City of Austin 2011
Golden-cheeked Warbler *(Setophaga chrysoparia)* and Black-capped Vireo *(Vireo atricapilla)* Monitoring Program

Balcones Canyonlands Preserve Annual Report
Fiscal Year 2010-11



Black-capped Vireo Male Feeding Female on Nest


Second-Year Golden-cheeked Warbler Male

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

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City of Austin

2011 Golden-cheeked Warbler and Black-capped Vireo Monitoring Program

Balcones Canyonlands Preserve Annual Report

FY 2010-11

This report summarizes the results of the City of Austin's 2011 golden-cheeked warbler (*Setophaga chrysoparia*) and black-capped vireo (*Vireo atricapilla*) endangered species monitoring program. The 2011 field season was the fourteenth year of endangered species monitoring on the City of Austin's Balcones Canyonlands Preserve (BCP) tracts. The golden-cheeked warbler (warbler) monitoring program was expanded in 2011 to gather data needed across the BCP to conduct a population viability and habitat suitability analysis for the warbler. This expanded monitoring effort was the first of a five-year agreement with the U.S. Forest Service (USFS) to develop models to better understand factors influencing the long-term viability of the warbler and its habitat and to predict the fate of both under various management scenarios. This collaborative project includes the USFS, City of Austin, Travis County, BCP managing partners (Lower Colorado River Authority, Travis Audubon Society, St. Edwards University/Wild Basin), Baylor University, and a team of volunteers all playing key roles and contributing data. Further, this project will build on existing monitoring and research, including the previous warbler survey data and work being conducted by Baylor University to estimate woodland stand age, successional pathways, and fire histories within the BCP. This research will provide a foundation for the models and will be used to evaluate how land use changes have affected habitat quality.

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

The City of Austin has contracted with Baylor University to analyze a decadal series of aerial photographs (1940 to present) and conduct a dendrochronology study to estimate stand ages, composition changes, and fire histories within the BCP's Ashe juniper-oak woodlands. This project was initiated in September 2009 (aerial photo analysis) and 2011 (dendrochronology) and is currently in the ground-truthing stage. It will be used to evaluate the influence of land use changes on warbler demographics and habitat suitability, as well as to identify priority (mature) woodlands for the warbler and potential management areas (earlier successional stages) for the vireo.

I. GOLDEN-CHEEKED WARBLER MONITORING

INTRODUCTION

Background

The golden-cheeked warbler (warbler) is a neotropical migrant passerine that breeds only in central Texas where mature Ashe juniper-oak (*Juniperus ashei* - *Quercus* spp.) habitat occurs (Ladd and Gass 1999). Due to accelerating loss of breeding habitat over the past several decades, this species was listed as federally endangered by the U.S. Fish and Wildlife Service in 1990 (USFWS 1990). The Balcones Canyonlands Preserve (BCP) was established in 1996 in part to mitigate for continual loss of warbler breeding habitat in western Travis County and to aid in the species' local recovery (BCP 1998). The BCP is managed by a number of public and private entities, including the City of Austin, Travis County, Lower Colorado River Authority, The Nature Conservancy, Travis Audubon Society, and St. Edwards University/Wild Basin. The City of Austin manages 13,600 acres of the approximately 30,000-acre BCP.

The primary goal of the BCP is to protect and enhance the habitat of endangered and rare species as mitigation for development in western Travis County. The BCP is critical to the survival and recovery of the warbler. Warbler habitat in western Travis County is widely considered to be the highest quality and least fragmented of any county within this species' breeding range. The BCP protects about 25-30% of the warbler's habitat in Travis County. To mitigate for the loss of the remaining habitat, management of the BCP must promote habitat sustainability, regeneration, and restoration to support a viable breeding population.

The warbler requires large blocks of mature, closed-canopy woodlands for nesting and raising young. Active habitat management requires minimizing threats to this species, including disturbance from human activities; declining oak regeneration from white-tailed deer, feral hogs, and oak wilt; non-native plants; and nest predators. Because the warbler requires mature woodlands, habitat regeneration could take decades to recover if negatively impacted by a poorly designed program. Given the complexity of the threats to the warbler, a more sophisticated analysis of the species, habitat, and management is needed to ensure effective management strategies are implemented.

Objectives

The Balcones Canyonlands Conservation Plan (USFWS 1996) states that "baseline monitoring will be gathered in accordance with the Land Management Guidelines and approved land management plans, and should concentrate on determining basic population levels on preserve lands, key population parameters, and other ecological parameters that may affect the target species." The Tier IIA-7 land management plan identifies the following goals and objectives: "The warbler population within the BCP will be monitored through a regional program to determine population size, territory density and trends, distribution, productivity, use of marginal habitat, and to determine the effects of habitat manipulation, urbanization, and recreation."

In February 2011, the City of Austin entered into a five-year agreement with the U.S. Forest Service (USFS) to provide population viability and habitat suitability modeling for the warbler populations within the BCP (Reidy and Thompson 2010). The USFS project focuses on four primary questions:

1) What is the absolute abundance of the warbler on the BCP and on individual macrosites?
2) How do demographics (e.g. density, productivity, survival) vary with landscape and habitat factors?
3) How viable are these populations?
4) How do various management scenarios influence population viability?

Answers to these questions are important to ensure the long-term viability of the warbler, which is the goal of the Balcones Canyonlands Conservation Plan. In order to fill these knowledge gaps, understand species' response to management, and provide reasonable demographic measures based on real data for modeling population growth and persistence, more intense monitoring across the BCP is necessary. The 2011 field season was designed as a collaborative project to collect data on fecundity, recruitment, dispersal, abundance, and survival on both previously established 100-acre monitoring plots and newly created intensive study areas that span the range of canopy cover and woodland stand age in which the warbler breeds on the BCP. BCP staff, managing partners, and volunteers also worked to refine and implement monitoring protocols to ensure the information collected can be utilized in the modeling project. Additionally, USFS continued efforts to refine a point count monitoring methodology. Existing species and habitat monitoring protocols will continue to be evaluated and revised as necessary to ensure collection of data is adequate for development of the viability models.

METHODS

A detailed description of the demographic methods used during the 2011 field season are described in Reidy and Thompson (2010). The methods closely followed the protocols outlined in the Tier IIA-7 land management plan guidelines (BCP 2007a), but required intensive monitoring, including more frequent surveys for territory delineations, and nest searching and monitoring. Population and productivity trends of color-banded individuals were tracked on a series of intensive study plots (including 100-acre plots and larger study areas). USFS, City of Austin, Travis County, Lower Colorado River Authority, Travis Audubon, and Wild Basin/St. Edwards staff and volunteers collected data on territory density, territory size and location, age structure, pairing success, breeding success, and productivity for each intensive study plot. BCP staff and volunteers also made a concerted effort to search for color-banded warblers outside of the intensive study areas to gather data on site fidelity and dispersal. Nests were located and monitored throughout the field season, and vegetation measurements were collected at each nest site at the end of the field season.

In addition, USFS staff conducted point counts and vegetation surveys at each point count location. Surveys were conducted from mid-April through mid-May in favorable weather conditions (winds <10 mph, no precipitation) from sunrise to 1100. Two observers surveyed 390 points resulting in detections of 269 individual warbler males. Complete methods and results of these surveys will be presented in a separate annual report prepared by the USFS.

Study Sites

During field season 2011, an effort was made to intensively monitor as much of the BCP as possible given staff and resource limitations, to include established study sites, and to capture the diversity of habitats across the BCP. Warbler territories were mapped on 19 intensive study plots, including 13 100-acre plots and six plots ranging from 57 to 450 acres in size (Table 1, Appendix A), and totaling about 2,676 acres. Intensive study plots were located within six of the seven BCP macrosites (all but the 259-acre Pedernales macrosite). The Motocross Park (Bike Park) in Emma Long Metropolitan Park and the Coldwater tract in the North Lake Austin macrosite were included in the intensive monitoring sites to continue the pilot study initiated in 2010 to further evaluate the effects of recreation. In addition, a 330-foot buffer was established around each of the 100-acre study plots (where access was permitted) to expand the search area for color-banded warblers and obtain additional information on return rates, dispersal, and territory size and configuration. While staff limitations prevented inclusion of the Bohls, Canyon Creek, and Ribelin plots in the intensive monitoring effort, BCP staff and volunteers conducted cursory surveys to resight color-banded warblers on Bohls and Canyon Creek, and Travis County staff continued to monitor the Ribelin plot. In addition, volunteers surveyed areas outside the intensive study plots and 330-foot buffers for plots where warblers were banded in 2009 and/or 2010 to obtain additional information on return rates and dispersal.

The intensive monitoring plots covered about nine percent of the existing BCP. Including the 330-foot buffers around each 100-acre plot (where access was allowed) and additional areas covered by the volunteers to search for color-banded warblers, about 20 percent of the BCP was included in surveys for this project in 2011.

Table 1. Intensive study plots for each macrosite within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Name, Ownership, and Acreage*	Barton Creek Macrosite	Bull Creek Macrosite	Cypress Creek Macrosite	No. Lake Austin Macrosite	So. Lake Austin Macrosite	West Austin Macrosite
Barton Creek (COA)	100 acres					
Gus Fruh (COA)**	210 acres					
Sunset Valley (COA)**	157 acres					
3M/St. Edwards (COA)		100 acres				
Canyon Vista (TC)		100 acres				
Forest Ridge (COA)		100 acres				
Butler (COA)		100 acres				
Hamilton West (COA)		100 acres				
Baker Sanctuary (Travis Audubon)			100 acres			
Lake Perspectives/ McGregor (LCRA, TC)			100 acres			

Vireo Ridge (TC)**			100 acres			
Vista Point (TC)			100 acres			
Bike Park (COA)				245 acres		
Coldwater (COA)				265 acres		
Emma Long (COA)				100 acres		
JJ&T COA)					100 acres	
Reicher (COA)**					100 acres	
Wild Basin/Vireo Preserve (COA, Wild Basin, St. Edwards, TC)**						445 acres
Ullrich Water Treatment Plant**						54 acres
Total Acreage Owned (as of 6/30/2011)	6,103 acres	5,024 acres	8,676 acres	5,379 acres	4,060 acres	478 acres
% of macrosite intensively surveyed*	>8%	>10%	>5%	>11%	>5%	100%

* Does not include the 330-foot buffers around the study plots (approx. 70-75 acres for square 100-acre plots, where access was allowed, totaling about 975 acres), resighting on the Canyon Creek, Bohls, and Ribelin 100-acre plots (300 acres), or the resighting areas beyond the buffers (about 1900 acres, see Appendix B).
**New study plots added in 2011.

Site Description

The topography and vegetation of the surveyed tracts are typical of the eastern edge of the Edwards Plateau. Steep, wooded canyons and riparian corridors dissect drier upland vegetation. Most streams are intermittent, though a few have a permanent water source, such as a perennial spring. The predominant vegetation association is mature Ashe juniper-oak woodlands, except at Hamilton West, Vireo Ridge, and Vireo Preserve, where the habitat includes more open canopy.

It is thought that woodlands in western Travis County were logged in the late 1800s and early 1900s and are currently in various stages of recovery (Keddy-Hector 1996). After clearing, much of the topsoil was lost due to chaining and subsequent goat and cattle overgrazing and erosion. On some steep slopes, this soil loss has greatly reduced the revegetation potential. Current and past over-browsing by white-tailed deer (*Odocoileus virginianus*) has reduced understory floral diversity and species abundance. Evidence of browse is visible on the majority of BCP tracts. A paucity of certain deciduous woody species is also evident throughout the BCP.

In woodlands and forests, the canopy is dominated by Ashe juniper, Texas red oak (*Q. buckleyi*), plateau live oak (*Q. fusiformis*), shin oak (*Q. sinuata* var. *breviloba*), escarpment black cherry (*Prunus serotina* var. *eximia*), Texas ash (*Fraxinus texensis*), and cedar elm (*Ulmus crassifolia*). Common understory species include young Ashe juniper, Carolina buckthorn (*Frangula caroliniana*), yaupon holly (*Ilex vomitoria*), red buckeye (*Aesculus pavia* var. *pavia*), Mexican buckeye (*Ungnadia speciosa*), Lindheimer silk-tassel (*Garrya ovata* var. *lindheimeri*) and elbowbush (*Forestiera pubescens*). Descriptions of individual plots can be found in Abbruzzese and Koehler (2003) and the Tier III Land Management Plans for each property.

In selecting the intensive study plot locations, an effort was made to represent a diversity of habitat types across the BCP, including vegetation types (i.e., evergreen, deciduous, and mixed evergreen-deciduous forests), stand ages, slope and aspect, habitat patch sizes, proximity to urban development, and land management activities. Resources used included aerial photos, preliminary stand age maps produced by Baylor University, and mapped vegetation types from Phase 1 of the Texas Ecological Systems Classification (http://morap.missouri.edu/Projects.aspx?ProjectId=57).

BCP-wide Monitoring Program: Intensive Study Plots

Color Banding

Color banding was conducted in conjunction with territory mapping (BCP 2007a) on all of the 19 intensive study plots, from March 11 through May 20. Methods consisted of mist netting within a male warbler's territory using playback of a tape-recorded male warbler's song to attract the bird to the net. All warblers captured in mist nets were marked with a unique combination of a U.S. Geological Survey (USGS) numbered aluminum band and auxiliary color bands to allow identification of each individual. The biological staff at Ft. Hood Military Reservation issued the color band combinations. Other data collected during banding included date, time, GPS coordinates of the banding location, temperature, weather conditions, and, as time allowed, wing chord length. Individuals were sexed and aged (second-year (SY), after second-year (ASY), after hatch-year (AHY)) according to Pyle (1997)), using data sheets developed by Ft. Hood staff. Each warbler was photographed just prior to release to document band combinations.

Territory Delineation and Density. Surveys on each intensive plot were conducted at least twice a week from mid-March through mid-June to delineate territories (dates used: March 15-May 25) and gather data on reproductive success (entire season, from March 15-June 15). During each visit, biologists attempted to identify the color combination of each banded warbler, obtain multiple locations for each male to assist with delineating territory boundaries, and determine the presence of a female, nest, and/or fledglings for each territory. To allow adequate time to collect these data and minimize observer bias, plots with five or more warblers were surveyed by two or more biologists. Due to the low densities of warblers, Gus Fruh, Sunset Valley, and Ullrich Water Treatment Plant plots were surveyed by one biologist. Appendix B lists the number of lead surveyors and survey hours for each intensive study plot.

To delineate territory size and configuration as accurately as possible, an effort was made to obtain at least 33 locations for each male from March 15 through May 25. Observations after May 25 were recorded, but were used to determine productivity and not to delineate territory boundaries. Males were considered territorial if they were observed in the same area on three different days spread at least a week apart and those locations were separated by 30 meters or more. Territorial boundaries for each male were delineated using minimum convex polygons in ArcGIS.

Warbler observations were recorded with Garmin global positioning units (GPS), which have an accuracy of 9 to 30 feet. Other sightings were recorded on topographic maps, using a 100-meter Universal Transverse Mercator (UTM) grid. Date, color combination (for observations of banded birds), UTM

coordinates, and presence of female, nest, and/or fledglings were recorded for each observation. The data were then entered into ArcGIS and displayed so that territories could be delineated.

The number of territories on the study plots was calculated three ways: 1) full territories (territories contained entirely within the plot), 2) full and edge territories, and 3) applying Verner's (1985) method (each full territory counted as 1.0 territory and each edge territory counted as 0.5 territories). Verner's counting method was recommended by Weckerly and Ott (2008) and avoids the upward bias inherent in the IBCC (1970) methodology (both full territories and edge territories counted as 1.0 territories). Finally, territory density is given as the number of territories (using Verner's counting method) per 100 hectares (ha). These calculations have been applied to the original City of Austin 100-acre plots for the past thirteen survey years. To allow for comparison with previous years, a summary of these data for the original 100-acre plots are provided in Appendix D.

The warbler monitoring program and data collection protocols are described in detail in Reidy and Thompson (2010), the Balcones Canyonlands Preserve Land Managers Handbook, Tier IIA, Chapter VII: Monitoring of the Golden-cheeked Warbler (BCP 2007a); the City of Austin Golden-cheeked Warbler and Black-capped Vireo Monitoring Program (Abbruzzese and Koehler 2003); and Appendix C of this document. As with previous years, no playback tapes of warbler songs or calls were used during this season's monitoring, except for the purpose of mist netting and color banding.

Age Structure. To calculate age structure for each study plot, the number of territorial SY males was divided by the total number of territorial males with a known age. The percentage of ASY and AHY males was also estimated for each plot. A summary of the 2009-2011 age structure data for the original City of Austin 100-acre plots is provided in Appendix E.

Return Rate. Return rates were based on the number of males color-banded in 2009 and 2010 that were observed again in 2011, divided by the total number banded within and near the plots in 2009 and 2010. Return rates were derived for the entire banding and resighting dataset and for each study plot. Summary data for the original City of Austin 100-acre plots are presented in Appendix F.

Pairing and Reproductive Success. For field season 2011, mated status and reproductive success are reported for both full and edge territories. However, to allow for comparison with previous years, a summary of the data for full territories only is presented for the original City of Austin 100-acre plots in Appendix G. Territories for which mated status and reproductive success were undetermined are not included in the analyses for these parameters.

A male was determined to be paired if he was observed associating with a female, observed tending young, or a nest was located for that male. Pairing success is the number of males determined to have paired with a female divided by the total number of territories. A territory was considered to have had breeding success if the male or female was observed tending one or more fledglings. Breeding success is the number of territories determined to have produced at least one fledgling divided by the total number of territories. Reproductive success is presented at the territory level (productivity) and by plot (number of

fledglings for all territories). Productivity is presented in two ways: 1) as the sum of all fledglings divided by the number of pairs that successfully bred (as defined above), and 2) as the sum of all fledglings divided by the total number of territories. Fecundity was derived by multiplying the total number of fledglings observed for all territories by 0.5 [based on studies indicating a 1:1 ratio of male and female offspring for this species (Anders 2000)] and then dividing by the total number of territories with females. To allow for comparison with previous years, an estimate of the number of male offspring per territorial male was also calculated.

Breeding success, productivity, and fecundity represent minimum estimates only because nests and fledglings are difficult to locate. Females and males often split their broods and can travel long distances from nests shortly after their young have fledged. In addition, young are often difficult to detect unless they are vocalizing. Reidy *et al.* (2008) has documented a mean number of 3.6 young fledged per successful nest in the Bull Creek and North Lake Austin macrosites. This estimate was applied to those territories where the number of fledglings was uncertain to obtain adjusted estimates of the number of young produced and productivity estimates. Since the estimate of 3.6 young fledged per nest may be high for some habitat patches, the actual number of fledglings is likely somewhere between the observed and adjusted values. Biologists increased their efforts in field season 2011 to try to locate all fledglings in a territory.

Nest monitoring. Biologists located nests from mid-March through mid-June while working within and near the study plots. UTM coordinates were recorded for each nest location using Garmin GPS units, and flagging was placed at least three meters from the nest to mark its location. Staff monitored each nest every few days to determine its fate and number of fledglings produced. If nest fate was not observed directly, a nest within a banded male's territory was assumed to have been successful only if that male was observed tending young shortly after the anticipated fledging date. Otherwise, the fate of the nest was recorded as unknown.

As part of a separate and ongoing study of nest success and nest predation within the BCP, Jennifer Reidy placed miniature video cameras on a subset of active nests found. Methodology for the camera monitoring is described in Reidy (2007a) and Reidy *et al.* (2008).

Once young had fledged, nest site and nest patch characteristics were recorded following methods developed by Reidy (2007a). Data were recorded on the nest tree species, nest height from the ground to the rim of the nest, nest tree height, diameter at breast height (DBH), and canopy cover. Nest and tree heights were obtained in meters using a clinometer, and DBH was measured in centimeters using a Biltmore stick. For trees with multiple trunks, DBH was measured as the largest trunk plus one-half of each of the smaller trunks. The diameters of Ashe junipers were also measured at the root collar using a DBH tape. Canopy cover was estimated using a densiometer. Other nest site and nest patch data, including distance of the nest to the main trunk, average height of junipers and oaks, nest cover, percent shrub cover, slope, stem density, basal area, and distance from trails were collected and will be presented in a separate report prepared by USFS.

Surveys for Banded Warblers Outside Intensive Study Plots

Surveys were conducted to search for and identify color-banded warblers in areas outside of the intensive study areas (plots plus buffers). Fourteen teams of 19 experienced, trained volunteers conducted surveys on approximately 1,900 acres. For each survey, observers were directed to allow roughly six hours per visit in each 100 acres of habitat for a minimum of three visits. The list of properties where surveys were conducted, total acres surveyed, and the survey effort for each tract are reported in Appendix B.

Pilot Study to Further Examine Effects of Recreation

During the 2002 and 2003 field seasons, Davis *et al.* (2003) conducted a study to evaluate the effects of mountain biking on the warbler at the Bike Park and Forest Ridge within the BCP and at Fort Hood. The study found that warbler territory sizes were 1.5 times larger, nest success was lower, and nest abandonment was higher in areas with bikes compared to non-biking sites. The study concluded that fragmentation and alteration of habitat from mountain bike trails may reduce the quality of nesting habitat. While disturbance from mountain biking was not reflected in the daily activity budgets of warblers, direct observations of warbler encounters with mountain bikers documented a flushing response of over 20 meters.

To document both temporal and spatial changes in warbler demographics, a follow-up study was initiated at the Bike Park in 2010 and continued in 2011. The control site in the Davis *et al.* study included the Forest Ridge 100-acre plot. The Coldwater tract was added as another control site in 2010 and was surveyed again in 2011. The Bike Park has a high trail density, is composed of open and closed-canopy trails, and allows the use of both mountain bikes and motorized dirt bikes during the warbler breeding season. The Bike Park is on the east side of City Park Road, northeast of the Emma Long intensive study plot. The Coldwater tract lies to the north of Emma Long Metropolitan Park. It contains Ashe juniper-oak woodlands as well as open areas with bare ground and shrubby growth that are currently not suitable warbler habitat. While there is no public access to the Coldwater tract, some closed-canopy trails and abandoned open-canopy ranch roads exist.

Warblers were color banded to determine territory size and configuration, pairing success, breeding success, and nest success, consistent with the Davis *et al.* 2010 study and following the methods employed on other intensive monitoring plots. Additionally, point counts surveys were conducted across the Bike Park and Coldwater for all bird species in both years to help evaluate survey methods and provide comparative data on the bird community on each tract.

This report provides a qualitative description of the data collected in 2011 and to date. Detailed results on density, return rates, age structure, and demography will be provided in a separate report prepared by USFS.

RESULTS AND DISCUSSION

Intensive Study Plots

Territory Densities and Locations. A total of 242 territories were identified in field season 2011, including 190.5 full + 0.5 edge territories for all 19 intensive study plots (an estimated average density of 0.07 territories per acre for the combined 2,676-acre study plots). Average warbler territory density (based on the full + 0.5 edge calculation) per 100 hectares for the 19 plots was 22 territories (range 0 to 46 territories/100 ha). Territory densities were highest in the Bull Creek, Cypress Creek, and North Lake Austin macrosites, and lowest in the small habitat patches surrounded by urban development, including the Gus Fruh and Sunset Valley portions of Barton Creek and in the West Austin macrosite. Data on territory numbers and densities are presented in Table 2 for field season 2011 (summary data for the original City of Austin 100-acre plots for field seasons 1998-2011 are presented in Appendix D).

Table 2. Golden-cheeked warbler territory number and estimated territory density (per 100 hectares) for each of the 19 intensive study plots on the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. See Methods section for calculations. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Name	No. of Full Territories	No. of Full and Edge Territories	No. of Full Territories + (0.5 x Edge Territories)	Territory Density 100 ha[1]
Barton Creek Macrosite				
Barton Creek	4	9	6.5	16
Gus Fruh	0	1	0.5	0.2
Sunset Valley	1	1	1	0.6
Bull Creek Macrosite				
3M/St. Edwards	12	25	18.5	46
Canyon Vista	10	22	16	40
Forest Ridge	13	20	16.5	41
Butler	12	22	17	42.5
Hamilton West	8	20	14	35
Cypress Creek Macrosite				
Baker Sanctuary	5	16	10.5	26
Lake Perspectives/McGregor	5	10	7.5	19
Vireo Ridge	7	13	10	25
Vista Point	15	17	16	40
North Lake Austin Macrosite				
Coldwater	11	16	13.5	13.5
Bike Park	12	15	13.5	13.5
Emma Long	10	16	13	32.5
South Lake Austin Macrosite				
Double J&T	3	4	3.5	9
Reicher	3	4	3.5	9
West Austin Macrosite				
Wild Basin/Vireo Preserve	8	11	9.5	5
Ullrich WTP	0	0	0	0
Total	**139**	**242**	**190.5**	

[1]Calculation based on Verner's counting method.

All plots are 100 acres except for Gus Fruh (210 acres, 85 ha), Sunset Valley (157 acres, 64 ha), Bike Park (245 acres, 99 ha), Coldwater (265 acres, 107 ha), Wild Basin/Vireo Preserve (445 acres, 180 ha), and Ullrich (54 acres, 22 ha).

Color Banding. A total of 170 warblers were banded in 2011, including 162 males and 8 females (Table 3). Of the 162 males, 68 were aged ASY, 92 were aged SY, and 2 were AHY. Five of the eight females were aged ASY and three were aged SY.

Table 3. Number of golden-cheeked warblers banded within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Name	No. Males Banded in 2011			No. Females Banded in 2011			Total No. Banded, 2011
	SY	ASY	AHY	SY	ASY	AHY	
Barton Creek Macrosite							
Barton Creek	0	3	0	0	0	0	3
Gus Fruh/ Sunset Valley	--	--	--	--	--	--	--
Bull Creek Macrosite							
3M/St. Edwards	10	6	0	1	0	0	17
Canyon Vista	5	10	0	0	0	0	15
Forest Ridge	8	10	0	1	0	0	19
Butler	10	0	0	0	0	0	10
Hamilton West	8	1	2	0	0	0	11
Cypress Creek Macrosite							
Baker Sanctuary	6	5	0	0	2	0	13
Lake Perspectives/ McGregor	3	4	0	1	0	0	8
Vireo Ridge	4	6	0	0	0	0	10
Vista Point	4	13	0	0	1	0	18
North Lake Austin Macrosite							
Coldwater	7	1	0	0	0	0	8
Bike Park	11	1	0	0	0	0	12
Emma Long	6	4	0	0	2	0	12
South Lake Austin Macrosite							
Double J&T	2	0	0	0	0	0	2
Reicher	1	2	0	0	0	0	3
West Austin Macrosite							
Wild Basin/ Vireo Preserve	7	2	0	0	0	0	9
Ullrich WTP	--	--	--	--	--	--	--
Total	**92**	**68**	**2**	**3**	**5**	**0**	**170**

Age Structure. We identified 242 territories on the 19 study plots in 2011, including 178 territorial males (74%) that were banded in 2009-2011, and 62 unbanded males (26%) (Table 4). Of the 178 banded males within the 19 study plots, 92 (52%) were ASY, 84 (47%) were SY, and two were AHY (1%). Barton Creek, Vista Point, Emma Long, and Canyon Vista had the highest percentages of ASY males (100%, 76%, 73%, and 71%, respectively), while Double J&T, the Bike Park, and Vireo Preserve/Wild Basin had the highest percentages of SY males (100%, 79%, 78%, respectively). The different age structures observed among plots suggest habitat characteristics may be influencing recruitment of young territorial males, but additional data are needed to understand the significance and potential underlying mechanisms.

Table 4. Golden-cheeked warbler age structure data for all banded territorial males observed within 19 intensive study plots on the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Name	% SY Males	%ASY Males	%AHY Males	Total No. Banded	Total No. Unbanded	% Banded
Barton Creek Macrosite						
Barton Creek	0	100%	0	6	3	67%
Gus Fruh/Sunset Valley	--	--	--	--	2	0
Bull Creek Macrosite						
3M/St. Edwards	56%	44%	0	18	7	72%
Canyon Vista	29%	71%	0	14	8	64%
Forest Ridge	35%	65%	0	17	3	85%
Butler	62%	37%	0	16	6	73%
Hamilton West	60%	27%	13%	15	5	75%
Cypress Creek Macrosite						
Baker Sanctuary	50%	50%	0	8	8	50%
Lake Perspectives/McGregor	43%	57%	0	7	3	70%
Vireo Ridge	37%	62%	0	8	5	62%
Vista Point	24%	76%	0	17	0	100%
North Lake Austin Macrosite						
Coldwater	54%	46%	0	13	3	81%
Bike Park	79%	21%	0	14	1	93%
Emma Long	27%	73%	0	11	5	69%
South Lake Austin Macrosite						
Double J&T	100%	0	0	2	2	50%
Reicher	33%	67%	0	3	1	75%
West Austin Macrosite						
Wild Basin/Vireo Preserve	78%	22%	0	9	2	82%
Ullrich WTP	--	--	--	--	--	--
Average	**47%**	**52%**	**1%**	**178**	**64**	**74%**

Return Rates. The overall return rate for males banded in 2010 was 41 percent, 19 percent for males banded in 2009, and 29 percent for males banded in 2009 and 2010 (Table 5). The Emma Long, Ribelin, and Hamilton West plots had the highest return rates for males banded in 2010 (67%, 67%, and 64%, respectively), but sample sizes were small. The Butler plot had the highest return rate for males banded in 2009 (33%). The South Lake Austin macrosite had the lowest return rate, with only one of ten males banded on the Bohls and Double J&T plots in 2009-2010 observed in 2011.

Table 5. Return rates for male golden-cheeked warblers banded in 2009 and 2010 within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Name	No. Males Banded 2009	No. 2009 Male Returns in 2011	% 2009 Male Returns in 2011	No. Males Banded 2010	No. 2010 Male Returns in 2011	% 2010 Male Returns in 2011	% Total Male Returns in 2011
Barton Creek Macrosite							
Barton Creek	6	1	17%	7	2	29%	23%
Gus Fruh/ Sunset Valley	--	--	--	--	--	--	--
Bull Creek Macrosite							
3M/St. Edwards	22	4	18%	11	3	27%	21%
Canyon Vista	--	--	--	--	--	--	--
Forest Ridge	16	3	19%	6	2	33%	23%
Butler	21	7	33%	11	5	45%	36%
Hamilton West	4	1	25%	11	7	64%	53%
Canyon Creek*	15	0	0	8	4	50%	17%
Ribelin*	--	--	--	6	4	67%	67%
Cypress Creek Macrosite							
Baker Sanctuary	--	--	--	--	--	--	--
Lake Perspectives/ McGregor	--	--	--	--	--	--	--
Vireo Ridge	--	--	--	--	--	--	--
Vista Point	--	--	--	--	--	--	--
North Lake Austin Macrosite							
Coldwater	--	--	--	13	5	38%	38%
Bike Park	--	--	--	8	2	25%	25%
Emma Long	14	3	21%	3	2	67%	29%
South Lake Austin Macrosite							
Double J&T	1	0	0	3	0	0	0
Reicher	--	--	--	--	--	--	--
Bohls*	2	0	0	4	1	25%	17%
West Austin Macrosite							
Wild Basin/ Vireo Preserve	--	--	--	--	--	--	--
Ullrich WTP	--	--	--	--	--	--	--
Total	**101**	**19**	**19%**	**91**	**37**	**41%**	**29%**

*Not one of the intensive study plots in 2011, but cursory surveys conducted to resight color-banded individuals.

Of the six females banded in 2009 and 2010, two returned in 2011 (33%), both of which were banded in 2009. One of these females was banded on Canyon Creek in 2009 and was observed near the Butler plot in 2010 and 2011. The other female was banded and resighted on the Butler plot. None of the three females banded in 2010 were observed in 2011.

Table 6. Return rates for female golden-cheeked warblers banded in 2009 and 2010 within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Name	No. Females Banded 2009	No. 2009 Female Returns in 2011	% 2009 Female Returns in 2011	No. Females Banded 2010	No. 2010 Female Returns in 2011	% 2010 Female Returns in 2011	% Total Female Returns in 2011
Barton Creek Macrosite							
Barton Creek	0	0	0	1	0	0	0
Gus Fruh/ Sunset Valley	--	--	--	--	--	--	--
Bull Creek Macrosite							
3M/St. Edwards	1	0	0	1	0	0	0
Canyon Vista	--	--	--	--	--	--	--
Forest Ridge	0	0	0	1	0	0	0
Butler	1	1	100%	0	0	0	100%
Hamilton West	0	0	0	0	0	0	0
Canyon Creek*	1	1**	100%	0	0	0	100%
Ribelin*	--	--	--				
Cypress Creek Macrosite							
Baker Sanctuary	--	--	--	--	--	--	--
Lake Perspectives/ McGregor	--	--	--	--	--	--	--
Vireo Ridge	--	--	--	--	--	--	--
Vista Point	--	--	--	--	--	--	--
North Lake Austin Macrosite							
Coldwater	--	--	--				
Bike Park	--	--	--				
Emma Long	0	0	0	0	0	0	0
South Lake Austin Macrosite							
Double J&T	0	0	0	0	0	0	0
Reicher	--	--	--	--	--	--	--
Bohls*	0	0	0	0	0	0	0
West Austin Macrosite							
Wild Basin/Vireo Preserve	--	--	--	--	--	--	--
Ullrich WTP	--	--	--	--	--	--	--
Total	**3**	**2**	**67%**	**3**	**0**	**0**	**33%**

*Not one of the intensive study plots in 2011, but cursory surveys conducted to resight color-banded individuals.
**Observed west of the Butler plot.

Dispersal. Of the 228 color-banded warblers observed in 2011 (170 banded in 2011, 58 banded in 2009-2010; tables 3, 5, and 6), BCP staff and volunteers documented six dispersal events both within and among habitat patches (Table 7). All six dispersal events were of individuals that were aged SY when banded; two were returns from 2009 (female) and 2010 (male), and four were banded in 2011. Of the 170 warblers that were color banded in 2011, ten were not observed again in addition to the four that were observed on other sites. The remaining 212 color-banded warblers observed in 2011 (93%) either returned to or remained within or near the same study plot, suggesting high site fidelity and low dispersal rates among adult warblers.

Dispersal distances observed in 2011 ranged from 0.9 to 11 kilometers and occurred within macrosites (4 of 6 dispersal events, ranging from 0.9 to 3.2 km) and between macrosites (2 of 6, ranging from 3.4 to 11 km). Dispersal between macrosites included Canyon Vista to Vireo Preserve (11 km), and from Vireo Preserve to Emma Long (3.4 km).

BCP staff surveyed both the intensive study plots and the 330-foot buffer around each study plot (where access was available). In addition, 14 teams of 19 volunteers devoted more than 288.5 hours and covered about 1900 acres (Appendix B) searching for banded warblers outside of the intensive study areas. Documenting the location of returning warblers is critical to understanding survival, dispersal, and site fidelity, all of which influence the viability of the warbler populations.

Table 7. Observed dispersal events for golden-cheeked warblers banded in 2009-2011 within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Where Banded	Date Banded	Age When Banded	Sex	Year(s) Resighted	Resighting Location(s)	Approx. Dispersal Distance	Comments
Canyon Creek	4/1/09	SY	F	2010, 2011	West of Butler	3 km	Resighted west of Butler on June 6; reproductive status unknown.
3M/St. Ed	4/13/10	SY	M	2011	Canyon Vista, 3M/St. Ed	1.8 km	Resighted on CV between April 7-May 7, and on 3M in late May. No established territory or reproduction.
Forest Ridge	3/18/11	SY	M	2011	Canyon Vista	3.2 km	Resighted on CV on April 26. No established territory or reproduction.
Canyon Vista	3/24/11	SY	M	2011	Canyon Vista, Vireo Preserve	11 km	Resighted on CV between March 24-April 16, paired with female, no reproduction; resighted on VP on May 19.
Vireo Preserve	4/17/11	SY	M	2011	Emma Long	3.4 km	Resighted on EL on April 27 and 29.
Emma Long	4/20/11	SY	M	2011	Bike Park	0.9 km	Resighted on Bike Park on May 26, feeding 2 fledglings.

Pairing and Reproductive Success. In 2011, a total of 242 territories were monitored for pairing and reproductive success on the 19 intensive study plots (Table 8). The average pairing and breeding success observed for all territories was 92 percent and 67 percent, respectively. No females or reproduction was observed on the Gus Fruh, Sunset Valley, or Ullrich study plots. For the plots where reproduction was observed, Canyon Vista, Double J&T, and Wild Basin/Vireo Preserve had the lowest observed pairing success (73-75%). Canyon Vista, Hamilton West, Bike Park, Double J&T, and Wild Basin/Vireo Preserve had the lowest observed breeding success (45-58%).

At least 402 fledglings were observed in 221 territories (reproduction on the remaining 21 territories was unknown). Average productivity for all 221 territories was 1.82 fledglings. Number of male offspring per territorial male averaged 0.91. Fecundity (number of female offspring per full territory with a female) averaged 0.96.

Applying the Reidy *et al.* (2008) estimate of 3.6 young fledged per successful nest in the Bull Creek and North Lake Austin macrosites to the number of territories where the number of fledglings was uncertain gives an adjusted total estimate of 525 young fledged and an average productivity per territory of 2.38. Adjusted number of male offspring per territorial male in the study plots averaged 1.19, and fecundity averaged 1.25. While the observed number of fledglings may be an underestimate, the adjusted number may be upwardly biased. The actual number is likely somewhere between these estimates.

Based on both the observed and adjusted number of fledglings, study plots in closed canopy woodlands near the center of the largest habitat patches in the Bull Creek (Butler, 3M/St. Edwards), Cypress Creek (Vista Point), and North Lake Austin (Coldwater, Emma Long) macrosites produced the greatest number of fledglings, while study plots in smaller habitat patches (Barton Creek, West Austin macrosites) and young woodlands (South Lake Austin macrosite) had the lowest reproductive output.

A few territories appeared to have double broods. Since double broods are rare for the warbler, and documentation is opportunistic, they are not included in the estimated number of fledglings and productivity.

Table 8. Golden-cheeked warbler reproductive success on 19 intensive study plots on the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Data are based on observations for both full and edge territories. See Methods section for calculations. Territories for which pairing and reproductive success were unknown are not included in the calculations (actual sample sizes are indicated in parentheses). Data for full territories are presented in Appendix G. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Name	No. of Territories	No. of Territories w/ Female	Pairing Success	No. of Territories Producing ≥ 1 Young	Breeding Success	Total No. of Fledglings Observed	Observed Product. per Territory	Adjusted Number of Fledglings*	Adjusted Product. per Territory*
Barton Creek Macrosite									
Barton Creek	9	8 (8)	1.00	6 (9)	0.67	17	1.89	21.4	2.38
Gus Fruh	1	0	0	0	0	0	0	0	0
Sunset Valley	1	0	0	0	0	0	0	0	0
Bull Creek Macrosite									
3M/St. Edwards	25	24 (25)	0.96	15 (23)	0.65	35	1.52	54.8	2.38
Canyon Vista	22	16 (22)	0.73	12 (22)	0.55	27	1.23	43.6	1.98
Forest Ridge	20	17 (17)	1.00	14 (19)	0.74	29	1.53	47.0	2.47
Butler	22	21 (22)	0.95	14 (21)	0.67	40	1.90	50.4	2.40
Hamilton West	20	18 (20)	0.90	10 (20)	0.50	24	1.20	24.0	1.20
Cypress Creek Macrosite									
Baker Sanctuary	16	13 (16)	0.81	10 (16)	0.63	22	1.38	36.4	2.28
Lake Perspectives/ McGregor	10	10 (10)	1.00	7 (10)	0.70	21	2.10	22.2	2.22
Vireo Ridge	13	10 (10)	1.00	8 (9)	0.89	22	2.44	29.0	3.22
Vista Point	17	16 (17)	0.94	12 (16)	0.75	42	2.63	45.4	2.84
North Lake Austin Macrosite									
Coldwater	16	14 (14)	1.00	10 (12)	0.83	36	3.00	36.0	3.00
Bike Park	15	12 (13)	0.92	7 (12)	0.58	24	2.00	26.8	2.23
Emma Long	16	16 (16)	1.00	14 (14)	1.00	41	2.93	51.6	3.69
South Lake Austin Macrosite									
Double J&T	4	3 (4)	0.75	2 (4)	0.50	2	0.50	7.2	1.80
Reicher	4	4 (4)	1.00	3 (3)	1.00	11	3.67	11.6	3.87
West Austin Macrosite									
Wild Basin/Vireo Preserve	11	8 (11)	0.73	5 (11)	0.45	9	0.82	18.0	1.64
Ullrich WTP	0	0	0	0	0	0	0	0	0
Total/Avg.	**242**	**210 (229)**	**92%**	**149 (221)**	**67%**	**402**	**1.82**	**525.4**	**2.38**

*Based on mean number of 3.6 young per successful nest (Reidy *et al.* 2008) for territories where the number of fledglings was uncertain; does not include territories with double broods.

Nest Data

BCP staff found and monitored a total of 109 active warbler nests during the 2011 field season (Table 9). The first nest was found on March 21, and the last nests were found on June 2. Sixty-seven nests fledged one or more young (61%), and 42 nest failed (39%).

Table 9. Fates of monitored golden-cheeked warblers nests within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Plot Name	Total No. Nests	No. Failed Nests	No. Successful	% Successful Nests	% Failed Nests
Barton Creek Macrosite					
Barton Creek	9	5	4	44%	56%
Gus Fruh/ Sunset Valley	0	--	--	--	--
Bull Creek Macrosite					
3M/St. Edwards	9	5	4	44%	56%
Canyon Vista	3	1	2	67%	33%
Forest Ridge	9	2	7	78%	22%
Butler	13	5	8	38%	62%
Hamilton West	9	5	4	44%	56%
Canyon Creek*	3	0	3	100%	0%
Cypress Creek Macrosite					
Baker Sanctuary	0	--	--	--	--
Lake Perspectives/ McGregor	1	1	0	0%	100%
Vireo Ridge	7	4	3	43%	57%
Vista Point	14	5	9	64%	36%
North Lake Austin Macrosite					
Coldwater	13	3	10	77%	23%
Bike Park	10	4	6	60%	40%
Emma Long	4	1	3	75%	25%
Cortaña	1	0	1	100%	0%
South Lake Austin Macrosite					
Double J&T	0	--	--	--	--
Reicher	2	1	1	50%	50%
West Austin Macrosite					
Wild Basin/Vireo Preserve	2	0	2	100%	0%
Ullrich WTP	0	--	--	--	--
Total	**109**	**42**	**67**	**61%**	**39%**

*Not one of the intensive study plots in 2011.

Three of the 109 nests were monitored with cameras until the nest failed or produced young: one on Coldwater and two on the Bike Park. The Coldwater nest fledged four young. One of the Bike Park nests

fledged four young and the other was depredated, but the camera battery died before the predation occurred so the predator could not be identified.

Seventy-eight nests were found in Ashe juniper (72%), 18 in live oak (16%), nine in cedar elm (8%), three in shin oak (3%), and one in a Texas red oak (1%) (Table 10). Nest tree height for all tree species averaged 8.45 meters (range 2.2-17.4 m), and DBH averaged 32 centimeters (range 7.7-83 cm). Nest height averaged 5.8 meters (range 2-13 m). Canopy cover averaged 82 percent (range 35-98%).

The nest data are part of a growing dataset of nests monitored on the BCP. These data will be used to analyze the relationships between habitat characteristics and nest success. Analyses will include effects of landscape metrics (i.e., land use, stand age, habitat composition, amount of edge) and more localized effects, which will be provided by USFS in a separate report.

Table 10. Summary of vegetation data collected for 109 golden-cheeked warbler nests found within the Balcones Canyonlands Preserve, Travis County, Texas, field season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Tree Species	Total No. Nests	Tree Height Avg, Range (m)	Tree DBH Avg, Range (cm)	Nest Height Avg, Range (m)	% Canopy Cover Avg, Range	% Successful Nests
Juniperus ashei (Ashe Juniper)	78	8.5 (2.2 - 12.2)	32.3* (7.7 - 83)	5.5 (2 - 9.4)	83% (64 - 98)	64%
Quercus fusiformis (Live Oak)	18	7.5 (4 - 12.4)	30.0 (10.5 - 68)	5.7 (3.1 – 8.3)	73% (35 – 92)	50%
Ulmus crassifolia (Cedar Elm)	9	10.7 (4.8 – 17.4)	28.5 (13.5 – 53)	8.5 (4.4 - 13)	86% (71 – 94)	60%
Quercus sinuate var. *breviloba* (Shin Oak)	3	7.6 (4.3 – 10)	20.3 (14 – 28)	6.2 (3.5 – 7.6)	85% (81 – 90)	67%
Quercus buckleyi (Texas Red Oak)	1	7.3	31.3	5.0	93%	0
Totals	**109**	**8.45 (2.2 – 17.4)**	**32.0 7.7 – 83)**	**5.8 (2 – 13)**	**82 (35 – 98)**	**61%**

*Represents average root collar measurement. Average DBH measurement (33.7 cm) for Ashe juniper was similar to the average root collar measurement.

Parasitism

In early June 2011, a Brown-headed Cowbird (*Molothrus ater*) chick was observed in a nest with one and perhaps two warbler nestlings on the Barton Creek plot, but the nest was depredated before it fledged. A female warbler was also seen feeding a brown-headed cowbird fledgling just off the Lake Perspectives/McGregor tract on June 8, 2011.

Recreation Study

The number of warbler territories increased on the Bike Park and Coldwater in 2011 compared to 2010 by a factor of 1.6 and 1.3, respectively (Table 11). As in 2010, pairing and breeding success in 2011 were higher on Coldwater (100 percent pairing success, 83 percent breeding success) than on the Bike Park (92 percent pairing success, 58 percent breeding success). The observed and adjusted number of fledglings and productivity values were also higher on Coldwater than on the Bike Park (Tables 8 and 11). Nest success was higher on Coldwater (77% of 13 nests produced young) than on the Bike Park (60% of 10 nest produced young) in 2011 (Table 9).

The number of SY males also increased on both the Bike Park and Coldwater in 2011 compared to 2010, and the percentage continued to be higher on the Bike Park (79%; 54% on Coldwater) (Table 12). In contrast, the Emma Long 100-acre plot, which is across the road from the Bike Park, has a high percentage of ASY males (89% in 2010, 73% in 2011). The presence of a perennial creek through the middle of the Emma Long plot is a factor that may be influencing the age structure in this area.

BCP staff mapped authorized and unauthorized trails on the Bike Park in 2010, but logistical limitations have precluded finalizing the data layer. However, field observations in 2010 and 2011 found trail networks extending into and crisscrossing the creek beds and slopes along the creeks, which are often where warbler territories tend to be concentrated. New unauthorized trails were also frequently encountered. BCP staff did not have the resources to document trail use, which included weekly mountain bike races from late May through June.

Data for the Forest Ridge 100-acre plot are also presented in tables 11 and 12 for comparison with the Bike Park and Coldwater data. The Davis *et al.* 2010 study covered a broader area surrounding the 100-acre plot in 2002 and 2003. Future survey efforts may attempt to survey the same area for a more comprehensive comparison. However, territory densities and reproductive success remained fairly stable and were higher on the Forest Ridge 100-acre plot. The number of SY males increased, but was still lower compared to the number of SY males on Coldwater and the Bike Park.

The higher reproductive success observed on Coldwater compared to the Bike Park is consistent with the findings in the Davis *et al.* 2010 study and suggests that habitat fragmentation and/or concentrated, intensive recreational uses that are limited to mountain biking and motorized dirt bikes may be having a negative effect. While not directly comparable, reproductive success was also higher on the Forest Ridge 100-acre plot. These sites will be surveyed again in 2012 to determine whether the observed trends persist.

Table 11. Golden-cheeked warbler reproductive success on the City of Austin's Motocross Park in Emma Long Metropolitan Park (Bike Park), Coldwater, and Forest Ridge intensive study plots, field season 2011. Data are based on observations of all territories. See Methods section for calculations. Territories for which pairing and reproductive success were unknown are not included in the calculations (actual sample sizes are indicated in parentheses).

Plot Name	No. of Territories	No. Territories w/ Female	Pairing Success	No. of Territories Producing ≥ 1 Young	Breeding Success	Adjusted No. of Fledglings*	Adjusted Product. per Territory*	Plot Size (acres)
Bike Park (2003)	16	13 (16)	0.81	8 (16)	0.50	29	1.80	245
Bike Park (2010)	9	8 (9)	0.89	5 (9)	0.56	18	2.00	245
Bike Park (2011)	15	12 (13)	0.92	7 (12)	0.58	24	2.23	245
Coldwater (2010)	12	11 (12)	0.92	7 (12)	0.58	25	2.10	265
Coldwater (2011)	16	14 (14)	1.00	10 (12)	0.83	36	3.00	265
Forest Ridge (2010)	20	16(19)	0.84	13(20)	0.65	47	2.35	100 + buffer
Forest Ridge (2011)	20	17(17)	1.00	14(19)	0.74	47	2.47	100 + buffer

*Based on mean number of 3.6 young per successful nest (Reidy *et al.* 2008).

Table 12. Golden-cheeked warbler age structure data for all territorial males on the City of Austin's Motocross Park in Emma Long Metropolitan Park (Bike Park), Coldwater, and Forest Ridge intensive study plots, field season 2011.

Plot Name	% SY Males	%AHY Males	%ASY Males	Total No. Banded	Total No. Unbanded	No. Territories	% Banded
Bike Park (2003)	0	25%	75%	8	8	16	50%
Bike Park (2010)	63%	0	38%	8	1	9	89%
Bike Park (2011)	79%	0	21%	14	1	15	93%
Coldwater (2010)	42%	0	58%	12	0	12	100%
Coldwater (2011)	54%	0	46%	13	3	16	81%
Forest Ridge (2010)	21%	0	79%	14	6	20	70%
Forest Ridge (2011)	35%	0	65%	17	3	20	85%

Other Observations

Field season 2011 was a very dry and windy, and many springs and spring runs that are typically flowing in the spring were dry. Adult warblers seemed to have more a difficult time finding enough food for themselves and their young, taking a long time to gather food and collecting very small invertebrates. The effects of the drought on the warblers (including survival during migration) and their habitat (plant diversity, food availability, sources of water for drinking and bathing) will likely be more apparent during the 2012 field season if the drought continues.

Warblers are frequently seen drinking and bathing in springs and shallow pools that are shaded by overhanging vegetation. During field season 2011, banded warblers were occasionally found at sites with water a good distance from their territories. No territorial disputes were apparent during these observations; the birds kept low to the ground and did not sing. BCP staff also videotaped fledglings bathing in a small puddle of water along a dirt road, which appeared to be the only source of water in the area.

As in previous years, field staff observed female warblers on the ground collecting nesting material. Both males and females were observed collecting food on the ground, and fledglings were often seen in dense mid-story vegetation and near the ground. BCP staff videotaped a female tending a day-old fledgling that was unable to fly, highlighting the vulnerability of newly fledged young and the importance of ground habitat to the warbler, in addition to the tree canopy and mid-story vegetation.

Consistent with Beardmore (1994), adult warblers appear to shift from foraging primarily in oaks and other hardwoods early in the season to foraging primarily in Ashe juniper later in the season. This shift appears to correspond with timing of young fledging from nests, around late April.

During the 2008 field season, staff videotaped an adult warbler distraction display (City of Austin 2008), and staff observed male and female warblers feigning wing injuries in 2009-2011 as well. Warblers displayed this injury-feigning behavior when field biologists were in the vicinity of newly fledged young.

A BCP biologist observed a red-eyed vireo stealing nesting material from a warbler nest while the female warbler was sitting on the nest. The red-eyed vireo cautiously flew just under the nest and started to pull material from the nest, at which point the female warbler looked over the edge of the nest and the red-eyed vireo backed off. It returned and continued to pull material from the nest while the female warbler quietly watched.

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II. BLACK-CAPPED VIREO MONITORING

INTRODUCTION

Background

The black-capped vireo (vireo) is an endangered, neotropical migrant that breeds in portions of Oklahoma, Texas, and Mexico (Grzybowski 1995). The U.S. Fish and Wildlife Service listed this species as endangered in 1987 (USFWS 1987). Major threats to the vireo's survival include habitat loss, habitat fragmentation, over-grazing/browsing, natural vegetation succession, and parasitism by brown-headed cowbirds. The Balcones Canyonlands Preserve (BCP) was established in 1996 in part to mitigate for loss of vireo habitat in western Travis County due to exurban sprawl, and to aid vireo recovery.

The vireo has been documented on several BCP tracts that are managed by the City of Austin. The largest known colony in Travis County formerly existed at the Wild Basin/Vireo Preserve. A 1961 wildfire created several hundred acres of vireo habitat in this area. The vireo colony likely peaked sometime in the 1970s, but declined steadily from 32 territories in 1987 to one territory in 1997 (Grzybowski 1989, Steed 1988, Abbruzzese 1998) and an intermittent sighting of a male in 2004 (Becker and Koehler 2004) and in 2011. A small breeding colony of vireos (three to five territories) has occupied habitat on the Cortaña tract every year since 2000. A part of this colony spills onto the adjacent River Place mitigation tract to the northeast. In 2009, vireos nested successfully on the Forest Ridge tract, and have returned there each of the past two years. On the Kent Butler Ecological Reserve (formerly known as the Ivanhoe tract), vireos nested in 2008 and 2009 along electric transmission line corridors, but no vireos have established territories in that area for two years now. Other records for vireos on the City of Austin's BCP tracts for the past decade include intermittent sightings of males on the Commons Ford, Parke West, and Hamilton West tracts.

Objectives

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

Because of the threat posed by brown-headed cowbirds, monitoring for direct and indirect signs of cowbird parasitism during field surveys is a high priority, and BCP staff are committed to intensive management of cowbirds at or near all vireo colonies.

Because of the early successional nature of vireo habitat, the land management plan (BCP 2007b) also emphasizes vegetation management and monitoring. Vireos occupy shrublands of mixed deciduous and

evergreen species with irregular height and distribution. Open spaces between clumps of woody vegetation are also important, so optimal vireo habitat appears as a mosaic of grassy or rocky spaces and clumps of shrubs. Shrubs that have a skirt of vegetative cover extending down to the ground are especially important to conceal nests. Because this early successional stage of habitat must continually be manipulated to remain viable, restoration projects in conjunction with habitat monitoring are typically undertaken every year on various City of Austin tracts.

METHODS

Sites and Survey Effort

To monitor population trends, surveys for vireos are conducted every year. The vireo monitoring program closely follows the golden-cheeked warbler (warbler) monitoring protocols (Section I, Appendix C). However, the smaller population size and more transitory nature of the vireo requires more flexibility in the location, size, and extent of the survey areas, as opposed to the permanent study plots with fixed size that have been established for the warbler.

In field season 2011, vireos were censused on a 39-acre section of the Cortaña tract. Combined with an 18-acre section of the adjacent River Place mitigation tract, this parcel makes up the 57-acre vireo habitat study area that was originally restored in 1996. Vireos were also censused on and adjacent to the Forest Ridge intensive study area. Because much of this area is more typically associated with warblers, the exact size of the vireo habitat on Forest Ridge is undetermined. Vireos detected during other endangered species surveys were also recorded and mapped, and attempts were made to determine their breeding status.

Survey effort on the established Cortaña colony is roughly equivalent, acre-for-acre, to the level of effort on the warbler intensive study plots. From the Cortaña colony, City of Austin staff biologists collected the following data: number of territories, territory location, pairing success, breeding success, parasitism, and productivity. Staff biologists used territory mapping (IBCC 1970, Bibby 1992) methods to determine numbers and locations of territories, conducting surveys from 16 April to 24 June 2011 for a total of 57.5 hours. We also returned to the site on June 11 and 19 to monitor a nest, and on July 19 to search for signs of re-nesting.

The Forest Ridge intensive study area was surveyed several times each week as part of the warbler monitoring program from March 15 through June 15. Once vireos were detected on April 12, staff collected data on the number of vireo territories, territory locations, pairing success, breeding success, parasitism, and productivity, continuing surveys through July 18. Because vireos and warblers both occurred at this site, the exact number of hours for the vireo is difficult to ascertain. However, a rough estimate is 113 hours from April 12 through July 18.

BCP staff and volunteers have managed cowbirds at the Cortaña colony every year since vireos were first observed there in 2000, and have also maintained a cowbird trap on the Kent Butler Ecological Reserve, near the area where vireos have nested.

Staffing limitations and county-wide burn bans prevented any prescribed burns to revive habitat this year. Due to the burn ban, other methods were used to treat previously cut vegetation on the Vireo Preserve.

Data Collection and Analysis

Vireo observations were recorded with Garmin global positioning units (GPS), which have an accuracy of 9 to 30 feet. Other sightings were recorded on topographic maps at a scale of 1:2,400 or 1:3,600, using a 100-meter UTM grid. Pairing status, breeding success, and number of fledglings produced per pair were determined for each territory. For methodology and calculations, see BCP-wide Monitoring Program: Intensive Study Plots, in Section I on Golden-cheeked Warbler Monitoring. No playback tapes of vireo songs or calls were used during this season's monitoring.

RESULTS AND DISCUSSION

In 2011, staff found vireos holding territories on two City-owned BCP tracts: Cortaña and Forest Ridge. A male vireo presumed to be a floater, not holding a territory, was observed once on the Kent Butler Ecological Reserve, and another was detected on the Wild Basin Preserve, adjacent to the Vireo Research Area. Figure 2 shows where vireos were found this year.

Territory Mapping on the Cortaña Study Site

Only one male vireo defended a territory on the restored portion of the Cortaña tract and none on the adjacent River Place mitigation tract, a decrease of two territories from 2010. The oldest male to be banded on this site, Red/White:Black/Silver (RD/WH:BK/SI, nicknamed "Gatekeeper," who was banded as an ASY in 2008 and thus would have been more than five years old), did not return to the territory he had held for several years near the entrance to the study site.

The one male observed on the site was a bird banded as an ASY male by William Simper (Texas State University) in 2008: Blue/Silver:Yellow/Black (BL/SI:YE/BK, a five-year-old male). The first detection, presumably of this male, was April 16, but the band combination was not confirmed until April 27.

Pairing, Breeding Success, and Productivity on the Cortaña Study Site

Pairing success was 100 percent. Biologists first observed a female on the site, in company with the banded male, on May 4. The banded male was frequently seen accompanying a female, presumably this same unbanded female.

A biologist found a partially completed nest on May 20. (Judging from the actions of the pair, there may have been an earlier unsuccessful nest, which observers did not locate, in the northwestern part of the study site.) A female, accompanied by the banded male, was observed carrying nesting material in the general vicinity of the partial nest. On May 26, the nest appeared to be complete, but empty. On June 2, the nest held 3 eggs.

The adults continued to incubate the eggs through at least June 19. However, close examination of the eggs on June 11 suggested they were not viable. A sharply-defined difference in color was visible (see

photo below) through the shell about one-quarter of the distance from the large end of the egg. According to those familiar with the species (David Cimprich, personal communication), this color difference is characteristic of non-viable eggs.

No vireos were detected on a July 19 visit to the site.

Productivity, therefore, on the Cortaña tract in 2011, was zero.



Territory Mapping on the Forest Ridge Study Site

Two territorial males were observed on and adjacent to the Forest Ridge intensive study plot in April, May, and June 2011. The male vireos were first detected on April 12, countersinging about 100 meters east of the plot boundary on the south rim of the ridge that runs through the plot. The males held territories along south-facing slopes on either side of a deep ravine.

One male was banded Orange/Silver:Blue/Green (OR/SI:BL/GR, a four-year-old male, banded as an SY in 2009 in this area); this male established a territory, initially, 100 to 200 meters east of the plot. Beginning on May 24, this male shifted westward onto the plot, and was observed several times on the ridgeline on the western half of the plot in late May. On June 7, this bird was identified approximately 300 meters northwest of the plot, again on the top of the ridge. He was last seen on June 23, when he was near the center of the plot, counter-singing with the second male. No female was ever observed with this male, and he was presumed unmated.

The second male was unbanded, and apparently held a territory that straddled the eastern edge of the study plot, on the south slope of the ridge. On June 7, a female was observed with this male, and a nest was located in a young juniper. Four nestlings, two to three days old, occupied the nest when it was

found. Two fledglings were observed with an unbanded male in this area on July 7. There may have been other fledglings from that nest, but they were not confirmed.

A third male vireo, also unbanded, was detected only three times, on the upland to the north of the other two vireo territories. There is no information on whether he was territorial, mated, or raised young.

Pairing, Breeding Success, and Productivity on the Forest Ridge Study Site

Based on the two confirmed vireo territories, pairing and breeding success at Forest Ridge was 50 percent. Productivity was two to four fledglings for the one successful territory, and 1.00 to 2.00 fledglings for both territories.

Vireos on Other Tracts

In 2011, as in 2010, no vireos established territories on the Kent Butler Ecological Reserve, where a pair had nested each of the previous two years along a utility line corridor near the northwest corner of the warbler intensive study area. A fast-moving male vireo was observed on the opposite (south) side of the plot on May 31, but was not found on subsequent visits; the habitat appears to be unsuitable (relatively closed-canopy oak and juniper woodland).

Also in 2011, a vireo was detected on the southern slopes near the Wild Basin/Vireo Preserve boundary on April 14, but was not detected again during subsequent surveys.

Parasitism

No brown-headed cowbirds were observed during vireo surveys at either Forest Ridge or Cortaña, though several were caught in a trap at the latter site. The trap on the Cortaña study area caught a total of 31 brown-headed cowbirds; fifteen of these were female cowbirds. A wooden mega-trap on the Kent Butler Ecological Reserve caught one female and two male cowbirds. No vireos were observed tending cowbird fledglings.

City staff observed neither interactions between vireos and potential predators, nor any harassment of vireos by other species.

Golden-cheeked Warblers in Black-capped Vireo Habitat

In some areas, vireo habitat may progress to warbler habitat through natural succession. Likewise, natural or anthropogenic disturbance patterns may convert warbler habitat to the early successional stage preferred by the vireo. These habitat types often overlap. During 2011 within the City of Austin BCP, territorial warblers and vireos were observed in the same or neighboring areas on the Cortaña and Forest Ridge tracts.

Warblers were incidentally mapped during vireo surveys around the 39-acre vireo habitat area on the Cortaña tract. Male warblers were usually detected singing near the perimeter of the vireo habitat area; the canyons surrounding the upland study site are excellent warbler habitat. On June 2, a warbler nest was discovered near the north boundary of the Cortaña tract in a band of Spanish oaks that encircles a knoll in the center of the study area. The nest successfully fledged at least two young, observed on June

4. (It was apparently the second brood for the pair, since a fledgling with two adults had been observed a few yards away on the River Place MUD side of the fence on April 27.)

On the Forest Ridge tract, the vireo territories were intermingled with warbler territories within prime warbler habitat on and near the intensive study plot.

III. BLACK-CAPPED VIREO HABITAT MANAGEMENT

Background. The Balcones Canyonlands Conservation Plan (USFWS 1996) requires maintaining or creating 2,000 acres of vireo habitat within the BCP, and the land management plan (BCP 2007b) provides additional, general guidelines to help achieve this goal. Focal areas for vireo habitat management on City of Austin BCP lands currently include Cortaña, Wild Basin/Vireo Preserve, Bohls, and infrastructure corridors (Kent Butler Ecological Reserve).

Maintenance of Currently Occupied Habitat – Cortaña. The Cortaña tract (1,752 acres) in the North Lake Austin Macrosite is the only City of Austin BCP property under active management that is currently occupied by vireos. In 1996, about 57 acres of juniper-oak woodlands on the northern Cortaña tract and the adjacent, privately managed, River Place mitigation tract were cut back to establish a shrubby successional stage favorable to vireos. Approximately 39 acres were treated on Cortaña and 18 acres on River Place. Both hand-clearing and hydro-axing methods were applied. In each year since 2000, three to five males had established territories in this area – until this year, when the site hosted only one pair.
During winter 2009-10, City of Austin staff created fire lanes in anticipation of a prescribed burn to enhance habitat on approximately 11 acres of the Cortaña tract. However, burn bans and staffing limitations may make mechanical treatments more feasible than prescribed burns for future habitat revitalization.

Restoration of Formerly Occupied Habitat – Wild Basin/Vireo Preserve. The Vireo Preserve and adjacent Wild Basin tract supported at least 32 vireo territories during the mid-1980s, making this the largest concentration of vireos known in Travis County. This area was once part of a larger ranch that was in the process of being cleared of brush in preparation for a cattle ranch and subsequently burned in April 1961 (Austin American-Statesman 1961, Respess 1987, Westlakehills undated). The wildfire was reportedly ignited by a cigarette tossed from a car along St. Stephens School Road, which started a grass fire. A strong cold front and the large piles of brush scattered throughout the ranch further fueled the fire, which burned for three days and spread over about 4,000 acres. Although shrubs and many trees burned, pockets of mature Ashe juniper woodlands survived. The brush clearing followed by the 1961 wildfire converted what was formerly a closed-canopy Ashe juniper-oak woodland (preferred habitat of the warbler) to mostly open shrub land (preferred habitat of the vireo). Analysis of a decadal series of aerial photos of this area shows habitat succession progressing steadily since the 1961 fire. Assuming vireo habitat in western Travis County has a life-span of 20 to 30 years following intense manipulation, and warbler habitat takes at least 50 years to recover (BAT 1990), a decline of the vireo colony as the habitat

matured toward a taller, more closed-canopy woodland would be expected during the 1980s-1990s. Complicating this issue, however, is the simultaneous increase in urbanization (including the building of Loop 360 and surrounding subdivisions) that occurred during this same time period. The last vireo observed nesting on the Wild Basin/Vireo Preserve (an 11-year old male banded as an SY in 1987) was in 1996, 35 years after the 1961 fire.

The Wild Basin/Vireo Preserve collectively supports over 250 acres of former vireo habitat (13% of the 2,000-acre requirement). To determine whether this area can again support a viable breeding colony of vireos, habitat restoration plans have been developed and are currently being implemented. Efforts to date include a prescribed burn on about seven acres (February 16, 2010), perimeter fencing (fall 2010), and mechanical manipulation of about 50 acres (fall 2010 and 2011). The primary focus of these habitat restoration efforts has been to encourage resprouting of evergreen sumac and other broad-leaved species, protect regenerating plants from browse by white-tailed deer, create a more open habitat with a diverse height structure on the uplands, and protect the diversity of habitat types across Wild Basin/Vireo Preserve. More details on the 2010-2011 restoration efforts are provided in City of Austin (2010).

Due to the 2011 drought and subsequent burn ban, City of Austin staff revised plans for 18.5 acres of woody vegetation that had been cut with a tree shear in preparation for a prescribed burn. During the fall of 2011, the majority of the slash was mulched to assist with other habitat restoration efforts within the BCP. This included making mulch and mulch socks to be used as part of a research project to restore soils and promote hardwood regeneration on degraded areas of the Wild Basin/Vireo Preserve that are currently not habitat for either the warbler or the vireo. Collaborative efforts among the City of Austin, Travis County, St. Edwards University, Wild Basin, and volunteers are currently underway to design and implement the research project, which will be implemented in early 2012. Since Wild Basin/Vireo Preserve supports many of the habitat types observed throughout the BCP, lessons learned at this site should be applicable to other areas within the BCP.

Creation of New Habitat – Bohls. In an effort to create vireo habitat, City staff coordinated a combination of mechanical cutting followed by a prescribed burn on about 30 acres of the Bohls tract. The mechanical clearing took place during the winter of 2003-04, in September 2005, and in February 2007a, and the prescribed burn in February 2007a. City of Austin staff continue to monitor habitat succession on this site, which has not yet been occupied by vireos. Additional work is planned to expand the vireo habitat management area near the established shinnery, including either a prescribed burn or mechanical treatment.

Monitoring Effects of Habitat Management Efforts. During the fall of 2009, BCP staff and a volunteer monitored habitat restoration efforts on the Cortaña and Bohls tracts, and recorded baseline data for the Vireo Preserve. On Cortaña and Bohls, monitoring consisted of taking photographs from established photo points, and collecting data along vegetation transects (point-intercept and line-transect methods). At Vireo Preserve, staff established and collected data along five vegetation transects on the knoll during the fall of 2008 and 2009, prior to conducting the prescribed burn. However, since none of

the transects were affected by the burn, these were not repeated in 2010 or 2011. During the fall of 2010, staff established 16 photo points just prior to the mechanical manipulation, and repeated the photo points upon completion of the manipulation in February 2011.

Identifying Other Potential Management Sites. Travis County and City of Austin BCP staff are currently working on a comprehensive plan to identify existing and potential sites for vireo habitat management. A GIS database has been developed to assess site characteristics and to locate suitable sites. Data layers include geology, soils, topography, historic vireo sightings, and warbler observations. Because vireo and warbler habitat are similar in composition but differ in successional stages, a map of composition and stand age is needed to help identify priority (mature) woodlands for the warbler and potential management areas (earlier successional stages) for the vireo. To assist with this effort, the City of Austin has a contract with Dr. Joseph White/Baylor University to analyze a decadal series of historic aerial photographs (1940 to present) and conduct a dendrochronology study to approximate stand ages, composition, and fire histories within the BCP's Ashe juniper-oak woodlands. This project was initiated in September 2009 (aerial photo analyses) and 2011 (dendrochronology), is currently in the ground-truthing stage, and expected to be completed in 2012. Other variables that are being considered in identifying sites for vireo management include size of the potential restoration area, history of occupation by vireos, proximity to the nearest vireo colony, proximity to urban development, and feasibility of management (for example, prescribed burns). Consistent with the recommendations in the BCCP, the BCP partners are evaluating the potential to create vireo habitat in areas within the BCP that are not currently suitable for either the vireo or the warbler and manage them for vireo habitat rather than for future warbler habitat. Since vireos occupy an earlier successional stage, actively managing to create vireo habitat may be a more realistic option in some areas than trying to restore mature, closed canopy woodlands. This would also protect existing warbler habitat from conversion or fragmentation to create vireo habitat. BCP partners will use all of this information to assess which areas have the potential to be managed as vireo habitat without impacting the warbler.

IV. LITERATURE CITED

Abbruzzese, C. 1998. 1998 golden-cheeked warbler and black-capped vireo monitoring program, Balcones Canyonlands Preserve. City of Austin Parks and Recreation Department, Natural Resources Division. Austin, Texas.

——. 2001. 2001 Golden-cheeked warbler and black-capped vireo monitoring program, Balcones Canyonlands Preserve. City of Austin Parks and Recreation Department, Natural Resources Division. Austin, Texas.

——, and D.L. Koehler. 2003. City of Austin 2003 golden-cheeked warbler and black-capped vireo monitoring program: Balcones Canyonlands Preserve annual report FY2002-03. City of Austin, Water Utility, Wildland Conservation Division, Balcones Canyonlands Preserve program. Austin, Texas.

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

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

Balcones Canyonlands Preserve. 1998. Management of the golden-cheeked warbler. *In* Balcones Canyonlands Preserve Land Management Plan, Tier IIA. Austin, Texas.

——. 2007a. Land management plan, Tier IIA-7, golden-cheeked warbler management. City of Austin and Travis County, Austin, Texas.

——. 2007b. Land management plan, Tier IIA-8, black-capped vireo management. City of Austin and Travis County, Austin, Texas.

Beardmore, C. 1994. Habitat use of golden-cheeked warblers in Travis County, Texas. M.S. thesis, Texas A&M University. College Station, Texas.

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

Bibby, C. J., N.D. Burges, and D.A. Hill. 1992. Bird Census Techniques. Academic Press. San Diego, California. 257pp.

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

City of Austin. 2008. City of Austin 2008 golden-cheeked warbler *(Dendroica chrysoparia)* and black-capped vireo *(Vireo atricapilla)* monitoring program: Balcones Canyonlands Preserve annual report FY 2007a-08. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

——. 2010. City of Austin 2010 golden-cheeked warbler *(Dendroica chrysoparia)* and black-capped

vireo *(Vireo atricapilla)* monitoring program: Balcones Canyonlands Preserve annual report FY 2009-10. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

——. 2011. City of Austin. Standards for conducting and documenting golden-cheeked warbler surveys. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

Davis, C., D. Leslie, W. Walter, and A. Graber. 2010. Mountain biking trail use affects reproductive success of nesting golden-cheeked warblers. The Wilson Journal of Ornithology 122(3):465-474.

DLS Associates. 1990. Black-capped vireo monitoring program, Travis County, Texas, 1990. Final report submitted to The Nature Conservancy of Texas, Inc. Austin, Texas.

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

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

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

Keddy-Hector, D.P. 1996. Conservation of the golden-cheeked warbler at the Barton Creek Habitat Preserve: 1996 field season. Austin, Texas.

Ladd, C., and L. Gass. 1999. Golden-cheeked warbler (Dendroica chrysoparia). *In* The Birds of North America, No. 181 (A. Poole and F. Gill, eds). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D. C.

O'Donnell, L., K. Nesvacil, and W. Reiner. 2007a. City of Austin 2007a golden-cheeked warbler *Dendroica chrysoparia* and black-capped vireo *Vireo atricapilla* monitoring program: annual report FY2006-07. City of Austin Water Utility Wildland Conservation Division. Balcones Canyonlands Preserve. Austin, Texas.

Peak, R. 2007a. Forest edges negatively affect golden-cheeked warbler nest survival. The Condor 109:628-637.

Pyle, P. 1997. Identification guide to North American Birds, Part I. Slate Creek Press, Bolinas, California, USA.

Reidy, J. 2007a. Golden-cheeked warbler nest success and nest predators in urban and rural landscapes. M.S. thesis, University of Missouri, Columbia, MO.

Reidy, J., M. Stake, and F. Thompson. 2008. Golden-cheeked warbler nest mortality and predators in urban and rural landscapes. The Condor 110(3):458-466.

Reidy, J. and F. Thompson. 2010. Golden-cheeked warbler population viability and habitat suitability within the Balcones Canyonlands Preserve. Proposal submitted to the City of Austin, Balcones Canyonlands Preserve, Austin, Texas.

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

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

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

——. 1990. Endangered and threatened wildlife and plants; emergency rule to list the golden-cheeked warbler as endangered. Federal Register 55(87):18844-18845.

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

Verner, J. 1985. Assessment of counting techniques. Current Ornithology. 2:247-302.

Weckerly, F. and J. Ott. 2008. Statistical trends of golden-cheeked warblers on Balcones Canyonlands Preserve, City of Austin, Texas. Texas State University, San Marcos, Texas.

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

V. APPENDICES

Appendix A: Distribution of Survey Areas, 2011 (Figures 1 and 2)

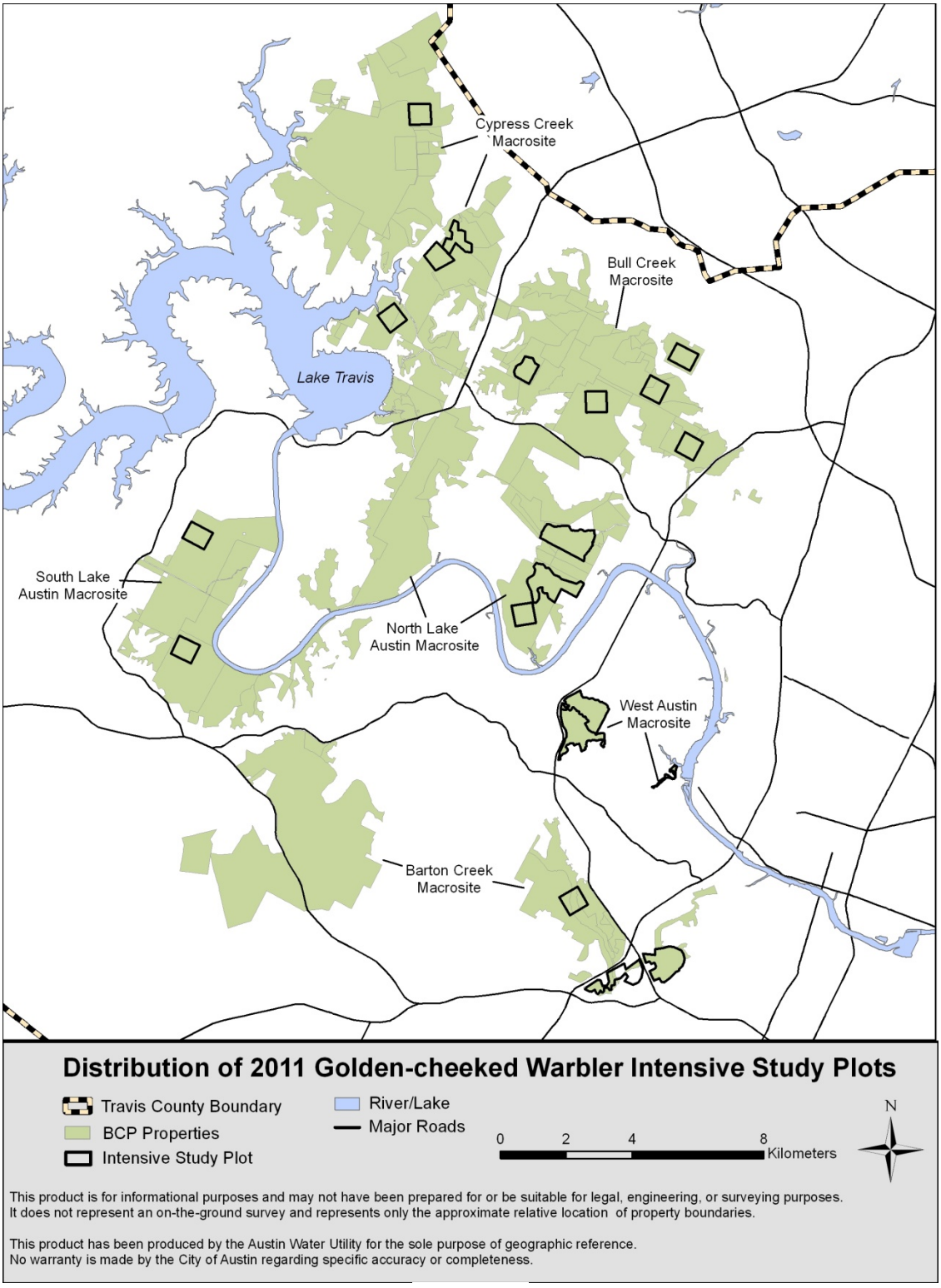
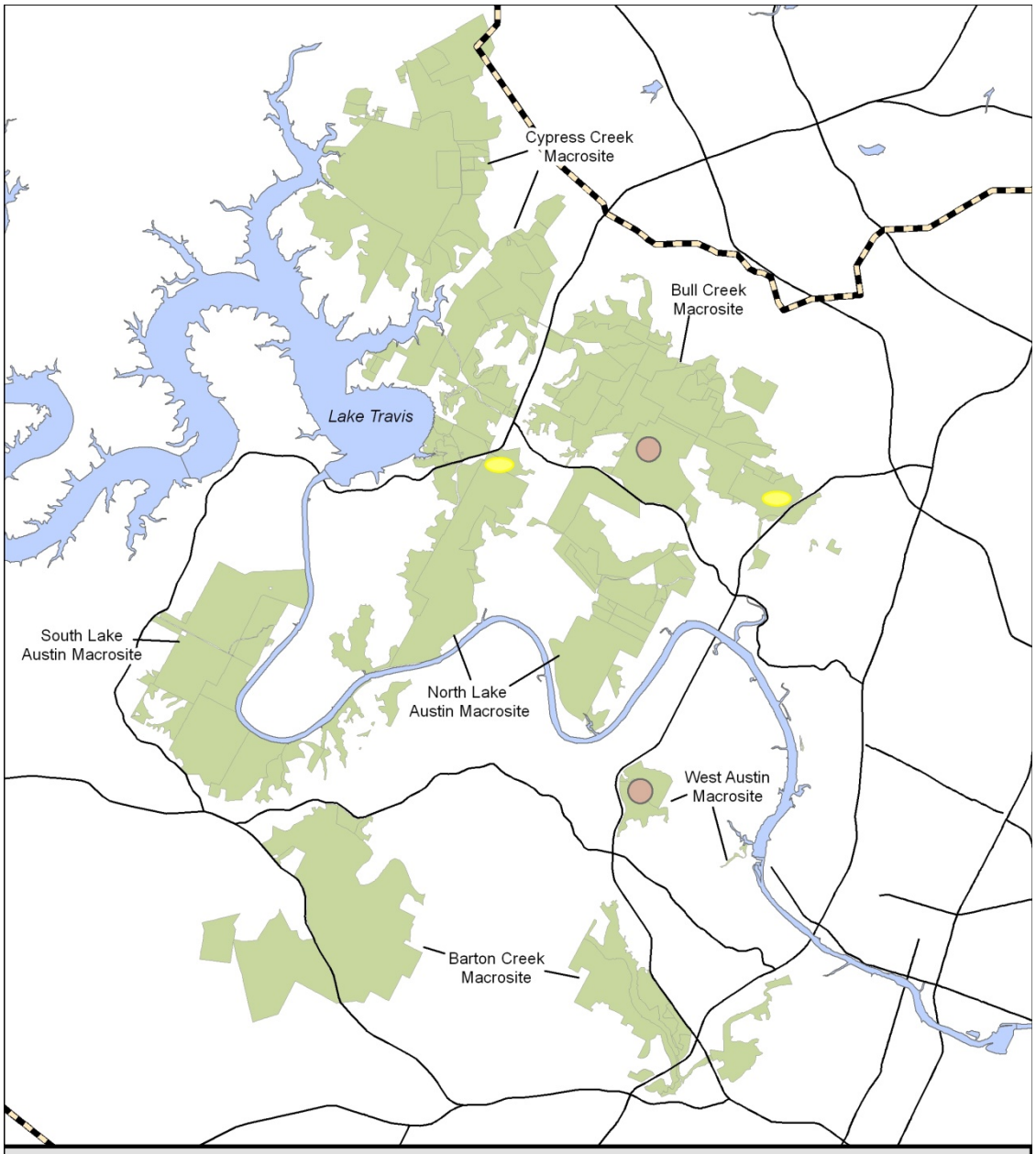


Figure 1



Distribution of 2011 Black-capped Vireo Survey Areas

Travis County Boundary
BCP Properties
BCVI Survey Area Location
River/Lake
Major Roads
Non-territoiral BCVI Observation

0 2 4 8 Kilometers

N

This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes.
It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries.

This product has been produced by the Austin Water Utility for the sole purpose of geographic reference.
No warranty is made by the City of Austin regarding specific accuracy or completeness.

Figure 2

Appendix B: Summary of Golden-cheeked Warbler Surveys on the Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract.

Intensive Study Plots	Lead Surveyor(s)	Survey Hours (March 15-June 15)	Acres Surveyed
Barton Creek Macrosite			
Barton Creek	James Hart, USFS Chris Warren, COA	233.75	100 + buffer
Gus Fruh	James Hart, USFS	37.25	210
Sunset Valley	James Hart, USFS	17.25	157
Bull Creek Macrosite			
3M/St. Edwards	Jason Hunt, Lisa O'Donnell, COA	314.00	100 + buffer
Canyon Vista	Renee Fields, William Simper, TC Cindy Sperry, COA	230.50	100 + buffer
Forest Ridge	Jim O'Donnell, Chris Warren, COA	236.25	100 + buffer
Butler	William Reiner, Mark Sanders, COA	286.00	100 + buffer
Hamilton West	John Chenoweth, Jason Hunt, COA	225.75	100 + buffer
Cypress Creek Macrosite			
Baker Sanctuary	Cindy Sperry, COA Chris Murray, Travis Audubon	153.25	100 + buffer
Lake Perspectives/McGregor	Todd Bayless, Paul Fushille, TC Lisa O'Donnell, COA Melanie Pavlas-Snyder, LCRA	255.00	100 + buffer
Vireo Ridge	Jennifer Reidy, Michael Wickens, USFS	129.00	100 + buffer
Vista Point	Jennifer Reidy, Michael Wickens, USFS	256.50	100 + buffer
North Lake Austin Macrosite			
Bike Park	Jennifer Reidy, James Hart, USFS	309.50	245
Coldwater	Jennifer Reidy, Martin Sluk, USFS	432.00	265
Emma Long	Kelly Nesvacil, COA Martin Sluk, USFS	287.00	100 + buffer
South Lake Austin Macrosite			
Double J&T	John Chenoweth, William Reiner, COA	78.25	100 + buffer
Reicher	Michael Wickens, USFS	155.00	100 + buffer
West Austin Macrosite			
Vireo Preserve/Wild Basin	James Hart, COA Darrell Hutchinson, Mitch Robinson, Wild Basin Kelly Nesvacil, COA	343.00	445
Ullrich WTP	James Hart, USFS	10.75	54
	Total	**3,990**	**2,676 + buffers**

COA = City of Austin, TC = Travis County, USFS = U.S. Forest Service.
Buffers = approx. 70-75 acres for square 100-acre plots, where access was allowed.

Appendix B: Summary of Golden-cheeked Warbler Surveys on the Balcones Canyonlands Preserve, Travis County, Texas, Field Season 2011 (continued).

Resighting Plots	Surveyor(s)	Survey Hours (March 15-May 25)	Acres Surveyed
Barton Creek Macrosite			
Barton Creek Northwest	Shelia Hargis Laurie Foss	18.08	100
Barton Creek Southwest	Stephen Ramirez	13.75	100
Bull Creek Macrosite			
Butler East Butler Northwest Interplot	Amanda Aurora Christina Williams	52.9	300
Forest Ridge Southeast 3M Northeast Hamilton Northwest	Paul Brick Tere Brick	36.00	300
3M South	Amanda Burke	17.25	100
Canyon Creek Northeast	Ed Fair	11.50	100
3M Southeast	Joseph Hunt Mike Rogan	18.00	100
Canyon Creek Southeast Canyon Creek 100-acre plot	John Lindsey	30.00	100
Butler Southeast	Jeff Mundy	15.50	100
Hamilton Northeast, Northwest	Jeremy Walther	16.50	100
Forest Ridge Southwest Forest Ridge Northwest	Jim Weber Lynne Weber	35.41	200
Canyon Creek 100-acre plot	Jason Hunt, COA Jim O'Donnell, COA Mark Sanders, COA Chris Warren, COA	51	100
Ribelin 100-acre plot	Travis County staff	--	100
North Lake Austin Macrosite			
Emma Long East	Kensley Greuter	12.67	100
Emma Long West	Nancy Norman	6.00	100
Emma Long South	Melissa Rothrock	5.00	100
South Lake Austin Macrosite			
Bohls 100-acre plot	Jason Hunt, COA Jim O'Donnell, COA Chris Warren, COA	17.50	100
Total		**357**	**2200**

COA = City of Austin.

Appendix C: Intensive Study Plot Protocol.

Golden-cheeked Warbler Monitoring
Balcones Canyonlands Preserve, City of Austin
Intensive Study Plot Protocol, 2011

OBJECTIVE: To delineate golden-cheeked warbler (warbler) territories as accurately as possible (>33 locations per male) and to document return rates, dispersal, pairing success, breeding success, and productivity (actual number of young per territory) to estimate long-term trends in these parameters. This field season will increase the level of effort to obtain observations of females, nests, and newly-fledged young for each territory to provide more accurate estimates of productivity. Additionally, two observers will split intensive study plots that average 5 or more territories to ensure comprehensive coverage and help address potential observer bias issues.

Study Sites: Within each intensive study plot, observers will focus on re-sighting color-banded warblers, mapping the location and extent of territories, searching for and monitoring nests, and looking for females and fledglings. In addition, the observers responsible for each study plot will search for color-banded birds within accessible portions of a 100-m buffer around each plot to better ascertain the fate of each banded warbler and to provide better estimates of the size and extent of edge territories. This re-sighting data is of paramount importance in learning about dispersal and differentiating survival from return rates.

Survey Dates: March 15 - May 25 for standard territory mapping visits (one visit/week with at least 5 days separation between visits). Each observer will visit the plot 1-2 additional days per week for the purposes of banding all territorial male warblers, finding and monitoring nests and fledglings, and re-sighting birds not re-sighted during the mapping visit. Productivity visits will continue into June.

Survey effort for territory mapping: 6 hours per 100 acres per visit *minimum*. There will be no maximum time constraints. The number of hours devoted to a plot will be based on territory densities, terrain, surveyor's physical condition, etc. Surveyors will take as much time as needed to collect data for each territory (estimate about 45 minutes per territory on each visit). As a general rule, observers should strive to obtain a minimum of 5 locations separated by ≥30 meters, up to 10 locations, for birds in each territory during each survey. This is an additional criterion that fits within the 45+ min time allotment.

Staffing: Two observers per plot averaging ≥5 territories, with a *minimum* 3 hours/50 acres/person (*minimum* 6 hours total) per territory mapping visit.

Training: All staff scheduled for the 2011 field season will have prior experience conducting intensive study plot surveys or be training by experienced personnel prior to the field season.

Survey Procedures: Observers are to follow the **Standards for Conducting and Documenting Golden-cheeked Warbler Surveys** (City of Austin 2011) during all field visits.

The following additional procedures are specific to surveying intensive study plots:

1. Surveys of intensive study plots should start within 30 minutes of sunrise (before or after).
2. Each observer will cover half (for plots averaging 5 or more territories) or the entire plot (for plots with <5 territories) on each territory mapping visit. For shared plots, observers will need to coordinate coverage. For the initial visit, observers will split and cover one-half of the plot. For each subsequent visit, each observer will rotate the area covered by 90° in a clockwise direction, where this is practical. This will ensure each observer covers the entire plot and begins at a different corner of the plot on each visit.
3. Volunteers will be recruited to conduct searches for banded warblers outside the 100-m buffers surrounding each intensive study plot. These surveys will be conducted at least three times within the season, ≥ 2 weeks apart. The observers responsible for each study plot may need to assist with these re-sighting surveys. Observers and volunteers conducting these searches will follow the **Standards for Conducting and Documenting Golden-cheeked Warbler Surveys** (City of Austin 2011).

Appendix D: Golden-cheeked Warbler 100-Acre Study Plot Territory Data. A summary of golden-cheeked warbler territory number per 100 acres and per 100 hectares for five 100-acre prime study plots, three 100-acre transitional study plots, and the Hamilton West 100-acre transitional plot on the City of Austin's BCP, Travis County, Texas, field seasons 1998-2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract. See Methods section for calculations.

Plot Name	Survey Year	No. of Full Territories	No. of Full Territories + 50% of Edge Territories	No. of Territories per 100 ha
Prime Plots				
Barton Creek	1998	2	5.0	12
	1999	6	9.0	22
	2000	5	7.0	17
	2001	3	5.0	12
	2002	2	5.0	12
	2003	2	5.5	14
	2004	3	6.5	16
	2005	4	7.0	17
	2006	6	9.0	22
	2007a	6	7.5	17
	2008	4	6.5	16
	Average	4	7.0	17
	Initiation of Color Banding			
	2009	2	5.0	12
	2010	2	6.0	15
	2011	4	6.5	16
Emma Long	1998	6	8.5	21
	1999	7	9.5	23
	2000	12	16.5	41
	2001	14	18.5	46
	2002	18	20.0	49
	2003	14	16.5	41
	2004	11	16.5	41
	2005	14	18.0	44
	2006	19	24.5	61
	2007a	5	10.5	26
	2008	9	13.5	33
	Average	12	16.0	39
	Initiation of Color Banding			
	2009	9	14.0	35
	2010	10	13.0	32
	2011	10	13.0	33
Butler	1998	7	10.0	25
	1999	8	12.5	31
	2000	7	13.0	32
	2001	2	8.0	20
	2002	9	15.5	38
	2003	13	21.5	53
	2004	12	21.0	52
	2005	15	20.5	51
	2006	20	24.0	59
	2007a	16	20.0	49
	2008	16	21.5	53
	Average	11	17.0	42
	Initiation of Color Banding			
	2009	11	18.0	44
	2010	11	15.5	38
	2011	12	17.0	43

Appendix D: Golden-cheeked Warbler 100-Acre Study Plot Territory Data (continued).

Plot Name	Survey Year	No. of Full Territories	No. of Full Territories + 50% of Edge Territories	No. of Territories per 100 ha
3M/St. Edwards	1998	6	9.0	23
	1999	7	11.0	28
	2000	7	12.0	30
	2001	3	6.0	15
	2002	9	12.5	31
	2003	8	12.5	31
	2004	6	11.5	28
	2005	7	13.0	32
	2006	8	11.5	28
	2007a	6	11.5	28
	2008	7	13.0	32
	Average	7	11.0	28
	Initiation of Color Banding			
	2009	9	18.0	44
	2010	13	19.5	48
	2011	12	18.5	46
Forest Ridge	1998	7	10.5	26
	1999	11	14.0	35
	2000	7	10.5	26
	2001	9	12.5	31
	2002	11	13.0	32
	2003	9	12.5	31
	2004	13	17.5	43
	2005	11	15.0	37
	2006	16	21.0	52
	2007a	4	9.0	22
	2008	7	10.5	26
	Average	10	13.0	32
	Initiation of Color Banding			
	2009	10	14.0	35
	2010	10	15.0	37
	2011	13	16.5	41
Average, All Prime Plots	1998	6	9.0	22
	1999	8	11.0	27
	2000	8	12.0	30
	2001	6	10.0	25
	2002	10	13.0	32
	2003	9	14.0	35
	2004	9	14.5	36
	2005	10	15.0	37
	2006	14	18.0	44
	2007a	7	12.0	30
	2008	9	13.0	32
	Average	9	13.0	32
	Initiation of Color Banding			
	2009	8	14	35
	2010	9	14	34
	2011	10	14	36

Appendix D: Golden-cheeked Warbler 100-Acre Study Plot Territory Data (continued).

Plot Name	Survey Year	No. of Full Territories	No. of Full Territories + 50% of Edge Territories	No. of Territories per 100 ha
Transitional Plots				
Bohls	1998	3	4.0	10
	1999	1	4.0	10
	2000	1	3.0	7
	2001	5	6.5	16
	2002	4	5.5	14
	2003	4	6.5	16
	2004	5	8.0	20
	2005	6	8.0	20
	2006	3	6.5	16
	2007a	1	4.0	10
	2008	1	3.0	7
	Average	4	5.0	13
	Initiation of Color Banding			
	2009	2	3.5	9
	2010	3	3.0	7
	2011	--	--	--
Canyon Creek	1998	0	4.0	10
	1999	2	4.5	11
	2000	0	4.0	10
	2001	3	7.5	19
	2003	0	3.5	9
	2005	3	8.0	20
	2007a	3	6.5	16
	Average	2	5.0	13
	Initiation of Color Banding			
	2009	3	10.0	25
	2010	6	10.0	25
	2011	--	--	--
Double J&T	1998	2	2.5	6
	1999	0	0.5	1
	2000	0	0.5	1
	2001	2	3.0	7
	2003	3	3.5	9
	2005	6	6.5	16
	2007a	3	3.5	9
	Average	2	3.0	6
	Initiation of Color Banding			
	2009	2	2.5	6
	2010	3	3.0	7
	2011	3	3.5	9
Average, All Transitional Plots	1998	2	3.5	7
	1999	1	3.0	7
	2000	0	2.5	6
	2001	3	5.5	14
	2003	2	4.5	11
	2005	5	7.5	19
	2007a	2	4.5	12
	Average	2	4.0	11
	Initiation of Color Banding			
	2009	2	5	13
	2010	4	5	13
	2011	--	--	--
Transitional Plot (Added in 2010)				
Hamilton West	2010	2	8	20
	2011	8	14	35

Appendix E: Golden-cheeked Warbler 100-Acre Study Plot Age Structure Data for All Territorial Males. A summary of golden-cheeked warbler male age structure data for five 100-acre prime study plots, three 100-acre transitional study plots, and the Hamilton West transitional plot on the City of Austin's BCP, Travis County, Texas, field seasons 2009-2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract. See Methods section for calculations.

Plot	Survey Year	% SY Males	%AHY Males	%ASY Males	Total No. Banded Males	Total No. Unbanded Males	% Banded Males
Prime Plots							
Barton Creek	2009	20	20	60	5	3	63
	2010	22	0	78	9	1	90
	2011	0	0	100	6	3	67
Emma Long	2009	0	0	100	13	6	68
	2010	11	0	89	9	7	56
	2011	27	0	73	11	5	69
Forest Ridge	2009	20	7	73	15	3	83
	2010	21	0	79	14	6	70
	2011	35	0	65	17	3	85
Butler	2009	53	18	29	17	8	68
	2010	33	0	67	15	5	75
	2011	62	0	37	16	6	73
3M/St. Edwards	2009	30	0	70	20	7	74
	2010	38	0	63	16	10	62
	2011	56	0	44	18	7	72
Transitional Plots							
Double J&T	2009	100	0	0	1	2	33
	2010	67	0	33	3	0	100
	2011	100	0	0	2	2	50
Bohls	2009	0	0	100	2	3	40
	2010	67	0	33	3	0	100
	2011	--	--	--	--	--	--
Canyon Creek	2009	27	7	67	15	2	88
	2010	36	0	64	11	3	79
	2011	--	--	--	--	--	--
Average, All Plots	**2009**	**27**	**7**	**66**	**88**	**34**	**72**
	2010	**31**	**0**	**69**	**80**	**32**	**71**
	2011	**--**	**--**	**--**	**70**	**26**	**73**
Transitional Plots (Added in 2010)							
Hamilton West	2010	40	0	60	10	4	71
	2011	60	13	27	15	5	75

Appendix F: Golden-cheeked Warbler 100-Acre Study Plot Return Rates for All Banded Males. A summary of golden-cheeked warbler banding and resighting data for five 100-acre prime study plots, three 100-acre transitional study plots, and the Hamilton West transitional plot on the City of Austin's BCP, Travis County, Texas, field seasons 2009-2010. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract. See Methods section for calculations.

Plot Name	Survey Year	No. Males Banded	No. 2009 Returning Males	% 2009 Returning Males	No. 2010 Returning Males	% 2010 Returning Males	Total % Returning Males
Prime Plots							
Barton Creek	2009	6	--	--	--	--	--
	2010	7	4	67%	--	--	--
	2011	3	1	17%	2	29%	23%
Emma Long	2009	14	--	--	--	--	--
	2010	3	9	64%	--	--	--
	2011	10	3	21%	2	67%	29%
Forest Ridge	2009	16	--	--	--	--	--
	2010	6	7	44%	--	--	--
	2011	18	3	19%	2	33%	23%
Butler	2009	21	--	--	--	--	--
	2010	11	10	48%	--	--	--
	2011	10	7	33%	5	45%	36%
3M/St. Edwards	2009	22	--	--	--	--	--
	2010	11	12	57%	--	--	--
	2011	16	4	18%	3	27%	21%
Transitional Plots							
Double J&T	2009	1	--	--	--	--	--
	2010	3	0	0	--	--	0
	2011	2	0	0	0	0	0
Bohls	2009	2	--	--	--	--	--
	2010	4	0	0	--	--	--
	2011	0	0	0	1	25%	17%
Canyon Creek	2009	15	--	--	--	--	--
	2010	8	2	13%	--	--	--
	2011	0	0	0	4	50%	17%
Total/Avg, All Plots	**2009**	**97**	**--**	**--**	**--**	**--**	**--**
	2010	**53**	**44**	**45%**	**--**	**--**	**--**
	2011	**59**	**18**	**19%**	**19**	**36%**	**25%**
Transitional Plot (added 2010)							
Hamilton West	2009	4	--	--	--	--	--
	2010	11	2	50%	--	--	--
	2011	11	1	25%	7	64%	53%

Appendix G: Golden-cheeked Warbler 100-Acre Study Plot Reproductive Success Data. A summary of golden-cheeked warbler reproductive success data for five 100-acre prime study plots and the Hamilton West transitional plot on the City of Austin's BCP, Travis County, Texas, field seasons 1998-2011. Kent Butler Ecological Reserve (Butler) represents the former Ivanhoe tract. See Methods section for calculations.

Plot Name	Survey Year	Pairing Success	Breeding Success	Productivity per Successful Territory	Productivity per Full Territory
Prime Plots					
Barton Creek	1998	0.50	0.50	2.00	1.30
	1999	1.00	1.00	2.20	2.20
	2000	0.80	0.40	1.50	0.60
	2001	1.00	0.67	2.50	1.67
	2002	1.00	0.50	2.00	1.00
	2003	1.00	1.00	1.50	1.50
	2004	1.00	0.67	1.50	1.00
	2005	1.00	1.00	3.00	3.00
	2006	0.83	0.67	2.25	1.50
	2007a	0.83	0.83	2.60	2.17
	2008	1.00	1.00	2.75	2.75
	Average	0.91	0.75	2.16	1.70
	Initiation of Color Banding				
	2009	1.00	1.00	3.00	3.00
	2010	1.00	1.00	4.00	4.00
	2011	1.00	0.75	3.33	2.50
Emma Long	1998	1.00	1.00	2.30	1.30
	1999	0.86	0.86	2.30	2.00
	2000	0.42	0.17	2.00	0.33
	2001	0.71	0.64	1.78	1.06
	2002	0.67	0.39	1.70	0.66
	2003	0.71	0.50	2.40	1.21
	2004	0.82	0.45	2.60	1.18
	2005	0.86	0.43	2.17	0.93
	2006	0.90	0.71	2.27	1.62
	2007a	0.80	0.80	2.25	1.80
	2008	0.89	0.78	2.43	1.89
	Average	0.79	0.61	2.20	1.27
	Initiation of Color Banding				
	2009	1.00	0.78	1.86	1.44
	2010	0.90	0.50	1.60	0.80
	2011	1.00	1.00	3.08	3.70
Butler	1998	0.43	0.43	2.70	1.30
	1999	0.50	0.50	2.80	1.30
	2000	0.14	0.14	3.00	0.43
	2001	1.00	1.00	3.00	3.00
	2002	0.67	0.56	3.00	1.70
	2003	0.69	0.69	2.70	1.80
	2004	0.58	0.33	3.00	1.00
	2005	0.53	0.27	2.50	0.67
	2006	0.70	0.30	2.17	0.65
	2007a	0.75	0.63	2.40	1.50
	2008	0.63	0.38	2.33	0.88
	Average	0.60	0.48	2.69	1.29
	Initiation of Color Banding				
	2009	1.00	0.82	2.22	1.82
	2010	1.00	0.82	2.22	1.82
	2011	1.00	0.58	3.00	1.75

Appendix G: Golden-cheeked Warbler 100-Acre Study Plot Reproductive Success Data (continued).

Plot Name	Survey Year	Pairing Success	Breeding Success	Productivity per Successful Territory	Productivity per Full Territory
3M/St. Edwards	1998	0.83	0.33	2.50	0.80
	1999	0.71	0.43	1.70	0.70
	2000	0.43	0.29	2.50	0.71
	2001	0	0	0	0
	2002	0.22	0.11	1.00	0.10
	2003	0.38	0.50	1.50	0.43
	2004	0.67	0.50	2.00	1.00
	2005	0.71	0.71	1.60	1.14
	2006	1.00	1.00	2.38	2.38
	2007a	0.83	0.83	3.20	2.67
	2008	0.86	0.71	2.00	1.43
	Average	0.60	0.49	1.85	1.03
	Initiation of Color Banding				
	2009	0.89	0.67	2.50	1.67
	2010	1.00	1.00	2.54	2.54
	2011	1.00	0.50	2.17	1.08
Forest Ridge	1998	0.57	0.43	2.30	1.10
	1999	0.67	0.55	2.70	1.50
	2000	0.86	0.71	2.80	2.00
	2001	0.78	0.44	2.50	1.30
	2002	0.82	0.45	2.60	1.20
	2003	0.78	0.67	2.30	1.60
	2004	0.54	0.54	3.00	1.62
	2005	0.91	0.73	1.75	1.27
	2006	1.00	0.78	2.50	1.94
	2007a	1.00	1.00	2.00	2.00
	2008	1.00	0.57	2.50	1.43
	Average	0.81	0.62	2.45	1.54
	Initiation of Color Banding				
	2009	0.80	0.80	1.88	1.50
	2010	0.70	0.70	1.86	1.30
	2011	1.00	0.77	1.90	1.46
Average, All Prime Plots	1998	0.67	0.54	2.36	0.97
	1999	0.74	0.67	2.34	1.30
	2000	0.53	0.34	2.36	0.81
	2001	0.70	0.55	1.96	1.56
	2002	0.68	0.40	2.06	0.93
	2003	0.71	0.67	2.08	1.30
	2004	0.72	0.50	2.42	1.16
	2005	0.80	0.63	2.20	1.40
	2006	0.89	0.70	2.31	1.62
	2007a	0.84	0.82	2.49	2.03
	2008	0.88	0.69	2.40	1.68
	Average	0.74	0.59	2.27	1.34
	Initiation of Color Banding				
	2009	0.93	0.78	2.16	1.68
	2010	0.91	0.78	2.28	1.78
	2011	1.00	0.72	2.70	2.10
Transitional Plot (Added 2010)					
Hamilton West	2010	1.00	1.00	2.50	2.50
	2011	0.90	0.50	2.80	1.75