Biodiversity and Biocultural Conservation Laboratory
University of Texas at Austin

Technical Note No. 52
Date 19 October 2008

Habitat Suitability for the Black-capped Vireo in Travis County, Texas

Trevon Fuller, Tiffany Hollon, and Sahotra Sarkar

We evaluate the suitability of habitat for the Black-capped Vireo, *Vireo atricapillus* (Woodhouse, 1852), in Travis County, Texas. The analysis is based on a niche model constructed using a maximum entropy algorithm implemented in the Maxent 3.2.1 software package (Phillips and Dudík 2008). This method has been shown to be one of the most reliable techniques for predicting species' distributions from presence-only (occurrence) data (Elith et al. 2006). As input, these models take occurrence data and environmental layers. The output consists of the fundamental niche of a species which must then be modified to obtain its realized niche and projected onto geographical space to obtain its predicted distribution or suitable habitat map.

1. **Study Region**.

In earlier work, we developed a Black-capped Vireo habitat model for a region that included Comal, Hays, and Travis Counties and the part of the Balcones Canyonlands National Wildlife Refuge that falls in Burnet and Williamson Counties (Fuller et al. 2008a). The present Technical Note reports the results of that model when the spatial extent of the model is restricted to Travis County. The analysis was performed at a 30 m $\times$ 30 m resolution which corresponds to the resolution of Landsat images used for some of the environmental layers. There were 294 784 data points or "sites."

2. **Occurrence Data**.

Occurrence data were collected from a variety of sources (see Table 1). When data were available as accurate polygons for the home range of an individual, these were converted into point data by calculating centroids of the polygons in ArcGIS (Hollon 2008). Only data from 1990 or later were used to construct the ecological niche model for the Vireo. A total of 848 points were used to construct the model. 481 of the points were located in Travis County. Figure 1 shows the location of data points.

3. **Environmental Layers**.

Topographic layers were obtained from public sources (see Table 2). A preliminary study of Travis County and the Balcones Canyonlands National Wildlife Refuge showed the importance of May temperature for determining habitat suitability for the Vireo (Trevon Fuller, unpublished results). Consequently, meteorological layers were

constructed for the entire study area. For a list of the weather stations used for the interpolations, see Fuller et al. (2008b).

4. **Model Parameters**.

Model settings in Maxent followed the recently published recommendations of Phillips and Dudík (2008). The settings were: 75/25 training/test split, linear, quadratic, product, threshold, hinge, and categorical features, regularization multiplier: 1, and logistic output. Models were generated using 10 000 background points (as pseudo-absences). The regularization value was 0.05 for the linear, quadratic, and product features, 0.25 for the categorial features, 1 for the threshold features, and 0.5 for the hinge features. The accuracy of the niche model was measured for a geographical region that included Comal, Hays, and Travis Counties and parts of Burnet and Williamson Counties (see “Study Region”).

5. **Results**.

Figure 2 shows the fundamental niche of the species as projected into geographical space. The performance of such models is principally judged by the area under curve (AUC), where the curve in question is the receiver operating characteristic curve which plots the true positive rate versus the false positive rate as judged using the test data. (The maximum possible AUC value is 1.0 while a random model should return a value of 0.5) The AUC for the model was 0.984, which is highly satisfactory. In other words, there were very few false positives. However, the AUC should not be used as the only criterion for judging preformance. We also used all internal tests in Maxent. All binomial tests on the model returned significant values (Table 3).

The most important variables for determining habitat suitability for the Vireo were elevation and April preicipitation. The former resulted in the highest AUC when it was the only variable included in the Maxent model. The latter resulted in the lowest AUC when omitted from the model.

6. **Model Refinement**.

Niche models predict the fundamental niches of species. To obtain the realized niche, these fundamental niches must be modified to take into account factors such as habitat modfication.

The logistic output from Maxent reports a suitability value (to be interpreted as the probability that the site is habitat) for each site in the study area. In the present analysis, sites predicted by Maxent to be Vireo habitat with probability 0.1 or greater are referred to as “suitable” habitat. Figure 3 shows the suitable habitat in the study region.

Because typical Vireo habitat is comprised of early successional shrub vegetation, the suitable sites were clipped to exclude sites without shrub/scrub vegetation as defined by the National Land-Cover Database (Homer et al., 2004) (Figure 4).

References

DeBoer, T. S. and Diamond, D. D. 2006. “Predicting Presence-Absence of the Endangered Golden-cheeked Warbler *(Dendroica chrysoparia*).” *Southwestern Naturalist* **51**: 181 -190.

Diamond, D. D. 2005. Development of Conservation Focus Area Models for EPA Region 7. Regional Geographic Initiative (RGI) Report. Environmental Assessment Team, Environmental Protection Agency. Kansas City, Kansas.

Diamond, D. D. and True, C. D. 2007. “Distribution of *Juniperus* Woodlands in Central Texas in Relation to General Abiotic Site Type.” In O. Van Auken, Ed. *Western North American Juniperus Communities: A Dynamic Vegetation Type*. Berlin: Springer, pp. 48 -58.

Elith, J., Graham, C. H., Anderson, R. P., Dudík, M., Ferrier, S., Guisan, A., Hijmans, R. J., Huettmann, F., Leathwick, J. R., Lehmann, A., Li, J., Lohmann, L. G., Loiselle, B. A., Manion, G., Moritz, C., Nakamura, M., Nakazawa, Y., Overton, J. M., Peterson, A. T., Phillips, S. J., Richardson, K. S., Scachetti-Pereira, R., Schapire, R. E., Soberon, J., Williams, S. E., Wisz, M. S., and Zimmermann, N. E. 2006. “Novel Methods Improve Prediction of Species' Distributions from Occurrence Data.” *Ecography* **29**: 129 -151.

Farr, T. G., Rosen, P. A., Caro, E., Crippen, R., Duren, R., Hensley, S., Kobrick, M., Paller, M., Rodriguez, E., Roth, L., Seal, D., Shaffer, S., Shimada, J., Umland, J., Werner, M., Oskin, M., Burbank, D., and Alsdorf, D. 2007. “The Shuttle Radar Topography Mission.” *Review of Geophysics* **45**: RG2004 DOI:10.1029/2005RG000183.

Fuller, T., Hollon, T., and Sarkar, S. 2008a. “Preliminary Report to Smith|Robertson: Habitat Suitability for the Black-capped Vireo in Comal and Hays County, Texas.” Technical Note No. 51. Biodiversity and Biocultural Conservation Laboratory. University of Texas at Austin. Austin, Texas.

Fuller, T., Hollon, T., and Sarkar, S. 2008b. “Preliminary Report to Smith|Robertson: Habitat Suitability for the Golden-cheeked Warbler in Comal and Hays County, Texas.” Technical Note No. 49. Biodiversity and Biocultural Conservation Laboratory. University of Texas at Austin. Austin, Texas.

Hollon, T. 2008. “Protocol for registration of images and extraction of polygons.” Technical Note No. 50. Biodiversity and Biocultural Conservation Laboratory. University of Texas at Austin. Austin, Texas.

Homer, C., Huang, C., Yang, L., Wylie, B., and Coan, M. 2004. “Development of a 2001 National Land-cover Database for the United States.” *Photogrammetric Engineering and Remote Sensing* **70**: 829 -840.

Phillips, S. J. and Dudík, M. 2008. “Modeling of Species Distribution with Maxent: New Extensions and a Comprehensive Evaluation.” *Ecography* **31**: 161 -175.

Woodhouse, S.W. 1852. “Descriptions of New Species of Birds of the Genera Vireo, Vieill., and Zonotrichia, Swains.” *Proceedings of the Academy of Natural Sciences of Philadelphia* **6**:60-61.

Yang, L., Huang, C., Homer, C. G., Wylie, B. K., Coan, M. J. 2003. “An Approach for Mapping Large-area Impervious Surfaces: Synergistic Use of Landsat-7 ETM+ and High Spatial Resolution Imagery.” *Canadian Journal of Remote Sensing* **29**: 230 -240.

Table 1

Point Data Sources

Source	Number of Points
Giri Athrey, University of Louisiana Lafayette	9
Bob Gottfried, Texas Natural Diversity Database, Texas Parks and Wildlife Department	33
Jayne Neal, City of San Antonio, Parks and Recreation Natural Areas	12
Chuck Sexton, US Fish and Wildlife Service, Balcones Canyonlands National Wildlife Refuge	247
Billy Simper, Texas State University, San Marcos	219
Jenny Wilson, US Fish and Wildlife Service, Austin Ecological Services Office	208
Laura Zebehazy, Travis County, Department of Transportation and Natural Resources	120

Table 2

Layers Used to Construct Niche Models

Layer	Source
Aspect	Derived from elevation using the Spatial Analyst Extension of ArcGIS (DEM: Farr et al. [2007]; web-site: seamless.usgs.gov)
Slope	Derived from elevation using Spatial Analyst (DEM: Farr et al. [2007]; web-site: seamless.usgs.gov).
Elevation	DEM: Farr et al. (2007); web-site: seamless.usgs.gov.
Canopy	Homer et al. (2004), web-site: seamless.usgs.gov.
Distance to cropland: measured as the distance in meters from the current pixel to the closest pixel classified as cultivated crops.	Derived from the National Land-cover Database of Homer et al. (2001), web-site:seamless.usgs.gov.
Distance to impervious surface: measured as the distance in meters from the current pixel to the closest pixel classified as an impervious surface in the National Land-cover Database. In this context, an impervious surface is an urban area.	Yang et al. (2003); web-site: seamless.usgs.gov.
Distance to forest interior: distance in meters from the current pixel to the closest pixel in the interior of a forest, defined as a site 75 meters or more from the edge of a deciduous, evergreen, or mixed forest patch.	The methodology is based on DeBoer and Diamond (2006). The data were derived from the National Land-cover Database of Homer et al. (2001) (web-site: seamless.usgs.gov) using the Zonal Statistics Tool in ArcToolbox.
Land position: a measure of elevation that incorporates the	The methodology for the construction of the raster is in Diamond (2005). The

elevation of the current pixel and the elevations of the nine neighboring pixels	data are from D. Diamond and C. D. True, personal communication.
Site type: a categorical variable based on topography and exposure (examples: “high flats”, “protected slopes”, “exposed slopes”, “low flats and floodplains”).	The methodology for the construction of the raster is in Diamond and True (2007). The data are from D. Diamond and C. D. True, personal communication.
April temperature	The data were interpolated from weather stations using ordinary kriging in the Geostatistical Analyst Extension of ESRI Arc Map 9.2. Weather records were obtained from the National Weather Service (web-site: http://gis.ncdc.noaa.gov/website/ims-cdo/som/viewer.htm) and the Lower Colorado River Association (LCRA) (Bob Rose, LCRA, personal communication).
April precipitation	For details, see “April temperature”.
May temperature	For details, see “April temperature”.
May precipitation	For details, see “April temperature”.

Table 3

Binomial Tests

Test	*p*-Value
Fixed cumulative value = 1	2.373×10^{-62}
Fixed cumulative value = 5	0
Fixed cumulative value = 10	0
Minimum training presence	4.592×10^{-22}
10th percentile training presence	0
Equal training sensitivity and specificity	0
Maximum training sensitivity plus specificity	0
Equal test sensitivity and specificity	0
Maximum test sensitivity plus specificity	0
Balance training omission, predicted area and threshold value	0
Equate entropy of thresholded and non-thresholded distributions	0

Figure 1

Occurrence Records for the Black-capped Vireo in Travis County

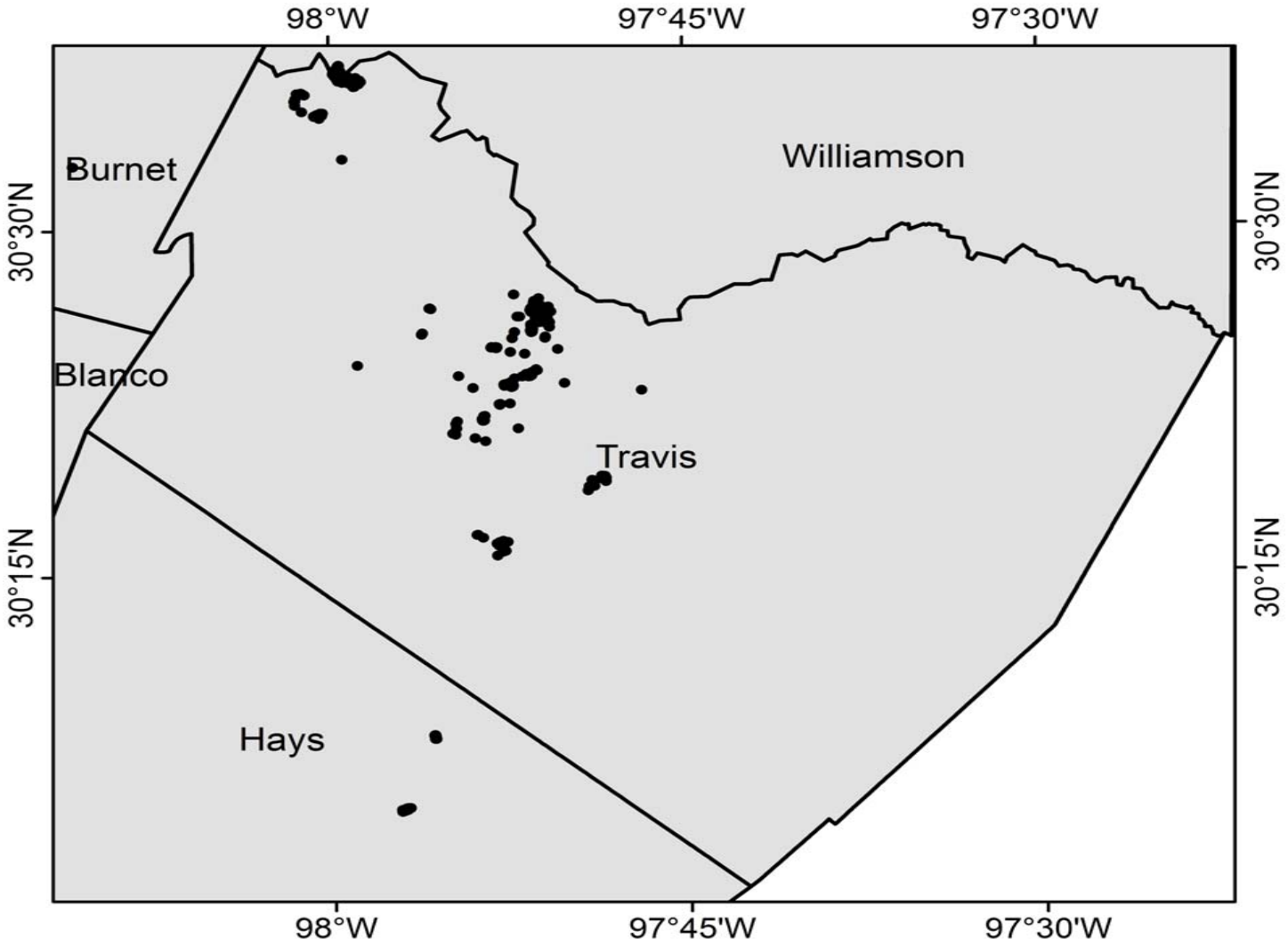

Figure 2

Fundamental Niche of the Black-capped Vireo in Travis County

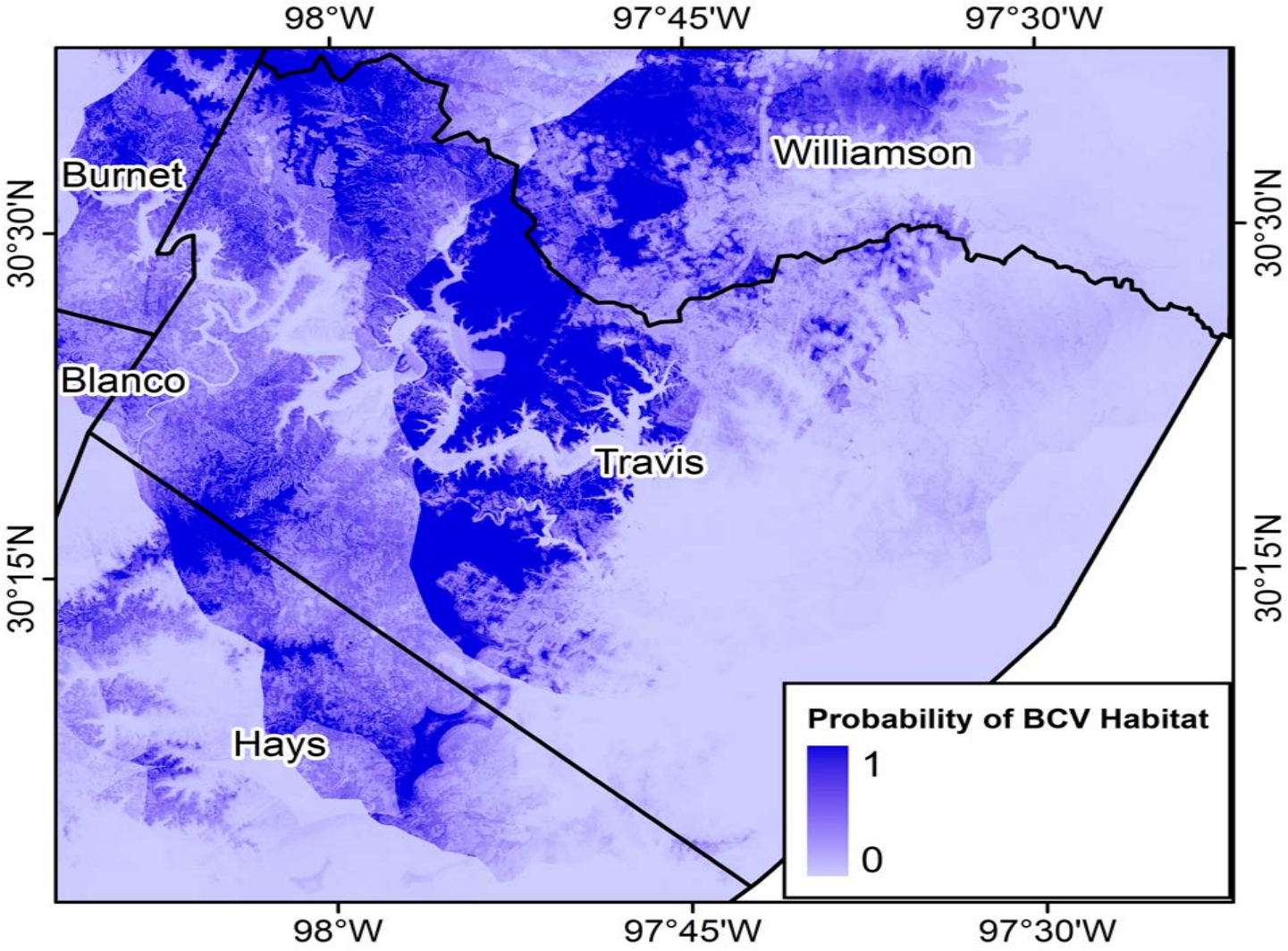

Figure 3

Modified Fundamental Niche of the Black-capped Vireo in Travis County

Sites with a predicted probability less than 0.1 are excluded. (Areas shown in gray are predicted by Maxent to be Vireo habitat with probability less than 0.1).

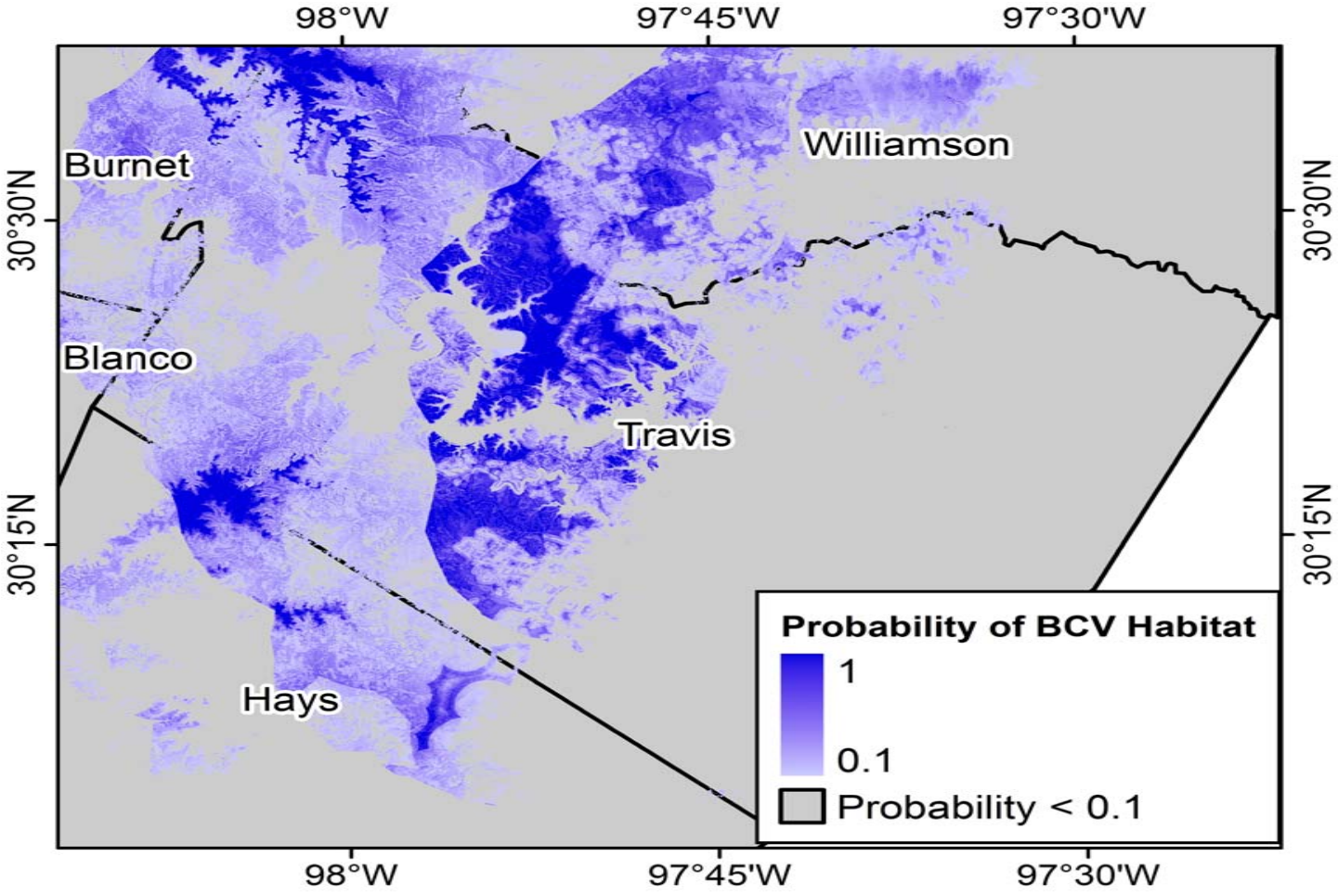

Figure 4

Modified Fundamental Niche of the Black-capped Vireo in Travis County Restricted to Shrubland

Sites with a predicted probability less than 0.1 or lacking shrub vegetation are excluded. (Areas shown in gray are either predicted by Maxent to be Vireo habitat with probability less than 0.1 or lack shrubs.)

