AMERICAN WOODCOCK (SCOLOPAX MINOR) MIGRATION ECOLOGY IN THE EASTERN MANAGEMENT UNIT

Year 1 Report

Compiled by: Alexander Fish, Erik Blomberg, and Amber Roth

The University of Maine

29 January 2018

A collaborative inter-agency partnership to understand the migratory ecology of American woodcock throughout eastern North America. This project would not have been possible without the support from multiple partners who are listed in the Acknowledgments. All findings in this report should be viewed as preliminary until they have undergone peer review and publication.

EXECUTIVE SUMMARY

The American Woodcock (*Scolopax minor)* is a migratory forest bird that has experienced population declines of 0.8 percent per year for the past five decades. Relatively little is known about woodcock migration compared to other life phases, but recent advances in satellite and GPS tracking technology have facilitated the ability to track individuals during migration at a level not previously possible. Our objectives are to describe migration ecology of American woodcock using Global Positioning System (GPS) transmitters, and this report documents the results of our pilot field season. In October of 2017, we deployed 6 Lotek Pinpoint GPS transmitters with ARGOS PTT transmission capability in central and eastern Maine. These transmitters were programmed to collect data on either a 1-day or 5-day schedule, and data transmission occurred after every 3rd location. All birds initiated migration from their location of capture, with the first woodcock departing Maine after 30 October 2018 and the last bird departing after 25 November 2018. We identified ≥1 stopover location for all marked woodcock, identified areas of residency (presence for >14 days) for 4 of the 6 birds, and woodcock locations were obtained from 8 states. Two woodcock have continued to transmit data until the writing of this report (January 29, 2018), while four birds have apparently ceased to transmit. We collected 199 locations from these marked birds, including a large volume of pre- and post-migratory movement data.

INTRODUCTION

Many species of North American birds (37%) are declining and migratory birds are declining at faster rates than many non-migratory bird species (Sanderson et al. 2006). The American Woodcock (Scolopax minor; woodcock hereafter) is a migratory forest bird that has experienced population wide long-term declines of 0.8% per year, over the past 50 years (Cooper and Rau 2012). Woodcock are distributed throughout the eastern United States where they primarily breed in the northern United States and Southern Canada, and overwinter in the southern United States. Previous research suggests woodcock migrate south between October-December and north between January-April (Moore 2016, Meunier et al. 2008, Butler 2003, Krementz et al. 1994). However, these estimates are principally derived from observational data and radio-tracking studies at stopover sites. While this information is useful, it has limited scope and cannot be applied broadly across the species range. The migratory knowledge gap prompted The Association of Fish and Wildlife Agencies to identify migratory ecology as one of the woodcock's greatest research needs (Case and Associates 2010).

Tracking woodcock throughout migration represents numerous challenges, as individuals must be continually relocated over vast distances, often spanning multiple countries (Myatt and Krementz 2007, Klassen et al. 2014). Birds in particular represent a unique research challenge, as small body size limits the weight of transmitters, which subsequently limits the distance over which individuals can be relocated (Klassen et al. 2014, Faaborg et al. 2010). Furthermore, re-sighting marked birds is difficult as migrating birds are commonly found in habitats that they are not typically associated (Rodewald and Brittingham 2004), thereby complicating individual relocation efforts. Recent improvements in tracking technologies allow for individuals to be tracked remotely throughout migration (Brown and Taylor 2017), but in some cases individuals must be recaptured to complete data retrieval (Lerche-Jørgensen et al. 2017, Röseler et al. 2017).

Methods to conduct remote telemetry using satellite and/or GPS receiving platforms have advanced rapidly in the past decade, and recently these methods have been successfully applied to the study of woodcock migration in the central management region (Moore 2016). These transmitters typically fall under two categories: platform terminal transmitters, or PTT, which communicate with ARGOS satellites and take advantage of Doppler shift to triangulate the location of marked birds, and GPS-enabled transmitters which function similarly to a handheld personal GPS unit. GPS units tend to collect locations that are consistently more precise (+/- m) compared with ptt (+/- 10m to >1000 m), however both record location data irrespective of where birds travel. PTT-equipped units transmit location data through the ARGOS satellites which facilitates remote retrieval of animal locations. GPS-enabled units have a number of options for data retrieval, including interface with a PTT (satellite download) in which case additional costs for data retrieval (typically per month, per tag) also exists. Satellite/GPS telemetry offers perhaps the best ability to track woodcock during migration, as it provides a record of both path and rate of travel, can identify stopover location, and has the ability to consistently monitor survival, without requiring recapture. Recent advances have reduced package size to ≤5 g, allowing for marking of almost all mature male and female woodcock.

In this report we summarize the results of a pilot field season designed to test the utility of GPS transmitters for tracking American woodcock migration. The overall goal of our project is to describe the migratory ecology of American woodcock in the Eastern Management Region. Accordingly, we've proposed the following specific objectives:

1. Evaluate the migratory ecology of American woodcock in the eastern region using GPS tags. We will assess patterns (rate and migratory path) of migration from breeding grounds in the fall, and from wintering grounds to breeding areas in the spring.

2. Compare data among northern and southern breeding populations to evaluate differences in migration strategies based on breeding latitude.

3. Analyze landscape patterns affecting migratory stopover during both spring and fall migration using the points derived from the GPS tags and associated land-use land-cover data sets. Compare this information to alternative data sources such as eBird and use these data to validate stopover habitat models developed through other objectives.

4. Evaluate survival of GPS-marked woodcock during migration and relate observed patterns in mortality associated with regional variation or landscape-scale factors identified in objective 2.

5. Combine GPS-based survival data with other existing datasets (band recovery, singing ground survey, parts collection) and develop an integrated, full life cycle population model for American woodcock.

METHODS

Study Area

Our study area includes the eastern United States and Canada (Figure1). This geographic area represents the eastern management unit for American Woodcock in North America, and the spatial unit at which the United States Fish and Wildlife Service manages woodcock populations. During 2017 we deployed transmitters in Maine, and during 2018 and moving forward we plan to mark additional woodcock at sites throughout the Eastern Region.

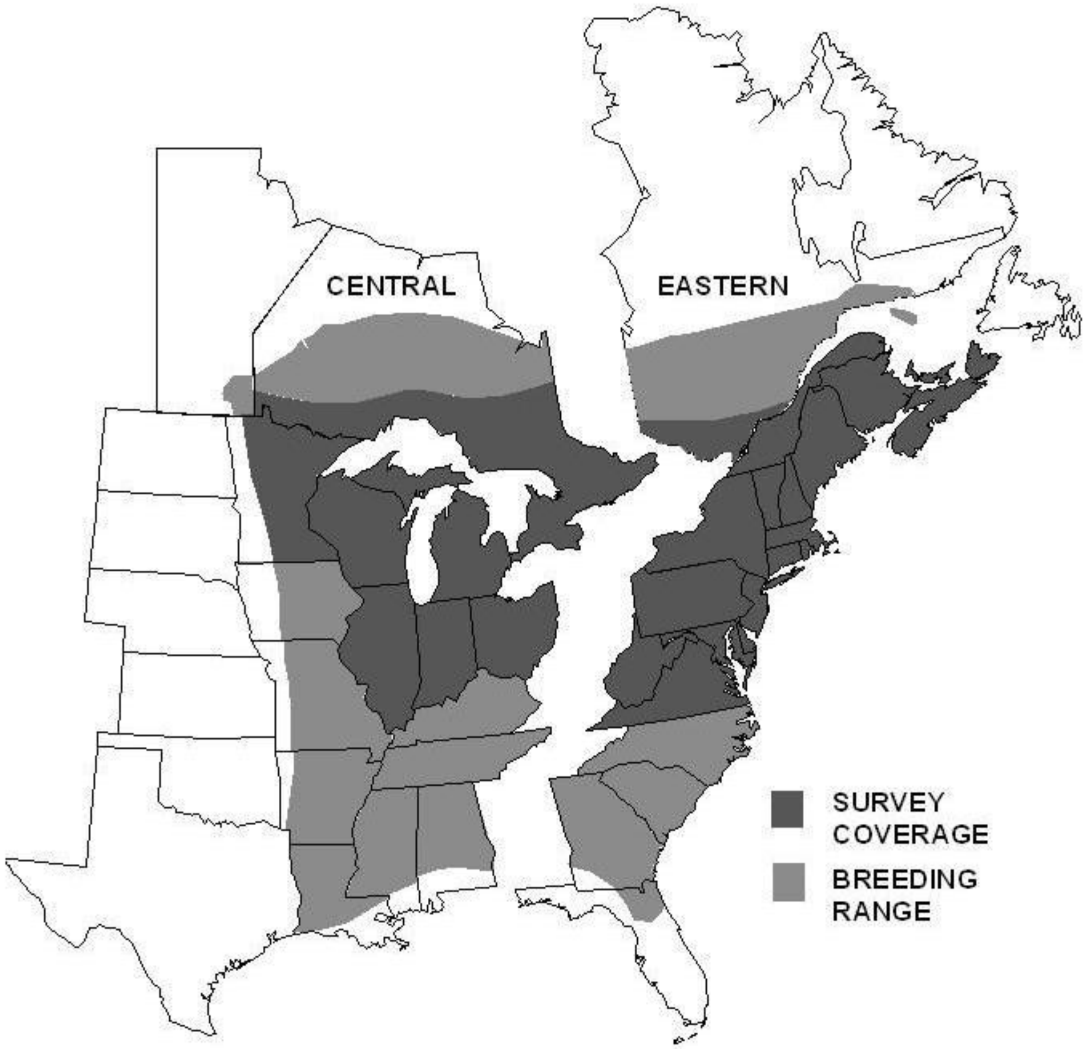

Figure 1 – American Woodcock central and eastern management regions, with distribution of breeding season survey coverage (Cooper and Rau 2012).

Woodcock captures

We captured woodcock in October 2017 using mist nets during crepuscular flights (Sheldon 1960) and by spot-lighting birds roosting in fields (Rienffenberger and Kletzly 1967, McAuley et al. 1993). We set-up mist net arrays near roosting fields, travel corridors, and forested wetlands to capture birds as they left diurnal use areas and flew to night roosting sites.

Additionally, we used spotlights to locate woodcock roosting in fields and capture using handheld nets. We aged woodcock as hatch year (HY) or after hatch year (AHY) using wing plumage characteristics, and sexed (male or female) using a combination of wing plumage, and bill length (Martin 1964, Mendell and Aldous 1943). Woodcock were fitted with a rump-mounted Lotek PinPoint ARGOS compatible satellite transmitter, which collect GPS locations of woodcock and transmit to a central database using an integrated PTT and the ARGOS satellite system. All capture, handling, and marking of woodcock was approved under USGS Federal Bird Banding Permit 23856 and the University of Maine Institutional Animal Care and Use Committee, Protocol number A2017_05_02.

Transmitter Programming

Transmitters were manually programmed using LOTEK PinPoint Host software, allowing us to specify the exact date and time locations were collected. Transmitters have limited battery life and can only collect approximately 75 locations before losing power. Transmitters were programmed with one of two scheduling options; collecting one location per day (1-day hereafter) from mid-October through the end of December, or one location every five days (5-day hereafter) from mid-October through the end of April. One-day schedules were used to evaluate fine-scale movement during migration and show day-by-day movement of individuals. 5-day schedules allow for woodcock to be tracked for both spring and fall migration, but data are less precise as multiple days occur between location collections. We systematically assigned a transmitter schedule to each captured woodcock, while controlling for equal sex and age ratios between programming treatments and across capture locations. Location data was transmitted to a remote database after every third location via the ARGOS satellite system, and we manually downloaded woodcock locations from the ARGOS website every 1 to 5 days. If the satellite transmitter's antenna contacts the ground, the PTT signal will be attenuated and cannot be transmitted; therefore woodcock that die or that drop their transmitters likely stopped data transmission, ceasing data collection for that individual.

Pilot Season Data Synthesis

Using the date and time signature unique to each location, we determined when woodcock departed the breeding grounds, arrived on the wintering ground, the number of stopover locations recorded, how many days they spent at each stopover, and the total length of migration in days. We defined a 'residency' state as occurring when a woodcock remained in the same general area (e.g. <20 ha) for more than 14 consecutive days. In practice the distinction between stopover and residency was quite clear. Number of days spent at each stopover location and total number of days spent migrating were calculated by subtracting first date from the last date at stopover sites, and departure date from the arrival date, respectively. With only a single season of data, we were unable to assess the influence of age, sex, and latitude on phenology, but will evaluate these factors in future years.

PRELIMINARY RESULTS

We captured and attached satellite transmitters to 6 woodcock during October 2017 in central (1 bird) and eastern Maine (5 birds). These included 2 AHY females and 4 HY males, with equal proportions of males and females assigned to 1-day and 5-day schedules (Table 1). All woodcock successfully initiated migration and travelled in excess of 500 km from their capture location, indicating that transmitters and attachment methods did not prevent the birds from migrating.

Woodcock departed Maine on fall migration between 30 October and 25 November, 2017, with most birds departing in early November and a single bird remaining until late November (Table 2). We documented woodcock use of 13 unique sites after initiating migration, and we documented at least one stopover location for each marked woodcock (Table 2.) Woodcock used distinct stopovers and/or established residency in 8 states; New York (3), Pennsylvania (2), North Carolina (3), Maine (1), West Virginia (1), Connecticut (1), Alabama (1), and Maryland (1). Woodcock with 1-day transmitters typically moved ~400 miles between stopovers, which is similar to distances observed in the central management zone (Moore 2016). However, we also documented a number of short distant movements (~100 miles), and woodcock regularly stopped over for only a single day before continuing migration, which suggests daily data are important for capturing migration fully. Locations for woodcock with 5-day transmitters ranged from 329-789 miles apart, but this range of distances is clearly an overestimate of single flight distances because we likely missed short-distant movements and stopovers from these birds due to the frequency of data collection (Table 2). The distribution of point-point distances from woodcock during migration is given in Table 3.

Four woodcock ultimately settled in areas for longer durations (>14 days) that suggested residency (i.e. wintering), whereas we lost contact with two woodcock before they established any long-term residency. We documented residency of woodcock in Pennsylvania, North Carolina, Maryland, and Alabama. Of these, the birds in Pennsylvania and Maryland stopped transmitting data before we could determine if they remained in those areas throughout the winter or ultimately continued southward migration. As of January 21 the bird in Alabama remained there. The bird residing in North Carolina spent >6 weeks within a very small area of the central part of the state, and then made an ~160 km movement to the Atlantic coast in early

January. As of January 28th, this bird had moved back to the central part of the state and was located ~16 km from the area it resided during November and December. Migration paths for each woodcock, along with representative stopover and residency locations, are shown in Figures 1-7.

ASSESSMENT OF DATA WITH RESPECT TO PROJECT OBJECTIVES

Based on transmitter programming and the amount of time transmitters functioned, the LOTEK PinPoint GPS transmitters uploaded data to the ARGOS satellite with an 89% success rate, and we obtained an average of 82% of the expected GPS locations (Table 1). This later number may increase as some transmitters may yet transmit previously un-obtained locations. Four of the 6 woodcock that we marked ceased transmitting data before their expected life span, which could be due to transmitter failure, lack of ARGOS coverage in a particular region, or death of the woodcock. On this later point, we learned that if a bird dies and the PTT antenna comes into contact with the ground it's signal will be attenuated, blocking transmission. This may give us the ability model survival as a function of lost communication with the birds, which would be analogous to normal capture-mark-recapture approaches based on, e.g., banding. Taking this approach would require that we could estimate transmitter failure rates and harness retention and incorporate these into survival models. Use of transmitters that function for long time periods (e.g. an entire year) will likely be crucial to ensure that lack of ARGOS coverage doesn't impede survival estimation.

We collected 199 locations from our 6 GPS-marked woodcock as of late January 2019. These data are very rich during pre- and post-migratory periods and there is probably great potential to understand habitat relationships during these times. In contrast migration was relatively short in duration for many birds, and stopovers frequently only 1 day (Table 2) which will inherently limit the amount of stopover data we obtain from any one bird. However, this is more a normal aspect of woodcock migration than a limitation of the transmitters, and the short duration of both migration and stopover may highlight the importance of frequent (daily) location data for obtaining as much stopover information as possible. Overall we believe these transmitters will invaluable for understanding habitat use pre-, during, and post-migration, as well as better-understanding the frequency and factors affecting mid-winter movements.

AKNOWLEDGEMENTS

Funding for this initial pilot season was provided by the Ruffed Grouse Society, US Fish and Wildlife Service Region 5, the Maine Department of Inland Fisheries and Wildlife, the Maine Agricultural and Forest Experiment Station, and the University of Maine. We also received significant logistic support from Moosehorn National Wildlife Refuge and USGS Patuxent Wildlife Research Center. Cooperating agencies for this work include: University of Maine, University of Rhode Island, SUNY – Cobleskill, Virginia Technological University, The Ruffed Grouse Society, The American Woodcock Society, Maine Department of Inland Fisheries and Wildlife, United State Fish and Wildlife Service, USGS Patuxent Wildlife Research Center, New York State Department of Environmental Conservation, New Jersey Department of Environmental Protection, Maryland Department of Natural Resources, Virginia Department of Game and Inland Fisheries, Pennsylvania Game Commission, Canadian Wildlife Service, Penn State University.

LITERATURE CITED

Brown, M.J., and P.D. Taylor. 2017. Migratory blackpoll warblers (Setophaga striata) makes regional-scale movements that are not oriented toward their migratory goal during fall. Movement Ecology 5:15. DOI 10.1186/s40462-017-0106-0.

Butler, C.J. 2003. The disproportionate effect of global warming on the arrival dates of short-distant migratory birds in North America. Ibis 145:484-495.

Cade, B.S., and R.W. Hoffman. 1993. Differential migration of blue grouse in Colorado. The Auk 110:70-77.

Case, D.L., and Associates (editor). 2010. Priority Information Needs for American Woodcock: A Funding Strategy. Developed for the Association of Fish and Wildlife Agencies' Migratory Shore and Upland Bird Support Task Force. 16pp.

Cooper, T.R., and R.D. Rau. 2012. American woodcock population status, 2012. United States Fish and Wildlife Service, Laurel, Maryland. 16 pp.

Faaborg, J., R.T., Holmes, A.D. Anders, K.L. Bildstein, K.M. Dugger, S.A. Gauthereaux Jr., P. Heglund, K.A. Hobson, A.E. Jahn, D.H. Johnson, S.C. Latia, D.J. Levey, P.P. Marra, C.L. Merkord, E. Noil, S.I. Rothstein, T.W. Sherry, T.S. Sillett, F.R. Thompson III, and N. Warnock. 2010. Conserving migratory landbirds in the New World: Do we know enough? Ecological Applications 20:398-418.

Klassen, R.H.G., M. Hake, R. Strandberg, B.J. Koks, C. Trierweiler, K-M. Exo, F. Bairlein, and T. Alerstam. 2014. When and where does mortality occur in migratory birds? Direct evidence from long-term satellite tracking of raptors. Journal of Animals Ecology 83:176-184.

Krementz, D.G., J.T. Seginak, and G.W. Pendleton. 1994. Winter movements and spring migration of American woodcock along the Atlantic coast. The Wilson Bulletin 106:482-493.

Lerche-Jørgensen, M., M. Willemoes, A.P. Tøttrup, K.R. Scotchburn Snell, and K. Thorup. 2017. No apparent gain from continuing migration for more than 3000 kilometers: will warbler breeding in Denmark winter across the entire northern savannah as revealed by geolocators. Movement Ecology 5:17. DOI 10.1186/s40462-017-0109-x

Martin, F.W. 1964. Woodcock age and sex determination from wings. Journal of Wildlife Management 28:287-293.

McAuley. D.G., J.R. Longcore, and G.F. Sepik. 1993. Techniques for research into woodcocks: experiences and recommendations. Journal of Wildlife Management 28:287-293.

Meunier, J., R. Song, D.E. Andersen, K.E. Doherty, J.G. Bruggink, and E Oppelt. 2008. Proximate cues for a short-distant migratory species: an application of survival analysis. The Journal of Wildlife Management 72:440-448.

Moore, J.D. 2016. Migration Ecology of American Woodcock (Scolopax minor). Thesis, The University of Arkansas, Fayetteville, USA.

Myatt, N. A., and D. G. Krementz. 2007. Fall migration and habitat use of American woodcock in the central United States. Journal of Wildlife Management 71:1197-1205.

Rodewald, P.G., and M.C. Brittingham. 2004. Stopover habitats of landbirds during fall: use of edge-dominated and early-successional forests. The Auk 121:1040-1055.

Röseler, D., H. Schmaljohann, and F. Bairlein. 2017. Timing of migration, routes and wintering grounds of a short-distance migrant revealed by geolocation: a case study of Linnets Carduelis cannabina. Journal of Ornithology 158:875-880.

Sanderson, F.J., P.F. Donald, D.J. Pain, I.J. Burfield, F.P.J. van Bommel. 2006. Long-term population declines in Afro-Paleartic migrant birds. Biological Conservation 131:93-105.

Sillett, T.S., and R.T. Holmes. 2002. Variation in survivorship of a migratory songbird throughout its annual cycle. Journal of Animal Ecology 71:296-308.

Sheldon, W.G. 1960. A method of mist netting woodcock in summer. Bird Banding 31:130-135.

Taylor, P.D., S.A. Mackenzie, B.G. Thurber, A.M. Calvert, A.M. Mills, L.P. McGuire, and C.G. Guglielmo. 2011. Landscape movements of migratory birds and bats reveal an explained scale of stopover. PLoS ONE 6:11. doi.org/10.1371/journal.pone.0027054.

Table 1. Migratory American woodcock (*Scolopax minor*) marked with satellite transmitters in central and eastern Maine, October 2017. Transmission and locations data received are numerical with missed data transmission or locations in parentheses.

ID	Sex	Age	Deploy	Last Transmission	Schedule	Active[a]	Expected No. Transmissions[b]	Realized Transmissions	Expected Locations	Realized Locations
172454	M	HY	10/15/2017	12/1/2017	1-day	No	12	11	53	36 (68%)
172455	F	AHY	10/15/2017	1/27/2018	1-day	Yes	33	30	107	93 (87%)
172456	F	AHY	10/21/2017	12/14/2017	5-day	No	5	4	15	14 (93%)
172457	M	HY	10/15/2017	12/19/2017	5-day	No	6	5	16	15 (94%)
172458	M	HY	10/15/2017	11/16/2017	1-day	No	10	9	33	27 (82%)
172459	M	HY	10/15/2017	1/18/2018	5-day	Yes	8	7	21	14 (67%)

[a]Considered active if data transmission received in the past month.

[b]Expected number of transmissions and locations based on time between deployment and last transmission.

Table 2. Phenology of American woodcock migration, derived from 6 woodcock marked with satellite transmitters in eastern and central Maine, 2017.

ID	Sex	Age	Schedule	Initiated Migration	Arrived at Winter Loc.	Days Migrating	Stopover Events
172454	M	HY	1-day	11/25/2017	--	--	1
172455	F	AHY	1-day	11/4/2017	11/10/2017	6	4
172456	F	AHY	5-day	11/4/2017	11/10/2017	6	1
172457	M	HY	5-day	11/14/2017	11/25/2017	11	1
172458	M	HY	1-day	11/4/2017	--	--	3
172459[a]	M	HY	5-day	10/30/2017	12/25/2017	56	2

[a]This bird has an ~1 month data gap where GPS locations have not been transmitted. So, length of migration and number of stopovers reflect over- and underestimates, respectively.

Table 3. Distribution of distances between successive locations of migrating American woodcock marked using GPS transmitters using programming schedules that collected point locations daily (1-day) or every 5th day (5-day).

Distance (miles)	**1-day**	**5-day**
0-100	1	0
100-200	2	0
200-300	0	0
300-400	6	2
400-500	0	0
500-600	0	2
600-700	0	0
700-800	0	1

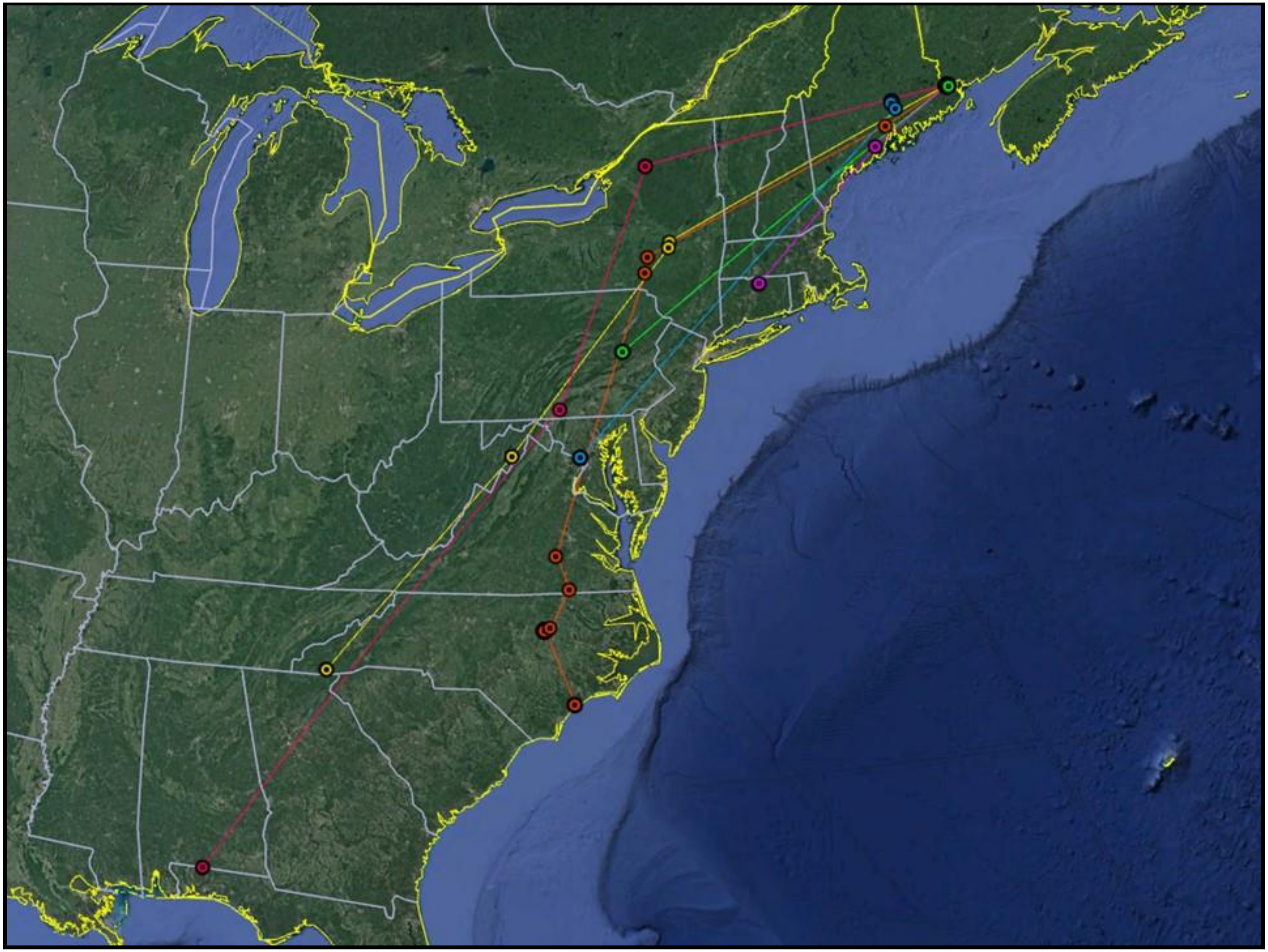

Figure 1. Migration routes for 6 American woodcock (*Scolopax minor*) marked with satellite transmitters in central and eastern Maine, October 2017, and followed as late as January 2018.

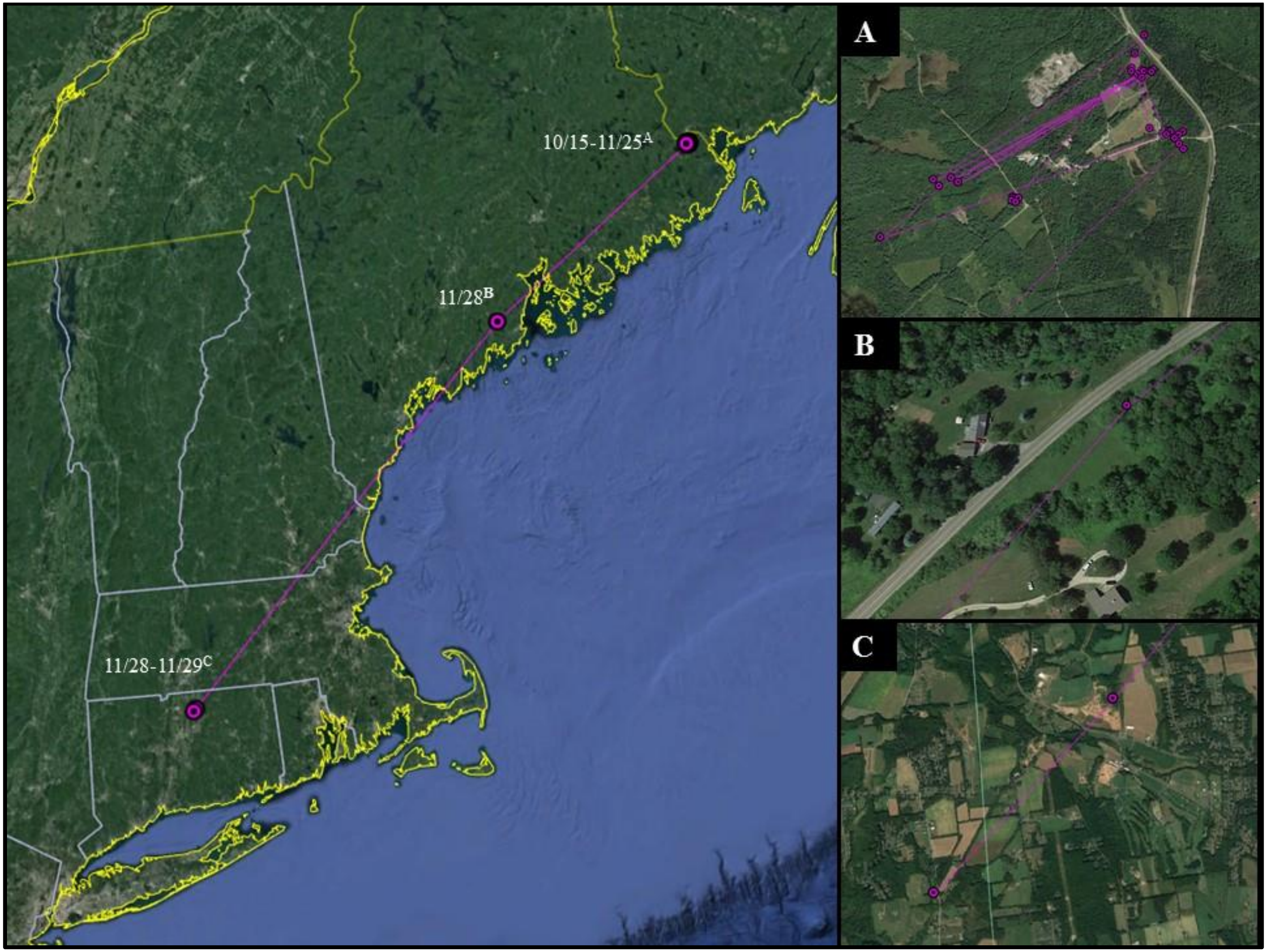

Figure 2. Migration route of a hatch year male American woodcock (*Scolopax minor*; 172454), initially marked at Moosehorn National Wildlife Refuge, Calais, ME and last located in north-central Connecticut, November 2017. Inset maps show pre-migration (A) and stopver locations (B and C)

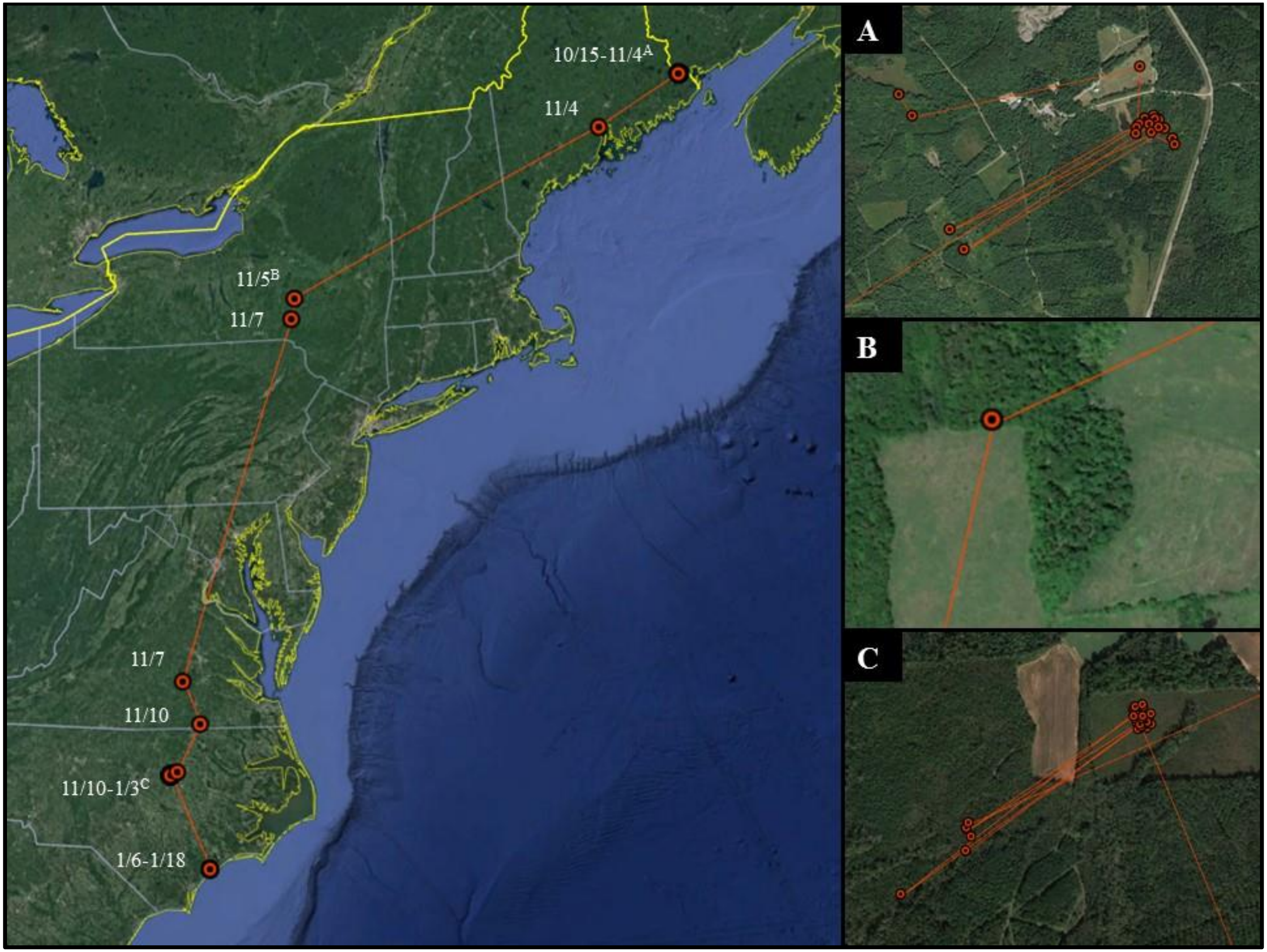

Figure 3. Migration route of an after hatch year female American woodcock (*Scolopax minor*; 172455), initially marked at Moosehorn National Wildlife Refuge, Calais, ME and last located in southeastern North Carolina, January 2018. Inset maps show pre-migration (A) a stopver location (B) and post-migration residency (C)

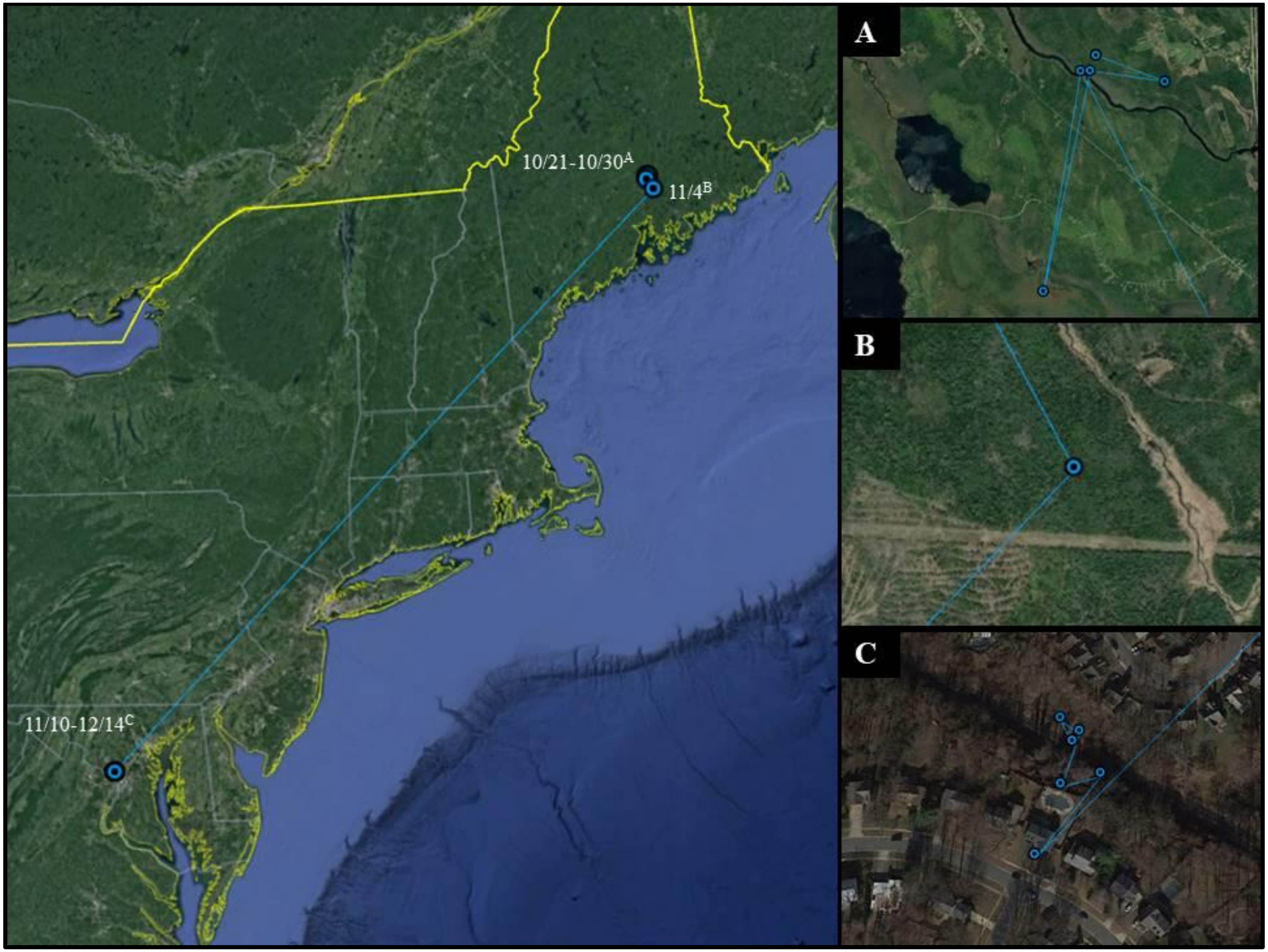

Figure 4. Migration route of an after hatch year female American woodcock (*Scolopax minor*; 172456), initially marked at The University of Maine's Henderson Forest, Old Town, ME and last located in Maryland, December 2017. Inset maps show pre-migration (A) stopover (B) and post-migration residency (C)

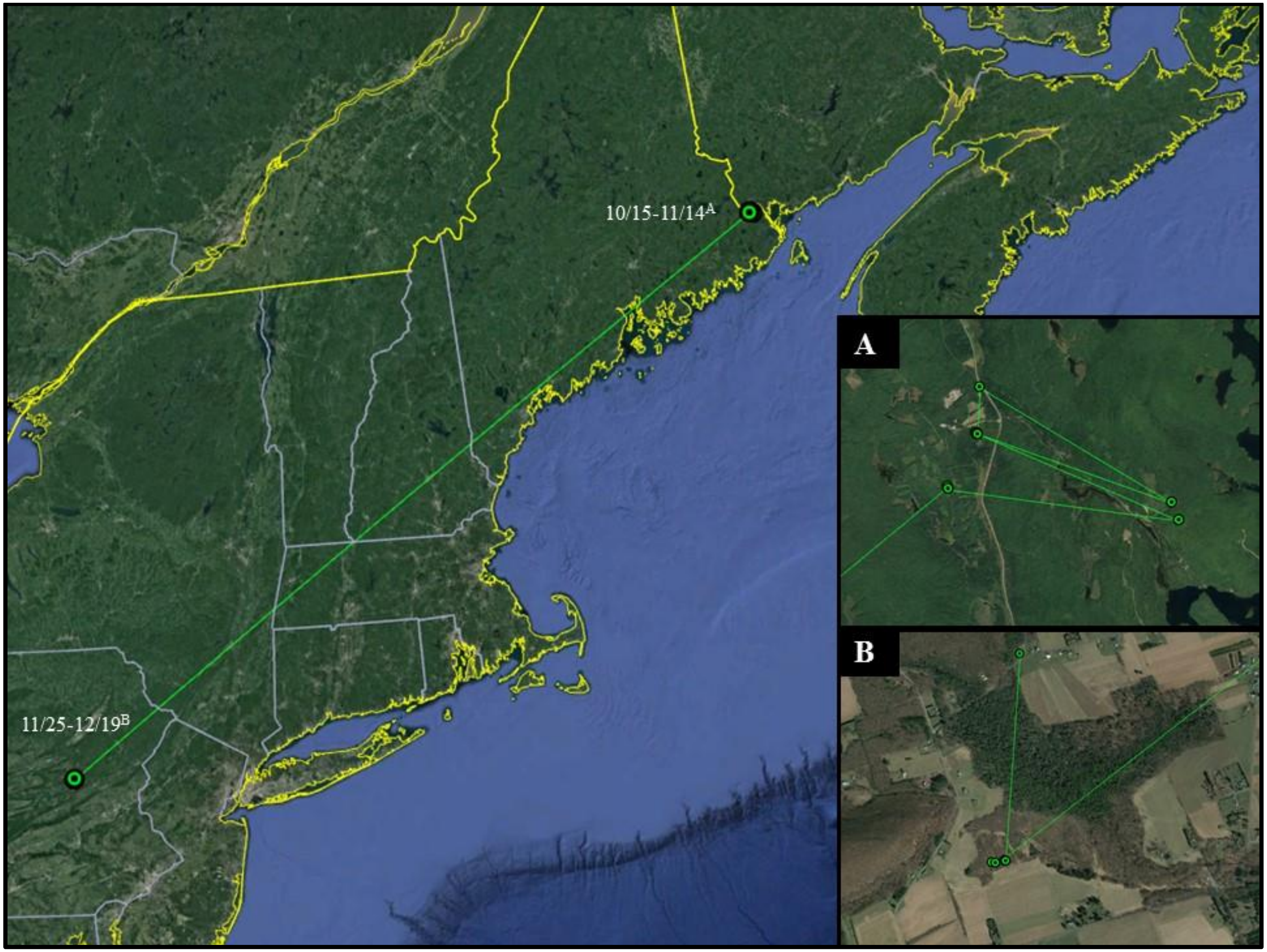

Figure 5. Migration route of a hatch year male American woodcock (*Scolopax minor*; 172457), initially marked at Moosehorn National Wildlife Refuge, Calais, ME and last located in the eastern Pennsylvania, December 2017. Inset maps show pre-migration (A) and post-migration residency (B)

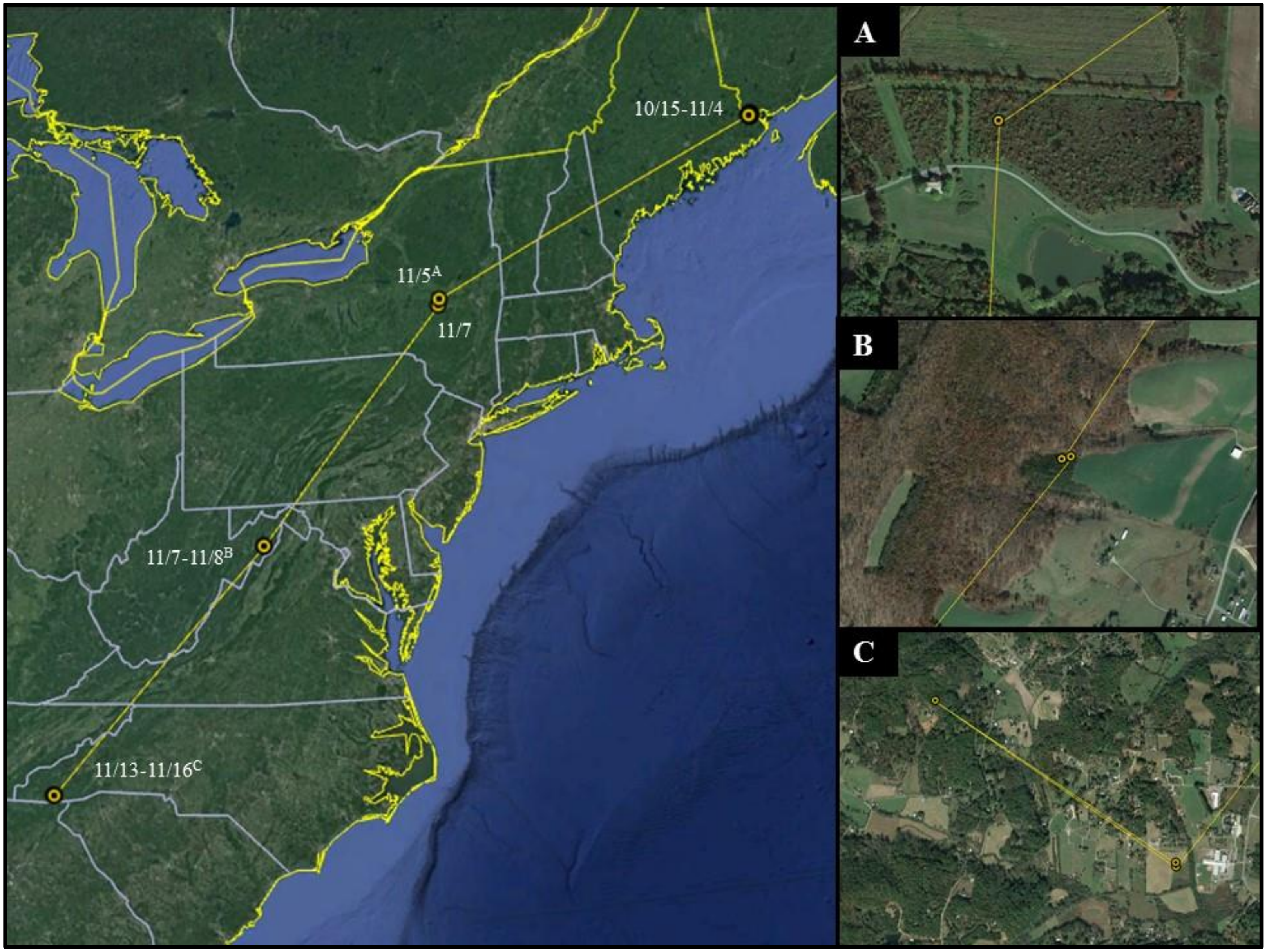

Figure 6. Migration route of a hatch year male American woodcock (*Scolopax minor*; 172458), initially marked at Moosehorn National Wildlife Refuge, Calais, ME and last located in the western North Carolina, November 2017. Inset maps show a sequence of three stopvers.

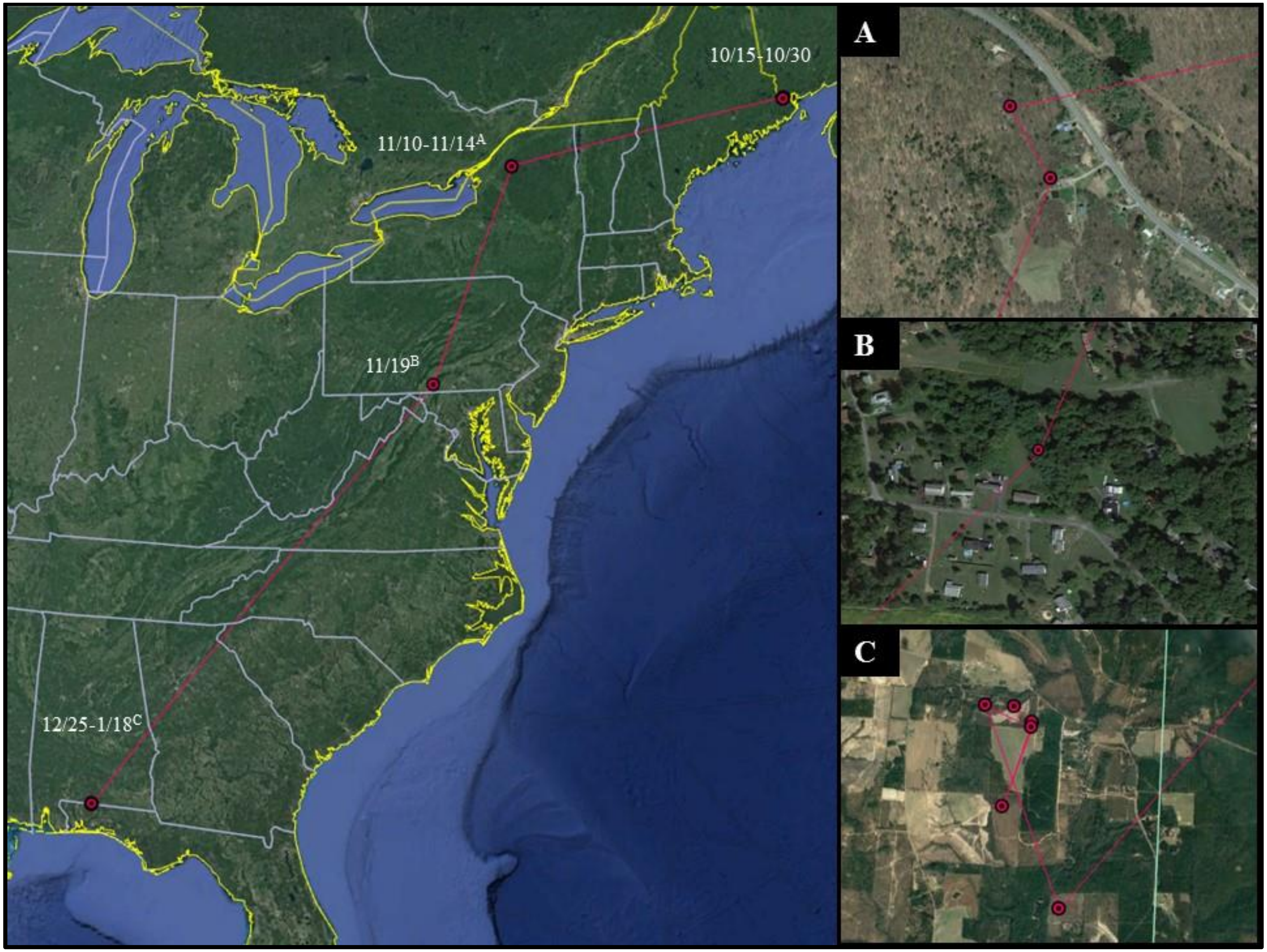

Figure 7. Migration route of a hatch year male American woodcock (*Scolopax minor*; 172458), initially marked at Moosehorn National Wildlife Refuge, Calais, ME and last located in Alabama, January 2018. Inset maps show stopover (A, B) and post-migration residency (C).