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MIGRATION ROUTES AND WINTERING LOCATIONS OF BROAD-WINGED HAWKS TRACKED BY SATELLITE TELEMETRY

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ABSTRACT.—During spring 2000, we captured five adult female Broad-winged Hawks (*Buteo platypterus*) in northcentral Minnesota and western Maryland and fitted them with satellite-received radio tags. The migrating hawks left their nesting areas about 10–15 September and moved south toward eastern Texas. They followed the Gulf Coast through Mexico and an inland course through Central America to their wintering areas. Mean fall migration distance for four hawks was about 7,000 km, and for three hawks the mean fall migration time was about 70 days and mean fall migration rate was about 100 km/day. Three hawks arrived on their wintering areas from about 15 October to 15 December. Wintering areas for four hawks were in Panama, Venezuela, Brazil, and Peru, between 08° 25′ N, 80° 54′ W and 11° 00′ S, 67° 07′ W. We tracked one hawk for her entire spring migration, and two hawks showed fidelity to their nest areas. *Received 5 October 2002, accepted 17 March 2003.*

Little information has been published about migration routes, timing, or wintering sites of the Broad-winged Hawk (*Buteo platypterus*; Goodrich et al. 1996). Observational and banding return data show that the species' winter range extends from southern Mexico into Central America and middle South America, with small numbers wintering in Florida (Goodrich et al. 1996).

Satellite-received radio tags (platform transmitter terminals, or PTTs) have allowed biologists to monitor the movements of Neotropical migrants such as Ospreys (*Pandion haliatus*; Martell et al. 2001), Peregrine Falcons (*Falco peregrinus*; Fuller et al. 1998, McGrady et al. 2002), and Swainson's Hawks (*Buteo swainsoni*; Fuller et al. 1998), providing new insights into these species' migratory and winter habits, and valuable data for their management and conservation. The objective of this study was to better understand the migratory movements of Broad-winged Hawks and to identify the wintering areas of birds from known nesting areas.

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METHODS

We captured five breeding adult female Broad-winged Hawks at their nesting sites using a mist net and a Great Horned Owl (*Bubo virginianus*) as a lure (Matray 1974) during June 2000, in western Maryland (39° 37′ N, 79° 13′ W) and northcentral Minnesota (46° 37′ N, 94° 14′ W; Fig. 1). We fitted them with 20-g PTTs (Northstar Science and Technology, Baltimore, Maryland), attaching them as backpacks using Teflon ribbon sewn with cotton thread that would break down over time (Britten et al. 1999).

We harnessed PTT numbers MN97, MN61, and MN88 to birds in Minnesota and numbers MD93 and MD95 to birds in Maryland. All hawks weighed between 445 and 475 g; thus, the PTTs were approximately 4% of the birds' body mass, similar to that of other studies using radio transmitters (Pennycuick et al. 1989, Vekasy et al. 1996, Marzluff et al. 1997, Fuller et al. 1998, Britten et al. 1999, Kenward 2001, and McGrady et al. 2002). We programmed the PTTs to transmit 6 h on and 246 h off during the 2000 summer season (7 cycles over 70 days), for 6 h on and 38 h off during fall migration (38 cycles over 60 days), and 6 h on and 80 h off throughout winter or until battery failure.

We located the hawks using NOAA satellites with onboard tracking equipment operated by ARGOS Inc. The data received from ARGOS included estimation of latitude and

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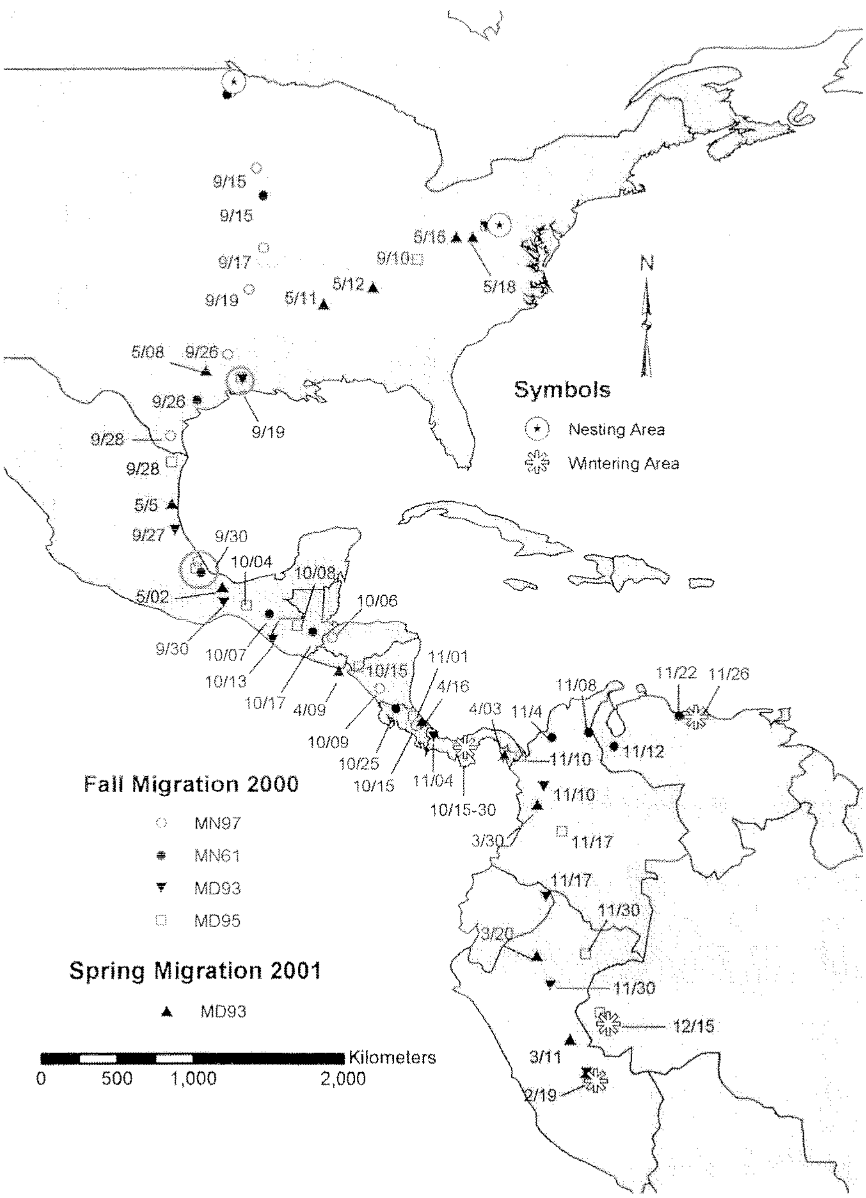

FIG. 1. Broad-winged Hawks nesting in Minnesota and Maryland migrated to wintering grounds in Central and South America. Data were collected by satellite telemetry.

longitude, time and date of transmission, and location error. We analyzed and displayed location data using ArcView ver. 3.2 Geographic Information System (GIS) software (Environmental Systems Research Institute 1992).

We defined the onset of fall and spring migration as the date of first locations after which all subsequent locations occurred at least as far away from the nesting area or wintering area (Fuller et al. 1998). We defined the end of migration as the date after which all subsequent points were localized (nondirectional movements) for the wintering areas and 2001 nesting areas (Fuller et al. 1998). If an activity sensor indicated that a PTT was no longer moving, we presumed that the bird had died or the PTT had dropped off. To map migration pathways we used a single, high quality (≤1,000 m error) representative location estimate per transmission cycle. For most cycles we used the single highest quality location (Fuller et al. 1998). We visually inspected location estimates using the GIS to remove outliers in the data (Fuller et al. 1998).

We calculated distance traveled by summing the lengths of segments between consecutive representative locations, beginning with the first migration location away from the nesting area and ending with the first wintering (after fall migration) or nesting area (after spring location) location for each hawk. We calculated migration time in days by taking the difference of the estimated departure and arrival date during both fall and spring migration. We calculated migration rates (km/day) by dividing the distance traveled during fall or spring migration by the migration time. We determined wintering areas using the Minimum Convex Polygon (MCP) home range estimator function of the animal movement extension in ArcView 3.2 (Hooge and Eichenlaub 2000).

RESULTS AND DISCUSSION

The four radio-tagged hawks left their nesting areas from about 10–15 September 2000. The fifth hawk, MN88, left her nesting area on 13 September 2000, but we did not receive another transmission until she returned to the same area in spring 2001.

Movements of the four hawks we tracked are presented in Fig. 1. The two Maryland birds moved to Louisiana and the two Minnesota birds migrated through central Iowa, Missouri, and Arkansas. The paths of all four hawks converged in eastern Texas, after which they moved along the Gulf Coast of Texas and Mexico, and then along an inland course through Central America. Bird MN97 ceased her migration and wintered in Panama. The other three hawks moved through Columbia. From Columbia bird MN61 moved to Venezuela where she wintered. Birds MD93 and MD95 continued south through Colombia and past the equator; MD93 wintered in southern Peru and MD95 wintered in southwestern Brazil.

Mean fall migration distance was about 7,000 km (5,625, 6,925, 7,770, and 7,672 km for birds MN97, MN61, MD93, and MD95, respectively), covering 43° of latitude. Mean fall migration time was about 70 days (45, 72, and 90 days for birds MN97, MN61, and MD95, respectively) and mean fall migration rate was about 100 km/day (125, 96, and 85 km/day for birds MN97, MN61, and MD95, respectively).

The wintering areas for all four hawks were in Panama, northern Venezuela, southwestern Brazil, and southern Peru, between 08° 25′ N, 80° 54′ W and 11° 00′ S, 67° 07′ W. Three of the hawks arrived on their wintering areas from about 15 October through 15 December, 2000. The winter area range was 4.3, 2.6, and 1.0 km² for birds MN97, MN61, and MD95, respectively.

Three hawks departed from their wintering areas from about 4–29 March 2001, with arrival on the nesting areas about 26 April (bird MN88) and 22 May (bird MD93). Due to radio failures, distance and complete timing for spring migration is available for only one bird (MD93), which had a travel distance of 7,868 km, migration time of 74 days, and a migration rate of 105 km/day. As with bird MN88, bird MD93 returned to the same nesting area used the previous year.

All four hawks tracked during migration followed previously described migration routes (Goodrich et al. 1996) through North America. Details of Broad-winged Hawk migration south of the U.S.-Mexican border are not well documented, but the hawks we tracked did pass over migration count sites in Veracruz, Mexico, and in Panama, and followed the same path described by Smith (1980) through Central America. The few data points we were able to obtain during spring preclude any detailed conclusions about these routes.

All five tracked hawks left their nesting areas within the time period expected, based on published records of Broad-winged Hawk departures (Bednarz et al. 1990). The four hawks tracked during migration crossed Veracruz from 27–30 September 2000, coinciding with the peak Broad-winged Hawk counts there that year (19 September through 5 October; E. R. Inzunza pers. comm.).

Maryland and Minnesota represent the eastern and western portions of the Broad-winged Hawk's breeding range. The similarity in timing and routes taken south of Texas by both the Minnesota and Maryland birds (in agreement with observational and banding data), coupled with similarities in fall migration paths taken by Swainson's Hawks (Fuller et al. 1998), Ospreys (Martell et al. 2001), and Turkey Vultures (*Cathartes aura*; Smith 1980), have potential conservation implications. These data highlight the importance of the relatively narrow flight path used during a short period of time by all of these species.

Winter area range sizes calculated for three of the hawks were based on 7–11 locations. However, for Northern Bobwhites (*Colinus virginianus*), the MCP home range estimator requires a sample size of >30 locations during a season (10 weeks) for an accurate home range estimation (Haines 2003). While the small sample of locations can give grossly inaccurate home range size estimates (Seaman et al. 1999), the lack of published data on this important aspect of the species biology (Goodrich et al. 1996) compels us to report it, albeit cautiously. While our data suggest that Broad-winged Hawks do not wander during winter and that home range size is constant, more reliable estimations of Broad-winged Hawk winter area range size are needed. Also, more investigation is needed to determine whether the more southerly wintering areas used by the Maryland birds relative to the Minnesota birds indicate winter segregation of hawks nesting in different regions, or whether this was an artifact of small sample size.

This study was the first to track Broad-winged Hawks using satellite telemetry. More extensive radio-tracking studies would aid in understanding the ecology of Neotropical migrants, including migration routes and key wintering areas. This information is essential for developing effective conservation strategies.

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LITERATURE CITED

Bednarz, J. C., D. Klem, Jr., L. J. Goodrich, and S. E. Senner. 1990. Migration counts of raptors at Hawk Mountain, Pennsylvania, as indicators of population trends, 1934–1986. Auk 107:96–109.

Britten, M. W., P. L. Kennedy, and S. Ambrose. 1999. Performance and accuracy evaluation of small satellite transmitters. J. Wildl. Manage. 63:1349–1358.

Environmental Systems Research Institute. 1992. ArcView ver. 3.2. Environmental Systems Research Institute, Redlands, California.

Fuller, M. R., W. S. Seegar, and L. S. Schueck. 1998. Routes and travel rates of migrating Peregrine Falcons *Falco peregrinus* and Swainson's Hawks *Buteo swainsoni* in the Western Hemisphere. J. Avian Biol. 29:433–440.

Goodrich, L. J., S. C. Crocoll, and S. E. Senner. 1996. Broad-winged Hawk (*Buteo platypterus*). No. 218 *in* The birds of North America (A. Poole and F. Gill, Eds.). Academy of Natural Sciences, Philadelphia, Pennsylvania, and the American Ornithologists' Union, Washington, D.C.

Haines, A. H. 2003. Effects of road baiting on home range and survival of Northern Bobwhites in southern Texas. M.Sc. thesis, Texas A&M Univ.-Kingsville, Kingsville.

Hooge, P. N. and B. Eichenlaub. 2000. Animal movement extension to ArcView ver. 2.0 and later. USGS Alaska Biological Science Center, Anchorage, Alaska.

Kenward, R. E. 2001. A manual for radiotagging. Academic Press, London, United Kingdom.

Martell, M. S., C. J. Henny, P. E. Nye, and M. J. Solensky. 2001. Fall migration routes, timing, and wintering sites of North American Ospreys as determined by satellite telemetry. Condor 103:715–724.

Marzluff, J. M., M. S. Vekasy, M. N. Kochert, and K. Steenhof. 1997. Productivity of Golden Eagles wearing backpack radiotransmitters. J. Raptor Res. 31:223–227.

Matray, P. F. 1974. Broad-winged Hawk nesting and ecology. Auk 91:307–324.

McGrady, M. J., T. L. Maechtle, J. J. Vargas, W. S. Seegar, and C. Porras Pena. 2002. Migration and ranging of Peregrine Falcons wintering on the Gulf of Mexico Coast, Tamaulipas, Mexico. Condor 104:39–48.

Pennycuick, C. J., M. R. Fuller, and L. McAllister. 1989. Climbing performance of Harris' Hawk (*Parabuteo unicinctus*) with added load: implications for muscle mechanics and for radiotracking. J. Exp. Biol. 142:17–29.

Seaman, E. D., J. J. Millspaugh, B. J. Kernohan, G. C. Brundige, K. J. Raedeke, and R. A. Gitzen. 1999. Effects of sample size on kernel home range estimates. J. Wildl. Manage. 63:739–747.

Smith, N. G. 1980. Hawk and vulture migrations in the Neotropics. Pp. 51–65 *in* Migrant birds in the Neotropics: ecology, behavior, distribution, and conservation (A. Keast and E. S. Morton, Eds.). Smithsonian Inst. Press, Washington, D.C.

Vekasy, M. S., J. M. Marzluff, M. N. Kochert, R. N. Lehmann, and K. Steenhof. 1996. Influence of radio transmitters on Prairie Falcons. J. Field Ornithol. 67:680–690.