Golden-cheeked Warbler Habitat Up-date

Final Report

November, 2010

David D. Diamond, Lee F. Elliott, and Ronnie Lea
Missouri Resource Assessment Partnership
University of Missouri
Columbia, MO 65201
Contact Email: diamondd@missouri.edu
elliottle@missouri.edu
lear@missouri.edu
Phone: 573.489.8966

The Southern Edwards Plateau Habitat Conservation Plan seeks to provide information to obtain a permit from the US Fish and Wildlife Service in compliance with the Endangered Species Act. The Golden-cheeked Warbler (GCW) is one of the species of concern in this regard. Land management practices and development for urban infrastructure result in loss of GCW habitat throughout the range.

Several versions of GCW habitat have been delineated. Most have been modeled based on satellite remote sensing information, while one, completed for TXDOT, was based on human interpretation and delineation from air photos. The remote sensing classifications have generally relied on both the location of woodland and forest, and on the overall amount of woodland and forest within a neighborhood (circular area around a given pixel). The remote sensing based classifications have largely resulted in similar delineations of habitat. Based on input from the Biological Advisory Team (BAT), we focused on a satellite remote sensing model called "new model C live oak as deciduous." A full discussion and evaluation of differences among models is beyond our current scope.

Our goal was to provide information to up-date the "new model C live oak as deciduous" GCW habitat model. Four Thematic Mapper satellite images are needed to cover the study area (Figure 1) Importantly, the new model C live oak as deciduous classification used two time periods of satellite data: most was based on 2005 to 2007, three-date satellite mosaics, but two small areas were filled-in using data from the middle to late 1990's (Figure 2). The fill-ins were needed because at the time new model C live oak as deciduous was completed, no new classified satellite data were available for those two scenes (Table 1). The areas that were filled in with 1990's data are small but the eastern sliver is significant, because it is centered just north and west of San Antonio, where development has occurred apace over the past 15 years.

Table 1. Dates of Thematic Mapper satellite data used for new model C live oak as deciduous Golden-cheeked Warbler habitat model.

Path/Row	Summer/Fall	Winter	Spring
27/39	9/26/2005	2/14/2007	4/4/2007
28/39	9/20/2006	2/8/2006	3/31/2007
27/40	from National Land Cover Dataset: mid to late 1990's		
28/40	from National Land Cover Dataset: mid to late 1990's		

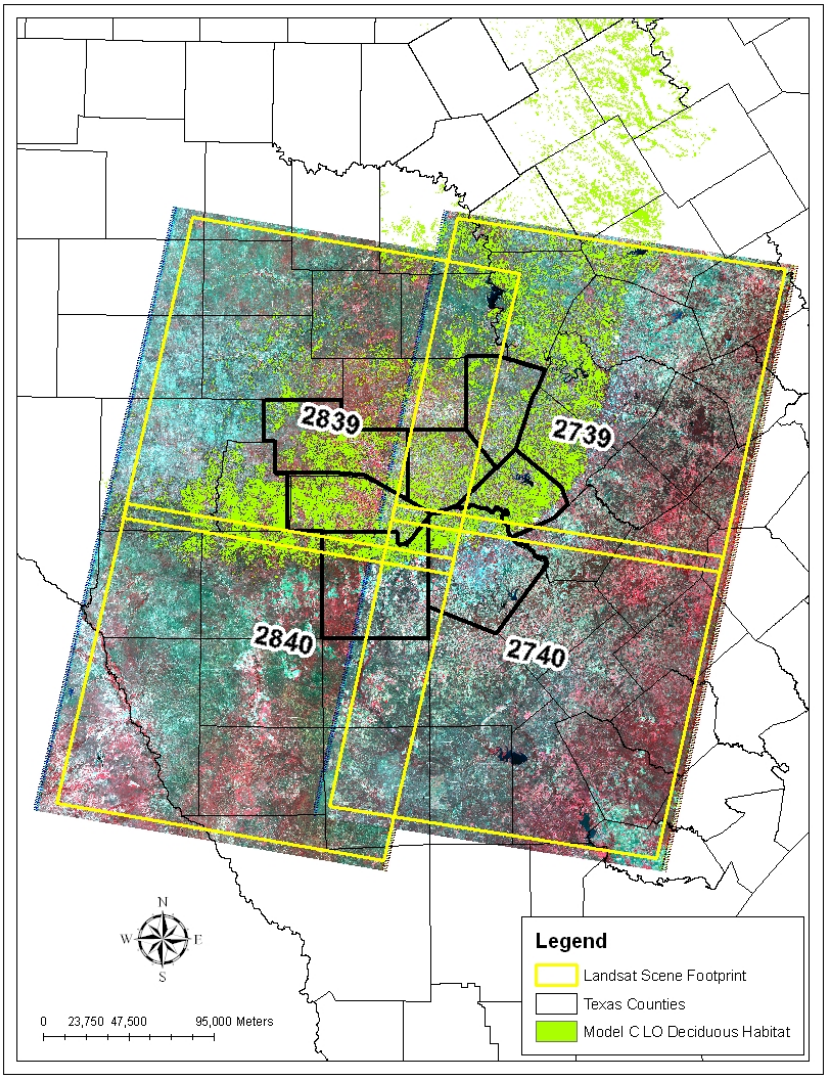

Figure 1. Satellite image footprints for the study area. For the new model C live oak as deciduous Golden-cheeked Warbler habitat model, path/row 27/39 and 28/39 used 2005 to 2007 data, whereas middle to late 1990's data were used for path/row 27/40 and 28/40 (see Figure 2).

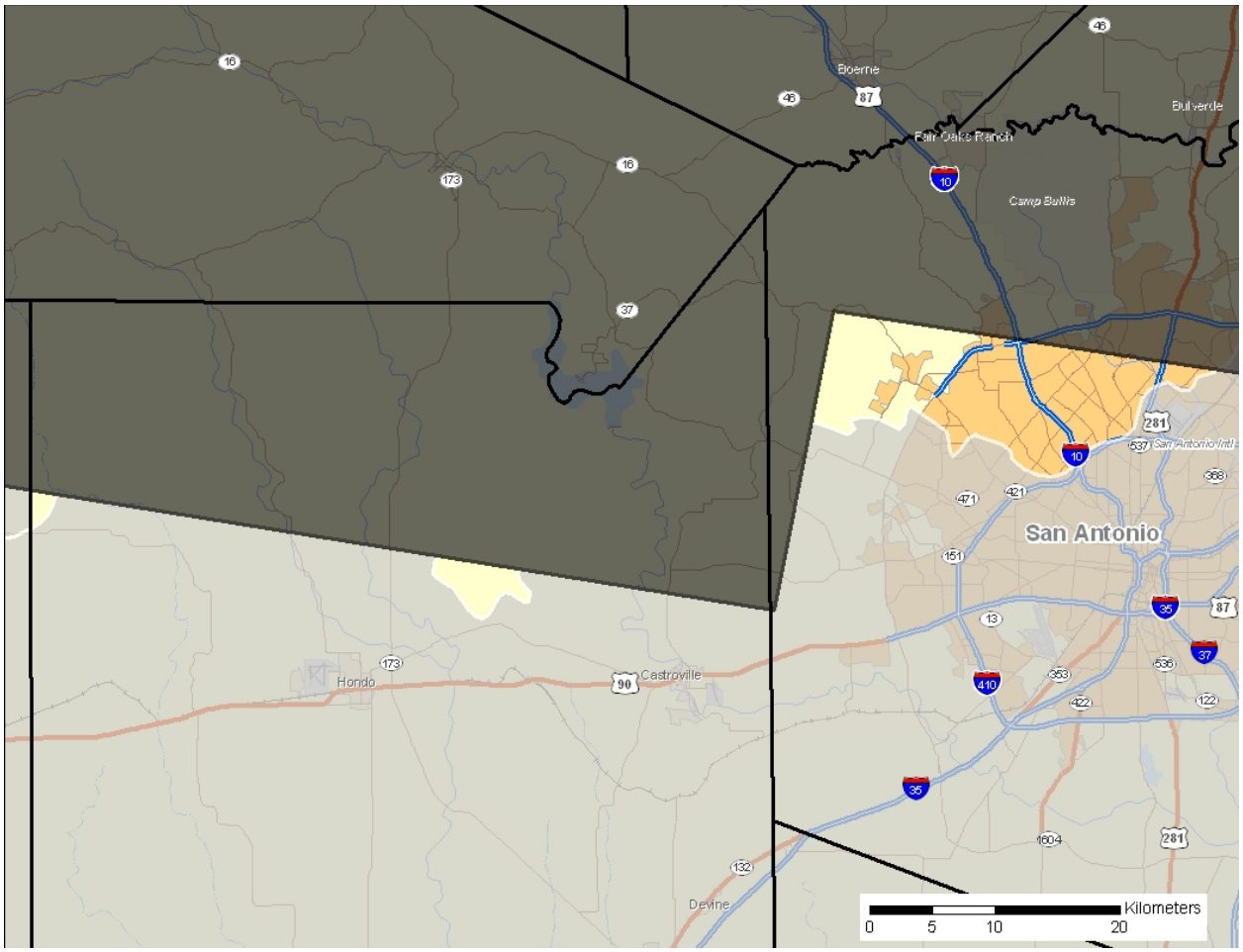

Figure 2. Depiction of area where 2005 to 2007 data were unavailable (un-shaded area), and National Land Cover Dataset (middle to late 1990's) data were used to develop new model C live oak as deciduous. Light yellow areas are within the range of the Golden-cheeked Warbler whereas the other un-shaded areas are outside the range.

Methods

We used ERDAS Imagine software and ArcMAP to perform all analyses. Basic steps included:

1. Create a 2010 Thematic Mapper satellite image mosaic (30 meter resolution) using 2010 data (August 23 for path/row 27/39 and 27/40, and October 1 for 28/39 and 28/40).

2. Classify the 2010 image mosaic into 'forest' and 'non-forest' using the Isodata routine in ERDAS Imagine, including cluster-busting of confused classes.

3. Perform change detection using Delta Cue in ERDAS Imagine using the 2010 mosaic versus a classification from the Texas Parks and Wildlife Department that used 2005 to 2007 data.

4. Overlay "non-forest" and "change" to define forest areas that have been cleared between 2005/ 2007 and 2010.

NOTE: steps #3 and #4 provided a GCW habitat change result for a three- to five-year time for most of the study area, but not for the small slivers on the south side, one of which covers an area immediately north and west of San Antonio (see Figure 1).

5. For the two southern slivers outlined above, we compared the 2010 "non-forest" with the National Land Cover Dataset (NLCD) "forest" classes. Areas that were not forested in 2010 but were in the NLCD represent forest clearing across an approximately 15-year time step, which corresponds with the timing of data used to develop new model C live oak deciduous.

6. Perform accuracy assessment (two workers, independently) on forest change using photo-interpretation of 2010 NAIP imagery. Sample points were selected in a stratified random manner, with 125 points each representing the change and no change classes. In addition, 50 points were selected within 100 meters of main roads per request from representatives of the granting agency.

Results and Discussion

Accuracy for the forest change detection was 92% overall, which is excellent for a product of this type (Table 1). Errors of commission were greater for change (14.4%) than for no change (1.6%). In other words, we may have suggested that some areas have been cleared when they have not, but these might well have been non-forest, and therefore non-habitat, in both 2010 and on the earlier dates. We almost never suggested an area has been cleared when it has not been cleared based on photo interpretation. Satellite imagery acquires data by averaging reflectance over a 900 square meter pixel, but we were able to interpret land cover using a point viewed on 2010 air photos of much higher resolution. A 900 square meter area might well be mainly forest or mainly grassland but may contain smaller amounts of other land cover types, or edges between different types. A photo-interpreter does not know how any given 900 square meter pixel is situated on the landscape (e.g. centered on the edge between forest and grassland, or centered over a very small opening in a forest), so errors invariably arise.

Table 2. Accuracy assessment for Golden-cheeked Warbler habitat change for the Southern Edwards Plateau Habitat Conservation Plan region.

# of Sample Points	Classification Data				
Reference Data	**Class Change**	**Class No Change**	**Row Total**	**Producer's Accuracy**	**Error's of Omission**
Lee & Ron Change	107	2	109	107/109	2/109
Lee & Ron No Change	18	123	141	123/141	18/141
Column total	125	125	250	230/250	20/250
User's Accuracy	107/125	123/125	**230/250**		
Error's of Commission	18/125	2/125	18/250		

Percentages	**Classification Data**				
Reference Data	**Class Change**	**Class No Change**	**Row Total**	**Producer's Accuracy**	**Error's of Omission**
Lee & Ron Change	42.8%	0.8%	43.6%	98.2%	1.8%
Lee & Ron No Change	7.2%	49.2%	56.4%	87.2%	12.8%
Column total	50.0%	50.0%	100.0%	92.0%	8.0%
User's Accuracy	85.6.2%	98.4%	**92.0%**		
Error's of Commission	14.4%	1.6%	8.0%		

A total of about 9,340 hectares (23,081 acres; 36 square miles) of forest clearing occurred within what was identified as Golden-cheeked Warbler habitat by model C live oak as deciduous between the time it was created and late 2010 (Figure 2; Table 3). This represents 2.4% of the habitat. The mean patch size of cleared areas was 0.37 hectares (0.91 acres), but 53.8% of the cleared area was in patches >1 hectare (2.47 acres), and 33.3% of the cleared area was in patches >4 hectares (9.88 acres). The largest loss of habitat was in Bexar, Bandera, and Kerr Counties, but note that change within parts of Bexar County was across a 15 year time step, rather than a five year time step as for most of the region (see Figure 1).

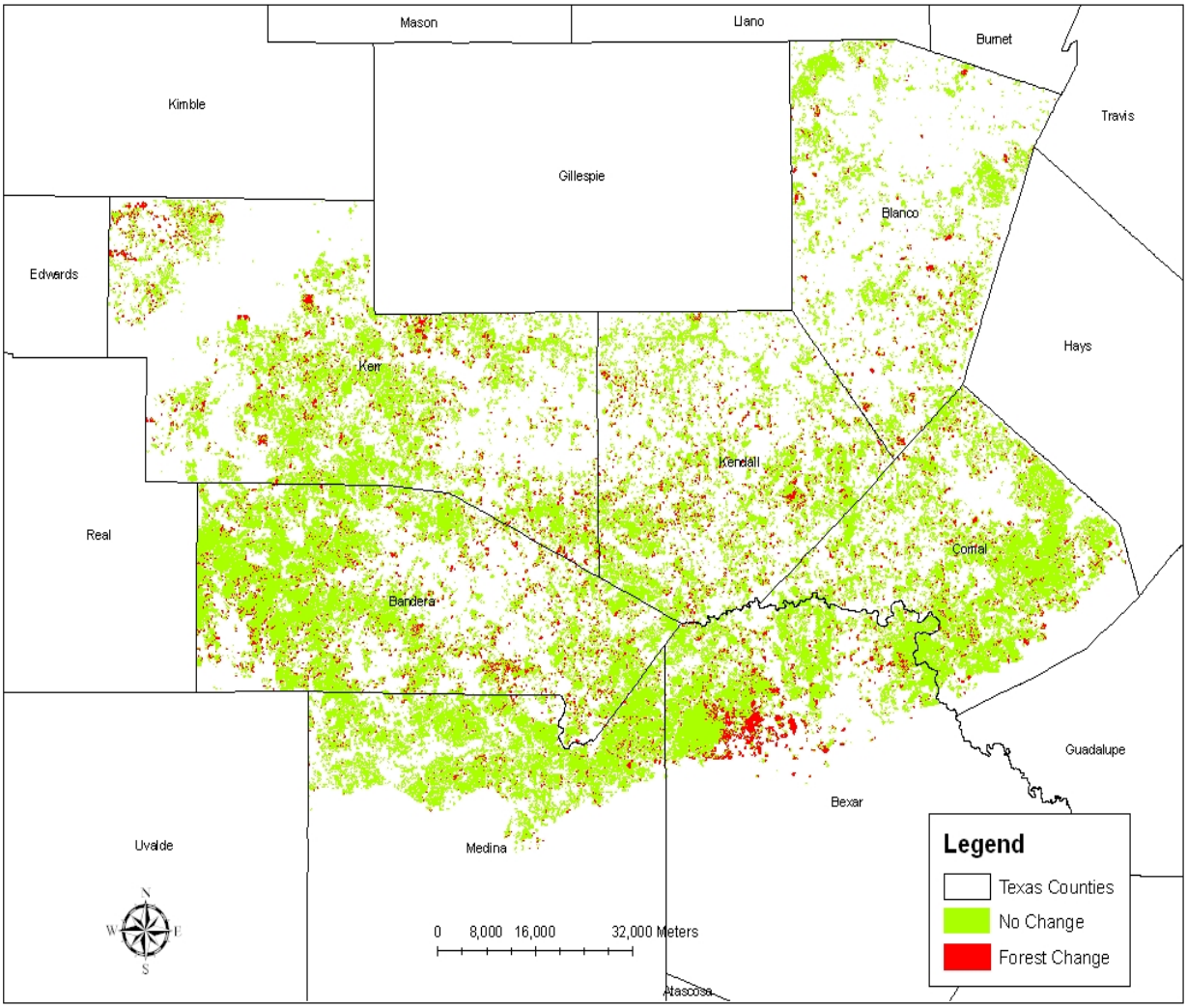

Figure 2. Location of change (forest clearing) within the area identified as Golden-cheeked Warbler Habitat by model C live oak as deciduous. Compare with Figure 1 to note the areas in the south where change was across a 15-year time step instead of a five year time step, especially the area immediately to the west of San Antonio. ***Note that the size of forest change patches are exaggerated for illustrative purposes, or change would scarcely be visible across much of the region.***

Table 3. Change (forest clearing) within Golden-cheeked Warbler habitat from model C live oak as deciduous. Time-step was five years for most of the area, but was about 15 years for a sliver in the south (see Figure 1)

County	Class	Class Area (ha)	% Class Area	# of Patches	Mean Patch Size	Median Patch Size	Patch StandDev
Bandera	No Change	91,893.69	24.2%	3,637.00	25.27	0.27	873.18
	Change	1,913.40	20.5%	6,953.00	0.28	0.09	0.78
Bexar							
	No Change	37,317.60	9.8%	2,095.00	17.81	0.27	266.94
	Change	2,241.09	24.0%	2,752.00	0.81	0.18	5.46
Blanco							
	No Change	29,581.38	7.8%	2,845.00	10.40	0.27	74.15
	Change	555.57	5.9%	1,355.00	0.41	0.09	1.22
Comal							
	No Change	58,706.82	15.5%	2,350.00	24.98	0.36	478.75
	Change	1,109.34	11.9%	3,267.00	0.34	0.09	1.04
Kerr							
	No Change	66,979.44	17.7%	5,244.00	12.77	0.27	170.51
	Change	1,856.43	19.9%	4,643.00	0.40	0.09	1.73
Kendall							
	No Change	46,601.82	12.3%	3,680.00	12.66	0.36	109.91
	Change	1,133.01	12.1%	4,074.00	0.28	0.09	1.18
Medina							
	No Change	48,249.90	12.7%	1,591.00	30.33	0.18	600.46
	Change	531.27	5.7%	1,991.00	0.27	0.09	1.23
Total	No Change	379,330.65	97.6%				
	Change	9,340.11	2.4%				

Final Notes

The original model C live oak as deciduous model was done on a 10-meter resolution, image object based land cover classification provided by Texas Parks and Wildlife Department. We used change in forest land cover at 30 meter resolution provided here to create a revised GCW habitat model at 30 meter resolution using methods developed for model C. This model is not directly comparable with "new model C live oak as deciduous," but does represent yet one more revision of the GCW habitat model – this time using 2010 data. Overall, we do not feel that use of this model will significantly impact planning efforts, and risks adding some confusion, given all of the different models available and the multitude of caveats attached to each.

We are available to modify and improve the delivered products and to provide clarifications and comments as needed. Hopefully, we can host a WebEx meeting for the Biological Advisory Team and partners, which will allow us to field questions, and will allow partners to view results on-screen in multiple locations, and at multiple resolutions. Please do not hesitate to contact us.