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# Long-distance Movement over a Period of Days by a Female *Myotis lucifugus* in Newfoundland, Canada

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**Abstract** - *Myotis lucifugus* (Little Brown Myotis) is a regionally migrating bat, widely distributed throughout North America. Through long-term monitoring systems deployed in 2 locations in Newfoundland, Canada, we recorded the movement of an adult female of at least 375 km over a period of 4 nights. Although not the longest travel distance recorded for this species, this observation emphasizes the capabilities of Little Brown Myotis for long-distance flights, the potential connectivity among distant maternity groups, and the value of long-term monitoring programs. To fully understand the movement patterns of Little Brown Myotis, advancements in technology and greater research effort are needed.

Many bat species are capable of traveling long distances, normally demonstrated during dispersal and migratory movements. Understanding movement patterns, both during and between migratory movements, is critical for understanding population dynamics and gene flow, both of which have important implications for management and conservation. However, given the small body size of many bat species and their nocturnal nature, collecting this information is technologically challenging, and thus detailed data sets on typical and anomalous movement patterns of bats are limited. *Myotis lucifugus* (Le Conte) (Little Brown Myotis) is a widely distributed North American bat and is considered a regional migrant, typically moving <500 km between maternity and hibernation sites (Davis and Hitchcock 1965, Fenton and Barclay 1980, Krauel et al. 2018). There is limited understanding of Little Brown Myotis movement patterns, including typical flight speeds and locations for both foraging and commuting movements. Using recovery of tags such as forearm bands, long-distance (>200 km) movements are normally reported over periods of months to years (Norquay et al. 2013). The longest movement distance reported for a Little Brown Myotis is ~800 km (500 mi) between 2 hibernacula in ≤32 days (Fenton 1969), whereas other studies have reported movements of up to 455 km (Humphrey and Cope 1976) and 600 km (Norquay et al. 2013) over multiple months.

Herein, we report a long-distance movement of a Little Brown Myotis that is notable both for the distance traveled and for the accuracy of the elapsed time between locations, thus providing unique insight into actual movement rates over long distances. We have a research and monitoring program in Newfoundland, Canada, using passive integrated transponder (PIT) tags and automated antennas at each of Salmonier Nature Park (47º15'53"N, 53º17''03"W) and Pynn's Brook (49º4'12"N, 57º33'28"W). On 13 July 2013, we tagged a nonreproductive, adult, female Little Brown Myotis at Salmonier Nature Park. She was recorded within the park at 4 of 11 available monitored roosts on 10 days from 13 to 28 July 2013. Her last record at a reader in Salmonier Nature Park was 28 July at 21:18, and she was captured and released at ~22:15 that same night. We next recorded this bat on 1 August 2013 at 17:50 in Pynn's Brook, a straight-line distance of 375 km. Given that this record occurred during daylight hours, it is likely that this bat arrived at Pynn's Brook by

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sunrise on 1 August 2013. Over the next 2 days we recorded this bat several times and at all 4 monitored roosts at the Pynn's Brook site, where she roosted in the same box on both days. She has not been recorded again despite monitoring through the summer of 2019. These records indicate that the individual travelled at least 375 km in ≤4 nights. Of over 1700 PIT-tagged bats that were recorded at readers throughout Salmonier Nature Park and Pynn's Brook, this was the only recorded movement between the 2 locations; however, it is possible that similar movements occur to the numerous unmonitored roosts across the island of Newfoundland, or even across the Gulf of St. Lawrence (McLeod et al. 2015).

This observation represents the most precisely reported long-distance movement of a Little Brown Myotis. Accounting for release time and a total of ~33 h and 19 min of darkness (between sunset and sunrise) over 4 nights of potential travel, the observed bat would have had to fly at a minimum speed of 11.2 km/h (3.1 m/s) if she flew for the entire duration of each night in a straight line. Near Salmonier Nature Park on the evening of 28 July 2013, winds varied from 13 to 36 km/h from the north and 0 to 12 km/h from the northeast on 29 July 2013 (Environment Canada - St John's International Airport hourly wind data). Wind-speed data was not available along the potential travel route; however, based on the windspeed and direction near the point of departure, we do not expect that wind or wind gusts would have impacted travel. Previous studies of Little Brown Myotis have reported movement speeds over shorter distances from 8 km/h (2.2 m/s) to 30.5 km/h (8.4 m/s) (Mueller and Emlen 1957), and thus this observed minimum speed is reasonable for the species. Using wing measurements for Little Brown Myotis (Norberg and Rayner 1987) and modeling the flight power curve for the species (Pennycuick 2008), the predicted minimum power speed of a Little Brown Myotis is 19 km/h (5.4 m/s) and the maximum range speed, the optimal speed for long-distance movements, is 39.6 km/h (11.0 m/s). Thus, it is possible she could have made this trip in as few as 2 nights if she flew at 39.6 km/h for 4.7 hours each night, or she may have covered additional distance during this time. Finally, with migration rates of up to 20.1 km/hour in the similarly sized *Myotis sodalis* Miller & Allen (Indiana Bat; Roby et al. 2019) and reports in *Pipistrellus kuhlii* Kuhl (Kuhl's Pipistrelle) of 33 km/h commuting flight speeds (Grodzinski et al. 2009), it is reasonable to assume that the bat observed here was travelling faster than the minimum required speed to get between these 2 locations in the elapsed time. At these speeds and flight times, this bat still would have had reasonable time during dark hours for exploration and foraging throughout this energetically expensive trip (Winhold and Kurta 2006).

This observation emphasizes many unknowns that remain about bat behavior, habitat use, and gene flow, raising questions about frequency and motivations for these longer movements and implications for population dynamics and management. Long-distance movements like these are not unexpected in regional migrating bat species but are generally thought to be uncommon, representing the upper end of migration distances in the population (Griffin 1970, Krauel et al. 2018). Complicating matters is that, given the small body size of Little Brown Myotis, the availability of technology required to create a distribution of travel distances and directions for these bats is limiting. Thus, it is difficult to obtain a full picture of how common these types of movements truly are. This observation emphasizes the value of long-term bat-monitoring systems, particularly the value of expanding the geographic coverage of bat-monitoring programs, to provide researchers a greater opportunity to observe infrequent, long-distance movements. This study illustrates the potential connectivity between widely dispersed maternity groups, but it will take technological advancements and greater investment into observations of movement patterns of bats to truly understand habitat use and population connectivity in this species.

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