FINAL REPORT TO THE NOVA SCOTIA HABITAT CONSERVATION FUND

Project Number: NSHCF10-19

INTRODUCTION

In Atlantic Canada, the predominant direction of fall migration is southwesterly and passerines following this route commonly cross the Gulf of Maine directly from Nova Scotia to New England (Richardson 1972, 1978). However, radar and orientation studies have also revealed considerable variation in the departure and migratory behaviors of migrants in this region (Richardson 1972, 1978, 1982; Fitzgerald and Taylor 2008, Calvert et al. 2009), suggesting that some individuals, rather than cross the Gulf of Maine directly, may detour around all or parts of the Gulf and/or temporarily relocate away from the barrier prior to continuing migration. If migrants do indeed employ these alternate migration strategies for negotiating the Gulf of Maine, then the amount of time they spend at stopover sites in western Nova Scotia may be considerably greater than previously determined (Calvert et al. 2009). Given that availability of and access to suitable stopover habitat is vital to the survival of migrating songbirds, understanding how much time migrants spend in western Nova Scotia and the proportion of migrants that relocate to inland sites and/or choose to detour around the Gulf of Maine is necessary for us to be able to assess the importance of stopover habitats in western Nova Scotia for sustaining the migration systems of passerines in the region.

To better understand how songbirds respond to the Gulf of Maine during fall migration, we studied the migratory and stopover behaviors of Northern Waterthrushes (*Parkesia noveboracensis*), Red-eyed Vireos (*Vireo olivaceus*), and Myrtle Warblers (*Setophaga coronata coronata*) during fall migration in southwest Nova Scotia using an automated digital telemetry array spanning from southwest Nova Scotia to southern Maine. With four telemetry towers in southwest Nova Scotia continuously scanning multiple, directional antennas, each with a range of 12-15 km, we were able to monitor the migratory and stopover movements of our study individuals at a fine temporal resolution and for multiple kilometres beyond their point of departure. Moreover, with telemetry towers at three locations along the coast of Maine and three locations on Kent Island in the Bay of Fundy, we were able to directly confirm whether migrants do indeed detour around the Gulf of Maine. This information allowed us to estimate 1) the percentage of migrants that detoured around the Gulf of Maine, 2) the percentage that temporarily relocated inland prior to continuing migration, and 3) the amount of time migrants stopped over in southwest Nova Scotia.

METHODS

Sampling and Tagging Birds. Birds were captured and tagged at two sites in southwest Nova Scotia, Bon Portage Island (43°28′N, 65°45′W) and Quinns Falls (43°40′N, 65°28′W), in conjunction with annual migration monitoring activities at the Atlantic Bird Observatory (Fig. 1). Bon Portage Island is a small island (3 × 0.75 km) situated 3 km from the mainland. Quinns Falls is situated roughly 8 km inland and 30 km northeast of Bon Portage Island. Birds were captured using mist nets between 18 August and 13 October 2010 and fitted with digitally coded radio transmitters (Avian NanoTag model NTQB-1, Lotek Wireless Inc., Newmarket, ON, Canada) using a figure-eight leg loop harness (Rappole and Tipton 1991). Transmitters operated on one of two VHF frequencies, 166.320 MHz (burst interval = 7.2 s) or 166.340 MHz (burst interval = 4.8 s), had approximate lifetimes of 21 days, and a mass of 0.29 g, which comprised 1.8 ± 0.03% of the total body weight of those tagged (max = 2.5%). Only hatch-year individuals were tagged because they comprise the bulk of captures in this region in the fall (Calvert et al. 2009; Ralph 1981). Individuals of all three species were tagged at Bon Portage Island. At Quinns Falls, only Red-eyed Vireos were tagged because very few Northern Waterthrush and Myrtle Warblers were encountered. All individuals were released within 1 h of initial capture.

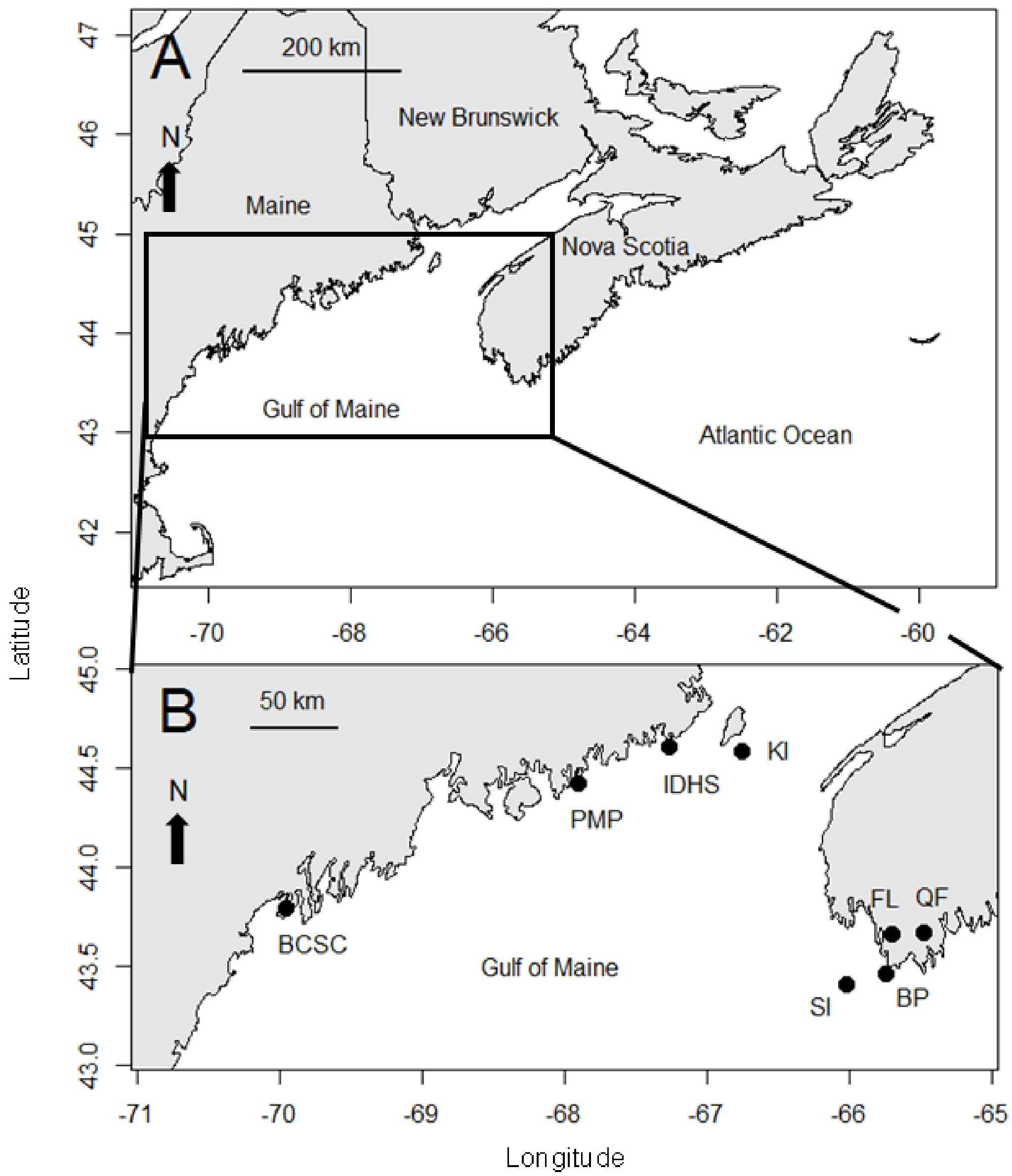

Figure 1. Study region (A) and locations of towers comprising the automated digital telemetry array (B). Towers were located at Inner Double Headshot Island (IDHS), Petit Manan Point (PMP), and the Bowdoin Coastal Studies Center (BCSC) in Maine, Kent Island (KI) in the Bay of Fundy, and Seal Island (SI), French Lake (FL), Bon Portage Island (BP), and Quinns Falls (QF) in southwest Nova Scotia.

Automated digital telemetry array. The automated telemetry array was active from 22 August 2010 to 31 October 2010. Towers comprising the automated digital telemetry array were positioned at four locations in southwest Nova Scotia, three locations on Kent Island in the Bay of Fundy, and three locations along the coast of Maine (Fig. 1). Each tower stood 8-15 m high and was equipped with a SRX-600 digital telemetry receiver (Lotek Wireless Inc., Newmarket, ON, Canada) and two or four antennas (see Table 1 for antenna configurations at each tower). All towers with the exception of those on Kent Island were equipped with nine-element Yagi antennas. Kent Island towers were equipped with four-element Yagi antennas. Receivers were programmed to scan each antenna for 7.8 s (a slightly longer time span than the longest transmitter burst interval of 7.2 s) on one frequency before switching to the next frequency. As a result, a single frequency was scanned continuously for 31.2 s (four antennas) or 15.6 s (two antennas) every 31.2 s or 15.6 s, respectively. When a signal was detected, receivers logged the digitally coded transmitter ID, time of detection, signal strength, and antenna on which the signal was detected. Binary data files containing this information were downloaded to a computer from local towers (Bon Portage, Quinns Falls, and French Lake) on a daily basis and from remote towers periodically. After the field season, binary files were post-processed to ensure that the data we analyzed contained only valid detections (Mills et al. 2011, Taylor et al. 2011).

Manual telemetry. Manual monitoring was performed using handheld SRX-600 receivers and a 5-element Yagi antenna. Individuals known or thought to be in a particular area were tracked on the ground by a single observer until they were sighted or until their signal strength indicated they were in the immediate (within 30 m) vicinity. Sighting was often not possible because of the density of habitat occupied, and because we did not want to disrupt the natural behavior of individuals. When individuals left Bon Portage Island or Quinns Falls and were no longer being detected manually or by towers at these locations, we performed manual scans from a series of points distributed across the study area in southwest Nova Scotia. To maximize our detection range, we positioned scan points in elevated areas where there were few obstructions. We scanned from each point for approximately 5 min and in all directions on a horizontal plane. When a signal was received we recorded the transmitter identification number and time of detection, and used the signal strength and receiver gain to estimate the approximate locations of where the signal originated. When possible, we travelled to the approximate location to re-locate the individual. All locations where individuals were observed were marked using a hand-held GPS unit. We attempted to locate all individuals in the study area each day, but this was not always possible for those that moved far away (> 1 km) from their initial capture site.

Flight classification. Departure flights were classified into three types, stopover, migratory, and ambiguous (Taylor et al. 2011), by visually inspecting plots of signal strength versus time for each individual. Stopover flights were flights 1) in any direction and initiated at any time of day that were followed by an automated or manual re-detection within southwest Nova Scotia at least 1 h after departure and at least 1 km from where the flight was initiated, or 2) to the northeast and at any time of day that were not followed by an automated or manual re-detection in southwest Nova Scotia. Migratory flights were flights initiated between civil twilight and civil dawn in a seasonally appropriate direction (180°-360°) with no subsequent manual re-detections, and either no automated re-detections in southwest Nova Scotia or re-detections on a different tower in southwest Nova Scotia and within 1 h of departure. Based on the arrangement of telemetry towers in southwest Nova Scotia (all were separated by a minimum of 18 km, corresponding to a ~ 30 min flight for a bird travelling at 10 m/s) and plotted signal patterns (plots of birds flying perpendicular to the main beam of an antenna produce a bell-shaped series of points), re-detections on a different tower within 1 h of departure were likely of birds in migratory flight as opposed to initiating landfall. Migratory flights oriented between 180° and 270° (inclusive) were further classified as 'southwesterly' and those oriented between 270° and 360° were classified as 'northwesterly'. Ambiguous flights were flights that were not followed by a manual or automated re-detection and whose direction could not be established.

RESULTS

We tagged 24 Northern Waterthrush, 55 Red-eyed Vireos (39 on Bon Portage Island and 16 at Quinns Falls), and 26 Myrtle Warblers between 22 August 2010 and 13 October 2010. Median dates of capture were 30 August for Northern Waterthrushes, 18 September for Red-eyed Vireos, and 7 October for Myrtle Warblers. Thirteen individuals (1 Northern Waterthrush and 12 Red-eyed Vireos) were killed by raptors prior to departure and 2 individuals (both Red-eyed Vireos) were killed by raptors after relocating from Bon Portage Island to the mainland.

Of the 92 individuals that survived to their initial capture site, 42% (n = 40) made a stopover flight, 38% (n = 35) initiated a migratory flight, and 20 % (n = 17) were classified as having made an ambiguous flight. Of the 40 individuals that made a stopover flight, 5% (n = 2) were re-detected making a second stopover flight, 27% (n = 11) were re-detected initiating a migratory flight, 7% (n = 3) were classified as having made an ambiguous flight, and 59% (n = 24) were not detected again in southwest Nova Scotia. Of the 2 individuals that made a second stopover flight, one was later detected initiating a migratory flight and the other was not re-detected. Of the 47 migratory departures detected, 57% (n = 27) were oriented in a southwesterly direction and 43% (n = 20) were oriented in a northwesterly direction.

Stopover flights occurred after an average of 2.55 ± 0.44 days, with nearly half (n = 20) occurring within 24 h of assumed arrival at the stopover site, whereas migratory flights occurred after an average of 7.25 ± 0.75 days, with only 17% (n = 8) occurring within 24 h of assumed arrival (Fig. 2).

After having left southwest Nova Scotia, 16% (n = 15) of individuals were re-detected 4 h to 15 (6.1 ± 1.3) days later over Kent Island in the Bay of Fundy and/or at one or more locations along the coast of Maine, 145-340 km west-northwest of where they were initially captured. The amount of time between when these individuals were last detected in southwest Nova Scotia and when they were first re-detected outside of Nova Scotia appeared to be negatively related to the amount of time they spent in southwest Nova Scotia (Fig. 3).

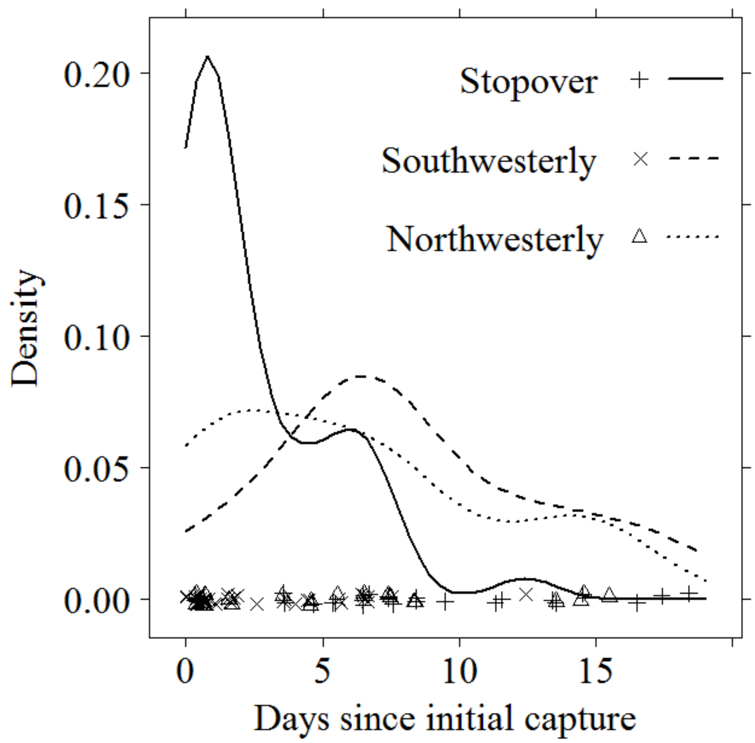

Figure 2. Relative probabilities (‘density’) of stopover and migratory flights in relation to days since initial capture.

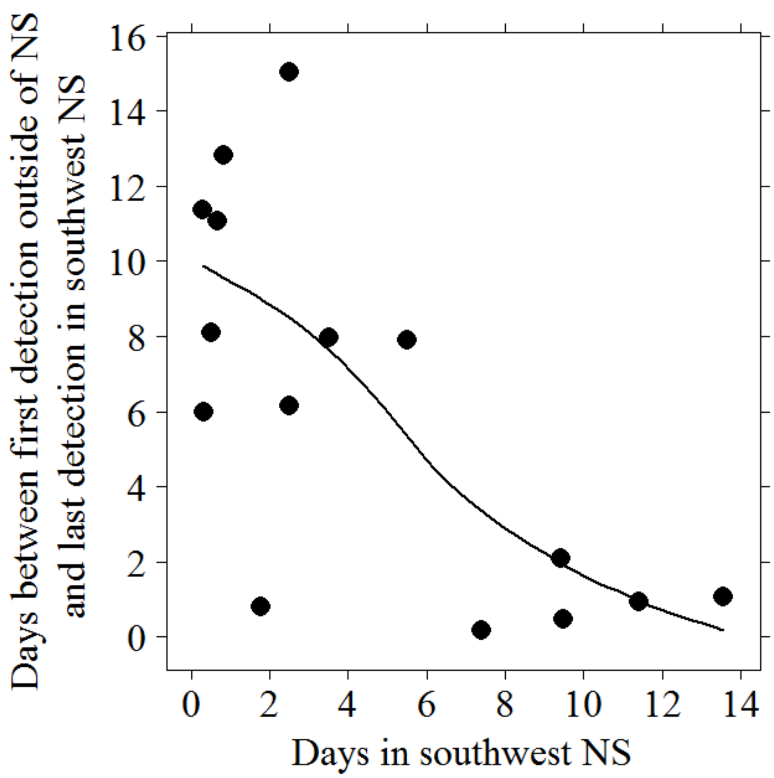

Figure 3. Days between last detection in southwest Nova Scotia and first detection outside of Nova Scotia versus days spent in southwest Nova Scotia for 15 individuals that were detected by the automated telemetry array over Kent Island and/or along the coast of Maine.

DISCUSSION

Although the predominant direction of fall migration in Atlantic Canada and New England has previously been shown to be southwesterly (Richardson 1972, 1978), we have direct evidence that 16% of the individuals we studied (those that were re-detected over Kent Island and/or along the coast of Maine) detoured around the vast majority if not all of the Gulf of Maine. Moreover, 40% of the migratory flights we detected (not including those initiated by individuals that were re-detected outside of Nova Scotia) were oriented in a northwesterly direction, away from the Gulf of Maine, which suggests that the proportion of migrants that detoured around at least part of the barrier may have been much greater than 16%.

The large range in the amount of time individuals that were re-detected outside of Nova Scotia spent detouring around the Gulf of Maine, suggests that migrants employed multiple strategies to detour around the Gulf. One individual appeared to fly directly from southwest Nova Scotia to Kent Island in a non-stop 4 hour flight; however, most others took multiple days to navigate around the Gulf of Maine, and thus must have made one or more additional stopovers in western Nova Scotia prior to crossing the Bay of Fundy or northern-most portion of the Gulf of Maine.

In addition to the high proportion of migrants that oriented away from and detoured around the Gulf of Maine, nearly half of the individuals we detected departing their initial stopover site relocated within southwest Nova Scotia prior to continuing migration. Similar to Taylor et al. (2011), about half of these flights occurred within 24 h of assumed arrival. In a mark-recapture analysis of the departure decisions of passerine migrants on Bon Portage Island, Calvert et al. (2009) found that up to 96% of migrants departed within 24 h of arrival in a given year; however, the timing and frequency of stopover flights we observed suggests that many of these ‘transients’ are likely individuals relocating to different stopover sites in the landscape, and not continuing migration immediately.

At least three of the stopover flights we observed were the result of aborted migratory flights, perhaps in response to weather conditions experienced after departure (Richardson 1978) or the barrier ahead (Bruderer and Liechti 1998). However, most were oriented in northwesterly-northeasterly directions (from Bon Portage Island towards mainland Nova Scotia) at departure, suggesting that the decision to relocate was made prior to departure. Relocations of this nature may enable migrants to find more suitable habitat inland where they can improve their body condition or safely wait for more favourable weather conditions in which to continue migration (Alerstam 1978, Lindstrom and Alerstam 1986, Akesson et al. 1996). That all of the mortalities we observed occurred on Bon Portage Island or near the coast suggests that coastal stopover sites can be dangerous for songbirds and that relocating inland, where concentrations of migrating raptors tend to be lower, may be the optimal stopover strategy in this region.

Our results confirm that songbirds adopt multiple strategies for negotiating the Gulf of Maine during fall migration in southwest Nova Scotia. That such a high proportion of migrants relocated within southwest Nova Scotia and/or detoured around the Gulf of Maine, and thus spent prolonged periods of time stopping over in western Nova Scotia, highlights the importance of conserving natural landscapes in this region for migrating birds.

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