FY 2016 Report on Monitoring and Management of the Black-capped Vireo (*Vireo atricapilla*) on Travis County's Balcones Canyonlands Preserve



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

Travis County

Department of Transportation and Natural Resources

Natural Resources & Environmental Quality Division

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INTRODUCTION

In the United States and Canada, 448 native bird species breed in terrestrial habitats (Rich et al. 2004). 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 due to a wide array of threats including, but not limited to, habitat loss, degradation, and fragmentation (Rich et al. 2004). 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: three counties in Oklahoma, portions of central and south-central Texas, and south into central Coahuila, through Nuevo Leon and into southwestern Tamaulipas, Mexico (Farquhar and Gonzalez 2005; Grzybowski et al. 1994; Grzybowski 1995, Oklahoma Dept. of Wildlife Cons. 1999; U.S. Fish and Wildlife Service 1991). Between 1996 and 2005, BCVI populations in Texas have been reported in only 38 south-central and central counties (Wilkins et al. 2006). 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, a petition in 2012 will likely result in an actual decision to either make no change or to down-list.

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 September 2016, the BCP encompassed over 31,700 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).

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 2016 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 2016 breeding season, BCVI territory surveys were primarily conducted on portions of the Jollyville Unit and the Lucas tract (Figure 2), as well as on the Travis County Parks Department's Milton Reimers Ranch County Park. Additional secondary locations were checked periodically for presence/absence of BCVIs on other areas of the Jollyville Unit, the Ribelin tract, and Kotrla Unit.

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 is dominated by black walnut (*Juglans nigra*), sycamore (*Platanus occidentalis*) and elms (*Ulmus* spp.), occupies riparian areas along creeks and drainages. Ridge tops are often dominated with shin oak (*Quercus* sinuata), the signature species dominating most occupied BCVI habitat in Central Texas.

The Lucas tract (Figure 2), which includes the Lake Travis Bluffs subsection, totals 297 acres (120 ha) located approximately 1.5 miles (2.4 km) northeast of Mansfield Dam which impounds Lake Travis (Colorado River). Primary access points are either on RM 620, which bounds the property to the south, or Comanche Trail, which

bisects the property into eastern and western sections. The Lucas tract is part Lake Travis Unit of the Cypress Creek Macrosite.

Vegetation types found on the Lucas tract are generally similar to those on the Jollyville Unit. Prior to Travis County ownership, small portions of this tract were cleared for livestock pens and hunting lanes. Malta starthistle (*Centaurea melitensis*), chinaberry (*Melia azedarach*) and Roosevelt weed (*Baccharis neglecta*) are common in these disturbed areas. The Lake Travis Bluffs section, acquired in 2011, is an 18.5 acre (7.5 ha) parcel that was previously cleared for development. Subsequently, most of Lake Travis Bluffs has grown into excellent BCVI habitat dominated by shin oak, sumacs (*Rhus* spp.) and Texas redbuds (*Cercis Canadensis* var*. texensis*).

Milton Reimers Ranch County Park (hereafter, Reimers Ranch Park) is situated in the extreme western portion of Travis County. It is located south of SH 71, east of the Blanco County line and north of the Hays County line. This park is managed by the Travis County Parks Division.

Reimers Ranch Park is comprised of four tracts, totaling approximately 1500 acres (607 ha). Site topography slopes to the west, with surface runoff flowing west towards the Pedernales River. Soils are generally comprised of Brackett and Volente series (Soil Conservation Service 1974). The park can be divided into the two general vegetation types: riparian and savannah areas. The riparian areas are characterized by large trees such as common bald cypress (*Taxodium distichum*), plateau live oak (*Quercus fusiformis* var*. fusiformis*), Texas oak (*Quercus Buckleyi*), cedar elm (*Ulmus crassifolia*), and pecan (*Carya illinoensis*) with an understory comprised of evergreen sumac (*Rhus sempervirens*), agarita (*Mahonia trifoliolata*), American beautyberry (*Callicarpa americana*), and frostweed (*Verbesina virginica*). The open meadow areas are savannah-like, characterized by wooded overstory trees such as live oaks, cedar elm, Texas persimmon (*Diospyros texana*), and only a few understory shrubs such as agarita, as well as numerous grass and wildflower species.

The tract was historic ranchland, and the upland areas were cleared for many years to improve livestock grazing. The canyon areas do not appear to have been cleared and the vegetation within them is diverse. A wildfire in 2011 altered portions of the

park and created pockets of potential BCVI habitat dominated by resprouting live oak and sumacs species.

The Ribelin tract is located within the Bull Creek macrosite (Figure 2). This 319 acre (129.1 ha) tract is located off of RM 2222 and McNeil Drive, which is the primary access point. The tract is located between Travis County's Sam Hamilton East tract and the City of Austin's Kent Butler tract and the Upper Bull Creek Unit. 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. 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.

The Kotrla Unit totals 950 acres (384 ha) and is comprised of the 500-acre Kotrla tract and the 450-acre Scott & White tract (Figure 2). These tracts are located in the Big Sandy Creek macrosite in far northwest Travis County. These properties contain habitat for both endangered songbirds and likely provide substantial connectivity between the BCP and BCNWR. 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. Other species include live oak, cedar elm, Texas ash (*Fraxinus texensis*) and Texas oak. In particular, the north-eastern section of the property contains habitat currently suitable for the BCVI, as well as areas which might be made suitable by burning or other vegetative manipulation.

A substantial canyon runs generally northwest to southeast between the two tracts. 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.

HABITAT RESTORATION

Beginning in FY2001, and continuing every winter thereafter, Travis County has conducted BCVI habitat restoration within BCVI Habitat Management Areas (HMAs) (Figure 3). 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 (*Ptelea trifoliata*), Carolina buckthorn (*Frangula caroliniana*) 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 2015-16, 1.75 acres on the Vireo Ridge tract was restored by hand, using chain saws and pruning loppers. This area expands upon a section originally restored in 2001 and where dense stands of shin oak had been choked out by Ashe juniper. Maintenance was also performed on approximately 4-5 acres of this previously restored habitat. These actions increased the cumulative total of restored habitat on Travis County managed lands to approximately 156.60 acres (63.37 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 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 habitat, diversity of desired woody species, and available budget. 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.

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 2016, 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 number ("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.

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 BCVIs on the Jollyville Unit and the Lucas tract, 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) areas along a power line easement on the Ribelin tract that were restored in 2009 and 2010 and occupied in 2013 and 2015; 3) three separate areas of habitat on the Kotrla Unit including sites occupied in 2014 and 2015; 4) the power line easement on the Sam Hamilton tract and 5) the Lake Travis Bluffs section of the Lucas tract that was occupied in 2011.

BCVIs were surveyed for a total of 142 hours from March 28 (first detection) to July 20, 2016 (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 2016, six adult male BCVIs and one adult female BCVI were banded. Since 2008, 47 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 2016, BCVIs were located on the Jollyville Unit (Figure 5), the Lucas tract of the Lake Travis Unit (Figure 6) and on Milton Reimers Ranch County Park (Figure 7). One male was detected on a single day on the Ribelin tract. Two unique males were also detected on a single day on the Jollyville Unit. These “one-day” detections are added to abundance, but not represented in detail on a map in this report. Abundance totaled 19 males.

On Travis County managed properties, 13 males established 14 territories with 13 located in areas where habitat restoration had previously occurred. One male established two separate territories over a half-mile apart from each other. One male established a territory on a Travis County Park in the far western side of the County. Six 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 and none were detected in areas slotted for presence/absence surveys.

Table 1 presents a summary of BCVI data collected during the 2016 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 Travis County properties).

Table 1. Summary of Jollyville Unit and Travis County BCVI survey data collected by various agencies, Travis County, Texas. 1989-2016.

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

Year Surveyed	Agency**	Jollyville Unit Abundance	Jollyville Unit No. Territories	Abundance/ No. Territories (all Travis County lands)
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

*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 2016 on the Jollyville Unit, eleven territories were considered successfully paired (Table 2). Eight territories fledged offspring, yielding at least 29 'hatch year' (HY) individuals observed in the field (Table 3). For the second time (first time in 2015) since the monitoring program began, a territory definitively had more than one successful nest. One territory each produced two successful nests producing a total of six HYs. An additional older fledgling was observed with an adult male on the Lucas tract (off the Jollyville Unit) bringing to total number of HYs to at least 30. 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.

Because of their dull-colored plumage, cryptic behavior, and unpredictable flights, we expect observer counts of fledglings to be biased low. Productivity in 2016 (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 2001-2016.

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

[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.

A total of 13 BCVI nests were located and monitored in 2016. 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=13), eight (61.5%) successfully fledged at least one young. Five nests were depredated (38.5%) by unknown predators. Four territories had second successful nest attempts following a failed nest. Three of these four territories had monitored nests, with the fourth deemed successful by the observation of a lone HY being tended to by a known adult. One territory had at least

two successful, monitored nests. One male established two separate territories with neither having a successful nest. Some initial nest discoveries occurred later in the season suggesting that earlier nests were never located and were likely unsuccessful.

Table 3. Breeding success and productivity for BCVI (*Vireo atricapilla*) territories on Jollyville Unit, Travis County, Texas, March-September 2001-2016.

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

[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 2016.

Substrate	Primary substrate height (m)	Additional Concealment	Nest height (cm)	Distance from stem (cm)	Distance from foliar edge (cm)	Orientation	Comments
Evergreen sumac (*Rus virens*)	1.75	Ashe juniper (*Juniperus Ashei*)	64	47	14	W 270°	Failed; (4 nestlings)
Texas persimmon (*Diospyros texana*)	3.0	Evergreen sumac (*Rus virens*)	107	113	18	S 174°	Successful; (3 HY, 1 egg)
Evergreen sumac (*Rus virens*)	3.0	Sunflower sp. (*Helianthus* sp.)	77	56	24	SW 173°	Successful second attempt; (3 HY, 1 egg)
Wafer ash (Ptilia trifoliate)	1.75	Little bluestem (*Schizachyrium scoparium*)	70	13	14	NE 58°	Failed; (4 eggs, one, 25% smaller)
Flameleaf sumac (*Rhus lanceolata*)	2.0	Live oak (*Quercus fusiformis*) Ashe juniper Prickly ash (*Zanthoxylum hirsutum*)	113	35	26	E 90°	Successful second attempt; (3 HY)
Carolina buckthorn (*Frangula caroliniana*)	4.0	Ashe juniper	146	61	25	NE 42°	Successful; (4 HY)
Shin oak (*Quercus sinuata*)	4.0	Sevenleaf creeper (*Parthenocissus heptphylla*)	75	38	24	NW 320°	Successful; (4 HY)
Shin oak Texas oak (*Q. fusiformis*)	2.5	Evergreen sumac Ashe juniper	86	43	20	E 85°	Failed; (4 eggs)
Texas ash *(Fraxinus texensis)*	>10.0	Ashe juniper	150	120	20	NE 48°	Successful second nest; (4 HY)
Shin oak	2.5	n/a	98	46	23	NW 298°	Successful; (4 HY)
Shin oak	2.5	Ashe juniper Texas persimmon Mexican buckeye (*Ungnadia speciosa*)	81	48	22	N 10°	Failed; (4 nestlings)

Substrate	Primary substrate height (m)	Additional Concealment	Nest height (cm)	Distance from stem (cm)	Distance from foliar edge (cm)	Orientation	Comments
Evergreen sumac	5	Ashe juniper	155	51	21	Center/S 195°	Successful; (4 HY)
Shin oak	4.0	Ashe juniper	112	39	20	E 50°	Failed; (4 nestlings)

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 on Jollyville Unit, Travis County, Texas, 2016.

Object-ID	Color Band Combination	Nesting attempt	UTM E	UTM N	LAT	LONG
El Tigre 1	OR/SI:BK/BK	1	609844	3368970	30.4417876	-97.855969
El Tigre 2	OR/SI:BK/BK	2	610112	3367925	30.438422	-97.853290
Prince	NB/MV:MV/SI	1	609567	3368137	30.440983	-97.858941
Prince	NB/MV:MV/SI	2	609636	3368070	30.439774	-97.858227
Bruiser	NB/SI:BK/BL	1	609649	3368304	30.441889	-97.858068
Bruiser	NB/SI:BK/BL	2	609851	3368216	30.441093	-97.858785
Guy Clark	DG/SI:YE/DB	1	609711	3368352	30.442315	-97.857416
Bob	OR/DG:YE/SI	1	610086	3368267	30.441512	-97.853521
Capt. Amer.	WH/SI:RD/DB	1	610213	3367743	30.436770	-97.852260
VR07	UB	1	610276	3367673	30.436131	-97.851608
VR07	UB	2	610340	3367663	30.436041	-97.850944
VR01	UB	1	610731	3367258	30.432346	-97.846912
VR02	UB	1	610846	3367130	30.431180	-97.845732

In all, a total of 11 individual adult BCVIs (seven males, four females) wearing color bands were observed on Travis County properties in 2016. Of these, six adult males and one adult female were banded during the 2016 field season. One additional male BCVI (banded in 2014) and three additional female BCVI (banded in 2009, 2013 and 2014) were also observed this year. It is worth mentioning that one banded female is A9Y (older than nine years old), paired but her nest was depredated. Of note, one of her four eggs was a quarter smaller than the three normal sized eggs.

Adult males showed a 16.7% return rate (one of six banded males observed in 2015). The one returning male shifted to a new area and paired with two separate

females on separate nest attempts. As previously mentioned one newly banded male established two separate territories over a half-mile apart. Two banded females observed in 2015 returned in 2016, hence a 100% return rate of females. A female banded in 2014, not seen in 2015 also returned 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 2016, six males were banded and of these, five were 'second year' males, i.e. males in their first reproductive season. All five 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 2016, the overall pSY, based on marked birds, was 71.4% (five of seven). This marks the highest figure since the banding program was initiated.
- Site fidelity: In 2016, one of six banded males observed in 2015 returned indicating a 16.7% return rate on all Travis County properties. Females showed a 66.7% return rate (two of three, from 2015).

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

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

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

DISCUSSION

The number of territories (-2) and overall abundance (-2) decreased slightly from the 2015 season's totals. In the core vireo habitat on the Jollyville Unit, 13 males established territories in 2015. In 2016, there were 14 unique males detected with 12 establishing territories marking a decrease of one territory. This marks the first decrease in territory numbers on the Jollyville Unit since 2010-11, albeit a modest drop (-1).

Two territories were discovered outside the Jollyville Unit. For the first time since a BCVI was monitored at Hippie Hollow Park in the mid-1990s, a male BCVI was monitored on Travis County Park property. This unpaired male spent over a month at Reimers Ranch Park. A second male established a successful territory on the Lucas tract and produced at least one HY. What drives changes in BCVI numbers is unclear, but normal population fluctuations, the easing of the drought, changes in migration patterns through the area, and changes in quality of habitat could be factors. Vegetative response to fire likely played a part at MRRP as a wild fire in 2011 altered the habitat, creating shrubby stands of oak and sumac. A controlled burn program at this park may create additional pockets of suitable habitat in the future and will need to be monitored.

On the Jollyville Unit, pairing success increased again above 90% as was the case from 2007-2014. Overall productivity (2.6 fledged offspring per full territory) dropped slightly from the previous four years but remained one of the higher rates since 2001. Productivity for the total number of successfully paired territories (2.4 fledglings per full territory) increased from 2015 and was the second highest on record (since 2001). Productivity for 2014-16 combined was the largest three-year output of fledglings (n=82) ever recorded since the monitoring program began. The second best three-year total was from 2006-2008 (n=68).

As in 2015, which was the first time on record for Travis County BCP, a second successful nest for a territory was noted. One territory produced a successful second brood. There was also an indication of extra females in the population as it was noted that one male paired with a banded female and after their nest was depredated, the male established a new, successful nest with an unbanded female. Similarly, a banded male established a territory that had an unsuccessful nest, then moved over a half-mile and created a new territory with presumably a new female.

Travis County acquired the Kotrla Unit for, among other things, its expansive swaths of potential BCVI habitat. Although much of the habitat has grown undesirable, small pockets remain along with a large swath of rangeland that is growing into suitable habitat. Here, two BCVIs were detected late in the season counter-singing but apparently did not establish territories. This marks the third year in a row that BCVIs have been detected on this property which shows promise of expanded occupation in the future. The nearby location to the USFWS Balcones National Wildlife Refuge and its's substantial BCVI population makes this new unit important to the regional stability of this species. Habitat restoration efforts are planned for the winter of 2016-17.

Total survey effort (10.1 hours/territory) was the lowest effort spent over the past seven seasons and decreased from the 2015 effort (11.2 hours/territory) and was a decrease from the overall survey effort average (15.0 hours/territory) from the previous six seasons (2010-2015). The amount of survey hours in 2016 decreased from 2015 by 37 hours. This decrease in effort can be attributed primarily to the result of staff surveying intensively for Golden-cheeked Warblers throughout the majority of the Jollyville Unit BCVI colony, thus "double sampling". This reduced much of the time spent initially discovering and identifying BCVI colonies and reduced the amount of time needed for some basic territory mapping. There was also the addition of two new employees that used much of the season getting acquainted with this species. As expected, there was an increase in banding effort in 2016 with the addition of new permitted staff, which also helped increase accuracy of territory delineations and reduced time-consuming, individual identification guess work. The cryptic behavior of certain individual males also made it difficult to determine territory status (pairing and productivity). Survey hours are more directly tied to the survey team's ability to acquire pairing and productivity data (nests) then on BCVI abundance and numbers of territories. It is important to note that survey hours also include those in areas without BCVIs (presence/absence surveys).

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 2016 occurred in the same general core areas on the Jollyville Unit as in previous years (Travis County 2001-2015). 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.

An area of special note is a portion of Vireo Ridge referred to as “35-acres”. This portion was occupied by two BCVIs in 2003 and 2004. In 2005 a lone BCVI was detected once and but did not establish a territory. Because this area was growing out of habitat it was restored in winter 2005. It appeared to have grown back into suitable habitat by 2009 and was finally re-occupied by a successfully paired (and banded) male in 2013. In 2014, two males established territories in this area and one male again established a territory in 2015. In 2016, two males again established successful territories. Similarly, areas on the southern edge of the Jollyville core area have increased to three territories in 2015 after several years with no territories. Similarly, some areas that have consistently occupied have had decreases. Notably, for the first time since 2001, no BCVIs established territories in a section of the Vireo Ridge tract referred to as “Denali”.

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 now show characteristics of prime BCVI habitat.

All of the 2016 BCVI territories on the Jollyville Unit, as well as those on the Lucas tract, were established primarily in previously manipulated areas which may be considered “restored”. This has been the observed trend since 2006. These observations indicate that BCVIs continue to respond positively to habitat restoration efforts undertaken since 2001, when it appeared that the remaining BCVIs were shifting annually from lesser quality habitat into higher-quality restored areas. It should be noted, however, that large areas of apparently restored habitat still have not been reoccupied and other areas that, although have been occupied, appear to have enough space 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.

It is worth mentioning that although the three years have generally been wetter, the general prolonged drought over the last few years is likely negatively impacting the population. These impacts may include decreased habitat suitability e.g., decreased invertebrate population or sparse vegetation cover, which in turn could affect reproductive success. However, reversely, the generally drier conditions, especially at the beginning of the decade, let to conditions that allowed a significant wild fire to consume a portion of Reimers Ranch Park that resulted in occupied BCVI habitat to form.

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 can be noted on the Kotrla Unit and on the Ribelin tract where unique males were detected later in the season in various habitat types. Although they may have been migrating, it is possible that they had established, or attempted to establish, territories nearby and were never detected due to their isolation.

Continued research and monitoring of BCVI on the Jollyville Unit is essential to determine whether the 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.

RECOMMENDATIONS

- 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 should 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. Research should be focused upon answering questions of immediate relevance to management and recovery priorities.
- Collect and compile age-specific survivorship and reproductive information for marked birds. This information may provide a more accurate picture of population dynamics in cases where field data is believed to be incomplete or biased (e.g. using mean values to account for number of HYs per nest rather than number of fledglings observed in the field).
- Continue to facilitate opportunities for graduate students to collect and analyze quantitative habitat and vegetation data in order to construct habitat suitability and dispersal models. Longitudinal studies are needed to compare the results of habitat restoration treatments over time. Ideally, such data would be collected in a GIS-compatible format and at a scale that would allow preserve-wide spatial analysis. Such analyses could improve our ability to locate existing areas of high quality habitat as well as areas with high potential for successful restoration. Additionally, further research is needed to better understand dynamics of vegetative succession and its relationship to BCVI habitat suitability and reproductive success in this region.
- Continue to refine and standardize BCVI monitoring procedures, giving special attention to minimum hours of survey and nest searching needed. This is especially important for new properties with potential BCVI habitat.

- BCVI habitat and potential habitat for restoration should continue to be identified and mapped on all tracts owned and managed by Travis County. Historic BCVI locations on properties owned and managed by Travis County should be visited regularly during the field season to determine presence/absence of BCVIs.
- Habitat restoration efforts will continue on tracts that support BCVI populations and on surrounding tracts that harbor potential habitat. Restoration methods will be evaluated to determine the best techniques for creating suitable BCVI breeding habitat.
- Create a more structured GCWA survey methodology for monitoring territories and productivity in both potential and managed BCVI habitat. Efforts should be 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.
- Judicious use of recorded BCVI vocalizations should continue in accordance with USFWS protocols, especially in areas where few and/or isolated BCVIs have been detected. This recommendation is also useful to determine absence of a target species. Playback should increase detections of territorial males (Horne 2000).
- Cowbird trapping should continue on and adjacent to any Travis County-managed properties occupied by endangered songbirds, with traps added or removed based on cowbird activity. Shooting female cowbirds in habitat is also recommended. The addition of the Kotrla Unit deep within rural northwestern Travis County will likely demand an aggressive trapping program in that area. Joining efforts with the USFWS Balcones National Wildlife Refuge or volunteers should be considered.
- Although it was unclear if any BCVI nest attempts failed due to red imported fire ant (*Solenopsis invicta*, RIFA) predation in 2016, 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 2016, thus no treatments occurred. Twenty-five meters is based on the foraging distance of RIFA (USFWS 2014).

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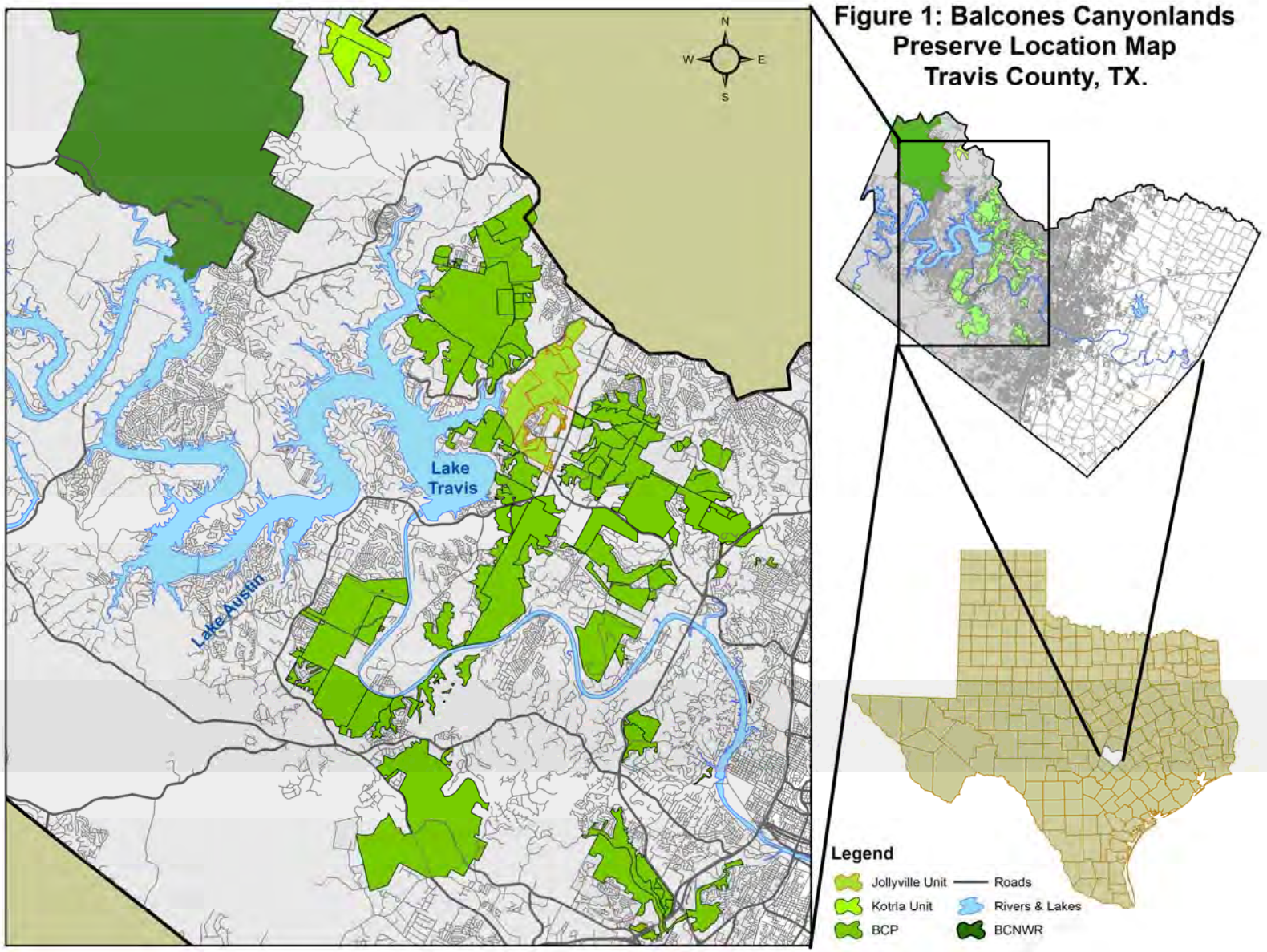


Figure 1: Balcones Canyonlands Preserve Location Map Travis County, TX.

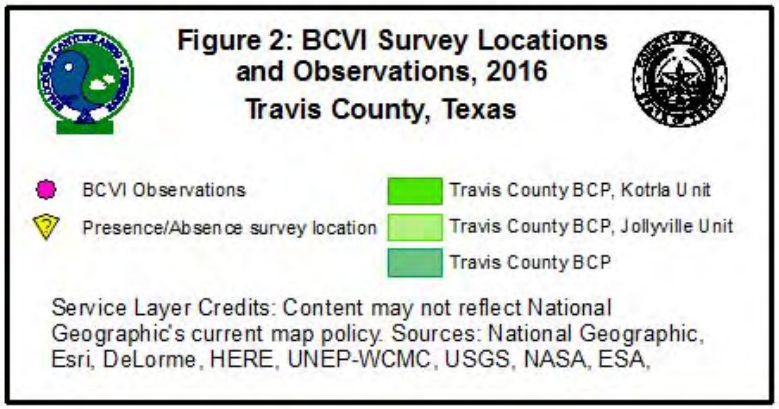
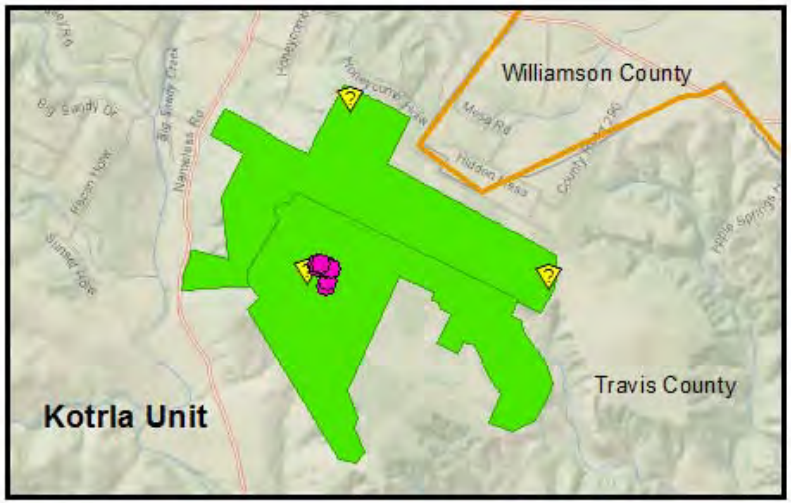
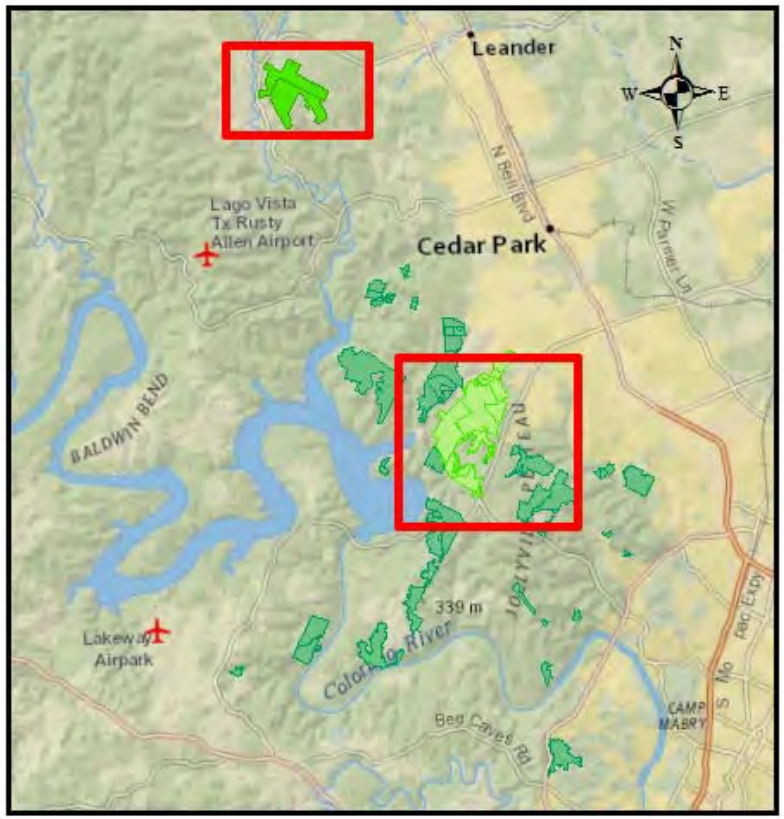
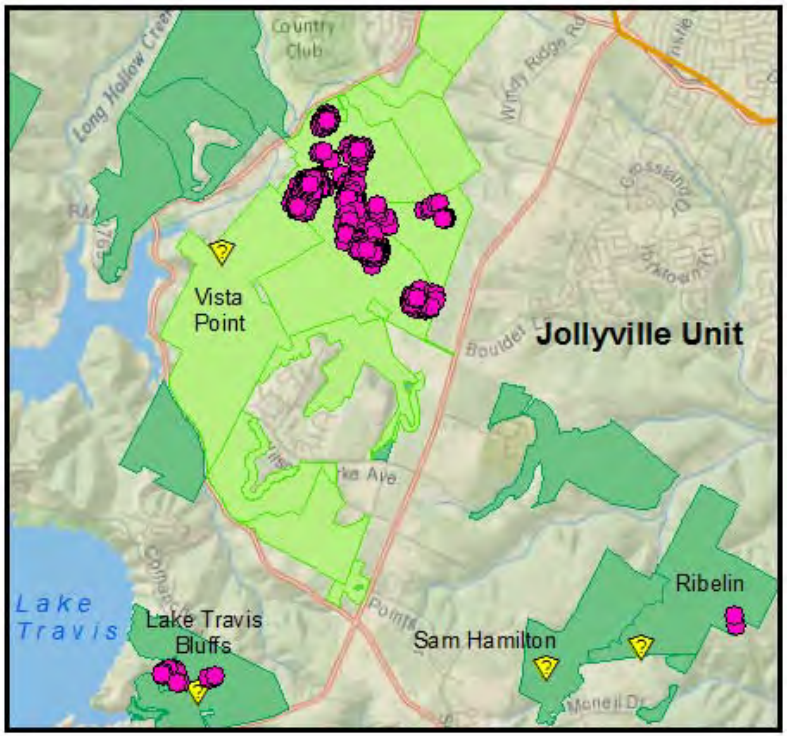


Figure 2: BCVI Survey Locations and Observations, 2016
Travis County, Texas
BCVI Observations
Presence/Absence survey location
Travis County BCP, Kotrla Unit
Travis County BCP, Jollyville Unit
Travis County BCP
Service Layer Credits: Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA,


Williamson County
Travis County
Kotrla Unit


Leander
Cedar Park
Lago Vista
Tx Rusty
Allen Airport
Lakeway
Airport
BALDWIN BEND
339 m
Colorado River
Bee Caves Rd
CAMP
MABRY


Vista
Point
Jollyville Unit
Lake
Travis
Lake Travis
Bluffs
Sam Hamilton
Ribelin

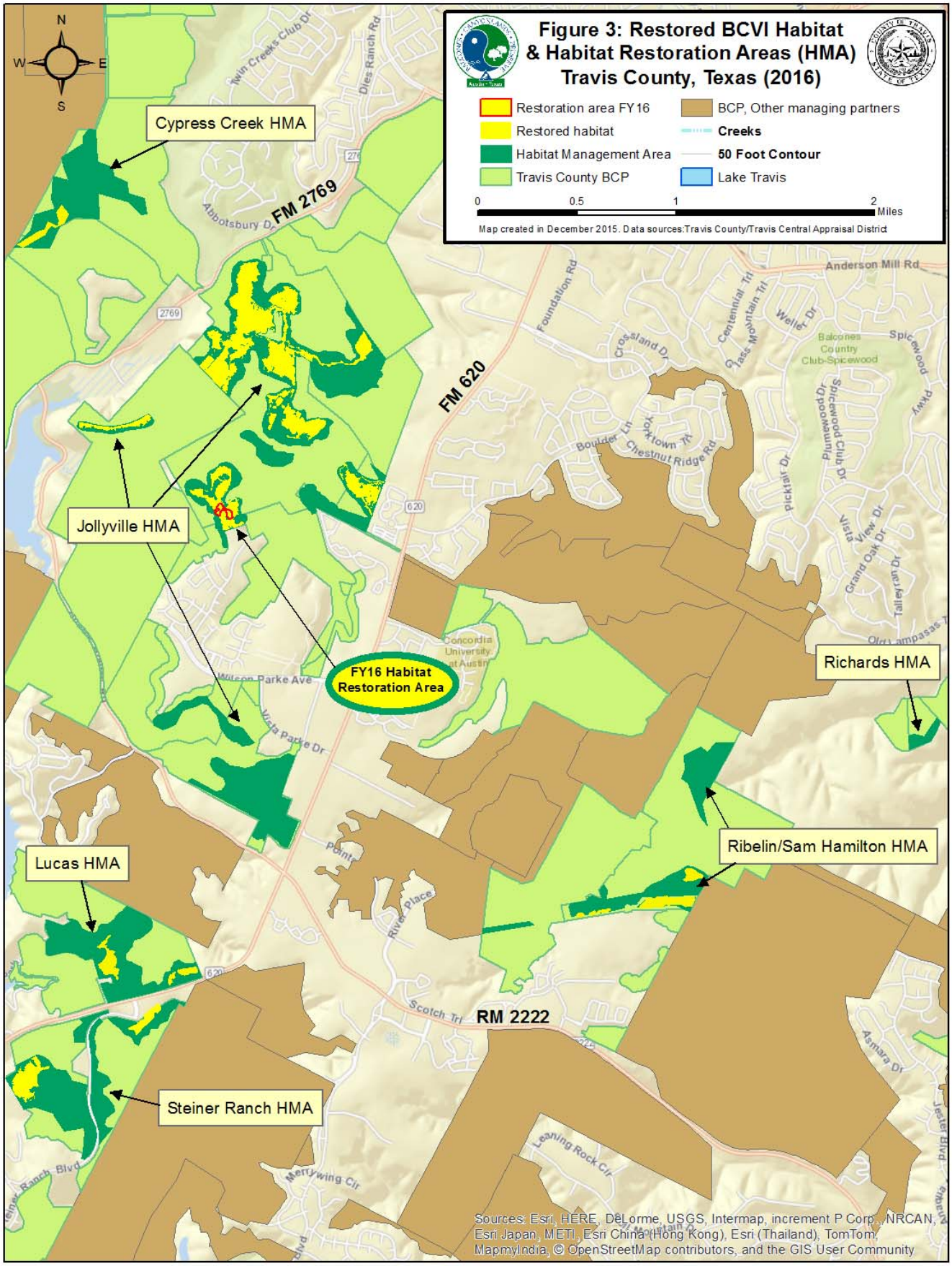


Figure 3: Restored BCVI Habitat & Habitat Restoration Areas (HMA) Travis County, Texas (2016)
Restoration area FY16
Restored habitat
Habitat Management Area
Travis County BCP
BCP, Other managing partners
Creeks
50 Foot Contour
Lake Travis
0 0.5 1 2 Miles
Map created in December 2015. Data sources:Travis County/Travis Central Appraisal District
N
W
E
S
Cypress Creek HMA
Jollyville HMA
Lucas HMA
Steiner Ranch HMA
Richards HMA
Ribelin/Sam Hamilton HMA
FY16 Habitat Restoration Area
FM 2769
FM 620
RM 2222
Anderson Mill Rd
Twin Creeks Club Dr
Dies Ranch Rd
Abbotsbury Dr
Foundation Rd
Crossland Dr
Centennial Trl
Glass Mountain Trl
Weller Dr
Balcones Country Club-Spicewood
Spicewood Pkwy
Spicewood Club Dr
Plumewood Dr
Boulder Ln
Yorktown Trl
Chestnut Ridge Rd
Picktair Dr
Vista View Dr
Grand Oak Dr
Talleyran Dr
Concordia University at Austin
Wilson Parke Ave
Vista Parke Dr
River Place
Scotch Trl
Asmara Dr
Leaning Rock Cir
Merrywing Cir
Steiner Ranch Blvd
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

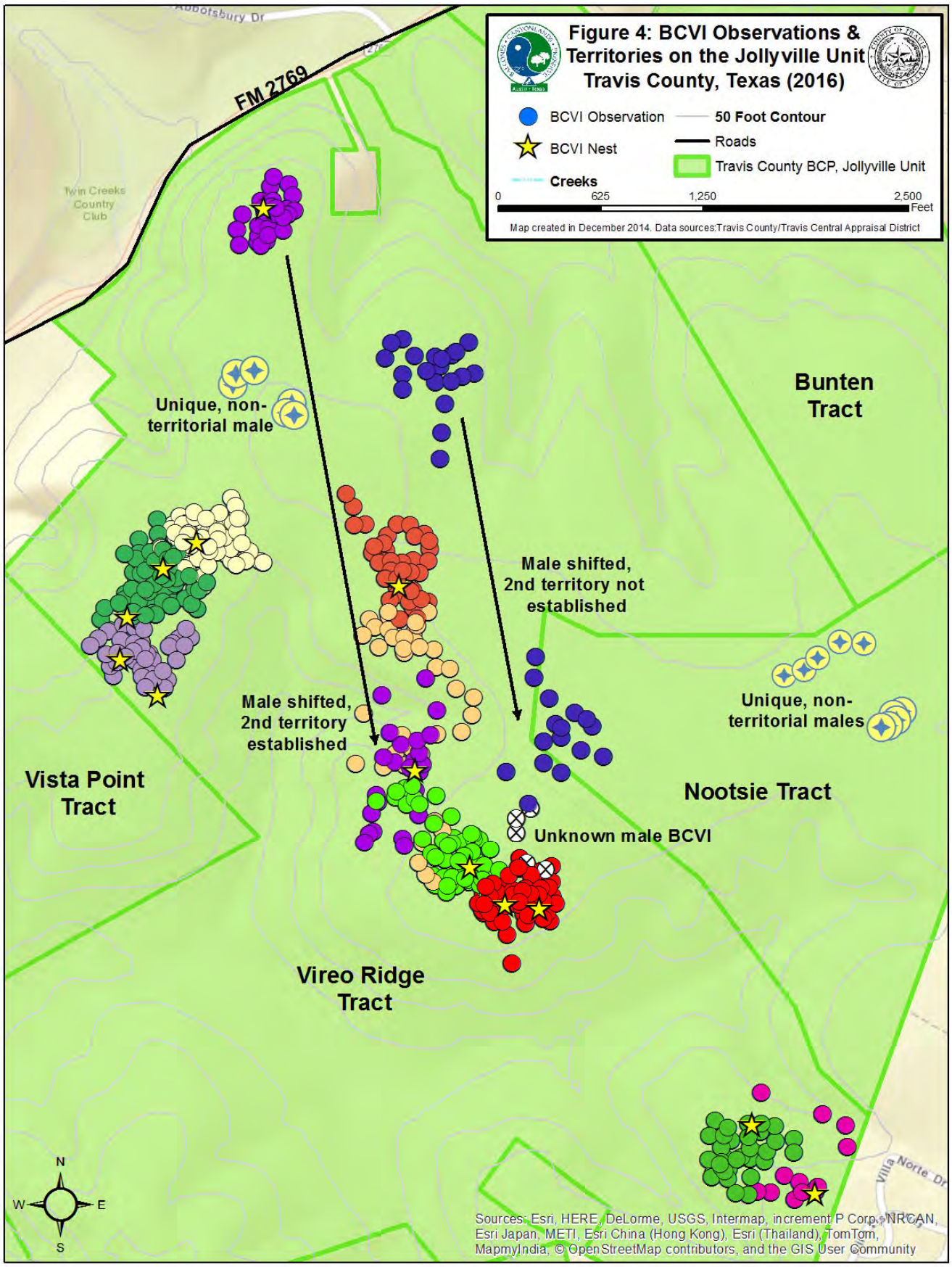


Figure 4: BCVI Observations & Territories on the Jollyville Unit Travis County, Texas (2016)
BCVI Observation
BCVI Nest
Creeks
50 Foot Contour
Roads
Travis County BCP, Jollyville Unit
0
625
1,250
2,500
Feet
Map created in December 2014. Data sources:Travis County/Travis Central Appraisal District
FM 2769
Abbotsbury Dr
Twin Creeks Country Club
Unique, non-territorial male
Bunten Tract
Male shifted, 2nd territory not established
Male shifted, 2nd territory established
Unique, non-territorial males
Vista Point Tract
Nootsie Tract
Unknown male BCVI
Vireo Ridge Tract
Villa Norte Dr
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

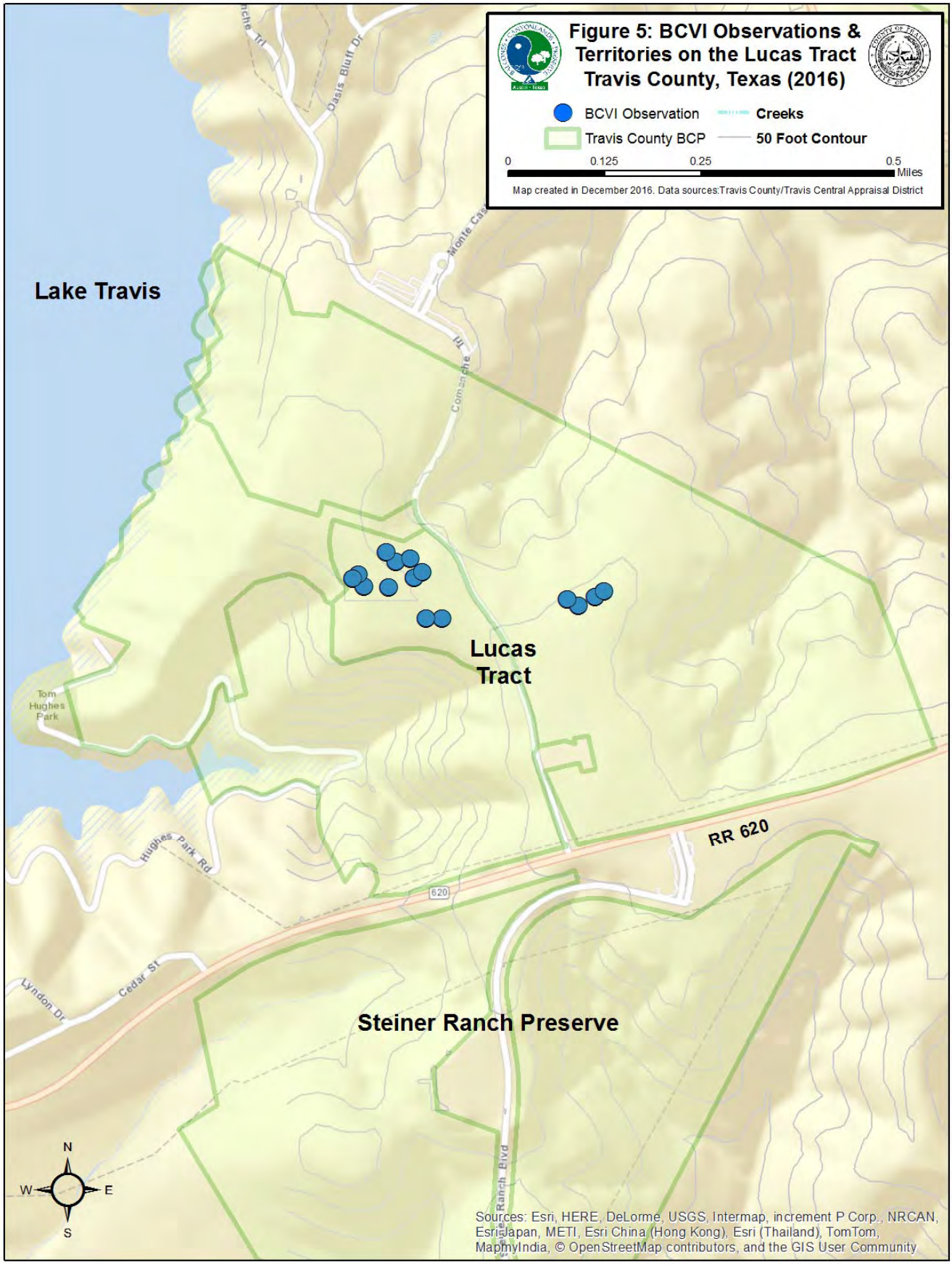


Figure 5: BCVI Observations & Territories on the Lucas Tract Travis County, Texas (2016)
BCVI Observation
Creeks
Travis County BCP
50 Foot Contour
0
0.125
0.25
0.5
Miles
Map created in December 2016. Data sources:Travis County/Travis Central Appraisal District
Lake Travis
Lucas Tract
Steiner Ranch Preserve
RR 620
620
Tom Hughes Park
Hughes Park Rd
Cedar St
Lyndon Dr
Dasis Bluff Dr
Comanche Trl
Monte Cas
Steiner Ranch Blvd
N
S
E
W
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

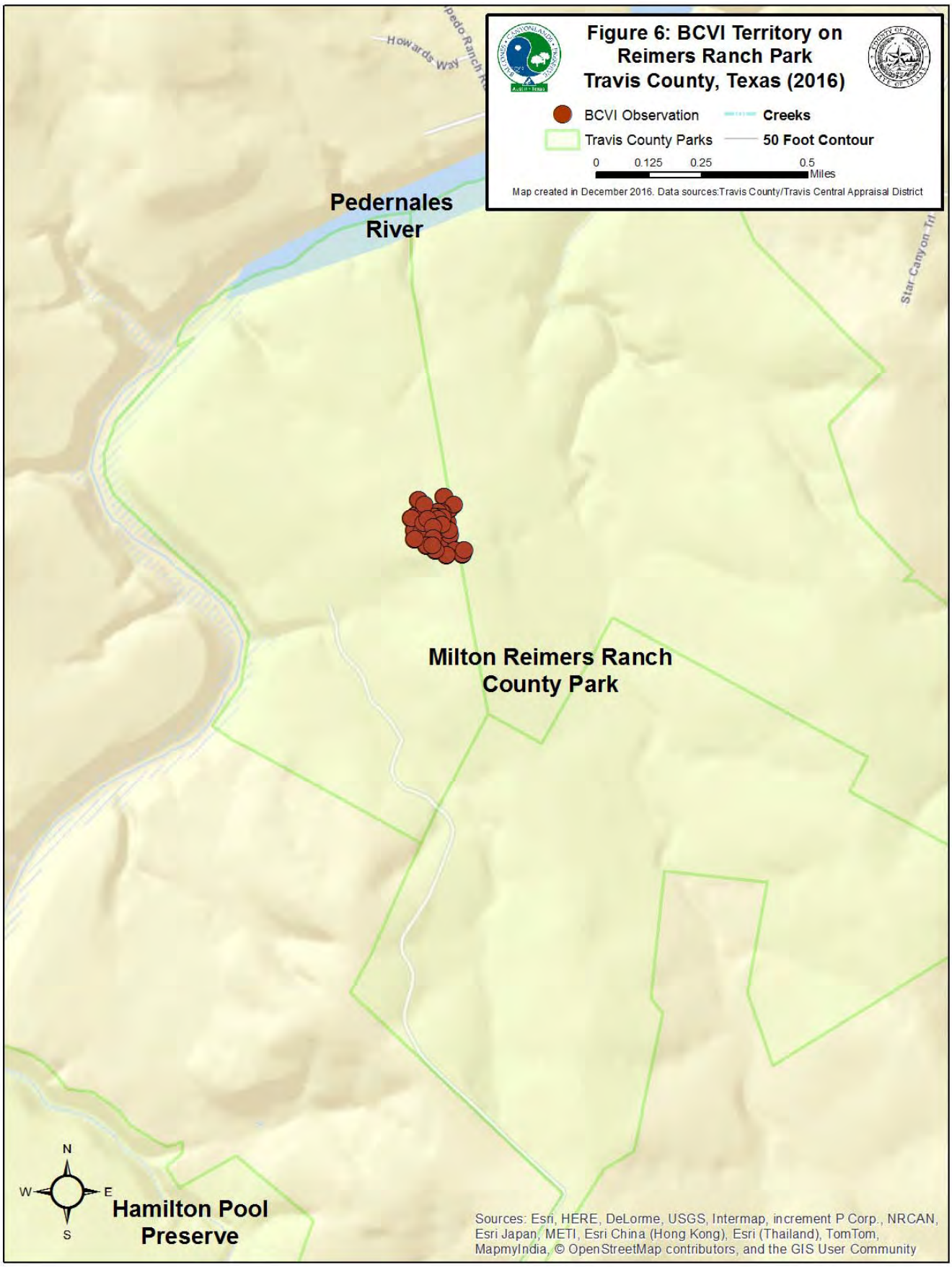


Figure 6: BCVI Territory on
Reimers Ranch Park
Travis County, Texas (2016)
BCVI Observation
Travis County Parks
Creeks
50 Foot Contour
0 0.125 0.25 0.5
Miles
Map created in December 2016. Data sources:Travis County/Travis Central Appraisal District
Howards Way
Pedernales
River
Star Canyon Trl
Milton Reimers Ranch
County Park
N
W
E
S
Hamilton Pool
Preserve
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