Aerial Insectivorous Birds Inventory & Research - Kootenays (COL-F18-W-2501)

Prepared for: Fish and Wildlife Compensation Program
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Contents

List of Tables

List of Appendices

Executive Summary

Nupqu Development (Nupqu), in collaboration with the Ktunaxa Nation Council (KNC) and Hemmera Envirochem (Hemmera), utilized Fish and Wildlife Compensation Program (FWCP) seed grant funding to develop a large grant application. The intention is to submit the large grant application during the FWCP 2019 annual grant application intake. The primary objective, as described in the seed grant application, was to investigate the potential cause of declines in aerial insectivorous bird populations within the Columbia Basin. The intention of the large grant application was to prepare a research strategy to inventory aerial insectivorous bird species in the Columbia Basin, to identify aspects of the species' habitat and biology contributing to observed population declines and investigate actions which could be undertaken to enhance these populations and/or their habitats. As outlined in the seed grant application, this scope was intended to align with a Species-Based Actions project type under the Species on Interest Action Plan. Upon review of the original scope, it was evident that the scope was more applicable as a secondary study. A more focused scope was developed which remains aligned with the Species of Interest Action Plan.

The large grant application that has been developed using the seed grant funding is designed to investigate what impact(s), if any, *Bacillus thuringiensis* subspecies *israelensis* (Bti) application has on insect species abundance and diversity in the region. The study is designed to investigate the diversity and abundance of insect populations in areas treated with Bti, and in untreated control areas. By conducting inventories on aerial insects, our team will then be able to estimate insect diversity and abundance across control sites and make comparisons with the diversity and abundance at sites receiving Bti applications. We ultimately seek to identify the potential impacts Bti applications may have on avian aerial insectivore populations in the Columbia Basin Region. Therefore, during the inventory of aerial insects, we plan to conduct preliminary inventories of aerial insectivorous birds, which we will conduct using point count surveys at the insect sampling sites. The project is designed to also acquire data and information on the abundance and distribution of the aerial insectivorous birds: Barn Swallows (*Hirundo rustica*), Black Swifts (*Cypseloides niger*), Northern Rough-winged Swallows (*Stelgidopteryx serripennis*), Tree Swallows (*Tachycineta bicolor*), Violet-green Swallows (*Tachycineta thalassina*), and Cliff Swallows (*Tachycineta thalassina*), identified by FWCP as inventory species within the Columbia Basin Region. This design aligns with the Species of Interest Action Plan and can be considered a Research and Inventory/Inventory and Monitoring project type. We also seek to acquire data on Bank Swallows and, optimistically, Common Nighthawks (*Chordeiles minor*) due to precipitous declines and designations by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Species at Risk Act (SARA). This research will provide baseline data on these populations of aerial insectivores. Since our research indicates that declines in aerial insectivorous birds may be related to declines in aerial insects, we will focus on insect surveys (with and without Bti application), in conjunction with bird surveys to understand how populations may be affected by prey abundance and distribution and gain new insights into this predator/prey interaction. These surveys and inventories will enable us to gather data related to insects and aerial insectivores, as well as their spatial and temporal abundance and distribution, with the intent of identifying and characterizing the predator/prey relationships, if possible. The site selection for surveys will be conducted with a preference for sites located in riparian or wetland areas. This is intended to contribute to the Riparian and Wetlands Action Plan by enabling monitoring of species presence and abundance in wetland and riparian areas.

Due to the nature of the knowledge gaps regarding the direct and indirect impacts of Bti application and the populations of these birds in the Columbia Basin, this study is designed to form a preliminary dataset that will guide future studies and conservation efforts. We will ultimately seek to maintain or improve the status of the named species of interest within the Columbia Basin by seeking to better understand species

presence and distribution in the study area, which in turn will help inform more detailed species or habitat specific actions that can be taken in the future.

1.0 Introduction

The following aerial insectivorous birds have been identified by the FWCP within the Species of Interest Action Plan as inventory species: Barn Swallow (*Hirundo rustica*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), Tree Swallow (*Tachycineta bicolor*), Cliff Swallow (*Petrochelidon pyrrhonota*), Black Swift (*Cypseloides niger*), and Violet-green Swallow *(Tachycineta thalassina).* These species are associated with a high conservation concern and have been affected by hydro-electric dams and reservoirs in the region, but detailed inventory and monitoring of these species is required to fill knowledge gaps and to establish trends. Aerial insectivores are a group of concern to the KNC, given their sensitivity to environmental health and change. Aerial insectivores that breed within the Columbia Basin were identified within the Breeding Bird Survey (BBS) results for BCR 10. We then compared BBS surveys to FWCP Species of Interest. **Table 1** below shows the comparisons and the estimated population changes for the following aerial insectivores: Barn Swallow, Bank Swallow (*Riparia riparia*), Northern Rough-winged Swallow, Tree Swallow, Cliff Swallow, Black Swift, Common Nighthawk *(Chordeiles minor)* and Violet-green Swallow.

Table 1 Population changes of aerial insectivores within Bird Conservation Region 10, Northern Rockies: 1970-2015

Species Name	Population Changes 1970 – 2015 (%)	FWCP: Species of Interest
Barn Swallow (*Hirundo rustica*)	-86.8	Inventory Species
Bank Swallow (*Riparia riparia*)	-93.8	---
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	-53.8	Inventory Species
Tree Swallow (*Tachycineta bicolor*)	-45.7	Inventory Species
Cliff Swallow (*Tachycineta thalassina*)	-89.9	Inventory Species
Black Swift (*Cypseloides niger*)	-91.7	Inventory Species
Common Nighthawk (*Chordeiles minor*)	-64.2	---
Violet-green Swallow (*Tachycineta thalassina*)	49.3	Inventory Species

Source: ECCC (2017)

It is important to note that these steep declines have led to Barn and Bank Swallows being designated as threatened by both COSEWIC and SARA and listed on Schedule 1 of SARA. In addition, the Black Swift has been assigned an Endangered status by COSEWIC; the Common Nighthawk has been given a status of Special Concern by COSEWIC and has also been designated as threatened by SARA and listed on Schedule 1. (Species at Risk Public Registry). **Table 2** below summarizes this information.

Table 2 Aerial insectivore species within Bird Conservation Region 10, Northern Rockies, that have been assigned a COSEWIC and/or SARA status

Species	COSEWIC Status	SARA Status
Barn Swallow (*Hirundo rustica*)	Threatened	Threatened
Bank Swallow (*Riparia riparia*)	Threatened	Threatened
Black Swift (Cypseloides niger)	Endangered	---
Common Nighthawk *(Chordeiles minor*)	Special Concern	Threatened

Sources: COSEWIC & SARA (2018)

Causes of these declines is unknown, but likely include limiting factors such as: changes of availability of nest sites, loss of artificial nesting sites, and habitat changes affecting foraging ranges. Within the Columbia Basin, habitat loss due to dam construction and impoundment has impacted primary and supporting habitat types for these species, however; none of these factors address the widespread decline in aerial insectivores that is not geographically or species specific. Scientists have been exploring links between insect population changes and aerial insectivore declines, given that feeding on aerial insects is a common feature among all the declining species. Unfortunately, 'long-term data on insect abundance in the Americas is sparse (2008).' There are no large-scale programs in place to monitor aerial insect populations, and little is known about insect population dynamics and trends. In the Bird Watch Canada feature, *Are Aerial Insectivores Being Bugged Out?* author John McCracken presents the concern held by entomologists that insects are in decline, possibly due to light pollution affecting nocturnal insect species, changing aquatic conditions affecting sensitive aquatic stages of flying insects, and climatic variations such as temperature and precipitation extremes (2008). However, McCracken also states that perhaps the most obvious factor causing the decline in insect populations is the widespread use of pesticides (2008).

If there is a change in insect populations, then it follows that this change could impact aerial insectivore populations. Poulin *et al.* address this relationship in their study on the indirect effects of *Bacillus thuringiensis* subspecies *israelensis* (Bti) on breeding birds (2010). As described by Health Canada, Bti is a biological pest control agent used to combat mosquitoes and black flies (2001). It is applied directly to breeding habitat (waterbodies, grassy fields) where mosquito and black fly larvae are found. The bacteria form a protein crystal, which is ingested by the larvae. Once ingested, toxins are activated in the alkaline environment of the insect's digestive system destroying the insect's stomach, which causes death (Health Canada, 2001). The Bti toxin requires an alkaline environment for activation; thus, it is highly effective in killing targeted species and is said to pose minimal risks to non-target organisms (Health Canada, 2001).

Despite the claims that Bti does not have an impact on non-target organisms, a study by Poulin *et al.* is the first to provide compelling evidence that Bti use does affect avian aerial insectivore populations following the suppression of prey species and suggests that widespread application of Bti can have substantial effects on the demography of insectivorous bird populations (2010). This study concluded that Bti treated sites had a compounding effect; not only did Bti application affect the presence of prey, but this study also found smaller prey, lower foraging rates, smaller clutch sizes, less fledged young, and very low chick success at treated sites.

Recent research has drawn linkages between declining aerial insectivore populations and changes in aerial insect populations, such as the research presented in the report, *Stable Isotopes from Museum Specimens*

May Provide Evidence of Long-Term Change in the Trophic Ecology of a Migratory Aerial Insectivore (2018). Through stable isotope analysis, English *et al.* were able to identify that Whip-poor-wills are feeding lower in the food web than they were in the last 100 years (2018). In addition, the team found that this result was consistent in adults as well as in juveniles, and this trend was slightly stronger in breeding grounds than in wintering grounds (English *et al., 2018).* This research corroborates the idea that aerial insectivores could be declining due to changes in the abundance of higher (more nutritionally valuable) trophic-level prey, and this change could be related to declines of insects in lower trophic levels.

The research suggesting that aerial insectivores are impacted by the presence and quality of prey is also reflected in the study, *Foraging Ranges of Insectivorous Bats Shift Relative to Changes in Mosquito Abundance*, in which Gonslaves *et al.* determined that aerial insectivorous bats altered their foraging range in response to fluctuations in distribution and abundance of a preferred prey source (2013). In this study, the preferred foraging site was treated with Bti and the bats responded to the loss of prey by changing their foraging range to a range that was less than ideal, preferentially seeking a specific food source (Gonslaves *et al*,.2013*).* A similar phenomenon was also demonstrated in a study carried out by Razeng *et al*., during which ground-foraging insectivores were selective in the type and quality of prey they ingested. Razeng *et al*. suggest that

> *"…nutritional factors may be a critical determinant of insectivore occurrence, helping to explain occurrence patterns at the patch and landscape scale…" (2015).*

Declining population levels of aerial insectivores are well documented. As indicated by the research, this decline could be due to the changes in insect populations – changes that include a prey source that is nutritionally lacking and/or the resulting need to forage less or further to find the sources aerial insectivores need. Given the potential for Bti to indirectly impact the food source of avian aerial insectivores, as well as the lack of research on insect populations in the Columbia Basin, investigating whether Bti application impacts aerial insect populations is a logical step to better understand insectivorous avian populations and their prey. Our work seeks to both identify insect diversity and to quantify insect biomass. Further, we will explore how biomass may change with Bti application. Our long-term purpose is to determine if a relationship between the insect biomass and aerial insectivore populations exists. Our study also has the potential to address the integrity of ecosystems by identifying if Bti application impacts ecosystem function through the interruption of the predator/prey relationships within it. The ultimate intention of our research is to identify the factor(s) leading to the declines of aerial insectivores in this region. The information gained during this preliminary investigation will be used to inform future investigations and actions, which will seek to maintain and hopefully contribute to the recovery of aerial insectivore species in the Columbia Basin.

2.0 Methods

The primary methods utilized for this project were literature review, desktop review, and personal communications.

2.1 Literature Review

The team undertook an extensive review of peer-reviewed literature pertaining to the direct and indirect impacts of Bti application on target and non-target species as well as ecosystem function. There are

several reports on this topic however, there is little consensus on the indirect impacts of Bti application. Additional literature review was undertaken to gain insight into the cause of avian aerial insectivorous population declines globally as well as within the Columbia Basin. Following these literature reviews, it was clear that there is a limited understanding of the cause of the population declines in these species. The identification of the knowledge gaps regarding Bti impacts and avian aerial insectivore population declines further highlighted the necessity of investigating these topics.

2.2 Large Grant Application Development

The team developed a large grant application based on the template provided by the FWCP. All findings from the initial literature review were used to inform the study design for a large grant application that will be submitted to FWCP in 2019.

2.2.1 Methodology Development

The methodologies developed for this study incorporate both insect abundance and diversity and avian aerial insectivore abundance. Additional research was conducted in order to develop methodology for the monitoring of insect species abundance and diversity. This research involved an additional review of existing peer-reviewed literature as well as personal communications with the Entomology Department at the Royal British Columbia Museum, Bti applicators within the Columbia Basin and other local interest groups. Combined, the research and consultations allowed the team to gain insight on appropriate methodologies and best practices for the monitoring of insect populations as well as collection and storage of specimens.

Methodologies for investigating avian aerial insectivore abundance were developed based on consultation with project team's biologist. The bird survey methodologies were designed to align with protocols established by the Resources Information Standards Committee (RISC). Additionally, the foraging behavior of the avian species of interest also informed the methodology development.

2.2.2 Site Selection

A thorough desktop review along with personal communications with Bti applicators were conducted to inform site selection. Site selection was based on the following components

- A review of regional Mosquito Control programs and associated historical reports of Bti applications.
- Presence of mosquito larvae in data collection season.
- Geospatial data of bird species presence from eBird and the Breeding Bird Survey databases.
- Preference was given to riparian & wetland sites given that FWCP identifies Riparian and Wetlands as the primary or first supporting ecosystem related to the Species of Interest being studied.
- Personal communications with Bti applicator from Morrow Bioscience that conducts annual Bti applications on behalf of the City of Cranbrook and the Regional District of the East Kootenay (Dirk Lewis).
- Avian aerial insectivorous species and insect species foraging behaviours were taken into account to determine minimum distance requirements for site spacing.

- Avian aerial insectivorous species and insect species habitat preferences were also used to inform site selection.
- Site accessibility for regular data collection.

Our final site selection will be based on results of the presence of mosquito larvae, and where Bti treatment occurs (because this can vary year to year).

3.0 Project Outcome

As previously stated, the preliminary research has indicated that significant data gaps exist regarding the in-direct impacts of Bti application on ecosystem components and the cause of avian aerial insectivore population declines, both globally and within the Columbia Basin region. Specific studies, such as the report put forward by English *et al*. indicate a correlation between declining aerial insectivore populations and changes in aerial insect populations (2018). Furthermore, work by Poulin *et al.* indicates the potential linkages between Bti application and the reproductive success of avian aerial insectivore populations (2010). It is recommended that an investigation is undertaken to identify how Bti application in the Columbia Basin is impacting diversity and abundance of insect population. It is suggested that bird surveys are completed in conjunction with this study to provide a baseline inventory and maximize the benefit of the overall project. It is also recommended that the findings of the investigation be used to inform future studies focused on avian aerial insectivore population declines. Our team intends to submit a large grant application to the FWCP during the 2019 intake period.

APPENDIX A – References

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