PROGRESS REPORT 2009
SPOT MAPPING, OCCUPANCY METHODS, AND MONITORING GOLDEN-CHEEKED WARBLER POPULATIONS

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ABSTRACT

The study began in 2008 and data collection was completed during the GCWA breeding season in 2009. The objective of this research is to examine the feasibility of estimating occupancy and abundance from point count data and productivity from fledgling surveys on Balcones Canyonlands Preserve. Data in 2009 was collected at 7 sites. At each site, 36 detection stations were visited 4 times to collect data to estimate abundance and occupancy. Transects were surveyed twice for fledglings on 5 sites. A brief description of the data collected in 2009 is provided.

INTRODUCTION

Biologists with the Balcones Canyonlands Preserve spot map breeding territories of Golden-cheeked warblers (GCWA, *Dendroica chrysoparia*) in eight 100 acre plots. Five plots are in habitat that is considered optimal or prime and three plots are in habitat that is viewed as suboptimal or transitional for GCWA. The data gathered from spot mapping is used to measure GCWA density (e.g., number of territories per 100 acres) and productivity (e.g., number of fledglings per territory). This information has been gathered annually since 1998 and is used to determine trends in GCWA populations throughout Balcones Canyonlands Preserve. Possible trends are GCWA populations have declined, increased, or remained stable.

With the objectives in the Habitat Conservation Plan of achieving a minimum viable population of 500 – 1000 pairs of GCWA's and 10,000 – 12,000 acres of GCWA habitat by 2024, it may be useful to pursue alternatives to spot mapping for purposes of monitoring GCWA. Spot mapping is labor intensive; consequently, GCWA density can only be measured in a very small part of the preserve. Extrapolating densities measured in 100 acre plots to areas of similar habitat where birds have not been monitored may be misleading. Weckerly and Ott (2008), for example, showed that the amount of variation from plot-to-plot in territory densities was about twice as much as the variation in territory density from year-to-year within plots. Also, some measures of productivity gathered during spot mapping, such as number of fledglings per territory, may provide inaccurate data. Some fledgling may not be detected because nests in territories may not be located or the fledglings themselves may be difficult to spot in densely vegetated habitat. An issue called imperfect detection.

To provide data needed to achieve goals for the Habitat Conservation Plan, we initiated a study in 2008 to explore alternative monitoring methods. The alternative monitoring methods were selected to achieve three objectives. *One, the data collected from another method should interface with existing spot mapping data*. The alternative methods should be calibrated with spot mapping to maintain the integrity of the long-term data series on GCWA population trends in the preserve. *Two, the method has to be cost effective*. A larger part of the preserve should be monitored then can be monitored at

the present time given the time, money, and personnel allotted. *Three, the data should be reliable*. Data on GCWA density and productivity should account for imperfect detection or the possibility of missing birds during surveys.

METHODS

The alternative methods for estimating abundance are occupancy and binomial mixture models (MacKenzie et al. 2006). Using these models requires that data on abundance is collected in such a way that areas are surveyed systematically and repeatedly. In 2008 we plotted a 'grid' of detection stations over five 100 acre plots (Fig. 1, 2). Detection grids have 36 detection stations (sampling points) that are 200 meters apart. Detection stations are 200 meters apart to minimize the potential of detecting the same bird at multiple detection stations. Observers record the number of distinct GCWA seen or heard at detection stations, regardless of distance from the detection station, in a 5 min survey period. A survey consists of sampling every station in a detection grid in one day. Also, surveys are conducted on days when weather conditions allow for songbird activities (calling and moving) that facilitate detection (Robbins 1981). Each grid was surveyed 4 times between 15 March and 15 April which was during the GCWA breeding season. Surveys began at dawn and the sequence that detection stations were sampled changed each survey so that stations were sampled at different times during the morning and early afternoon. Surveys of detection grids are conducted by graduate students and faculty of Texas State University.

In each 100 acre plot, the standard spot mapping technique (Bibby et al. 1992) was conducted by biologist with the City of Austin. Every 100 acre plot was surveyed 10 times throughout the GCWA breeding season from mid-March to the end of May. A spot mapping survey of a 100 acre plot lasts 6 hours and was initiated at dawn.

This past summer the graduate student of the project (Jason Hunt) estimated occupancy (proportion of detection stations occupied by one or more GCWA) and density (GCWA per detection station) using Occupancy and Binomial mixture models. Estimates obtained from these techniques will be compared to estimates of territory density obtained from spot mapping to assess interface, cost-effectiveness, and reliability (see Introduction).

In May 28 – 35 belt transects (50 X 200 m) on each grid were measured for number of fledglings. Each belt transect in a grid was sampled twice in May, again, surveys began at dawn. We collected data using the double observer design (Nichols et al. 2000). In each belt transect, two observers surveyed at the same time and kept separate records of the number of fledglings and adult GCWA sighted. By conducting surveys in this manner we can estimate detection probabilities of fledglings and estimate the extent to which fledglings are missed or imperfect detection (Nichols et al. 2000).

RESULTS AND DISCUSSION

Number of detections among surveys and number of GCWA detected at detection stations (per grid) is summarized for the 2009 season in Table 1 and for the 2008 season in Table 2. In 2009 two more grids were established and surveyed (Double J&T, Barton Creek) than in 2008. Between years the number of detections was similar. For grids in prime habitat (Emma Long, Forest Ridge, Ivanhoe, 3M/St. Edwards) detections were considerably higher than in transitional habitat (Bohls and Double J&T). For fledgling surveys the number of GCWA groups ($\geq$ 1 fledgling or adult in a group) detected per

survey ranged from 0 to 13 in both 2008 and 2009. Analysis of the fledgling survey data will begin in spring 2010.

The formal analysis of data collected in 2008 and 2009 began this summer and is now complete. Jason Hunt is just beginning to write his thesis (which should be completed by late summer). Jason's analysis examined models to assess whether occupancy varied across sites (grid) and what influenced detection. Detection was found to be influenced by time of day (detection allowed to vary linearly with time since sunrise or in a quadratic manner), and a linear effect of survey week (detection increased or declined from the first to last week of surveys). The models and statistics for selecting the model are presented in Tables 3 and 4. Models that allowed occupancy to vary among sites were selected in both years (2008 and 2009). For selected models (low ΔAIC) detection probabilities varied among sites, weeks of surveys, and time of day. The models compared and the findings from the selected binomial mixture models were much the same as for occupancy (Tables 5 and 6). The models selected (again low ΔAIC) in 2008 and 2009 allowed density or lambda (number of GCWA per detection station) to vary among sites. Detection probabilities varied among sites, week of surveys, and time of day.

Estimated detection probabilities are in Table 7. Detection probabilities ranged from a low of 0.42 at Bohls in 2009 to a high of 0.81 at Ivanhoe in 2008. The estimates of occupancy and density (lambda) are in Tables 8 and 9. Occupancy estimates ranged from a low of 0.49 at Bohls in 2008 to highs of 1.0 at three of the sites. Density estimates using Binomial Mixture Estimators were unrealistically high. For example, in 2008 the abundance estimated from density (lambda * 36 detection stations = 136.9) at Ivanhoe was more than twice the number projected over the area of our grid from spot mapping (46.4, City of Austin 2008). Therefore a new estimator was used. This estimator was calculated as counts divided by detection probabilities. The estimates calculated from the ratio estimator were less than estimates from the binomial mixture model. Across sites in both years ratio estimates ranged from a low of 36 at Double J&T to a high of 106 at Emma Long in 2009.

CONCLUSION

The objectives of the research are to assess alternative methods to the spot mapping technique for estimating GCWA abundance and whether abundance varies with the spatial scale that is used to gather data to estimate abundance. The research will allow the City of Austin to evaluate a variety of methods and select methods that are practical and provide reliable estimates. In February 2010 we are scheduled to meet with City of Austin and compare spot mapping abundance estimates with estimates from our methods.

REFERENCES

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Table 1. Summary of detections (stations where ≥1 GCWA detected) and number of GCWA detected (when at least 1 GCWA was detected) at grids among the four surveys in 2009.

	Number of detections per survey of 36 detection stations		Number of GCWA detected		
Grid	Minimum	Maximum	Median	Minimum	Maximum
Bohls	6	11	0	0	3
Emma Long	21	24	3	1	4
Forest Ridge	16	22	2	0	2
Ivanhoe	18	33	3	1	4
3M/St. Edwards	18	34	3	0	4
Barton Creek	22	25	3	1	4
Double J&T	4	9	0	0	2

Table 2. Summary of detections (stations where ≥1 GCWA detected) and number of GCWA detected (when at least 1 GCWA was detected) at grids among the four surveys in 2008.

	Number of detections per a survey of 36 detection stations		Number of GCWA detected		
Grid	Minimum	Maximum	Median	Minimum	Maximum
Bohls	4	14	1	1	2
Emma Long	21	28	1	1	5
Forest Ridge	12	22	1	1	4
Ivanhoe	22	34	1	1	4
3M/St. Edwards	15	30	1	1	4

Table 3

Occupancy Models 2008

Models	no. Par.	AIC	ΔAIC
psi (site) p(site, survey linear, time linear)	12	803.14	0
psi (site) p(site, survey linear, time quadratic)	12	804.23	1.09
psi (.) p(site, survey linear, time linear)	8	834.77	31.63
psi (.) p(site, survey linear, time quadratic)	8	835.36	32.22

psi = estimate of occupancy
p = estimate of detection probability
(.) = value for parameter is constant
site = covariate for BCP properties
survey linear = the linear effect of survey week on p
time linear = the linear effect of time of day on p
time quadratic= the quadratic effect of time of day on p
no. Par. = the number of parameters in model
AIC = Akaike information criterion
Δ AIC = change in AIC value among competing models

Table 4

Occupancy Models 2009

Models	no. Par.	AIC	ΔAIC
psi (site) p(site, survey linear, time quadratic)	16	1190.47	0
psi (site) p(site, survey linear, time linear)	16	1191.49	1.02
psi (.) p(site, survey linear, time linear)	10	1203.22	12.75
psi (.) p(site, survey linear, time quadratic)	10	1203.71	13.24

See Table 1 for definitions of parameters and covariates.

Table 5

Binomial Mixture Models 2008

Models	no. Par.	AIC	ΔAIC
lambda (site) p(site, survey linear, time linear)	8	1568.14	0
lambda (site) p(site, survey linear, time quadratic)	8	1568.37	0.23
lambda (site) p(site, observer, survey linear, time linear)	9	1569.05	0.91
lambda (site) p(site, observer, survey linear, time quadratic)	9	1569.26	1.12
lambda (.) p(site, survey linear, time linear)	8	1576.23	8.09
lambda (.) p(site, survey linear, time quadratic)	8	1576.5	8.36
lambda (.) p(site, observer, survey linear, time linear)	9	1578.23	10.09
lambda (.) p(site, observer, survey linear, time quadratic)	9	1578.5	10.36

lambda = estimate of abundance
observer = covariate that accounts for differences in detection due to observer

Table 6
Binomial Mixture Models 2009

Models	no. Par.	AIC	ΔAIC
lambda (site) p(site, survey linear, time quadratic)	10	2038.15	0
lambda (site) p(site, observer, survey linear, time quadratic)	11	2038.99	0.84
lambda (site) p(site, survey linear, time linear)	10	2039.1	0.95
lambda (site) p(site, observer, survey linear, time linear)	11	2039.92	1.77
lambda (.) p(site, survey linear, time quadratic)	10	2043.58	5.43
lambda (.) p(site, survey linear, time linear)	10	2044.54	6.39
lambda (.) p(site, observer, survey linear, time quadratic)	11	2045.58	7.43
lambda (.) p(site, observer, survey linear, time linear)	11	2046.54	8.39

See Table 3 for definitions of parameters and covariates.

Table 7
Detection Probability Estimates 2008 and 2009

	2008	2008	2009	2009
Site	Detection Probability	Std. error	Detection Probability	Std. error
Emma Long	0.74	0.10	0.68	0.05
Ivanhoe	0.81	0.09	0.70	0.07
St. Edwards	0.66	0.14	0.68	0.09
Forest Ridge	0.59	0.10	0.60	0.09
Bohls	0.51	0.1	0.42	0.08
Barton Creek	-	-	0.65	0.07
Double J&T	-	-	0.55	0.06

std. error = the standard error of estimate

Table 8
Parameter Estimates 2008

Site	Occupancy	Std. error	Lambda	Std. error	100 ha	N	Std. error
Emma Long	0.9768	0.0277	3.4264	0.5423	123.35	95.43	13.5369
Ivanhoe	1	-	3.803	0.5833	136.9	93.44	10.029
St. Edwards	1	-	3.3123	0.5332	119.24	105.89	20.4954
Forest Ridge	0.855	0.0645	2.4773	0.4203	89.18	71.13	12.9846
Bohls	0.4872	0.0863	1.7069	0.3171	61.45	47.33	16.4656

occupancy = proportion of detection stations occupied
std. error = the standard error of estimate
lambda = estimate of abundance from binomial mixture models (average number of birds per point)
*100 ha = estimate of number of birds per 100 hectare grid (lambda * 36 detection stations)*
N = the estimate of abundance for each 100 hectare grid obtained by C/p = N
p = detection probability
where C is the raw count of birds at each grid and p is the probability of detecting an individual

Table 9
Parameter Estimates 2009

Site	Occupancy	Std. error	Lambda	Std. error	100 ha	N	Std. error
Emma Long	1	-	5.9248	2.0704	213.29	105.79	8.7057
Ivanhoe	1	-	6.0132	2.0982	216.48	100.72	10.5412
St. Edwards	0.9799	0.0279	6.0121	2.0886	216.44	104.27	14.7584
Forest Ridge	0.8848	0.0603	4.7113	1.6851	169.61	81.55	11.9919
Bohls	0.5238	0.0968	2.6433	0.9989	95.16	45.49	9.076
Barton Creek	1	-	5.3724	1.8964	193.41	93.02	9.9235
Double J&T	0.6026	0.1276	2.5591	0.9718	92.13	36.13	4.1909

See Table 8 for definitions of parameters.

Fig. 1. A map illustrating the location of detection stations in relation to the location of the 100 acre plot on one site, Forest Ridge. The Forest Ridge 100 acre plot is delineated in red and the grid of the 36 detection stations is denoted by black dots.

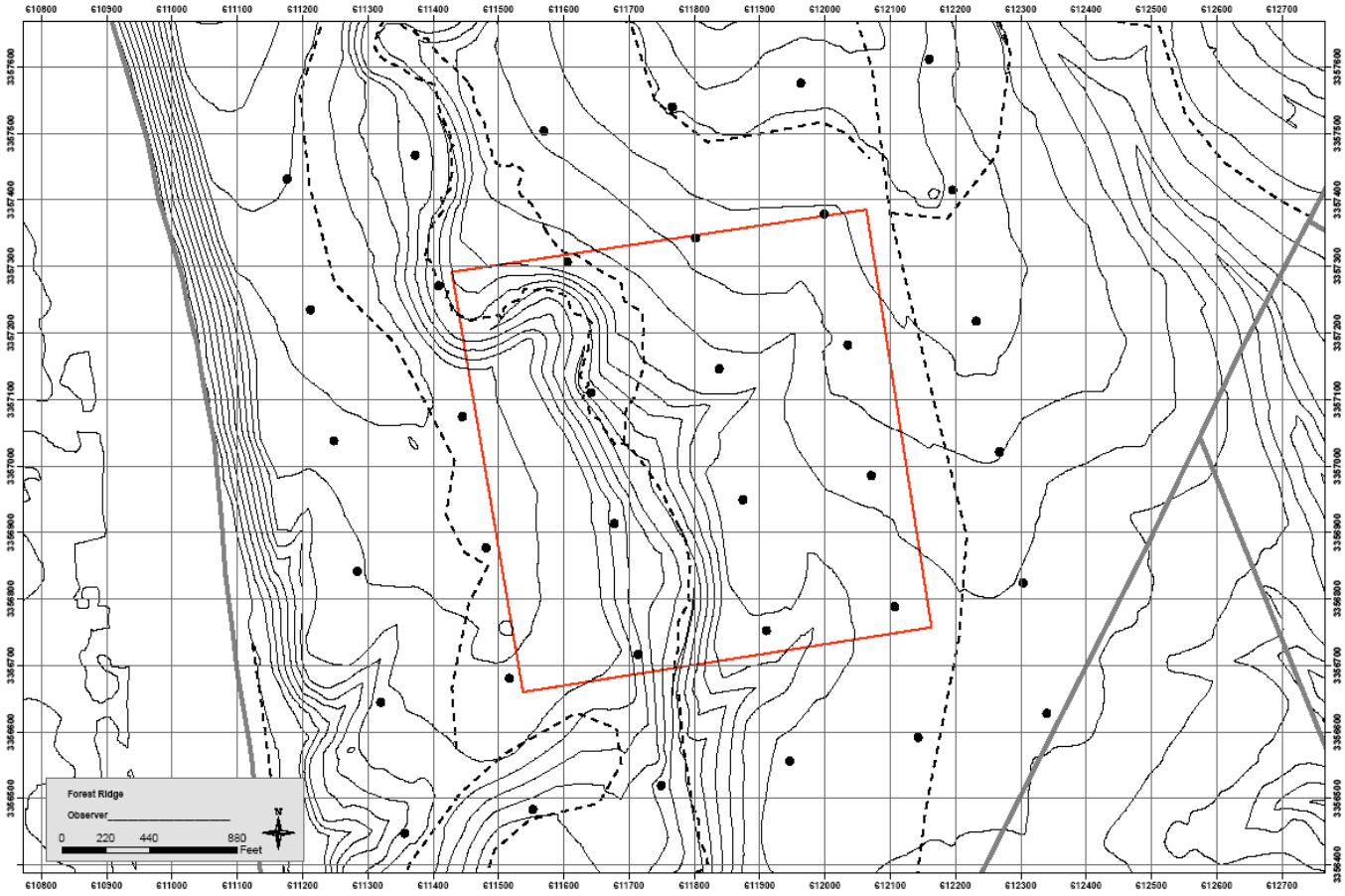

Fig. 2. Map of Balcones Canyonland Preserve showing locations of 8-100 acre plots where golden-cheeked warbler densities are measured by biologists with the City of Austin. In 2008 and 2009 we collected data on detection grids overlaid on 5 of the 100 acre plots; Bohls, Emma Long, Ivanhoe, 3M/St. Edwards, and Forest Ridge. In 2009 we collected data from detection grids overlaid on 2 additional 100 acre plots; Barton Creek and Double J&T.

