknowledgments

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Appendix 1 List of bird counts from the BirdNet ID and probability of accurate ID

Highlighted species indicate a target species for the bird box project.

Common name	Count
Olive-sided Flycatcher	836
Willow Flycatcher	694
American Goldfinch	271
Violet-green Swallow	266
Swainson's Thrush	264
Northern Flicker	227
Pine Siskin	130
Spotted Towhee	127
White-throated Sparrow	115
White-crowned Sparrow	107
Cedar Waxwing	57
Song Sparrow	55
Common Nighthawk	54
Solitary Sandpiper	44
Brown Creeper	34
Red-breasted Nuthatch	34
Pileated Woodpecker	27
Least Flycatcher	22
Pacific-slope Flycatcher	22
Bohemian Waxwing	20
Dark-eyed Junco	19
House Wren	18
Bewick's Wren	17
Trumpeter Swan	17
Chestnut-backed Chickadee	16
Hammond's Flycatcher	15

Northern Waterthrush	15
Bushtit	12
Northern Shoveler	11
Common Raven	10
Marbled Murrelet	10
Common Redpoll	9
Golden-crowned Kinglet	9
Tree Swallow	9
American Pipit	8
American Robin	8
Yellow-rumped Warbler	8
Red-tailed Hawk	7
Western Tanager	7
House Finch	6
Sandhill Crane	6
Brown-headed Cowbird	5
Eastern Kingbird	4
Purple Finch	4
Belted Kingfisher	3
MacGillivray's Warbler	3
Marsh Wren	3
Red Phalarope	3
Ruby-crowned Kinglet	3
Bald Eagle	2
Black-capped Chickadee	2
Chipping Sparrow	2
Dusky Flycatcher	2
Mallard	2
Mountain Chickadee	2
Rock Wren	2
Sora	2

Vesper Sparrow	2
White-winged Crossbill	2
American Tree Sparrow	1
Barn Swallow	1
Black-backed Woodpecker	1
Black-throated Gray Warbler	1
California Quail	1
Canada Goose	1
Caspian Tern	1
Downy Woodpecker	1
Eurasian Wigeon	1
Great Blue Heron	1
Hermit Warbler	1
Northern Goshawk	1
Pygmy Nuthatch	1
Red Crossbill	1
Red-naped Sapsucker	1
Townsend's Warbler	1
Tundra Swan	1
Varied Thrush	1
Vaux's Swift	1
Warbling Vireo	1
Wood Duck	1
Total:	**3712**

Probability of Violet Green Swallow given data recordings

Estimated mean probability: 0.519 (≈51.9%)

Median score: 0.463

Share of clips ≥ 0.5: 45.1%

Share ≥ 0.7: 23.7%

Share ≥ 0.9: 4.1%

95% Confidence Interval for Violet Green Swallow

Sample size (n): 266

Mean value: 0.5193

Standard deviation: 0.2059

95% Confidence Interval: (0.494, 0.544)

So we can be 95% confident that the true mean value for Violet-green Swallow lies between 0.494 and 0.544

Appendix 2 Results from the Merlin ID app