

Wildlife Research Permit Background

Title: Migratory connectivity, contaminant exposure, demographics, diet and behavior of boreal treeline passerines during the breeding and migration seasons

Main Investigators:

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Objectives

- 1) Migratory Connectivity:** Assess spatial linkages between breeding and non-breeding areas of adult birds using feather stable isotopes and miniaturized radio tags. Focal species: Harris’s Sparrow (*Zonotrichia querula*), American Tree Sparrow (*Spizelloides arborea*), Blackpoll Warbler (*Setophaga striata*) and Gray-cheeked Thrush (*Catharus minimus*).
- 2) Contaminants:** Assess neonicotinoid pesticide exposure in adult birds during spring migration and carryover to the breeding season.
- 3) Diet and trophic partitioning:** Use fecal metabarcoding and stable isotopes as proxies for diet and trophic partitioning and positioning of multiple common bird species.
- 4) Breeding demographics:** Determine factors influencing productivity, return rates, and survival of birds captured at a boreal forest – Arctic tundra ecotone (northern “treeline”) breeding site in the Northwest Territories. Focal species: all passerine species captured using this protocol.

Timeline

Sampling for this project will be conducted during migration, ~May 5 – 20 (Saskatoon, SK), and during the breeding season ~June 1 – July 15 (northeast of Yellowknife; Figure 1). We will conduct a pilot study in 2023 and, depending on the results, will aim to increase sampling effort in 2024 – 2027. Samples will be analyzed in the fall and winter following the year of collection and manuscripts will be submitted for publication in scientific journals following completion of analyses and meaningful engagement with our indigenous partners.

Background

The northern treeline ecosystem provides important breeding habitat for migratory birds and is expected to undergo major perturbations resulting from human-induced climate change. Populations of several passerine species that breed at the northern treeline have undergone steep declines in North America over the last half century with several species being listed under the Species at Risk Act (SARA) or assessed by the Committee for the Status of Endangered Wildlife in Canada (COSEWIC). For example, Harris's Sparrow is a species of Special Concern under SARA, COSEWIC has scheduled Grey-cheeked Thrush for a status report preparation for November 2023, and Blackpoll Warbler and American Tree Sparrow are on the candidate assessment lists as mid-priority and low-priority, respectively. However, population status and trend data for boreal songbirds including treeline species are mainly derived from Breeding Bird Surveys, which has very limited coverage North of 60 (Bird Conservation Regions 3, 4, 6 and 7), or from Christmas Bird Counts conducted in the United States when these species are on their wintering grounds, which cannot differentiate trends among breeding populations. While baseline population size data is being collected through existing CWS long-term monitoring projects (e.g. BMS, Arctic PRISM; Figure 1), generation of trend information from these programs for treeline songbirds are still years away and significant spatial gaps in monitoring coverage and research remain.

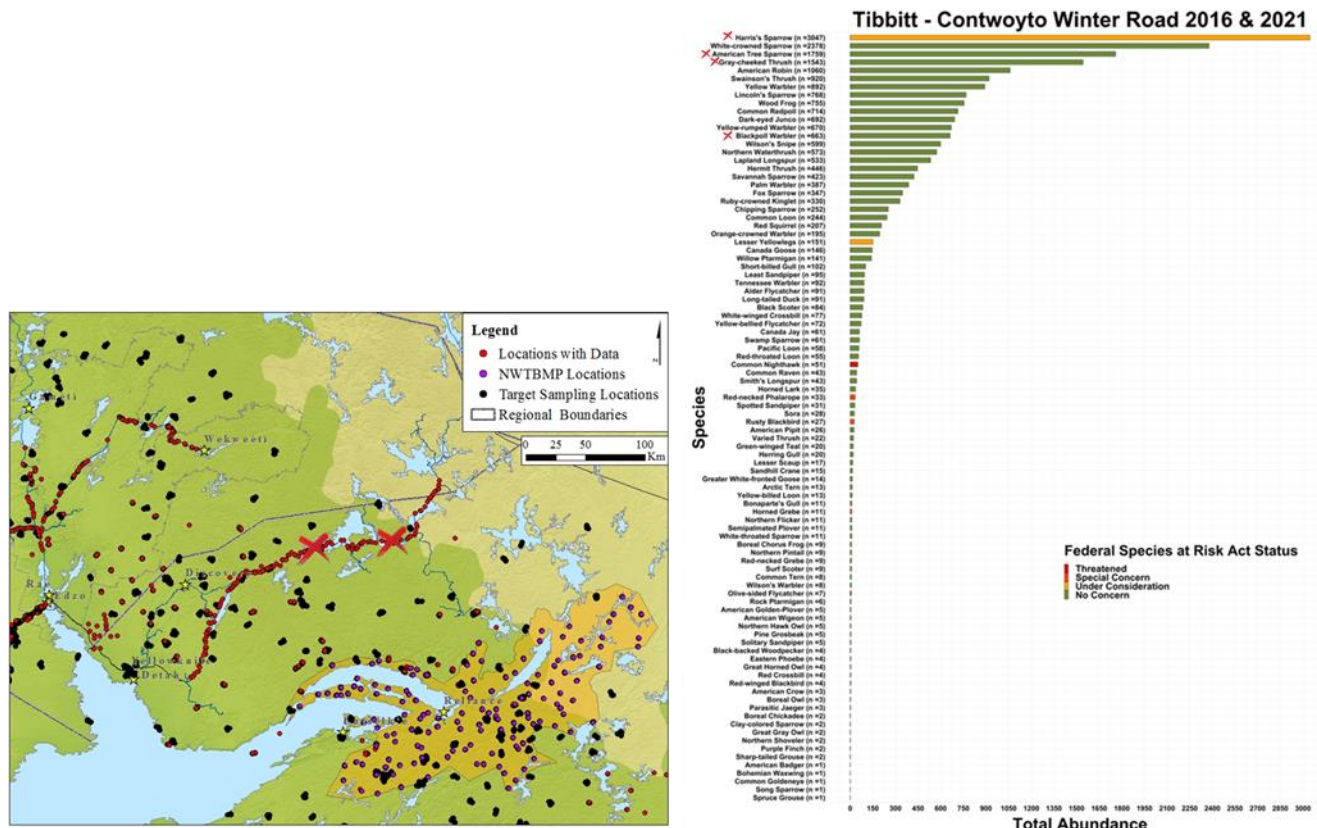


Figure 1. Map shows the Boreal Monitoring Strategy (BMS) sampling locations with avian data (in red; audio recorders or human point-count surveys), with both audio recorders and wildlife camera data (purple), and those that are not yet sampled. The bar graph shows the number of detections per species for the Tibbitt to Contwoyto Winter Road monitoring program (99 sampling locations surveyed in 2016

and a subset of these locations in 2021). The red X in the map shows two potential sites for this study and those in the bar graph is to indicate the values for the four main focal species in the study.

Avian research in the treeline ecosystem in Canada is limited due to logistical difficulties in working there (i.e. remote) with most studies occurring ca. 30 years ago. As a result, little is known about the breeding ecology of treeline birds and potential threats over the annual cycle. Targeted studies on treeline breeding birds including community-habitat relationships, demographics, threats during migration, and other fundamental ecological questions can ultimately help inform COSEWIC and SAR processes, conservation management, and land use planning.

Boreal breeding migratory birds including treeline species are exposed to multiple threats over the full-annual cycle. Climate change effects on the breeding grounds and increasing land use intensification (e.g. agriculture) and contaminant exposure on the non-breeding grounds are potential factors influencing population dynamics of treeline species. Migratory connectivity, the spatial connections between breeding and wintering areas can help assess the degree of population mixing and together with existing or enhanced monitoring programs can provide insight into factors driving population trends. Treeline breeding species that over-winter in agricultural areas in the United States and Latin America are potentially exposed to deleterious contaminants and land use changes that may have carry-over effects on key demographic parameters (e.g. breeding success) and survival. Additionally, spring migration coincides with agricultural sowing in the North American Great Plains during which potentially toxic pesticides (e.g. neonicotinoids) are applied and available for consumption representing an additional threat, particularly to granivorous or omnivorous ground foraging birds.

To understand factors affecting demographic parameters of birds breeding in the treeline ecosystem, the study will focus on common passerines (Table 1) breeding at a single location in the treeline ecosystem northeast of Yellowknife, NT (exact location to be determined) using a modified mapping avian productivity and survivorship (MAPS) protocol (<https://birdpop.org/docs/misc/MAPSManual23.pdf>). Birds will be captured using passive and playback and banded in a mist-net 'grid' (~20 nets / 40 ha). Color bands will be applied to four focal species, Harris's Sparrow, American Tree Sparrow, Gray-cheeked Thrush and Blackpoll Warbler. Banding and recaptures or re-sightings will occur over 3 to 4 years following the first year of banding. We will assess our ability to quantify return rates and apparent survival of individual species from these data after one to two years of data collection and incorporate multiple environmental variables into our analyses (e.g. precipitation, temperature). Depending on results from preliminary analyses, we may also try to determine if pesticides influence survival and productivity.

Table 1. Anticipated sample sizes of each treeline breeding passerine species of the study.

Species	Procedure	Anticipated Sample Sizes
Harris' Sparrow	Capture/Band/Morphometrics	60 (20 migration; 40 breeding)
	Color band	40 (breeding)
	Feather, blood sample	40 (20 migration, 20 breeding)
	Fecal sample	20 (10 migration, 10 breeding)
	Fit Radio transmitters	30 (breeding)
American Tree Sparrow	Capture/Band/Morphometrics	60 (40 breeding)
	Color band	40 (breeding)

Species	Procedure	Anticipated Sample Sizes
	Feather, blood sample	40 (20 migration, 20 breeding)
	Fecal sample	20 (10 migration, 10 breeding)
	Fit Radio transmitters	20 (breeding)
Blackpoll Warbler	Capture/Band/Morphometrics	60 (20 migration, 40 breeding)
	Color band	40 (same birds, breeding)
	Feather, blood sample	30 (10 migration, 20 breeding)
	Fecal sample	20 (10 migration, 10 breeding)
	Fit Radio transmitters	20 (breeding)
Gray-cheeked Thrush	Capture/band/morphometrics	60 (20 migration, 40 breeding)
	Color band	40 (breeding)
	Feather, blood sample	40 (20 migration, 20 breeding)
	Fecal sample	20 (10 migration, 10 breeding)
	Fit Radio transmitters	20 (breeding)
Other songbirds: White-crowned Sparrow, Wilson's Warbler, Dark-eyed Junco, Common Redpoll, Yellow-rumped Warbler	Capture using mist nets/band (metal)/morphometrics	300 (100 migration, 200 breeding)
	Feather sample	50 (same birds; ~10/species, breeding)

We will also assess migratory connectivity using VHF radio-transmitters fit to birds on the breeding grounds, which can be detected using the Motus receiver network (<https://motus.org/>) distributed across many parts of southern North America (Figure 2). This part of the study will also target Harris's Sparrow, American Tree Sparrow, Blackpoll Warbler and Gray-cheeked Thrush. This technology requires that focal species are tagged on the breeding grounds to be detected on the non-breeding grounds. We are also planning on deploying a Motus receiver at the study site (Figure 1), which will allow us to determine apparent survival and departure dates for tagged individuals. There is currently only one Motus tower within the Canadian boreal-Arctic treeline. In future years, we plan on deploying tags and expanding the network of Motus receivers across the breeding range of these "treeline species".

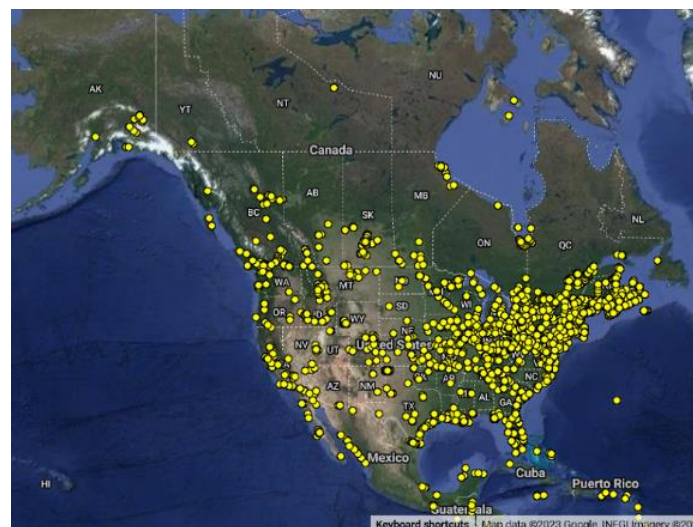


Figure 2. Locations of current and historic Motus towers in North America. The single tower in the Northwest Territories is located at Daring Lake within the treeline ecosystem.

Stable isotopes are incorporated into animal tissues via diet and drinking water and provide useful information on where the tissue was grown. Feathers are especially useful because stable isotope profiles are 'locked in' once formed therefore feathers sampled away from the region of growth (e.g. during migration) can be used to estimate likely origins. Thus, determining origins using isotopic assignment therefore requires capturing and sampling an individual only once. To help assess migratory connectivity during migration, feathers (one tail feather, R3) will be sampled during migration near Saskatoon, SK, but feathers will also be sampled from multiple passerine species on the breeding grounds in the treeline ecosystem to provide isotopic values for these species in our study area.

Diet and isotope niche (a proxy for ecological niche) of the four species will be investigated using fecal and feather samples. Fecal samples are assayed using metabarcoding which provides an assessment of up to species level insect identification. Along with $\delta^2\text{H}_i$, which provides an indication of aquatic diet sources, carbon ($\delta^{13}\text{C}_i$) and nitrogen ($\delta^{15}\text{N}_i$) will also be analyzed providing additional information on aquatic sources and trophic level, respectively. Only one feather sample is required for analysis of all three isotopes therefore feathers collected during the breeding season, and fecal samples collected during breeding and migration seasons will be used for these assays. Feces provide an assessment of diet in the previous hours and feathers provide a measure of isotope niche during the period of feather growth (~10 days).

To assess the potential toxic or negative sub-lethal effects of pesticide exposure over the non-breeding season and during migration through agricultural regions, we will sample blood of the four target species for neonicotinoid assays. Sampling will occur during the breeding season at our boreal treeline study site and during spring migration near Saskatoon, SK. This will allow assessing neonicotinoid exposure during spring migration and pesticide retention over the breeding season. Concentrations of neonicotinoids in blood plasma will be compared among the four species, which have different diet and foraging behaviors, the two sparrow species are omnivorous and the warbler and thrush species are insectivorous, which potentially exposes each species to different levels of neonicotinoids.