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NEW DISTRIBUTIONAL RECORDS FOR ENDANGERED BLACK-CAPPED VIREOS (*VIREO ATRICAPILLA*) ON THEIR WINTERING GROUNDS IN MEXICO

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Abstract—Little information is available regarding the distribution of the endangered black-capped vireo (*Vireo atricapilla*) on its wintering grounds along the Pacific slope of mainland Mexico. We surveyed 62 sites from October 2011 to January 2012 to identify previously undocumented wintering locations for the black-capped vireo. We located 66 individuals at 31 sites (47%) in seven states, including Michoacán, Guerrero, and Oaxaca, where there have been few surveys for black-capped vireos. Vireos occupied sites between 12 and 1,328 m, with slopes ≤23°. We detected vireos at 67% of dry forest and 17% of pine-oak (*Pinus-Quercus*) forest survey sites. Occupied locations were commonly characterized as deciduous, semideciduous, or agricultural lands and other disturbed areas. We found no evidence of latitudinal segregation in this species on its wintering grounds. These observations contribute to our understanding of the distribution and ecology of wintering black-capped vireos.

Resumen—Hay poca información disponible sobre la distribución del vireo de gorra negra (*Vireo atricapilla*)en peligro de extinción en sus áreas de invernación a lo largo de la vertiente del Pacífico de la parte continental de México. Muestreamos 62 sitios de octubre del 2011 a enero del 2012 con el propósito de identificar nuevas localidades de invernación del vireo de gorra negra. Localizamos 66 individuos en 31 sitios (47%) en siete estados, incluyendo Michoacán, Guerrero, y Oaxaca, donde se han realizado pocos muestreos para vireos de gorra negra. Los vireos ocuparon sitios entre 12 a 1,328 m, con pendientes ≤23°. Detectamos vireos en 67% de los sitios en bosques secos y en 17% de los sitios en bosques de pino-encino (*Pinus-Quercus*). Lugares ocupados se caracterizaron comúnmente como caducifolia, subcaducifolia, o tierras agrícolas y otras áreas perturbadas. No encontramos ninguna evidencia de segregación latitudinal en esta especie en sus áreas de invernación. Estas observaciones contribuyen a nuestro conocimiento de la distribución y ecología de de vireos de gorra negra en el invierno.

More than 300 migratory bird species breed in the continental United States and Canada and migrate to tropical destinations in Latin America and the Caribbean each fall. Population declines in many of these Neotropical migrants were first reported in the 1970s (e.g., Aldrich and Robbins, 1970; Temple and Temple, 1976; Briggs and Crisswell, 1979), and determining factors driving declines has become a major research focus in the years since (e.g., Terborgh, 1980; Ballard et al., 2003; Faaborg et al., 2010). The black-capped vireo (*Vireo atricapilla*) is an endangered Neotropical songbird that breeds in Oklahoma, Texas, and eastern Mexico and winters exclusively along the Pacific slope of Mexico (Ratzlaff, 1987; Secretaría de Medio Ambiente y Recursos Naturales, 2002, 2010). On their breeding grounds, habitat loss and nest parasitism by brown-headed cowbirds (*Moluthrus ater*) threaten black-capped vireo populations (Ratzlaff, 1987; United States Fish and Wildlife Service, 1991).

Like other Neotropical migrants, black-capped vireos spend a considerable portion of their annual life cycle on the wintering grounds, arriving as early as August (Graber, 1957) and remaining as late as April (Sullivan et al., 2009). Most of the previous research efforts for black-capped vireos have focused on breeding periods, and information regarding the distribution, habitat requirements, and threats to black-capped vireos during nonbreeding periods is limited (Wilkins et al., 2006; United States Fish and Wildlife Service, 2007). Understanding Neotropical migratory bird distributions and ecology throughout the year is necessary for successful conservation (Terborgh, 1980; Martin et al., 2007), and obtaining this information is a high priority for managing black-capped vireo recovery in the United States and

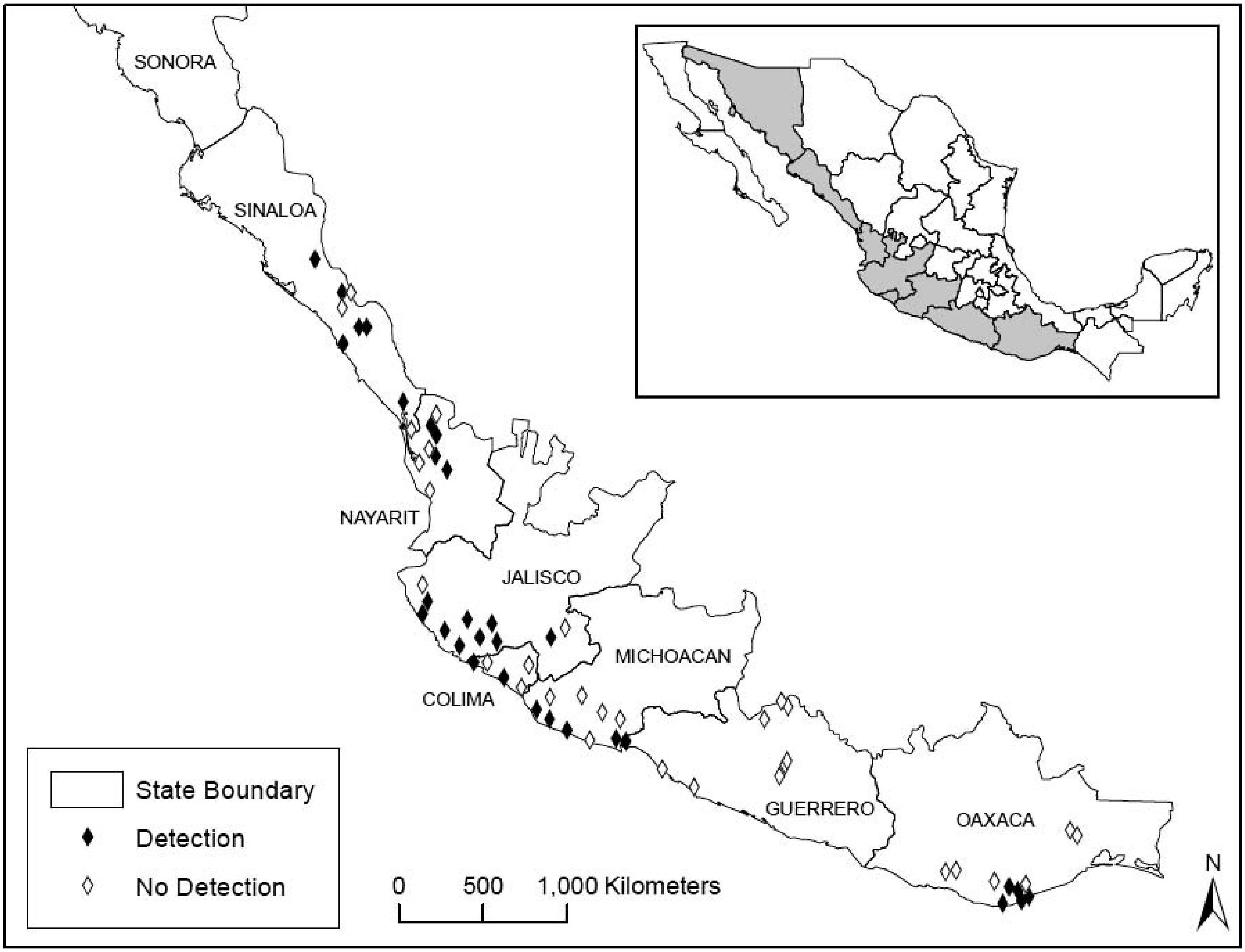

FIG. 1—Map of Mexican states surveyed for wintering black-capped vireos (*Vireo atricapilla*) in 2011–2012.

Mexico (United States Fish and Wildlife Service, 1991, 2007; Wilkins et al., 2006).

Wilkins et al. (2006:10) described the extent of the wintering range as "an elongated and patchily distributed area along the Pacific slopes of the Sierra Madre Occidental Mountains in Mexico, extending from southern Sonora to Oaxaca" (Fig. 1). Occasional reports exist outside of this range, but most are considered accidental or migratory (i.e., one in Hidalgo [Marshall et al., 1985], one in Mexico [Escalona et al., 1995], two in Sonora [Russell and Morrison, 1996], one in eastern Michoacán [MacGregor-Fors et al., 2012]). Most records of wintering black-capped vireos have come from Sinaloa and Nayarit in the northern portion of the range, which Graber (1961) described as the center of the winter range. Until recently, however, most research on wintering black-capped vireos was conducted in these states (Graber, 1961; Marshall et al., 1985; González-Medina et al., 2009), and observations regarding the winter distribution of the species may be biased according to survey effort.

Most reports of black-capped vireos south of Sinaloa and Nayarit consist of occasional net captures or detections as part of general avian studies (i.e., Davis, 1960; Schaldach, 1963; Phillips, 1966; Binford, 1989; Hutto, 1992; Vega Rivera et al., 2011). Similarly, there are few museum specimens collected in the central and southern portions of the range (three in Colima, five in Jalisco, one in Michoacán, one in Guerrero, and three in Oaxaca as indicated in Powell, 2013). However, from 2002 to 2004, Powell (2013) conducted the first range-wide survey of wintering black-capped vireos. He observed black-capped vireos in both the northern and central portions of their wintering range, but not in the southernmost states of Michoacán, Guerrero, and Oaxaca. Like Graber (1961), Powell (2013) suggested black-capped vireos might be less common in these southern states during winter than in other parts of their wintering range.

Vega Rivera et al. (2011) developed a model to predict the potential distribution of black-capped vireos across their wintering range. Their model suggested the wintering range of the black-capped vireo could extend further inland in some states than previously proposed (Wilkins et al., 2006) and that it might also include more lowland coastal areas. Despite few observations recorded from the southern states, the Vega Rivera et al. (2011) model suggested these states might contain the largest area of potential habitat. In 2011–2012, we conducted a range-wide survey of black-capped vireos on their wintering grounds in Mexico. Given the rarity of records from the wintering range, particularly in the southern states, our study provides new information on the distribution of black-capped vireos that could lead to improved winter-distribution models as well as a better understanding of habitat requirements and threats outside of the breeding period.

Materials and Methods—*Study Area*—We conducted surveys across the wintering range of the black-capped vireo in all Pacific coastal states from Sinaloa south to Oaxaca (Fig. 1) in Mexico. We used a niche-based MaxEnt model of the vireo's potential winter distribution (S. Sarkar, pers. comm.) to guide site selection. We identified potential survey locations with a $\geq$10% probability of suitable habitat according to the model. From among the potential sites, we selected survey locations that were $\geq$1.5 km from previously documented black-capped vireos and where lack of access, security, or habitat did not prohibit searches.

Climate varies geographically across the winter range of the vireo. The states of Guerrero and Oaxaca receive more rainfall annually and in the early months of the wintering season than other states within the wintering range of the black-capped vireo, and temperatures in these southern states remain relatively constant throughout the nonbreeding season (Hijmans et al., 2005). Temperatures become somewhat cooler over time in winter in the northern states, which also experience greater monthly rainfall as the season progresses (Hijmans et al., 2005). Jalisco and Colima, in the center of the winter range, remain relatively warm and dry during the nonbreeding season (Hijmans et al., 2005).

Collection and Analysis of Data—Black-capped vireos begin migrating to the wintering grounds in August and September (Gryzbowski, 1995). We began surveys on 16 October 2011 in Oaxaca and traveled north to Sinaloa before returning south again on 28 November 2011. We completed our final survey in Oaxaca on 27 January 2012, well before black-capped vireos begin migrating to the breeding grounds (Gryzbowski, 1995). We conducted all surveys between sunrise and 1300h. We walked slowly at each study location, actively searching for black-capped vireos or mixed-species flocks of which black-capped vireos could have been a part. At randomly selected points and whenever encountering a mixed-species flock, we stopped for 5–20 min and looked and listened for black-capped vireos. If no black-capped vireos were detected using these methods, we used brief playbacks of black-capped vireo songs mixed with calls of ferruginous pygmy-owls (*Glaucidium brasilianum*) to elicit responses. Survey points were located approximately 100–300 m apart. Variation in the length of time at or distance between points was a reflection of topography, bird activity, or both.

At each point, we recorded the date, time, location, and bird species present. If we detected black-capped vireos, we recorded the number and, if possible, the sex of individuals. It is difficult to reliably age and sex wintering black-capped vireos by sight with the exception of after-second-year (ASY) males (Pyle, 1997; pers. observ.), so we classified individuals as ASY males or others (i.e., females and younger males) as in González-Medina et al. (2009) and Powell (2013). We also examined the legs of all black-capped vireos detected to determine whether they had bands, but did not observe any banded individuals.

We extracted topographic information (i.e., elevation, slope, aspect) for each survey point from the ASTER Global Digital Elevation Model (United States National Aeronautics and Space Agency and Japan's Ministry of Economy, Trade, and Industry, http://eros.usgs.gov/#/Find_Data/Products_and_Data_Available/Aster) using ArcMap v. 10.2 (Environmental Systems Research Institute, Redlands, California). We compared elevation and slope at detection and nondetection points using Mann–Whitney–Wilcoxon tests. When we identified differences, we calculated the magnitude of the difference by using a correlation coefficient (Cohen, 1988; Fritz et al., 2011) and the Hodges–Lehmann estimator with 95% confidence interval (CI) to aid in our evaluation of results. Aspect refers to the direction of the slope at a particular site (e.g., south-facing slope). We created eight aspect categories (N, NE, E, SE, S, SW, W, NW) and compared the frequency of each at detection and nondetection points by using a Fisher's exact test. We calculated effect size as Cramer's V when $P \leq 0.10$. To reduce overlap and increase the likelihood of independence between survey points, we took a subset of all points and included only points that were $\geq$200 m apart in our analyses.

We also extracted information on ecoregions (Olson et al., 2001) and land cover (Instituto Nacional de Estadística Geografía e Informática, 2005) to describe landscapes at our survey locations. We compared landscapes using Fisher's exact tests and conducted post hoc pairwise comparisons with Bonferroni-corrected P values to determine significance when appropriate. We calculated effect size as Cramer's V when $P \leq 0.10$. Lastly, we used a Mann–Whitney U rank-sum test ranked by latitude to examine the geographic distribution of ASY males and others across the range by using all detection points. We also determined whether ASY males or others were detected more than expected by region (north, central, south; Table 1) by using χ^2 tests. We conducted all statistical analyses in R v. 3.1.1 (R Core Team, Vienna, Austria).

Results—We spent 466 survey hours searching for black-capped vireos from 16 October 2011 to 27 January 2012 (Table 1), sampling 1,382 points at 62 locations in seven states from Sinaloa in the north to Oaxaca in the south. We detected 66 black-capped vireos at 59 points from 31 locations (Table 1). Just over one-half (53%) of all black-capped vireos detected were ASY males (Table 1). We located black-capped vireos in all states surveyed. Relative to survey effort, there was a significant difference with frequency of detection in the northern and central states being greater compared to the southern states ($\chi^2 = 11.97$, $df = 1$, $P < 0.01$, $V = 0.10$), but not between the northern and central states relative to each other ($\chi^2 = 0.00$, $df = 1$, $P = 0.99$, $V = 0.01$). Our northernmost

TABLE 1—Total number of hours, locations, and points surveyed for black-capped vireos (*Vireo atricapilla*) on their wintering grounds in Mexico in 2011–2012, including number of detections by location and by point and number of individuals and after-second-year (ASY) males by state.

			Locations		Points			
Region	State	Hours	Sampled	With detection	Sampled	With detection	Total no. of individuals detected	Total no. of ASY males detected
North	Sinaloa	57	8	6	191	10	11	7
North	Nayarit	67	9	4	148	10	11	9
Central	Jalisco	99	11	9	314	22	26	9
Central	Colima	40	5	2	93	3	4	3
South	Michoacán	65	9	4	166	6	6	3
South	Guerrero	53	9	1	226	1	1	1
South	Oaxaca	85	11	5	244	7	7	3
	Total	466	62	31	1,382	59	66	35

detection was at 24°52′03″N, 107°13′53″W (elevation 147 m) in Sinaloa and our southernmost detection at 15°43′04″N, 96°26′45″W (elevation 287 m) in Oaxaca (Fig. 1). Of special interest were 14 detections in the three southernmost states, where few searches for black-capped vireos have previously been conducted (Table 2).

We surveyed points ranging in elevation from 8 to 2,505 m (mean = 574 m, CI = 511–638 m) and encountered black-capped vireos at elevations from 12 to 1,328 m (mean = 387 m, CI = 277–498 m). Elevation did not differ between detection and nondetection points ($W = 8{,}977.5$; $P = 0.25$). Survey points ranged in slope from 0 to 43° (mean = 10.9°, CI = 10.1–11.7°); we did not detect black-capped vireos at points with slopes greater than 23° (mean = 8.2°, CI = 6.7–9.8°). When comparing points at all survey locations, slopes were less steep at detection than nondetection points ($W = 9{,}740$; $P = 0.03$); however, the magnitude of this effect was small ($r = -0.11$, Hodges–Lehmann estimator = 2.1°, CI = 0.22–4.13°). In contrast, when comparing points only at locations where we detected black-capped vireos, we found no difference in slope at detection and nondetection points ($W = 3{,}717.5$; $P = 0.47$). Survey points were evenly distributed among aspect categories ($\chi^2 = 4.88$, $df = 7$, $P = 0.68$), and we found no difference in direction between detection and nondetection points overall (Fisher's exact test $P = 0.13$, $V = 0.18$) or between north- and south-facing slopes specifically ($\chi^2 = 2.98$, $df = 1$, $P = 0.08$, $V = 0.10$).

Sixty-eight percent ($n = 42$) of survey locations occurred in dry forest ecoregions, 29% ($n = 18$) in pine-oak (*Quercus-Pinus*) forest ecoregions, and 3% ($n = 2$) in mangrove forest ecoregions (Olson et al., 2001). We detected black-capped vireos at 67% ($n = 28$) of dry forest sites and 17% ($n = 3$) of pine-oak forest sites. We did not detect the species at either mangrove forest site. We detected black-capped vireos in dry forest ecoregions significantly more than we did in pine-oak forest ecoregions given survey effort (Fisher's exact test $P < 0.001$, $V = 0.46$).

Forests within these ecoregions can be further delineated into more specific land-cover types based on ecological characteristics. Fifteen of our survey sites were disturbed (i.e., agricultural, pasturelands, or associated secondary forests), 15 were temperate forests (i.e., pine, oak, mixed, cloud), and 32 were tropical forests (i.e., deciduous, semideciduous; Instituto Nacional de Estadística Geografía e Informática, 2005). We detected black-capped vireos at 47% ($n = 7$) of the disturbed sites, 20% ($n = 3$) of the temperate forest sites, and 66% ($n = 21$) of tropical forest sites. Low-level cattle grazing and fruit and vegetable plantations (e.g., coconut [*Cocos*], pineapple [*Ananas*], coffee [*Coffea*], corn [*Zea*], mango [*Mangifera*]) often characterized disturbed locations with black-capped vireos. The likelihood of detecting black-capped vireos varied significantly depending on land-cover type (Fisher's exact test $P = 0.02$, $V = 0.37$); post hoc pairwise tests showed a significant difference in detection only between temperate and tropical forest sites (Fisher's exact test $P < 0.01$, $V = 0.43$), with the likelihood of recording a black-capped vireo being greater in tropical forest sites.

We detected more ASY males than other black-capped vireos in the north and more others than ASY males in the central states (Table 1). However, the locations of ASY males ($\chi^2 = 1.2$, $df = 1$, $P = 0.55$) and others ($\chi^2 = 1.68$, $df = 1$, $P = 0.43$) by region were no different than expected by chance given our survey effort, and we found no latitudinal differences between ASY males and other black-capped vireos ($U = 488.5$, $Z = 0.69$, $P = 0.49$).

DISCUSSION—We observed black-capped vireos in all coastal states from Sinaloa south to Oaxaca. There are no winter records north or south of those reported in this paper, with the exception of reports by Russell and Morrison (1996) in Sonora, which likely represent accidental or migratory birds (Powell, 2013). Although most of our detections were in the northern (36%) and central (45%) portions of the wintering range, we also detected black-capped vireos in the southernmost states of Michoacán, Guerrero, and Oaxaca, where only one

Table 2—Date and location for black-capped vireos (*Vireo atricapilla*) detected in 2011–2012 in three southernmost states of their wintering range in Mexico.

State	Latitude	Longitude	Elevation (m)	Date
Michoacán	18°29′16″N	103°30′12″W	95	6 January 2012[a]
Michoacán	18°21′25″N	103°18′25″W	408	5 January 2012
Michoacán	18°21′10″N	103°18′26″W	408	5 January 2012[a]
Michoacán	18°13′38″N	103°02′11″W	343	4 January 2012
Michoacán	18°12′06″N	103°04′08″W	73	4 January 2012
Michoacán	18°05′39″N	102°17′39″W	203	18 December 2011[a]
Guerrero	18°03′29″N	102°08′40″W	98	19 December 2011[a]
Oaxaca	15°56′16″N	96°21′21″W	961	27 January 2012[a]
Oaxaca	15°56′10″N	96°21′01″W	781	27 January 2012
Oaxaca	15°53′28″N	96°12′29″W	318	26 January 2012[a]
Oaxaca	15°47′31″N	96°02′51″W	0	23 January 2012
Oaxaca	15°45′17″N	96°09′18″W	79	21 January 2012
Oaxaca	15°44′51″N	96°10′06″W	9	21 January 2012[a]
Oaxaca	15°43′04″N	96°26′45″W	287	19 January 2012

[a] Indicates after-second-year male.

other study (Powell, 2013) has previously focused on this species. All of our detections in the southern states occurred in lowland coastal areas, indicating that these areas might be of importance for wintering black-capped vireos.

Survey effort in the three southernmost states was comparable to effort in all other states combined, yet we encountered approximately 35 and 55% fewer black-capped vireos in the southern states than in the northern and central states, respectively. Like others (Graber, 1961; Powell, 2013), our observations suggest occupancy by black-capped vireos may well be lower in the southern states. However, logistical constraints (e.g., lack of roads, steep slopes) and personal-security issues restricted our choice of survey locations in these states, which may have biased our results. In particular, we were limited in our access to coastal sites in Guerrero, although we were able to visit several inland areas that Vega Rivera et al. (2011) identified as potentially suitable for black-capped vireos. These areas were higher in elevation (1,500–2,500 m) and characterized by either pine-oak forests or heavily modified agricultural areas. Only 17% of the Vega Rivera et al. (2011) model included elevations >1,250 m, and only 8% of black-capped vireos detected by Powell (2013) were at higher elevations. Similarly, we found few individuals at higher elevations and, based on experience, suspect that high-elevation, inland sites in Guerrero offer little potential in terms of suitable habitat for wintering black-capped vireos.

The wintering range of the black-capped vireo is primarily comprised of tropical dry forests, although black-capped vireos do occupy pine-oak forests to a lesser extent (Graber, 1961; Vega Rivera et al., 2011; Powell, 2013). Dry forests are deciduous forests found <2,000 m and characterized by short trees (8–12 m), dense undergrowth, low rainfall, and marked seasonality (Rzedowski, 1978; Trejo-Vázquez, 1999). Presently, 27% of dry forests in Mexico remain intact (Trejo and Dirzo, 2000), and only 0.2% of dry forest land is protected (Portillo-Quintero and Sánchez-Azofeifa, 2010). Dry forests are regularly cleared for agriculture and cattle grazing (Janzen, 1988), and dry forests in Mexico may be especially vulnerable to conversion for these land uses (Miles et al., 2006). However, clearing of dry forests is less intense with increasing slope (Trejo and Dirzo, 2000; Portillo-Quintero and Sánchez-Azofeifa, 2010).

Powell (2013) found that black-capped vireos in the northern and central states tended to use steeper, more southern-facing slopes. McFarland et al. (2013) similarly detected black-capped vireos more frequently on steeper slopes on their breeding grounds in Texas; however, the pattern was not consistent across the breeding range. When examining points from all survey locations, we found that slopes at detection points were less steep, although the magnitude of the difference was small and limited to a few degrees. We did not detect a difference in the use of slopes when we limited analysis to locations with known occupancy. Dry forests in Mexico are climatically and topographically diverse and exhibit significant geographic variation in vegetation structure and species composition (Trejo and Dirzo, 2000). Black-capped vireos are more flexible in their use of habitat on the wintering grounds than on the breeding grounds (Graber, 1961; González-Medina et al., 2009; Powell, 2013) and, where use of steeper slopes is observed, it is likely the result of local climate and land-use factors and not a range-wide characteristic.

Hutto (1992) suggested black-capped vireos were likely restricted to undisturbed tropical deciduous forests. However, his assessment was based on a single individual captured in a protected area. We detected black-capped vireos at 47% of the disturbed sites surveyed, which were typically characterized by low-level cattle grazing, fruit and vegetable plantations (e.g., coconut, pineapple, coffee, corn, mango), or secondary forests associated with these land uses. Disturbed locations occupied by black-capped vireos tended to be shaded and in proximity to deciduous or semideciduous forests. Our observations are consistent with those of Vega Rivera et al. (2011), who suggested that black-capped vireos might not be restricted in their use of disturbed habitats so long as those areas are part of heterogeneous landscapes that include nearby forest patches.

Seasonal habitat segregation by different classes (e.g., age, sex, behavior) of Neotropical birds is well documented (e.g., Lynch et al., 1985; Lopez Ornat and Greenberg, 1990; Sherry and Holmes, 1996). Birds can occupy different latitudes because of social dominance by one class (Ketterson and Nolan, 1976; Gauthreaux, 1978; Lynch et al., 1985; Marra, 2000) or because of habitat specialization between classes (Lynch et al., 1985; Morton, 1990). This segregation can complicate interpretations of habitat use and can have consequences for population dynamics (Rodenhouse et al., 1997; Marra et al., 1998; Komar et al., 2005). Powell (2013) observed a significant difference in the distribution of ASY males compared to other black-capped vireos on the wintering grounds, but we found no evidence to support latitudinal segregation in our study. Additional research is needed to determine whether segregation on the wintering grounds occurs in this species.

Our surveys identified new wintering locations for black-capped vireos across their wintering range. Although our objective was not specifically to test the Vega Rivera et al. (2011) distribution model, we confirmed their prediction that black-capped vireos use lowland coastal areas, particularly in the southern part of the winter range, and that the species will use disturbed areas in some instances. The new locations we provide can be used to improve future distribution models of wintering black-capped vireos and to help in the development of management guidelines. Powell (2013) contributed significantly to our understanding of fine-scale habitat use by wintering black-capped vireos in the northern and central portions of the winter range, but measurements associated with habitat quality, threats, and areas of concentration are still needed range wide.

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Literature Cited

Aldrich, J. W., and C. S. Robbins. 1970. Changing abundance of migratory birds in North America. Smithsonian Contributions to Zoology 26:17–26.

Ballard, G., G. R. Geupel, N. Nur, and T. Gardali. 2003. Long-term declines and decadal patterns in population trends of songbirds in western North America, 1979–1999. Condor 105:737–755.

Binford, L. C. 1989. A distributional survey of the birds of the Mexican state of Oaxaca. Ornithological Monographs 43:1–418.

Briggs, S. A., and J. H. Crisswell. 1979. Gradual silencing of spring in Washington. Atlantic Naturalist 32:19–26.

Cohen, J. 1988. Statistical power analysis for the behavioral sciences, 2nd ed. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

Davis, J. 1960. Notes on the birds of Colima, Mexico. Condor 62:215–219.

Escalona, G., M. Torres, A. G. Navarro, R. Villalon, B. Hernandez, and H. Benitez. 1995. Migratory birds of the cloud forests of Mexico. Pages 15–33 in Conservation of Neotropical migratory birds in Mexico. Miscellaneous publication 727 (M. H. Wilson and S. A. Sader, editors). Maine Agricultural and Forest Experiment Station, Orono.

Faaborg, J., R. T. Holmes, A. D. Anders, K. L. Bildstein, K. M. Dugger, S. A. Gauthreaux, Jr., P. Heglund, K. A. Hobson, A. E. Jahn, D. H. Johnson, S. C. Latta, D. J. Levey, P. P. Marra, C. L. Merkord, E. Nol, S. I. Rothstein, T. W. Sherry, T. S. Sillett, F. R. Thompson III, and N. Warnock. 2010. Conserving migratory land birds in the New World: do we know enough? Ecological Applications 20:398–418.

Fritz, C. O., P. E. Morris, and J. J. Richler. 2011. Effect size estimates: current use, calculations, and interpretation. Journal of Experimental Psychology 1:2–18.

Gauthreaux, S. A., Jr. 1978. The ecological significance of behavioral dominance. Pages 17–54 in Perspectives in ethology. Volume 3 (P. P. G. Bateson and P. H. Klopfer, editors). Plenum, New York.

González-Medina, E., U. T. Angulo-Gastelum, J. A. Castillo-Guerrero, and M. Guevara-Medina. 2009. Distribución y abundancia relativa invernal del vireo de cabeza negra (*Vireo atricapilla*) en Sinaloa, Mexico. Ornitología Neotropical 20:291–298.

Graber, J. 1957. A bioecological study of the black-capped vireo (*Vireo atricapilla*). Ph.D. dissertation, University of Oklahoma, Norman.

Graber, J. 1961. Distribution, habitat requirements, and life history of the black-capped vireo (*Vireo atricapilla*). Ecological Monographs 31:313–336.

Grzybowski, J. A. 1995. Black-capped vireo (*Vireo atricapilla*). Issue 181 in The birds of North America online (A. Poole, editor). Cornell Lab of Ornithology, Ithaca, New York.

Hijmans, R. J., S. E. Cameron, J. L. Parra, P. G. Jones, and A. Jarvis. 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25:1965–1978.

Hutto, R. L. 1992. Habitat distributions of migratory landbird species in western Mexico. Pages 221–239 in Ecology and conservation of Neotropical migrant landbirds (J. M. Hagan III and D. W. Johnston, editors). Smithsonian Institution Press, Washington, D.C.

Instituto Nacional de Estadística Geografía e Informática. 2005. Conjunto de datos vectoriales de uso del suelo y vegetación, escala 1:250,000, Serie III. Instituto Nacional de Estadística Geografía e Informática, Aguascalientes, Mexico.

Janzen, D. H. 1988. Tropical dry forests: the most endangered major tropical ecosystem. Pages 130–137 in Biodiversity (E. O. Wilson and F. M. Peter, editors). National Academies Press, Washington, D.C.

Ketterson, E. D., and V. Nolan, Jr. 1976. Geographic variation and its climatic correlates in the sex ratio of eastern-wintering Dark-eyed Juncos (Junco hyemalis hyemalis). Ecology 57:679–693.

Komar, O., B. J. O'Shea, A. T. Peterson, and A. G. Navarro-Siguenza. 2005. Evidence of latitudinal sexual segregation among migratory birds wintering in Mexico. Auk 122:938–948.

Lopez Ornat, A., and R. Greenberg. 1990. Sexual segregation by habitat in migratory warblers in Quintana Roo, Mexico. Auk 107:539–543.

Lynch, J. F., E. S. Morton, and M. E. Van der Voort. 1985. Habitat segregation between the sexes of wintering hooded warblers (*Wilsonia citrina*). Auk 102:714–721.

MacGregor-Fors, I., A. G. Navarro-Siguenza, L. Morales-Perez, and J. E. Schondube. 2012. Note on the distribution and migration of the black-capped vireo (*Vireo atricapilla*). Huitzil 13:17–21.

Marra, P. P. 2000. The role of behavioral dominance in structuring patterns of habitat occupancy in a migrant bird during the nonbreeding season. Behavioral Ecology 11:299–308.

Marra, P. P., K. A. Hobson, and R. T. Holmes. 1998. Linking winter and summer events in a migratory bird by using stable-carbon isotopes. Science 282:1884–1886.

Marshall, J. T., Jr., R. B. Clapp, and J. A. Grzybowski. 1985. Status report: *Vireo atricapillus* Woodhouse, black-capped vireo. Office of Endangered Species, United States Fish and Wildlife Service, Albuquerque, New Mexico.

Martin, T. G., I. Chadés, P. Arcese, P. P. Marra, H. P. Possingham, and D. Norris. 2007. Optimal conservation of migratory species. PLoS ONE 2:e751.

McFarland, T. M., H. A. Mathewson, J. E. Groce, M. L. Morrison, and R. N. Wilkins. 2013. A range-wide survey of the endangered black-capped vireo in Texas. Southeastern Naturalist 12:41–60.

Miles, L., A. C. Newton, R. S., DeFries, C. Ravilious, I. May, S. Blyth, V. Kapos, and J. E. Gordon. 2006. A global overview of the conservation status of tropical dry forests. Journal of Biogeography 33:491–505.

Morton, E. S. 1990. Habitat segregation by sex in the hooded warbler: experiments on proximate causation and discussion of its evolution. American Naturalist 135:319–333.

Olson, D. M., E. Dinerstein, E. D. Wikramanayake, N. D. Burgess, G. V. N. Powell, E. C. Underwood, J. A. D'Amico, I. Itoua, H. E. Strand, J. C. Morrison, C. J. Loucks, T. F. Allnutt, T. H. Ricketts, Y. Kura, J. F. Lamoreux, W. W. Wettengel, P. Hedao, and K. R. Kassem. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. BioScience 51:933–938.

Phillips, A. R. 1966. Further systematic notes on Mexican birds. Bulletin of the British Ornithologists' Club 86:86–94.

Portillo-Contero, C. A., and G. A. Sánchez-Azofeifa. 2010. Extent and conservation of tropical dry forests in the Americas. Biological Conservation 143:144–155.

Powell, R. A. 2013. Ecology of wintering black-capped vireos in Mexico. Ph.D. dissertation, Texas A&M University, College Station.

Pyle, P. 1997. Identification guide to North American birds. Part I: Columbidae to Ploceidae. Slate Creek Press, Bolinas, California.

Ratzlaff, A. 1987. Endangered and threatened wildlife and plants: determination of the black-capped vireo to be an endangered species. Federal Register 52:37420–37423.

Rodenhouse, N. L., T. W. Sherry, and R. T. Holmes. 1997. Site-dependent regulation of population size: a new synthesis. Ecology 78: 2025–2042.

Russell, S. M., and G. Morrison. 1996. The birds of Sonora. University of Arizona Press, Tucson.

Rzedowski, J. 1978. Vegetacíon de Mexico. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México.

Secretaría de Medio Ambiente y Recursos Naturales. 2002. Protección ambiental-especies nativas de México de flora y fauna silvestres. Categorías de riesgo y especificaciones para su inclusion, exclusion o cambio. Lista de especies en riesgo. Diario Oficial de la Federación, Estados Unidos Mexicanos. Norma Oficial Mexicana. NOM-059-ECOL-2001. Secretaría de Medio Ambiente y Recursos Naturales, Mexico D.F.

Secretaría de Medio Ambiente y Recursos Naturales. 2010. Protección ambiental - especies nativas de México de flora y fauna silvestres. Categorías de riesgo y especificaciones para su inclusion, exclusion o cambio. Lista de especies en riesgo. Secunda Sección. Diario Oficial de la Federación, Estados Unidos Mexicanos. Norma Oficial Mexicana. NOM-059-ECOL-2010. Secretaría de Medio Ambiente y Recursos Naturales, Mexico D.F.

Schaldach, W. J. 1963. The avifauna of Colima and adjacent Jalisco, Mexico. Proceedings of the Western Foundation Vertebrate Zoology 1:1–100.

Sherry, T. W., and R. T. Holmes. 1996. Winter habitat quality, population limitation, and conservation of Neotropical-Nearctic migrant birds. Ecology 77:36–48.

Sullivan, B. L, C. L. Wood, M. J. Iliff, R. E. Bonney, D. Fink, and S. Kelling. 2009. eBird: a citizen-based bird observation network in the biological sciences. Biological Conservation 142:2282–2292.

Temple, S. A., and B. L. Temple. 1976. Avian population trends in central New York state, 1935–1972. Bird Banding 47:238–257.

Terborgh, J. W. 1980. The conservation status of Neotropical migrants. Pages 21–30 in Migrant birds in the Neotropics: ecology, behavior, distribution, and conservation (A. Keast and E. S. Morton, editors). Smithsonian Institution Press, Washington, D.C.

Trejo, I., and R. Dirzo. 2000. Deforestation of seasonally dry tropical forest: a national and local analysis of Mexico. Biological Conservation 94:133–142.

Trejo-VÁzquez, I. 1999. El clima de la selva baja caducifolia en Mexico. Investigaciones Geograficas 39:40–52.

United States Fish and Wildlife Service. 1991. Black-capped vireo (*Vireo atricapilla*) recovery plan. United States Fish and Wildlife Service Region 2, Albuquerque, New Mexico.

United States Fish and Wildlife Service. 2007. Black-capped vireo (*Vireo atricapilla*). 5-year review: summary and evaluation. United States Fish and Wildlife Service, Arlington, Virginia.

Vega Rivera, J. H., M. A. Ortega-Huerta, S. Sarkar, and J. H. Rappole. 2011. Modelling the potential winter distribution of the endangered black-capped vireo (*Vireo atricapilla*). Bird Conservation International 21:92–106.

Wilkins, N., R. A. Powell, A. A. T. Conkey, and A. G. Snelgrove. 2006. Population status and threat analysis for the black-capped vireo. United States Fish and Wildlife Service Region 2, Albuquerque, New Mexico.

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