ANALYSIS OF THE GOLDEN-CHEEKED WARBLER IN RELATION TO CONSTRUCTION ACTIVITY ALONG HIGHWAY 71

2013 SUMMARY

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Introduction

Human-related activities within the natural habitat of animals are known to cause modifications in the behavior of some species. Conditions associated with roadways are known to influence animal behavior, with possible effects including: traffic noise, visual disturbance, air pollution, microclimatic effects, road kill, or increased attraction of predators to the roadside (Forman et al. 2002, Federal Highway Administration 2004). Burton et al. (2002) found reduced densities and feeding behavior in several species of shorebirds near a construction site, but did not attribute these changes to a specific aspect of the construction.

Much of the concern regarding the effects of roads on animals has involved traffic noise. Noise has the greatest potential to affect animals, such as birds, that rely heavily on auditory signals for daily activities because it can interfere or mask communication signals used in breeding and survival. Early studies of the effect of noise on birds indicated no significant impairment by noise (Federal Highway Administration 2004). Golden-cheeked warblers (*Setophaga chrysoparia*), an endangered species that breeds exclusively in Texas, were found to sing without regard to the level of roadway noise (Benson 1995). In a study of 43 species of woodland birds, Reijnen et al. (1995) found that 26 (60%) showed some reduction in density adjacent to the road. They noted that there was no pattern of interference with song calls; thus, the immediate cause of the effect was not apparent. They speculated that a supplementary aspect might have been stress.

A thorough literature review by the Federal Highway Administration (2004) showed that many species display a decrease in breeding activity and abundance when in proximity to highways. The distances at which these effects were shown, however, varied from <100 m to ~3 km from the right of way (hereafter ROW); most species that showed an effect did so between 100 and 1500 m. Most studies did not, however, analyze highway noise as a function of distance from the ROW. The general conclusion was that some bird species were sensitive during breeding to high noise levels and that the distances over which this effect is seen can be considerable, varying from a few meters to more than 3 km.

Goal and Objectives

The goal of this study is to determine if construction activity and noise influenced abundance, breeding success, and behavior of the golden-cheeked warbler. We compared differences in productivity measures and behavioral responses relative to distance from ROW and among three study areas: treatment (construction), road-noise only, and control sites. If highway construction noise impacts warbler productivity and behavior, we would expect to see different productivity and behavioral responses within the construction site, relative to the road-noise only and control sites.

To test for elevated noise levels in the construction site, we recorded ambient noise levels across a distance gradient from the ROW across the study areas. Specific objectives are:

1. Compare direct impacts of highway construction noise on measures of reproductive success. We conducted transect surveys, mapped and monitored territories, and monitored nests to

determine (1) pairing success, (2) territory fledging success, and (3) nest success and predation events.

2. Quantify behavioral responses of golden-cheeked warblers to construction activity and noise. We examined behavioral responses of adult golden-cheeked warblers to construction noise and activity by (1) assessing territory establishment using measures of territory density, location of territories relative to the ROW, and returns of banded birds in subsequent breeding seasons; (2) recording adult activity patterns at the nest using digital video recorders; (3) determining the initial behavioral response to recordings of construction noises using an experimental design (hereafter playback experiment); and (4) recording vocalizations of territorial males to determine if golden-cheeked warblers alter their vocalizations to account for construction noise and activity.

3. As indicated from the study results, evaluate the spatial and temporal extent of highway construction impacts on the study species.

4. Make recommendations for alleviating any negative impacts of highway construction noise on warblers.

Study Area

We conducted this study on the Barton Creek Habitat Preserve, a 1,653 ha property managed by the Nature Conservancy, located just west of Austin, Texas in Travis County, from 25 February through 14 June 2013. The dominant vegetation found on the preserve is oak- juniper woodland with lesser amounts of grass and shrubland. Two major roads run though Barton Creek Habitat Preserve, Highway 71 and Southwest Parkway. Surrounding land-use is primarily residential.

Study design

The study design is that of an impact assessment study, conforming to the before-after-control-impact (BACI) protocol. Using a BACI design allows us to account for temporal variation that might influence the magnitude of differences among bird responses within the study areas before or after an impact (Morrison et al. 2008). We collected pretreatment data during the 2008, 2009 and 2010 breeding seasons prior to the initiation of construction on Highway 71. In 2011, we began the construction phase of the study, which continued through the 2012 and 2013 breeding seasons. It is the intention of Texas Department of Transportation (TXDOT) to continue data collection for at least one year post-construction, which will begin in 2015 following one more year of highway construction. We identified 3 types of sites for this study, 1 treatment (construction) site and 2 reference sites (road-noise only and control; Fig. 1). Selection of 2 reference sites allows for spatial replication across the study area. These reference sites were similar enough to the treatment site to allow us to assume that temporal variation would have similar impacts on all 3 study sites (Morrison et al. 2008).

1. Treatment (construction) site: Site along Highway 71 undergoing construction activities; this site experienced both construction activity and road noise (vehicle traffic). This study site included potential habitat along Highway 71, up to 1 km perpendicular to the ROW.

Prior to TXDOT beginning construction, we referred to this site as the pre-construction site. TXDOT initiated construction prior to the 2011 breeding season and carried on through the 2013 season. Although construction activity did not occur along the entire roadway in 2013, we considered the entire construction study site affected by construction noise, as construction noise was audible by the human ear throughout the study site throughout the breeding season. (Fig. 1).

2. Road-noise only reference sites: We assigned land along a road (Southwest Parkway) adjacent to Highway 71 that was not undergoing construction as the road-noise only control site. This study site extended up to 1 km perpendicular to the ROW. This site allowed us to separate the effects of road noise from construction activity on bird behavior.

3. Control sites: These sites experienced no road or construction noise and activity. We used sites on Barton Creek Habitat Preserve that were >1 km from any roads or Highway 71, thus eliminating road noise and construction activity as factors potentially influencing birds. These sites allowed us to separate the effects of road noise and disturbance on bird behavior.

METHODS

Territory monitoring, productivity surveys, and nest searching

In order to locate golden-cheeked warbler (hereafter "warbler") and black-capped vireo (*Vireo atricapilla*; hereafter "vireo") territories, we conducted transect surveys across the property 25 February through 19 March. We also surveyed specific areas, labeled vireo search areas, (Figure 1) two additional times during mid-April. We took GPS locations for each warbler and vireo detection. The number of detections does not imply individual warblers as birds may have been detected multiple times during the survey period. We delineated territories by recording 1 point every 2 minutes for $\leq$ 1 hour per visit. We observed focal individuals or pairs for $\leq$ 60 minutes using an observational method for identifying reproductive status (Vickery et al. 1992). We revisited each territory at least once every seven days throughout the breeding season. We actively searched for warbler nests using behavioral cues from adults, and checked for activity at nests at least every 3-4 days while active. We used minimum convex polygons in ArcMap 9.3 to determine the minimum area used by male warblers. We also used these minimum convex polygons to determine area surveyed and density of warblers.

Target mist-netting and banding

To examine movement of breeding birds between years, we banded a subsample of adults within the study sites and conducted band resights in subsequent years. We conducted all banding under supervision of a Master Bird Bander or sub-permittee (USGS Federal bird banding permit for Dr. Michael L. Morrison). We broadcast conspecific or heterospecific songs at normal frequencies to attract warblers to the nets, for no more than 30 minutes within 1 territory in a single day. We placed nets within sight of the banders, so that banders monitored nets constantly and to allow for removal of warblers as quickly as possible. We did not mist net if we detected any potential predators in the area or in inclement weather (i.e., cold, rain, or windy conditions). We fitted

warblers with a USGS metal band and plastic color bands; we obtained unique color combinations from The Nature Conservancy, Fort Hood, TX. We resighted adult warblers throughout the field season, documenting whether the warbler was banded or unbanded. If we located a banded individual, we resighted the bird at least 3 times to confirm the color combination of the bands.

Automatic Recording Units and sound meters

We used 9 Automatic Recording Units (hereafter ARUs) to gather audio data on warbler song type and frequency from 26 March 2012 through 28 May 2013. Recordings ran from 07:00-11:00 daily. We placed each ARU near a well-known singing location in a warbler territory (Figure 2) and allowed the recorder to run for 21 days before moving it to another. No ARU remained in the same territory for a minimum of 21 days. We used SonoBirdTM v1.6.5 to extract and analyze individual songs from our recordings. Golden-cheeked warblers have two primary song types, the A song and the B song.

We also measured ambient noise levels using 12 data-logging sound meters along 5 transect pairs positioned perpendicular to the road, spaced according to the inverse square law; i.e. at intervals of approximately 16m, 32m, 64m, 128m, 256m, and 512m (Fig. 2). Sound meters recorded for approximately 24 hours. We relocated sound meters twice a week from 27 March 2012 to 30 May 2013.

Playback

To examine the initial behavioral response of territorial birds to loud, erratic construction noises, we played recordings of construction noise to male warblers. We recorded behavior for 1-2 minutes before playback, and then broadcasted construction noise with a hand-held speaker for 1–5 seconds. Surveyors then documented after-playback behavior every minute for 10 minutes or until the bird could no longer be located. The surveyor recorded the time and initial behavior as well as subsequent behavior changes with the corresponding time. We considered a playback experiment to have elicited a behavioral response if the warbler ceased singing, flew from its previous perch and out of the surveyor's view (≥10 m) or changed behavior before or exactly at the end of hearing 5 seconds of construction noise.

We did not want to introduce construction noise into our control study site, so playback surveys were not done in the control area (>1 km from the road). Instead, playback surveys were restricted to the construction and road-noise sites, and we considered areas of both the construction and road-noise sites greater than 400 m from the road to be a "reduced-noise" control area. We also conducted control playbacks, to control for the potential effects of observer presence. Experimental protocol for the control group duplicated that of the experimental group, except we did not play the construction noise recordings.

STATISTICAL ANALYSIS

We determined productivity for each warbler territory. We considered males unpaired if we never observed them with a female, paired if we observed them with a female, and successfully

fledged if we detected at least one host fledgling with a pair. We used minimum convex polygons in ArcMap 9.3 to determine the density of territories in each study site (Fig. 3). We used the centroid point for each territory polygon to determine territory placement in relation to the right of way in each study site.

We will analyze ambient noise levels as a function of distance from the road. We will measure and analyze 3 parameters within warbler songs: the duration of the phrase, the frequency at maximum power during the phrase, and the time to maximum power. We will analyze this information by study site and distance from the ROW. We will analyze bird reaction to playback experiments in relation to distance from the ROW and study site type.

RESULTS

Golden-cheeked warbler

We detected warblers 213 times during surveys conducted between 25 Feb and 19 March 2013. We monitored 97 male warblers for territorial activity. Of the 97 territories, 70% paired (Table 1). Of the 68 paired territories we monitored, we detected fledglings at 66% of them (Table 1). We found 8 warbler nests, 4 of which successfully fledged young (Fig. 3). We did not detect evidence of nest parasitism or observe double brooding behaviors.

Table 1: Detections, territory, and nest success by study site on Barton Creek Habitat Preserve, 2012.

Study Site Type	Detections	Monitored Territories	Paired Territories		Territories Fledged		Nests	Fledged
Construction	30	18	78%	14	57%	8	2	0
Road-noise Only	56	23	65%	15	60%	9	2	1
Control	127	56	70%	39	72%	28	4	3
Total	213	97	70%	68	66%	45	8	4

We based our density estimates on the total area surveyed across Barton Creek Habitat Preserve; they are not necessarily representative of bird density within habitat. The control study site had the highest territory density at 0.07 territories/ha, with an equal territory density of 0.04 territories/ha in both the construction and the road-noise only sites. Territory density across Barton Creek Habitat Preserve was 0.06 territories/ha.

Table 2: Territory density (territory/ha) by study site on Barton Creek Habitat Preserve, 2012.

	Area surveyed (ha)	**Total number of territories**	**Density (territories/ha)**
Construction	414.09	18	0.04
Road-noise only	514.55	23	0.04
Control	761.43	56	0.07
Total	1690.07	97	0.06

We banded 7 adult (after-hatch year) male warblers and 1 adult female warbler in 2009, of which we have not detected any of these 8 adults on our study areas in subsequent years (2010–2013). In 2010 we banded 2 birds and both returned 2011-2012 to establish territories within 100m of their 2010 banding location. In 2013 only one of these males was detected and he established a territory 100m from his original banding location (Fig. 4). No birds were banded in 2011-2012. In 2013 we banded an additional 9 adult male warblers (AHY) and monitored their territories throughout the season.

We conducted 51 construction noise playback surveys and 25 control playback surveys. Of these surveys, 4 elicited a response; 3 construction noise playback surveys and one control playback survey. Of the construction noise playback surveys, two responses were in the construction study site at 575 m, and 650 m from the ROW and one response occurred in the road-noise only site at 485 m from the ROW. The one control playback survey that resulted in a response occurred in the construction study site 292 m from the ROW.

Black-capped vireo

We did not detect any vireos during our surveys.

2013 Field Season

TXDOT construction along Highway 71 will continue into the 2014 breeding season and it is their intention to collect at least 1 year of post-construction data. Thus, we will continue this study in 2014 and 2015. No changes to the current study protocol are expected. We will provide results from our study in an annual report in December 2013. Final analysis from all years of this study is expected in spring of 2016.

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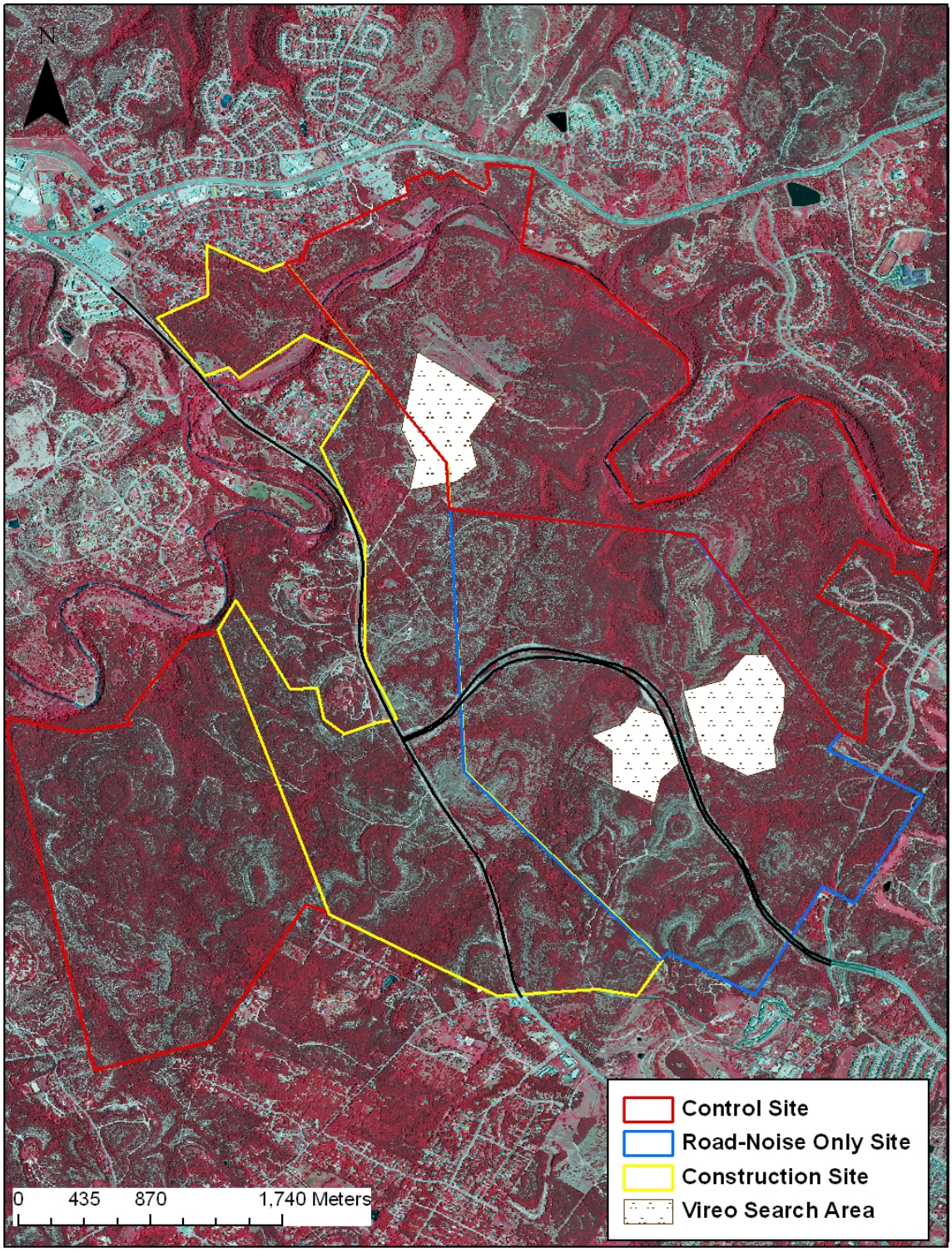

Figure 1: Construction, road-noise only, and control study sites and vireo search area for Barton Creek Habitat Preserve in 2013, Travis County, TX USA.

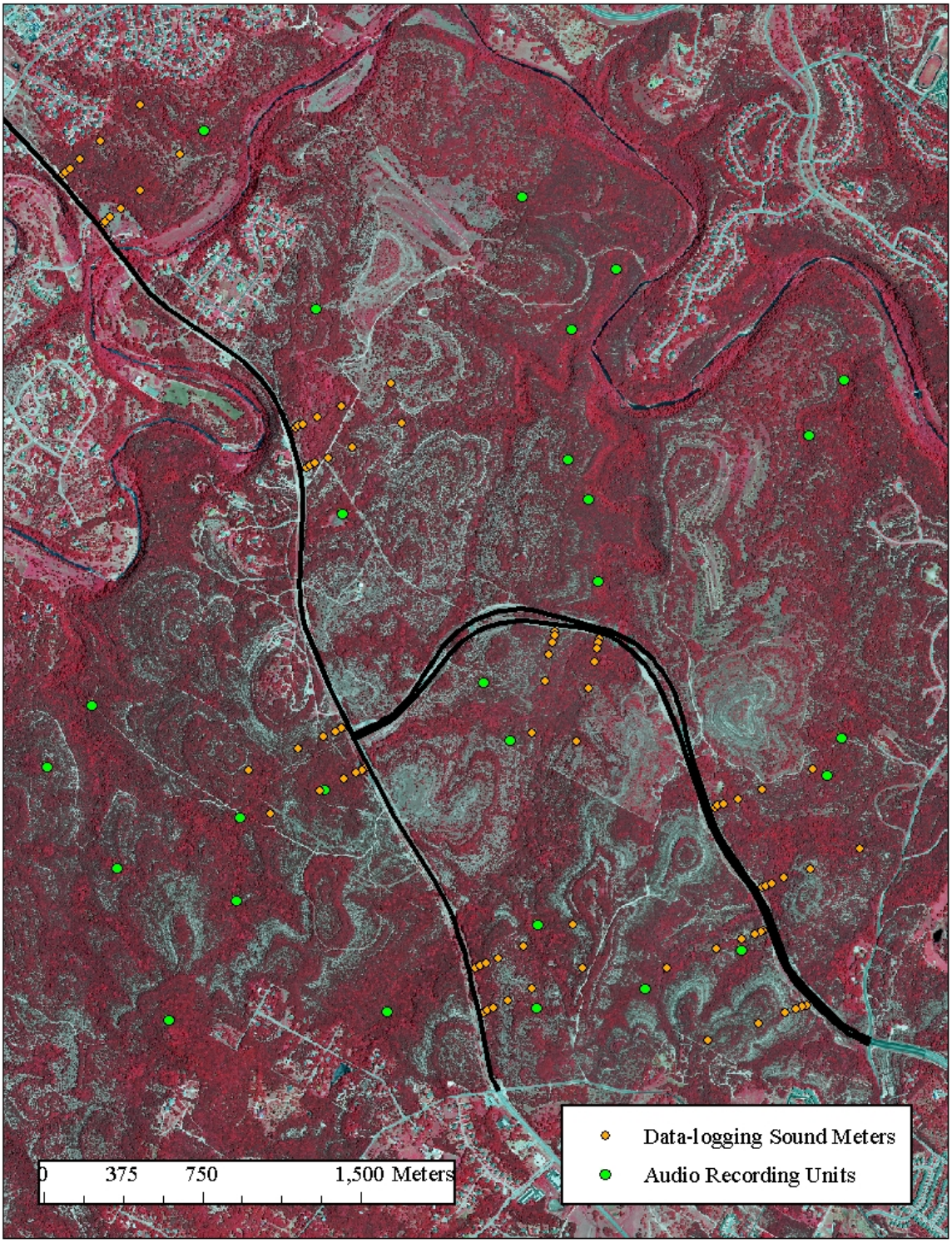

Figure 2: Data-logging sound meter and automatic recording unit locations on Barton Creek Habitat Preserve in 2013, Travis County, TX USA.

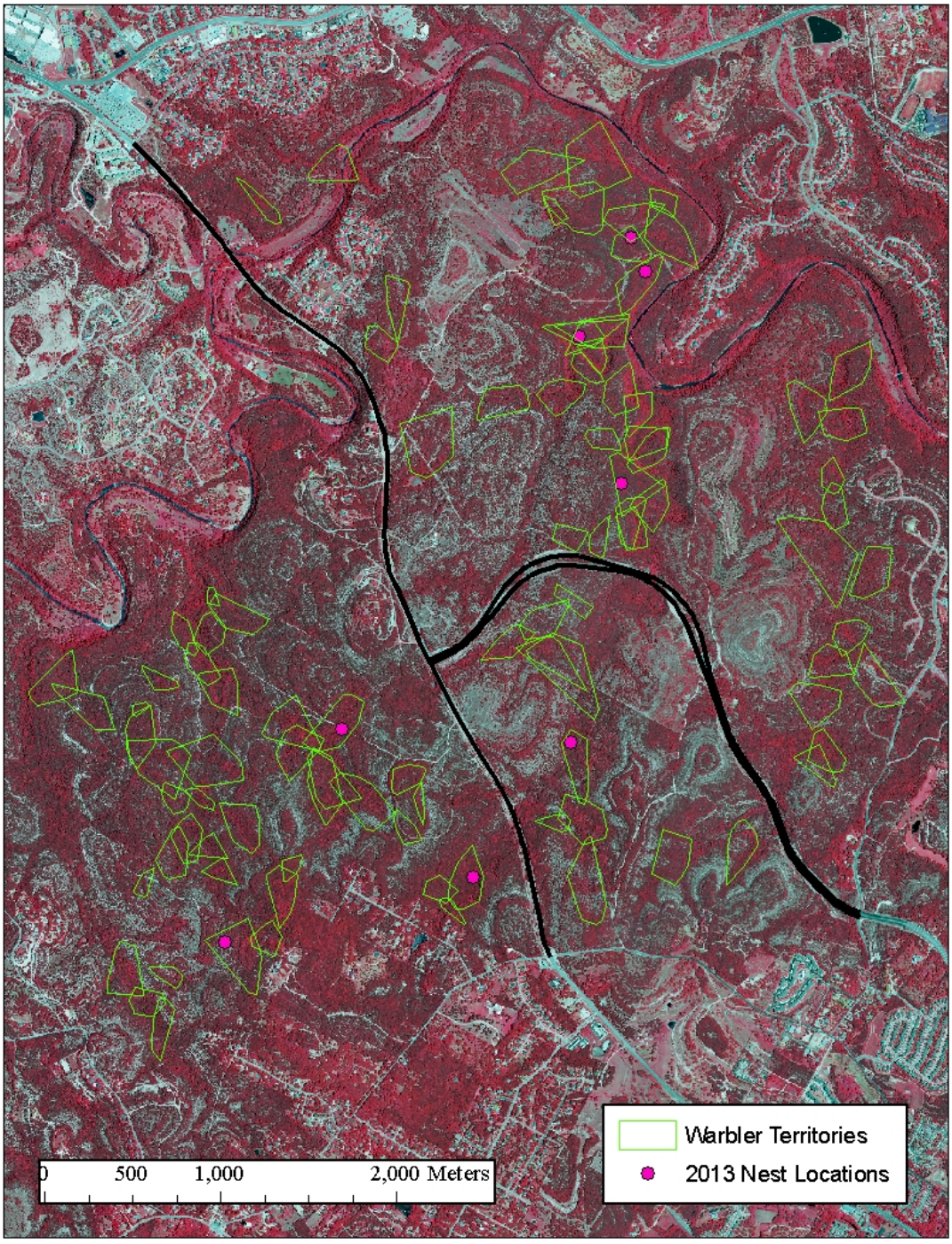

Figure 3: Golden-cheeked warbler territory polygons and nest locations on Barton Creek Habitat Preserve in 2013, Travis County, TX USA.

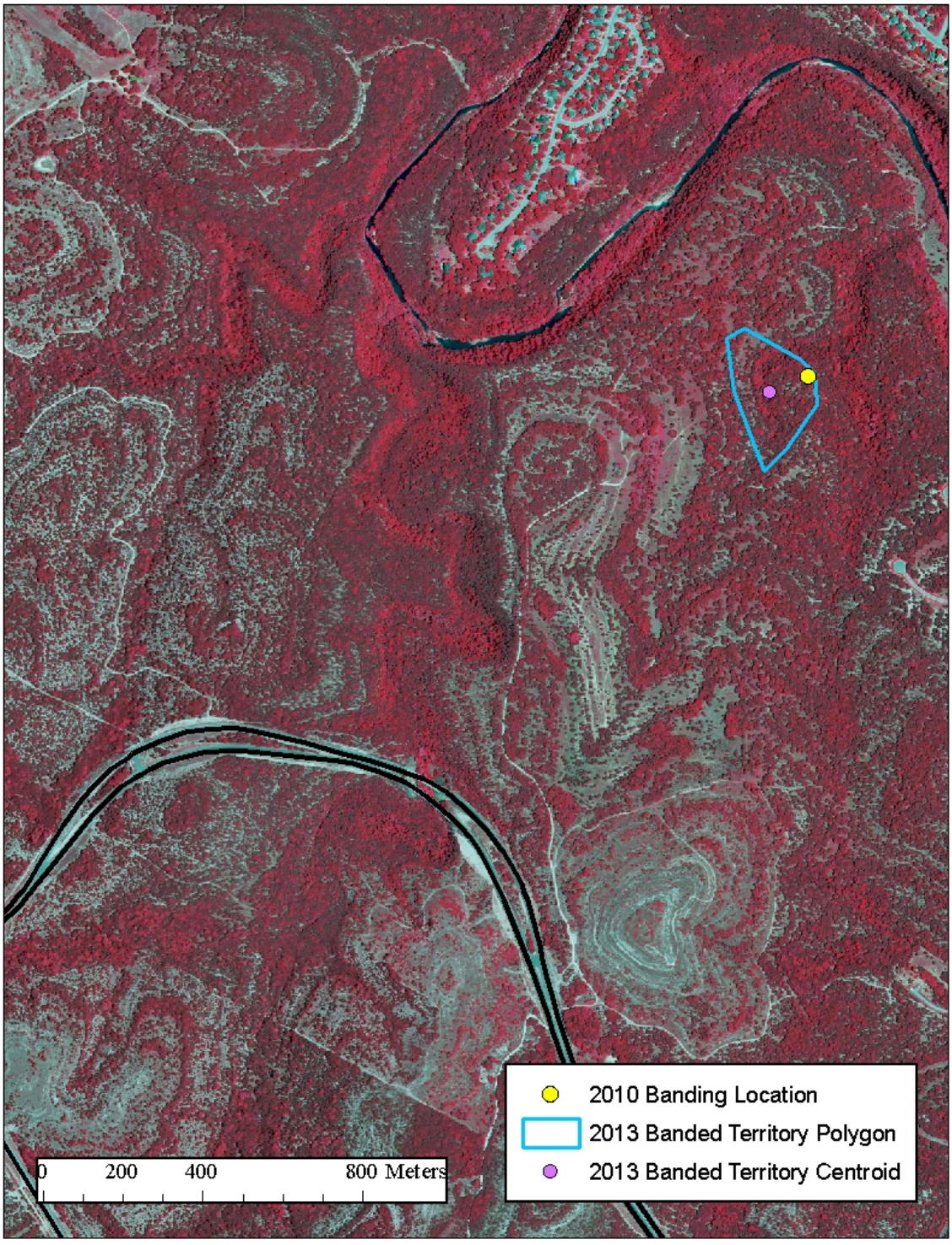

Figure 4: Map of territory polygon and centroid for returning banded male warbler in 2013, with banding location from 2010. Barton Creek Habitat Preserve, Travis County, TX USA.