

Prothonotary Warbler Reproductive Success and Site Fidelity in a Fragmented Oklahoma Landscape

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ABSTRACT

We studied site fidelity of Prothonotary Warblers (*Protonotaria citrea*) in a fragmented riparian landscape from 2003 to 2005. Adult and nestling warblers were mist-netted or captured at the nest site during three breeding seasons at the Tishomingo National Wildlife Refuge in southern Oklahoma. We banded 127 adult Prothonotary Warblers (57 males; 70 females) and 456 nestlings for a total of 583 warblers banded. We recorded 83 recaptures of 50 different warblers for an overall recapture rate of 8.6%. Forty-one of the 127 adult warblers originally banded were recaptured for an adult recapture rate of 32%. Nine of the 456 nestling warblers originally banded were recaptured as adults for a 2% recapture rate. Recaptured Prothonotary Warblers relocated an average of 312 m from the previous year's nest sites and relocated an average of 271 m from the first nest attempt to the second nest attempt within breeding seasons. Recaptured female warblers averaged a total of 2.7 nest attempts and 8.8 fledglings produced over their capture/recapture history. Recaptured males averaged 1.8 nest attempts and 7.5 fledglings produced over their capture/recapture history. Male and female Prothonotary Warblers demonstrated strong site fidelity and high reproductive success in a fragmented riparian landscape.

INTRODUCTION

Prothonotary Warblers (*Protonotaria citrea*) are a secondary-cavity nesting species occurring in the eastern United States that reach the western margin of their range in Oklahoma (Walkinshaw 1953, Petit 1999). Abandoned Downy Woodpecker (*Picoides pubescens*) cavities are the primary source of cavities for Prothonotary Warblers. However, these warblers also use nest boxes (Blem and Blem 1991, Flaspohler 1996, Cartwright 1997). Prothonotary Warblers predominantly nest in flooded bottomland hardwood forests and riparian areas (Blem and Blem 1991, Wood 2004). Previous studies suggested that male Prothonotary Warblers exhibit strong site fidelity and that reproductive success may influence site fidelity in both males and females (Petit 1999, Hoover 2003).

Our research objectives were to study site fidelity and reproductive success of banded Prothonotary Warblers as part of a broader study of warbler ecology in a fragmented forest at the western edge of the species' range (Wood 2004). Our specific objectives included: 1) band all adult and nestling Prothonotary Warblers possible during three consecutive breeding seasons; 2) recapture as many warblers as possible; 3) record reproductive success of Prothonotary Warblers annually; and 4) use geographic information system (GIS) software to examine the inter- and intra-seasonal distances moved by recaptured warblers. We used analysis of variance models with an *a priori* alpha level of 0.05 to test for statistical differences in the number of young fledged based on inter- and intra-seasonal movements.

METHODS

Research was conducted at the Tishomingo National Wildlife Refuge (TNWR; about 34° 11' N, 96° 38' W) in south-central Oklahoma from 2003 to 2005. TNWR is 6,700 ha of fragmented riparian

woodlands interspersed with upland forests, agricultural fields, and the Cumberland Pool of Lake Texoma. Prothonotary Warblers were studied at two sites located within 1.5 km of each other within TNWR. The Sandy Creek site is a 12-ha stand of mature black willow (*Salix nigra*), green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*), and pecan (*Carya illinoensis*). The Goose Pen Pond site is located 1.4 km west of the Sandy Creek Site and consists of 4 ha of buttonbush (*Cephalanthus occidentalis*), honey locust (*Gleditsia triacanthos*), cedar elm (*Ulmus crassifolia*), American elm (*U. americana*), and dead hardwood trees. Both sites are inundated periodically with 0 - 1.5 m of standing water during the breeding season.

In 2003, 41 nest boxes with snake guards were installed throughout the study sites. In 2005, 15 more boxes were installed in areas adjacent to the original box locations. Boxes were checked every 3 - 7 d until nesting was initiated (Martin and Geupel 1993). Nests were then checked more frequently to determine clutch size, number of eggs hatched, and number of young fledged per nest (Flaspohler 1996). We captured male Prothonotary Warblers using playback tapes, decoys, and mist net arrays near active nests. Female Prothonotary Warblers were caught at the nest during incubation by placing a mist net over the cavity entrance and then flushing the female into the net. We recorded age, sex, and other morphometric measurements on all adult warblers (Pyle 1997). Nestlings were banded and weighed at approximately 9 d post-hatching (Petit 1989, Podlesak and Blem 2002). Adults were captured only once during a breeding attempt; captures of banded individuals at a subsequent breeding attempt (within the same or in following years) were classified as recaptures.

RESULTS

Banding, recapture rates, and reproductive success – From 2003 to 2005, we banded 127 adult and 456 nestling Prothonotary Warblers. Total bandings for 2005 were higher because of the increased number of nest boxes available (Table 1). We captured almost three times as many after-second-year (ASY) males as second-year (SY) males but approximately equal numbers of ASY and SY individuals among females (Table

1). We recorded 83 recaptures of 50 different individual warblers (11 males; 39 females) for an overall recapture rate of 8.6%. We recaptured 16 warblers in 2004 and 34 warblers in 2005. Forty-one of the 127 warblers originally banded as adults were recaptured for an adult recapture rate of 32% (females 76%; males 27%). Nine of the 456 warblers banded as nestlings were recaptured as SY birds in 2004 or 2005 (6 females; 3 males) for a 2% recapture rate. Recaptured warblers originally banded as nestlings were recruited into the breeding population and averaged four nestlings fledged in subsequent nesting events. In order to develop an estimate of total reproductive success, we calculated the average number of nest attempts and number of young fledged for each male and female warbler. This statistic included all young fledged from any nest attempt between the original capture to the most recent recapture for each bird. Recaptured females averaged 2.7 nest attempts and 8.8 fledglings produced from 2003 - 2005; recaptured males averaged 1.8 nesting attempts and 7.5 nestlings produced over their recapture history.

Table 1. Number of Prothonotary Warblers banded by age and sex at Tishomingo National Wildlife Refuge, OK, 2003-2005

Age-Sex	2003	2004	2005	Total
SY-M	2	7	5	14
ASY-M	7	14	22	43
SY-F	16	9	13	38
ASY-F	11	6	15	32
L-U	132	130	194	456

Intra-seasonal movements and reproductive success – We recorded 37 intra-seasonal recaptures of which 25 re-nested in the same nest box as their first nest. The other 12 re-nested, but moved to a different nest box. The average distance moved by re-nesting female warblers was 271 m ($n=10$); males ($n=2$) remained on the same territory as their first nests. More young fledged when females re-nested in the same box (mean = 3.52 fledglings \pm 0.28 SE, $n=50$) compared to females that re-nested in a different box (mean = 2.38 fledglings \pm 0.45 SE, $n=24$; $F_{1,72} = 5.17$, $p =$

0.03). The number of fledglings in first (mean = 3.88 fledglings \pm 0.44 SE, $n = 25$) and second nests (mean = 3.16 fledglings \pm 0.33 SE, $n = 25$) of warblers that re-nested in the same box were not different ($F_{1,48} = 17.3$, $p = 0.19$). Similarly, the number of fledglings in first (mean = 2.25 fledglings \pm 0.70 SE, $n = 12$) and second nests (mean = 2.50 fledglings \pm 0.58 SE, $n = 12$) of warblers that re-nested in a different box within a season were not different ($F_{1,22} = 0.08$, $p = 0.79$).

Inter-seasonal movements and reproductive success – We documented 46 inter-seasonal recaptures of which 16 returned to the same nest box as the previous year. Thirty warblers relocated an average of 312 m (range = 27 - 1071 m) to new nest boxes from their previous year's nest. Females moved an average of 312 m ($n = 23$, range = 27 - 922 m) and males moved an average of 342 m ($n = 7$, range = 67 - 1071 m) from their previous year's nest. There was no difference in the number of warblers fledged by females that re-nested in the same box between years (mean = 3.63 fledglings \pm 0.39 SE, $n = 30$) and the number fledged by females that re-nested in a different box between years (mean = 3.86 fledglings \pm 0.31 SE, $n = 44$; $F_{1,72} = 0.22$, $p = 0.64$). The number of young fledged by warblers from their first nest (mean = 3.47 fledglings \pm 0.48 SE, $n = 15$) and from re-nests by recaptured females in the same box (mean = 3.80 fledglings \pm 0.63 SE, $n = 15$) in the following breeding seasons was not different ($F_{1,28} = 0.18$, $p = 0.68$). No difference existed for the number of young fledged from first nests (mean = 4.09 fledglings \pm 0.38 SE, $n = 22$) compared to re-nests (mean = 3.64 fledglings \pm 0.48 SE, $n = 22$) by recaptured females that moved to a new box in a subsequent breeding season ($F_{1,42} = 0.55$, $p = 0.46$).

Individual warbler histories – We have included five recapture histories of individual Prothonotary Warblers to demonstrate site fidelity and reproductive success observed in our study.

Female 2290-84503 was originally banded as a SY female nesting in box 31 in 2003. She returned to box 31 for her first nest of 2004, but moved 50 m to box 41 for her second nest of 2004. She then returned in 2005, but moved 210 m from her previous year's nest to box 34 to nest. She fledged nine nestlings from four nest attempts since her original capture.

Female 2290-84501 was banded as a SY female nesting in box 7 in 2003. She returned to box 7 for two nests in 2004; in 2005 she returned, but moved 207 m to box 9 for her first nest. She then moved 438 m to box 2 for her second nest of 2005.

Although most females moved to a different nest box in at least one year, female (1680-50852) was an exception. She was originally banded in 2003 as a SY female nesting in box 9 and recaptured in the same box later that year. She was recaptured subsequently in 2004 in the same box during two different nest attempts, and was also recaptured at box 9 in 2005. She fledged 21 young from four nest attempts, but her 2005 nest failed due to black rat snake (*Elaphe obsoleta obsoleta*) predation during incubation.

Of the nine warblers that were originally banded as nestlings and recaptured in 2004 or 2005, all successfully produced ≥ 1 fledglings during subsequent breeding seasons. Two females and one male nestling returned as SYs in 2004 and fledged an average of three young/nest attempt. In 2005, four female and two male nestlings returned as SYs and fledged an average of 3.8 young/nest attempt. Two nestlings returned as SYs in 2005, paired together at box E6, and had a successful nest fledging four young—the female 2360-89824 originated from box 21 (810 m distant from box 21) and the male 2280-26616 from box 2 (1071 m distant).

DISCUSSION

Recapture rates – Prothonotary Warblers demonstrated strong site fidelity as evidenced by a 32% adult recapture rate which is high for a Nearctic-Neotropical migrant. We recaptured 76% of female Prothonotary Warblers banded as adults at TNWR. Other researchers have documented strong site fidelity in female Prothonotary Warblers (Petit 1999). Blem et al. (1999) reported a 48% recapture rate of female Prothonotary Warblers in Virginia. Although sample size for recaptured males was low compared to other studies, male Prothonotary Warblers demonstrated strong site fidelity with a 27% recapture rate. Kowalski (1985) reported a male Prothonotary Warbler recapture rate of 57% (4 of 7 males) to a study site in Indiana. In Illinois, Kleen (1973) reported an extremely high one-year recapture rate of 93% (13 of 14 males) that returned to their nesting territories.

We documented a 2% recapture rate for nestlings originally banded in nest boxes at TNWR. Nestlings recaptured as SY adults were recruited into the breeding population and all successfully nested the first year after fledging. Similarly, Blem et al. (1999) reported a 1.7% recapture rate for nestling warblers originally banded in nest boxes in Virginia. In our study, we did not observe any infertile eggs in the nests of SY females; however, Blem et al. (1999) reported greater infertility rates among SY females.

High recapture rates have been documented for other warbler species. Nolan (1978) reported that 59% of male and 13% of female Prairie Warblers (*Dendroica discolor*) returned to their breeding territories in Indiana. Similarly, Pulich (1976) observed that 45% of male and 22% of female Golden-cheeked Warblers (*Dendroica chrysoparia*) returned to a study area in Texas. Hann (1937) reported that 54% of male and 52% of female Ovenbirds (*Seiurus aurocapillus*) returned to the same territories in Michigan.

Site fidelity is not limited to breeding grounds for Prothonotary Warblers. Lefebvre et al. (1994) reported a recapture rate of 6% for Prothonotary Warblers in Venezuelan mangroves. Warkentin and Hernandez (1996) reported a 12% recapture rate for Prothonotary Warblers wintering in mangroves in Costa Rica one year post-banding. The highest reported winter recapture rate for Prothonotary Warblers was 27% in Panama (Petit 1999).

Intra-seasonal movements and reproductive success – Female Prothonotary Warblers moved an average distance of 271 m between successive nest attempts at TNWR, although most females remained in the same nest box for their second nesting attempt. This distance was greater than the average of 40 m that female Prothonotary Warblers moved between successive nest attempts in Tennessee (Petit 1999). Female Prothonotary Warblers at TNWR that re-nested in the same box fledged more young than females that moved to a different box. Females that changed boxes for their second nest attempt had often lost their first nest to raccoon (*Procyon lotor*) or snake predation. We recaptured only two males during second nesting attempts and they both held

the same territory as their first nest attempt. Males developed trap shyness and proved difficult to be recaptured twice in a season.

Inter-seasonal movements and reproductive success – Although 35% of warblers returned to the same nest box as in previous years, 65% of recaptured male and female Prothonotary Warblers moved to different nest boxes at TNWR. Competition for nest sites and fledgling dispersal accounted for inter-seasonal movements among boxes (Wood 2004). The proximity of nest boxes in suitable habitat also may have influenced movement patterns among Prothonotary Warblers. Both males and females moved an average of approximately 300 m to new nest sites, although some moved 900 - 1000 m from the previous year's nest. Other banded Prothonotary Warblers may have returned to the study area, but nested beyond the scope of our searches. Prothonotary Warbler movements at TNWR were somewhat greater than those reported by Petit (1999). Female warblers moved an average of 203 m to different nest sites between breeding seasons, whereas male warblers moved an average of 48 m to different territories in Tennessee (Petit 1999). At TNWR, there was no difference detected in the number of fledglings produced by adult warblers that returned to the same box as the previous year or moved to a different nest box. Hoover (2003) reported that the number of successful broods positively influenced site fidelity in Prothonotary Warblers. Specifically, warblers that fledged two broods had the highest site fidelity. We observed this among some female warblers at TNWR such as 1680-50852 mentioned in the Results section. Because we did not affect nest success, our results are not directly comparable to that of Hoover (2003); however, our results suggest that nest success or failure may influence Prothonotary Warbler site fidelity at TNWR.

Reproductive success – We documented the reproductive success of banded Prothonotary Warblers over three breeding seasons. Recaptured warblers provided an opportunity to examine reproductive success for birds caught in one-to-three breeding seasons. Prothonotary Warblers demonstrated high reproductive success compared to estimates in the literature. In terms of total reproductive success (i.e., from initial capture to

the most recent recapture), female warblers at TNWR averaged 2.7 nest attempts and fledged 8.8 young. In Tennessee, Petit and Petit (1996) documented that female warblers fledged an average of 3.9 young over a four-year period using the same criteria for fledging. In terms of total reproductive success, male warblers at TNWR averaged 1.8 nest attempts and fledged 7.5 young. At TNWR, the reproductive success of Prothonotary Warblers and recruitment of young fledged from the site in previous years suggests that this site may act as a population source in a fragmented landscape.

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