City of Austin 2015
Black-capped Vireo *(Vireo atricapilla)*
Monitoring and Management Program

Balcones Canyonlands Preserve Annual Report

Photo by Alexis Escarfullery

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

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

City of Austin
2015 Black-capped Vireo Monitoring and Management Program
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This report summarizes the results of the City of Austin's 2015 Black-capped Vireo (*Vireo atricapilla*) endangered species monitoring and habitat management program. The 2015 field season was the eighteenth year of endangered species monitoring on the City of Austin's Balcones Canyonlands Preserve tracts.

Collaborative efforts to create and restore habitat continue for the Black-capped Vireo. The City of Austin is partnering with Travis County, St. Edwards University, Wild Basin, and volunteers to restore, create, and monitor vireo habitat on the Wild Basin/Vireo Preserve, including degraded areas that are currently not habitat for either the Black-capped Vireo or the Golden-cheeked Warbler (*Setophaga chrysoparia*). Since Wild Basin/Vireo Preserve supports many of the habitat types observed throughout the BCP, lessons learned at this site should be applicable to other areas within the BCP.

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.

The Vireo has 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), and 2012 (City of Austin et al. 2012). 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. Two to four 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), Vireos nested along electric transmission line corridors in 2008, 2009, 2013, and 2014. 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.

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 actively monitors Vireo territories for the presence of cowbirds, and are committed to reducing or eliminating the threat of cowbird parasitism of Vireo nests. With the absence of Vireos on the Cortaña tract since 2012, and the lack of evidence of cowbird parasitism at the Forest Ridge colony, BCP staff ceased active trapping of cowbirds on City of Austin properties beginning in 2013.

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 grassy or rocky spaces and clumps of shrubs. 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, 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 2015 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 once or twice each week in conjunction with the Warbler monitoring program from March 15 through June 15. Once Vireos were detected on April 6, 2015, staff collected data on the number of Vireo territories, territory locations, pairing success, breeding success, parasitism, and productivity, continuing surveys through August 3, 2015, for a total of 94.75 hours.

The Kent Butler population was also monitored in conjunction with the Warbler monitoring program. Once the first Vireos were detected on March 30, 2015, they were monitored once or twice weekly through July 7, 2015, to determine number of territories, territory locations, pairing success, breeding success, parasitism, and productivity. The Kent Butler population was surveyed for a total of 21 hours.

Since no Vireos had established territories on the Cortaña tract for two years, staff had not actively monitored that site since 2013. A Vireo was again found on site by a staff biologist on May 9, 2015, and the site was monitored until July 9 to determine if there was nesting success. Surveys on Cortaña totaled 11.25 hours.

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. No playback tapes of Vireo songs or calls were used during this season's monitoring.

RESULTS AND DISCUSSION

In 2015, staff found Vireos holding territories on three City-owned BCP tracts. Suitable habitat was again occupied on the Forest Ridge and Kent Butler tracts, and a pair established a territory in the Cortaña tract shinnery for the first time since 2011. Staff also heard male BCVIs singing briefly on April 16 and June 9 in different areas of the Hamilton tract, but no territory was established in either location.

Territory Mapping and Reproductive Success on the Forest Ridge Tract

At least five territorial male Vireos were observed on and adjacent to the Forest Ridge intensive Warbler study plot in 2015. On April 6, the first Vireo, OR/SI:BL/GR was seen and heard singing on the plot. OR/SI:BL/GR returned as a seven-year-old male who was banded as a second-year male in 2009 on Forest Ridge by William Simper, Travis County BCP. OR/SI:BL/GR returned to the same ridge top which he defended in prior years. At least four other territorial males were observed on the Forest Ridge Tract throughout the Vireo season, all of which were unbanded. The three areas occupied by unbanded males in 2014 were occupied again this year. A fifth area was also occupied, just northeast of, and slightly overlapping, the two eastern unbanded territories (See Figure A). Field staff believed there may have been

one more territory in this same area but, due to all birds being unbanded, were not able to confirm its presence. As such, all numbers for the Forest Ridge tract represent the minimum that was confirmed.

The first documented nest on this tract was found while being built by the westernmost pair on April 14. This nest, built in a Texas persimmon (*Diospyros texana*), was found during the incubation stage on May 7, and on May 27 the male was documented feeding at least three fledglings. On June 26, this male was seen and heard near a second nest, in a mountain laurel. On July 13, the nest contained an unhatched egg and the nestlings were assumed fledged based on behavior of the adults.

The banded male, OR/SI:BL/GR, was found at a nest in a Texas mountain laurel (*Sophora secundiflora*) on May 27 and later that day a female was seen bringing material. On June 11, this same male was seen incubating. On June 26, this nest was found to be depredated, and in the same day the pair was found giving distress calls near a newly built nest in a Texas red oak (*Quercus buckleyi*). On July 20, three nestlings were confirmed in the nest. On July 24, the nest was empty and both parents were behaving as though very young fledglings were nearby. It is assumed that all three nestlings fledged the nest, even though they weren't observed.

Male Black-capped Vireo on nest, © Jonny Scalise

Just east of the banded male, in the center of the upper, flatter ridge top was the territory of an unbanded male who was seen with a female. No active nests or fledglings were found in this territory. A bachelor nest was found in a flame-leaf sumac (*Rhus lanceolata*), as well as an inactive, likely depredated nest in a Texas mountain laurel.

The territory positioned at the top of the south and southeast facing slope did successfully produce young. No nest was found, but the male was found feeding a very young fledgling on June 18. On July 20, this male was found with at least two older fledges and the family group had moved further northeast along the east facing slope and the family group was seen interacting with the unbanded male whose territory was the closest. This last male, the more northerly of the two eastern unbanded males on the tract, was never documented as being paired with a female or exhibiting behavior that would suggest an active nest or fledglings.

Pairing success for the five territories at Forest Ridge was at least 80 percent, and breeding success was at least 40 percent using moderate estimations that do not include territories where fledgling observations were not confirmed. At least 5 fledglings were confirmed for this tract, giving a minimum productivity estimate of 1 fledgling per territory. However, it is believed that 5 other fledglings successfully fledged, but without confirmed observations, which would have raised productivity to 2 fledglings per territory.

Territory Mapping and Reproductive Success on the Kent Butler Ecological Reserve

Banded male Vireo DG/MV:YE/SI was first found singing on March 30, within the same part of the habitat improvement area where he and a mate had successfully nested in 2014. On April 11, this male was accompanied by a female Vireo. This female was later seen to be unbanded. On May 11, after following DG/MV:YE/SI as he carried food, a staff biologist found a nest containing three featherless chicks and an unhatched egg. The nest was under the canopy of a large Carolina buckthorn (*Frangula caroliniana*), but actually attached to the fork of a wafer-ash (*Ptelea trifoliata*) branch. Only the unhatched egg remained in the nest on May 26; two fledglings were heard in the vicinity, but not seen. On later visits, all three fledglings were seen, being tended by DG/MV:YE/SI. The female was not seen after May 26. The male occupied the territory until at least July 7. No Vireos were detected in this territory on July 30.

Location (large shrub at left center) of successful nest in habitat restoration area, Kent Butler, © William Reiner

On April 13, a second male, unbanded, was seen within the eastern habitat improvement area. (See Figures B and C for locations of Vireo nests and observations in relation to habitat improvement areas.

A staff biologist discovered a Vireo nest in a Carolina buckthorn (*Frangula caroliniana*) during the incubation stage in this territory on June 15. The nest was found destroyed on July 2. No Vireos were detected in this territory after June 23.

Location of unsuccessful nest (in largest shrub); this was the first nest found in the eastern habitat improvement area, Kent Butler, © William Reiner

A third male Vireo, also unbanded, counter-sang with the second male on April 23, to the east along the utility corridor, and also within the habitat improvement area. This male was not confirmed again.

For the two established territories on the Kent Butler site, pairing success was 100%, breeding success was 50%, and productivity was 3 fledglings (or 1.5 fledglings per territory).

Territory Mapping on the Cortaña Study Site

On May 9, a staff biologist found an unbanded male Vireo actively defending a territory near the center of the northern Cortaña tract (see Figure D). This male was seen carrying nesting material two separate times on this date. On May 22, this male was found with an unbanded female. The pair was seen moving throughout the territory, but no nesting behavior was documented. On June 16, a bird was briefly seen that appeared to be a female Black-capped Vireo, but may have been a White-eyed Vireo; no male was detected on this date. On July 9, a male Vireo was again heard. During the season there was no behavior or other observations that indicated there was an active nest or fledglings on the Cortaña study site.

Parasitism and Interaction with Predators

No Brown-headed Cowbirds (*Molothrus ater*) were observed during Vireo surveys on either the Forest Ridge or the 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 observed neither interactions between Vireos and potential predators, nor any harassment of Vireos by other species. Western Scrub-jays (*Aphelocoma californica*) were observed near Vireos at Forest Ridge.

City staff checked a nest on the Forest Ridge tract, post-fledging, and were surprised to find four Mexican buckeye (*Ungnadia speciosa*) seeds placed in the nest. Mexican buckeye occurs nearby, but no branches pass above the nest. City staff checked the nest again at a later date and the seeds had been removed. It was presumed that the nest was used as a caching site by a Western Scrub-jay. A game camera was set up to try to document caching of seeds, but no scrub-jays were picked up by the camera. The camera did pick up several evenings where a Ringtail (*Bassariscus astutus*) visited the nest shrub, but as it was a Texas persimmon, we believe the Ringtail was eating fruit and was not caching anything in the nest.

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 2015 within the City of Austin BCP, territorial Warblers and Vireos were observed in the same or neighboring areas on the Forest Ridge and Kent Butler tracts.

On both tracts, the Vireo territories were intermingled with Warbler territories within prime Warbler habitat on and near the intensive study plots. 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. Vegetation trimmed below its normal height in some places along these lines, to prevent damage to the wires, encouraged a shrubby growth that is suitable for Vireos. Warblers occupy habitat on both sides of the utility corridors, and in a wooded strip between them. The Vireo territory overlapped with the Warbler territories in the wooded strip and on either side of the transmission lines.

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, actively managing to create Vireo habitat may be a more realistic option in some areas than trying to restore mature, closed canopy woodlands. This would also protect existing Warbler habitat from conversion or fragmentation to create Vireo habitat. 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). BCP staff is also evaluating areas with significant tree mortality from the 2011 drought for potential as future Vireo habitat.

Expanding Vireo Habitat – Kent Butler

In 2008, BCP staff found a pair of Vireos had established a territory and successfully fledged at least one chick on the Kent Butler tract. They had chosen an area bisected by four electric transmission lines. Utility crews had kept vegetation trimmed below its normal height in some places along these lines, where tree limbs might cause damage to the infrastructure; they also maintained roads for vehicular access. The trimming encouraged a shrubby growth that was apparently suitable for this pair of Vireos.

Since utility corridor maintenance would always prevent the vegetation in the corridors under these lines from becoming optimal Warbler habitat, BCP staff proposed to the Lower Colorado River Authority (LCRA) and Austin Energy (AE), who own the lines, a new approach. In a few places where maintenance had kept vegetation at suboptimal structure for Warblers, but the trees were too tall for good Vireo habitat, the vegetation would be cut to the ground. Highest priority was given to areas where stump-sprouting shrubby species were already established.

The utilities agreed, and in February 2009, an LCRA crew removed the above-ground trunks of woody vegetation in three areas (Figure B). No vegetation was altered where the Vireo family had been seen in 2008 (City of Austin 2009).

A Vireo pair established a territory 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 established a territory, and fledged three chicks. In 2014, a different male established a territory in this same area. He and his mate fledged two chicks by mid-June, then a third chick from a second brood in July. See Figure B for locations of nests found in 2009, 2013, and 2014 in relation to habitat improvement areas, and Figure C for observations of Vireos and locations of nests in 2015.

Vireos established new benchmarks this year in the Kent Butler habitat improvement areas:

1) The male banded in 2014 returned to the same territory he had held last year. This is the first confirmation of a Vireo returning to a territory established in one of the utility corridor habitat improvement areas.

2) For the first time, a second male established a territory, and attracted a mate.

3) This was the first year in which a Vireo pair built a nest *within* any of the habitat improvement areas. In past years, Vireos utilized the improved habitat, but built nests outside it. This year, both pairs built within the improved habitat, and one nest was successful.

BCP staff continue to monitor the vegetation as it matures within the improvement areas, from six photo points established before, or soon after, the treatment.

Maintenance of Formerly Occupied Habitat – Cortaña

The Cortaña tract (709 hectares) in the North Lake Austin Macrosite has been under active management for over 15 years. In 1996, about 23 hectares of juniper-oak woodlands on the northern Cortaña tract and 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. In each year from 2000 to 2011, one to five males had established territories in this area. No Vireo established a territory on the Cortaña tract from 2012 through 2014. One male established a territory in 2015, but there was apparently no successful nest.

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. The fire lanes were cleared again in the winter of 2014-15. Burn bans and staffing limitations have prevented burning to date, and may make mechanical treatments more feasible than prescribed burns for future habitat revitalization.

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. This area was once part of a larger ranch that was in the process of being cleared of brush in preparation for a cattle ranch and subsequently burned in April 1961 (Austin American-Statesman 1961, Respess 1987, Westlakehills undated). The wildfire was reportedly ignited by a cigarette tossed from a car along St. Stephens School Road, which started a grass fire. A strong cold front and the large piles of brush scattered throughout the ranch further fueled the fire, which burned for three days and spread over about 1,620 hectares. Although shrubs and many trees burned, pockets of mature Ashe juniper woodlands survived. The brush clearing followed by the 1961 wildfire converted what was formerly a closed-canopy Ashe juniper-oak woodland (preferred habitat of the Warbler) to mostly open shrub land (preferred habitat of the Vireo). 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 as the habitat matured toward a taller, more closed-canopy woodland would be expected during the 1980s-1990s. Complicating this issue, however, is 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 supports over 100 hectares of former Vireo habitat (13% of the 810-hectare requirement). Habitat restoration efforts to date have included a prescribed burn on about 2.8 hectares (February 16, 2010), perimeter fencing (fall 2010), and mechanical manipulation of about 20 hectares (fall 2010 and 2011). The primary focus of these habitat restoration efforts has been to encourage re-sprouting of mature evergreen sumac and other broad-leaved species, to protect regenerating plants from browse by white-tailed deer, to create a more open habitat with a diverse height structure on the uplands, and to protect the diversity of habitat types across Wild Basin/Vireo Preserve, including Warbler habitat. Due to the 2011 drought and subsequent burn ban, City of Austin staff revised plans for 7.5 hectares of woody vegetation that had been cut with a tree shear in preparation for a prescribed burn. During the fall of 2011, the majority of the slash was mulched to assist with other habitat restoration efforts within the BCP. More details on these restoration efforts are presented in City of Austin (2010 and 2011).

Since Wild Basin/Vireo Preserve supports many of the habitat types observed throughout the BCP, is easily accessible, and offers the opportunity to partner with Travis County and St. Edwards University, it is an ideal site to experiment with habitat creation and restoration techniques. Lessons learned at this site should be applicable to other areas within the BCP. We are continuing adaptive management efforts to restore areas degraded by past land use (Bray 1904) by rebuilding soils, controlling erosion, and increasing diversity, with the goal of creating and enhancing endangered species habitat. Adaptive management includes installing berms and swales on contour to capture, spread, and sink, water, and using locally and commercially available materials (mulch, mulch socks, biochar, mycorrhizal fungi, soil amendments, native seed and plants) to help rebuild soils and promote regeneration of woody plants. Mulch is a common by-product of juniper-oak forest clearing and thus readily available for habitat restoration projects. Allowing mulch to age and "compost" contributes additional nutrients and micro-organisms. Biochar is a low temperature charcoal produced from the biomass of wood and leafy plant materials; it is a commercially produced soil amendment that increases plant growth yields by contributing carbon and increasing mycorrhizal fungi activity. Other soil amendments used to date include organic fertilizers, composts, and/or mycorrhizal fungi inoculants. Photographs showing examples of habitat restoration projects are presented in City of Austin et al. (2013).

In conjunction with the habitat restoration work, St. Edwards University continued two research projects initiated in 2012: abundance, distribution, and diversity of ants in recently manipulated and non-manipulated areas; and soil metagenomics to determine how microbial populations (bacteria, fungi) change in response to soil amendments.

Habitat Creation – Bohls

In an effort to create Vireo habitat, City staff coordinated a combination of mechanical cutting followed by a prescribed burn on about 12 hectares of the Bohls tract. 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, which has not yet been occupied by Vireos. Additional work is planned to expand the Vireo habitat management area near the established shinnery, including 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. 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. Experimental treatments were combinations of soil manipulation techniques and soil amendments. Soil manipulation techniques included building swales and berms, vertical staking, and vertical mulching. Amendments included shredded mulch, composted mulch, compost tea, and sulfur. A vegetation survey of the plots was completed in October.

Identifying Other Potential Management Sites

Travis County and City of Austin BCP staff are continuing work on a comprehensive plan to identify existing and potential sites for Vireo habitat management. A GIS database has been developed to assess site characteristics and to locate suitable sites to restore or create Vireo habitat. Data layers include geology, soils, topography, historic Vireo sightings, and Warbler observations. Other variables that are being considered in identifying sites for Vireo management include size of the potential restoration area, history of occupation by Vireos, proximity to the nearest Vireo colony, proximity to urban development, and feasibility of management.

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V. FIGURES

Figure A: Locations of Black-capped Vireos on Forest Ridge, 2015
(2012 aerial photography)

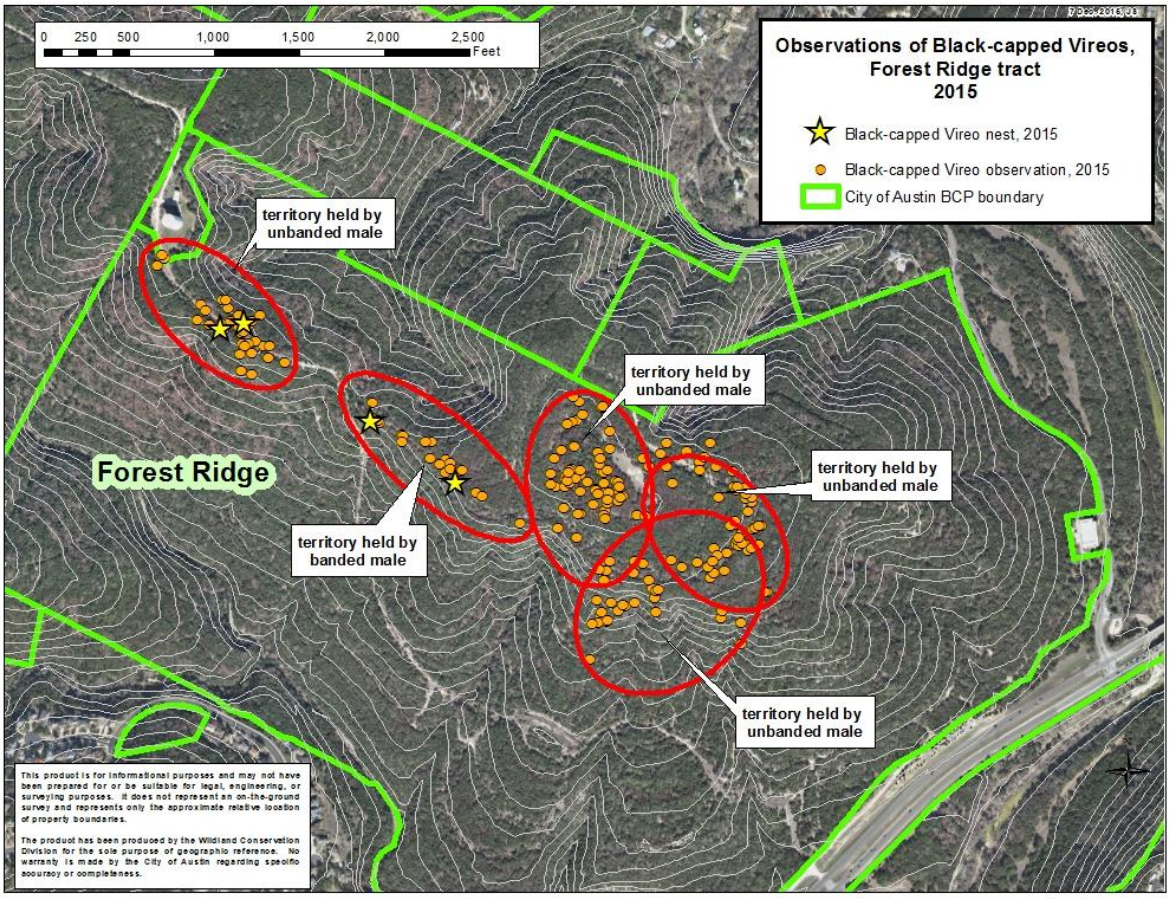

Figure B: Locations of 2009 Black-capped Vireo Habitat Improvement, Kent Butler Ecological Reserve, and Vireo Nests Found Through 2014
(2009 aerial photography)

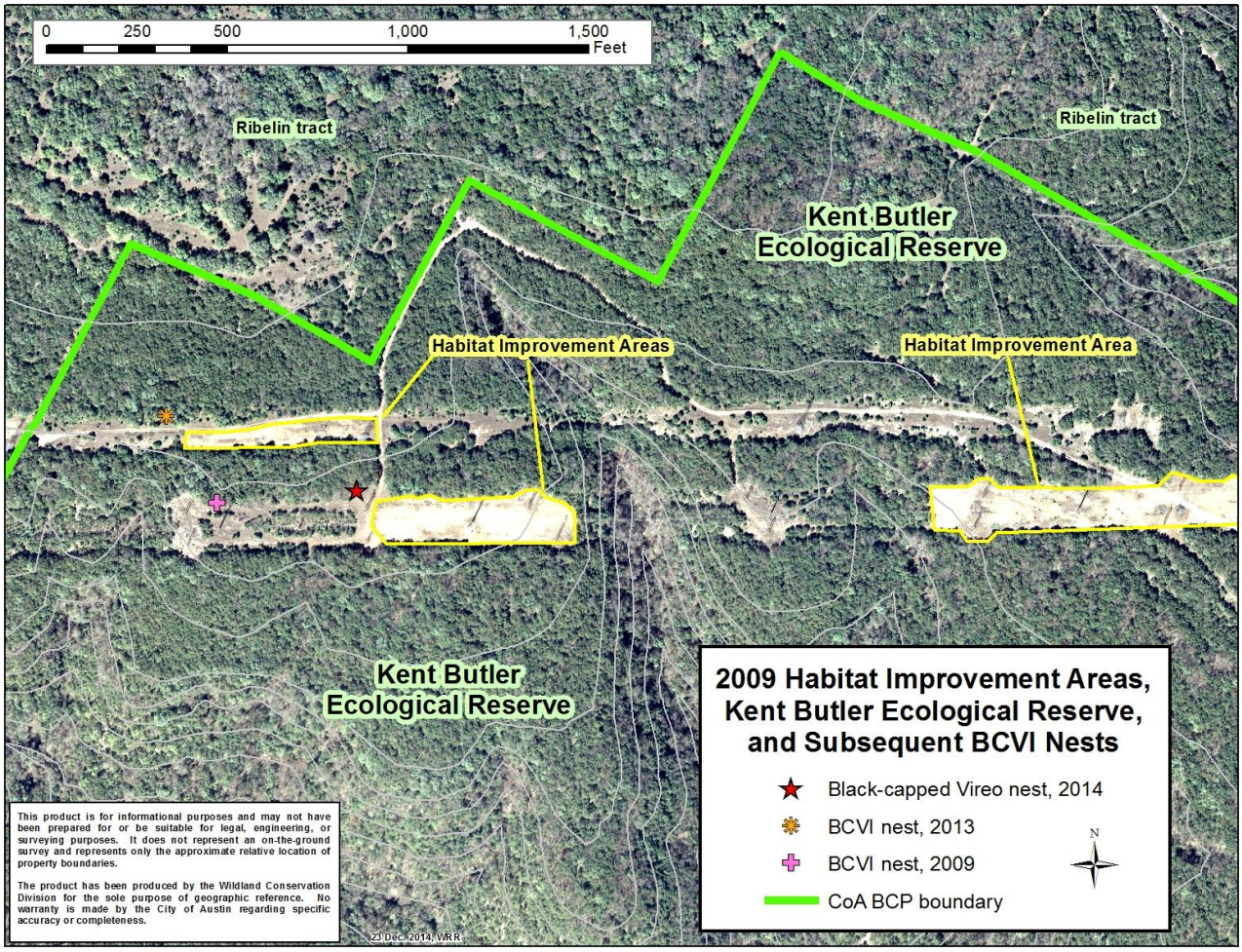

Figure C: Locations of Black-capped Vireos and Nests on Kent Butler Ecological Reserve, 2015
(2012 aerial photography)

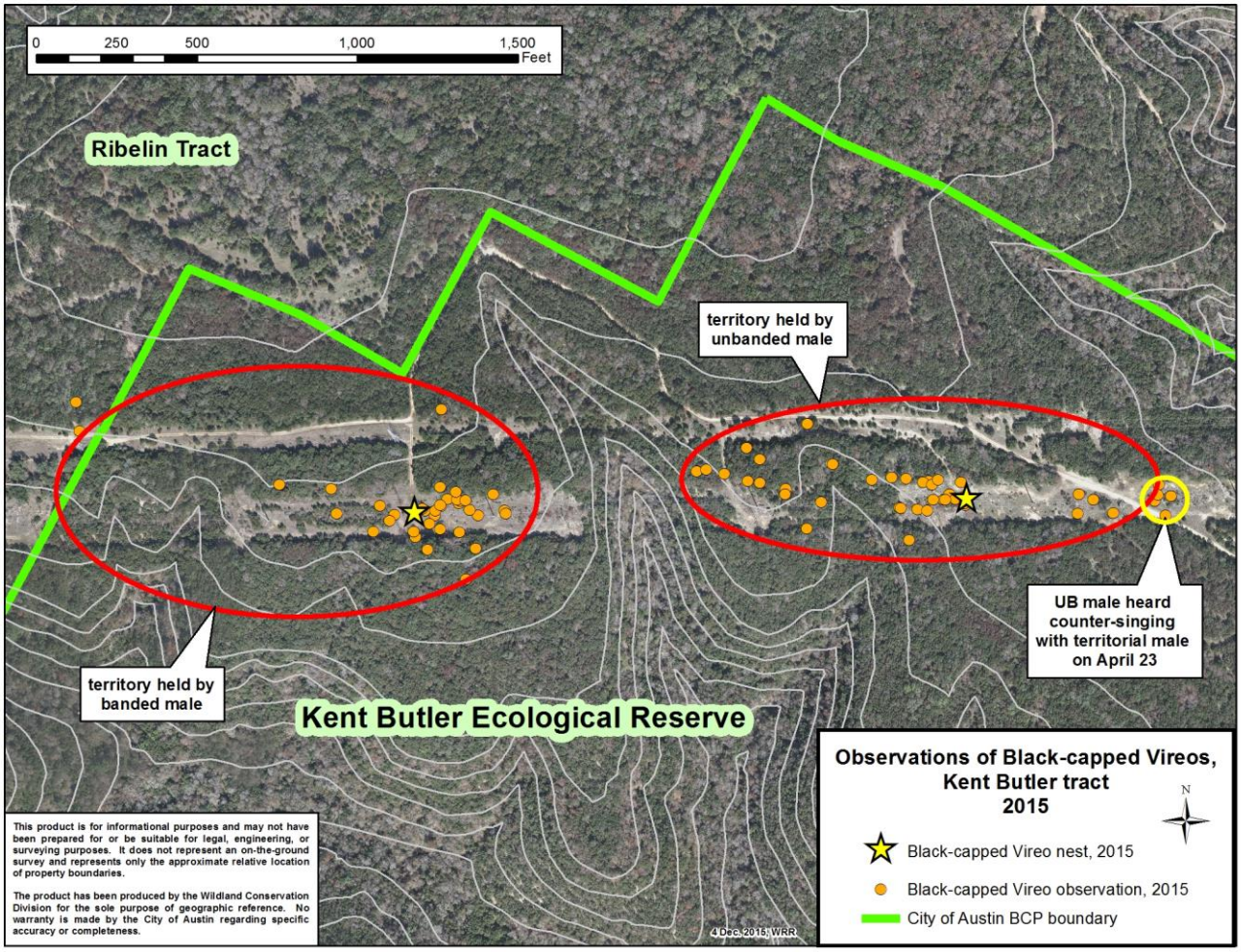

Figure D: Locations of Black-capped Vireos on Cortaña, 2015
(2012 aerial photography)