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Insights from a decade of using the Motus network to track boreal bird species from Observatoire d'oiseaux de Tadoussac, Québec to temperate and tropical wintering grounds

Perspectivas de una década de uso de la red Motus para rastrear especies de aves boreales desde el Observatoire d'oiseaux de Tadoussac, Québec, hasta sus áreas de invernada templadas y tropicales

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ABSTRACT. Migration is the least-studied phase of the life cycle for many bird species, despite its importance to the full understanding of their life history traits and conservation. Between 2014 and 2023, we deployed tracking devices at Observatoire d'oiseaux de Tadoussac, Québec and used the Motus Wildlife Tracking System to investigate migration patterns of 10 species that breed in boreal and Arctic habitats of eastern Canada, and migrate to wintering areas in the United States and South America. Several species were of special conservation concern in the United States and Canada. Motus receiving stations from Québec to Colombia provided migratory movements for over 350 individual birds. We present and discuss tracking duration and distances, migration routes, stopover, flight statistics, and phenology of fall migration for these species. The array of Motus receivers in the region surrounding the tagging site detected many individuals clearly upon departure, allowing for comparisons of post-capture stopover duration and departure strategy. All tagged species stopped over at the tagging location following capture (mean 8.2 days ± 6.7 SD), which could have been an effect of the capture and tagging process. Short distance migrants (mean 10.6 days ± 7.6 SD) stopped over longer than long-distance migrants (mean 5.3 days ± 3.8 SD). Prolonged (> 7 days) stopovers were detected elsewhere along the migratory routes for six of the species tagged. Eight species were detected during long-distance (> 100 km) migratory flights and estimated flight speeds were similar across species (mean 53.5 km/h ± 22.3 SD). All but one species made primarily nocturnal departures for migratory flights, and three of the species with nocturnal departures were previously thought to be diurnal migrants. The Motus network allowed a reliable method to assess and compare migratory routes and timing for a variety of small birds nesting in Arctic and boreal ecosystems.

RESUMEN. La migración es la fase menos estudiada del ciclo de vida de muchas especies de aves pese a su importancia para comprender plenamente sus rasgos de historia de vida y su conservación. Entre 2014 y 2023, colocamos dispositivos de rastreo en el Observatoire d'oiseaux de Tadoussac, Québec, y utilizamos el Sistema de Rastreo de Vida Silvestre Motus para investigar los patrones migratorios de 10 especies que se reproducen en hábitats boreales y árticos del este de Canadá, y migran hacia sus áreas de invernada en Estados Unidos y América del Sur. Varias de estas especies son de preocupación especial para la conservación en Estados Unidos y Canadá. Las estaciones receptoras de Motus, desde Québec hasta Colombia, registraron los movimientos migratorios de más de 350 aves individuales. Presentamos y discutimos las duraciones y distancias del rastreo, rutas migratorias, sitios de parada, estadísticas de vuelo y la fenología de la migración otoñal de estas especies. La red de receptores Motus en la región circundante al sitio de marcaje detectó a muchos individuos claramente al momento de su partida, lo que permitió comparar la duración de la parada posterior a la captura y las estrategias de partida. Todas las especies marcadas permanecieron en el sitio de marcaje luego de la captura (media de 8.2 días ± 6.7 DE), lo que podría haber sido un efecto del proceso de captura y marcado. Los migrantes de corta distancia (media de 10.6 días ± 7.6 DE) permanecieron más tiempo que los migrantes de larga distancia (media de 5.3 días ± 3.8 DE). Se detectaron paradas prolongadas (> 7 días) en otros puntos a lo largo de las rutas migratorias para seis de las especies marcadas. Ocho especies fueron detectadas durante vuelos migratorios de larga distancia (> 100 km) y las velocidades de vuelo estimadas fueron similares entre especies (media de 53.5 km/h ± 22.3 DE). Todas las especies, excepto una, iniciaron sus vuelos migratorios con partidas principalmente nocturnas, y tres de las especies con partidas nocturnas eran previamente consideradas como migrantes diurnas. La red Motus representó un método confiable para evaluar y comparar rutas migratorias y tiempos de migración en una variedad de aves pequeñas que nidifican en ecosistemas árticos y boreales.

Key Words: *boreal birds; departure timing; Motus; nocturnal migration; stopover; Tadoussac; tagging effects*

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INTRODUCTION

Despite its importance to the full understanding of many bird life history traits and population dynamics, migration remains the least-studied phase of avian life cycles (Barlein and Coppack 2006). The small size of many bird species has limited the use of common tracking technologies to study migration in detail for these species. Advances in tracking technology for individual birds (e.g., satellite telemetry, geolocators, global position system [GPS] tags) has allowed an enhanced understanding of their habitat needs, niche, and phenology, but until recently, this has been limited to large-sized birds or required recapturing individuals to acquire position data (Perras and Nebel 2012). Since 2012, the development of the Motus Wildlife Tracking System (hereafter Motus; Taylor et al. 2017) and the miniaturization of tracking devices have provided individual tracking data on a diverse suite of small-sized birds, providing migration routes, departure times, habitat use, stopover sites, and general behavior (Woodworth et al. 2015, Gómez et al. 2017, Smetzer et al. 2017, Taylor et al. 2017, Bégin-Marchand et al. 2020, 2021, Walker et al. 2024). The Motus radio-telemetry network, consisting of receiving stations covering the American continent and especially the eastern flyway, has expanded rapidly over the past decade and is now capable of providing detailed information on broad-scale movements for many different individuals and species simultaneously without having to recapture the birds (Bégin-Marchand et al. 2020, 2021). Our knowledge regarding bird migration has thus greatly improved over the last decade, especially because of this emerging technology.

Boreal bird species tend to be understudied because of their remote breeding habitats; population trends as well as migratory routes and timing for these species would greatly benefit from additional scientific attention (Sauer et al. 2017, Roy et al. 2019, Walker and Taylor 2020). The limited data available indicate many avian boreal populations have declined in abundance over the last decades in North America and several boreal species are showing alarming declines (Niven et al. 2004, Soykan et al. 2016, Sauer et al. 2017, Rosenberg et al. 2019). The cause(s) of these declines remain largely unknown but identifying migratory routes and stopover sites that link breeding and non-breeding grounds, appears to be one of the most important aspects to study (Webster et al. 2002). Tracking of boreal species via the Motus network allows us to understand key aspects of their life history that may be useful for conservation.

The Observatoire d'oiseaux de Tadoussac (hereafter OOT, https://ootadoussac.ca/en/) was founded in 1993 on the north shore of the St. Lawrence Estuary in Québec to monitor the migration of boreal and Arctic birds and is a member of the Canadian Migration Monitoring Network (CMMN). The north shore of the St. Lawrence Estuary has long been known as a corridor for migratory birds heading to and from the northeastern boreal forest and Arctic, as evidenced by spectacular displays of bird migration in both spring and fall (Ibarzabal 1999; e.g., eBird checklists: https://ebird.org/checklist/S46118050, https://ebird.org/checklist/S139156460, and https://ebird.org/checklist/S31814740). The estuary poses a significant barrier to landbird migration, and in fall, migrants concentrate on the north shore of the St. Lawrence and travel predominantly southwest along the shoreline rather than crossing the estuary (Gagnon et al. 2011). The banding station at OOT is well situated to monitor movements of birds to and from a vast region of boreal forest in eastern Québec and Labrador (Hobson et al. 2015, Brisson-Curadeau et al. 2020).

Here we aim to provide an overview of migratory behavior for 10 boreal and Arctic species tagged along the St. Lawrence Estuary, a migratory corridor for birds that breed on the Labrador Peninsula and eastern Québec. Tagging activities for each species were conducted under separate projects with different research objectives, and the data generated have and will be used for detailed species-specific publications (Bégin-Marchand et al. 2020, 2021, Walker et al. 2024). To date, published studies using these data have shown that: (i) Swainson's, Gray-cheeked, and Bicknell's Thrushes from breeding populations in the same region follow different migratory routes, with Swainson's Thrushes taking a more inland route and stopping over more than the other two species (Bégin-Marchand et al. 2020), (ii) Swainson's Thrushes from six sites in eastern Canada maintained their spatial structure during migration despite converging in the same region north of the Gulf of Mexico (Bégin-Marchand et al. 2021), and (iii) Rusty Blackbirds tagged at OOT and at breeding sites in New England exhibited chain migration by maintaining their latitudinal sequence throughout the year, despite converging on the same stopover region in the mid-Atlantic U.S. (Walker et al. 2024). To date, tracking data from the other seven species have not been published. Here we combine the datasets from these distinct projects to compare aspects of migratory behavior including routes, post-capture stopover duration, stopover sites, flights, and phenology across 10 boreal and Arctic breeding species. The Motus network provides a unique opportunity to reveal migratory behavior of species that are too small to carry satellite tags, and for which recapturing birds to download GPS or geolocator data is not feasible. Strategic placement of Motus receivers allowed for stopover durations, migratory departures, and flight paths to be quantified.

METHODS

Study species

Between 2014 and 2023, we deployed tracking devices using Motus to investigate migration patterns of 10 boreal and Arctic breeding bird species in eastern Canada: Northern Saw-whet Owl (*Aegolius acadicus*), Horned Lark (*Eremophila alpestris*), Gray-cheeked (*Catharus minimus*), and Swainson's Thrushes (*Catharus ustulatus*), American Pipit (*Anthus rubescens*), Pine Grosbeak (*Pinicola enucleator*), Purple Finch (*Haemorhous purpureus*), Pine Siskin (*Spinus pinus*), Rusty Blackbird (*Euphagus carolinus*), and Blackpoll Warbler (*Setophaga striata*). Of these 10 species, three were long-distance migrants known to winter in South America (Gray-cheeked Thrush, Swainson's Thrush, and Blackpoll Warbler) and the remainder were short-distance migrants or irruptive species, that winter in North America.

Study site

We captured birds during fall migration at Observatoire d'oiseaux de Tadoussac, Québec (OOT; 48.15°N, -69.67°W), located in the south of the Labrador Peninsula. OOT is situated on the north shore of the St. Lawrence estuary, an area that concentrates migratory birds during both spring and fall migration as they travel to and from boreal and Arctic breeding areas of the Labrador Peninsula (Hobson et al. 2015, Brisson-Curadeau 2020). The banding site is located in the dunes of Tadoussac, a raised coastal terrace with expanses of open sand surrounded by stunted boreal forest. Because of the openness of the vegetation, migrating birds are mostly observed passing through the site rather than settling in to refuel during stopover. We included additional Horned Larks birds captured nearby at Pointe-à-Émile, Québec (48.57°N, -69.19°W), a coastal sandspit bordering intertidal mudflats. Pointe-à-Émile lies 58 km northeast of OOT, and is also situated on the north shore of the St. Lawrence Estuary. In contrast to the dunes at Tadoussac, where migrants typically pass through the banding area, Pointe-à-Émile is a known stopover site for Horned Larks.

Capture and tagging methods

Although OOT conducts standardized banding activities annually along fixed net lanes, we specifically targeted most of the species in this study with separate capture procedures. We typically deployed mist nets in a square configuration around a speaker that periodically broadcasted calls of the target species to lure in birds as they passed over or through the site. At Pointe-à-Émile, we deployed mist nets in the grassy vegetation on the sand spit during low tide, and captured Horned Larks as the tide rose and covered the surrounding mud flats.

Once captured, we affixed lightweight Lotek Avian NanoTags to the banded species using an "8"-shaped harness made beforehand with elastic thread with polyester liner (Rappole and Tipton 1991, Streby et al. 2015). The tag model was selected according to the species weight and we ensured the harness and transmitter represented < 4% of the body mass of the individual, which should not affect the long-term behavior and survival rate of the bird (Caccamise and Hedin 1985, Powell et al. 1998, Townsend et al. 2012, Streby et al. 2015). Each nanotag transmitted at 166.800 Hz and had a unique signature signal, with a burst interval between 5 to 35 seconds and an estimated lifespan between 78 and 938 days, depending on the model, size, and burst interval (Appendix 1). Telemetric monitoring was provided by the Motus network of automated receivers.

Data processing and analysis

All data processing and analyses were conducted using the R 4.3.3 statistical software (R Core Team 2024). We downloaded detection data and metadata from Motus using the R package *motus* 6.0.1 (Birds Canada 2023) on 1 February 2024. The detection data were filtered to eliminate false detections following methods suggested in the Motus R book (Crewe et al. 2018). All runs of two detections were discarded, and runs of three detections or more were retained and evaluated graphically using a *shiny* 1.7.4 application (Chang et al. 2022) to visualize detection patterns for each tagged bird. For each individual, the *shiny* application created plots of latitude and longitude by date, a map of the detections, a table of transitions between receivers including distance and time between detections, and plots of signal strength by time and antenna for specified time periods. The application allowed for visual examination of every detection and created a log of false detections. Tags detected at the capture locations but at no other receivers were considered undetected.

Once the presumed false detections were removed from the dataset, we further used the *shiny* application to identify migratory stopovers and flights. Stopovers were defined as series of detections over multiple hours to days for which there was little change in position (< 100km) or latitude. We defined migratory flights as time periods for which there were sequential detections at multiple receivers in a migratory direction within a ~24-hour period. These migratory flights appeared as vertical lines in the plot of latitude by date in the *shiny* application. To allow for the inclusion of migratory movements of longer duration, we allowed flights to exceed 24 hours but did not include gaps between detections of longer than 24 hours. In cases when there was a series of detections at a stopover site immediately followed by detections at other receivers indicating a migratory flight, we recorded a known departure time for that flight.

We calculated summary statistics using the cleaned detection, stopover, and flight datasets. Tags that were only detected at receivers within 10 km of the capture site were considered undetected for summary statistics, though were included in post-capture stopover or flight departure statistics if a clear departure was evident in the detection data. We calculated tracking duration as the number of days between deployment and the last detection for each transmitter, and tracking distance as the Haversine distance between the capture location and the most distant receiver with a detection using R package *geosphere* 1.5-18 (Hijmans 2022). We portrayed overall migration routes and stopover sites per species using the R packages *ggmap* 4.0.0 (Kahle and Wickham 2013) and *leaflet* 2.2.2 (Cheng et al. 2024).

Many individuals stopped over at or near OOT after being captured and tagged. We measured post-capture stopover duration of these individuals using two methods: known duration and last detection. Those with known duration showed obvious departure flights in the Motus detection data (e.g., sequential detections at multiple receivers heading away from the capture site, or peaks in signal strength at local receivers upon departure). The last detection method included the birds with known duration but also birds that were later detected elsewhere in the Motus network, but for which there was no obvious departure. For birds lacking obvious departures, we calculated duration as the number of days between capture and the final detection at the local receivers. Post-capture stopover durations of long-distance (Gray-cheeked Thrush, Swainson's Thrush, and Blackpoll Warbler) and short-distance (Northern Saw-whet Owl, Horned Lark, American Pipit, Purple Finch, and Rusty Blackbird) migrants were compared with a two-sample t-test. Stopover duration at sites away from the capture location are presented but were not tested statistically because arrival and departure at the sites were mostly unknown.

For flight summary statistics, flights < 30 min duration, < 30 km distance, > 125 km/hr speed, and > 12 hr duration were excluded to minimize the effects of receiver geometry and periods of stopover. We calculated the Haversine distance between the receivers with the first and last detections of each flight using R package *geosphere* 1.5-18 (Hijmans 2022) and elapsed time between the last detection at the first receiver and first detection at the last receiver to estimate flight speed. Flight departure times were recorded when migratory flights were detected leaving the capture site or other stopover sites. A second more inclusive method for estimating flight initiation times recorded the time of first detection for each migratory flight, regardless of whether the flight had a known departure time.

Table 1. Deployment years, number of tags deployed, number and percentage of tags detected > 10km from the capture site, distance traveled (average, SD, maximum), duration of tracking (average, SD, maximum), and number of receivers (n Recvs, average, SD) with detections per species of bird tracked via the Motus network in eastern North America over 10 years (2014–2023). See main text ("Study species") for species scientific names.

Species	Years	Deployed	Detected (%)	Avg km (SD)	Max km	Avg days (SD)	Max days	n Recvs (SD)
Northern Saw-whet Owl	2017-2018	20	11 (55)	219 (245)	818	54 (76)	211	4 (2)
Horned Lark	2019-2022	107	66 (62)	796 (445)	1451	138 (114)	461	5 (3)
Gray-cheeked Thrush	2015-2017	56	48 (86)	1922 (1649)	4902	45 (63)	248	8 (5)
Swainson's Thrush	2014-2017	112	83 (74)	1603 (1785)	4902	51 (70)	242	5 (3)
American Pipit	2019-2021	89	48 (54)	1041 (488)	1959	96 (85)	247	6 (3)
Pine Grosbeak	2014	2	0					
Purple Finch	2022-2023	38	25 (66)	942 (683)	2300	107 (120)	393	7 (4)
Pine Siskin	2014	14	2 (14)	275 (178)	401	23 (2)	24	3 (1)
Rusty Blackbird	2017-2020	114	68 (60)	787 (515)	1859	84 (109)	616	7 (4)
Blackpoll Warbler	2014	27	5 (19)	432 (310)	772	16 (13)	38	4 (2)

To examine migration phenology of the tagged species, we fit a generalized additive mixed effects model (GAMM) to the Motus detection data using R package *mgcv* 1.8-42 (Wood 2011) to estimate latitude by date (day of year) for the six species with sufficient sample sizes (Horned Lark, Gray-cheeked Thrush, Swainson's Thrush, American Pipit, Purple Finch, and Rusty Blackbird). We used detection data from the full calendar year, and used a smoothed interaction term for date by species with a cyclical cubic regression spline, but did not fit a global smoothed term for date, to allow smoothers to take different shapes for each species. We fit a random effect term for each tagged individual, which was fit as a factor smoother, assuming that individuals of each species might take different routes, and fit a random intercept term for year. We fit the model on a reduced dataset including only the final detection per date of each individual, which allowed us to include a continuous temporal autoregressive correlation structure at lag one, to account for repeated detections of the same tagged individuals over time. We calculated predicted values and their 95% confidence intervals from the GAMM model for plotting using the population level means, excluding random effects. Though models were fit for the entire year to provide a bounding latitude for each species, we were primarily interested in interpreting data from fall migration where the number of detections were adequate across species.

RESULTS

In total, we deployed 579 transmitters of which 356 (61%) had valid detections in the Motus network > 10 km from the capture location (Table 1). Detection rates (detected/deployed) varied between species and years, and were lowest for species tagged in 2014 and highest for the two thrush species (Table 1). Neither of the two Pine Grosbeaks tagged in 2014 were later detected, and only two of the 14 Pine Siskins tagged were detected away from the capture site. The two thrush species, which are long-distance migrants, traveled the greatest distances, and both species were detected in Panama and Colombia in years when receivers were active in those countries (Table 1, Online Resource 1). Tracking duration was mostly related to tag model and size, with the longest average durations coming from tags with longer burst intervals that conserve battery life (Appendix 1).

Migratory routes

Motus receiving stations (n = 350) from Canada to South America detected migratory movements for the 356 individual tagged birds (Fig. 1, Online Resource 1, Appendix 2). Online Resource 1 is an interactive map that allows readers to zoom in on migratory routes of each species. Migration routes varied by species depending on wintering destinations, but some similarities were noticeable between species (Fig. 1, Online Resource 1). As expected, during fall migration most individuals of each species headed southwest along the St. Lawrence coastline at least as far south as Québec City, though there were some exceptions for each species where individuals crossed the St. Lawrence and headed to the Atlantic coast (Fig. 1, Online Resource 1). Beyond Québec City, migration patterns diverged with some species taking a more coastal route (e.g., Gray-cheeked Thrush and Blackpoll Warbler) and other species taking a more inland route (e.g., Horned Lark and Swainson's Thrush; Fig. 1, Online Resource 1). Swainson's Thrush migratory routes followed the St. Lawrence to a greater extent than the other species, with many individuals continuing west along the north shore of Lake Ontario and into southern Ontario. There were too few Motus detections from spring to make meaningful comparisons between species for that season, but the data indicate that spring routes may be more inland than fall routes on average (Fig. 1, Online Resource 1, Table 2).

Detection patterns from the six species with the greatest number of tags deployed suggested that shared migratory corridors may exist between some of the boreal and Arctic species tagged at OOT. Many birds clearly followed the St. Lawrence estuary, and the Adirondack/Appalachian Mountains in northern New York appeared to channel birds through the Hudson River Valley or toward the eastern shore of Lake Ontario (Fig. 1, Online Resource 1). In particular, Horned Lark routes diverged near Montréal, and went to either side of the mountains (Fig. 1, Online Resource 1). American Pipits and Rusty Blackbirds showed a similar pattern, though few receivers were in operation in the Hudson River Valley during the years when Rusty Blackbirds were tagged (Fig. 1, Online Resource 1, Appendix 2). Similarly, Lake Ontario appears to present a barrier to migration for individuals of species that migrated that far west, and few birds showed routes that crossed over the water body (Online Resource 1). Many birds were detected on the eastern shore of Lake Ontario, a point where

Fig. 1. Detections of boreal birds tracked via the Motus network in eastern North America during fall migration (orange), winter (blue), and spring migration (green), 2014–2023. Receivers lacking detections are depicted in gray. To aid visualization, the range of the maps omits detections of the two thrush species in Central and South America and Texas, and one Horned Lark detection in Labrador. See main text ("Study species") for species scientific names.

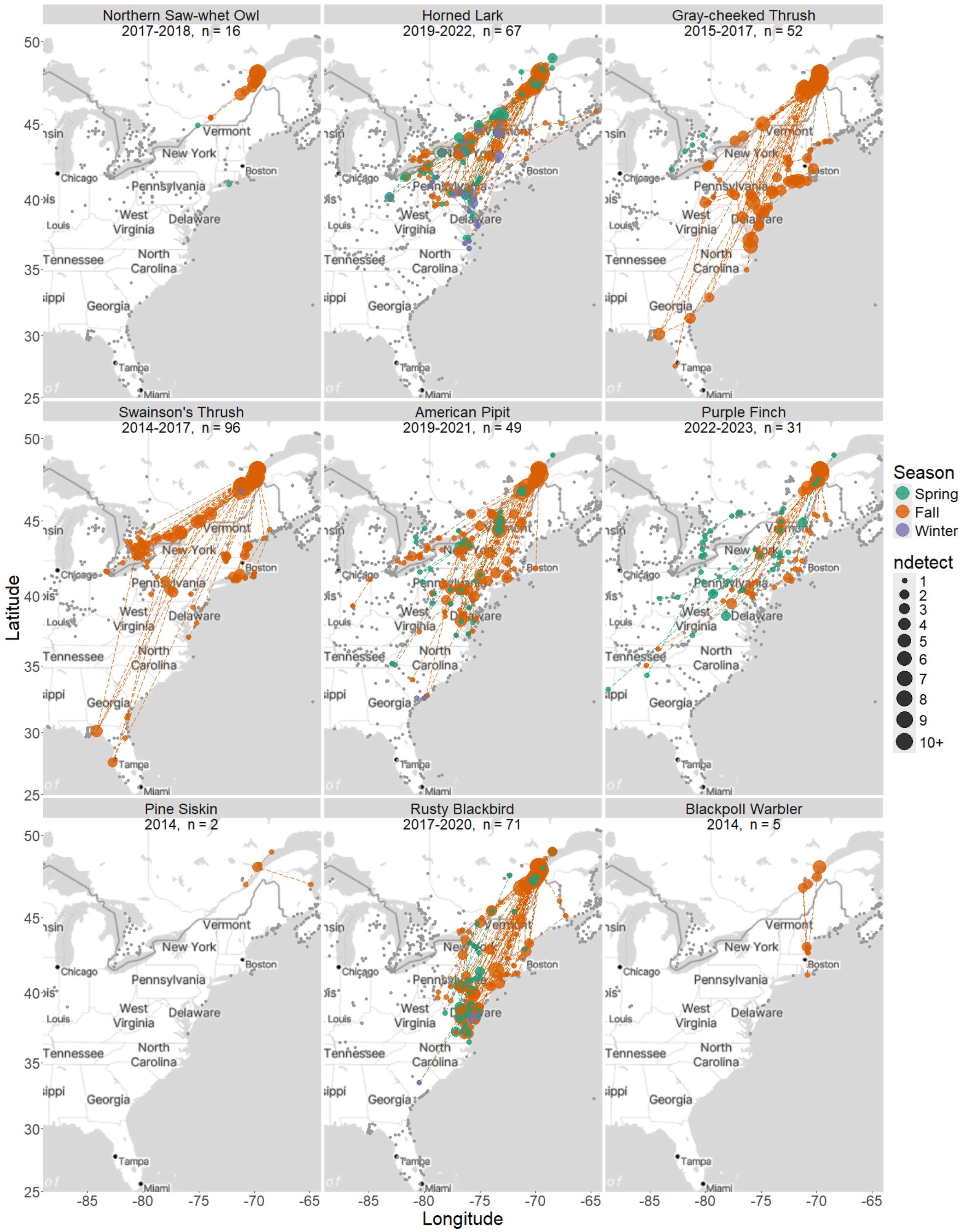


Table 2. Mean capture dates and date ranges for ten boreal and Arctic breeding species affixed with NanoTags at Observatoire d'oiseaux de Tadoussac during fall migration, 2014-2023. The number of tags deployed by species and number of individuals detected by the Motus network each season are also included. See main text ("Study species") for species scientific names.

Species	Deployments				Detections		
	Mean date	First date	Last date	n tags	Fall	Winter	Spring
Northern Saw-whet Owl	07-Sep	01-Sep	21-Sep	20	11	0	2
Horned Lark	28-Sep	21-Sep	10-Oct	107	66	26	32
Gray-cheeked Thrush	20-Sep	14-Sep	26-Sep	56	48	0	6
Swainson's Thrush	19-Sep	10-Sep	29-Sep	112	83	3	15
American Pipit	23-Sep	16-Sep	09-Oct	89	48	2	15
Pine Grosbeak	04-Nov	03-Nov	06-Nov	2	0	0	0
Purple Finch	02-Oct	18-Sep	26-Oct	38	25	0	9
Pine Siskin	17-Oct	04-Oct	06-Nov	14	2	0	0
Rusty Blackbird	23-Sep	10-Sep	04-Oct	114	68	3	13
Blackpoll Warbler	20-Sep	15-Sep	27-Sep	27	5	0	0

many routes shifted from a southwestern to a more southern trajectory (Fig. 1, Online Resource 1). In general, migratory routes were highly variable within each species, and no species showed a consistently narrow migratory corridor. Purple Finch routes showed the least amount of variation in routes and appeared to follow the mountains more than other species, though sample sizes were smaller than the other species (Fig. 1, Online Resource 1).

Few inferences could be made about routes of the four species with the fewest number of tags deployed. Detection rates were low for the species tagged in 2014 (Pine Grosbeak, Pine Siskin, and Blackpoll Warbler), perhaps because of the limited number of receivers available in the region that year (Table 1, Fig. 1). Detections of Northern Saw-whet Owls, tagged in 2017 and 2018, came mostly from the shore of St. Lawrence estuary with one spring detection along the Atlantic coast (Fig. 1). The average tracking duration for Northern Saw-whet Owls was comparable to the other species but the average distance traveled was the least (Table 1). The Motus network detected many individuals of other species tagged at OOT during those years at greater distances, so it appears Northern Saw-whet Owls did not migrate as far as the other species tagged and traveled to areas with low receiver density (Table 1).

Post-capture stopover at OOT

Almost all of the birds tagged at OOT that were later detected elsewhere in the Motus network stopped over near the capture site for multiple days after being tagged (mean 8.2 days ± 6.7 SD; Table 3). Post-capture stopover duration varied by species, and long-distance migrants (mean 5.3 days ± 3.8 SD, n = 104) stopped for 5.3 fewer days on average than short distance migrants (mean 10.6 days ± 7.6 SD, n = 124; t = 6.5, $P < 0.001$; Table 3).

Migratory stopovers

Motus receivers detected 75 migratory stopovers away from the capture location of seven species, 62 in fall and 13 in spring, ranging from 12 hours to three weeks in duration (Fig. 2, Online Resource 1, Table 4). Stopover durations should be considered minima because clear arrivals and departures were not evident in Motus detection patterns for most stopovers away from the capture location. Six of the species studied made prolonged

Table 3. Post-capture stopover duration (days) at the capture site for birds affixed with NanoTags at Observatoire d'oiseaux de Tadoussac during fall migration, 2014–2023. Stopover duration was assessed by two methods: known duration and last detection. Birds with known duration showed clear departures from the capture site in the Motus detection data. The last detection method included stopovers of known duration and additional birds that were later detected elsewhere by the Motus network for which there were no clear departures. See main text ("Study species") for species scientific names.

Species	Known duration			Last detection		
	Mean days (SD)	Range	n	Mean days (SD)	Range	n
Northern Saw-whet Owl	7.1 ± 6.7	0.9 - 24.1	9	6.8 ± 7.8	0.1 - 24.1	12
Horned Lark	16.3 ± 12.2	0 - 38.9	19	14.7 ± 11.9	0 - 38.9	28
Gray-cheeked Thrush	4.5 ± 3.3	0.5 - 13.5	41	3.8 ± 3.2	0.1 - 13.5	52
Swainson's Thrush	5.9 ± 4.1	0.5 - 24.5	59	5.8 ± 5.6	0.1 - 41.6	86
American Pipit	6.7 ± 3.4	1.9 - 15	18	4.8 ± 3.9	0 - 15.0	34
Purple Finch	7.6 ± 3.4	0.1 - 15.8	20	7.3 ± 3.4	0.1 - 15.8	25
Rusty Blackbird	11.5 ± 6.4	1.2 - 40.5	58	10.8 ± 6.6	0 - 40.5	64
Blackpoll Warbler	5.4 ± 2.2	2.4 - 7.5	4	5.4 ± 1.9	2.4 - 7.5	5

stopovers > 1 week in duration. Stopover locations were widespread in northeastern and mid-Atlantic North America and lacked noticeable clustering between species, though the Chesapeake and Delaware Bays region in Pennsylvania, Delaware, Maryland, and Virginia hosted individuals of five of the seven species (Fig. 2).

Migratory flights

The Motus network detected 251 migratory flights of eight species that met our criteria for inclusion in flight statistics (Table 5). Flight speed estimates were similar between species for which there were adequate sample sizes, with an overall mean of 53.5 km/hr ± 22.3 SD (Fig. 3, Table 5). Most of the species were detected on long distance flights of > 200 km and five species were detected on flights exceeding 350 km (Table 5). Flight metrics were not tested statistically because of the imperfect nature of the Motus detections and uncertainty related to receiver geometry.

Diurnal vs nocturnal movements

The departure times of migratory flights indicated that Horned Larks were primarily diurnal migrants, leaving shortly after sunrise, and the remainder of the species with departure data were primarily nocturnal (Fig. 4). Using the first detection of each migratory flight detected by Motus receivers as opposed to using only known departure times yielded a similar (though more dispersed) pattern of detection, suggesting that in the absence of known departure times, flight initiation times could still be estimated (Fig. 4B). Almost all Gray-cheeked and Swainson's Thrushes departed in the first two hours after sunset with little variability (Fig. 4A). Rusty Blackbirds also initiated migratory flights shortly after sunset, but departure times were more variable than those of the thrush species. American Pipits departed throughout the night, and Purple Finches primarily departed four to five hours before sunrise (Fig. 4).

Phenology

Capture dates were similar for long-distance and short-distance migrants passing through OOT, but the long-distance migrants (Gray-cheeked and Swainson's Thrushes) traveled south at a

Fig. 2. Stopover locations during fall (left) and spring (right) migration for seven species affixed with NanoTags at Observatoire d'oiseaux de Tadoussac during fall migration, 2014–2023, that were tracked using the Motus network. The colors of points indicate the species and size shows the duration of stopover in days. Points are partially transparent to show overlap between individuals. The capture location is a black star. Gray points are Motus receivers that were active during the years of the study. See main text ("Study species") for species scientific names.

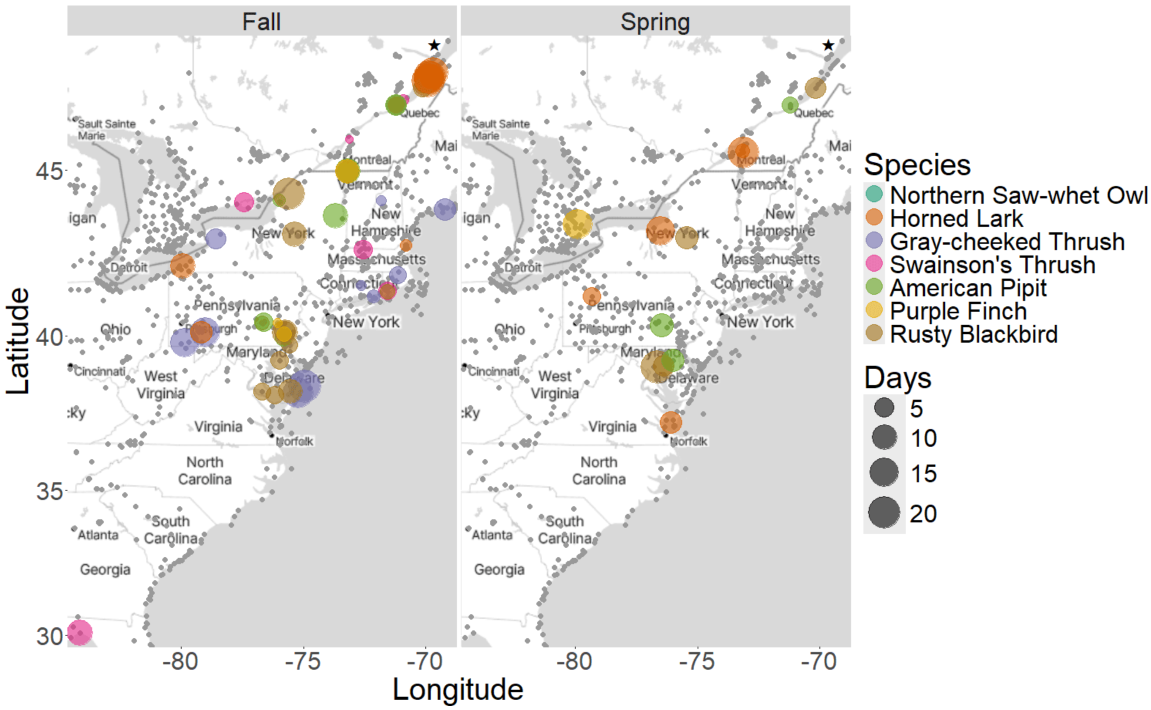


Table 4. Mean stopover duration in days for seven species of birds affixed with NanoTags at Observatoire d'oiseaux de Tadoussac during fall migration, 2014–2023, that were tracked using the Motus network. The range of stopover duration and number of stopovers (n) detected are included. See main text ("Study species") for species scientific names.

Species	Mean days (SD)	Range	n
Northern Saw-whet Owl	3.1 ± 0.0	3.1 - 3.1	1
Horned Lark	9.6 ± 6.0	1.0 - 21.6	26
Gray-cheeked Thrush	9.0 ± 7.9	0.6 - 21.6	10
Swainson's Thrush	4.2 ± 3.7	0.5 - 10.7	6
American Pipit	6.2 ± 3.2	1.1 - 10.6	11
Purple Finch	7.1 ± 7.2	0.6 - 16.0	4
Rusty Blackbird	7.4 ± 5.7	1.9 - 21.2	17

faster pace than the other species after release (Table 2, Fig. 5). Horned Larks wintered the farthest north of any of the species detected outside of the St. Lawrence corridor, and were the only species consistently detected during the winter by the Motus network (Fig. 1, Online Resource 1, Table 2). Horned Larks traveled south at the slowest rate of the species analyzed (Fig. 5). Fall migration timing and rates were similar for American Pipits, Purple Finches, and Rusty Blackbirds (Fig. 5). These three short-distance migrants appeared to winter at similar latitudes in the southeastern U.S. but the density of Motus receivers and hence number of detections was low in that region.

Table 5. Flight statistics for eight species of birds affixed with NanoTags at Observatoire d'oiseaux de Tadoussac during fall migration, 2014–2023, that were tracked using the Motus network. Mean flight speed (km/hr), mean distance traveled (km), and maximum distance traveled (Max km) are included. Flights < 30 min duration, < 30 km distance, > 125 km/hr speed, and > 12 hr duration were excluded to minimize the effects of receiver geometry and stopover. See main text ("Study species") for species scientific names.

Species	n	Mean km/hr (SD)	Mean km (SD)	Max km
Northern Saw-whet Owl	2	17.5 ± 10.4	91.9 ± 67.7	139.7
Horned Lark	35	49.6 ± 25.1	81.3 ± 44.5	198.1
Gray-cheeked Thrush	50	61.9 ± 22.8	212.5 ± 156.0	733.1
Swainson's Thrush	55	48.8 ± 15.7	145.9 ± 105.0	544.2
American Pipit	36	54.9 ± 24.5	169.8 ± 121.4	501.6
Purple Finch	16	54.6 ± 23.6	178.5 ± 117.7	363.2
Rusty Blackbird	55	54.1 ± 21.7	125.4 ± 101.1	456.3
Blackpoll Warbler	2	28.0 ± 14.7	90.0 ± 73.3	141.8

DISCUSSION

Across species, most tagged individuals followed the shoreline of the St. Lawrence Estuary southwest during fall migration, confirming findings of previous studies on bird migration in the region (Ibarzabal 1999, Gagnon et al. 2011). Migratory routes started to diverge at the head of the estuary in Québec City, with

Fig. 3. Histograms of flight speed estimates in km/hr for six species of birds affixed with NanoTags at Observatoire d'oiseaux de Tadoussac during fall migration, 2014–2023, that were tracked using the Motus network. Northern Saw-whet Owl and Blackpoll Warbler flights are not depicted since only two flights were detected for each species. See main text ("Study species") for species scientific names.

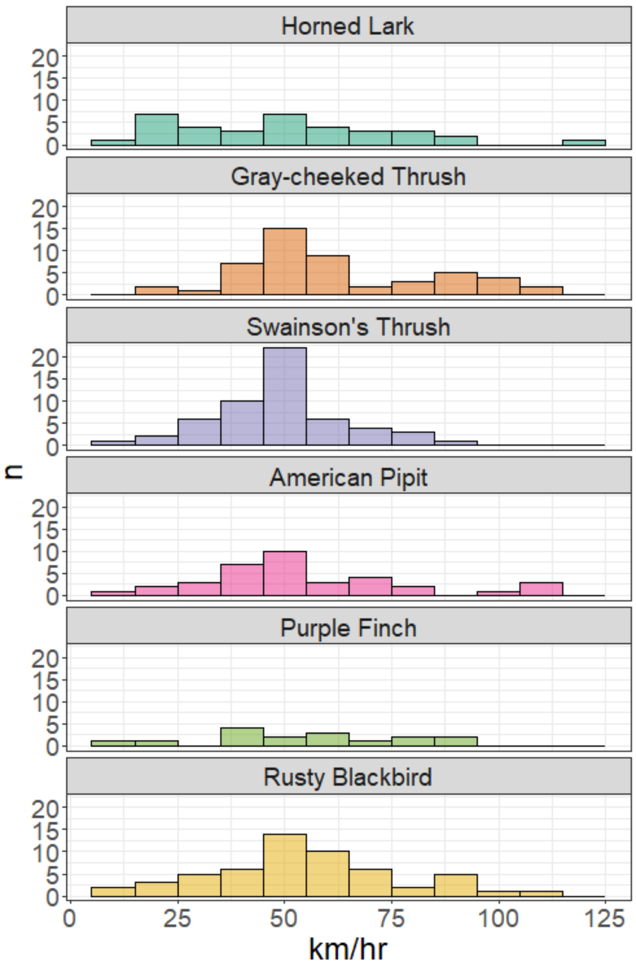
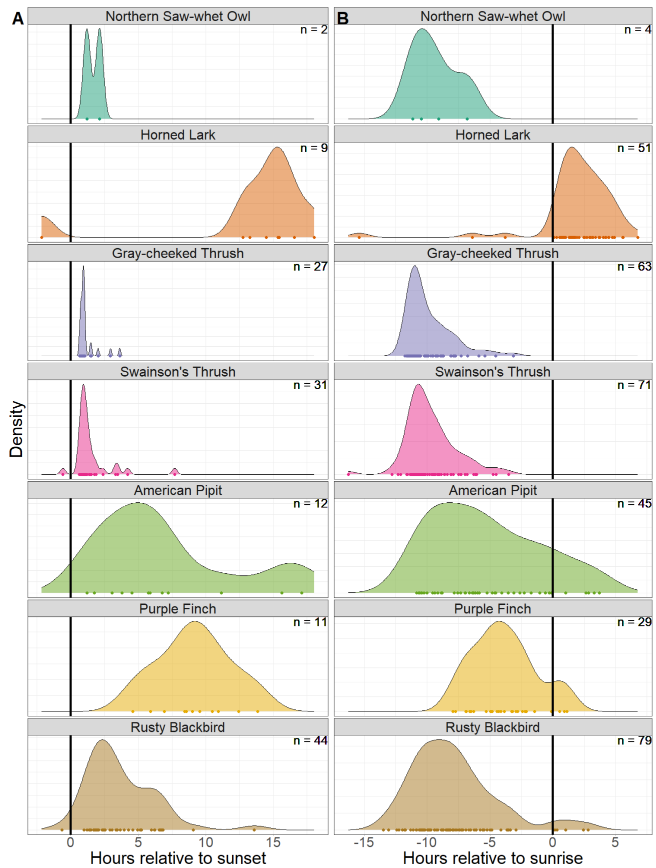


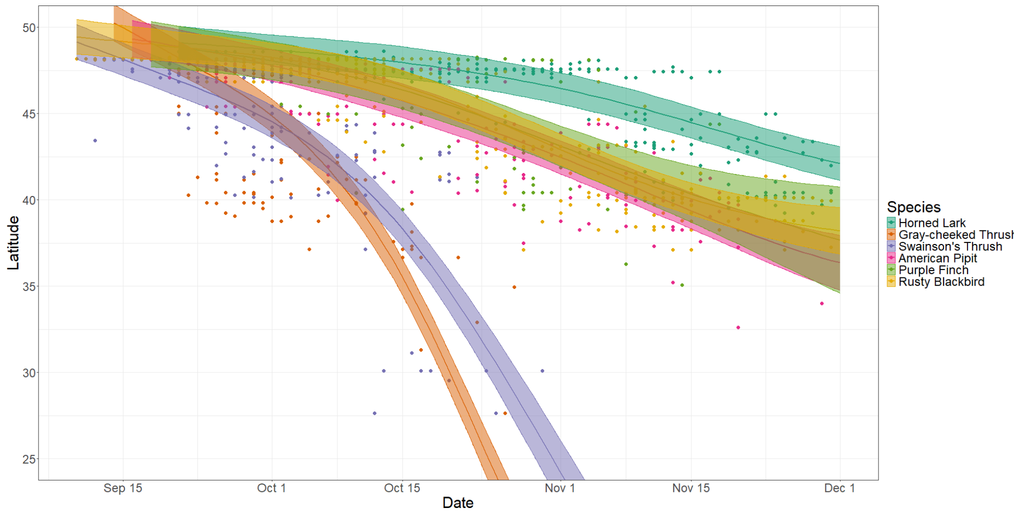
Fig. 4. Density plots of migratory flight departure times relative to sunset (A) and sunrise (B) for seven boreal and Arctic breeding species based on Motus detection data. In panel A, only known departure times were included. Panel B includes the first detection of each migratory flight, regardless of whether the departure time was known or unknown. The y-axis scales vary by species and panel to aid interpretation. The breadth of the colored region is related to the variability in departure time. See main text ("Study species") for species scientific names.



many birds detected in the Hudson River Valley and along the eastern shore of Lake Ontario. Overall, migration routes varied widely both within and between species, which was expected given the vast region of boreal and Arctic habitats on the Labrador Peninsula where birds that migrate through OOT originate. Migration phenology of tagged birds showed that long-distance migrants traveling to South America headed south the fastest, and increased in pace with decreasing latitude.

The density of receivers in the Motus network increased exponentially during the course of this study; however, gaps in receiver coverage in critical areas for birds migrating south from the eastern boreal forest hampered some comparisons between species. For instance, receivers in the northern Hudson River valley were first deployed in 2021 (e.g., Missisquoi Bay NWR and Shelburne Farms; Appendix 2) and detected large numbers of birds from OOT once deployed, but it was impossible to infer if birds tagged prior to 2021 would have taken this route. Similarly, receivers deployed on the eastern shore of Lake Ontario detected many OOT birds (e.g., Derby Hill Bird Observatory, Fassler, and Three Rivers WMA; Appendix 2), but were only installed in 2020. Our detection data suggested that the Adirondack Mountains may present an obstacle for some species, with few routes crossing over the mountains. However, there are no Motus receivers in the Adirondacks to verify whether or not tagged birds take this route. If the Hudson River Valley is indeed a migratory corridor for multiple bird species, placement of Motus receivers in the Adirondacks could show this more equivocally. Identifying such corridors could be critical to placement decisions for wind energy facilities. Overall, an increase in the density of Motus receivers in the state of New York would greatly enhance our understanding of migratory routes of birds from the eastern boreal forest.

Fig. 5. Latitude by date of six species of boreal and Arctic breeding birds affixed with NanoTags at Observatoire d'oiseaux de Tadoussac during fall migration, 2014–2023. The smoothed lines are predicted values and 95% confidence intervals from a GAMM using Motus detection data. See main text ("Study species") for species scientific names.



Additionally, increasing Motus coverage across the boreal forest in Canada and in parts of the southern U.S. would provide invaluable detection data to assess migration connectivity and overall life history characteristics of boreal and Arctic avifauna. In the north, few birds were detected north of Tadoussac because of sparse receiver coverage, and we were not able to identify breeding areas for birds carrying tags with lifespans that were long enough to transmit during the return migration in spring. In the south, the lack of inland Motus receivers below ~38° latitude, namely in Virginia and North Carolina, limited our ability to identify wintering areas for the short distance migrants in this study. Horned Larks were the only species detected consistently during the winter, likely because they wintered farther north in an area with a high density of Motus receivers. Additionally, migratory routes of the two thrush species in the southern U.S. could not be determined, and showed large gaps in detections between northern latitudes and Florida.

Other than Horned Larks tagged at Pointe-à-Émile, we did not anticipate that tagged individuals of other species would stop over near the capture sites. Although the St. Lawrence Estuary is a known corridor that concentrates migratory birds, field observations suggest that migrants primarily pass through OOT rather than stopping over at the site (AT, PC, CBM, FG *personal observations*). We believe the capture and tagging process could have induced these stopovers, or perhaps caused birds to stopover at the tagging site rather than at other stopover sites nearby. These results may have implications for other bird observatories that affix tracking devices to birds during migration, and deserve further investigation. Other studies have documented stopovers subsequent to tagging, though most have occurred at known stopover sites so tagging effects were not discussed (Wright et al. 2018, Green et al. 2019, Grinde et al. 2021, Rüppel et al. 2023). The low overall detection rate of tagged birds away from the capture site (61%) was comparable to other tagging studies and could indicate additional tagging effects such as mortality or the inability to migrate (Rüppel et al. 2023). Although some of these birds simply could have avoided detection by traveling outside the range of Motus receivers, in this study there were many tags that were detected for multiple days or weeks by receivers near the tagging location. Manual tracking with mobile receivers during the weeks following tagging activities could help alleviate some of these concerns, and determine whether tags have been dropped, if birds behaved normally, or if mortality occurred.

With the proliferation of Motus receivers over the past decade, migratory stopover areas can now be identified using automated radio telemetry in eastern North America (Smetzer and King 2018, Smith et al. 2023, Walker et al. 2024). Previously, such inferences could only be made using light level geolocators, archival or transmitting GPS tags, or satellite tags, which require recapturing tagged individuals to acquire data or large species (Perras and Nebel 2012). The stopovers identified in this study further support findings from other studies suggesting that many species of passerines make prolonged (> 7 days) stopovers along their migratory routes, comparable to stopovers made by shorebirds and waterfowl (Smetzer and King 2018). Although the precise locations of stopover sites identified by Motus receivers is unknown, the theoretical maximum detection range of most receivers is 15 km (Taylor et al. 2017) and suggests stopover locations could be within that radius. Further increasing the density of Motus receivers in the network would allow more stopovers to be detected along migratory routes and provide more accurate estimates of stopover locations.

Although it has long been known that many species migrate nocturnally, our understanding of nocturnal versus diurnal migration strategies is still limited for many species and often based on observation data such as diurnal observations, light attraction at night, nocturnal flight calls, and collision events (Farnsworth 2005). The miniaturization of tracking technology has now made these determinations possible. For instance, Rusty

Blackbirds were formerly considered to be diurnal migrants based on observations of flocks migrating over in the morning at locations such as OOT. Motus detection data from birds tagged in Ohio (Wright et al. 2018) and this study show that Rusty Blackbirds are in fact nocturnal migrants, and diurnal observations of migratory flocks are the continuation of nocturnal flights. Here we present new information regarding the migratory strategies of both American Pipits and Purple Finches. Both species were previously considered primarily diurnal migrants, but Motus detection data from birds tagged at OOT indicate migratory departures were mainly nocturnal (Holmes 1982, Hendricks and Verbeek 2020). In contrast, Horned Larks were the only species previously considered to be a diurnal migrant that indeed showed diurnal departures, though several nocturnal flights were detected (Beason 2020). The nocturnal departures for Gray-cheeked and Swainson's Thrushes corroborated our understanding of these species migration strategies, and agreed well with findings of Cooper et al. (2023) that suggested long-distance passerine migrants leave synchronously in the first hour after sunset. Departure times for American Pipits, Purple Finches, and some Rusty Blackbirds occurred in the middle of the night rather than near sunset, suggesting that these short-distance migrants may make shorter flights or continue migrating longer into daylight hours than long-distance migrants. The strategic placement of Motus receivers near OOT and along the migratory corridor of the St. Lawrence Estuary provided accurate departure data for a high proportion of tagged individuals and bird observatories undertaking large scale NanoTag deployments during migration should consider placement of local receivers carefully to ensure that departure information can be obtained reliably. Nocturnal versus diurnal movements could still be assessed based on the Motus detection data in the absence of known departures, though these data were more variable and biased toward later departures.

The comparisons of migratory routes and strategies of the species in this study would not have been possible previously without a method for reliably recapturing tagged individuals. The Motus network provides a reliable and relatively affordable means to directly link breeding areas, migratory stopovers, and wintering areas. As the network of receivers continues to grow, the amount of information that can be obtained from each tag will increase. The results of this study have implications for other bird observatories that tag birds during migration at migratory concentration points. Continued use of Motus on a variety of species may begin to reveal shared migratory corridors and stopover locations critical to conservation of migratory bird species.

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Data Availability:

The data and code that support the findings of this study are available here: https://doi.org/10.17605/OSF.IO/HBY95.

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Appendix 1. Number of Lotek Lightweight Avian NanoTags deployed at Observatoire d'oiseaux de Tadoussac, Québec, 2014-2023, by bird species tagged and model type. Range in mass for each species (g), tag mass (g), burst interval (s), estimated lifespan (days), number deployed, mean tracking duration (days), maximum tracking duration (days), and mean number of Motus receivers that detected each tag are included.

Species	Mass	Model	Tag mass (g)	Burst interval (s)	Estimated lifespan (days)	N deployed	Mean days	Max days	Mean detections
Northern Saw-whet Owl	(65-151g)	ACT-626	1.30	13.0	358	10	116	211	5
Northern Saw-whet Owl	(65-151g)	NTQBW-4-2	1.00	4.7	233	10	18	38	3
Horned Lark	(28-48g)	NTQB2-1	0.28	10.1	78	6	33	51	3
Horned Lark	(28-48g)	NTQB2-3-2	0.68	9.6-10.5	268-287	60	117	237	6
Horned Lark	(28-48g)	NTQB2-3-2-M	0.68	31.1	570	25	255	461	5
Horned Lark	(28-48g)	NTQB2-4-2S	1.00	12.7	662	16	75	192	2
Gray-cheeked Thrush	(26-30g)	NTQB-3-2	0.68	10.1	186	1	184	184	14
Gray-cheeked Thrush	(26-30g)	NTQB-3-2	0.68	12.7	209	7	85	189	7
Gray-cheeked Thrush	(26-30g)	NTQB-4-2	1.00	5.3	254	7	15	59	7
Gray-cheeked Thrush	(26-30g)	NTQB-4-2	1.00	10.7	390	10	25	40	9
Gray-cheeked Thrush	(26-30g)	NTQB-4-2	1.00	19.9	515	31	40	248	9
Swainson's Thrush	(23-45g)	NTQB-3-2	0.68	6.1	137	40	17	94	3
Swainson's Thrush	(23-45g)	NTQB-3-2	0.68	10.1	186	3	176	182	7
Swainson's Thrush	(23-45g)	NTQB-3-2	0.68	12.7-13.1	209-213	32	113	206	6
Swainson's Thrush	(23-45g)	NTQB-4-2	1.00	5.3	254	1	15	15	6
Swainson's Thrush	(23-45g)	NTQB-4-2	1.00	10.7	390	15	16	30	5
Swainson's Thrush	(23-45g)	NTQB-4-2	1.00	19.9	515	21	40	242	8
American Pipit	(19-26g)	NTQB2-1	0.28	10.1	78	10	30	53	3
American Pipit	(19-26g)	NTQB2-3-2	0.68	9.6-10.5	268-287	61	129	247	6
American Pipit	(19-26g)	NTQB2-3-2	0.68	12.5-12.7	326-330	18	57	227	6
Pine Grosbeak	(20-25g)	NTQB-3-2	0.68	6.1	137	2			0
Purple Finch	(18-32g)	NTQB2-3-2-M	0.68	31.1-31.7	570-575	38	107	393	7
Pine Siskin	(12-18g)	NTQB-2	0.35	35.3	127	14	23	24	3
Rusty Blackbird	(47-80g)	ACT-521	0.46	13.0	179	40	38	65	6
Rusty Blackbird	(47-80g)	ANTC-M4-2	1.00	14.9	457	22	77	230	3

Rusty Blackbird	(47-80g)	NTQB-2	0.32	19.9	106	5	31	51	4
Rusty Blackbird	(47-80g)	NTQB-4-2	1.00	5.3	254	1			0
Rusty Blackbird	(47-80g)	NTQB-4-2	1.00	19.9	515	3	110	235	9
Rusty Blackbird	(47-80g)	NTQB2-4-2S	1.00	13.0	673	21	81	225	10
Rusty Blackbird	(47-80g)	NTQB2-6-1	1.70	12.7	938	22	153	616	10
Blackpoll Warbler	(12-13g)	NTQB-2	0.35	35.3	127	27	42	81	4

Appendix 2. Motus receivers that detected boreal and Arctic breeding bird species affixed with NanoTags at Observatoire d'oiseaux de Tadoussac, Québec, including coordinates (latitude °N, longitude °W), years of operation, and number of individuals detected of each species. Banding codes are used to save space, species included are: Northern Saw-whet Owl (NSWO), Horned Lark (HOLA), Gray-cheeked Thrush (GCTH), Swainson's Thrush (SWTH), American Pipit (AMPI), Purple Finch (PUFI), Pine Siskin (PISI), Rusty Blackbird (RUBL), and Blackpoll Warbler (BLPW).

Receiver Name	Lat °N	Lon °W	Date range	NSWO	HOLA	GCTH	SWTH	AMPI	PUFI	PISI	RUBL	BLPW	Total
Tadoussac2	48.16	-69.66	2014-2021	16	11	52	50	30	0	0	64	0	223
Pointe Noire	48.12	-69.72	2014-2023	8	2	34	62	6	25	2	60	5	204
St-Denis-sur-Mer	47.52	-69.95	2014-2023	3	9	26	24	5	7	0	23	2	99
Kamouraska	47.57	-69.86	2014-2024	3	34	6	12	11	7	0	24	0	97
Grève de Tadoussac	48.14	-69.72	2016-2024	6	1	20	18	7	7	0	31	0	90
D'Estimauville	46.84	-71.21	2014-2024	4	6	13	21	13	2	0	12	2	73
Cap Tourmente	47.07	-70.79	2014-2024	2	8	11	20	10	5	1	8	2	67
Anse au Persil	47.88	-69.55	2017-2023	0	16	6	2	12	7	0	18	0	61
Tadoussac - Mobile	48.16	-69.66	2017, 2022-2023	1	3	11	8	0	25	0	6	0	54
St-Roch-des-Aulnaies	47.31	-70.17	2017-2024	3	10	11	4	3	5	0	18	0	54
Riviere-Ouelle	47.43	-70.06	2015-2023	0	18	6	4	0	2	0	11	0	41
St. Andre Est (Kamouraska)	47.70	-69.70	2015-2019	1	5	13	8	1	0	0	11	0	39
Port-aux-Saumons	47.76	-69.95	2014-2019	7	1	6	10	1	0	0	2	0	27
Derby Hill Bird Observatory	43.53	-76.24	2020-2024	0	15	0	0	5	0	0	2	0	22
Grandes-Bergeronnes	48.26	-69.52	2014-2024	1	12	0	1	0	3	1	3	0	21
Blue Marsh Lake SGL	40.41	-76.08	2017-2024	0	8	1	0	3	3	0	4	0	19
La Fragua	4.32	-74.54	2015-2016	0	0	4	15	0	0	0	0	0	19
Missisquoi Bay NWR	44.97	-73.20	2021-2024	0	8	0	0	7	3	0	0	0	18
Shelburne Farms	44.40	-73.27	2021-2024	0	6	0	0	9	3	0	0	0	18
D8C_2	40.40	-76.68	2017-2024	0	3	0	0	6	2	0	6	0	17
FM Camp Mercier	47.22	-71.22	2014-2023	0	1	6	7	0	0	0	1	0	15
McGill_Bird_Observatory	45.43	-73.94	2015-2024	1	1	2	6	2	0	0	2	0	14
St-Jean-Baptiste	45.52	-73.13	2022-2024	0	10	0	0	1	2	0	0	0	13
Black Log Tower	40.43	-77.65	2017-2024	0	4	2	2	3	1	0	1	0	13
Pte-Moreault	47.96	-69.48	2017-2019	0	3	1	0	0	0	0	8	0	12

Saunders	45.01	-74.79	2016-2024	0	0	6	4	0	0	0	1	0	11
Pointe à la Loupe	48.08	-69.28	2017-2023	0	5	0	0	0	2	0	3	0	10
FM Jardin Nord	47.39	-71.08	2015-2017	0	0	7	3	0	0	0	0	0	10
FM4_2	47.34	-71.12	2015, 2017	0	0	6	4	0	0	0	0	0	10
SUNY Potsdam - Bowman Hall	44.66	-74.97	2020-2024	0	6	0	0	2	0	0	2	0	10
Newtowne Neck State Park, Compton, MD	38.25	-76.70	2017-2024	0	0	0	0	5	0	0	5	0	10
Crysler Park Marina	44.94	-75.09	2014-2024	1	2	1	5	0	0	0	0	0	9
Lemoine Point C.A.	44.22	-76.61	2014-2024	0	0	3	5	0	0	0	1	0	9
Lake Shore Marshes WMA	43.31	-76.78	2020-2024	0	7	0	0	2	0	0	0	0	9
Deer Pond Farm	41.55	-73.52	2018-2024	0	0	0	0	3	0	0	6	0	9
B10A	40.48	-76.61	2017-2024	0	1	0	0	2	2	0	4	0	9
Rushton Farm	39.98	-75.49	2016-2024	0	2	0	0	3	0	0	4	0	9
Patuxent River Park	38.77	-76.71	2017-2024	0	0	3	0	1	0	0	5	0	9
SKID	37.13	-75.93	2016-2017	0	0	8	1	0	0	0	0	0	9
Pointe-aux-Outardes3	49.04	-68.46	2016-2023	0	2	0	0	1	1	0	4	0	8
Macdonald Campus of McGill University	45.41	-73.94	2018-2024	1	1	0	0	2	0	0	4	0	8
Fassler	43.37	-75.91	2020-2024	0	3	0	0	3	0	0	2	0	8
Northern Montezuma WMA	43.07	-76.72	2017-2024	0	5	0	1	2	0	0	0	0	8
Strawberry Fields Preserve	42.92	-74.12	2020-2024	0	2	0	0	3	1	0	2	0	8
PKR_salt_pannes	42.78	-70.81	2014-2024	0	1	2	1	0	0	0	3	1	8
Hammonassett SP	41.26	-72.55	2015-2016, 2019-2024	0	0	2	0	3	2	0	1	0	8
Middle Creek SGL	40.27	-76.25	2017-2024	0	3	0	0	3	1	0	1	0	8
Buck Run	39.94	-75.81	2020-2024	0	1	0	0	2	1	0	4	0	8
Bucktoe Preserve	39.82	-75.72	2017-2024	0	0	6	0	1	0	0	1	0	8
Buntings	38.14	-75.19	2014-2024	0	1	3	1	0	0	0	3	0	8
St. Marks NWR, FL	30.09	-84.16	2017-2024	0	0	4	4	0	0	0	0	0	8
Three Rivers WMA	43.21	-76.32	2020-2024	0	6	0	0	1	0	0	0	0	7
LACK04	41.45	-74.99	2020-2024	0	1	0	0	4	0	0	2	0	7
South Valley	44.87	-71.23	2019-2024	0	0	0	0	2	2	0	2	0	6
Murcrest Farms	43.91	-75.71	2021-2024	0	5	0	0	1	0	0	0	0	6
Sandbanks Provincial Park	43.89	-77.27	2014-2024	0	0	3	2	1	0	0	0	0	6
WNERR	43.34	-70.55	2013-2023	0	0	1	2	0	0	0	3	0	6

Greenwoods Conservancy	42.72	-75.10	2020-2024	0	1	0	0	1	3	0	1	0	6
Westfield Correll	42.31	-79.65	2015-2024	0	3	2	1	0	0	0	0	0	6
FRIS	40.63	-73.22	2016-2024	0	0	3	0	0	0	0	3	0	6
Ned Smith Center	40.53	-76.94	2018-2024	0	1	0	0	2	0	0	3	0	6
SHNJ	40.43	-73.98	2016-2024	0	0	4	0	0	0	0	2	0	6
D2 Pine Tree	40.43	-76.72	2017-2024	0	1	0	0	3	2	0	0	0	6
Waggoners Gap	40.28	-77.28	2017-2024	0	1	2	3	0	0	0	0	0	6
DuPont Environmental Education Center	39.72	-75.56	2020-2024	0	2	0	0	1	0	0	3	0	6
Lamb's Knoll	39.45	-77.63	2019-2024	0	0	0	0	2	3	0	1	0	6
Grain Elevator	39.23	-75.99	2019-2021	0	2	0	0	1	0	0	3	0	6
FORT	39.22	-75.17	2014-2024	0	0	4	0	0	0	0	2	0	6
Interstate Fire Tower	38.80	-75.72	2020-2024	0	1	0	0	0	0	0	5	0	6
SAVA03	37.32	-76.01	2017-2022	0	1	1	0	2	0	0	2	0	6
BBVA	36.67	-75.92	2016-2024	0	0	6	0	0	0	0	0	0	6
UdeSherbrooke	45.38	-71.93	2016-2024	0	0	1	0	2	0	0	2	0	5
Napanee LOSH	44.35	-76.89	2016-2024	0	0	0	3	2	0	0	0	0	5
Perch River WMA	44.09	-75.97	2020-2024	0	4	0	0	0	0	0	1	0	5
Buckner	43.59	-73.41	2019-2024	0	4	0	0	1	0	0	0	0	5
Iroquois NWR Headquarters	43.11	-78.40	2020-2024	0	4	0	0	1	0	0	0	0	5
Binbrook Conservation Area	43.10	-79.83	2014-2024	0	2	0	2	1	0	0	0	0	5
TRUS	41.37	-71.58	2015-2023	0	0	3	1	0	0	0	1	0	5
NAPA	41.31	-71.88	2014-2024	0	0	3	2	0	0	0	0	0	5
PLIS	41.19	-72.16	2015-2017	0	0	5	0	0	0	0	0	0	5
BISE	41.15	-71.55	2014-2017	0	0	4	1	0	0	0	0	0	5
Big Pocono Fire Tower	41.04	-75.35	2019-2024	0	2	0	0	1	1	0	1	0	5
A34 Repeater	40.44	-76.60	2017-2024	0	2	0	0	1	0	0	2	0	5
Green Valley	40.15	-75.69	2017-2024	0	0	2	1	0	0	0	2	0	5
Marshlands 1	40.13	-75.77	2017-2024	0	0	0	0	1	1	0	3	0	5
James River NWR	37.26	-77.14	2018-2022	0	0	0	0	2	0	0	3	0	5
Upper & Lower Lakes WMA	44.62	-75.23	2020-2024	0	2	0	0	0	0	0	2	0	4
Rome WMA	43.18	-75.50	2020-2024	0	0	0	0	0	2	0	2	0	4
Seneca Meadows	42.93	-76.85	2017-2021	0	2	0	0	2	0	0	0	0	4

PKR_nelson	42.75	-70.82	2013-2019	0	0	1	2	0	0	0	0	1	4
Albany Pine Bush Preserve Discovery Center	42.72	-73.86	2018-2024	0	1	0	0	1	1	0	1	0	4
Myers Point	42.54	-76.55	2019-2024	0	1	0	0	1	0	0	2	0	4
Elk38	41.54	-78.87	2018-2024	0	4	0	0	0	0	0	0	0	4
SACH	41.48	-71.24	2014-2024	0	0	1	3	0	0	0	0	0	4
Snowshoe_2	41.03	-77.96	2017-2024	0	1	0	2	0	1	0	0	0	4
CONY	40.57	-73.98	2016-2024	0	0	3	0	0	0	0	1	0	4
Connex Village	40.47	-76.60	2017-2024	0	0	0	0	1	0	0	3	0	4
Binkey	40.25	-79.33	2016-2024	0	1	0	0	1	2	0	0	0	4
Hickory Ridge	39.71	-78.00	2019-2024	0	1	0	0	2	0	0	1	0	4
Norman G. Wilder WMA	39.03	-75.64	2020-2024	0	1	0	0	0	0	0	3	0	4
CHDE	38.77	-75.09	2016-2022	0	0	1	0	0	0	0	3	0	4
Castleton View	38.60	-78.11	2019-2024	0	0	0	0	1	2	0	1	0	4
Assateague State Park	38.24	-75.14	2014-2024	0	1	2	0	0	0	0	1	0	4
Wellington WMA	38.16	-75.62	2019-2024	0	0	0	0	1	0	0	3	0	4
New Point Comfort	37.32	-76.28	2019-2022	0	1	0	0	0	0	0	3	0	4
Fisherman's Island	37.10	-75.98	2018-2024	0	1	0	0	0	0	0	3	0	4
GA_SSI_DOCK	31.30	-81.34	2017-2024	0	0	3	1	0	0	0	0	0	4
Galeta	9.40	-79.86	2016-2024	0	0	3	1	0	0	0	0	0	4
Cate's Hill	44.51	-71.19	2021-2024	0	1	0	0	1	0	0	1	0	3
Lennox OPG	44.15	-76.84	2020-2024	0	2	0	0	0	0	0	1	0	3
Wolfe	44.14	-76.39	2016-2024	0	0	0	2	1	0	0	0	0	3
Bronte Creek Provincial Park	43.40	-79.76	2015-2024	0	0	0	2	1	0	0	0	0	3
FURBISH (RHC-2)	43.28	-70.58	2014-2018	0	0	1	2	0	0	0	0	0	3
Utica Zoo	43.08	-75.25	2020-2024	0	0	0	0	0	1	0	2	0	3
Bennington College	42.92	-73.24	2022-2024	0	2	0	0	0	1	0	0	0	3
Bennett Meadow	42.68	-72.47	2015-2018	0	0	1	2	0	0	0	0	0	3
West Port Bruce	42.66	-81.06	2015-2024	0	1	0	0	2	0	0	0	0	3
MountToby	42.49	-72.54	2015-2016	0	0	2	1	0	0	0	0	0	3
Fort River	42.34	-72.57	2015-2024	0	0	0	1	2	0	0	0	0	3
Kilgas	42.18	-79.84	2015-2024	0	1	2	0	0	0	0	0	0	3
RCPT	42.07	-70.24	2015-2017	0	0	3	0	0	0	0	0	0	3

Center at Pomfret	41.87	-71.95	2021-2024	0	0	0	0	1	1	0	1	0	3
Pymatuning - Ford Island	41.64	-80.42	2019-2024	0	1	0	0	1	1	0	0	0	3
SGL 44_2	41.32	-78.77	2017-2024	0	0	1	1	0	1	0	0	0	3
NOMA	41.26	-70.82	2014-2024	0	0	2	1	0	0	0	0	0	3
BLOCKI-1	41.21	-71.56	2014-2015	0	0	1	2	0	0	0	0	0	3
Oley Valley High School	40.39	-75.78	2022-2024	0	3	0	0	0	0	0	0	0	3
Jay Drasher	40.32	-75.90	2017-2024	0	0	3	0	0	0	0	0	0	3
PARC Mt. Laurel	40.18	-79.15	2018-2023	0	1	0	0	2	0	0	0	0	3
Columbus Zoo	40.16	-83.11	2018-2024	0	3	0	0	0	0	0	0	0	3
Friedline Field	40.14	-79.29	2016-2017, 2021-2024	0	0	0	1	0	2	0	0	0	3
PARC SGL223	39.77	-80.01	2017-2018	0	0	3	0	0	0	0	0	0	3
AVNJ	39.09	-74.72	2016-2024	0	0	3	0	0	0	0	0	0	3
Patuxent Research Refuge	39.03	-76.80	2019-2024	0	0	0	0	1	0	0	2	0	3
DWL Great Cypress Swamp	38.48	-75.32	2019-2024	0	1	0	0	1	0	0	1	0	3
Blackwater NWR	38.45	-76.09	2019-2024	0	0	0	0	1	0	0	2	0	3
Dameron Marsh	37.79	-76.31	2019-2022	0	0	0	0	0	0	0	3	0	3
Langley AFB	37.10	-76.36	2018-2024	0	0	0	0	0	0	0	3	0	3
FDSHQ	27.62	-82.71	2017-2024	0	0	1	2	0	0	0	0	0	3
Panama Sewage Plant	9.02	-79.45	2016-2024	0	0	2	1	0	0	0	0	0	3
FM Jardin Ouest	47.38	-71.09	2016	0	0	2	0	0	0	0	0	0	2
FM Crete 3	47.34	-71.11	2015-2016	0	0	2	0	0	0	0	0	0	2
Sorel	45.98	-73.17	2015-2018	0	0	1	0	0	0	0	1	0	2
SommetMSH	45.56	-73.16	2022-2024	0	2	0	0	0	0	0	0	0	2
UQO	45.42	-75.74	2019-2021	0	0	0	0	2	0	0	0	0	2
Fort-Lennox	45.13	-73.26	2020-2021	0	0	0	0	2	0	0	0	0	2
Bull Hill	45.09	-69.09	2021-2024	0	1	0	0	0	1	0	0	0	2
Valentine Farm	44.42	-70.81	2022-2024	0	1	0	0	0	1	0	0	0	2
New_Farm	44.29	-80.22	2014-2020	0	0	1	1	0	0	0	0	0	2
South_Shore	44.16	-76.65	2019-2024	0	0	0	0	1	0	0	1	0	2
Brighton	44.01	-77.75	2016-2024	0	0	0	2	0	0	0	0	0	2
METINIC	43.89	-69.13	2013-2022	0	0	1	1	0	0	0	0	0	2
Wilmot Creek	43.89	-78.64	2015-2024	0	0	0	1	1	0	0	0	0	2

DarlingtonPP	43.87	-78.79	2014-2016	0	0	0	2	0	0	0	0	0	2
Rathwell	43.66	-81.16	2014-2021	0	0	1	1	0	0	0	0	0	2
Guelph_Lake_CA	43.61	-80.27	2014-2024	0	0	0	1	0	1	0	0	0	2
Campbellville	43.44	-80.01	2016-2024	0	0	0	2	0	0	0	0	0	2
Bright	43.26	-80.65	2014-2024	0	0	0	2	0	0	0	0	0	2
Glover's Ledge	43.15	-72.39	2019-2024	0	0	0	0	1	0	0	1	0	2
GB_ferry_way	43.09	-70.85	2014-2015	0	0	0	0	0	0	0	0	2	2
Curries	43.06	-80.75	2014-2022	0	0	0	2	0	0	0	0	0	2
Wantastiquet	42.86	-72.54	2015-2022	0	0	1	1	0	0	0	0	0	2
Hogback	42.85	-72.80	2015-2016	0	0	1	1	0	0	0	0	0	2
Zorad	42.79	-80.40	2016-2021	0	1	0	0	1	0	0	0	0	2
Langton	42.73	-80.56	2016-2024	0	0	0	1	1	0	0	0	0	2
SatansKingdom	42.71	-72.51	2015-2016	0	0	1	1	0	0	0	0	0	2
Turkey Point	42.71	-80.36	2015-2024	0	0	0	0	1	1	0	0	0	2
Capital District WMA	42.65	-73.39	2022-2024	0	1	0	0	0	1	0	0	0	2
Old Cut	42.58	-80.40	2021-2024	0	1	0	0	1	0	0	0	0	2
Drumlin Farm Sanctuary	42.41	-71.33	2021-2024	0	0	0	0	0	1	0	1	0	2
Amherst College 1	42.36	-72.51	2017-2018	0	0	1	0	0	0	0	1	0	2
Rondeau Provincial Park	42.28	-81.84	2014-2024	0	0	0	1	1	0	0	0	0	2
SGL 154	42.00	-79.70	2017-2024	0	1	0	1	0	0	0	0	0	2
Girard	41.99	-80.34	2016-2024	0	2	0	0	0	0	0	0	0	2
SGL 143	41.88	-79.46	2017-2024	0	1	0	0	1	0	0	0	0	2
Great Hollow Nature Preserve	41.50	-73.53	2017-2023	0	0	2	0	0	0	0	0	0	2
Guilford	41.27	-72.67	2017-2024	0	0	0	0	1	0	0	1	0	2
NOMS	41.25	-70.81	2014-2024	0	0	0	1	0	0	0	0	1	2
LUZE04	41.16	-76.17	2019-2024	0	0	0	0	0	0	0	2	0	2
MNTK	41.06	-71.87	2014-2024	0	0	1	1	0	0	0	0	0	2
MASH	41.05	-72.27	2018-2024	1	0	0	0	0	1	0	0	0	2
Restore Native Plants	41.04	-74.26	2020-2024	0	0	0	0	2	0	0	0	0	2
Mount'n'Meadow	41.03	-74.98	2020-2024	0	0	0	0	1	0	0	1	0	2
Princeton	41.00	-80.20	2018-2024	0	0	0	0	1	1	0	0	0	2
Templeton	40.91	-79.44	2018-2024	0	2	0	0	0	0	0	0	0	2

Mauch Chunk Fire Tower	40.87	-75.70	2019-2024	0	0	0	0	0	1	0	1	0	2
Summit Fire Tower	40.78	-78.25	2019-2024	0	0	0	0	2	0	0	0	0	2
JBNY	40.62	-73.82	2016-2024	0	0	1	0	0	1	0	0	0	2
Rg27 Tower	40.41	-76.71	2017-2024	0	0	0	0	0	0	0	2	0	2
SGL 228	40.08	-78.75	2018-2024	0	1	0	0	0	0	0	1	0	2
Town Hill Fire Tower	39.69	-78.41	2020-2024	0	1	0	0	0	1	0	0	0	2
Wills Mountain	39.68	-78.77	2020-2024	0	1	0	0	0	0	0	1	0	2
NBNJ	39.43	-74.34	2016-2017	0	0	2	0	0	0	0	0	0	2
Bluestem Farm	39.23	-75.99	2021-2024	0	1	0	0	1	0	0	0	0	2
Reed	39.13	-74.89	2017-2018	0	0	1	0	0	0	0	1	0	2
Wetland	39.06	-74.77	2014-2019	0	0	2	0	0	0	0	0	0	2
Lupine Field	38.34	-75.43	2019-2024	0	0	0	0	1	0	0	1	0	2
EAREC	37.59	-75.82	2017-2022	0	0	1	0	0	0	0	1	0	2
Mackay Island NWR, NC	36.53	-75.99	2016-2024	0	1	0	0	0	0	0	1	0	2
Pisgah Astronomical Research Institute	35.20	-82.87	2018-2024	0	0	0	0	2	0	0	0	0	2
Santee NWR, SC	33.53	-80.43	2017-2021	0	0	0	0	0	0	0	2	0	2
Cape Romain NWR, SC (Bulls Island)	32.91	-79.61	2016-2024	0	0	2	0	0	0	0	0	0	2
Little Bear	32.62	-80.00	2019-2024	0	0	0	0	2	0	0	0	0	2
GA_DNR_DOCK	31.12	-81.48	2017-2024	0	0	1	1	0	0	0	0	0	2
Canopy Tower	9.08	-79.65	2016-2024	0	0	2	0	0	0	0	0	0	2
Goose Bay	53.30	-60.33	2023-2024	0	1	0	0	0	0	0	0	0	1
Niapiskau2	50.20	-63.75	2017-2023	0	0	0	0	0	1	0	0	0	1
Grande-Ile	50.19	-63.91	2014-2023	0	0	0	0	0	1	0	0	0	1
Pointe-aux-Outardes	49.05	-68.47	2014-2021	0	0	0	0	0	0	1	0	0	1
Portneuf2	48.62	-69.10	2016-2024	0	0	0	0	0	0	0	1	0	1
Portneuf	48.62	-69.10	2014-2022	0	1	0	0	0	0	0	0	0	1
Rimouski	48.45	-68.51	2016-2024	0	1	0	0	0	0	0	0	0	1
FERS	48.24	-71.25	2017-2024	0	1	0	0	0	0	0	0	0	1
LacEdouard-Champs	47.65	-72.29	2018-2022	0	0	0	0	0	0	0	1	0	1
FM Belle-Fontaine	47.40	-71.14	2015	0	0	0	1	0	0	0	0	0	1
FM Jardin Est	47.38	-71.08	2016	0	0	1	0	0	0	0	0	0	1
FM Morency	47.37	-71.02	2015	0	0	0	1	0	0	0	0	0	1

FM2	47.31	-71.14	2014	0	0	0	1	0	0	0	0	0	1
FM4	47.31	-71.10	2014	0	0	0	1	0	0	0	0	0	1
FM Tour Jutras Demo	47.28	-71.15	2016	0	0	1	0	0	0	0	0	0	1
Escuminac	47.08	-64.87	2014-2024	0	0	0	0	0	0	1	0	0	1
Hodgdon 1	46.04	-67.83	2019-2024	0	0	0	0	0	0	0	1	0	1
Johnson's Mills	45.83	-64.51	2016-2024	0	1	0	0	0	0	0	0	0	1
UQROP	45.76	-73.01	2022-2024	0	0	0	0	0	1	0	0	0	1
Beloeil	45.57	-73.20	2022-2024	0	1	0	0	0	0	0	0	0	1
Bromley	45.54	-76.84	2021-2024	0	0	0	0	0	1	0	0	0	1
Perrault	45.45	-77.06	2021-2024	0	0	0	0	0	1	0	0	0	1
Shutdown Mtn	45.42	-70.19	2022-2024	0	0	0	0	0	1	0	0	0	1
Kibby Mountain	45.42	-70.54	2019-2021	0	0	0	0	1	0	0	0	0	1
Bowerbank	45.33	-69.21	2022-2024	0	0	0	0	0	1	0	0	0	1
Craigmont Ridge	45.32	-77.62	2021-2024	0	0	0	0	0	1	0	0	0	1
The Divide	45.32	-69.93	2022-2024	0	0	0	0	0	1	0	0	0	1
Moosehorn NWR Air Qu	45.13	-67.27	2015-2024	0	0	0	0	0	0	0	1	0	1
Harmon Mt.	45.03	-67.66	2022-2024	0	1	0	0	0	0	0	0	0	1
Crystal Mtn	44.94	-71.21	2021-2024	0	0	0	0	1	0	0	0	0	1
Wasaga	44.54	-79.98	2021-2024	0	0	0	0	1	0	0	0	0	1
BHILL	44.43	-68.59	2013-2016	0	0	0	1	0	0	0	0	0	1
Friday Harbour	44.38	-79.55	2021-2024	0	0	0	0	0	1	0	0	0	1
Roberts Farm Preserve	44.21	-70.57	2021-2024	0	0	0	0	0	1	0	0	0	1
Monocliffs	44.05	-80.09	2014-2024	0	0	0	0	0	1	0	0	0	1
Presqu'ile Provincia	44.01	-77.74	2014-2016	0	0	0	1	0	0	0	0	0	1
Mount Forest	43.96	-80.78	2014-2024	0	0	0	0	1	0	0	0	0	1
Cobourg	43.96	-78.13	2016-2018	0	0	0	1	0	0	0	0	0	1
Luther_Marsh	43.95	-80.46	2014-2024	0	0	0	1	0	0	0	0	0	1
Headquarters	43.94	-71.70	2019-2021	0	0	0	0	0	0	0	1	0	1
HART	43.91	-69.27	2014-2015	0	0	1	0	0	0	0	0	0	1
Seal	43.89	-68.73	2014-2015	0	0	1	0	0	0	0	0	0	1
Darlington	43.88	-78.74	2020-2024	0	0	0	0	1	0	0	0	0	1
Forks_of_the_Credit	43.83	-80.01	2014-2024	0	0	0	0	0	1	0	0	0	1

Hindmarsh Tower	43.76	-80.15	2017-2019	0	0	0	1	0	0	0	0	0	1
Popham Beach	43.74	-69.80	2015-2016	0	0	1	0	0	0	0	0	0	1
Conestogo	43.67	-80.73	2014-2024	0	0	0	0	1	0	0	0	0	1
Hullet Provincial Wildlife Area	43.65	-81.47	2014-2024	0	0	0	1	0	0	0	0	0	1
Tommy Thompson Park	43.61	-79.34	2015-2018	0	0	0	1	0	0	0	0	0	1
Mitchell	43.45	-81.20	2015-2024	0	0	0	1	0	0	0	0	0	1
Flamborough_Quarry	43.31	-80.01	2015-2022	0	0	0	1	0	0	0	0	0	1
Pinery_Provincial_Park	43.25	-81.82	2014-2024	0	0	1	0	0	0	0	0	0	1
Grimsby Wetland	43.22	-79.61	2020-2024	0	0	0	0	1	0	0	0	0	1
Russell Reid PS	43.17	-80.29	2016-2024	0	0	0	0	0	1	0	0	0	1
GB_thomas	43.08	-70.84	2014-2017	0	0	0	0	0	0	0	0	1	1
Granite Lake Headwaters	43.02	-72.10	2020-2024	0	0	0	0	1	0	0	0	0	1
Hagersville_Landfill	42.99	-80.13	2015-2024	0	1	0	0	0	0	0	0	0	1
The Putney School	42.98	-72.55	2022-2024	0	0	0	0	0	1	0	0	0	1
Phillips Exeter Academy	42.98	-70.95	2021-2024	0	0	0	0	0	0	0	1	0	1
Ruthven	42.98	-79.88	2017-2024	0	1	0	0	0	0	0	0	0	1
Bookton	42.97	-80.52	2017-2018	0	0	0	1	0	0	0	0	0	1
Nelles	42.94	-79.96	2015	0	0	0	1	0	0	0	0	0	1
Haldimand Raptor Reserve	42.89	-79.92	2014-2019	0	0	0	1	0	0	0	0	0	1
Mosaic Port Maitland	42.86	-79.56	2014-2024	0	0	0	1	0	0	0	0	0	1
Falconer_Farm	42.81	-80.59	2014-2019	0	0	0	1	0	0	0	0	0	1
Dover_Quarry	42.81	-80.18	2015-2017	0	0	0	1	0	0	0	0	0	1
Nanticoke	42.81	-80.05	2017-2024	0	0	0	0	0	1	0	0	0	1
Aylmer	42.80	-80.95	2014-2024	0	1	0	0	0	0	0	0	0	1
Werden_3	42.76	-80.27	2017-2024	0	0	0	0	0	1	0	0	0	1
Hopkins Forest	42.73	-73.27	2022-2024	0	0	0	0	0	1	0	0	0	1
PKR_stage	42.71	-70.78	2013-2016	0	0	0	0	0	0	0	0	1	1
MountGrace	42.69	-72.36	2015-2016	0	0	0	1	0	0	0	0	0	1
Bolin_Port_Burwell	42.62	-80.72	2014-2020	0	0	0	1	0	0	0	0	0	1
BSC HQ_2	42.61	-80.46	2014	0	0	0	1	0	0	0	0	0	1
Shelburne	42.61	-72.72	2015-2016	0	0	0	1	0	0	0	0	0	1
Hentz	42.60	-81.45	2020-2024	0	0	0	0	1	0	0	0	0	1

Clear Creek	42.58	-80.58	2015-2024	0	0	0	1	0	0	0	0	0	1
Long_Point_Tip	42.55	-80.05	2014-2021	0	0	0	1	0	0	0	0	0	1
Wachusett Meadow Sanctuary	42.46	-71.90	2022-2024	0	0	0	0	0	1	0	0	0	1
Orchard Hill 2	42.40	-72.52	2017-2022	0	0	1	0	0	0	0	0	0	1
St.Clair NWA	42.38	-82.40	2014-2024	0	0	0	0	1	0	0	0	0	1
October Mtn State Forest	42.36	-73.14	2023-2024	0	0	0	0	0	1	0	0	0	1
Jug End	42.15	-73.46	2022-2024	0	0	0	0	0	1	0	0	0	1
PresqueIsle	42.11	-80.15	2016-2024	0	1	0	0	0	0	0	0	0	1
Holiday_Beach_CA	42.04	-83.03	2014-2018	0	0	1	0	0	0	0	0	0	1
Fannie Stebbins_2	42.03	-72.60	2016-2018	0	0	1	0	0	0	0	0	0	1
Rice Family Farm	41.93	-77.41	2019-2024	0	0	0	0	0	1	0	0	0	1
WELL	41.91	-69.97	2015-2024	0	0	0	0	1	0	0	0	0	1
Norrie Point	41.83	-73.94	2022-2024	0	0	0	0	0	1	0	0	0	1
Central Landfill	41.80	-71.54	2022-2024	0	0	0	0	0	1	0	0	0	1
Stutchbury	41.79	-80.02	2017-2024	0	1	0	0	0	0	0	0	0	1
Cedar Point	41.70	-83.34	2014-2024	0	0	0	1	0	0	0	0	0	1
OttawaWeir	41.64	-83.22	2013-2021	0	0	0	1	0	0	0	0	0	1
MNYN	41.61	-69.99	2013-2024	0	0	0	1	0	0	0	0	0	1
MNYS	41.55	-70.01	2013-2024	0	0	0	1	0	0	0	0	0	1
Cleveland Museum of Natural History	41.51	-81.61	2020-2024	0	1	0	0	0	0	0	0	0	1
PARC Honey Hut	41.49	-81.93	2018-2024	0	1	0	0	0	0	0	0	0	1
Plumer Fire Tower	41.48	-79.64	2019-2024	0	1	0	0	0	0	0	0	0	1
Yeany's Maple	41.47	-79.12	2021-2024	0	1	0	0	0	0	0	0	0	1
GTPT	41.39	-70.05	2013-2024	0	0	0	1	0	0	0	0	0	1
Barn Island	41.34	-71.88	2017-2024	0	0	0	0	0	0	0	1	0	1
CTPT	41.31	-70.06	2013-2020	0	0	0	1	0	0	0	0	0	1
High Knob	41.30	-75.12	2019-2024	0	1	0	0	0	0	0	0	0	1
SGL 74	41.22	-79.32	2019-2024	0	1	0	0	0	0	0	0	0	1
Bluecast	41.15	-84.86	2019-2024	0	0	0	0	1	0	0	0	0	1
Stratford Point	41.15	-73.10	2015-2024	0	0	0	0	0	0	0	1	0	1
Sherwood	41.11	-73.33	2017-2024	0	0	0	0	0	0	0	1	0	1
Bear's Head Fire Tower	40.85	-76.08	2019-2024	0	0	0	0	0	0	0	1	0	1

PARC Armour	40.18	-79.27	2017-2024	0	0	1	0	0	0	0	0	0	1
PARC Banding	40.16	-79.27	2017-2024	0	0	1	0	0	0	0	0	0	1
PARC Friedline Field	40.13	-79.29	2019-2021	0	0	0	0	1	0	0	0	0	1
Penn - DRL	39.95	-75.19	2018-2024	0	0	0	0	0	0	0	1	0	1
Westtown School	39.95	-75.54	2018-2024	0	0	0	0	0	0	0	1	0	1
Hebron Fish Hatchery	39.94	-82.52	2022-2024	0	0	0	0	0	1	0	0	0	1
Carriage Hill Metropark	39.87	-84.09	2022-2024	0	0	0	0	0	1	0	0	0	1
PARC Brownfield	39.81	-79.69	2017-2021	0	0	1	0	0	0	0	0	0	1
High Rock	39.54	-79.10	2020-2021, 2023-2024	0	1	0	0	0	0	0	0	0	1
Thayerville Fire Tower	39.52	-79.30	2020-2024	0	0	0	0	1	0	0	0	0	1
RTNJ	39.51	-74.32	2016-2024	0	0	1	0	0	0	0	0	0	1
Morgan Monroe State Forest	39.32	-86.41	2020-2024	0	0	0	0	1	0	0	0	0	1
Bombay Hook	39.21	-75.46	2015-2024	0	0	0	1	0	0	0	0	0	1
Norbury	39.05	-74.93	2015-2019	0	0	1	0	0	0	0	0	0	1
Dads Place	39.03	-74.80	2016-2017	0	0	1	0	0	0	0	0	0	1
Smithsonian Conservation Biology Institute	38.89	-78.16	2019-2024	0	0	0	0	1	0	0	0	0	1
Poplar Island	38.76	-76.38	2019-2024	0	0	0	0	1	0	0	0	0	1
Redden SF	38.74	-75.41	2019-2024	0	0	0	0	0	0	0	1	0	1
Chincoteague NWR	37.98	-75.28	2019-2024	0	0	0	0	0	0	0	1	0	1
PARR	37.57	-75.62	2016-2022	0	0	0	0	1	0	0	0	0	1
Hanging Rock	37.50	-80.45	2021-2024	0	0	0	0	1	0	0	0	0	1
East River Mountain Overlook	37.25	-81.18	2023-2024	0	0	0	0	0	1	0	0	0	1
Craney Island North Cell	36.92	-76.38	2018-2024	0	1	0	0	0	0	0	0	0	1
Massengale Mtn., TN	36.29	-84.30	2021-2024	0	0	0	0	0	1	0	0	0	1
Caesar's Head	35.11	-82.63	2021-2024	0	0	0	0	1	0	0	0	0	1
TRGT Office Site Tower	35.07	-85.34	2023-2024	0	0	0	0	0	1	0	0	0	1
Cedar Island NWR, NC	34.96	-76.28	2015-2024	0	0	1	0	0	0	0	0	0	1
Mt Berry House of Dreams	34.34	-85.25	2022-2024	0	0	0	0	0	1	0	0	0	1
Garden	34.01	-81.08	2018-2024	0	0	0	0	1	0	0	0	0	1
Noxubee NWR, MS	33.27	-88.78	2019-2024	0	0	0	0	0	1	0	0	0	1
Dewees Island	32.84	-79.73	2019-2024	0	0	0	0	1	0	0	0	0	1
Fort Moultrie	32.76	-79.86	2019-2024	0	0	0	0	1	0	0	0	0	1

Nemours Wildlife Foundation_ACE Basin_SC	32.64	-80.68	2021-2024	0	0	0	0	1	0	0	0	0	1
High_Island	29.56	-94.39	2016-2021	0	0	1	0	0	0	0	0	0	1
Dunn's Creek	29.53	-81.59	2016-2024	0	0	0	1	0	0	0	0	0	1
Brazoria National Wildlife Refuge	29.09	-95.28	2017-2021	0	0	0	1	0	0	0	0	0	1
Finca Las Palmeras	8.53	-76.10	2017-2024	0	0	1	0	0	0	0	0	0	1