FY 2017 Report on Monitoring and Management of the Black-capped Vireo (*Vireo atricapilla)* on Travis County managed Balcones Canyonlands Preserve Tracts



Photo: Black-capped Vireo nestling & unhatched egg in damaged nest.

Travis County

Department of Transportation and Natural Resources

Natural Resources & Environmental Quality Division

October 1, 2016 – September 30, 2017

TABLE OF CONTENTS

INTRODUCTION....4

STUDY SITES....6

HABITAT RESTORATION....8

METHODS....9

Data Collection....9

Banding....11

Data Analysis....11

RESULTS....12

DISCUSSION....18

LITERATURE CITED....23

LIST OF FIGURES

Figure 1. Balcones Canyonlands Preserve Location Map, Travis County, TX....28

Figure 2. BCVI Survey Locations and Observations on the BCP 2017, Travis County, Texas....29

Figure 3. Restored BCVI Habitat and Habitat Restoration Areas (HMA) Travis, County, Texas (2017)....30

Figure 4. BCVI Observations and Territories on the Jollyville Unit, Travis County, Texas (2017)....31

Figure 5. BCVI Observations and Territories on the Ribelin tract, Travis County, Texas (2017)....32

Figure 6. BCVI Observations and Territory on the Kotrla tract, Travis County, Texas (2017)....33

LIST OF TABLES

Table 1. Summary of Jollyville Unit and Travis County BCVI survey data collected by various agencies, Travis County, Texas. 1989-2017…….. 13
Table 2. Abundance, territory number, and pairing success rate for BCVIs (*Vireo atricapilla*) on Jollyville Unit, Travis County, Texas, March-September 2001-2017 14
Table 3. Breeding success and productivity for BCVI (*Vireo atricapilla*) territories on Jollyville Unit, Travis County, Texas, March-September 2001-2017..... . 15
Table 4. Features of BCVI nests located on Travis County BCP lands in 2017……..16
Table 5. BCVI (*Vireo atricapilla*) nest locations on Travis County BCP, Travis County, Texas, in 2017……..…… 17
Table 6. Proportion of second-year males (pSY) and site fidelity on Travis County BCP, Travis County, Texas. 2010-2017……....18

INTRODUCTION

In the United States and Canada, nearly 450 native bird species breed in terrestrial habitats (Rosenberg et al. 2016). Approximately 200 of those terrestrial species, commonly known as neotropical migrants, breed in North America, and then migrate south to winter in Mexico, Central America, South America, and the Caribbean (Sibley 2001). A majority of neotropical migratory bird species face population declines from widespread diminishing of habitat quantity and quality due to urban growth, unsustainable agriculture and forestry, climate change and direct mortality from anthropogenic sources (Rosenberg et al. 2016). Partners in Flight, the U.S. Fish and Wildlife Service (USFWS), and many other cooperating agencies are actively developing recovery and conservation plans, acquiring and protecting critical habitat, and educating the general public about bird conservation issues in order to slow or prevent further population declines.

The Black-capped Vireo (*Vireo atricapilla*, hereafter BCVI, or vireo) was listed as a federally endangered species in 1987. Habitat loss and nest parasitism by Brown-headed Cowbirds (*Molothrus ater*) are among the greatest threats to BCVI populations. The breeding range of this neotropical migrant has decreased markedly within the last few decades. Historically, BCVIs in the United States were found in Kansas, Oklahoma, and Texas during the breeding season (Grzybowski 1995). Presently, the BCVI breeds in a restricted range that includes: five counties in Oklahoma, portions of central and south-central Texas, and south into central Coahuila, through Nuevo Leon and into southwestern Tamaulipas, Mexico (USFWS 2016). Between 2009 and 2014, BCVI populations in Texas have been reported in 40 south-central and central counties (USFWS 2016).

A USFWS review of the BCVI population status was completed as required by the Endangered Species Act in 2006 and the bird's status was recommended to be down-listed to threatened (Wilkins et al. 2006). Although no action was taken by USFWS, it appeared that a petition in 2012 would possibly lead to a down-listing. In 2016, the USFWS issued a Species Status Assessment Report for the BCVI and in 2017, proposed a rule on a 12-month Petition Finding to delist the BCVI. A final decision is set to be made in 2018. Travis County, the City of Austin, other BCP partners and organizations across Texas and the United States have urged USFWS to reconsider the proposed rule because, among other things, 1) the 1991 recovery plan was never updated, 2) the last review (2007) and petition (2012) recommended

down-listing, 3) a current population viability analyses should be conducted and 4) new threats (oil, gas, wind farm development) should be considered before any action on status is taken. It is worth mentioning that Partners in Flight lists the BCVI on their Red Watch List and is one of only 19 species with extremely high vulnerability due to a variety of threats (Rosenberg et al. 2016).

Available BCVI habitat, and subsequently BCVI populations, in Travis County have been significantly reduced as natural disturbances, such as fire, are suppressed and suburban development continues to expand. Additionally, browse pressure from White-tailed deer (*Odocoileus virginianus*) overpopulation can negatively affect BCVI habitat structure (Grzybowski 1995). In 1996, less than 100 individual BCVIs were estimated to occur in Travis County (USFWS 1996a). More recent analyses of survey data indicate that since 2000, the BCVI population estimate in Travis County is fewer than 50 individuals (Wilkins et. al 2006).

The USFWS issued the Balcones Canyonlands Conservation Plan (BCCP) section 10(a)1(B) permit to the City of Austin and Travis County in 1996 (USFWS 1996b). The plan calls for a minimum of 30,428 acres of endangered species habitat in western Travis County to be set aside and managed within the Balcones Canyonlands Preserve (BCP or Preserve; see Figure 1). As of October 2017, the BCP encompassed over 31,785 acres. A minimum of 2,000 of these acres are required to be designated as BCVI habitat. Due to changes in land use and fire suppression, most BCVI habitat will have to be maintained and/or created through habitat restoration efforts (USFWS 1996c). Travis County hopes to introduce prescribed fire as a tool to maintain and enhance habitat during the winter of 2018-2019.

BCVI habitat has been described as:

> "low scrubby growth, mostly deciduous and of irregular height and distribution, with small spaces between the thickets and clumps, with vegetation cover to ground level. This is an early to mid-successional progression, or one maintained in edaphic (due to soil or topography) settings such as occurs in rocky gullies, edges of ravines, and on eroded slopes; thus often quite localized (Grzybowski 1995)."

Additionally BCVI habitat has been characterized as including the following:

- greater density of deciduous vegetation in height zones from 0 - 2 meters.

- average amounts of deciduous cover ranging from 30-45%, with total woody cover including Ashe juniper (*Juniperus Ashei*) ranging from 36-55%.
- greater within-territory heterogeneity of vegetation structure (with shrubs closely spaced but still separated, and allowing light to penetrate to ground levels).
- openness not exceeding about 65% in older adult vireo territories (i.e. at least 35% woody cover) (Grzybowski 1995, Bailey and Thompson 2007).

This report presents the results of the 2017 BCP surveys for BCVI conducted by Travis County Natural Resources personnel. Annual BCVI population data collected from Travis County-managed lands is analyzed in order to monitor changes in distribution, abundance, and productivity. Monitoring the population will help gauge the effectiveness of habitat restoration projects and prioritize sites for future restoration activities.

STUDY SITES

During the 2017 breeding season, BCVI territory surveys were primarily conducted on portions of the Jollyville Unit, the Ribelin tract and the Kotrla Unit (Figure 2). Additional secondary locations where BCVIs historically were present, or contain suitable habitat, were checked periodically for presence/absence of BCVIs on other areas of the Jollyville Unit, the Sam Hamilton East tract, the Lucas tract, the Wheless tract and Milton Reimers Ranch County Park (not a BCP tract).

Historically, the Jollyville Unit contains the core BCVI colony on the BCP. The Jollyville Unit is comprised of 1,887 acres (764 ha) and includes the following tracts: Bunten, Collins, Cuevas, Cuevas East, Grandview Hills, Nootsie, Snowden, Vireo Ridge, and Vista Point (Figure 2). The Jollyville Unit is located approximately 13 miles (21 km) northwest of downtown Austin. Both Golden-cheeked Warbler (*Setophaga chrysoparia*) and BCVI inhabit this unit. Topography includes upland plateaus that give way to irregular, steep slopes and ravines. Ravines drain into an unnamed tributary of Lake Travis (Colorado River) or into Cypress Creek. Drainages tend to flow from the east to west. The Travis County soil survey shows that riparian soils in these drainages are composed primarily of soils of the Volente complex; Brackett and Tarrant soils are found on steep slopes (USDA 1974). Tarrant soils also occur in level upland areas.

The Jollyville Unit contains closed canopy, oak-juniper woodlands, which cover the majority of the canyons and slopes. Historic harvest of mature Ashe juniper has allowed shrubby, secondary-growth junipers to dominate much the uplands and slopes. Open grasslands are found in some valleys and ridge tops, and riparian vegetation, which contains black walnut (*Juglans nigra*), sycamore (*Platanus occidentalis*), cedar elm (*Ulmus crassifolia*), and oaks in areas along creeks and drainages. Portions of the ridge tops are often dominated with shin oak (*Quercus* sinuata), the signature species dominating most occupied BCVI habitat in Central Texas. Other common woody species include Texas redbuds (*Cercis Canadensis* var*. texensis*), grape (*Vitus* sp.), Texas ash (*Fraxinus texensis*), Texas oak (*Quercus Buckleyi*) agarita (*Mahonia trifoliolata*), twist leaf yucca (*Yucca rupicola*), wafer ash (*Ptelia trifoliata*), Carolina buckthorn (*Frangula caroliniana*), *Ilex* sp. and sumacs.

The 319 acres (129.1 ha) Ribelin tract is located within the Bull Creek macrosite (Figure 2). The tract contains a short section of Bull Creek, and the topography includes upland plateaus that give way to irregular, steep slopes and ravines. Primary soils on this tract are found in the Tarrant series (USDA 1974). Closed canopy oak-juniper woodlands cover the majority of the canyons and slopes. Vegetation composition is similar to that of the Jollyville Unit, described above. Humans have heavily impacted the lands comprising the Ribelin tract. There are several ranch roads, a substantial power line corridor (which makes up the south boundary of the property line), man-made clearings, old dumps, and fences found throughout the tract. In recent history, the land was utilized for cattle and livestock ranching. Areas, generally along a power line easement, were restored for BCVIs in 2009 and 2010.

The Kotrla Unit totals 954 acres (384 ha) and is comprised of the 500-acre Kotrla tract, the 450-acre Scott & White tract, and the 4-acre Endres (McLin) tract (Figure 2). These tracts are located in the Big Sandy Creek macrosite in far northwest Travis County. This unit contains habitat for both endangered songbirds and likely provides substantial connectivity between the BCP and the Balcones Canyonlands National Wildlife Refuge. The upland areas are relatively flat and are underlain by the hard gray limestone of the Edwards formation. These areas are classified as Karst Zone 2, and several known caves and sinks are scattered throughout the upland area.

Upland areas contain substantial Ashe juniper and areas of concentrated shin oak growing in shrub form. In particular, the dominant savannah (old pasture land) on the southern ridge contains suitable BCVI habitat. Other areas, particularly on the north

side, might be made suitable by on-going restoration efforts. Dominant vegetation throughout this unit is similar to that of the Jollyville Unit.

A substantial canyon runs generally northwest to southeast through the property. The sloped areas are steep and heavily wooded. The tree canopy is generally taller than that on the upland areas, although the species composition is similar. There is a substantial deciduous component to the tree composition on these slopes, particularly Texas oak. A substantial colony of rare Texabama croton (*Croton alabamensis* var*. texensis*) occurs in this canyon.

Presence/absence surveys were focused on locations where either BCVIs had been detected in the recent past, or where suitable habitat was created through restoration efforts. Areas containing suitable vegetation and structure were checked in additional areas of the Jollyville Unit, portions of the Sam Hamilton East, Lucas, and Wheless tracts and Milton Reimers Ranch Park.

HABITAT RESTORATION

Beginning in FY2001, and continuing every winter thereafter, Travis County has conducted BCVI habitat restoration within BCVI Habitat Management Areas (HMAs). These HMAs are located within Travis County BCP lands and they have been designated as having the potential to be restored to BCVI habitat. HMA locations are targeted based on known historic vireo occupancy and soil and vegetative components necessary for vireo habitat. More HMAs will be developed as additional land with restoration potential is acquired.

Poor quality BCVI habitat has been altered through a variety of techniques to create the patchy, early to mid-successional physiognomy associated with BCVI breeding habitat. By selectively removing undesirable monoculture woody species such as Ashe juniper, the growth and shrubby structure of other woody species can be improved. The following woody species benefit from Ashe juniper removal: shin oaks, possomhaw (*Ilex decidua*), yaupon (*Ilex vomitoria*), Texas redbud, wafer-ash, Carolina buckthorn and sumacs. Several sections of habitat, particularly those restored in the first half of the 2000s, have become good to excellent quality habitat. It has been observed on the Jollyville HMA that BCVIs begin occupying restored areas three to five years following initial habitat manipulation.

During the winter of 2016-17, 1.9 acres on the Kotrla Unit was restored by hand, using chain saws and pruning loppers (Figure 3). These actions increased the cumulative total of restored habitat on Travis County managed lands to approximately 181.30 acres (73.37 ha).

Follow up clearing is required to maintain BCVI habitat at an early to mid-successional stage. In most previously manipulated areas, much of the refined hand clearing is completed in subsequent years rather than at the onset of the initial larger scale brush removal, which is typically completed mechanically. Portions of areas cleared in 2001-2003 are beginning to grow out of ideal BCVI habitat and will require maintenance in the near future. Other locations being considered for targeted habitat restoration in the future include areas on the Vireo Ridge, Lucas, Ribelin, New Life and Cuevas East tracts as well as the Kotrla Unit due to their history of occupancy and proximity to currently occupied habitat. The Kotrla Unit has a particularly high value for restoration due to its large swaths of shin oaks and recent occupation by BCVIs.

Restoration activities will continue where habitat potential has been identified on the HMAs. Target areas for restoration vary from year to year based primarily on the following: habitat utilized by BCVIs during the preceding breeding season, presence of occupied Golden-cheeked warbler (GCWA) habitat, diversity of desired woody species, and available budget. Efforts are made to document any co-occurrences of GCWA and BCVIs during the breeding season in order to investigate and evaluate the possibility of creating areas of mixed or composite habitat. Travis County staff utilizes a flexible multi-year BCVI habitat restoration plan which defines areas targeted for restoration and allows for additional areas to be added or removed based on new land acquisitions, changes in land use and updated management techniques and recommendations. As previously mentioned, Travis County plans to introduce prescribed fire beginning in winter 2018-19.

METHODS

Data Collection

Detailed protocol for BCVI territory mapping, nest monitoring, and presence/absence surveys are described in an unpublished report by Travis County (2009). In FY 2017, territory mapping was used to estimate BCVI abundance and number of individual territories present. All observations (both visual and auditory) of male, female and juvenile BCVIs were plotted on hard-copy, digital ortho-photo maps with a scale of

1:3,000 or less. The following data were recorded in the field for each observation: location, date, behavior, sex, age, presence of a mate, number of fledglings and color band combination (if banded). BCVI locations and corresponding data were later recorded into an ArcGIS 10 (ESRI, Inc., Redlands, CA) geodatabase with the Texas State Plane (with NAD 1983 projection) coordinate system. All males encountered were assigned a unique territory ID ("territory number") to signify them as individuals. Female locations were either recorded as independent locations or with the corresponding territory number of a territorial male where applicable. If color-banded, the band combination was used as the territory number.

Territory mapping methods generally followed International Bird Census Committee (IBCC) guidelines (1970). Bibby's (2000) "consecutive flush" method was employed to increase accuracy in assigning observations of BCVIs to specific territories ("clusters"). However, Bibby's method was modified to be less intrusive in order to avoid harassment and/or human induced behaviors (Holiman and Craft 2000). No more than 10 locations for an individual bird were mapped at one time. The presence of returning color-banded BCVI allowed identification of particular individuals in many cases. When band status was unknown or when dealing with unmarked BCVI, conspecific singing or counter-singing was used to differentiate between males. BCVIs that could not be positively identified were designated as "unknown." Playback tapes of BCVI vocalizations were used infrequently late in the season in accordance with USFWS protocol to elicit BCVI responses.

Pairing status of male BCVIs was determined by observing one or more of the following conditions: a male associating with a female, an active nest associated with a male, and/or a male tending at least one fledgling. If any of the criteria for pairing success was met or if a male was observed in the same general location on at least three different occasions with at least one week between observations, it was considered to have established a breeding territory.

Nests were located opportunistically during normal territory mapping surveys. Disturbance was minimized by refraining from intensive nest searches. When found, nests were checked every five to seven days from the date of discovery until an outcome could be determined. Nest stage, contents, location and behavior of the attending adult were recorded during each nest check. In territories where no nest was found, but fledglings were present, staff recorded the maximum number of fledglings observed being attended. Fledglings observed being tended by a male or

female confirmed breeding success within a territory; the total number of fledglings observed at any one time was used as a conservative measure of productivity.

In addition to territory mapping and select presence/absence surveys for BCVIs on the Jollyville Unit, the Ribelin tract and the Kotrla Unit, additional presence/absence surveys were conducted at the following additional sites (Figure 2): 1) the east-west running ridge of the Vista Point tract, referred to as “Coffee Cup Ridge” that was restored in 2008; 2) the power line easement on the Ribelin and Sam Hamilton tracts; 3) the Lake Travis Bluffs section of the Lucas tract that was occupied in 2016; 4) a restored area on the newly acquired Wheless tract and 5) an area on Milton Reimers Ranch Park that was occupied in 2016 (not represented in a figure).

BCVIs were surveyed for a total of 146 hours from March 24 (first detection) to August 21, 2017 (last detection). Data can be interpreted as a comprehensive census due to the relatively large amount of time spent monitoring these birds.

Banding

In an effort to build a long term demographic data set, the banding program initiated in 2008 as part of a graduate study of avian dispersal, has continued. The original project investigated interpatch dispersal patterns within a fragmented preserve network (Simper 2009). Throughout the survey season, Travis County staff updates and shares data, including banded bird resightings and nest locations in an effort to coordinate banding attempts. In 2017, two adult male BCVIs were banded. Since 2008, 49 adult BCVIs have been banded on Travis County BCP properties. Travis County intends to continue the BCVI banding program.

Data Analysis

BCVI abundance is defined as the sum of all individual male BCVIs detected at a given study site (regardless of territory status). Overall species distribution is comprised of all locations where BCVIs were detected (i.e. registrations) and includes males, females, fledglings, and multiple sightings of the same individual. An individual male was considered to have established a breeding territory if the following behaviors were observed: 1) accompanying a female, 2) tending a nest or fledglings, or 3) singing in the same locality on three separate occasions each separated by one week (i.e. six days between observations). In calculating territory numbers, all BCVI territories, whether they were observed entirely or partially on Travis County property, were considered ‘full’ territories (as opposed to ‘edge’ or partial territories). Due to limitations of time and survey effort, the set of registrations

shown on attached maps do not represent a definitive description of territory boundaries.

Pairing success rate was calculated as the proportion of territories within which a female was observed or a nest was located (Anders 2000). Productivity data is represented in the following two ways: 1) the total number of fledglings divided by the total number of territories and 2) the total number of fledglings divided by the number of successful territories. A territory was considered successful if at least one fledgling was observed with a territorial male or female. The breeding success rate is the proportion of full territories that successfully fledged young (Koloszar and Becker 2000).

RESULTS

In 2017, BCVIs were located on the Jollyville Unit (Figure 4), the Ribelin tract (Figure 5) and on the Kotrla Unit (Figure 6). One male was detected on a single day on the Volente tract as well as the Webb tract. These “one-day” detections are added to abundance, but not represented in detail on a map in this report. Abundance totaled 12 males plus a unique female detected once, not associated with a male.

On Travis County managed properties, nine males established nine territories in areas where habitat restoration had previously occurred. Three unique males did not establish territories, possibly being transient or migrating individuals, and were only accounted for in abundance. No BCVI territories were established in entirely new areas on the Jollyville Unit. Three males, with two of these establishing territories, were detected in areas slotted for presence/absence surveys. Once detected, territory surveys were conducted.

Table 1 presents a summary of BCVI data collected during the 2017 breeding season in addition to data collected by various agencies exclusively on the Jollyville Unit since 1989. Since the primary BCVI colony exists on the Jollyville Unit, these data are reflected for historic context. This table also indicates total abundance and territories on all Travis County properties (including BCVI detected from [off of] Travis County properties).

Table 1. Summary of Jollyville Unit and Travis County BCVI survey data collected by various agencies, Travis County, Texas. 1989-2017.

Year Surveyed	Agency**	Jollyville Unit Abundance	Jollyville Unit No. Territories	Abundance/ No. Territories (all Travis County lands)
1989	DLS	11	5	n/a
1990	DLS	11	5	n/a
1991	DLS	14	9	n/a
1992	TXDOT	Unknown[1]	Unknown	n/a
1993	TXDOT	25	20	n/a
1994	TXDOT	27	27	n/a
1995	TXDOT	23	23	n/a
1996	SWCA	19-22	15	n/a
1997	No Data	Unknown[1]	Unknown	n/a
1998	No Data	Unknown	Unknown	n/a
1999	No Data	Unknown	Unknown	n/a
2000	SWCA	3[2]	Unknown	n/a
2001	Travis County TNR	19	13	19/13
2002	Travis County TNR	21	19	21/19
2003	Travis County TNR	21	20	22/20
2004	Travis County TNR	13	12	13/12
2005	Travis County TNR	12	11	12/11
2006	Travis County TNR	12	9	13/9
2007	Travis County TNR	14	13	18/15
2008	Travis County TNR	15	15	15/15
2009	Travis County TNR	13[3]	11	15/11
2010	Travis County TNR	13	11	13/11
2011	Travis County TNR	9	8	10/9
2012	Travis County TNR	9	8[4]	9/8
2013	Travis County TNR	13	9	15/11
2014	Travis County TNR	14	12	14/12
2015	Travis County TNR	15	13	21/16
2016	Travis County TNR	14	12[4]	19/14
2017	Travis County TNR	6	6	12/9

*Study area is only referred to as "Jollyville Unit" since 2001. ** See Literature Cited for appropriate report citation.

[1] Restricted access on the tract. [2] Detected while on brief site visit.

[3] Does not include individual detected on Lake Perspectives tract (now part of the Lake Travis Unit).

[4] One banded male established two separate, isolated territories.

In 2017 on all Travis County managed lands, nine territories (100%) were considered successfully paired. Seven territories fledged offspring, yielding at least 24 “hatch year” (HY) individuals. On the Jollyville Unit alone (for historic context), all six territories were considered successfully paired (Table 2). Four territories fledged offspring, yielding at least 15 ‘hatch year’ (HY) individuals observed in the field (Table 3). Current protocol counts either the number of fledglings directly observed in the field or the number of nestlings discovered in a nest that is later demonstrated to be successful. For the third time (first time in 2015) since the monitoring program began, a territory definitively had more than one successful nest.

Because of their dull-colored plumage, cryptic behavior, and unpredictable flights, we expect observer counts of fledglings to be biased low. Productivity in 2017 (Table 3), whether measured relative to successful territories (2.6 HY/ territory) or all territories (2.4 HY/ territory), is likely slightly underestimated due to the fact that one territory produced young where only one HY was detected as no nest was located to monitor - thus exact HY totals were unknown.

Table 2. Abundance, territory number, and pairing success for BCVIs (*Vireo atricapilla*) on Jollyville Unit, Travis County, Texas, March-September 2001-2017.

Year	Total Hours Surveyed•	Abundance	No. Territories	Successfully Paired	Pair Success Rate (%)
2001	100	18[a]	15 [a]	13 [a]	86.7 [a]
2002	179	21	19	18	94.7
2003	290 [b]	21	19 [a]	14	73.7 [a]
2004	127.5	13	12	9	75
2005	140	12	11	8	72.7
2006	146	11 [a]	9	8	88. 9
2007	178	14	13	12	92.3
2008	199	15	15	14	93.3
2009	204	13[c]	11	11	100
2010	181	13	11	11	100
2011[d]	131	9	8	8	100
2012	141	9	8	8	100
2013	154	13	9	9	100
2014	190	14	12	11	91.7
2015	179	15	13	11	84.6
2016	142	14	12	11	91.7
2017	146	6	6	6	100

[a] Adjusted values to reflect BCVI found only on the JV Unit. • Total hours for entire season on all properties, not only JV Unit
[b] Total hours surveyed for 2003 could not be verified and likely overestimated.
[c] The male located at Lake Perspectives (Lake Travis Unit) was not included in this dataset.
[d] The territory located at Lucas-Lake Travis Bluffs (Lake Travis Unit) was not included in this dataset.

County-wide, a total of 14 BCVI nests were located and monitored in 2017. One of these was found after it had failed. Detailed data regarding nest substrate, height, and orientation were collected post breeding season for each nest found (Table 4). Table 4 also lists the outcome for each nest identified and Table 5 lists nest location data.

Of the nests monitored (n=14), six (46.2%) successfully fledged at least one young. Seven nests were depredated (50%) by unknown predators and one was abandoned in egg stage. Two territories had nest attempts after a successful nest, however both failed. One had a successful nest following a depredated nest. One territory had two failed nests while another territory had three failed nests; all were depredated. One territory had at least two successful, monitored nests. Two unmonitored (not located) nests were deemed successful based on adults tending to young.

Table 3. Breeding success and productivity for BCVI (*Vireo atricapilla*) territories on Jollyville Unit, Travis County, Texas, March-September 2001-2017.

Year	No. of territories with breeding success[1]	Breeding success rate (%)	No. Fledglings	No. fledglings/ successful territory[2]	No. fledglings/ total no. territories[3]
2001	4	26.7*	12	3.0*	0.8*
2002	13*	68.4*	25*	1.4*	1.3*
2003	9	47.4*	16	1.8	0.8
2004	6	50.0	13	2.2	1.1
2005	1	9.1	1	1.0	0.1
2006	8	88.9	15	1.9	1.7
2007	8	61.5	24	3.0	1.8
2008	10	66.7	29	2.9	1.9
2009	7	63.6	12	1.7	1.1
2010	8	72.7	10	1.3	0.9
2011	4	50.0	11	2.8	1.4
2012	7	87.5	21	3.0	2.6
2013	6	66.7	19	3.2	2.1
2014	8	66.7	23	2.9	2.1
2015	7	53.8	30	2.7	2.3
2016	8	66.7	29	2.6	2.4
2017	4	66.7	15	3.8	2.5

[1] Represents the number of all territories that fledged at least one young.
[2] Represents the average no. of fledgling from territories with breeding success.
[3] Represents the average no. of fledgling from all successfully paired territories.
* Adjusted values to reflect BCVI found only on the JV Unit.

Table 4. Features of BCVI (*Vireo atricapilla*) nests located on Travis County BCP in 2017.

Substrate	Primary substrate height (m)	Additional Concealment	Nest height (cm)	Distance from stem (cm)	Distance from foliar edge (cm)	Orientation	Comments
Shin oak (*Quercus sinuata*)	4.5	Ashe juniper (*Juniperus Ashei*) Live oak (*Quercus fusiformis*)	116	146	11	E 112°	Failed; Discovered likely depredated
Carolina buckthorn (*Frangula caroliniana*)	2.0	Evergreen sumac (*Rus virens*)	124	63	29	NE 44°	Successful second attempt; (4 HYs)
Shin oak	2.5	n/a	70	81	20	N 9°	Failed; (4 eggs)
Shin oak	1.75	Ashe juniper	70	13	14	NE 58°	Failed second attempt; (3 nestlings, one egg)
Ashe juniper	4.0	Shin oak	140	87	29	NNE 21°	Successful; (4 HY)
Shin oak	3.0	Ashe juniper	95	70	29	NNE 21°	Failed; abandoned; (2 eggs)
Evergreen sumac	2.5	Ashe juniper	57	38	22	NE 41°	Failed; (3 eggs)
Evergreen sumac	2.0	Common Beebush (*Aloysia gratissima*)	52	22	18	E 78°	Failed second attempt; (4 eggs)
Shin oak	3.0	Ashe juniper	96	76	31	N 12°	Failed third attempt; (4 eggs)
Netleaf hackberry (*Celtis laevigata* var. *reticulata*)	3.0	Texas persimmon (*Diospyros texana*)	79	68	51	NNE 30°	Successful; (3 HYs)
Shin oak	2.0	Cedar elm (*Ulmus crassifolia*)	98	33	19	SSW 202°	Failed (3 nestlings)
Shin oak	3.5	Flameleaf sumac (*Rhus lanceolata*)	70	80	12	E 78°	Successful; (3 HYs, 1 egg)

Substrate	Primary substrate height (m)	Additional Concealment	Nest height (cm)	Distance from stem (cm)	Distance from foliar edge (cm)	Orientation	Comments
Shin oak	4.0	Mustang grape (Vitis mustangensis)	63	59	15	E 86°	Successful; (3 HY, 1 egg)
Shin oak	5.0	Ashe juniper	85	95	23	SW 219°	Successful; (2 HY, 1 egg)

Definitions: Substrate: plant species in which the nest is located. Concealment: plant species or other substrates that is primarily responsible for concealing the nest. Orientation: compass direction of nest relative to its substrate.

Table 5. BCVI (*Vireo atricapilla*) nest locations, Travis County, Texas, 2017.

Object-ID	Color Band Combination	Nesting attempt	UTM E	UTM N	LAT	LONG
El Fuego	OR/SI:YE/OR	1	602202	3380971	30.556823	-97.934369
Bruiser	NB/SI:BK/BL	1	609658	3368078	30.439843	-97.858005
Bruiser	NB/SI:BK/BL	2	609563	3368069	30.439770	-97.858987
Bruiser	NB/SI:BK/BL	3	609741	3368174	30.440699	-97.857124
Prince	NB/MV:MV/SI	1	609762	3368326	30.442076	-97.856889
Prince	NB/MV:MV/SI	2	609758	3368397	30.442716	-97.856930
Bob	OR/DG:YE/SI	1	610110	3368288	30.441696	-97.853277
Bob	OR/DG:YE/SI	2	610077	3368352	30.442275	-97.853606
VRUB03	UB	1	610193	3367755	30.436880	-97.852469
VRUB03	UB	2	610204	3367712	30.436492	-97.852353
VRUB01	UB	1	610121	3367961	30.438749	-97.853193
VRUB01	UB	2	610099	3368158	30.440530	-97.853397
Homer	YE/YE:WH/SI	1	613373	3363838	30.401239	-97.819768

In all, a total of five individual adult BCVIs (all males) wearing color bands were observed on Travis County properties in 2017. Of these, two adult males were banded during the 2017 field season. The three additional male BCVIs were banded in previous years (one in 2014, an A4Y; two in 2016, both 3Y).

Adult males showed a 42.9% return rate (three of seven banded males observed in 2016). One returning male returned to his same 2016 territory while the other two swapped areas. No banded females were observed in 2016. Nestlings were not banded due to permit restrictions.

Prior to 2008 there was no banding program in place, precluding staff from determining return rates, recruitment and associated data. From 2003 to 2009 BCVI

territory and abundance numbers slowly declined despite a period of growth in 2007 and 2008. In 2017, two males were banded and of these, one was a 'second year' male, i.e. males in their first reproductive season. The age of the second male was unclear and listed as an "after hatch-year" (AHY). All banded males established territories. Table 6 summarizes relevant demographic information since 2010.

- Proportion of SY males (pSY): The proportion of second year males has been used as an indicator of recruitment. A minimum pSY value (29%) has been suggested as a measure of a stable population (USFWS 1996a). In 2017, the overall pSY, based on marked birds, was 20% (one of five). Note that one newly banded male's age was listed as AHY and may have been a SY bird. This would increase the pSY to 40.0%.
- Site fidelity: In 2017, three of seven banded males observed in 2016 returned indicating a 42.9% return rate on Travis County properties.

Table 6. Proportion of second-year males (pSY) and site fidelity on Travis County BCP, Travis County, Texas. 2010-2016.

Year	pSY	Site Fidelity (males)	Site Fidelity (females)
2010	27.3	70.0	n/a
2011	20.0*	25.0	n/a
2012	28.6*	66.7	50.0
2013	57.1	16.7	100.0
2014	62.5*	42.9	50.0
2015	43.8**	71.4	50.0
2016	71.4	16.7	66.7
2017	20.0*	42.9	n/a

* conservative number, at least three (2011), one (2012), two (2014) and one (2017) males were unsuccessfully aged.

** unofficial number based primarily on observations of territorial (n=7 of 16) males and not solely marked BCVIs.

DISCUSSION

BCVI numbers dropped both in the Jollyville Unit colony and throughout Travis County-managed lands. On the Jollyville Unit, there was a dramatic decline in abundance (-57.1%) and territories (-50%). The drop was slightly less steep in the County as a whole, in both abundance (-36.8%) and numbers of territories (-35.7%). This marks the largest decrease in BCVI numbers since Travis County began

managing BCVIs on the BCP (2001). The last time a significant drop occurred on the Jollyville Unit was from 2003-2004, where both abundance and territories dropped by nearly 40%. The number of territories in 2017 on the Jollyville Unit (6) was the lowest number ever detected. The previous low was seven in 2011 and 2012. Despite the drop in territories on the Jollyville Unit, all six males successfully paired with four producing young. At least 15 HYs were produced which tied or was greater than seven other years since monitoring began (2001), however this number was nearly a 50% decrease from the previous season. Although breeding success and productivity numbers were high in 2017 compared to most other years, comparisons to other seasons will not be made for this report as a result of the small population size.

The Ribelin tract area continues to steadily establish territories on both Travis County and City of Austin lands indicating the continued utilization of power/transmission line corridors by BCVIs. For the first time since Travis County has managed the Kotrla Unit, a successful BCVI territory was established and produced young. This unit offers a significant amount of possible BCVI habitat, both existing and potential. The three territories monitored off the Jollyville Unit all were successful and produced at least nine HYs.

What drives changes in BCVI numbers is unclear, but normal population fluctuations, climate, changes in migration patterns through the area, and changes in quality of habitat are likely factors. A variety of active measures should benefit this species on Travis County-managed properties. The potential of increasing suitable habitat on the Kotrla Unit through both mechanical methods and eventual prescribed fire will likely increase BCVI numbers on this unit. The proximity of this unit to the BCVI populations on the USFWS Balcones Canyonlands National Wildlife Refuge is an added benefit, if recruitment from dispersal occurs. 2017 marks the fourth subsequent year that BCVIs have been detected on this unit. Additionally, the continued prescribed burn program in Travis County Parks may also create additional pockets of suitable habitat in the future and will need to be monitored. Milton Reimers Ranch Park is a good example where burns have occurred and habitat has been created. Pace Bend Park is another property that has the potential of habitat creation through prescribed burning.

Several factors may influence territory distribution, including the intrinsic habitat characteristics of the site, the age structure of the population, overall population

density, and habitat restoration activities in protected areas (Grzybowski et al. 1994; Anderson and Gutzwiller 1996). Territory establishment in 2017 occurred in the same general core areas on the Jollyville Unit as in previous years (Travis County 2001-2016). Although the same areas are being utilized, often by returning males (documented by resighting of banded birds), the distribution of BCVI territories on the Jollyville Unit has changed each year.

Habitat loss and degradation is a primary concern for BCVI recruitment onto Travis County BCP properties. Typical BCVI nesting habitat was uncommon on the Jollyville Unit when first acquired by Travis County in 2000 and 2001. Habitat change through vegetational succession, dominated primarily by encroaching Ashe juniper, reduced canopy openings. Additionally, the successional change in vegetation structure tends towards closed canopy woodlands, rather than the low, shrubby, mid-successional stage preferred by BCVIs. Through mechanical efforts of BCVI habitat restoration, significant portions of the Jollyville Unit HMA still show characteristics of prime BCVI habitat. However, portions are beginning to grow out of optimal habitat and may have contributed to the decline in BCVI numbers.

Technically, all of the 2017 BCVI territories both on the Jollyville Unit, as well as those on the Ribelin tract and Kotrla Unit, were established primarily in previously manipulated areas which may be considered “restored”. This has been the observed trend since 2006. In the case of the Kotrla Unit, previous owners manipulated the uplands to improve grazing, which eventually modified the habitat into the shrub land that the County now manages for BCVI. These observations indicate that BCVIs continue to respond positively to habitat restoration efforts undertaken in the past. It should be noted, however, that not all areas of apparently restored habitat have been reoccupied. Still other areas that have been occupied appear to have enough suitable habitat for additional territories. Numerous factors influence territory establishment, but regional natural population fluctuations, declining connectivity, as well as the location of the Preserve on the far eastern edge of BCVI range are all likely to contribute to overall population trends.

In general, BCVIs tend to be “semi-colonial” and establish territories near other BCVIs (Ward and Schlossberg 2001). However, isolated territories composed of either individual pairs or small-clusters have occasionally been located (Grzybowski 1990). These territories are often difficult to detect as noted by Ward and Schlossberg (2001). They found that in low-density populations of BCVIs, song

rates and duration of song bouts were much lower than in high-density populations. Thus, low detection rates of these isolated territories may affect estimates of abundance. This phenomenon was noted on the Jollyville Unit in 2017 where a unique male was detected late in the season feeding young. This territory was almost missed despite that it was adjacent to another territory and the area had been routinely checked.

Travis County is committed to continued research and monitoring of BCVI, particularly on the Jollyville Unit, to determine whether this, or any other colony, is a source population or a population sink. Source populations contribute to the general overall population and help to maintain satellite colonies. Population sinks are maintained solely through immigration and contribute nothing to species-wide abundance (Pulliam 1988). Data obtained from continued banding efforts would improve estimates of inter-population connectivity as well as age-specific survival and reproduction. If adequate connectivity with neighboring sub-populations is not maintained, then BCVI numbers on isolated preserve tracts may decline precipitously, leading to local extinctions and deficient levels of colonization. Information regarding productivity and dispersal is limited because it is difficult and slow to obtain. Additional survey seasons and continued research will help gauge the effectiveness of habitat restoration projects and prioritize sites for future restoration. Without comprehensive productivity, survivorship, and dispersal information, as well as complimentary data from surrounding properties, we cannot make a definitive statement regarding the role of the Jollyville Unit within the central Texas portion of the BCVI's range.

Travis County will continue to conduct intensive BCVI monitoring, including annual color-banding. Such research could help address many questions concerning the long-term viability of the Jollyville Unit colony and its relationship to other sub-populations in the region. The long-term data sets generated from such studies would facilitate yearly comparisons and improve the accuracy of model-generated population forecasts. Data collected will continue to include the following: abundance, age structure, dispersal patterns, distribution of subpopulations, habitat associations throughout the breeding season, nest success, recruitment, return rates and age-specific measures of productivity and survivorship. Future research should be focused upon answering questions of immediate relevance to management and recovery priorities.

Notes concerning the presence of non-native ant species:

- Although it did not appear that any BCVI nest attempts failed due to red imported fire ant (*Solenopsis invicta*, RIFA) predation in 2017, control of this nuisance species should continue within restored BCVI habitat areas when warranted. RIFA have been documented as a common cause of nest failure in BCVI (Smith, et al. 2002). There were no instances of RIFA mounds within 25 meters of nests in 2017, thus no treatments occurred. Twenty-five meters is based on the foraging distance of RIFA (USFWS 2014).
- The discovery of a new, imported ant species, the Tawny Crazy Ant (*Nylandaria fulva*) in the far northern region of the Jollyville Unit is a great concern. This species is known to displace other vertebrate and invertebrate species and is particularly detrimental to nesting avian species. As this is an entirely new threat to the Preserve, any and all information gathered through study will assist in its management.

LITERATURE CITED

Anders, A. D. 2000. Demography of golden-cheeked warblers on Fort Hood, Texas in 2000: productivity, age structure, territory density, and adult return rates. In Endangered species monitoring and management at Fort Hood, Texas: 2000 annual report. Fort Hood Project, The Nature Conservancy of Texas, Fort Hood, Texas, USA.

Anderson, S. H., and K. J. Gutzwiller. 1996. Habitat evaluation methods. Pages 592-606 *in* T. A. Bookhaut, ed. Research and management techniques for wildlife and habitats. Fifth ed., rev. The Wildlife Society, Bethesda, Maryland, USA.

Balcones Canyonlands Preserve Land Management Plan 2007. BCVI management. Chapter 8 *in* Tier II A, Balcones Canyonlands Management Handbook. Unpublished document. Travis County, Texas, USA.

Bailey, W. J., and F. R. Thompson. 2007. Multiscale Nest-Site Selection by BCVIs. Journal of Wildlife Management 71:828-836.

Bibby, C. J., N. D. Burges, D. A. Hill and S. H. Mustoe. 2000. Bird census techniques. Second edition. Academic Press.

DLS Associates. 1989b. BCVI monitoring program, Travis County, Texas and vicinity, 1989. Submitted to: The Nature Conservancy of Texas, Inc. and Executive Committee of the Austin Regional Habitat Conservation Plan.

_____. 1990a. BCVI monitoring program, Travis County, Texas and vicinity, 1990. Submitted to: The Nature Conservancy of Texas, Inc. and Executive Committee of the Balcones Canyonlands Habitat Conservation Plan.

_____. 1992. BCVI monitoring program, Travis County, Texas and vicinity, 1991. Submitted to: The Nature Conservancy of Texas, Inc. and Executive Committee of the Balcones Canyonlands Habitat Conservation Plan.

O, J.A. 1990. Population and nesting ecology of the Black-capped vireo--1990. Austin (TX): Texas Parks and Wildlife Department. Report nr E-1-3. Job 29. 39 p.

_____ . 1995. BCVI (*Vireo atricapillus*). In The Birds of North America, No. 181 (A. Poole and F. Gill, editors). The Academy of Natural Sciences, Philadelphia, Pennsylvania, USA and The American Ornithologists' Union, Washington, D.C., USA.

_____, D. J. Tazik, and G. D. Schnell. 1994. Regional analysis of BCVI breeding habitats. Condor 96: 512-544.

Holiman, W. C., and R. A. Craft. 2000. Breeding density and productivity of the golden-cheeked warbler on Fort Hood, Texas in 1999. Pages 79-103 *in* Endangered Species monitoring and management at Fort Hood, Texas: 1999 annual report. Fort Hood Project, The Nature Conservancy of Texas, Fort Hood, Texas.

International Bird Census Committee. 1970. An international standard for a mapping method in bird census work, recommended by the International Bird Census Committee. Audubon Field Notes 24 (6):722-726.

Koloszar, J. A. and H. M. Becker. 2000. Monitoring of the BCVI during 2000 on Fort Hood, Texas. Endangered species monitoring and management at Fort Hood, Texas: 2000 annual report. Fort Hood Project, The Nature Conservancy of Texas, Fort Hood, Texas, USA.

Pulliam, H.R. 1988. Sources, sinks, and population regulation. American Naturalist 132: 652-661.

K. V. Rosenberg, J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J.D. Alexander, C. J. Beardmore, P. J. Blancher, R. E. Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W. E. Easton, J.J. Giocomo, R.H. Keller, A. E. Mini, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, T. Will. 2016. Partners in Flight Landbird Conservation Plan: 2016 Revision for Canada and Continental United States. Partners in Flight Science Committee. 119 pp.

Sibley, D. A. 2001. The Sibley Guide to Bird Life and Behavior. Alfred A. Knopf, Inc.New York. 587 p.

Simper, W.S. 2009. Black-capped vireo (*Vireo atricapilla*) color banding and surveying on the Balcones Canyonlands Preserve and the Balcones Canyonlands National Wildlife Refuge: Project Year 2. Austin (TX): USFWS. Report nr TE168189-0-2009. 32 p.

Smith, J.E., S.J. Taylor and C.J. Whelan. 2002. Red Imported Fire Ant (*Solenopsis invicta*) depredation of Black-capped Vireo (*Vireo atricapillus*) nests at Ft. Hood, Texas. Illinois Natural History Survey Technical Report 2002(24).

SWCA 1996. Master BCVI survey map, Grandview Hills Parcel 13. Unpublished document. Travis County, Texas, USA.

Texas Department of Transportation. 1992. BCVI monitoring program, northwest Travis County, Texas. Unpublished report.

_____. 1993. BCVI monitoring program, northwest Travis County, Texas. Unpublished report.

_____. 1994. BCVI monitoring program, northwest Travis County, Texas. Unpublished report.

_____. 1995. BCVI monitoring program, northwest Travis County, Texas. Unpublished report.

_____. 2001. Monitoring of the Golden-cheeked warbler 2001 field season. Unpublished report.

_____. 2001. Status of the BCVI on the Vireo Ridge Tract, Travis County, Texas, 2001 field season. Unpublished report.

_____. 2002. Monitoring of the BCVI, 2002 field season, Travis County, Texas. Unpublished report.

_____. 2003. Monitoring of the BCVI, 2003 field season, Travis County, Texas. Unpublished report.

_____. 2004. Monitoring of the BCVI, 2004 field season, Travis County, Texas. Unpublished report.

_____. 2005. Monitoring of the BCVI, 2005 field season, Travis County, Texas. Unpublished report.

Travis County Natural Resources and Environmental Quality Division. 2006. Monitoring of the BCVI, 2006 field season, Travis County, Texas. Unpublished report.

_____. 2007. Monitoring of the BCVI, 2007 field season, Travis County, Texas. Unpublished report.

Travis County Natural Resources and Environmental Quality Division. 2008. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2008 field season, Travis County, Texas. Unpublished report.

_____. 2009. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2009 field season, Travis County, Texas. Unpublished report.

_____. 2010. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2010 field season, Travis County, Texas. Unpublished report.

_____. 2011. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2011 field season, Travis County, Texas. Unpublished report.

_____. 2012. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2012 field season, Travis County, Texas. Unpublished report.

_____. 2013. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2013 field season, Travis County, Texas. Unpublished report.

_____. 2014. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2014 field season, Travis County, Texas. Unpublished report.

_____. 2015. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2015 field season, Travis County, Texas. Unpublished report.

_____. 2016. Monitoring and Management of the BCVI (*Vireo atricapilla*) in Western Travis County, Texas: 2016 field season, Travis County, Texas. Unpublished report.

U.S. Department of Agriculture. 1974. Soil survey of Travis County, Texas. United States Department of Agriculture, Soil Conservation Service, Washington, D.C. 123pp.

U.S. Fish and Wildlife Service. 1996a. BCVI (*Vireo atricapillus*) recovery plan. U.S. Fish and Wildlife Service, Austin, Texas, USA.

_____. 1996b. Federal Fish and Wildlife Permit No. PRT-788841.

_____. 1996c. Habitat Conservation Plan and Final Environmental Impact Statement. U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.

_____. 2014. Karst Preserve Managing and Monitoring Recommendations. Austin Ecological Services Field Office, Austin, TX. Pg. 14.

Ward, M. and S. Schlossberg. 2001. Conspecific attraction in BCVIs. 2001 Annual Report. Natural Resources Branch. Endangered Species Management Program, Ft. Hood, Texas

Wilkins, N., R. A. Powell, A. A. T. Conkey and A. G. Snelgrove. 2006. Population Status and Threat Analysis for the BCVI. Department of Wildlife and Fisheries Sciences, Texas A&M University.

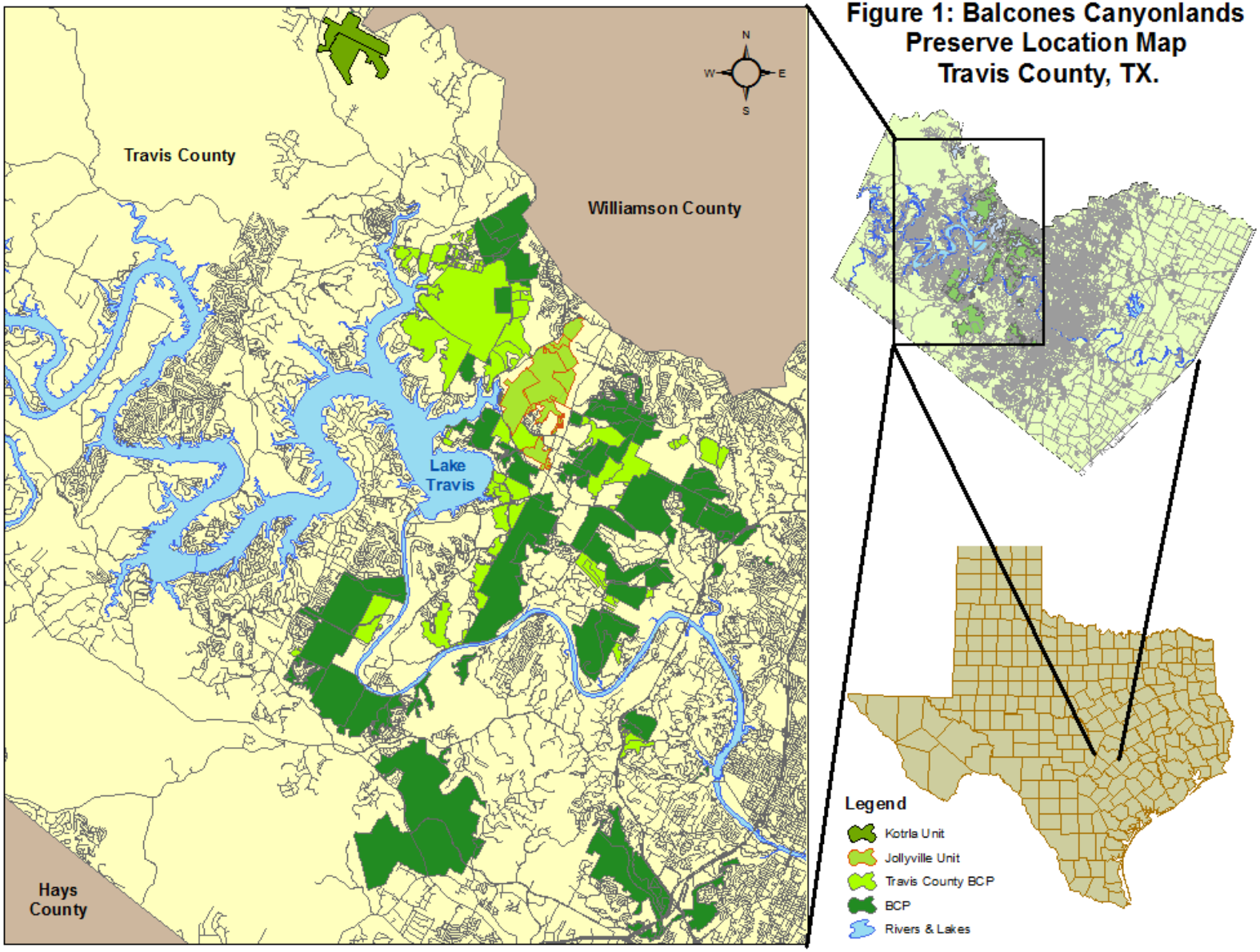


Figure 1: Balcones Canyonlands Preserve Location Map Travis County, TX.

Figure 2: BCVI Survey Locations and Observations, 2017
Travis County, Texas

BCVI Observations

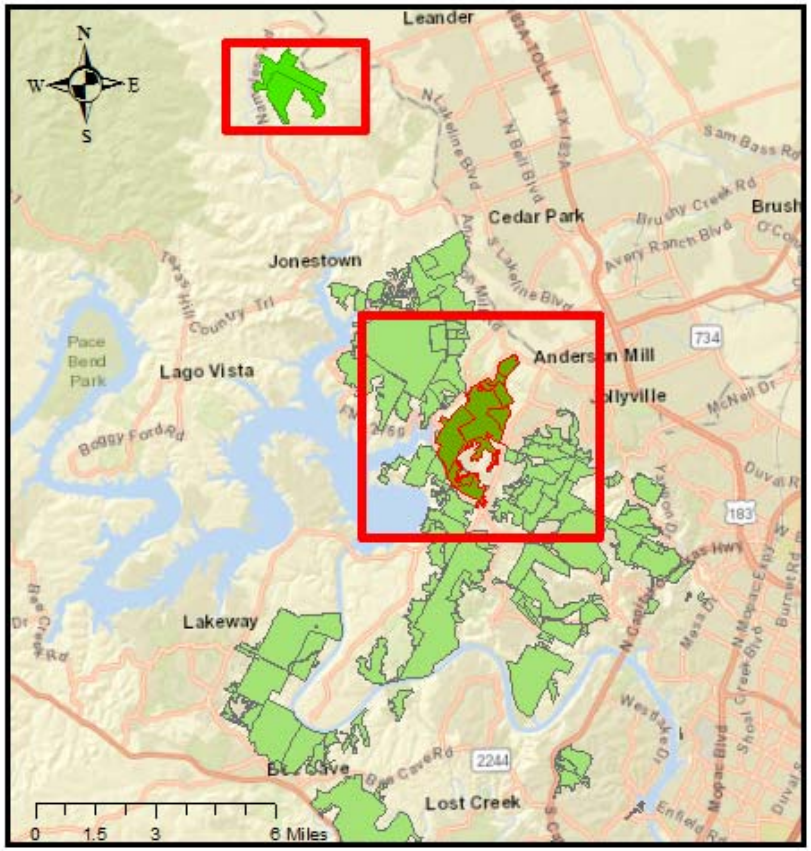
Presence/Absence survey location

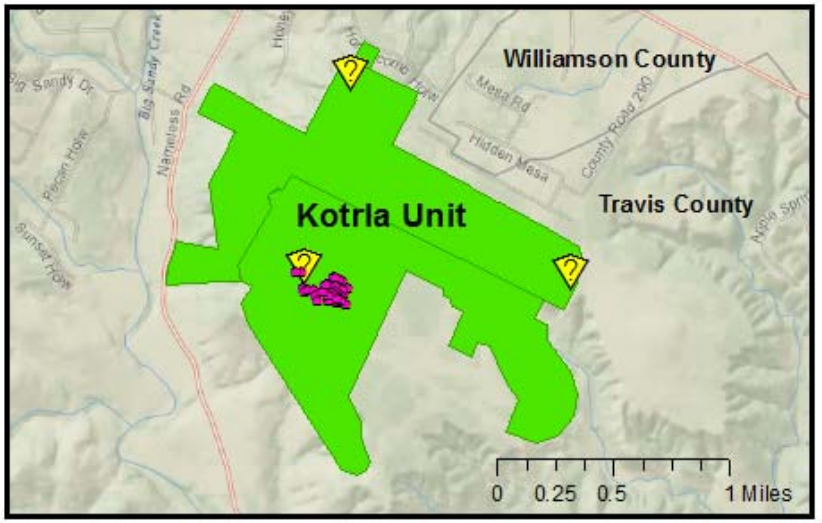
Travis County BCP, Kotrla Unit

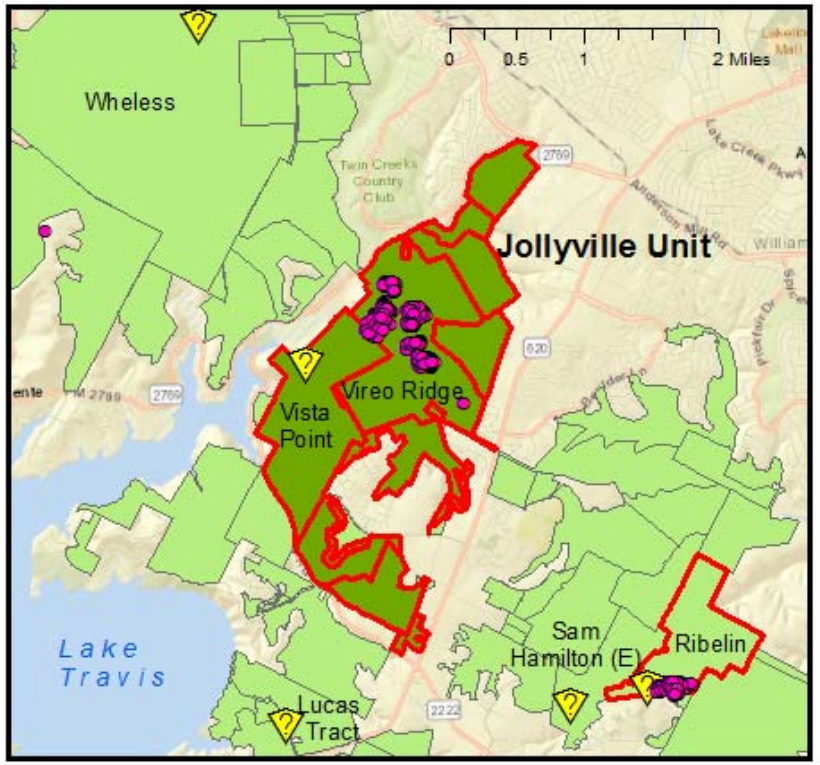
Travis County BCP, Jollyville Unit

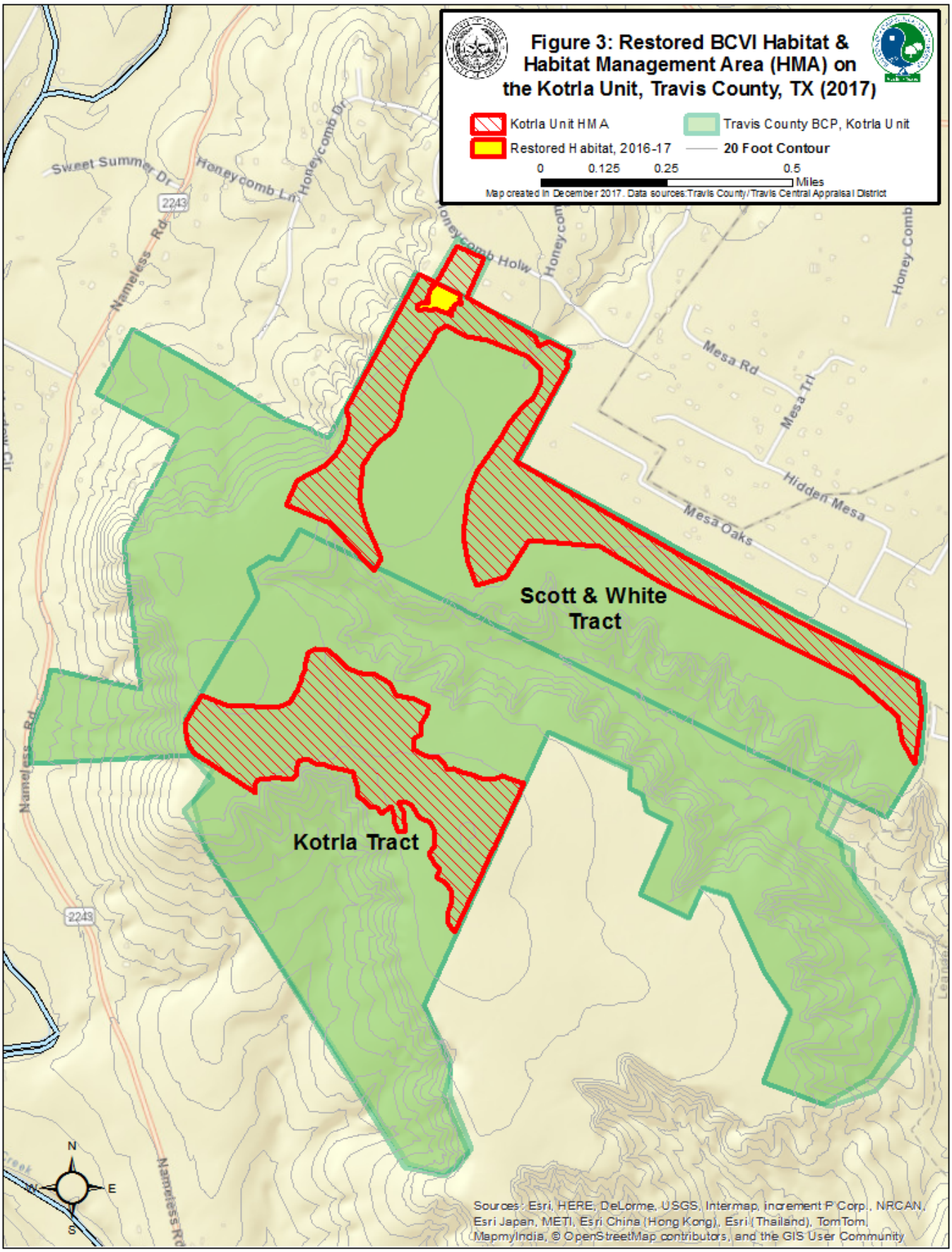
Balcones Canyonlands Preserve

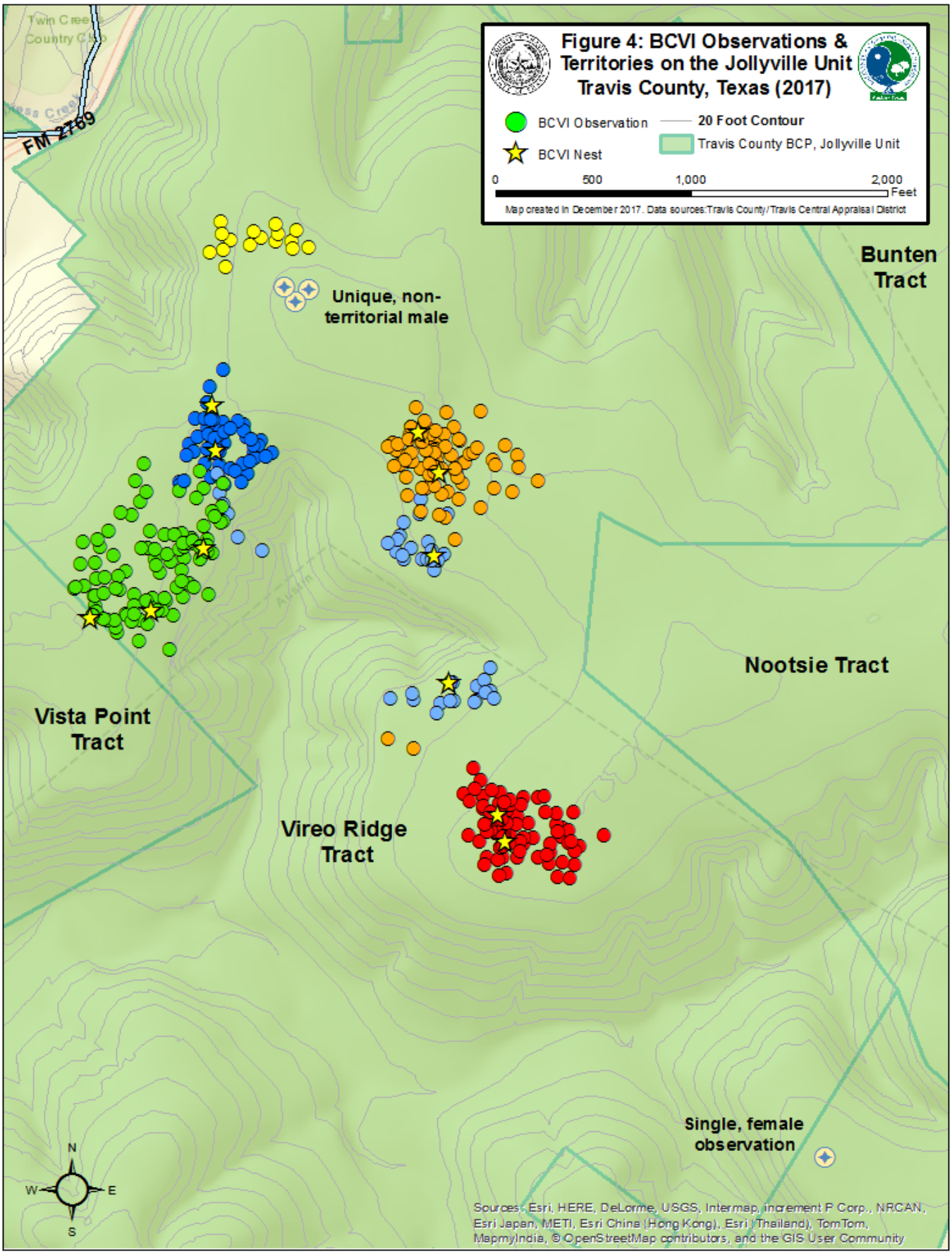
Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

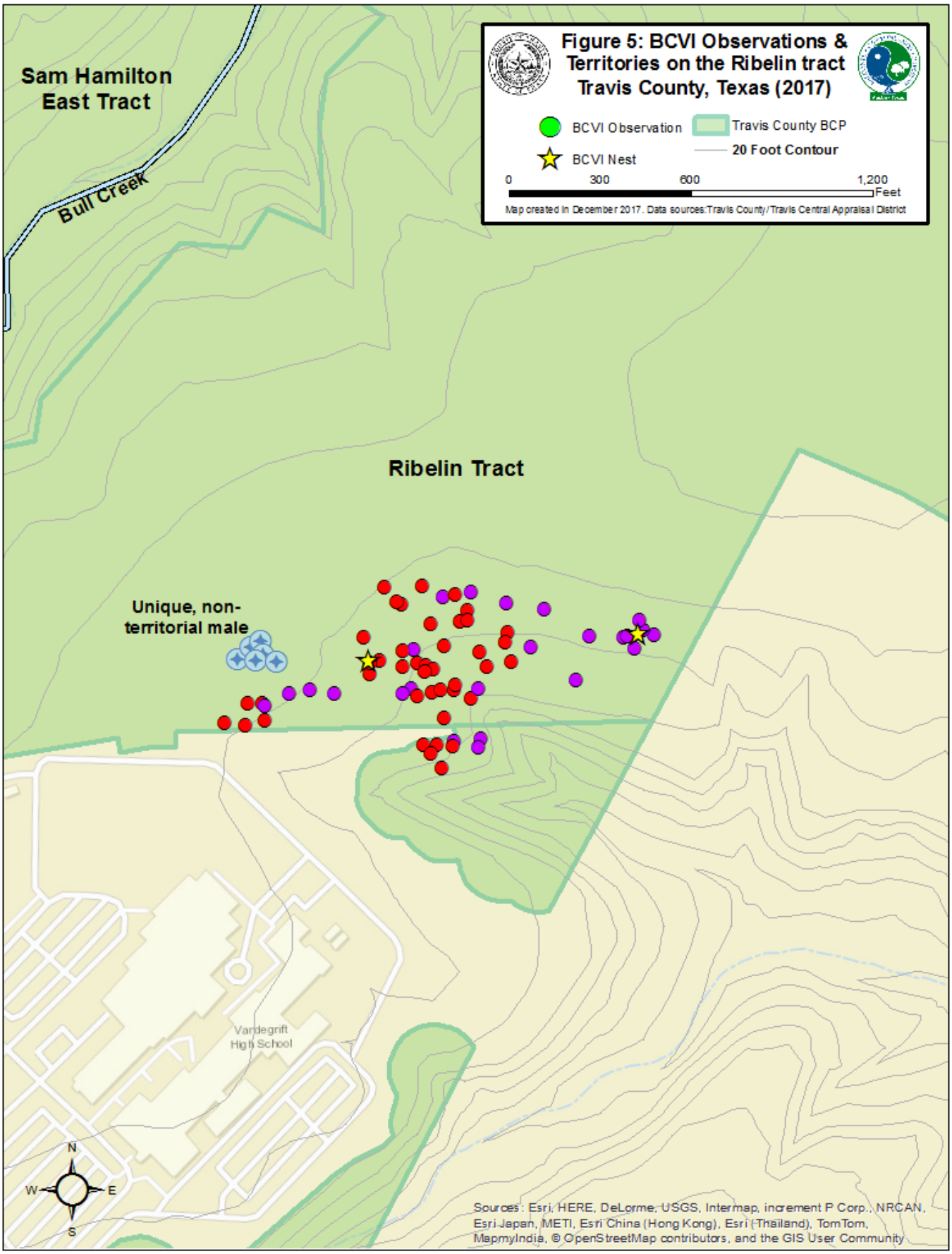


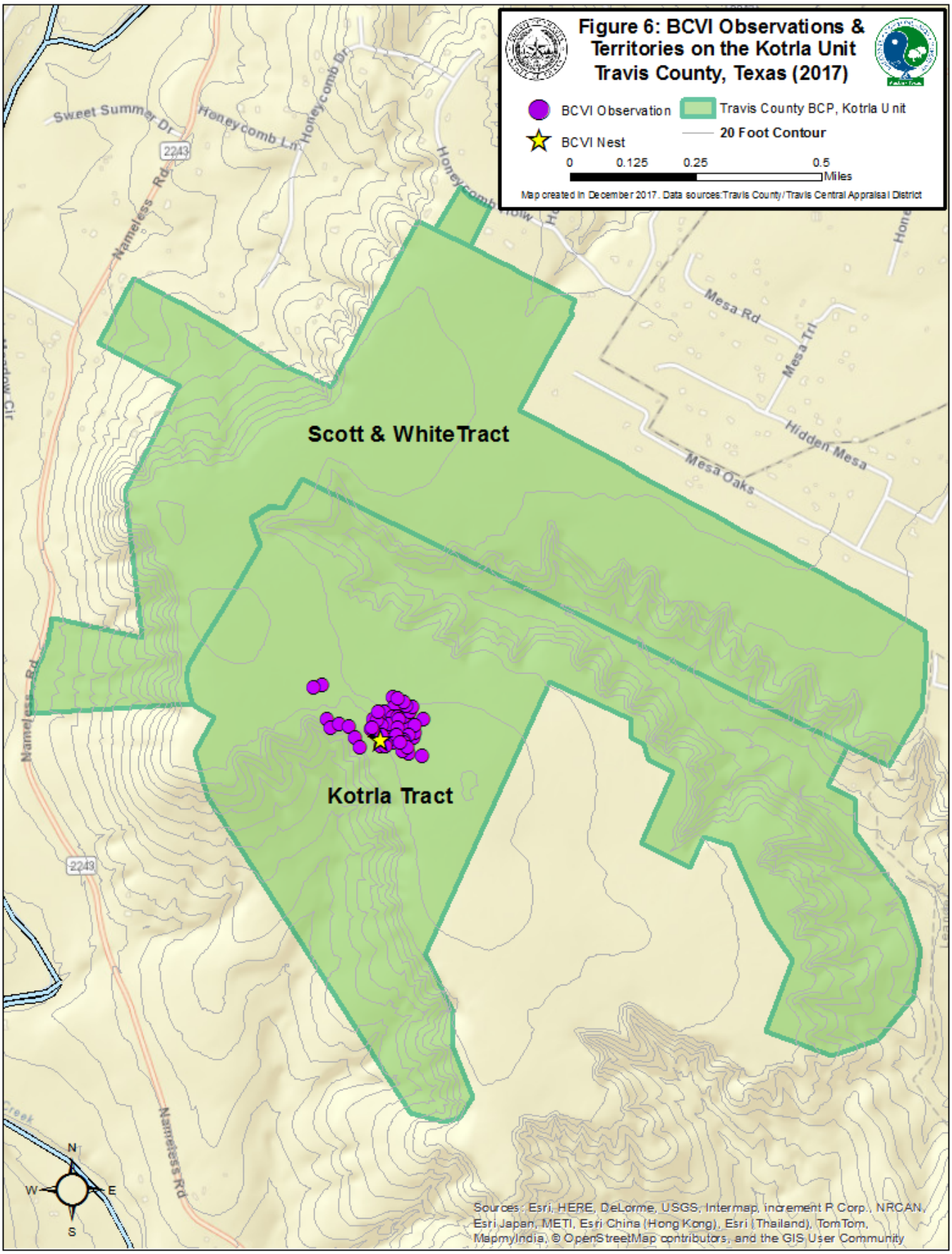





Figure 3: Restored BCVI Habitat & Habitat Management Area (HMA) on the Kotrla Unit, Travis County, TX (2017)
Kotrla Unit HMA
Travis County BCP, Kotrla Unit
Restored Habitat, 2016-17
20 Foot Contour
0 0.125 0.25 0.5
Miles
Map created in December 2017. Data sources:Travis County/Travis Central Appraisal District
Sweet Summer Dr
Honeycomb Ln
Honeycomb Dr
Honeycomb Holw
Nameless Rd
2243
Mesa Rd
Mesa Trl
Hidden Mesa
Mesa Oaks
Scott & White Tract
Kotrla Tract
N
E
S
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community


Figure 4: BCVI Observations & Territories on the Jollyville Unit
Travis County, Texas (2017)
BCVI Observation
BCVI Nest
20 Foot Contour
Travis County BCP, Jollyville Unit
0
500
1,000
2,000
Feet
Map created in December 2017. Data sources:Travis County/Travis Central Appraisal District
Twin Creeks Country Club
FM 2769
Unique, non-territorial male
Bunten Tract
Nootsie Tract
Vista Point Tract
Vireo Ridge Tract
Single, female observation
N
W
E
S
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community


Figure 5: BCVI Observations & Territories on the Ribelin tract
Travis County, Texas (2017)
BCVI Observation
BCVI Nest
Travis County BCP
20 Foot Contour
0
300
600
1,200
Feet
Map created in December 2017. Data sources:Travis County/Travis Central Appraisal District
Sam Hamilton East Tract
Bull Creek
Ribelin Tract
Unique, non-territorial male
Vandegrift High School
N
W
E
S
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community


Figure 6: BCVI Observations & Territories on the Kotrla Unit Travis County, Texas (2017)
BCVI Observation
BCVI Nest
Travis County BCP, Kotrla Unit
20 Foot Contour
0 0.125 0.25 0.5
Miles
Map created in December 2017. Data sources:Travis County/Travis Central Appraisal District
Scott & WhiteTract
Kotrla Tract
Sweet Summer Dr
Honeycomb Ln
Honeycomb Dr
Nameless Rd
2243
Mesa Rd
Mesa Trl
Hidden Mesa
Mesa Oaks
N
W
E
S
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community