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IDENTIFYING MIGRATORY PATHWAYS USED BY RUSTY BLACKBIRDS BREEDING IN SOUTHCENTRAL ALASKA

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ABSTRACT.—We placed light-level geolocators on 17 Rusty Blackbirds (*Euphagus carolinus*) in 2009 to track their migrations from nest sites near Anchorage, Alaska to wintering areas and back. We recaptured three of these birds in 2010 and found they departed breeding areas during the first half of September, spent 72–84 days migrating to overwintering areas, but only 16–30 days on their northward migration to Alaska. Birds took similar Central Flyway routes on southward and northward migrations, which were not previously described for this species. The birds used a series of stopover sites across the prairie region from southern Saskatchewan to Iowa over a 4 to 5 week period on their southward migration to wintering areas that spanned from South Dakota to northern Louisiana. We found upon recapture in 2010, the geolocator attachment harnesses had abraded the surrounding feathers on all three birds. This coupled with the low return rate (18%) for instrumented birds indicates a better harness method must be developed before this technology is more widely used on Rusty Blackbirds. *Received 8 February 2012. Accepted 19 June 2012.*

Understanding migratory routes and how they link breeding, stopover, and wintering areas is a key component of effective conservation for declining populations of migratory birds (Webster et al. 2002). This task is complicated for songbirds by their small size, large ranges, and inconspicuous behaviors, which make them difficult to effectively track using conventional mark-recapture techniques or radio or satellite telemetry. Recent advances in light-level geolocators (Burger and Shaffer 2008) have provided new opportunities to study the migration pathways of songbirds (Stutchbury et al. 2009, 2011; Heckscher et al. 2011; Ryder et al. 2011; Bairlein et al. 2012; Seavy et al. 2012). We used this technology to track annual movements of Rusty Blackbirds (*Euphagus carolinus*), a species of high conservation concern (Greenberg et al. 2011), from their breeding areas in southcentral Alaska to wintering areas and back.

The Rusty Blackbird breeds in wetlands throughout the Nearctic boreal forest from northeastern North America across Canada to Alaska. It winters in wooded wetlands in the eastern half of the United States where widespread wetland loss and degradation is believed to be the principal cause for the 90% decline in population size (Greenberg and Droege 1999, Niven et al. 2004, Greenberg et al. 2011, Sauer and Link 2011). Feather isotopes suggest the species may comprise western and eastern populations with individuals breeding from Alaska through central Canada wintering in the Mississippi Alluvial Valley, and those breeding east of Manitoba wintering along the Atlantic Coastal Plain (Hobson et al. 2010). Little is known, however, about timing of migration or important migratory stopovers. The latter may be particularly important given the species is a temperate migrant and may spend extended periods of time at stopover locations before settling in wintering areas in the southeastern U.S. (Hamel and Ozdenerol 2009).

We used geolocators to provide the first detailed look at the migratory movements of Rusty Blackbirds over an entire annual cycle. We also chronicle general habitats used for stopovers and wintering, and the potential adverse effects of geolocators on this species.

METHODS

We captured 17 adult Rusty Blackbirds (12 females and 5 males) in June 2009 near Anchorage, Alaska (61° N, 149° W) using mist nets placed near their nest sites. We attached 1.2-g light-level geolocators (model Mk10S with 10-mm sensor stalk at a 30° angle, British Antarctic Survey, Cambridge, UK) to each bird using a

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synsacrum harness (Rappole and Tipton 1991) of 5-mm tubular Teflon ribbon (Bally Ribbon Mills, Bally, PA, USA). Harness size was calculated using allometric equations (Naef-Daenzer 2007) and adjusted in the field for individual fit. The geolocator and attachment harness weighed 2.0 g, or 3.4% of a Rusty Blackbird's body mass ($\bar{x}$ = 57.8 g, n = 16 birds). We monitored each instrumented bird over the nesting period for evidence of poor fit or abnormal behavior. We located three birds fitted with geolocators and recaptured them at their nest sites in June 2010 following intensive, repeated surveys of the study area (Matsuoka et al. 2010).

The Mk10S measured light-level data at 60-sec intervals and stored maximum values every 10 min. Geolocators were calibrated during a 5-day period that preceded deployment. We estimated the average sun elevation angle that corresponded to our chosen light threshold from clean sunrise/sunset events during the calibration period (Fox 2010). We analyzed the data on ambient light levels from the geolocators to identify daily locations using BasTrak software with the single threshold method (Fox 2010). We visually inspected the transitions at each sunrise and sunset, and removed any that appeared to be influenced by shading events and other sources of interference. Latitude was estimated from the length of each solar day/night and longitude from the timing of each solar noon/midnight. We did not estimate latitude from data recorded 15 days before and after spring and autumn equinoxes because latitude estimates during equal day and night lengths are highly inaccurate (Stutchbury et al. 2009, Fox 2010).

Rusty Blackbirds are believed to move during the non-breeding season in response to changes in weather and availability of foraging habitats and food resources (Hamel and Ozdenerol 2009, Luscier et al. 2010). We estimated core areas used by each individual during the non-breeding season, rather than a single averaged location. We used Home Range Tools (Rodgers et al. 2007) and ArcGIS 9.3 (ESRI 2009) to estimate kernel probability densities of home ranges during autumn stopover and winter periods. We used a fixed-kernel parameter with least-squares cross validation for calculating the smoothing parameter (h). This has performed well for simple mixtures ($<$16 components) of points with the precision of fitted surfaces approaching an asymptote at a sample size of 50 locations (Seaman and Powell 1996, Seaman et al. 1999). Variances of the x and y coordinates were unequal, and we rescaled data after Rodgers et al. (2007). The grid size was 1 km. We conservatively defined each bird's core area for stopover and wintering periods using the 50% density contour (Seaman et al. 1999). We used landcover data from the North American Land Change Monitoring System (2005) to characterize the general habitats within core ranges. We identified long-distance movements from breeding and wintering areas as migration events and delineated stopover areas as clusters of locations recorded during $\geq$3 days. We used the center of core ranges to estimate distances among breeding, stopover, and wintering locations, and summed the individual flight segments to estimate the total distance traveled.

RESULTS

All 17 birds fitted with geolocators were alive and behaving normally when we last observed them in breeding areas as late as mid-July 2009, 4 to 6 weeks following attachment. Individuals with geolocators were associated with 13 nests; two were abandoned (1 pair re-nested and successfully fledged young), three were depredated or flooded, and eight fledged young. We recaptured two females and one male in June 2010, but did not observe any of the remaining 14 birds (82%) in either the 2010 or 2011 breeding seasons. The original mean ($\pm$ SD) weight of the three birds that returned ($\bar{x}$ = 57.7 $\pm$ 0.8 g) was similar to birds (n = 13) with geolocators that did not return ($\bar{x}$ = 57.9 $\pm$ 3.8 g). We found harnesses to be loose fitting upon recapture and to have worn away the surrounding feathers on the synsacrum and inner thighs of each of the three birds. However, each of the birds behaved normally in breeding areas in 2010, and all three fledged young from separate nests.

The distance between the filtered geolocator locations and known nest sites during the breeding season averaged 145 km (range = 128–175 km, n = 3). The routes and timing of migration were similar for all three birds (Fig. 1). The three birds departed breeding areas during 7–9 September and used a series of stopover sites from 19 October to 29 November spanning the Prairie Potholes, Badlands and Prairies, and Eastern Tall Grass Prairie regions that included southern Saskatchewan, North Dakota, South Dakota, and Iowa. Each bird stopped in either North or South Dakota or both (Fig. 1). Mean habitat composition of core

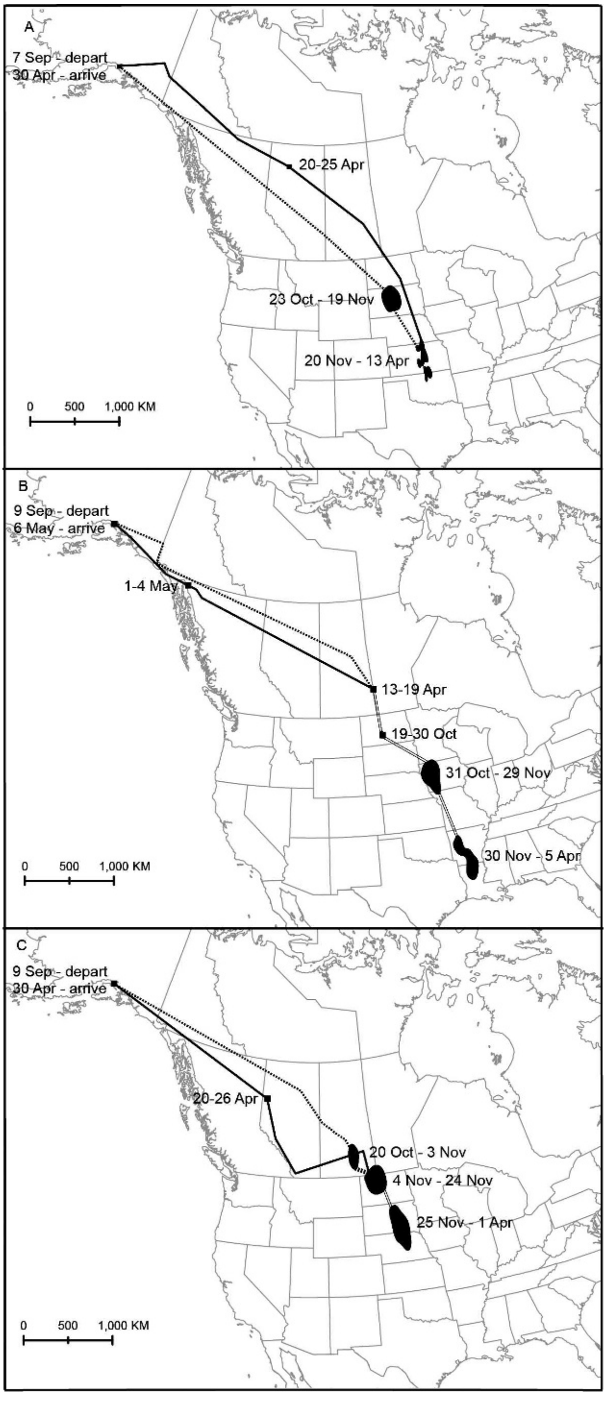

FIG. 1. Annual movements and estimated migratory arrival and departure dates of two female (A, B) and one male (C) Rusty Blackbirds captured near Anchorage, Alaska, USA, in 2009. Dotted lines indicate approximate autumn migration routes, solid lines indicate spring migration, and double solid lines indicate similar routes used during autumn and spring. Black polygons delineate 50% kernel densities.

stopover areas was 60% cropland, 36% grassland, 2% water, 1% wetland, and 1% other.

The birds arrived in wintering areas between 20 and 30 November; 72–84 days following departure from breeding areas. Wintering areas differed among the three birds and included South Dakota, Nebraska, Kansas, Oklahoma, Arkansas, and northern Louisiana (Fig. 1). Distance from breeding sites to wintering areas ranged from 3,854 to 5,027 km ($\bar{x}$ = 4,430 km). Core winter ranges for the male and one female wintering in the Central Mixed Grass Prairie and Prairie Potholes regions were 99% cropland and grassland habitats, whereas the winter range of the female in the Western Gulf Coastal Plain contained 51% coniferous forest, 17% deciduous woodland, 18% wetland, 4% other, and only 10% cropland and grassland.

Spring departure from core wintering areas occurred during 1–13 April. The male and female that wintered in the Central Mixed Grass Prairie and Prairie Potholes stopped in northwestern Alberta during 20–26 April before flying the remaining 1,820–1,840 km to Anchorage in 4–5 days ($\bar{x}$ = 366 km/day; Figs. 1A and 1C). The female that wintered in the Western Gulf Coast Plain migrated through this same area, but did not appear to stop (Fig. 1B). Instead, she stopped in southeastern Saskatchewan and northwestern British Columbia between 13–19 April and 1–4 May, respectively. All three birds followed spring routes that approximately matched their migration routes the previous autumn. The two birds that wintered in the Central Mixed Grass Prairie and Prairie Potholes arrived at their Anchorage breeding areas on 30 April and the bird that wintered in the Western Gulf Coast Plain arrived on 6 May. Duration of spring migration was 16–30 days.

DISCUSSION

We provide the first description of the annual movements of the Rusty Blackbird, a temperate migrant we documented to move in stages over a prolonged autumn (72–84 days) and briefer spring migration (16–30 days). The Prairie Potholes region, from southern Saskatchewan to Iowa, was an important stopover region during both autumn and spring migrations; all three birds stopped in North or South Dakota or both. Our data indicate at least these three Alaska breeding birds overwintered along the western portion of the species' principal wintering range. Two birds overwintered in areas shown by Christmas Bird Count data (1946–2011) to have relatively high occurrence of Rusty Blackbirds—(1) the Arkansas River Valley along the Kansas-Oklahoma border, and (2) the Western Gulf Coast Plain from the Ouachita Mountains south to northern Louisiana (Hamel and Ozdenerol 2009). A third bird overwintered in an area spanning South Dakota and Nebraska, a region with a lower rate of occurrence during winter (Hamel and Ozdenerol 2009). The species has recently been found, based on feather isotopes and band recoveries, to have separate Mississippi and Atlantic flyways (Hamel et al. 2009, Hobson et al. 2010). Data for our Alaska breeding population indicate the additional possibility of a Central Flyway route, which is also supported by limited numbers of band recoveries (Hamel et al. 2009: fig. 1). Alternatively, the western distribution of wintering birds in our study may have reflected an interannual shift in the core winter range that is thought to occur in response to variation in winter weather across years (Hamel and Ozdenerol 2009, Luscier et al. 2010). The winter of 2009–2010 was particularly cold in the eastern U.S. (NOAA 2011) and may have pushed birds farther west than during a typical year.

The duration and timing of autumn stopover estimated from geolocators (19 Oct to 29 Nov) was similar to observations of migrating Rusty Blackbirds using wetlands farther east at Buckeye Lake, Ohio (15 Oct to 15 Nov; Trautman 1940). Rusty Blackbirds complete prebasic molt by late-September (Mettke-Hofmann et al. 2010). Thus, late autumn may be a distinct phase in the annual cycle during which Rusty Blackbirds rest from migration to forage in wetlands and agricultural areas over a 1-month period before traveling to overwintering areas farther south. Populations may be susceptible to habitat losses and alterations in key stopover regions as hypothesized for wintering areas (Greenberg and Droege 1999, Greenberg et al. 2011). The species uses similar routes for spring and autumn migration, and disturbances in stopover areas may have compounding effects on populations. Rusty Blackbirds are typically associated with wetland habitats throughout the annual cycle (Avery 1995), but the core areas used by each of the three birds for stopover during autumn migration and by two birds during winter were in landscapes largely converted by agricultural use. Other researchers also occasionally found the species in agricultural fields primarily adjacent to wetlands (Trautman 1940, Luscier et al. 2010).

Identification and conservation of key habitats, particularly at stopover sites, may be additional considerations for recovering populations of Rusty Blackbirds (Greenberg et al. 2011).

Additional tracking of Rusty Blackbird migrations from other breeding locations would further identify migratory linkages and important non-breeding areas for stopover and overwintering. This information could test more specific hypotheses of the species' decline, (e.g., the effect of differing migration strategies on demographic variables, such as overwinter survival) and be used to coordinate conservation across the species' annual cycle (Greenberg and Matsuoka 2010, Greenberg et al. 2011). The winter distribution of the species tends to vary both within and between years (Hamel and Ozenderol 2009, Luscier et al. 2010). Multi-year tracking of individual Rusty Blackbirds could add information on the plasticity of migratory movements and perhaps climatic events that trigger them. However, the benefits from this potential information should be carefully weighed against the potential harm to birds fitted with these devices. Only 18% of the Rusty Blackbirds we fitted with geolocators in 2009 returned in 2010, much lower than the 60% of Rusty Blackbirds banded in 2008 that returned in 2009 (SMM, unpubl. data). This was similar to differential return rates reported for Purple Martins (*Progne subis*; 10% return rate with geolocators, 54% for banded only), but contrary to Wood Thrushes (*Hylocichla mustelina*; 50% return rate with geolocators, 33% return rate for banded only; Stutchbury et al. 2009, 2011). Other studies that used geolocators to track annual movements of songbirds found return rates did not significantly differ between tagged birds and individuals that were banded and released without geolocators; e.g., Northern Wheatear (*Oenanthe oenanthe*; 12.5% return rate with geolocators, 6.0% for banded only; Bairlein et al. 2012), Veery (*Catharus fuscescens*; 67% return rate with geolocators, 62% for banded only; Heckscher et al. 2011), Gray Catbird (*Dumetella carolinensis*; 31.8% return rate with geolocators, 29.9% for banded only; Ryder et al. 2011), and Golden-crowned Sparrow (*Zonotrichia atricapilla*; 33% return rate with geolocators, 39% for banded only; Seavy et al. 2012). Thus, species may vary in suitability for this technology and subtle differences in harness materials and methods may be critical to survival success.

All three Rusty Blackbirds upon recapture in 2010 had loosely fitting harnesses that had abraded the surrounding feathers along the thighs and synsacrum. Body mass was lower in 2010 for the male and the female that wintered in the Western Gulf Coast Plain (by 4 and 12%, respectively), but not for the second female. Rusty Blackbirds often forage in water, which may have made the birds in our study more vulnerable to a combination of feather wear and reduced thermoregulation. This coupled with the cold weather conditions of the 2009–2010 winter may have been particularly detrimental to birds in our study. The weight of the geolocator and harness we used were below 4% of body mass. However, we recommend future studies using geolocators on Rusty Blackbirds should consider sub-gram devices. A thorough evaluation of materials used for harnesses is also warranted. Elastic cord that could maintain a tight fit by accommodating seasonal changes in body mass could be easily damaged by Rusty Blackbirds. Elastic cord threaded through tubular Teflon ribbon (3 mm; Bally Ribbon Mills, Bally, PA, USA), however, may possibly produce a better fitting harness that allows for changes in body mass yet is sufficiently durable.

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