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# Nesting Success and Juvenile Survival for Wood Thrushes in an Eastern Iowa Forest Fragment

Larkin A. Powell<sup>1</sup>, Lara J. Scott, and Jason T. Hass

## ABSTRACT

Forests in NE Iowa are highly fragmented, which may affect sustainability and dynamics of bird populations. We studied Wood Thrush (*Hylocichla mustelina*) nesting success at the Mines of Spain Recreation Area near Dubuque, IA during 2001. We also monitored movements of juveniles using radio transmitters during the birds' initial dispersal from the nest site, and we used DNA analyses to determine their gender. Seventy percent of the nests (n=10) were parasitized by Brown-headed Cowbirds (*Molothrus ater*). The daily nest success rate was 0.9612 (SE=0.0189), and daily juvenile survival was 0.9703 (SE=0.0169). Three juveniles dispersed 270 m (female), 746 m (male), and 980 m (male). Females in our simulation model built 2.90 nests per year (SD = 1.02), and 0.63 fledglings per female were alive at the end of the breeding season. We used a simulation model to predict annual population growth for this small breeding population as 0.546 (95% CI = +/-0.025). During 2001, this population can certainly be classified as a "sink," which reinforces the need for more information on regional juvenile and adult movements.

## INTRODUCTION

The dynamics of small populations can be critical to their temporal sustainability. The small forest fragments remaining in many Iowa landscapes have proportionally more "edge"; similar habitat effects have caused lower reproductive success for Wood Thrushes (*Hylocichla mustelina*) in other regions (Fauth 2000; Weinberg and Roth 1998). Edge-specific predators (e.g., raccoons [*Procyon lotor*]) and brood parasites such as Brown-headed Cowbirds (*Molothrus ater*) often cause increased nest failure for songbirds in fragmented habitats (Donovan et al. 1995; Robinson et al. 1995).

Juvenile dispersal, the distance traveled from the nest site during the first few weeks after fledging, is poorly understood, although recent data have emphasized its importance to managing habitats for bird species (Ferriere et al. 2000). Dispersal of excess juveniles from growing, or "source," populations can be critical for the support of declining, or "sink," populations (Pulliam 1988). However, high dispersal of juveniles may result in local population declines (Roth and Johnson 1993). Therefore, determining juvenile dispersal patterns appears to be a high priority when assessing the demographic viability of critical species.

Fragmented landscapes offer a different array of choices for juvenile birds than large, contiguous forests. Nest success, fledgling survival, and juvenile dispersal patterns are apt to reflect those differences, and population dynamics should be directly affected. To our knowledge, there are no published studies that simultaneously estimate nest success, daily fledgling survival, and fledgling dispersal for songbirds in fragmented habitats.

Dispersal dynamics could be especially important to local population dynamics in fragmented habitats. Plissner and Gowaty (1996) found that juvenile female Eastern Bluebirds (*Sialia sialis*, another member of Muscicapidae) dispersed greater distances than males.

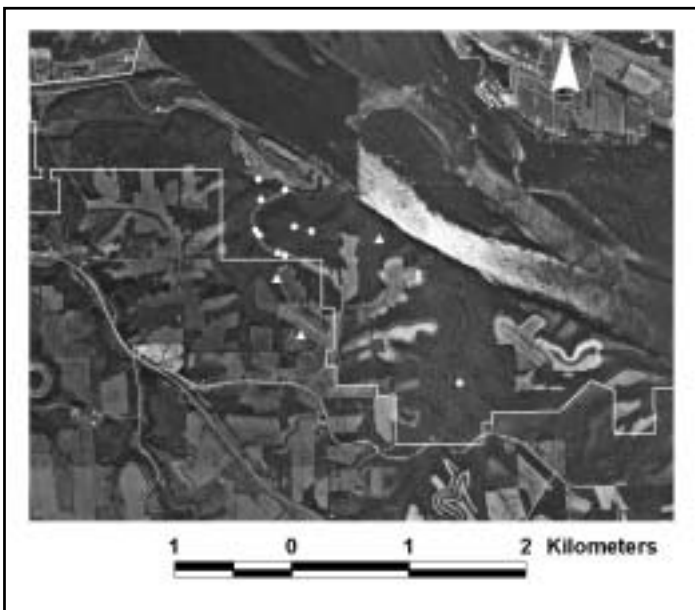
Lang et al. (2002) reported a bimodal distribution of juvenile dispersal distances for Wood Thrushes, but sex-specific dispersal could not be determined as gender cannot be determined by external characteristics for juvenile Wood Thrushes (Pyle et al. 1987). Local breeding populations of Wood Thrushes have the potential, then, to decline because of the combination of adult female mortality and juvenile female dispersal distances.

Our research goal was to determine if the Wood Thrush population at Mines of Spain Recreation Area was self-sustainable. Our objectives were to (1) estimate nest success, (2) estimate juvenile survival rates using radio telemetry, (3) determine gender of juvenile Wood Thrushes, (4) document movement patterns of juvenile Wood Thrushes after fledging, and (5) determine annual population growth rate ( $\lambda$ ) for the local population.

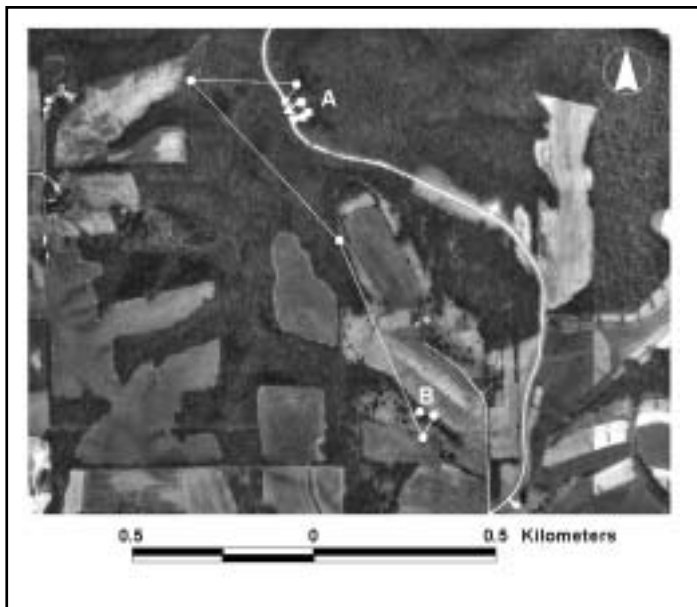
## METHODS

### Field Methods

Our study site was located in the Mines of Spain Recreation Area (MSRA), south of Dubuque, IA and within 0.5 kilometers (km) of the Mississippi River. MSRA habitats include 558 hectares (ha) of oak/hickory-dominated (*Quercus and Carya* spp.) upland and maple-dominated (*Acer* spp.) floodplain forests, wetlands, and small prairie fragments. Approximately 70% of land cover in MSRA is forest, but MSRA forests are highly dissected (Figure 1) and include almost no “core” area (as defined by Temple and Cary 1988). Forest habitats outside the park are even more fragmented (Figure 1). The Wood Thrush population in MSRA was highly localized, being found in few areas within the park; many areas appeared to have suitable habitat but did not contain breeding Wood Thrushes during our scouting of the entire area in summer 2001.



**Figure 1.** Forest habitat and boundaries of Mines of Spain Recreation Area (MSRA) near Dubuque, IA. Mississippi River is the northern boundary of MSRA. Circles indicate Wood Thrush nest locations; triangles indicate dispersal locations of three surviving fledglings.



**Figure 2.** *Movements of a male juvenile Wood Thrush from its nest at Mines of Spain Recreation Area (MSRA) near Dubuque, IA. Triangle near “A” indicates nest site, and circles indicate daily telemetry locations. “B” indicates dispersal location, away from the MSRA (see Figure 1).*

We captured and banded adult Wood Thrushes using mist nets placed in suspected territories, usually from 6:30 to 10:00 A.M. CST. We searched for Wood Thrush nests in areas where we heard singing males during our scouting. We also found nests by attaching radio transmitters to the backs of five adult females with nongel super glue, which allowed us to follow them to their nests. The adhesive failed within 2 to 4 days, and the radio was reused on another female.

Nest locations were marked with blue flagging 5 to 10 meters (m) from the nest tree. Nests were monitored every 2 to 4 days until the nestlings fledged or the nest failed. Nest failure was assumed when nests appeared disturbed, broken egg shells were found, or nests were empty more than three days before the calculated fledging date. Nests that fledged at least one Wood Thrush nestling were considered successful. Mirrors mounted on extension poles enabled us to visually examine the contents of the nest; all nests found were within reach of poles. Nest locations were mapped using GPS receivers.

When the birds fledged we banded them and attached 1.6-gram (g) radio transmitters, using the Rappole and Tipton (1991) thigh harness method, as described by Powell et al. (2000). Blood was collected from the brachial artery using capillary tubes, and stabilized in buffer solution. We relocated the fledglings once every 1 to 2 days using handheld antennas until the fledglings died or the signal disappeared. We used GPS receivers to document the location of the juveniles. We terminated our radio telemetry observations on 20 August 2001, after the initial juvenile dispersal event.

## Analytical Methods

We estimated daily nest success using program SURVIV (White 1983) as our monitoring data contained intervals of different lengths (Bart and Robson 1982; Hensler and Nichols 1981). Cohorts of radio-marked fledglings were used to estimate juvenile daily survival probabilities, also with program SURVIV (White 1983). We used the delta method (Weir 1990), described by Powell et al. (2000) to approximate the variance for daily nest success and survival when re-scaling of time intervals was necessary.

ArcView<sup>®</sup> version 3.2 was used to develop a database of movement locations; we used tools within ArcView<sup>®</sup> to determine daily movement distances and dispersal distances from the nest location. Juvenile dispersal distance was measured from the nest to the first known location of the bird after a major movement from the nest area (example: from “A” to “B” in Figure 2). Sex of juveniles was determined by amplifying sex-specific introns on the CHD gene, as described in Griffiths et al. (1998).

We used the Knutson et al. (2001) SAS/IML productivity model to estimate  $P$ , the average number of fledglings produced per female per year, alive at the end of the breeding season. This stochastic model is a modification of the Powell et al. (1999) productivity model to include brood parasitism. Model inputs included our estimates of daily nest success, clutch size, parasitism rate, effect of parasitism, and juvenile survival; we obtained an estimate of adult survival from Powell et al. (1999). We simulated the breeding season for 200 females. The productivity model outputs were (1) the average number of nests initiated by a female during the year, (2) the average number of successful nests for females during the breeding season, (3)  $P$ , and (4) the average number of parasitized nests per female during the breeding season. The stochastic model incorporated the uncertainty in our demographic parameter estimates; by repeating our simulation 200 times, we were able to estimate the SD for the model outputs.

We used a second simulation model, described by Powell et al. (2000), to estimate the annual population growth rate ( $\lambda$ ) and the variance of the growth rate ( $\text{var}[\lambda]$ ) of the Wood Thrush population in MSRA. The SAS/IML model stochastically simulates 200 years of population growth, using point and variance estimates for annual adult survival ( $S_A$ ), juvenile survival from the end of the breeding season to the next breeding season ( $S_J$ ), and annual fecundity, or number of females alive at end of breeding season produced per female ( $B$ ). We assumed a 50:50 nestling sex ratio, and calculated  $B = 0.5 \lambda P$ , where  $P$  was predicted by our first simulation model, above. Our study provided estimates of  $S_J$  during the breeding season, but did not provide  $S_J$  during the winter; therefore, we used a value of  $1/2 S_A$ , following Donovan et al. (1995). Because ours was a single-year study, we could not incorporate annual variation in demographic parameters (Link and Nichols 1994), which prevents us from generalizing our model predictions on a temporal scale.

Following Powell et al. (2000), we used the approximation of  $\text{var}(\lambda)$  to construct a 95% confidence interval (CI) to determine whether  $\lambda = 1.0$ . We calculated upper and lower CIs for  $\lambda$  as:  $\pm 1.96 \cdot [\text{var}(\lambda)]^{1/2}$  (Sokal and Rohlf 1981). Johnson (1999) suggested the use of confidence intervals, in place of hypothesis testing; in our case, if the 95% CI did not include 1.0, a source ( $\lambda > 1.0$ ) or sink ( $\lambda < 1.0$ ) designation could be assigned.

## RESULTS

We found 10 active Wood Thrush nests at MSRA. Six nests (60%) produced Wood Thrush fledglings. Daily nest success was 0.9612 (SE = 0.0189); 24-day (nesting interval for Wood Thrush) success was 0.3873 (SE = 0.1830, Table 1).

Seven nests (70%) were parasitized by Brown-headed Cowbirds (Table 1). The average number of cowbird eggs in parasitized nests was 1.7; only one nest was abandoned due to parasitism. Three cowbird juveniles were known to have fledged from two nests. Two parasitized nests had no host eggs, and two parasitized nests fledged only Wood Thrush young.

Low nest success and high parasitism (including nests with no host eggs) reduced the available fledglings for radio telemetry study; we were able to radio-mark only six juvenile Wood Thrushes. DNA analyses revealed that two radio-marked young were males, and four were females. Three radio-marked fledglings (all females) were killed by predators within five days of fledging. Daily juvenile survival rate was 0.9703 (SE = 0.0169, Table 1); the weekly estimate was 0.8097 (SE = 0.0974).

Our simulation model predicted that adult females at MSRA built 2.90 nests (SD = 1.02) based on demographic information we gathered (Table 1); on average, 1.2 nests (SD = 0.64) per female were successful, and 2.2 were parasitized (SD = 1.05). Our model predicted that average P (total young per female, surviving to the end of the breeding season) was 0.63 (SD = 0.82). The second simulation model predicted an annual population growth rate of  $\lambda = 0.546$  (95% CI = +/-0.025, Table 1), well below replacement ( $\lambda = 1.0$ ).

The low nest success resulted in few fledglings that could be radio-marked, and only three fledglings survived long enough to disperse from the nest site. We documented juvenile dispersal distances of 270 m (male), 746 m (female), and 980 m (male, see Figure 2). These dispersals occurred after 22, 18, and 28 days, respectively. The female that dispersed 746 m probably dispersed farther, beyond the boundaries of MSRA, as we lost the radio signal immediately after this initial dispersal. Therefore, only the 270-m male disperser stayed within MSRA (Figure 1).

## DISCUSSION

Our study provides the first gender determination of juvenile Wood Thrushes in the context of dispersal, but high nest mortality and high predation of fledglings prevented us from determining whether female juveniles disperse farther from the nest. However, our successful application of the Griffiths et al. (1998) method to juvenile Wood Thrushes provides stimulus for this type of research in the future.

Patterns of juvenile dispersal from MSRA nests were similar to those reported by Anders et al. (1998), Vega Rivera et al. (1998), and Lang et al. (2002). These studies reported juveniles dispersing to dense "survival" habitats. MSRA dispersal distances were also shorter than the average reported by Anders et al. (1998): 2.08 km; Vega Rivera et al. (1998): 1.5 km; and Lang et al. (2002): 2.19 km. Roth et al. (1996) reported many Wood Thrush juveniles staying within a 15-ha forest fragment in Delaware. Juveniles from MSRA may have also been constrained by the lack of contiguous forest to use for dispersal. Lang et al. (2002) reported some juveniles made more than one major postfledging dispersal movement before migration. Because we terminated our observations in late August, perhaps some juveniles eventually dispersed farther from MSRA. Juvenile dispersal patterns at MSRA indicate that lands surrounding public lands are important for supporting bird populations, as two of our juveniles dispersed beyond the borders of MSRA. Therefore, conservation efforts in this region should focus on a landscape approach.

Anders et al. (1997) reported daily survival estimates between 0.938 and 0.990 during the first three weeks after fledging, after which survival was 1.000 for weeks 4–8. Our value of 0.9703 is much lower than the Powell et al. (2000) report of daily survival of 0.997 throughout the postfledging period. Our pattern of early mortalities is similar to patterns

reported by Anders et al. (1997) and Powell et al. (2000). Although our sample of radio-marked juveniles was smaller, the sample size was considered during the parameter estimation process; the SEs and 95% CIs that we report allow our study to be compared with others. Our 50% predation rate matches the Anders et al. (1997) estimate of a 50.6% chance of predation after fledging. All mortalities were females, but our sample size prevents any generalizations to the population.

Are Wood Thrush populations in eastern Iowa self-maintaining? The estimate of  $\lambda = 0.546$  (95% CI = +/-0.025) certainly suggests that this was a “sink” population in 2001. High brood parasitism, high nest predation, and high juvenile mortality may be a function of the fragmented landscape of the region. Trine (1998) reported  $P = 0.3-2.1$  (not accounting for juvenile mortality), which overlaps our estimate of  $P = 0.63$ . In more contiguous forests of Georgia, Powell et al. (1999) reported  $P = 2.04$  (more than 3X our estimate) using the same simulation model. Our study site is near the Robinson et al. (1995) western Illinois study site, which was determined to be highly fragmented—low average forest patch size, almost no forest interior area, and approximately 20% of the landscape forested. Although our parasitism rate was high (70%), it is less than the predicted rate of approximately 85% (Robinson et al. 1995); our daily nest mortality rate of 0.0388 matches the Robinson et al. (1995) prediction of approximately 0.04.

If our estimated growth rate is realized yearly in MSRA, it would take a local population of 100 birds (probably a high estimate) only nine years to be reduced to less than one bird, without immigration. Therefore, it would appear that MSRA Wood Thrush populations are sustained largely through immigration events. This may explain the localized nature of MSRA Wood Thrush populations and the lack of Wood Thrushes in some apparently suitable habitat areas. But, if MSRA is a “sink,” where is the “source”?

Knutson et al. (2001) reported that Wood Thrush populations in Minnesota and Wisconsin portions of the Driftless Area Ecoregion were a “source,” with a  $\lambda = 1.08$  ( $\pm 0.05$  95% confidence interval). The Knutson et al. (2001) parasitism rate was only 53%, compared to 70% in MSRA. The Robinson et al. (1995) predictions for western Illinois and southeast Iowa would not favor them as the source of immigrants to MSRA. If 2001 was a representative year for Wood Thrushes in MSRA, it is highly probable that populations to the north of Dubuque, IA (MN or WI) are maintaining the MSRA Wood Thrush population

**Table 1. Demographic parameter estimates (SE or SD) for Wood Thrushes at Mines of Spain Recreation Area, near Dubuque, Iowa in 2001. Information is provided for estimation methods; see text for further information.**

Parameter	Estimate	Estimation method
Daily nest success (DNS)	0.9612 (0.0189)	Field data, program SURVIV
24-day nest success	0.3873 (0.1830)	DNS <sup>24</sup>
Parasitism rate	70%	Field observations
Daily juvenile survival	0.9703 (0.0169)	Field data, program SURVIV
Average nests built (per female)	2.90 (1.02)	Simulation model
Annual productivity (yg per female)	0.63 (0.82)	Simulation model
Annual population growth rate	0.546	Simulation model

through immigration of excess individuals. Our study, combined with the results of Knutson et al. (2001), reinforces the need for more information on regional juvenile and adult Wood Thrush movements.

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