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Winter Site Fidelity and Winter Residency of Six Migratory Neotropical Species in Mexico

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ABSTRACT.—Neotropical migratory bird survivorship during the time they spend in wintering areas has been of major concern during the last several decades, yet still little is known about it. Evidence of behaviors that could increase the probability of individual survival, as well as increasing future reproductive success such as winter site fidelity and winter residency have gradually been documented for several migratory species. No evidence of these behaviors has been documented in urban areas. We present the results of a 9-year monitoring study in the green area of the Ethnobotanical Garden in the urban area of Oaxaca, Oaxaca, Mexico, using banding. Six of the 48 neotropical migratory species captured were selected

for analysis of winter site fidelity and winter residency. The Warbling Vireo (*Vireo gilvus*) had the highest recapture rate (31.7%) with the highest winter fidelity (14.6%) and winter residency (24.4%). The next four species had recapture rates between 10.6–15.7%, winter fidelity between 6.0–10.4%, and winter residency between 5.1–19.1%. The Cedar Waxwing (*Bombycilla cedrorum*) demonstrated neither winter fidelity nor winter residency. Our results suggest urban green space areas may have an underestimated role in migratory bird conservation. *Received 8 May 2012. Accepted 26 September 2012.*

Key words: banding, recapture, return, winter ground.

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Wintering biology of migratory birds has received substantial attention in the last several decades because the biotic and abiotic conditions that influence the non-reproductive stage have proved to have important roles as limiting factors for bird populations (Rappole and McDonald

1994, Sherry and Holmes 1996). Factors that influence survival capability of birds during winter and their reproductive capacity the following summer are of concern for both the scientific and conservation communities (Sherry and Holmes 1996, Johnson et al. 2006). One strategy that could increase the probability of individual survival, as well as increasing future reproductive success, would be the annual return to the same wintering site (non-breeding area) showing site fidelity (as defined by Gauthreaux 1982) and winter residency at the site. Familiarity with the site would have potential advantages in terms of territorial dominance, spatial knowledge, awareness of the daily and temporal variations of the resources, and an increased ability to evade predators (Baker 1978, Gauthreaux 1982, Shields 1984, Dobson and Jones 1986, Warkentin and Hernandez 1996, Brown et al. 2000, Latta and Faaborg 2001, Somershoe et al. 2009).

Neotropical bird monitoring has intensified during the past 60 years making it possible to demonstrate winter site fidelity for different migratory species (e.g., Van Tyne 1931, Snow and Snow 1960, Nickell 1968). However, of the 338 species of birds in North America that spend the winter south of the Tropic of Cancer (Hayes 1995, Rappole 1995) the great majority still lack studies in their wintering areas (Rogers et al. 1982, Berlanga et al. 2010), which would allow us to learn about many aspects of their wintering biology. More specific and less studied, is the winter site fidelity of individuals of different sex and age groups of neotropical migratory species in urban sites. Thus, it is of interest to study the patterns and possible implications of urban sites for conservation of migratory birds.

We have been operating a bird monitoring program for more than a decade in the Botanical Garden in the urban area of the city of Oaxaca, Mexico. The Botanical Garden banding station was conceived to study a variety of questions including: (1) whether neotropical migratory birds have between year winter site fidelity and winter residency to urban sites, and (2) whether there are differences among species in both behaviors.

We present the results of a study of site fidelity and winter residency intervals for the six most frequently captured migratory species in an urban site within the city of Oaxaca, Oaxaca, México during a 9-year monitoring period (2001–2010) based on captures and recaptures.

METHODS

The study site was within the Botanical Garden of Oaxaca (Jardín Ethnobotánico de Oaxaca), which is part of the Cultural Center of Santo Domingo in the midst of the urban zone of the City of Oaxaca de Juárez within the State of Oaxaca, México (217° 03' N, 96° 43' 21" W, 1,564 m asl). The site is in the geographic region known as the Central Valleys of Oaxaca, adjacent to the Isthmus of Tehuantepec, which narrows into a bottleneck formation through which birds that migrate towards the south during autumn must pass.

The site is characterized as a small 'oasis' of native vegetation cultivated within an urban environment, measuring 2.10 ha, with irrigation channels that cross the entire area, as well as fountains and pools. The average tree height is <5 m and the entire garden is surrounded by a green quarry stone wall of ~5 m.

Our analysis of winter site fidelity and residency focuses on six migratory neotropical species; Cedar Waxwing (*Bombycilla cedrorum*), Warbling Vireo (*Vireo gilvus*), Nashville Warbler (*Oreothlypis ruficapilla*), Audubon's Yellow-rumped Warbler (*Setophaga coronata auduboni*), Western Tanager (*Piranga ludoviciana*), and Orchard Oriole (*Icterus spurius*), respectively. These species all breed north of Mexico's Rio Grande border in the United States and Canada; two in eastern North America (*I. spurius*, *O. ruficapilla*), two in the west (*P. ludoviciana*, *S. c. auduboni*), and the remaining two which have a wider geographic range area (*V. gilvus*, *B. cedrorum*). These species occur in southern Mexico during the winter and some also occur in a large part of Central America.

Six mist nets were used (12 × 2.5 m) during 6-hr sessions, starting at sunrise, on the last Sunday of every month ($n = 101$) between December 2001–April 2010. Captured birds were banded and processed to obtain morphological data (wing chord, body mass, fat, etc.), which were stored in a database. Each bird was released at the capture location after recording the data. The capture and banding methodology used followed Ralph et al. (1996), as well as the recommendations of the North American Banding Council (2003).

Birds that were captured that had been previously banded were classified as recaptures and biological information was recorded separate-

TABLE 1. Total individuals captured per species and percentage of individuals that showed evidence of winter site fidelity, winter residency, and/or both, Oaxaca, Mexico.

Species	Total individuals captured 2001–2010	Number (%) individuals recaptured	Number (%) winter fidelity (returns)	Number (%) winter residency (repeats)	Number (%) birds that showed winter fidelity and residency
Cedar Waxwing	272	0 (0)	0 (0)	0 (0)	0 (0)
Warbling Vireo	82	26 (31.7)	12 (14.6)	20 (24.4)	6 (7.3)
Nashville Warbler	489	77 (15.7)	51 (10.4)	41 (8.4)	15 (3.1)
Audubon's Y-r Warbler	349	37 (10.6)	21 (6.0)	18 (5.1)	2 (0.6)
Western Tanager	242	28 (11.5)	19 (7.8)	12 (4.9)	3 (1.2)
Orchard Oriole	131	28 (21.3)	13 (9.9)	25 (19.1)	10 (7.6)

ly. The number of days between original banding date and the date of recapture was calculated using the capture-recapture history recorded in the database. Two types of recaptures were considered: repeats and returns based on the work of Yunick (1983). Repeats are defined as recaptures of an individual banded within the same winter season. Returns refer to individuals banded the previous winter season or before with one or more annual cycles had passed before the recapture). All return recaptures were considered in the interannual winter site fidelity analysis, and the repeat recaptures correspond to the analysis of winter residency for those species during the same or intra-winter season. Both categories are not mutually exclusive as a single bird may show both winter residency as well as winter site fidelity.

RESULTS

We captured 2,500 birds of 48 neotropical migratory species at the station during the 9-year monitoring period. Of these, 1,565 individuals were of the six species under consideration of which 196 individuals were subsequently recaptured at least one time (Table 1). All recaptures at the Botanical Garden were of birds banded at that site. The average rate of recapture was 18.2%, excluding *Bombycilla cedrorum*, since no individuals were recaptured. There was a relationship between captures and recaptures per species and percentages of birds that demonstrated winter fidelity, winter residency, and both (Table 1).

The highest recapture rates were for Warbling Vireos (31.7%), in contrast to Cedar Waxwings where none were recaptured. Warbling Vireos also had the highest rate of winter residency (24.4%), between year winter site fidelity (14.6%), and in the number of individuals that demonstrated both winter site fidelity and winter

residency (7.3%) of the total number of banded individuals.

Nashville Warblers and Western Tanagers, based on the total number of recaptured individuals, had the highest numbers of individuals recaptured as returns, (66.2% for both species) while Orchard Orioles had the highest repeat recaptures (89.3%). The average number of individuals (excluding Cedar Waxwings) as return recaptures exceeded $56.35 \pm 9.97\%$, and for repeats it was $64.26 \pm 17.84\%$.

Only one bird (Nashville Warbler) banded in the Botanical Garden had been reported recaptured elsewhere (in Quebec, Canada) through December 2010. It was captured the following spring after being banded during the winter at our site.

DISCUSSION

Our knowledge of the behavior and survival strategies of neotropical migratory species during the time they spend in wintering areas is insufficient despite the great attention the Neotropics has received in the last several decades. Our study represents the first on winter site fidelity and winter residency for four (Warbling Vireo, Nashville Warbler, Western Tanager, Orchard Oriole) of the six species. Only limited information exists for the other two species (Cedar Waxwing, Audubon's Yellow-rumped Warbler).

We considered the reported fidelity, territoriality, flocking, and/or nomadic behaviors the species exhibited in breeding areas in our attempt to understand what fidelity could be expected for the six species. The Warbling Vireo was expected to have high winter site fidelity and winter residency similar to that shown in its breeding areas (Gardali and Ballard 2000). This species had the highest winter site fidelity and winter residency, and was the second highest species that had both behaviors (7.3%).

Audubon's Yellow-rumped Warblers, Western Tanagers, and Orchard Orioles are also reported to have some fidelity to breeding sites (Stewart 1988, Hudon 1999, Scharf and Kren 2010). We demonstrated these three species show between year winter site fidelity and winter residency. Orchard Orioles had the highest rate of birds that presented both behaviors (7.6%) and Audubon Yellow-rumped Warblers had the lowest fidelity (6.0%) of all species, excluding Cedar Waxwings.

Information is lacking on site fidelity for Nashville Warblers for both breeding and wintering areas. However, other *Oreothlypis* species have high to medium fidelity to breeding areas (Olson and Martin 1999, Gilbert et al. 2010). In our study, 10.4% and 8.4% of captured Nashville Warblers showed between year winter site fidelity and winter residency, respectively.

Cedar Waxwing was the only species where no individuals were recaptured. This species is a flocking nomadic with irregular occurrence (Grosselet and Ruiz-Michael 2004). Other studies (Brugger et al. 1994, Witmer et al. 1997) have shown little to no site fidelity between and within years for this species, which is consistent with that observed at our site. Our results support the pattern previously observed for the species.

The majority of the species, with the exception of the Cedar Waxwing, demonstrated winter site fidelity as indicated by the rate of recaptures of both repeats and returns; this coincides with the fidelity shown by some of these species for their breeding areas (e.g., Hudon 1999, Gardali and Ballard 2000). The winter site fidelity shown by these species underlines the urban site context, and coincides and surpasses the affirmation by Wunderle and Latta (2000) that a great proportion of the border effect in small fragments of habitat might not be as damaging for these species in tropical areas as it is in their temperate forest breeding areas. Our results support much of the evidence which shows that neotropical migratory species are using disturbed areas in their wintering areas (McGregor et al. 2010).

We consider that, because of our limited sampling effort and the necessity of recapturing individuals to record fidelity, our results underestimate the real percentage of birds that have between and within year winter fidelity. Our data suggest many birds are returning year after year and staying during the winter in the urban area of Oaxaca associated with the Botanical Garden.

The winter site fidelity at our location shows not only that birds are surviving in urban areas, but also provides indirect evidence that the resources present are sufficient for individuals to survive during the winter and return in subsequent winter seasons. However, more study is needed to assess the rates of body mass gain during the winter. This would provide a better understanding of the winter dynamics of these species and the food supply provided by urban areas.

The demonstrated winter site fidelity and winter residency of five of the six migratory species, as well as the continued loss of habitat in the Neotropics demonstrates the importance of green areas within urban sites and its importance for conservation of migratory birds. Maintenance, care, and expansion of urban green areas should be promoted as a conservation policy, as well as incorporating native elements into urban landscapes. However, the presence of green areas within cities does not in any way substitute for the function and importance of natural native ecosystems, as well as our responsibility for conserving and managing them in a sustainable way.

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