Monitoring and Management of the Black-capped Vireo (*Vireo atricapilla*) in Western Travis County, Texas: 2009 Field Season



Photo: Black-capped vireo, Vireo Ridge Tract (J. Brown)

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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) 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 et al. 2005; U.S. Fish and Wildlife Service [USFWS] 1991; Grzybowski et al. 1994; Grzybowski 1995, Oklahoma Dept. of Wildlife Cons. 1999). Between 1996 and 2005, BCVI populations have been reported in only 38 south-central and central Texas counties (Wilkins et al. 2006). A USFWS review of the BCVI population status was completed as required by the Endangered Species Act in 2006 (Wilkins et al. 2006).

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. 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), see **Figure 1**; a minimum of 2000 of these acres will 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 1996b). Currently, Travis County manages 6,265 acres of preserve land of which 5,446 acres is designated part of the BCP. Currently, less than 150 acres of Travis County managed BCP land could be classified as BCVI habitat. 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:

- 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 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).

This report presents the results of the 2009 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 2009 breeding season, BCVI surveys were conducted in three locations (**Figure 2**). The primary site is located on the Jollyville Unit, owned and managed by Travis County and part of the Cypress Creek Macrosite of the BCP. The second site is on the Ribelin tract, owned and managed by Travis County and part of the Bull Creek Macrosite of the BCP. The

third site is located on the Steiner Ranch Preserve. This site is the result of a conservation easement agreement between Steiner Ranch and Travis County, under a BCCP Participation Certificate as directed by the USFWS. Although the Steiner Ranch Preserve is not officially part of the BCP, Travis County manages this easement under the same management guidelines as the rest of the BCP.

The Jollyville Unit is comprised of 1909 acres (772.5 ha) and includes the following tracts: Bunten, Cuevas, Cuevas East, Grandview Hills, Mirtsching, Nootsie, Snowden, Vireo Ridge, and Vista Point (**Figure 2**). It is located approximately 13 miles (21 km) northwest of downtown Austin. Primary access points are on FM 2769, RM 620 and adjacent to the Grandview Hills subdivision located off Wilson Parke Road. Both golden-cheeked warbler (*Dendroica chrysoparia,* hereafter GCWA) 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 riparian soils in these drainages are composed primarily of 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 (*Quercus sp.-Juniperus ashei*) woodlands, which cover the majority of the canyons and slopes. Historic harvest of mature Ashe juniper has allowed shrubby, secondary-growth junipers to dominate the uplands. Open grasslands are found in valleys, while riparian vegetation, dominated by black walnut (*Juglans nigra*), sycamore (*Platanus occidentalis*) and elms (*Ulmus* spp.), occupies riparian areas along creeks and drainages.

The 319-acre Ribelin tract is located off of RM 2222 and McNeil Drive, which is the primary access point (**Figure 2**). The tract is located adjacent to the City of Austin's Ivanhoe 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 (Soil Conservation Service 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 Steiner Ranch Preserve comprises five separate tracts totaling 819 acres (331 ha), and is located approximately nine miles (14 km) west of downtown Austin on RM 620 (**Figure 2**). The property is contiguous to the City of Austin's BCP Cortaña tract. Topography of the four northern tracts consists of upland hills incised by a number of draws or drainages. The southernmost section of the Steiner Ranch Preserve encompasses three steep, wooded canyons. Here, preserve property interdigitates with residential development that is situated on canyon divides. Creeks in the canyons drain southward into Lake Austin, and many of their tributaries are intermittently spring-fed. The preserve is bordered to the south by Lake Austin with 2100 feet (640 m) of river frontage. Brackett series soils predominate on rolling uplands and gentle slopes while Tarrant series soils occur on steep slopes and in canyons (USDA 1974). Vegetation ranges from open juniper brakes on uplands and shallow slopes to closed canopy juniper-oak woodlands on steeper, mesic slopes. Existing BCVI habitat occurs in limited quantity along areas adjacent to RM 620 and the City of Austin's BCP Cortaña tract. Historically, both areas have had significant BCVI populations.

HABITAT RESTORATION

The 2000 acre minimum designation of BCVI habitat required by the BCCP has been a challenging goal for the BCP partners. Due to the rate of land use change over the past few decades and fire suppression, most BCVI habitat has already been developed, or is growing out of suitability. BCVI habitat that does exist within the BCP is primarily maintained and/or created through habitat restoration efforts. As mentioned earlier, Travis County currently manages less than 150 acres of BCP land that could be classified as BCVI habitat.

BCCP Goals for BCVI recovery, outlined in the BCP Land Management Plan (2007), include maintaining and increasing the current population and protecting contiguous blocks of habitat. At present, most of the County owned BCVI habitat occurs on the Jollyville Unit's Vireo Ridge tract (**Figure 2**). Additionally, isolated pockets of potential habitat can also be found on Travis County's Vista Point and Grandview Hills tracts of the Jollyville Unit and on the north end of Steiner Ranch Preserve (**Figure 2**). Most existing, unrestored BCVI habitat, whether occupied or not, is of poor to marginal quality. Upon the inclusion of the various tracts that make up the Jollyville Unit, very little high, or even moderate, quality BCVI habitat existed. The only substantial BCVI habitat, prior to any restoration efforts, was located along the southwestern boundary of the Vireo Ridge tract adjacent to the Grandview Hills subdivision. This area had been cleared previously for development prior to Travis County ownership but had since grown back into BCVI habitat.

Beginning in the winter of 2001-2002, and continuing every winter thereafter, Travis County has conducted BCVI habitat restoration within two BCVI Habitat Management Areas (HMAs) (**Figure 3**). These HMAs are located within Travis County BCP lands that have been designated as having potential for restored BCVI habitat sites. HMA locations are targeted based on known historic vireo occupancy and having soil and vegetative components necessary for vireo habitat. HMAs may be established on the Lucas and Ribelin tracts as early as 2010.

Through a variety of techniques, poor quality BCVI habitat has been altered through the selective removal of undesirable monocultures of woody species, such as Ashe juniper (*Juniperus ashei*) while stimulating the growth and shrubby structure of other woody species, such as shin oaks (*Quercus sinuata*), possomhaw (*Ilex decidua*), yaupon (*Ilex vomitoria*), Texas redbud (*Cercis canadensis*), wafer-ash (*Ptelea trifoliata*), Carolina buckthorn (*Rhamnus caroliniana*) and sumacs (*Rhus* spp.), to create the patchy, early to mid-successional physiognomy or appearance associated with BCVI breeding habitat. Several sections, particularly those restored from 2001 to 2004, have become good to excellent quality habitat. It has been observed on the Jollyville HMA that BCVIs begin occupying restored areas in three to five years of initial manipulation activity.

In January and February 2009, approximately 3.7 acres (1.5 ha) on the Jollyville Unit HMA were primarily hand-cleared with cuttings chipped or mulched on site. These restoration areas are located in and adjacent to occupied BCVI habitat (**Figure 3**). A ninth phase of restoration is planned for winter 2009-2010. As BCVI habitat tends to be early to mid-successional, follow up clearing is required to maintain it at this stage. Also, in most previously manipulated areas, much of the refined hand clearing is not completed during initial larger scale brush removal and must be completed in subsequent years. Other locations being considered for targeted clearing include areas on the Ribelin and Cuevas East tracts due to their history of occupancy and proximity to currently occupied habitat.

Areas manipulated for habitat restoration on the Jollyville Unit are illustrated in **Figure 3** for each year restoration activities were conducted. As of February 2009, approximately 126 acres (51 ha) have been manipulated on the Jollyville Unit HMA. An additional 17 acres (6.9 ha) were cleared in 2005 and 2008 on the Steiner Ranch HMA (Travis County 2008). Travis County has manipulated an average of approximately 14 acres (5.7 ha) for BCVI habitat restoration each year since 2001.

Restoration activities will continue where habitat potential has been identified on the HMAs and well as on other BCP tracts where BCVIs were known to exist and where it does not conflict with other protected species habitat. Target areas for restoration vary from year to year based primarily on habitat utilized by BCVI the preceding breeding season, the presence of golden-cheeked warbler habitat, diversity of desired woody species and available budget. Travis County Natural Resources staff is currently preparing a multi-year BCVI habitat restoration plan that will be completed in 2010.

CURRENT RESEARCH

William Simper, a Texas State University graduate student was permitted to do scientific research on the Jollyville Unit to continue a study of BCVI dispersal patterns within a fragmented preserve network. In the spring of 2009, the project's second season, this involved resighting or recapturing previously banded birds in order to obtain direct measurements of interpatch dispersal (Simper 2009). Survey procedures were similar to those recounted in the methods section of this report. Throughout the survey season, Travis County staff were in contact with Simper to coordinate site visits and to share data, including records of resightings and nest locations. For more detailed information on this project see *Report of Activities Conducted* submitted by William Simper which is an appendix of the 2009 BCP Annual Report to USFWS.

METHODS

Data Collection

In 2009, Travis County developed BCVI monitoring guidelines (**Appendix A**) to facilitate the survey season and outline methods for territory mapping, nest searching and monitoring, and standardizing a presence/absence methodology. All potential BCVI habitat on the Jollyville Unit was surveyed at least once a week throughout the 2009 breeding season. Additionally, four areas were visited utilizing the newly developed presence/absence protocol minimally for the presence of BCVIs: 1) tracts four and five of the Steiner Ranch Preserve, 2) an eastern section of Grandview Hills North, 3) a potion of Vireo Ridge referred to as "35 acres" and 4) the northern boundary of the Crossings (**Figure 2**). BCVIs were surveyed for a total of 204 hours from 25 March to 19 September. On the primary BCVI colony located on the Vireo Ridge tract, data can be interpreted as a comprehensive census due to the relatively large amount of time spent monitoring these birds. However, due to limited survey effort, results from other County-managed tracts should be interpreted as merely a baseline estimate of abundance (Verner 1985).

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 1:3000 or less. The following data is 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 9.2 (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, if encountered with a territorial male, associated with that territory number.

Territory mapping methods generally followed International Bird Census Committee (IBCC) guidelines (1970). Bibby's (2000) "consecutive flush" 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 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 indentified 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.

For the 2009 breeding season, a system of point counts was established to determine BCVI presence/absence in two areas where BCVIs had been detected in the past. This was done in an effort to ensure that some areas previously overlooked were systematically checked. To ensure that an area was monitored throughout the prime breeding season, minimum visits, frequency of visits, and the amount of time spent at a site were specified beforehand. Refer to Appendix A for a detailed description of monitoring guidelines for presence/absence surveys.

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 a 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 and the total number of fledglings observed at any one time was used as a conservative measure of productivity.

Data Analysis

We define BCVI abundance to be 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). This includes males, females, fledglings, and multiple sightings of the same individual. An individual male was considered to have established a breeding territory if he was observed either 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 number, all BCVI territories, whether they were observed entirely or partially on Travis County managed 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 located (Anders 2001). Productivity data is represented in 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 2009, BCVI abundance on all Travis County tracts totaled fifteen males (**Figures 2**). Fourteen males were observed on, or adjacent to, the Jollyville Unit and eleven of these established territories in areas in which habitat restoration had previously occurred (**Figures 4 and 5**). It should be noted that prior to 2009, the Lake Perspectives tract was considered part of the Jollyville Unit, however it has recently been incorporated into the newly formed Lake Travis Unit. No BCVI territories were established in entirely new areas on the Jollyville Unit. However, two 'second year' males (i.e. in their first breeding season) were detected in

separate, outlying tracts (i.e. Lake Perspectives and Cuevas East). These individuals were observed singing and occupied well-defined areas for a span of approximately one week. Both were captured and color-banded, but neither established territories where they had originally been detected or in other surveyed portions of the BCP. No BCVIs were detected on County-managed land in Steiner Ranch Preserve. One male did establish a territory on the Ribelin tract (Bull Creek Unit), although he isn't believed to have successfully paired or bred (**Figure 2**). **Table 1** presents a summary of BCVI data collected during the 2009 breeding season in addition to data collected by various agencies only on the Jollyville Unit since 1989.

Table 1. Summary of BCVI survey data collected by various agencies in the study area (referred to as Jollyville Unit since 2001), Travis County, Texas.

Year Surveyed	Agency*	Abundance	No. Territories
1989	DLS	11	5
1990	DLS	11	5
1991	DLS	14	9
1992	TXDOT	No Data[1]	Unknown
1993	TXDOT	25	20
1994	TXDOT	27	27
1995	TXDOT	23	23
1996	SWCA	19-22	15
1997	No Data[1]	Unknown	Unknown
1998	No Data	Unknown	Unknown
1999	No Data	Unknown	Unknown
2000	SWCA[2]	3	Unknown
2001	Travis County TNR	19	13
2002	Travis County TNR	21	19
2003	Travis County TNR	21	20
2004	Travis County TNR	13	12
2005	Travis County TNR	12	11
2006	Travis County TNR	12	9
2007	Travis County TNR	14	13
2008	Travis County TNR	15	15
2009	Travis County TNR	13[3]	11

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

[3]-Does not include one individual detected on adjacent Lake Perspectives tract (Lake Travis Unit)

* See Literature Cited for appropriate report citation.

In 2009, all 11 territories were considered successfully paired (**Table 2**). Additionally, seven territories fledged offspring, yielding at least 12 'hatch year' (HY) individuals observed in

the field. Productivity in 2009, whether measured relative to successful territories (1.7 HY per terr.) or all territories (1.1 HY per terr.), is probably underestimated due to the low number of nests located prior to fledging (**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. Because of their dull-colored plumage, cryptic behavior, and unpredictable flights, we expect observer counts of fledglings in the field to be biased low.

Table 2. Abundance, territory number, and pairing success for BCVIs (*Vireo atricapilla*) on Jollyville Unit, Travis County, Texas, March-September 2001-2009.

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

[a] Adjusted values to reflect BCVI found only on the Jollyville Unit

[b] Total hours surveyed for 2003 could not be verified and may be overestimated

[c] The male located at Lake Perspectives (Lake Travis Unit) was not included in this data set

Table 3. Breeding success and productivity for BCVI (*Vireo atricapilla*) territories on Jollyville Unit, Travis County, Texas, March-September 2001-2009.

Year	No. of territories with breeding success[1]	Breeding success rate (%)	No. Fledglings	No. fledglings/ successful territory	No. fledglings/ total no. territories
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	13	2.2	1.1
2005	1	9.1	1	1	0.1
2006	8	88.9	15	1.9	1.7
2007	8	61.5	24	3	1.8
2008	10	66.7	29	2.9	1.9
2009	7	63.6	12	1.7	1.1

[1] Represents the number of all territories that fledged at least one young.

* Adjusted values to reflect BCVI found only on the Jollyville Unit

A total of five BCVI nests were located in 2009 (**Figures 4 and 5**). Detailed data was collected post breeding season for each nest found in 2009 including nest substrate, height, orientation, etc. Individual nest data is provided as **Appendix B** to this report. Table 4 lists the nest substrates and outcome for each nest identified. One nest was a second attempt. Of the five nests located, two (40%) successfully fledged at least one young. A total of three (60%) nests failed either due to predation (n=2) or were abandoned/fate unknown (n=1). No nests were known to have been parasitized by cowbirds (*Molothrus sp*.) during the 2009 breeding season. A total of nine individual HYs were observed where no nest was located.

Table 4. Nest data for BCVI (*Vireo atricapilla*) territories on Jollyville Unit, Travis County, Texas, March-September 2009.

Nest Substrate	Result	2nd nest located	Nest substrate	Result
Yaupon holly	successful, 3-4 HYs	no	na	na
Shin oak	nest predated	yes	Texas ash	failed, undetermined
Shin oak	successful, 1 HY	no	na	na
Shin oak	nest predated	no	na	na

In all, a total of eleven individual adult BCVIs wearing color bands were observed on the Jollyville Unit in 2009: six returning males (two of which were banded as HYs in 2008) and five adult BCVI banded in the 2009 field season (four male, one female). No adult BCVIs banded in 2008 were found on any other Travis County managed tracts. Adult males showed a 50% return rate (four of eight adults banded in 2008) and juvenile return was 12.5% (two of sixteen banded on the Jollyville Unit as HYs in 2008). Additionally, two other BCVIs banded as nestlings in 2008 on the Vireo Ridge tract were resighted off of their natal site in 2009, one on a City of Austin managed BCP tract and a second on the Balcones Canyonlands National Wildlife Refuge (Simper 2009).

DISCUSSION

Overall abundance and number of territories were lower in 2009 than in 2008 (**Table 1**), but whether this is due to changes in habitat quality, survivorship, dispersal, or is merely stochastic fluctuation is unknown. Productivity was also numerically lower, probably due to fewer nests being located (and thus accurately counted), but pairing success increased in 2009 and the percentage of located nests that successfully fledged was actually higher than in 2008. Survey effort in 2009 was very similar to that of 2008, while less effort was expended in locating and monitoring nests in 2009.

Territory establishment in 2009 occurred in the same general core areas on the Jollyville Unit as in previous years (Travis County 2001-2008). Although the same general areas are being utilized, the distribution of BCVI territories on the Jollyville Unit has changed each year. Several factors may influence territory distribution, including the intrinsic habitat characteristics of the site, the age structure of the population, the overall population density, and habitat restoration activities on the preserve (Grzybowski et al. 1994; Anderson and Gutzwiller 1996). Another factor influencing territory distribution is residential development, which has increased adjacent to the Grandview Hills and Vireo Ridge tract boundaries. Excellent habitat previously utilized by BCVIs on vacant property adjacent to the Grandview Hills tract has now been completely cleared for construction activity and continues to be developed.

Habitat loss and degradation is a primary concern for BCVI recruitment onto Travis County BCP properties and may be affecting productivity. 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, primarily encroaching Ashe juniper, had reduced the openings in the deciduous cover generally associated with optimal BCVI habitat. Additionally, the vegetative growth pattern in historically occupied areas tends to be vertical, rather than the horizontal, mid-successional stage, preferred by BCVIs. Through the efforts of mechanical BCVI habitat restoration, significant portions of the Jollyville Unit HMA now show characteristics of prime BCVI habitat.

All 2009 BCVI territories on the Jollyville Unit were established primarily in previously manipulated areas that could now be considered “restored”. This has been the observed trend since 2006. These observations seem to indicate that BCVIs continue to respond positively to habitat restoration efforts undertaken since 2001. It has been difficult to determine if new BCVIs were being recruited onto the Jollyville Unit because each year, from 2003 to 2006, 1) BCVI territory and abundance numbers had slowly declined, 2) it appeared that the remaining BCVIs were shifting annually from lesser quality habitat into higher-quality restored areas, and 3) the BCVIs were not banded, precluding staff from determining return rates. The recent banding study has shed some light on this issue. Sixteen nestlings banded in 2008 on the Jollyville Unit successfully fledged. Of those sixteen, two were resighted (both males) on Jollyville Unit (return rate = 12.5%). One returned to the same ‘colony’ (i.e. Vireo Ridge) but not to its natal territory, which was already occupied, possibly by the male parent (who was unbanded in 2008). The other was found 4.2 km (Cuevas East/Jollyville Unit, **Figure 2**) away and did not appear to establish a breeding territory, at least at the site where it was observed. Neither of these males was known to produce offspring in 2009; however

both were behaving territorially enough to be recaptured by targeted mist netting utilizing playback of recorded vocalizations.

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. In 2009, two males were detected for a short period of time (two days to one week) in areas relatively distant from any known conspecifics. Although they were observed singing and briefly occupied relatively well-defined areas, they did not appear to establish permanent territories at these sites, and in fact were not relocated in 2009. Most likely these individuals were recent arrivals who had settled temporarily and were attempting to attract a mate or who were exploring the landscape before settling. In two other cases males settled in areas sufficiently isolated as to make countersong unlikely. In all cases these males were in their first reproductive year (i.e. they were 'second year' or SY). This is consistent with current theory which posits that older, more experienced and dominant males will hold and defend the same territories year after year (presumably because of reproductive advantages attributable to higher quality habitat) while younger males are forced to occupy habitat located on the fringes of established colonies (Grzybowski 1990). All four of the returning males banded as adults in 2008 occupied the same approximate areas (i.e. territories) in 2009.

Of the sixteen BCVI banded as nestlings on the Vireo Ridge tract in 2008, three were detected off of their natal patch in 2009. Dispersal distances, sex of dispersers, and information about reproductive success are given in **Table 5**. It is interesting to note that the SY female that settled on the Forest Ridge tract (BCP, managed by the City of Austin [COA]) was the only female known to be present in a newly initiated 'colony' composed of three males, at least two of which were SYs (that site is exceptional in that its species composition and vegetation structure more closely resemble golden-cheeked warbler habitat than stereotypical BCVI breeding habitat). Seven territorial males on the Jollyville Unit began the 2009 breeding season without color bands (three of these were banded in 2009), so the maximum number of immigrant males (seven) exceeds the known number of emigrant males (two) by five (350%). The number of marked fledglings which may have dispersed to sites which weren't surveyed cannot be determined, but it remains to be seen whether additional banded juveniles will continue to return to the Jollyville Unit in subsequent years.

Table 5. Reproductive status of dispersing BCVI originating from the Vireo Ridge tract of the Jollyville Unit.

Destination (tract)	Distance from origin (km)	Sex	Breeding success
Cuevas East (TC BCP)	4.2	M	unknown
Forest Ridge (COA BCP)	8.2	F	4 nestlings
Rodgers (BCNWR)	22	M	≥1 fledgling

Continued research and monitoring of BCVI on the Jollyville Unit is essential to determine whether the colony is a source population, adding to the general overall population and helping to maintain satellite colonies, or a population sink which is maintained solely through immigration, contributing 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, BCVI numbers on isolated preserve tracts could decline precipitously, eventually leading to local extinctions. Information regarding productivity and dispersal is difficult and slow to obtain and is thus very limited. 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 Jollyville Unit and its role 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 setting 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.
- Refine and standardize BCVI monitoring procedures, giving special attention to minimum hours of survey and nest searching needed, especially 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 and/or are detected, or to determine absence of target species (U. S. Fish and Wildlife Service 2003). 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.

- No BCVI nest attempts failed due to red imported fire ant predation in 2009; however control of this nuisance species should continue to be conducted within restored BCVI habitat areas.

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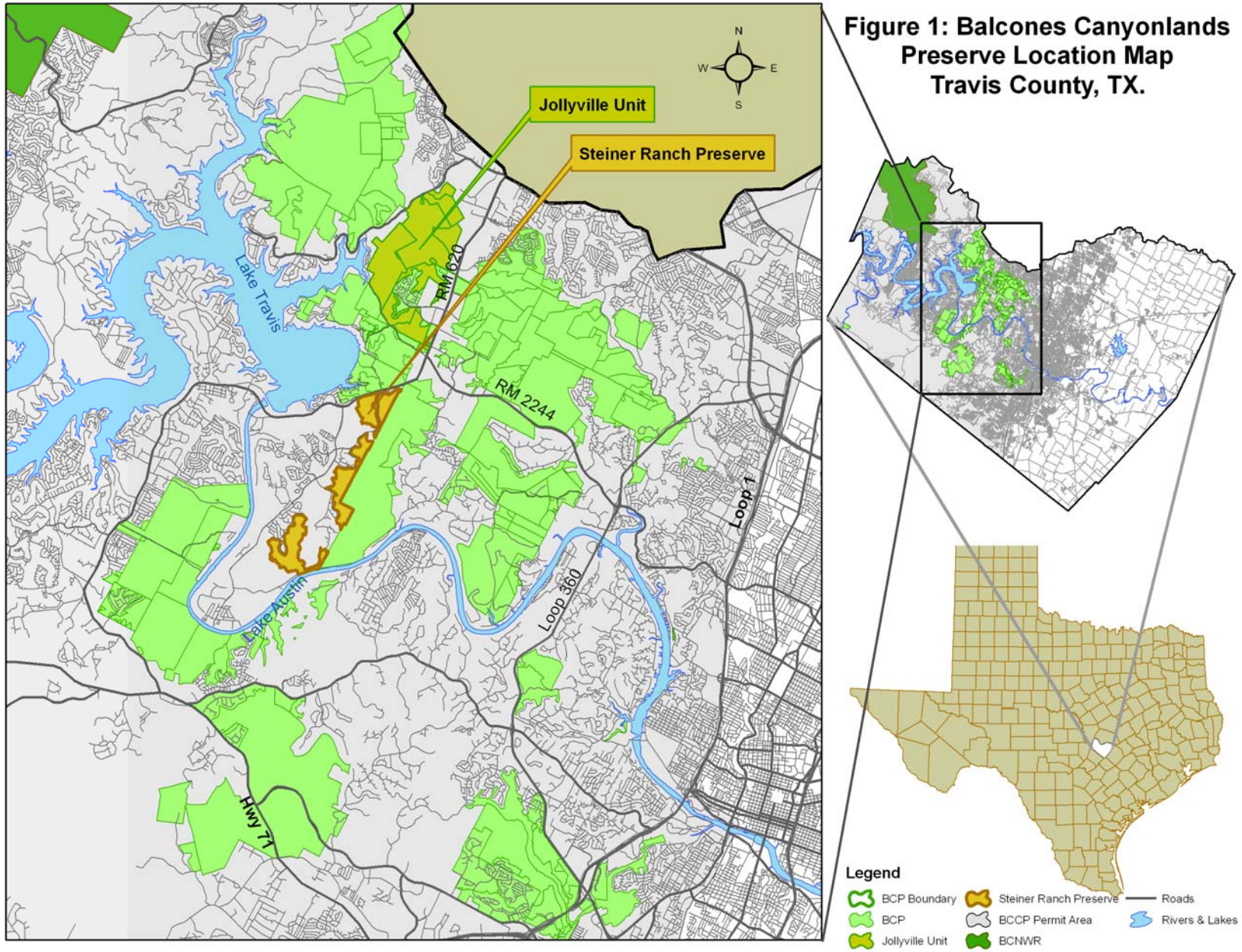
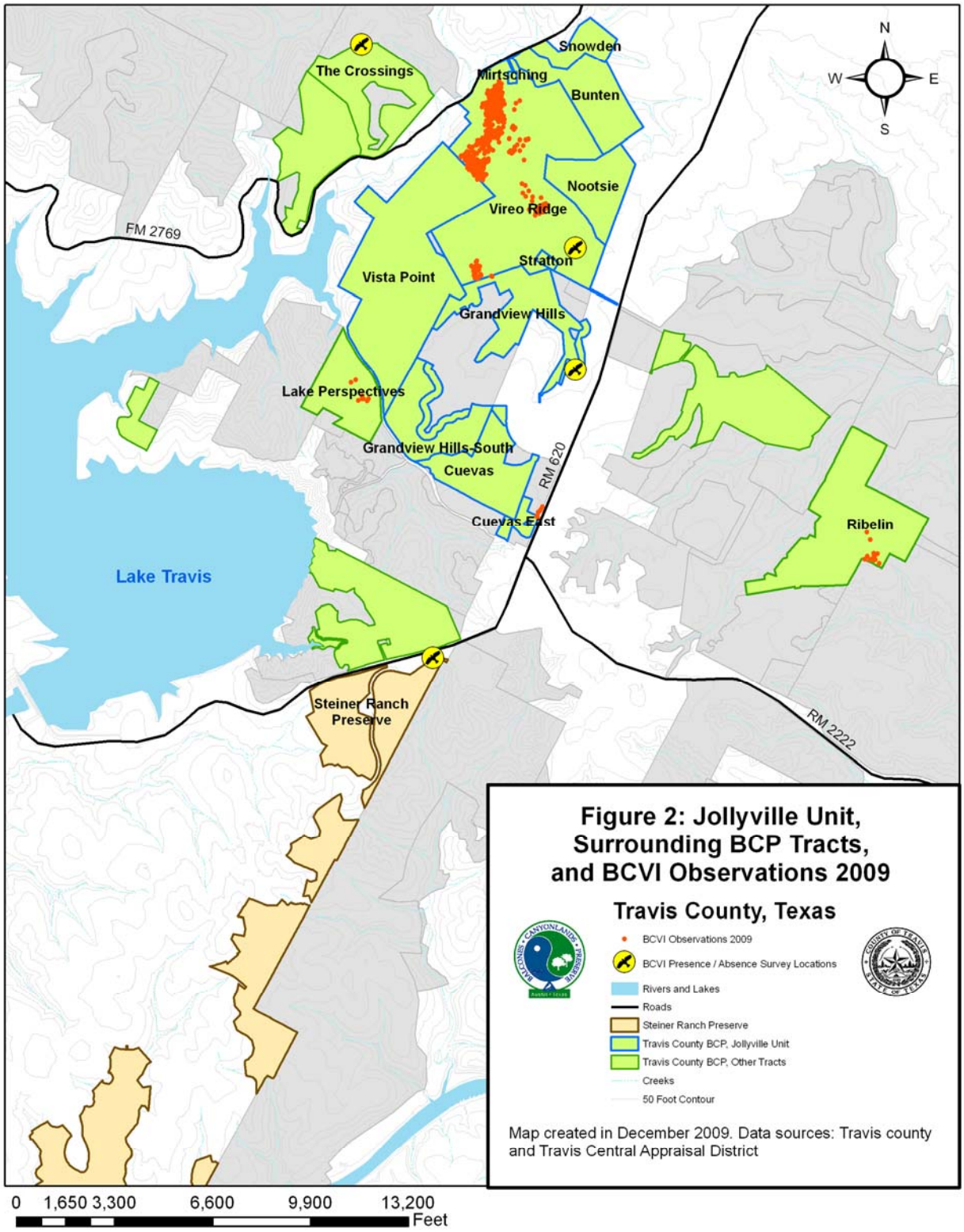
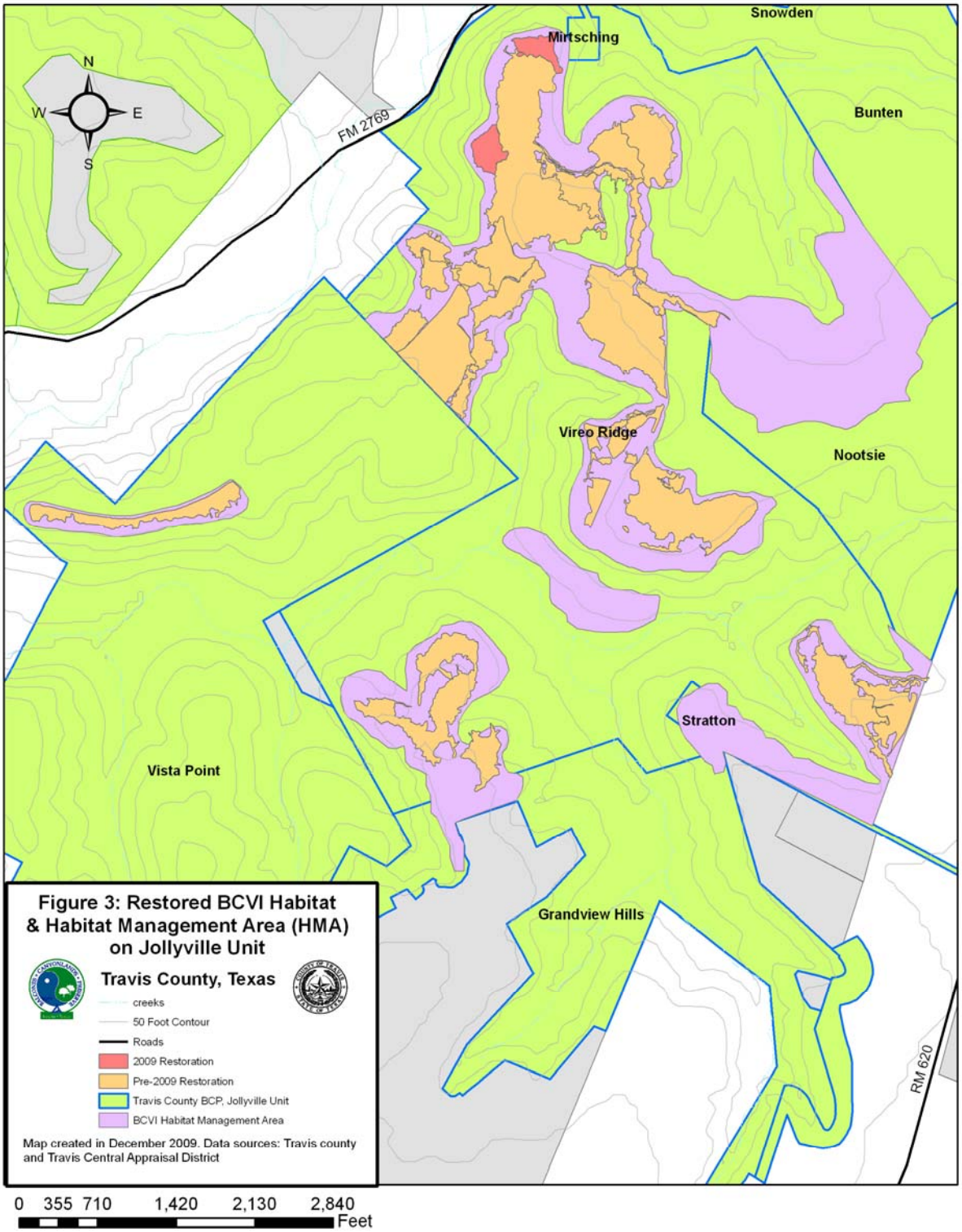
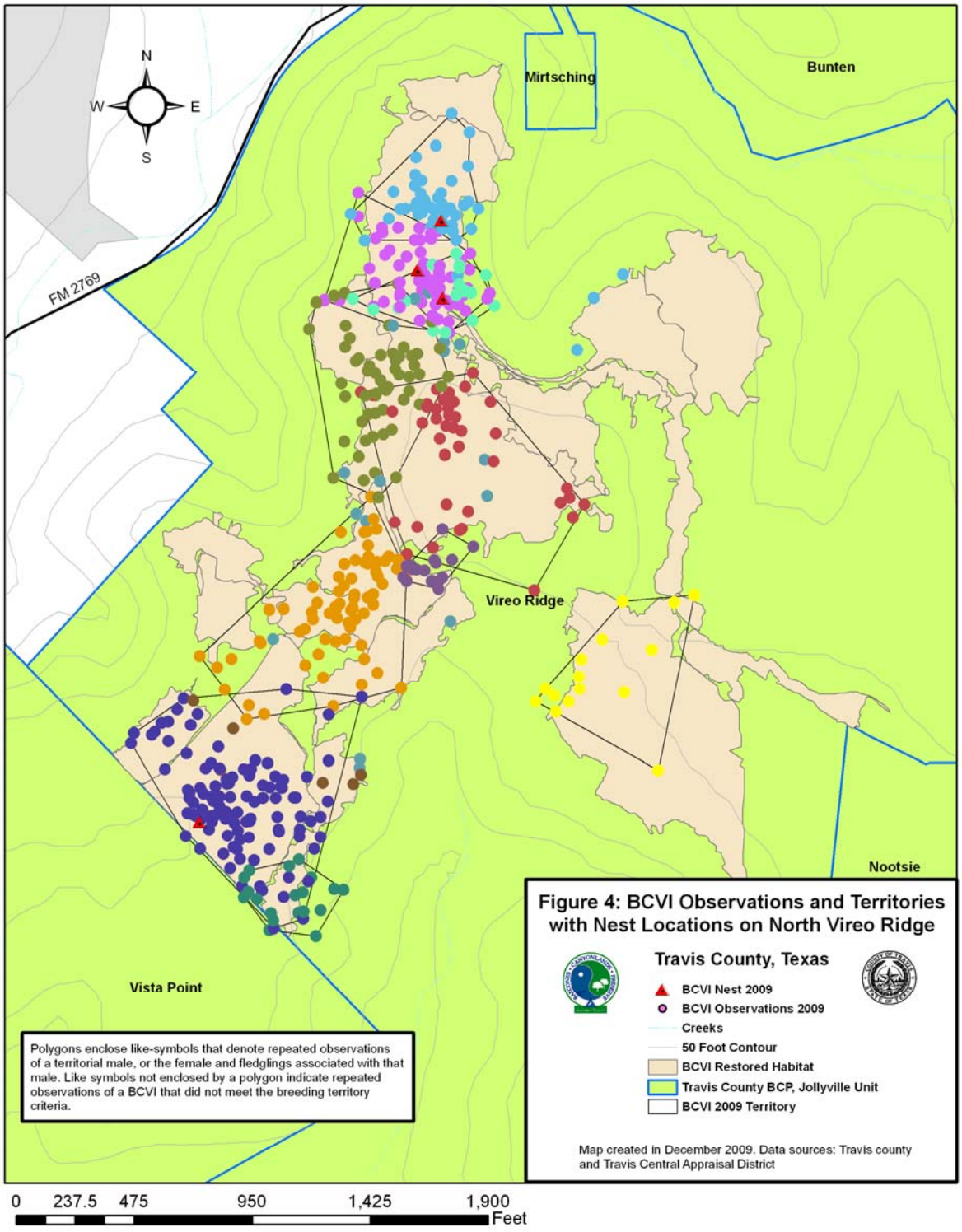
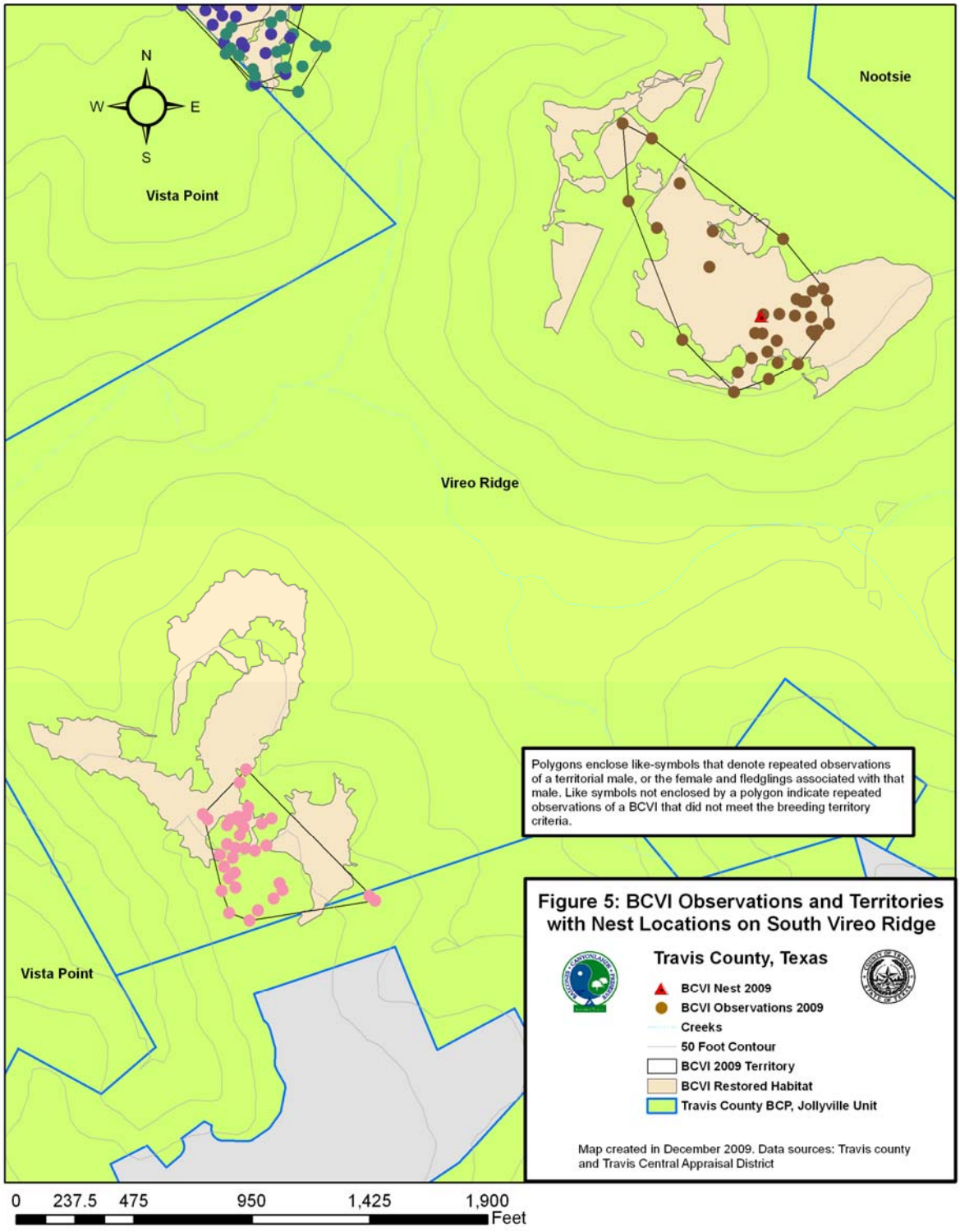


Figure 1: Balcones Canyonlands Preserve Location Map Travis County, TX.
N
W
E
S
Jollyville Unit
Steiner Ranch Preserve
Lake Travis
RM 620
RM 2244
Loop 1
Loop 360
Lake Austin
Hwy 71
Legend
BCP Boundary
BCP
Jollyville Unit
Steiner Ranch Preserve
BCCP Permit Area
BCNWR
Roads
Rivers & Lakes


The Crossings
Snowden
Mirtsching
Bunten
Nootsie
Vireo Ridge
Stratton
Vista Point
Grandview Hills
Lake Perspectives
Grandview Hills South
Cuevas
Cuevas East
Ribelin
Steiner Ranch Preserve
Lake Travis
FM 2769
RM 620
RM 2222
N
W
E
S
0 1,650 3,300 6,600 9,900 13,200
Feet
Figure 2: Jollyville Unit, Surrounding BCP Tracts, and BCVI Observations 2009
Travis County, Texas
BCVI Observations 2009
BCVI Presence / Absence Survey Locations
Rivers and Lakes
Roads
Steiner Ranch Preserve
Travis County BCP, Jollyville Unit
Travis County BCP, Other Tracts
Creeks
50 Foot Contour
Map created in December 2009. Data sources: Travis county and Travis Central Appraisal District


Snowden
Mirtsching
Bunten
N
W
E
S
FM 2769
Vireo Ridge
Nootsie
Stratton
Vista Point
Grandview Hills
RM 620
Figure 3: Restored BCVI Habitat & Habitat Management Area (HMA) on Jollyville Unit
Travis County, Texas
creeks
50 Foot Contour
Roads
2009 Restoration
Pre-2009 Restoration
Travis County BCP, Jollyville Unit
BCVI Habitat Management Area
Map created in December 2009. Data sources: Travis county and Travis Central Appraisal District
0 355 710 1,420 2,130 2,840
Feet


N
W
E
S
FM 2769
Mirtsching
Bunten
Vireo Ridge
Nootsie
Vista Point
Polygons enclose like-symbols that denote repeated observations of a territorial male, or the female and fledglings associated with that male. Like symbols not enclosed by a polygon indicate repeated observations of a BCVI that did not meet the breeding territory criteria.
Figure 4: BCVI Observations and Territories with Nest Locations on North Vireo Ridge
Travis County, Texas
BCVI Nest 2009
BCVI Observations 2009
Creeks
50 Foot Contour
BCVI Restored Habitat
Travis County BCP, Jollyville Unit
BCVI 2009 Territory
Map created in December 2009. Data sources: Travis county and Travis Central Appraisal District
0 237.5 475 950 1,425 1,900
Feet


N
W
E
S
Vista Point
Nootsie
Vireo Ridge
Vista Point
Polygons enclose like-symbols that denote repeated observations of a territorial male, or the female and fledglings associated with that male. Like symbols not enclosed by a polygon indicate repeated observations of a BCVI that did not meet the breeding territory criteria.
Figure 5: BCVI Observations and Territories with Nest Locations on South Vireo Ridge
Travis County, Texas
BCVI Nest 2009
BCVI Observations 2009
Creeks
50 Foot Contour
BCVI 2009 Territory
BCVI Restored Habitat
Travis County BCP, Jollyville Unit
Map created in December 2009. Data sources: Travis county and Travis Central Appraisal District
0 237.5 475 950 1,425 1,900
Feet

APPENDIX A

Travis County Natural Resources and Environmental Quality Guidelines for Monitoring Black-capped vireos [BCVI] (*Vireo atricapillus*), February 2009

General note: To insure that BCVIs are monitored consistently and thoroughly, regular meetings will address survey scheduling and status of territories (ex. locations, nest building, tending to nestlings, feeding fledglings, etc.).

I. General monitoring guidelines

- All BCVI monitoring will begin in the **second week in April** or two weeks after the first observation of season, which ever is sooner.
- All BCVI territories will be visited a **minimum of seven times** and visits will be spread throughout the survey season. All territories will be visited at a minimum of once every two weeks.
- Survey effort is defined as either *intensive mapping* (**I**) or *casual/spot-mapping* (**C**). Intensive mapping is defined as a prolonged (>30 minutes) presence within a territory – either with sustained proximate mapping, or nest searching, that may have caused increased stress in the targeted territory pair/young. Intensive mapped territories will be allowed a minimum of four days rest between surveys. *(Note: territories where netting/banding attempts have been made are considered intensively mapped and will be allowed at least four days rest)*. Casual/spot mapping is defined as a short visit in a territory, where BCVIs are generally mapped from a distance and for a short duration. If necessary, these territories can be visited more frequently, however scheduling usually will result in at least a day separating visits.
- Focused territory mapping will be completed by the end of the third week of July (approx. 15 weeks). However, sample location points will be taken occasionally (no more than 1x/week) after the third week in July for active territories to capture occupational duration.
- When targeting a territory, a minimum of 15 minutes will be spent within that territory.
- Late nest searching/monitoring will be finished by **September 15;** generally only a few territories are targeted past mid-August. Nest searching will be focused on target territories that have not been successful raising a brood or those behaving in a way that suggests that they are re-nesting. Any late-season

nest discovered will be monitored minimally (once every five days) until fate can be determined.

II. Presence/Absence (P/A) surveys

- One of two monitoring methods will be utilized for P/A surveys: point counts or a general area search. The locations and method to be used at specific locations will be determined prior to the survey season. If at any time during the season, new potential locations are discovered, they may be added to the survey schedule.

General guidelines:

- Most survey sites will be determined before the season and will be visited a minimum **five** times.
- Additional sites may be added during the season if necessary and if time allows.
- Visits will begin in the second week of April and be completed by the end of the second week in June (approx. 10 weeks).
- Duration between visits: minimum of five and maximum of 14 calendar days.
- Playbacks (cassette tape, mp3, etc.) can be used on any visit.

Point Counts:

- Surveyors will spend 8 minutes at each point. This does not include a two minute rest period before the point count commences.
- Points will be placed 250m apart when feasible.
- If a BCVI is detected, territory mapping will commence under the aforementioned monitoring guidelines.
- On point counts, all predetermined points where no BCVIs are detected will continue to be visited, even if a BCVI is detected at one (or more) points. *Those points where BCVIs have been detected will be incorporated into full territory mapping methods.* This is to insure that all potentially occupied habitat is monitored through the second week in June.

General Area Search:

- Smaller areas (< 5 acres) may be surveyed by a casual walk throughout the area.
- A general area search will last a minimum of one hour, regardless of habitat patch size.
- While searching an area include targeted searches of habitat with suitable vegetation components and structure as this may flush a BCVI that may not have been detected.

III. Nest searching and nest monitoring

(Adapted from *Guidelines for Black-capped vireo (BCVI) Field Work*, by James A. Koloszar, The Nature Conservancy – Fort Hood, TX. 2000)

BCVI nests are located and monitored for productivity and predation data. Nests may be difficult to locate initially, but will become easier with time and experience if the following directives and methods are applied:

- Use a systematic set of basic search methods (see below).
- Develop alertness for the unexpected.
- Develop a willingness to persist despite periods of unsuccessful searches.

New and less experienced staff should spend time with more experienced staff early in the season visiting old nest sites to help develop their skills and train on search methods and visual cues.

Basic Nest Searching Methods:

- Listen for calling or singing BCVI. As you approach singing males listen and look around for females and / or a nest. Often the male will sing from a position close or in view of the nest.
- Once a territorial male is located sit quietly for a few moments and watch the area of interest. By “letting the birds show you an area of activity”, you may observe nesting behavior and even located the nest while minimizing disturbance to the area.
- Follow “suspicious-looking” females towards potential nest sites. Non-nesting females often look relaxed – feeding or perched and preening quietly. BCVI with active nests generally give frequent alarm sounds, move rapidly and flick

wings and tail often. Females often make direct flights to their nest – follow their line of flight and search the area of their destination. Females and males carrying food should always be investigated when the nest for that territory has not been found.

- Vocal cues to nest locations include mobbing or strongly vocalizing (shradding). Look around carefully as a nest may be very close. A shradding female is the best clue to the presence of a nest or fledglings as a male may lead predators away from the nest site or young. If the mobbing / shradding continues (>5 minutes) and a nest cannot be found, move away and observe from a distance. If you still have not found the nest note the area on your map and return later to minimize possible disturbance in areas around nest sites.
- Search areas where males start and stop singing. This may indicate a change of incubation by adults at the nest.
- Often a male and female can be seen chattering quietly and hopping about in a clump of vegetation. This may be the site of a nest in the early building stages. Observe quietly, being careful not to intrude and cause desertion.
- Occasionally, a pair may offer no vocalization during the incubation period but will shrad loudly when nestlings are present. Be aware of this possibility when attempting to locate nests.
- Listen for a “lazy” shrad from a second vireo while the male is singing. This is usually the female near a nest.
- Look for nests in areas of dense vegetation. There are several patterns seen in regard to location; nests are usually found on the outer edge of a clump of vegetation, in a corridor or tunnel passing through a clump of vegetation, on the edge of a small opening in the interior of a dense clump of vegetation, and in an understory clump just inside a taller wooded edge (i.e. Just at the edge of warbler habitat).
- Try to visualize possible nest locations in the field and search accordingly. BCVI often nest in a Y-shaped fork of a horizontal branch. BCVI nests have been found most frequently in redbud (*Cercis canadensis* var. *texensis*), wafer ash (*Ptelea trifoliata*), shin oak (*Quercus sinuata*), texas oak (*Quercus texana*) and yaupon (*Ilex vomitoria*) and occasionally in other tree species such as sumac (*Rhus sp.*) and Ashe juniper (*Juniperus Ashei*).
- BCVI nest may often be oriented on the northeast edges of thickets

- BCVI nests are usually found between 1.5 and 5 feet (~.5-1.5m) above the ground.

Nest Checking / Monitoring Schedule:

- Upon discovering a BCVI nest, observe from a distance. Check contents if able to do so and with minimum disturbance to determine nest stage, i.e. building, laying, incubating, nestlings, number of eggs or nestlings, etc. Also note the nest substrate and record location on field map.
- Return to check nest status at no less than five days intervals taking into account key events that should be recorded such as laying, hatching, fledging, abandonment, predation, or parasitism.
  - Nest building can take 1 to 5 days.
  - 3 to 5 eggs can be laid in a clutch, one egg laid per day.
  - BCVI incubation is 14 to 17 days from the day before the last egg is laid.
  - Hatching occurs over two days and is asynchronous.
  - Nestlings fledge from nest approximately 11 days after hatching.
- Approach nest carefully and only if necessary to determine status after the initial check.
- Try and approach nest from different angle each time a check is needed.
- Check nest on day of fledging or day prior to fledging to determine the success of the nest.
  - If nest is empty at the expected fledge time, note the state of the nest (disturbed or undisturbed, etc.)
  - Check for adults giving alarm calls nearby or carrying food
  - Check the area for nestlings that may have fledged prematurely
  - A recently fledged nest will usually have a flaky coating of feather sheathings inside.

Several points to consider when conducting nest checks:

- Keep time spent near a nest to a minimum. If a nest is discovered in the building stage, note its location and leave the area immediately. BCVI are more prone to abandon nests under construction.

- When noting nest location use distinguishing landmarks and/or natural "flagging whenever possible. If forestry flagging must be used, discreetly flag the trail to the nest, note compass bearing, distance and substrate on flagging itself, and keep any flagging at least 10 meters from the nest.
- Do not check nests at dawn, dusk, in very bad light, or during extreme weather conditions. This may affect nest success, promote desertion, and inaccurate assessment of nest contents
- Do observe nests from a distance. If large young are obvious and visible, do not disturb nestlings by any close approach to the nest as they may fledge prematurely. Estimate nest status, the age and number of young from a distance if at all possible.
- If a BCVI is sitting tight on a nest, note the location and return later to check when she is away.
- If there are no young visible and no adults are tending the nest, proceed carefully to check the nest.

Do not assume that once a BCVI pair fledges young, monitoring is no longer necessary. Even successful pairs will renest, sometimes changing mates and may even renest while tending fledglings from previous nest attempts. It is helpful to verify identification (leg banding) at every territory check.

To obtain an accurate record of the fate of a nest and its status with respect to **brown-headed cowbird (BHCO) nest parasitism**, three essential pieces of information are necessary:

- A count of the number and types of eggs present in the nest.
  - When possible, nest checks should include the laying and incubation stages.
  - BCVI eggs are small and all white. BHCO eggs are noticeably larger and speckled brown and grey all over.
  - BHCO eggs should be removed only after a clutch is completed. Record date discovered and removed.

- If BHCO hatchling is discovered in BCVI nest it should be removed and destroyed (record this information).
- A count of the number of young present on the day of or one day prior to fledging. This count / nest check is critical for estimates of productivity and knowing the number of young raised to fledging.

APPENDIX B:

Summary of 2009 BCVI Nest Data

Territory #	Substrate(s)	Primary substrate height (m)	Concealment	Nest height (cm)	Distance from stem (cm)	Distance from foliar edge (cm)	Orientation	Comments
2	Shin oak *Quercus sinuata*	2.5	Shin oak	76	34	20	West	failed
2	Shin oak *Quercus sinuata*	5	Texas ash	164	122	37	Northeast	failed
3	Yaupon holly *Ilex vomitoria*	5	Yaupon holly	71	110	115	Northeast	successful
9	Shin oak *Quercus sinuata*	4	Shin oak	79	71	28	East	successful
11	Shin oak *Quercus sinuata*	3	Shin oak	108	85	188	West	failed
UK	Shin oak *Quercus sinuata*	2	Shin oak	72	25	22	Northeast	Year, territory, and fate unknown
UK	Wafer ash *Ptelea trifoliata*	1.75	Wafer ash	63	46	21	West	Year, territory, and fate unknown

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