City of Austin 2016
Black-capped Vireo *(Vireo atricapilla)*
Monitoring and Management Program

Balcones Canyonlands Preserve Annual Report



Photo © William Reiner

City of Austin, Austin Water
Wildland Conservation Division
Balcones Canyonlands Preserve Program

TABLE OF CONTENTS

INTRODUCTION 1
Background 1
Objectives 2
METHODS 2
Sites and Survey Effort 2
Banding 3
Data Collection and Analysis 4
RESULTS AND DISCUSSION 4
First Vireo Sighted on the Bohls Tract 5
Territory Mapping and Reproductive Success on the Forest Ridge Tract 5
Territory Mapping and Reproductive Success on the Kent Butler Ecological Reserve 6
Territory Mapping and Reproductive Success on the Cortaña Study Site 6
Parasitism and Interaction with Predators 7
Golden-cheeked Warblers in Black-capped Vireo Habitat 7
BLACK-CAPPED VIREO HABITAT MANAGEMENT 7
Expanding Vireo Habitat – Kent Butler 8
Maintenance of Formerly Occupied Habitat – Cortaña 8
Restoring and Creating Habitat – Wild Basin/Vireo Preserve 8
Habitat Creation – Bohls 9
Monitoring Effects of Habitat Management Efforts 9
LITERATURE CITED 10

FIGURES

FIGURE A. Sites Where Black-capped Vireos Were Observed on City of Austin BCP Tracts, 2016

FIGURE B. Locations of Black-capped Vireos on Forest Ridge, 2016

FIGURE C. Locations of Black-capped Vireos on Kent Butler Ecological Reserve, 2016

FIGURE D. Locations of Black-capped Vireos on Cortaña, 2016

Disclaimer: The data and information presented in this report are provisional and subject to revision.

City of Austin
2016 Black-capped Vireo Monitoring and Management Program
Balcones Canyonlands Preserve Annual Report

This report summarizes the results of the City of Austin's 2016 Black-capped Vireo (*Vireo atricapilla*) endangered species monitoring and habitat management program. The 2016 field season was the nineteenth year of endangered species monitoring on the City of Austin's Balcones Canyonlands Preserve (BCP) tracts.

For the first time in the 19 years of monitoring on the BCP, City biologists obtained permits to capture and band Black-capped Vireos. A Black-capped Vireo appeared for the first time on the Bohls tract, and the species also successfully raised young on the Cortaña tract for the first time in six years.

INTRODUCTION

Background

The Black-capped Vireo (hereafter Vireo) is an endangered, neotropical migrant that breeds in portions of Oklahoma, Texas, and Mexico (Grzybowski 1995). The U.S. Fish and Wildlife Service listed this species as endangered in 1987 (USFWS 1987). Major threats to the Vireo's survival include habitat loss, habitat fragmentation, over-grazing/browsing, natural vegetation succession, and parasitism by Brown-headed Cowbirds (*Molothrus ater*). Rapid westward expansion of development from the City of Austin led to the creation of the Balcones Canyonlands Conservation Plan (a Habitat Conservation Plan). The U.S. Fish and Wildlife Service issued a 10(a)(1)(B) permit to the City of Austin and Travis County in 1996, to mitigate for the incidental "take" of habitat loss due to development, and to facilitate the local recovery of the Vireo and seven other endangered species (USFWS 1996). The permit requires a minimum of 12,300 hectares of endangered species habitat in western Travis County be set aside as a preserve (the BCP) for these species. The BCP is owned and managed by a number of public and private entities, including the City of Austin, Travis County, Lower Colorado River Authority, The Nature Conservancy, Travis Audubon Society, and St. Edwards University/Wild Basin.

Vireos have been documented on several BCP tracts that are managed by the City of Austin. The largest known colony in Travis County formerly existed at the Wild Basin/Vireo Preserve. A 1961 wildfire created several hundred hectares of Vireo habitat in this area. The Vireo colony likely peaked sometime in the 1970s, but declined steadily from 32 territories (22 breeding pairs) in 1987 to one territory in 1997 (Grzybowski 1989, Steed 1988, DLS Associates 1989, 1990, Abbruzzese 1998), and intermittent sightings of single males in 2004 (Becker and Koehler 2004), 2011 (City of Austin 2011), 2012 (City of Austin et al. 2012), and 2016.

A small breeding colony of Vireos (three to five territories) had occupied habitat on the Cortaña tract from 2000 to 2011. A part of this colony spilled onto the adjacent River Place mitigation tract to the northeast. However, the number of territories in that colony dwindled to only one in 2011; no Vireos

established territories there from 2012 through 2014. A male established a territory on this site in 2015; he was possibly mated, but no evidence of nesting was confirmed.

Two to seven Vireo territories have been established on the Forest Ridge tract each year since 2009. On the Kent Butler Ecological Reserve (formerly known as the Ivanhoe tract, hereafter Kent Butler), one or two Vireo pairs nested along electric transmission line corridors in 2008 and 2009, and again from 2013 to present.

Other records for Vireos on the City of Austin's BCP tracts for the past decade include intermittent sightings of males on the Commons Ford and Sam Hamilton West tracts. Though other areas on City property have been managed to create Vireo habitat – a portion of the Bohls tract, a ridge in the center of the Cortaña tract, and a small patch on the Lime Creek tract – no Vireos had been detected at any of those sites before this year.

Objectives

The Balcones Canyonlands Conservation Plan (USFWS 1996) states that "baseline monitoring will be gathered in accordance with the Land Management Plan Guidelines and approved land management plans, and should concentrate on determining basic population levels on preserve lands, key population parameters, and other ecological parameters that may affect the target species." The Tier IIA-8 land management plan (BCP 2007) identifies "distribution, abundance, productivity, and recruitment" as key population parameters to monitor. The City of Austin's Vireo monitoring program continues to focus on estimating abundance, the extent of territories, pairing, nesting, and productivity for all Vireos detected each year.

BCP staff monitor Vireo territories for the presence of cowbirds, and are committed to reducing or eliminating the threat of cowbird parasitism of Vireo nests. BCP staff ceased active trapping of cowbirds on City of Austin properties beginning in 2013, after Vireos abandoned the Cortaña tract colony in 2012. Cowbird parasitism of Vireo nests has not been observed recently on any City BCP property.

The land management plan (BCP 2007) emphasizes vegetation management and monitoring to maintain Vireo habitat. Vireos occupy shrublands of mixed deciduous and evergreen species with irregular height and distribution. Open spaces between clumps of woody vegetation are also important, so optimal Vireo habitat appears as a mosaic of shrubby patches separated by grassy or rocky spaces. Shrubs that have a skirt of vegetative cover extending down to the ground are especially important to conceal nests. Because this early successional stage of habitat must continually be manipulated to remain viable, restoration projects in conjunction with habitat monitoring are frequently undertaken on various City of Austin tracts (see Black-capped Vireo Habitat Management).

METHODS

Sites and Survey Effort

To determine population trends, BCP biological staff begin by searching suitable habitat for Vireos every year during the breeding season. With the exception of the Cortaña tract shinnery, occupied Vireo habitat

on City of Austin BCP property is near to, or within, plots intensively monitored for the Golden-cheeked Warbler (Warbler). Vireos are first detected during the course of intensive Warbler monitoring (see Methods in City of Austin et al. 2014). When Vireos are detected around a Warbler study plot, staff biologists will monitor them once or twice weekly for evidence of mated status and breeding success.

During the 2016 field season, Vireos were mapped on, and adjacent to, the Warbler intensive study plots within the Forest Ridge and Kent Butler tracts. Because much of the habitat on these two study plots is more typically associated with Warblers, the exact size of the Vireo habitat in each area is undetermined.

The Forest Ridge intensive study plot was surveyed at least twice each week in conjunction with the Warbler monitoring program from March 15 through June 15, and then weekly until July 15. Once Vireos were detected on March 26, staff collected data on the number of territories, territory locations, pairing success, breeding success, parasitism, and productivity, continuing surveys through July 15

The Kent Butler population was also monitored in conjunction with the Warbler monitoring program. After the first Vireos were detected on April 4, they were monitored once or twice weekly through June 21, then once more in July.

Since Vireos had apparently attempted to recolonize the Cortaña tract in 2015, staff resumed active monitoring of that site in 2016. The first Vireos – a pair – were found on April 14. The site was then monitored at least weekly (except for a two-week gap in early May) until July 20.

Table 1. Summary of Black-capped Vireo Survey Effort on the Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2016

Study Plots	Observer(s)	Survey Hours (Mar. 26-July 20)
Bohls	John Chenoweth	7.25
Cortaña	William Reiner, Darrell Hutchinson, John Chenoweth	124.25
Forest Ridge	Jonathan Scalise, Jim O'Donnell, Cristina Campbell	107.5
Hamilton West	Lisa O'Donnell	4.0
Kent Butler	William Reiner, Darrell Hutchinson, Mark Sanders	28.75
Total		**271.75 hrs.**

Banding

City BCP staff obtained permits to mist-net and band Vireos for the first time in 2016. Vireos were captured and color-banded from May 18 to June 9, in conjunction with territory mapping on three of the four City-managed sites where Vireos attempted to establish territories. City staff also assisted Travis

County staff with banding Vireos on County BCP tracts. Methods were essentially the same as those used to capture and band Golden-cheeked Warblers (City of Austin, et al., 2014).

Staff played recorded songs and calls of Vireos to attract the birds to a mist-net set up within a male Vireo's territory. Once captured, a Vireo was marked with a unique combination of a U.S. Geological Survey (USGS) numbered aluminum band and auxiliary color bands to allow identification of each individual. The biological staff at Ft. Hood Military Reservation issued the color-band combinations.

Other data collected during banding included date, time, banding location, temperature, and weather conditions. Individuals were sexed and aged (second-year [SY], after second-year [ASY], or after hatch-year [AHY]) according to Pyle (1997), using data sheets developed by Ft. Hood staff. Each Vireo was photographed just before release, to document band combinations. A summary of banding data is provided in Table 2.

Table 2. Summary of Black-capped Vireos Banded on the Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2016.

Date	Color Band Combination	USGS Band Number	Site	Sex	Age
18 May	DG/SI:DB/WH	2590-26311	Forest Ridge	male	ASY
18 May	NB/SI:OR/DB	2590-26312	Forest Ridge	male	SY
20 May	BK/YE:YE/SI	2590-26307	Cortaña	male	SY
20 May	BL/SI:NB/OR	2590-26308	Cortaña	male	SY
20 May	BK/WH:BL/SI	2590-26309	Cortaña	female	SY
23 May	RD/WH:YE/SI	2590-26321	Bohls	male	SY
9 June	RD/SI:NB/RD	2590-26310	Forest Ridge	male	SY

Data Collection and Analysis

Vireo observations were recorded with Garmin global positioning units (GPS), which have an accuracy ranging from 3 to 9 meters. Other sightings were recorded on topographic maps at a scale of 1:2,400 or 1:3,600, using a 100-meter UTM grid. Pairing status, breeding success, and number of fledglings produced per pair were determined for each territory. For methodology and calculations, see City of Austin et al. 2014.

RESULTS AND DISCUSSION

In 2016, staff found Vireos holding territories in suitable habitat on three City-owned BCP sites, on the Forest Ridge, Cortaña, and Kent Butler tracts. Staff also observed an unbanded Vireo singing on May 10 and May 13 on the Hamilton tract, and at the Vireo Preserve on April 20, but no territory was established at either of these sites.

First Vireo Sighted on the Bohls Tract

For the first time ever, a Vireo briefly occupied the habitat created on the Bohls tract. This SY male, banded on May 23, was not detected again on the Bohls tract, but shifted to the Forest Ridge tract, where he was first observed on June 20.

Territory Mapping and Reproductive Success on the Forest Ridge Tract

Six territorial male Vireos were observed on and adjacent to the Forest Ridge intensive Warbler study plot in 2016. (See Figure B.) The only previously-banded Vireo, OR/SI:BL/GR, was seen and heard singing just outside of the plot on March 31. OR/SI:BL/GR returned as an eight-year-old male. He had been banded as a SY male in 2009 on Forest Ridge by William Simper (Travis County BCP), and returned to the same ridge top which he defended in prior years. Five other males, all of which arrived unbanded, held territories on Forest Ridge. Three of those males were banded by City staff (Table 2). Additionally, a seventh male showed up who was banded a few weeks prior on the Bohls tract, but was not observed enough times to be included as a territory.

Ten active nests were found on the Forest Ridge tract, from five Vireo pairs. Five of these nests failed due to predation, and five successfully fledged at least one young. One nest was notably placed very high, 3.5-4.5 meters above the ground, near the end of a thin Ashe juniper (*Juniperus ashei*) limb. Both parents were confirmed as feeding young at this nest which was later depredated. This pair's next nesting attempt was a more typical height (about 2m high in a gum bumelia [*Sideroxylon lanuginosum*]).

Table 3. Summary of Black-capped Vireo Nests Found on the Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2016.

Plot	Male ID	Nest Substrate	Breeding Success	Number of Fledglings*
Forest Ridge	DG/SI:DB/WH	*Dermatophyllum secundiflorum*	Yes	3 - 4
Forest Ridge	OR/SI:NB/BL	*Dermatophyllum secundiflorum*	No	
Forest Ridge	UB	*Diospyros texana*	No	
Forest Ridge	OR/SI:NB/BL	*Dermatophyllum secundiflorum*	No	
Forest Ridge	UB	*Juniperus ashei*	No	
Forest Ridge	UB	*Dermatophyllum secundiflorum*	Yes	1 - 4
Forest Ridge	OR/SI:NB/BL	*Quercus buckleyi*	Yes	1 - 4
Forest Ridge	DG/SI:DB/WH	*Ungnadia speciosa*	Yes	1 - 3
Forest Ridge	NB/SI:OR/DB	*Quercus sinuata*	Yes	3 - 4
Forest Ridge	UB	*Sideroxylon lanuginosum*	No	
Kent Butler	DG/MV:YE/SI	*Quercus buckleyi*	Yes	3
Kent Butler	DG/MV/YE/SI	*Frangula caroliniana*	Yes	2
Cortaña	BK/YE:YE/SI	*Rhus virens*	No	
Cortaña	BK/YE:YE/SI	*Ungnadia speciosa*	Yes	3 - 4

* Fledgling Vireos were difficult to observe in dense vegetation, especially on the Forest Ridge tract, so a range of fledglings is listed for some nests. The lower number is the tally of fledglings actually observed. The higher number is the maximum that may have fledged given the number of eggs/chicks originally found in the nest, minus unhatched eggs or dead nestlings found after fledging.

Territory Mapping and Reproductive Success on the Kent Butler Ecological Reserve

The banded male Vireo that had successfully mated and raised young for the past two years (DG/MV:YE/SI) returned to the same area in 2016. He again attracted a mate, and the pair fledged at least 5 chicks from two different nests. However, two eggs in the first nest, and one in the second, remained unhatched, leading to concerns over the possibility of inbreeding (Noordwijk and Scharloo, 1981).

A second male, unbanded, established a territory within the eastern habitat improvement area (first found on April 2). He attracted a mate, who was seen with nesting material on April 25, but neither bird was observed after May 3.

See Figure C for locations of Vireo observations and territories, and Tables 3 and 4 for nest and productivity data.

Territory Mapping and Reproductive Success on the Cortaña Study Site

At least five male Vireos attempted to establish territories in the shinnery at the north end of the Cortaña tract in 2016 (Figure D). Of these, four were seen with females. One pair was observed on the site for a span of only eight days, so was not considered to have established a territory. All Vireos arrived unbanded, but three – two males and a female – were caught and banded (Table 2).

Staff found only two active nests, both tended by BK/YE:YE/SI and his unbanded mate. The first nest failed shortly before fledging – apparently when a May 19 thunderstorm drenched the nestlings. The second nest fledged at least 3, and probably 4, young; this represents the first confirmed successful nesting in the Cortaña shinnery since 2010. Though the female of the remaining unbanded pair was observed carrying nesting material beyond the boundary of the tract on June 10, no other fledglings were found.

See Tables 3 and 4 for nest and productivity data.

Table 4. Summary of Black-capped Vireo Reproductive Success per Plot on the Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2016.

Site	No. of Territories	No. of Territories w/ Female	Pairing Success	No. of Territories Producing ≥ 1 Young	Breeding Success	Productivity *	Productivity Per Successful Territory*	Total No. of Fledglings*
Forest Ridge	6	5 (6)	83	4 (6)	83%	1.5 / 3.2	1.8 / 4.7	9 / 19†
Kent Butler	2	2 (2)	100	1 (2)	50%	2.5 / 2.5	5.0 / 5.0	5 / 5†
Cortaña	4	3 (4)	75	1 (4)	25%	0.7 / 1/0	3.0 / 4.0	3 / 4
Total/Avg.	**12**	**10 (12)**	**83**	**6 (12)**	**58%**	**1.4 / 2.3**	**2.8 / 4.7**	**17 / 28**

***** Ranges indicate fledglings actually observed vs. maximum possible (see note with Table 3). † Includes all fledglings found, including those from second broods.

Parasitism and Interaction with Predators

No Brown-headed Cowbirds (*Molothrus ater*) were observed during Vireo surveys on the Forest Ridge, Cortaña, or Kent Butler tracts. No Vireos were observed tending cowbird fledglings.

BCP staff and volunteers had managed cowbirds at the Cortaña colony every year since Vireos were first observed there in 2000. However, since no Vireo had established a territory at this site since 2011, trapping was discontinued.

City staff did not directly observe any interactions between Vireos and potential predators, nor any harassment of Vireos by other species. A Texas Rat Snake (*Elaphe obsoleta lindheimeri*) was found by staff investigating a shrub where a male Vireo was giving "shrad" calls.

Golden-cheeked Warblers in Black-capped Vireo Habitat

In some areas, Vireo habitat may progress to Warbler habitat through natural succession. Likewise, natural or anthropogenic disturbance patterns may convert Warbler habitat to the early successional stage preferred by the Vireo. These habitat types often overlap. During 2016 within the City of Austin BCP, territorial Warblers and Vireos were observed in the same or neighboring areas on the Forest Ridge, Cortaña, and Kent Butler tracts.

Vireo territories were intermingled with Warbler territories within prime Warbler habitat on and near the intensive study plots of the Forest Ridge and Kent Butler tracts. The Forest Ridge study plot supports a dense understory of vegetation that is used by both species. On the Kent Butler tract, four electric transmission lines cross the tract at the north edge of the Warbler study plot. Vireos concentrate their activity in the shrubby growth within the utility corridors, where vegetation has been trimmed short in some places, to prevent damage to the wires. Warblers occupy habitat on both sides of the utility corridors, and in a wooded strip between them. The Vireo territories overlapped with the Warbler territories in the wooded strip and on either side of the transmission lines.

On the Cortaña tract, Warblers occupy steep, wooded canyons on three sides of the shinnery, as well as a low, wooded knoll in the middle of the shinnery. Warblers were occasionally observed in the shinnery, and Vireos were rarely observed within the edges of the mature forest.

BLACK-CAPPED VIREO HABITAT MANAGEMENT

The Balcones Canyonlands Conservation Plan (USFWS 1996) requires maintaining or creating 810 hectares (2,000 acres) of Vireo habitat within the BCP, and the land management plan (BCP 2007) provides additional, general guidelines to help achieve this goal. The Balcones Canyonlands Conservation Plan recommends focusing potential Vireo management areas in portions of the BCP that are not currently occupied by the Warbler. Consistent with these recommendations, BCP staff are implementing adaptive management to create Vireo habitat in areas within the BCP that are not currently suitable for either the Vireo or the Warbler.

Since Vireos occupy an earlier successional stage than Warblers, actively managing to create Vireo habitat may be a more realistic means to achieve the acreage goals than trying to convert mature, closed canopy woodlands to Vireo habitat. This would also protect existing Warbler habitat from loss or fragmentation. Focal areas for Vireo habitat management on City of Austin BCP lands currently include the Cortaña tract, Wild Basin/Vireo Preserve, the Bohls tract, and infrastructure corridors (Kent Butler tract). BCP staff are also evaluating areas with significant tree mortality from the 2011 drought for potential as future Vireo habitat.

Expanding Vireo Habitat – Kent Butler

In February 2009, a Lower Colorado River Authority (LCRA) crew, following guidance from BCP staff, removed above-ground trunks of woody vegetation in three areas under transmission lines crossing the Kent Butler tract. Vireos had successfully nested in a nearby location, and vegetation was suitable for attempting habitat improvement. For details, see City of Austin (2009, under "Habitat Restoration Efforts – Ivanhoe") and City of Austin (2015). A Vireo pair established a territory in the area later in 2009, but failed to raise a brood. No Vireos were detected in the project area for the next three years, but in 2013 a pair again successfully nested. In 2014, a different male established a territory in this same area, mated, and raised young. That male returned to mate and nest successfully again in 2015 and 2016. In the latter two years, Vireo nests were situated within two of the improved habitat areas, and Vireos were frequently observed foraging in both areas. See Figure C for observations of Vireos on the Kent Butler tract in 2016.

Maintenance of Formerly Occupied Habitat – Cortaña

In 1996, about 23 hectares of juniper-oak woodlands on the northern end of the Cortaña tract and on the adjacent, privately-managed, River Place mitigation tract were cut back to establish a shrubby successional stage favorable to Vireos. Approximately 15.8 hectares were treated on Cortaña and 7.3 hectares on River Place. Both hand-clearing and hydro-axing methods were applied.

During winter 2009-10, City of Austin staff created fire lanes in anticipation of a prescribed burn to enhance habitat on approximately 4.5 hectares of the Cortaña tract. Since that time, burn bans and staffing limitations have prevented burning. Such limitations may make mechanical treatments more feasible than prescribed burns for future habitat revitalization. With the recolonization of the Cortaña tract by Vireos in 2016, further habitat manipulation will be postponed. See Figure D for observations of Vireos in the Cortaña shinnery in 2016.

Restoring and Creating Habitat – Wild Basin/Vireo Preserve

The Vireo Preserve and adjacent Wild Basin tract supported at least 32 Vireo territories during the mid-1980s, making this the largest concentration of Vireos known in Travis County. A wildfire in April 1961 (Austin American-Statesman 1961, Respess 1987, Westlakehills undated) burned for three days and spread over about 1,620 hectares. Analysis of a decadal series of aerial photos of this area shows habitat succession progressing steadily since the 1961 fire (City of Austin et al. 2012).

Assuming Vireo habitat in western Travis County has a life-span of 20 to 30 years following intense manipulation, and Warbler habitat takes at least 50 years to recover (Biological Advisory Team, 1990), a decline of the Vireo colony could have been expected during the 1980s-1990s as the habitat matured toward a taller, more closed-canopy woodland. Complicating this issue, however, was the simultaneous increase in urbanization (including the building of Loop 360 and surrounding subdivisions) that occurred during this same time period. The last Vireo observed nesting on the Wild Basin/Vireo Preserve (a 10-year-old male banded as an SY in 1987) was in 1996, 35 years after the 1961 fire.

The Wild Basin/Vireo Preserve collectively contains over 100 hectares of former Vireo habitat. Habitat restoration efforts to date have included a prescribed burn on about 2.8 hectares (February 16, 2010), mechanical manipulation of about 20 hectares (fall 2010 and 2011), and efforts to protect and rebuild soils and promote native plant diversity. We are continuing adaptive management efforts to re-create habitat and to restore areas degraded by past land use (Bray 1904) as described in City of Austin (2010 and 2011) and City of Austin et al. (2015).

Habitat Creation – Bohls

From 2003 to 2007, City staff coordinated a combination of mechanical cutting followed by a prescribed burn on about 12 hectares of the Bohls tract, in an effort to create Vireo habitat. The mechanical clearing took place during the winter of 2003-04, in September 2005, and in February 2007, and the prescribed burn in February 2007. City of Austin staff continue to monitor habitat succession on this site. In future, staff may expand the Vireo habitat management area near the established shinnery, with either a prescribed burn or mechanical treatment.

Monitoring Effects of Habitat Management Efforts

Staff have established photo points and vegetation transects on the Bohls and Vireo Preserve tracts, and two locations on the Cortaña tract, in order to track changes to the habitat over time. They also set photo points in habitat management areas under the Kent Butler transmission lines. Monitoring of these sites takes place before and after habitat manipulation events, and otherwise when feasible.

Before the spring season, staff began an experimental restoration project on the JJ&T tract. This project consists of twenty-nine 7-meter by 7-meter experimental treatment plots placed along contour in openings with very little soil or vegetative growth. Ongoing experimental treatments include combinations of soil manipulation techniques and soil amendments. Soil manipulation techniques include building swales and berms, vertical staking, and vertical mulching. Amendments include shredded mulch, composted mulch, and compost tea.

LITERATURE CITED

Abbruzzese, C. 1998. 1998 Golden-cheeked Warbler and Black-capped Vireo monitoring program, Balcones Canyonlands Preserve. City of Austin Parks and Recreation Department, Natural Resources Division. Austin, Texas.

Austin American-Statesman. 1961. Newspaper articles reporting Westlake fire, April 14-18. Austin, Texas.

Balcones Canyonlands Preserve. 2007. Land management plan, Tier IIA-8, Black-capped Vireo management. City of Austin and Travis County, Austin, Texas.

Biological Advisory Team. 1990. Comprehensive report of the Biological Advisory Team. Austin, Texas.

Becker, H. and D. Koehler. 2004. City of Austin 2004 Golden-cheeked Warbler *Dendroica chrysoparia* and Black-capped Vireo *Vireo atricapilla* monitoring program: Balcones Canyonlands Preserve annual report FY2003-04. City of Austin Water, Utility Wildland Conservation Division, Balcones Canyonlands Preserve program. Austin, Texas.

Bray, W. 1904. The timber of the Edwards Plateau of Texas: its relation to climate, water supply, and soil. U.S. Department of Agriculture, Bureau of Forestry – Bulletin No. 49. Government Printing Office, Washington.

City of Austin. 2009. City of Austin 2009 Golden-cheeked Warbler *(Dendroica chrysoparia)* and Black-capped Vireo *(Vireo atricapilla)* monitoring program: Balcones Canyonlands Preserve annual report FY 2008-09. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

——. 2010. City of Austin 2010 Golden-cheeked Warbler *(Dendroica chrysoparia)* and Black-capped Vireo *(Vireo atricapilla)* monitoring program: Balcones Canyonlands Preserve annual report FY 2009-10. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

——. 2011. City of Austin 2011 Golden-cheeked Warbler *(Setophaga chrysoparia)* and Black-capped Vireo *(Vireo atricapilla)* monitoring program: Balcones Canyonlands Preserve annual report FY 2010-11. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

——. 2012. City of Austin 2012 Black-capped Vireo (Vireo atricapilla) monitoring program: Balcones Canyonlands Preserve annual report FY 2011-12. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

——. 2015. City of Austin 2015 Black-capped Vireo (Vireo atricapilla) monitoring and management program: Balcones Canyonlands Preserve annual report, FY 2014-15. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

City of Austin, Travis County, and U.S. Forest Service. 2013. 2013 annual report: Golden-cheeked Warbler *(Setophaga chrysoparia)* monitoring program, Balcones Canyonlands Preserve. Prepared by City of Austin Water Utility Wildland Conservation Division, Travis County Department of Transportation and Natural Resources, U.S. Forest Service Northern Research

Station, Department of Fisheries & Wildlife Sciences, University of Missouri. Balcones Canyonlands Preserve, Austin, Texas.

——. 2014 annual report: Golden-cheeked Warbler *(Setophaga chrysoparia)* monitoring program, Balcones Canyonlands Preserve. Prepared by City of Austin Water Utility Wildland Conservation Division, Travis County Department of Transportation and Natural Resources, U.S. Forest Service Northern Research Station, Department of Fisheries & Wildlife Sciences, University of Missouri. Balcones Canyonlands Preserve, Austin, Texas.

DLS Associates. 1989. Black-capped Vireo monitoring program, Travis County, Texas and vicinity, 1989. Final report submitted to The Nature Conservancy of Texas, Inc. and the Executive Committee of the Balcones Canyonlands Habitat Conservation Plan. Austin, Texas.

DLS Associates. 1990. Black-capped Vireo monitoring program, Travis County, Texas, 1990. Final report submitted to The Nature Conservancy of Texas, Inc. and the Executive Committee of the Balcones Canyonlands Habitat Conservation Plan, Austin, Texas.

Grzybowski, J.A. 1989. Interim report: Black-capped Vireo investigations: population and nesting ecology. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

——. 1995. Black-capped Vireo (Vireo atricapillus). *In* The Birds of North America, No. 181 (A. Poole and F. Gill, eds). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D. C.

Noordwijk, A. J. Van, and W. Scharloo. 1981. Inbreeding in an island population of the Great Tit. Evolution 35: 674-688.

Pyle, Peter. 1997. Identification Guide to North American Birds, Part I. Slate Creek Press, Bolinas, California.

Respess, K. 1987. Notes toward a vegetational history of Wild Basin. Wild Basin, Austin, Texas.

Steed, D. 1988. Black-capped Vireo in Travis County, Texas. Technical Brief. July 1987. Revised 1988. DLS Associates. Austin, Texas.

U.S. Fish and Wildlife Service. 1987. Endangered and threatened wildlife and plants; determination of the Black-capped Vireo to be an endangered species. Federal Register 52(193):37420-37423.

——. 1996. Final environmental impact statement/habitat conservation plan for proposed issuance of a permit to allow incidental take of the Golden-cheeked Warbler, Black-capped Vireo, and six karst invertebrates in Travis County, Texas. Prepared by Regional Environmental Consultants (RECON) and U.S. Fish and Wildlife Service. Albuquerque, New Mexico.

Westlakehills. Undated. Fire history of the Westbank. Website article: http://www.westlakehills.org/FireSafety/documents/Fire%20History%20of%20the%20Westbank.pdf

V. FIGURES

Figure A: Sites where Black-capped Vireos were observed on City of Austin BCP Tracts, 2016

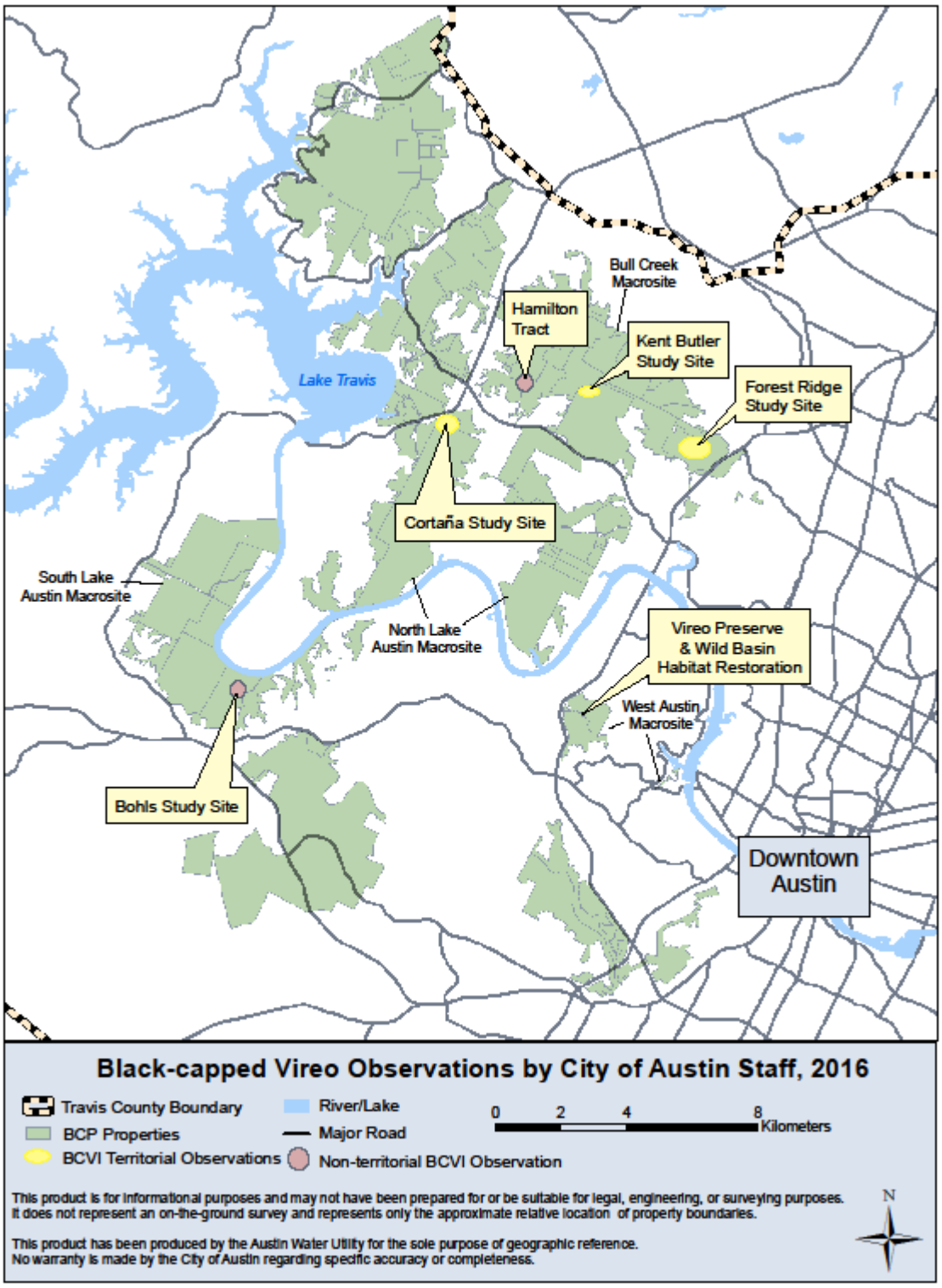

Figure B: Locations of Black-capped Vireos on Forest Ridge, 2016

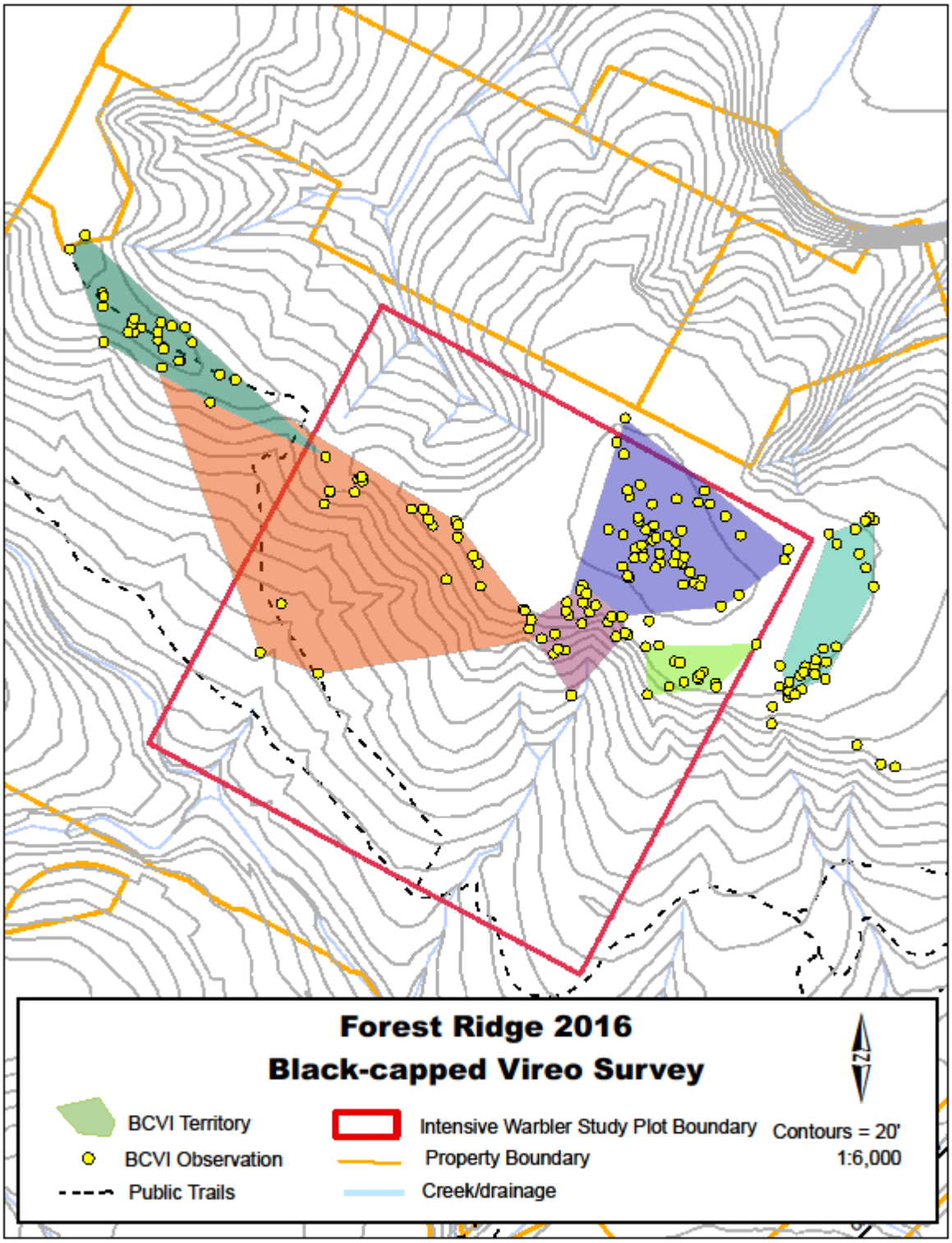

Figure C: Locations of Black-capped Vireos on Kent Butler Ecological Reserve, 2016

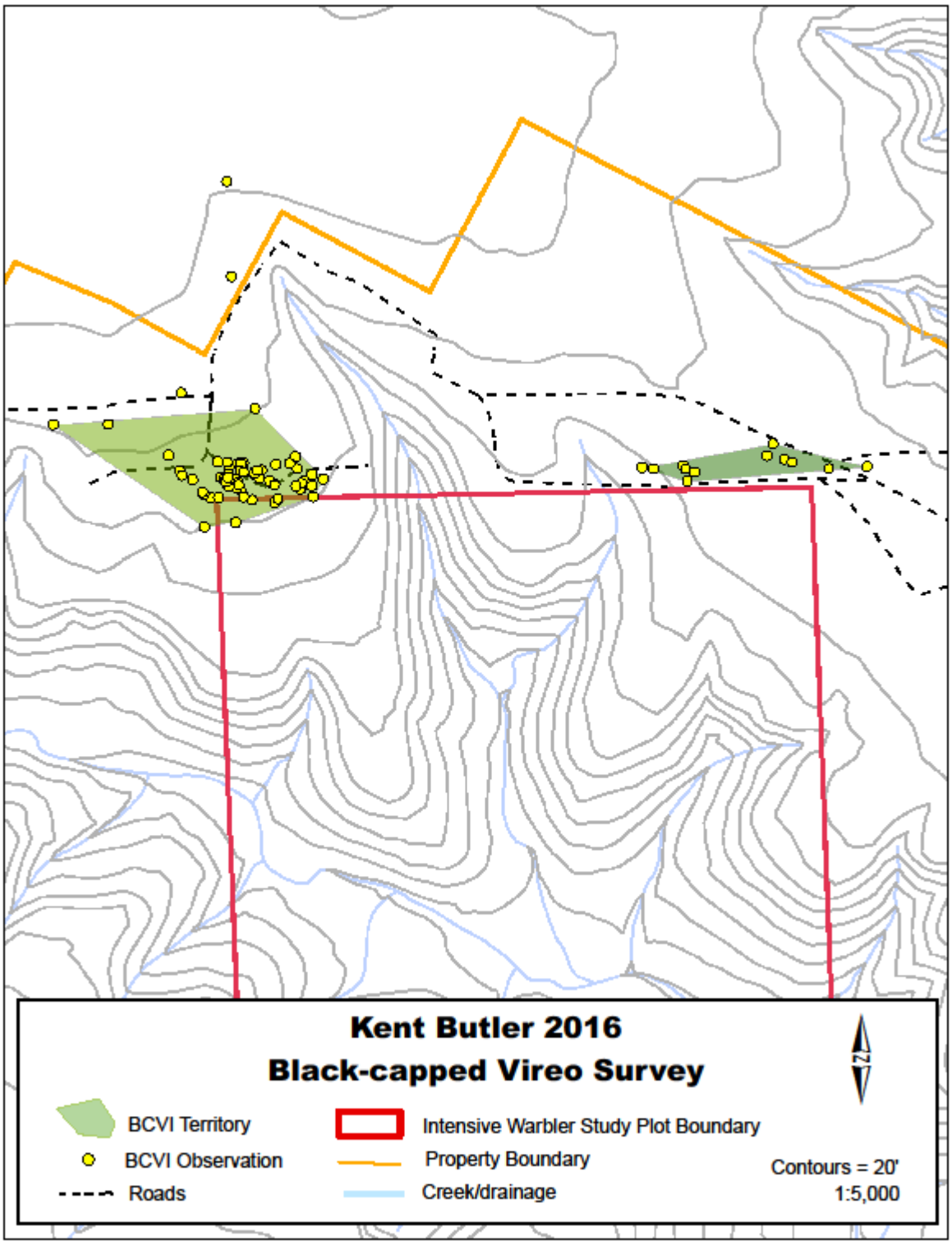

Figure D: Locations of Black-capped Vireos on Cortaña, 2016

