Project Report

Migratory and Interhabitat Connectivity of North American Wintering Songbirds on the South Coast of Puerto Rico: Application of Geolocator Technology

Report to the Nuttall Ornithological Club for 2016-17

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Abstract. The effective conservation of long-distance migratory birds requires the identification and protection of the birds, nesting habitat as well as their stop-over and wintering habitats. This project provides the first implementation of archival light-level geolocator data logger technology by a Puerto Rican institution to study the migratory connectivity of Neotropical migratory birds in Puerto Rico and compliments existing information derived from banding returns and stable isotope analyses to determine the geographic origins in North America of birds that occur in Puerto Rico during the non-breeding seasons. We applied this technology to help establish the specific intercontinental migratory connectivity of the 15-20 g Northern Waterthrush (*Parkesia noveboracensis*), a species breeds in North America and passes the winter in the Caribbean, Central and South America. We deployed 40 data loggers on Northern Waterthrushes at Jobos Bay in Salinas, Puerto Rico in coastal dry forest habitat from September 2015 through April 2016, as birds wintered in Puerto Rico and/or prepared for their return to nesting grounds in North America. This report provides a preliminary analysis of the results obtained from the data loggers recovered from birds that returned to Puerto Rico from September 2016 through April 2017. Of these, 11 (28%) were recovered from September 2016 to April 2017 – a success rate that compares favorably with previous studies elsewhere. preliminary analyses of downloaded geolocator data, suggest that our visiting Northern Waterthrushes nest predominantly in the area from Massachusetts and New Hampshire to southern Quebec and New Brunswick.

Introduction

Long-distance migratory organisms are under strong selection to migrate efficiently. Long distance flights of thousands of km in Neotropical migratory songbirds, highlight the key importance of stopover sites and efficient migratory routes to the migration strategy of this species (Forschler and Bairlein 2011; Stanley et al. 2012, 2014; Arlt et al. 2013; Bridge et al. 2013; Cotina et al. 2013; McKinnon et al. 2013, 2014, 2015; Renfrew et al. 2013; Hobson et al. 2014; DeLuca et al. 2015; Cooper et al. 2017; Gómez et al. 2017; Snijders et al. 2017). Neotropical migrant birds can be limited in size by factors such as reproductive success and parental survival rates during the breeding season, and by individual survival during the nonbreeding season (see also Marra et al. 1993), as well as during the long-distance migration between sites (see Paxton et al. 2007; 2008; Faaborg et al. 2010a, 2010b, Hobson et al. 2014). Moreover, a species may occur in distinct populations that winter in different locations or whose departure and return dates may be quite different, and these differences may be key to understanding population trends. For example, Rubenstein et al. (2002), using stable isotopic methods demonstrated that northern populations of the Black-throated Blue Warbler *(Setophaga caerulescens*) with stable population trends wintered in Cuba and the Western Greater Antilles, while declining populations nesting in the southern portion of their range tended to winter in eastern Hispaniola.

This project is operated in the secondary mesquite (*Prosolis juliflora*) -dominated, coastal woodland and a mangrove-dry forest interhabitat corridor at Jobos Bay National Estuarine Research Reserve (JBNERR – "the Reserve" Figure 1). During the period from September 2015 to May 2016, the project encountered (captured or recaptured) nearly **1,150** birds at 3 locations, and during September 2016 to May 2017 at 2 locations (sites 2 and 5) another **1135** encounters including **582** new bands, **453** recaptures and **100** unprocessed birds, for a total of approximately **6,300** encounters since the beginning of this effort in 2011. Moreover, for Northern Waterthrushes (NOWA), banding efforts provided for increasing numbers of returning recaptures from previous years approaching numbers similar to newly banded birds. These numbers are due in large part to the acquisition of sufficient equipment and supplies (funding support from the Blake-Nuttall Fund), enhanced outreach and program development.

Our mist netting recoveries compare favorably with those of Hallworth et al.'s (2013) geolocator study wherein they recaptured 20 of 50 (40%) Ovenbirds on the nesting grounds; and, they also recaptured 12 of 46 (26%) Ovenbirds in route or on the wintering grounds in Florida and Jamaica, also compare well to recovery rates of geolocators in previous studies elsewhere (Table 2). Though not encumbered with a geolocator, the ability to predictably recapture Northern Waterthrushes at JBNERR makes these birds excellent candidates for a geolocator study of the nesting origins of the Reserve's winter visitors, as well as possible winter movements further south.

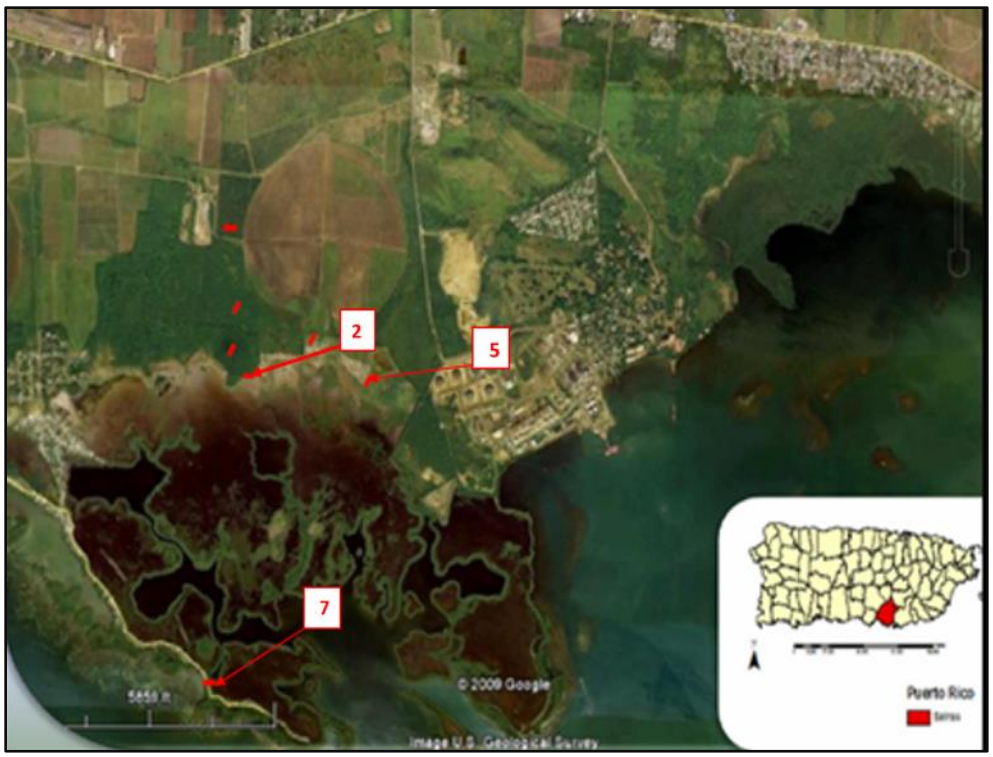

Figure 1. Jobos Bay National Estuarine Research Reserve (JBNERR) and adjacent agricultural lands. Short red lines indicate previous and current mist netting sites, including (Site 2) a mangrove-dry forest interhabitat corridor *("El Corredor"),* (Site 5) a mesquite *(Prosopis juliflora)* dominated coastal area adjacent to mangroves *("La Poza")* near a freshwater impoundment, and (Site 7) a red mangrove *(Rizophora mangle)* dominate site at *"Camino del Indio".*

Table 1. Summary of mist netting efforts (NOWA = Northern Waterthrush).

	Sep 2014-May 2015	Sep 2015-May 2016	Sep 2016-May 2017
Total Encounters	1008	1150	1135
Total New Bands	643	712	582
Total Recaptures	298	394	453
Unprocessed	53	44	100
NOWA New Bands	83	174	104
NOWA Recaptures	117	138	163
NOWA Recaptures	0	0	1

Table 2. Recovery rates of geolocators from previous studies In the Literature.

Study	Species	Recovery	
Stutchbury et al. 2009	Purple Martin	3 of 16	19%
Stutchbury et al. 2009	Purple Martin	2 of 18	11%
Stutchbury et al. 2009	Wood Thrush	2 of 14	14%
Bairlein et al. 2012	N Wheatear	5 of 30	16%
Bairlein et al. 2012	N Wheatear	2 of 16	13%
Contina et al. 2013	Painted Bunting	5 of 11	15%
Renfrew et al. 2013	Bicknell's Thrush	4 of 45	9%
Renfrew et al. 2013	Bicknell's Thrush	13 of 60	22%
Macdonald et al. 2012	Snow Bunting	13 of 90	14%
DeLuca et al. 2015	Blackpoll Warblers	5 of 37	11%
Hallworth et al. 2013	Ovenbird	20 of 51	39%
Hallworth et al. 2013	Ovenbird	12 of 46	26%
McKinnon et al. 2014	Wood Thrush	62 of 355	18%
Stanley et al. 2014	Wood Thrush	102 of 733	14%
Peterson et al. 2015	Gldn-wgd Warblers	18 of 39	39%

Methods

We conducted intensive mist netting (10 12-m, 0 mm mesh nets) set at least monthly at each if 2 sites (Site 2 and Site 5) in mangrove night-roost areas beginning well before dawn in order to intercept birds before they leave the roosting areas and thus allow the capture of both despots and diurnal migrants. Mist netting also. All birds captured were banded and color banded with unique 4-color band combinations to permit individual identification, and the time and specific capture location will be recorded. Standard morphometric data including wing length and body mass, breast muscle size and fat scores, and body condition index parameters were collected.

We initially obtained 20 geolocators and placed our first geolocator on a Northern Waterthrush on Monday, Sept. 21st, 2015 – one of the first geotagged birds in Puerto Rico and the first placed by a Puerto Rican institution **(Figures 2-3).** However, with recapture probabilities substantially less than 100%, we felt we needed additional units in order to achieve sufficient returns to determine the proportions of birds that use Puerto Rico as a transit (stop-over) location versus those that use our site as a complete wintering area. Although these first-deployed units (Migrate Technology Integeo-P50B1-7-dip, *ca.* 0.50 - 0.55 g) offered the advantage of an 11-month estimated battery life, their greater weight meant that we had to be very selective and only deploy on birds over 18 g.

Unlike the results of Gomez et al. (2017) we could not use a regression of Wing Chord (X) and “0 Fat Score” weight to estimate lean body mass for best estimation of lean body mass of birds to be selected for geolocator deployment (Figure 5).

Some 20 additional units were purchased with in March 2016. These newer units were the Migrate Technology Integeo-P30Z-7- DIP Light-level Geolocator model, with an estimated battery life of 6-7 months (vs 11 months for the previous units). They have the advantage of being light enough (less than 0.40 g) to be placed on any sized Northern Waterthrush **(Figures 2-3),** but the disadvantage they present is that they cannot be activated or deactivated on board (on the bird) and data cannot be downloaded onboard. However, the estimated battery life of these newer units was believed to be sufficient to capture the birds’ return trips to their nesting grounds and most of their flights back from their nesting grounds.

Both the previous units and the new units were mounted on the birds using a modification of the leg-loop harness of Rappole and Tipton (1981) and Streby et al. (2015) (Figure 2). The previous units also could be activated in the field and all but two (2) were mounted with a custom-fitted braided nylon cord provided by the manufacturer **(Figures 2-3)** In contrast to the previous units, the new units must be activated and the contacts cut and sealed with adhesive prior to deployment on the bird **(Figure 2-3).**

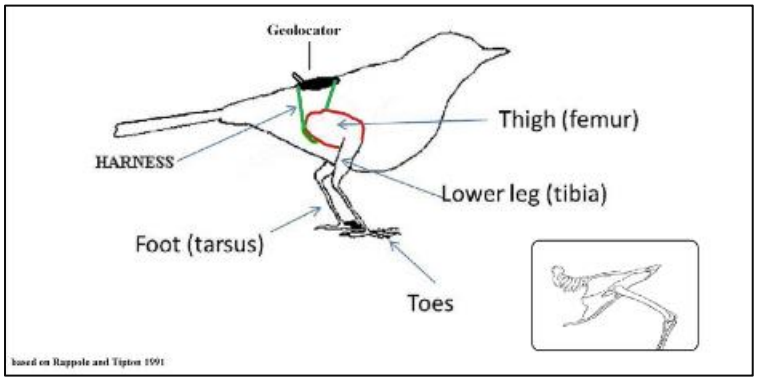

Figure 2. Leg-loop harness, adapted from Rappole and Tipton (1991) and Streby et al. (2015).


Figure 3. Larger (left) and smaller (right) geolocator units mounted on Northern Waterthrushes.

A total of 21 geolocator units were placed on birds from February 27th through April 3rd, 2015, in addition to the 19 units deployed Sep-Dec 2015 – a total of 40 units were deployed on birds in the environment (Figure 5). Three birds tagged during Sep-Dec 2015 were recaptured on Feb. 7, 27 and 28, 2016 (birds 29906, 5287 and 3307, respectively), and bird 29906 was recaptured again on April 10th, 2016. All were found to be in excellent physical condition and bird 52874 had increased it body mass by 10% at the time of recapture (18.0 g on Dec. 12th to 19.9 g on Feb. 27th, not including the tag). On Feb. 28th, 2016 the heavier tag that bird 39307 carried since October 4th, 2015 was replaced with the newer, lighter model unit. By the end of the season, (May 1st, 2015) 19 birds had been fitted with the older units in (Sep-Dec 2015) and released – 17 with braided cord harnesses and two with plastic harnesses. Nine of these were birds that had been captured and banded in a previous year or previously during the same season (Recaptures), while 10 were birds captured for the first time (New Bands). All geolocator deployed birds were captured at either the mesquite site (Site 5, *"La Poza")* or at the interhabitat corredor site (Site 3, "El Corredor").

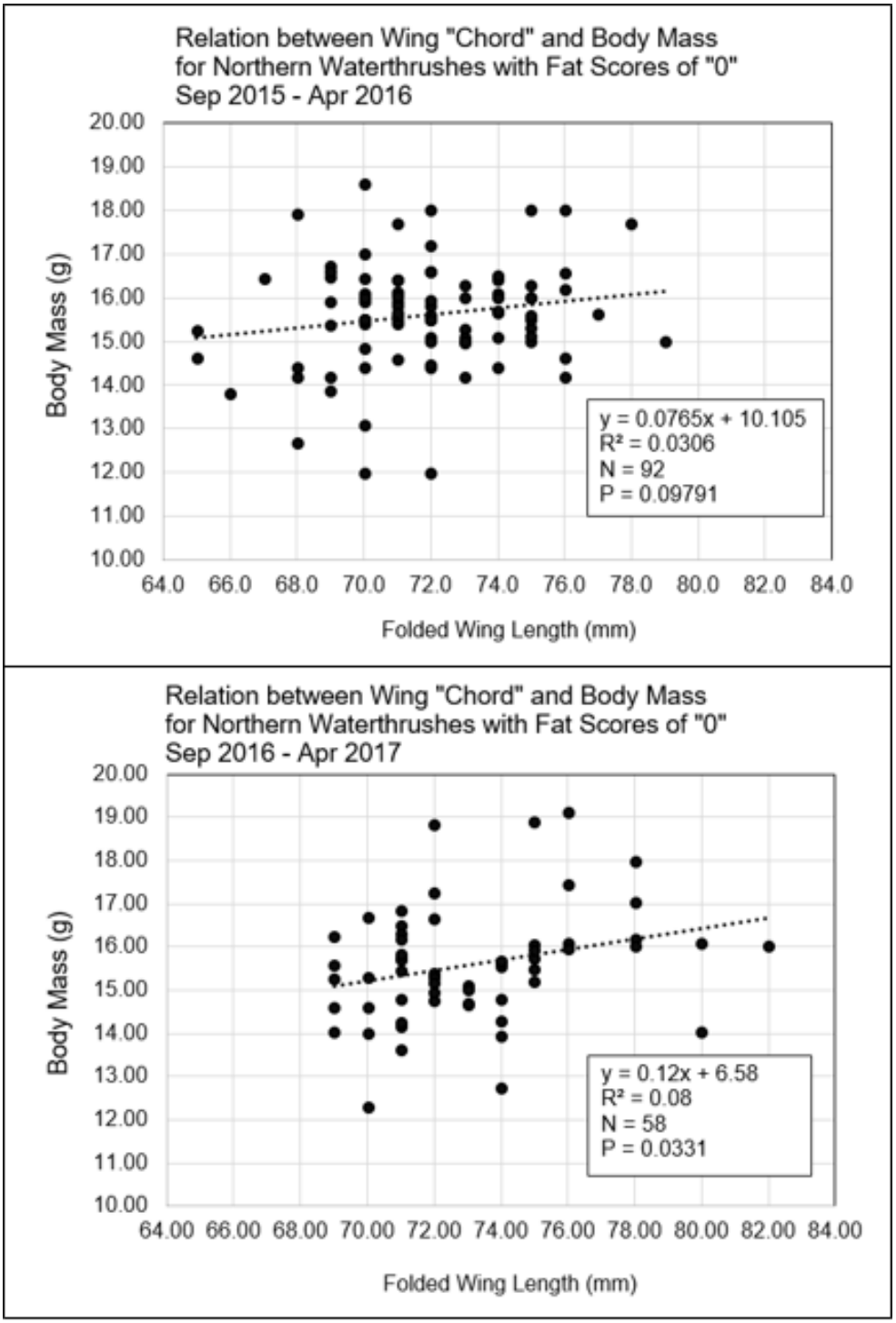

Figure 4. Wing Chord (Folded Wing Length) and 0 Fat Score body masses of Northern Waterthrushes in 2015-2016 and 2016-2917.

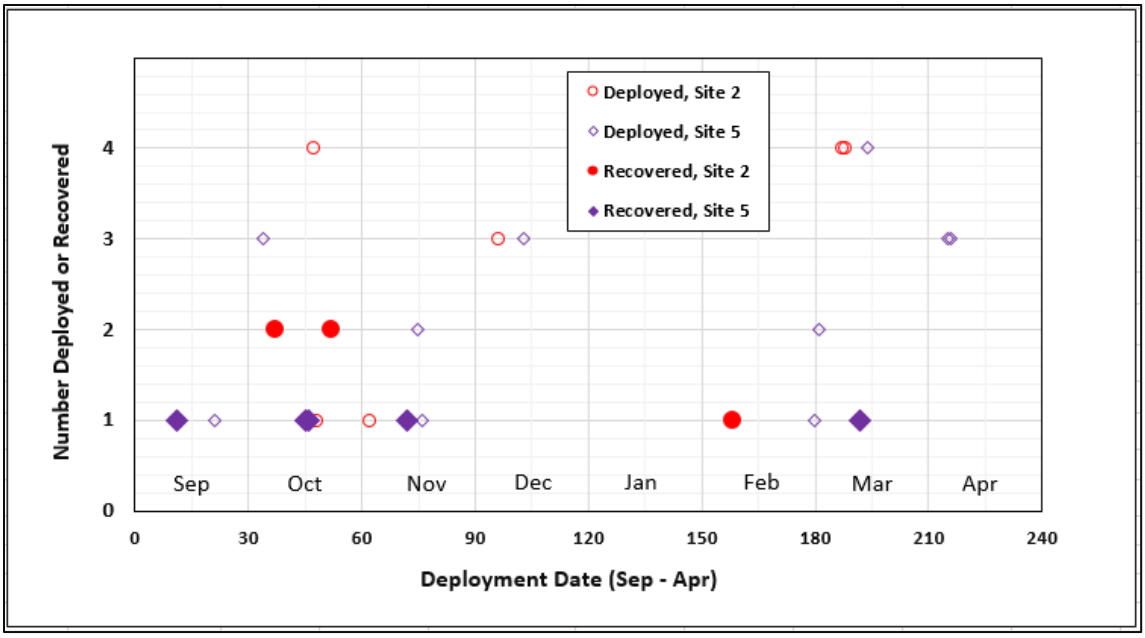

Figure 5. Deployment dates of geolocators deployed Sep 2015-Apr 2016. Season day 1 is Sep. 1 (Appendix 1).

Results and Discussion

- **Mist Netting and Banding**

We continued mist netting and banding during 2016-2017 as in previous seasons and summarized in the introduction herein.

- **Tag Recoveries**

Of the 40 geolocators deployed, 11 were recovered (Figure 6, Table 3). The first geolocator recovered was a larger model tag (X047) on Sep. 11, 2016 at Site 5 (Poza), and which was deployed at the same site on Apr. 3, 2016. The last geolocator recovered was a smaller model tag (X338) on April 2, 2017, also at Site 2 (Corridor), and which was deployed at the same site on Mar. 5, 2016. The overall recovery rate of 28% compares favorably with previous studies.

Figure 6. Sep-Dec 2015, Migrate Technology, Integeo-P50B1-7-dip, 0.55 g, 11-12 months estimated life. Unit V717, recovered October 7, 2016.

Figure 7. Feb-Apr 2016, Migrate Technology, Integeo-P30Z11-7-dip, 0.40 g 7 month life; Unit 339 recovered Saturday March 11, 2017.

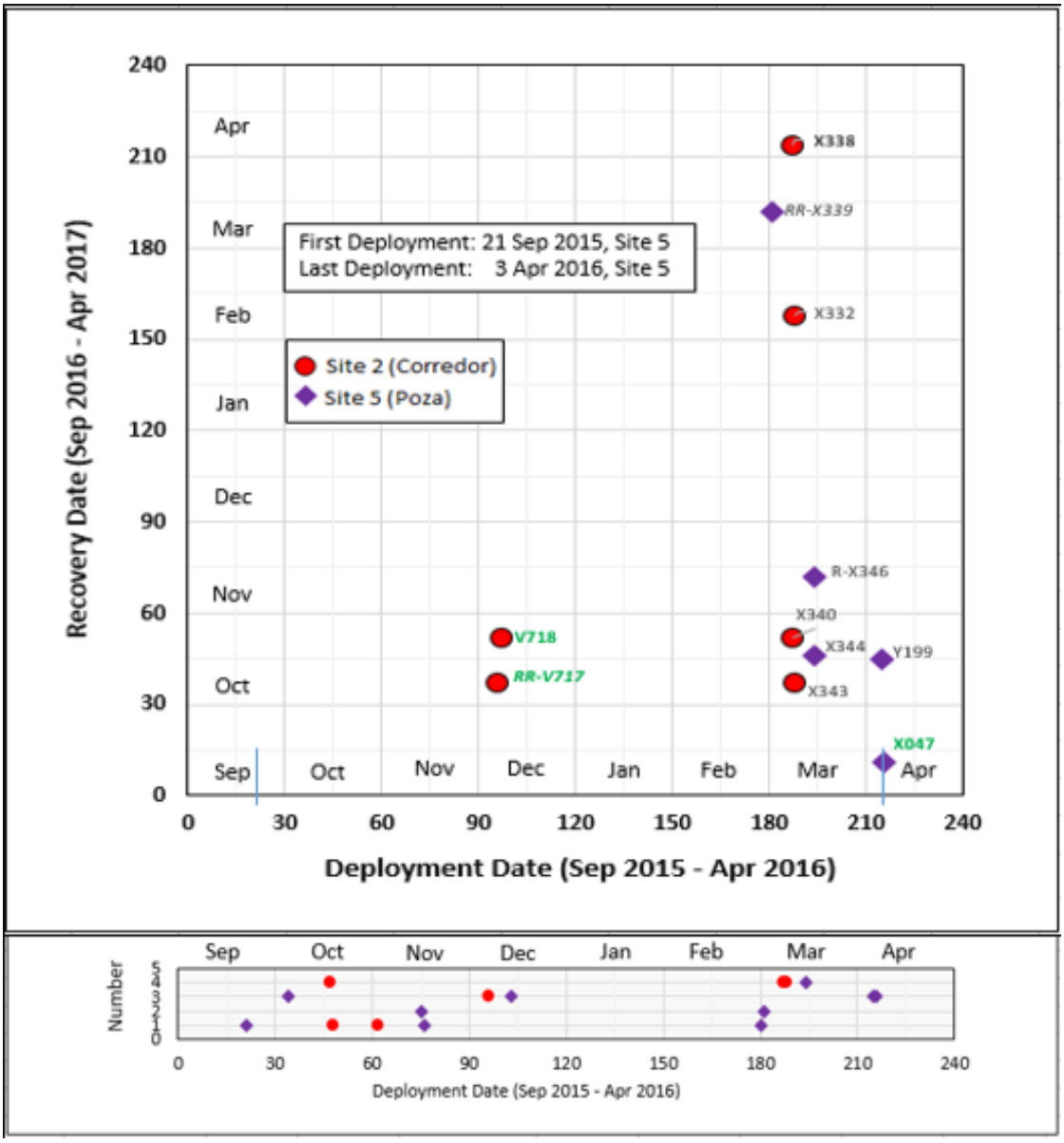

Figure 8. Recoveries of geolocators (Sep 2016-April 2017) deployed in 2015-2016. Season day one is Sep. 1 (Appendix 1).

However, the recovery rates for Sep-Dec 2016 deployments were low, with no recoveries of the units (larger model) deployed at Site 5. Recoveries of units deployed Jan-Apr 2016 were notably higher, with 50% recovery of the smaller units deployed in Jan-Apr 2016 (Table 3). These results suggest a need to repeat this methodology in the Sep-Dec (wet) migratory season, especially at Site 5 (mesquite monoculture) in order to better understand the dynamics of this cohort of the population. They also of argue strongly for use of the lighter model geolocator.

Table 3. Summaries of recoveries of geolocators from Northern Waterthrushes. All 19 units deployed Sep-Dec 2016 were the larger model while 20 of the 21 units deployed Jan-Apr 2016 were the smaller model. The final unit deployed in Apr 2016 was a larger model.

	Number of Tags Recovered		
Deployment Dates	Site 2	Site 5	Total
Sep-Dec 2015	2 of 9 (22%)	0 of 10 (0%)	2 of 19 (11%)
Jan-Apr 2016	4 of 8 (50%)	5 of 13 (38%)	9 of 21 (43%)
Total	6 of 17 (35%)	5 of 23 (17%)	11 of 40 (28%)

Overall, 47 of /151 non-tagged birds originally captured at sites 2 and 5 in 2015-2016 and not carrying a geolocator were recaptured = 0.3113 (31.13%). Chi-squared goodness of fit, $P = 0.000169$.

Movements of Geolocator Tagged birds

Complete analyses of light-level and geographic data currently are underway. However, preliminary analyses of four recovered units indicate that our birds summered widely in the area of the northeastern USA and southeastern Canada from Massachusetts to Ontario, Quebec and New Brunswick (Figures 9 & 10). Geolocator V718 (Figures 10 & 11) was carried by and adult female, as indicated by the fully shaded period in June (Figure 12). This bird spent the summer in the same area as the previously mentioned birds and made used an extensive oceanic route to return to Puerto Rico from New England.

Figure 9. Preliminary analyses of four recovered geolocator units. These four units are the lighter weight model (Peter Olsson).

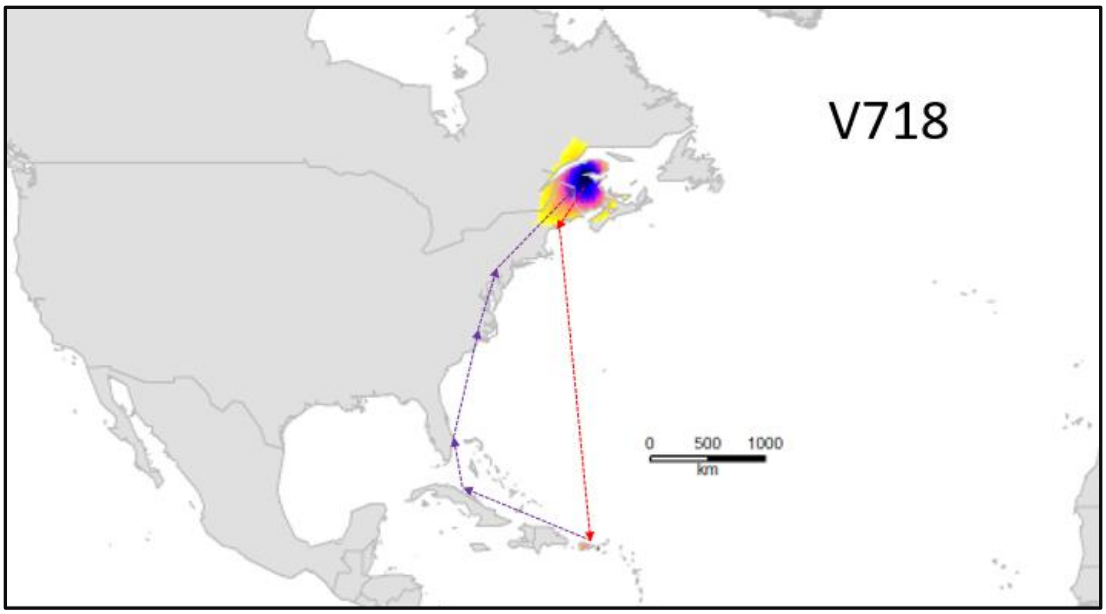

Figure 10. Preliminary analysis of movements from geolocator V718, a larger weight model carried by an adult female (Michael Hallworth).

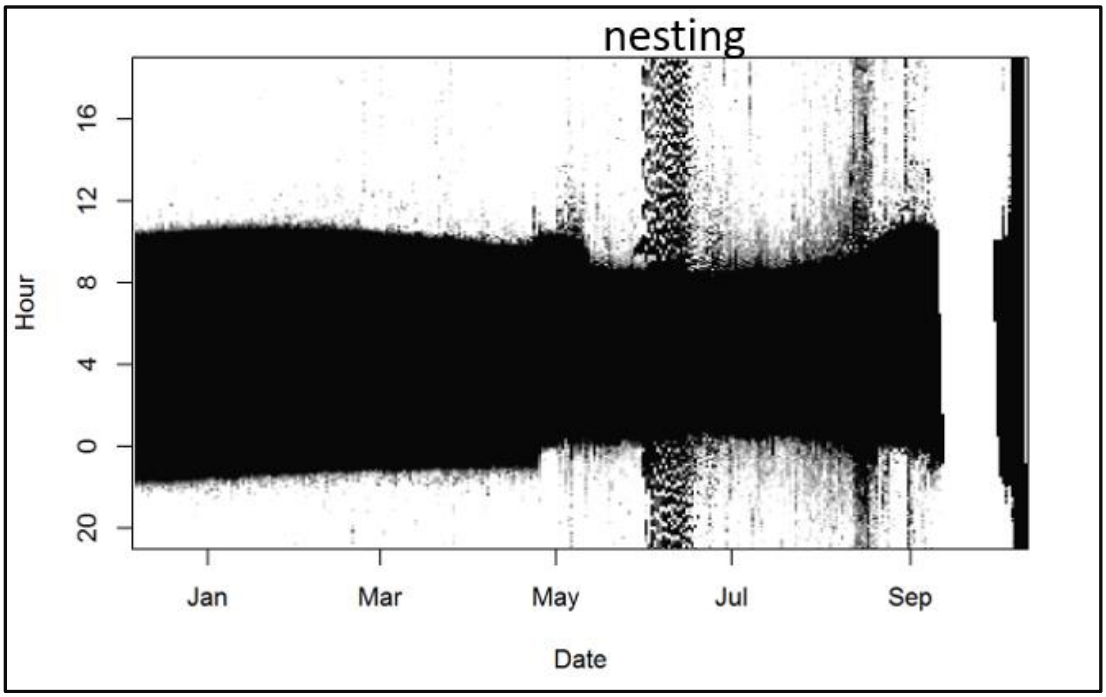

Figure 11. Light data for geolocator V718, carried by a nesting female, as indicated by the shaded incubation period in June (Michael Hallworth).

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This study was conducted under the authorization of Animal Care and Use Committee (ACUC) Protocols A03-006-13 and A03-023-16 of the Ana G Mendez University System Office of Compliance.

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Appendix 1. Season days in 2015-2016 and 2016-2017.

Day	Date 2015-16	Date 2016-17
1	9/1/2015	9/1/2016
31	10/1/2015	10/1/2016
62	11/1/2015	11/1/2016
92	12/1/2015	12/1/2016
123	1/1/2016	1/1/2017
154	2/1/2016	2/1/2017
183	3/1/2016	3/2/2017
214	4/1/2016	4/2/2017
243	4/30/2016	5/1/2017