Density and Habitat Use of Gray Vireos in the San Juan Basin Natural Gas Field in Northwestern New Mexico

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Introduction

Probably the greatest threat to the Gray Vireo (*Vireo vicinior*) in New Mexico is habitat degradation due to land management activities (Barlow et al. 1999) and clearing for development. In the San Juan Basin, natural gas development has fragmented habitats that were once relatively undisturbed by stripping areas of vegetation for the construction of well pads, roads, and pipelines. Natural gas development in the San Juan Basin has accelerated in recent years and is projected to continue. Therefore, it is important that wildlife managers assess how these activities affect breeding bird communities.

The objectives of this study were to establish baseline estimates of Gray Vireo density in northwestern New Mexico, where natural gas wells are present at relatively high densities, and to identify habitat characteristics that might be important to vireos during the breeding season.

Methods

The study was conducted in 2006 and 2007 on Bureau of Land Management (BLM) lands in San Juan and Rio Arriba counties, New Mexico. Each year, we randomly established 29 1.75-km transects in piñon (*Pinus* spp.)-juniper (*Juniperus* spp.) habitat and conducted distance sampling using the line-transect method (Buckland et al. 1993) to estimate Gray Vireo density and identify occupied habitat. Surveys were conducted between mid-May and late-June and occurred between about sunrise and 1100 MDT.

Habitat sampling followed a modified BBIRD protocol (Martin et al. 1997). We measured elevation, slope, aspect, mean tree height, tree and snag density, canopy cover, mean tree diameter at ankle height (DAH), shrub density, and percentage of various types of live and non-live groundcover at Gray Vireo locations and randomly selected locations. Live groundcover categories included shrubs, grasses and forbs; non-live groundcover included bare ground, rock, litter, and woody debris that was ≥ 8 cm diameter at breast height. Using ESRI ARCMAP Version 9.2 (ARCMAP), we measured the distance from each vireo detection and random point to the nearest: 1) natural gas well; 2) road; and 3) habitat edge. We also quantified the number of wells within 2-km and 5-km radii of each detection and random point using Geographic Information System (GIS) files of well locations obtained from the New Mexico Department of Natural Resources, Oil Conservation Division.

We analyzed line transect data using program DISTANCE (Thomas et al. 2003) and selected the best model to estimate density using Akaike's Information Criterion for small sample size (AIC_c). Model fit was evaluated using a Chi-square goodness-of-fit test where higher *P*-values indicated that the data were a good fit to the model.

Habitat and GIS data were analyzed using SYSTAT 12. For continuous variables, we compared means of detection and random plots as well as effect size and 95% confidence interval (CI) around effect size (Anderson et al. 2001, Di Stefano 2004). For categorical variables, we used a Chi-

TABLE 1. Best models generated in DISTANCE for Gray Vireo (*Vireo vicinior*) survey data collected in San Juan and Rio Arriba counties, New Mexico in 2006 (n = 23) and 2007 (n = 29).

Year	Model	Density (birds/ha ± SE)	95% CI	% CV	AIC_c
2006	Uniform	0.044 ± 0.013	0.025–0.080	29.80	70.31
2007	Hazard	0.066 ± 0.028	0.029–0.151	42.40	84.20

TABLE 2. Results of significant ($P \leq 0.15$) univariate logistic regression analysis for habitat variables at Gray Vireo (*Vireo vicinior*) detection plots (n = 46) and randomly selected plots (n = 50) in San Juan and Rio Arriba counties, New Mexico.

Habitat Variable	Estimate ± SE	Z	*P*
Elevation (m)	0.004 ± 0.002	2.082	0.037
Number of trees 0.5–2.0 m tall	0.153 ± 0.103	1.485	0.138
Number of trees > 4.0 m tall	-0.151 ± 0.090	-1.674	0.094
Downed woody debris	-0.728 ± 0.429	-1.699	0.089

square test of association to compare detection and random plots. We used binary logistic regression to identify habitat variables that might be important to Gray Vireos. We reduced the number of candidate variables using univariate logistic regression (Hosmer and Lemeshow 1989), retaining variables that differed between occupied and random plots ($P \leq 0.15$). We performed multiple logistic regression on the full model and all subsets and used AIC_c to rank the models (Anderson et al. 2001).

RESULTS

The best density estimates for Gray Vireo were 0.044 vireos/ha (± 0.013 SE) in 2006 and 0.066 vireos/ha (± 0.028 SE) in 2007 (Table 1). Chi-square goodness-of-fit tests indicated the data were a good fit in the 2006 ($\chi^2 = 1.916$, df = 4, $P = 0.751$) and 2007 ($\chi^2 = 0.531$, df = 2, $P = 0.767$) models.

Habitat sampling and GIS analyses were conducted at 46 Gray Vireo detection and 50 random sites. Elevation (m) was the only variable that differed between detection (1964.0 ± 16.2 [SE]) and random plots (1917.7 ± 14.2 [SE]; Effect Size = 46.3, 95% CI = 3.5−89.2).

We retained four habitat variables for multiple logistic regression analysis including elevation, number of trees 0.5−2.0 m tall, number of trees > 4.0 m tall, and the percent of the ground covered by downed woody debris (Table 2). The four best models ($AIC_c < 2$) indicated that occupied Gray Vireo habitat was likely to be slightly higher in elevation than randomly selected habitat (Table 3). Three of these models also indicated that occupied habitat was likely to contain less downed woody debris than randomly selected habitat. Two models indicated that vireo habitat was likely to have fewer trees > 4.0 m tall, and one model showed that vireo habitat was likely to contain more trees between 0.5 and 2.0 m than randomly selected habitat (Table 3).

DISCUSSION

Our density estimates are similar to other recent studies conducted using similar survey techniques in Colorado, Arizona, and Utah (Table 4). Therefore, our data suggest that Gray Vireo density in the San Juan Basin is similar to that across much of the species' range.

Our habitat data suggests that Gray Vireos might be selecting younger piñon-juniper stands than the proportion of available habitat in the study area, as occupied habitat contained fewer tall trees (> 4 m) and more, shorter trees (< 2 m) compared with random locations. Occupied habitat also contained less downed woody debris than the randomly selected habitat. Woody debris might be related to stand age, and younger stands likely contain fewer dead and decaying trees. None of these trends was reported by Schlossberg (2006),

TABLE 3. Logistic regression models predicting Gray Vireo (*Vireo vicinior*) use areas (n = 46) compared with random habitat (n = 50) in Rio Arriba and San Juan counties, New Mexico.

Model [a]	AIC_c	$\Delta\ AIC_c$	-2loge(L)	w^b	P^c
-10.099+(0.006 E)+(-1.113 W)	128.758	0.000	122.158	0.098	0.005
-10.545+(0.006 E)+(-0.130 T4)+(-0.878 W)	129.342	0.584	120.316	0.073	0.006
-9.809+(0.006 E)+(0.116 T2)+(-1.101 W)	129.942	1.184	120.916	0.054	0.007
-9.433+(0.005 E)+(-0.187 T4)	130.328	1.570	123.728	0.045	0.010

[a] E = Elevation; T2 = number of trees 0.5−2.0 m tall; T4 = number of trees > 4 m tall; and W = % of woody debris
[b] Akaike weight
[c] Probability values from χ^2 test of model significance

TABLE 4. Comparison of Gray Vireo (*Vireo vicinior*) density estimates from Wickersham and Wickersham (2006, 2007) with four recent studies in the United States Southwest utilizing distance sampling.

Location	Density (birds/ha)	Reference
Northwest New Mexico	0.044	Wickersham and Wickersham 2006
Northwest New Mexico	0.066	Wickersham and Wickersham 2007
Arizona and southern Utah	0.064	Schlossberg 2006
Western Colorado and southern Utah	0.069	Hutton et al. 2006
Western Colorado	0.055	Giroir 2001
Colorado	0.060	Colorado BLM 1995

who conducted the only other extensive study of Gray Vireo habitat use across the species' range.

Our habitat models also indicated that Gray Vireos might prefer habitat slightly higher in elevation than the average elevation in our study area. Schlossberg (2006) also reported a relationship between elevation and Gray Vireo density in Arizona and Utah. However, density was lower at higher elevations (> 1900 m) in his study area compared with lower elevations (1500−1900 m). Although habitat was similar, elevation was slightly lower in his study area (approximately 1550−2100 m) compared with our study area (1725−2228 m); and, in our study, 74% of Gray Vireo detections occurred above 1900 m. Johnson (1972) also reported a higher elevation range (1830−2100 m) for Gray Vireos in Nevada.

Density of natural gas wells and proximity of wells and roads did not appear to influence Gray Vireo distribution in the San Juan Basin; or, if so, the effect has already been realized within the breeding population. However, well density was relatively high (39 wells/2-km radius and 244 wells/5-km radius). Therefore, there might be few places to establish a relatively undisturbed territory.

CONCLUSIONS

Gray Vireo density in the San Juan Basin appears to be similar to that across much of its breeding range. In addition, structural habitat characteristics appear to have more influence on occupancy than infrastructure associated with natural gas development. There are no historical data on Gray Vireo distribution, density, or abundance prior to the natural gas exploration boom in the San Juan Basin. Thus, additional studies comparing relatively contiguous piñon-juniper habitat with that of the San Juan Basin are needed to determine if natural gas exploration has any measurable impacts on distribution, density, and habitat use. Potential comparison sites with larger, relatively undisturbed tracts of piñon-juniper woodlands include the adjacent Navajo Indian Reservation to the west, some of which occurs within the San Juan Basin gas field. Alternatively, if no measurable contiguous habitat can be identified, our study provides baseline data to which further studies in the San Juan Basin might be compared over time.

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