

Trends in Golden-cheeked Warbler Habitat Change Through Time



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NAH: Texas Parks and Wildlife

TH: Environmental Conservation Alliance, Inc.



History

- GCWA range reductions, population decline, loss of prime nesting habitat
- Due to human population growth; land development, urban sprawl, land clearing, juniper eradication

Demonstration at
Capitol to preserved
endangered species
(ES) habitat





Endangered Species Listing

- May 4, 1990: Emergency rule to place GCWA on the endangered species list
- Still, development and growth continues especially west of Austin in the THC
- Balcones Canyonlands Conservation Plan (BCCP)
 - creation of a 30,428 acre preserve system in Travis County (Balcones Canyonlands Preserve (BCP))



Previous Assessments and Current Needs

- Previous Research: usually single time-point estimations of population numbers and available habitat
- To discern trends in loss or gain of habitat – need to use the same methodology across time
- Presented results of our 1986 to 2004 assessment at the last symposium; Today, we add another decade.



Technological Prerequisites for Habitat Change Detection

- Apples to Apples: Conduct the assessment the same each time period so they are comparable.
- Same geospatial data type
- Use Similar Phenological cycle image (similar time within a season)
- Same Pixel Resolution (spatial resolution, 6in, 1ft, 1m, 10m, 30m)
- Same Spectral Resolution (true color, color infrared, multispectral)

Thus, for a 30 year study, we were limited to the technology available in the mid 1980s; Satellite imagery

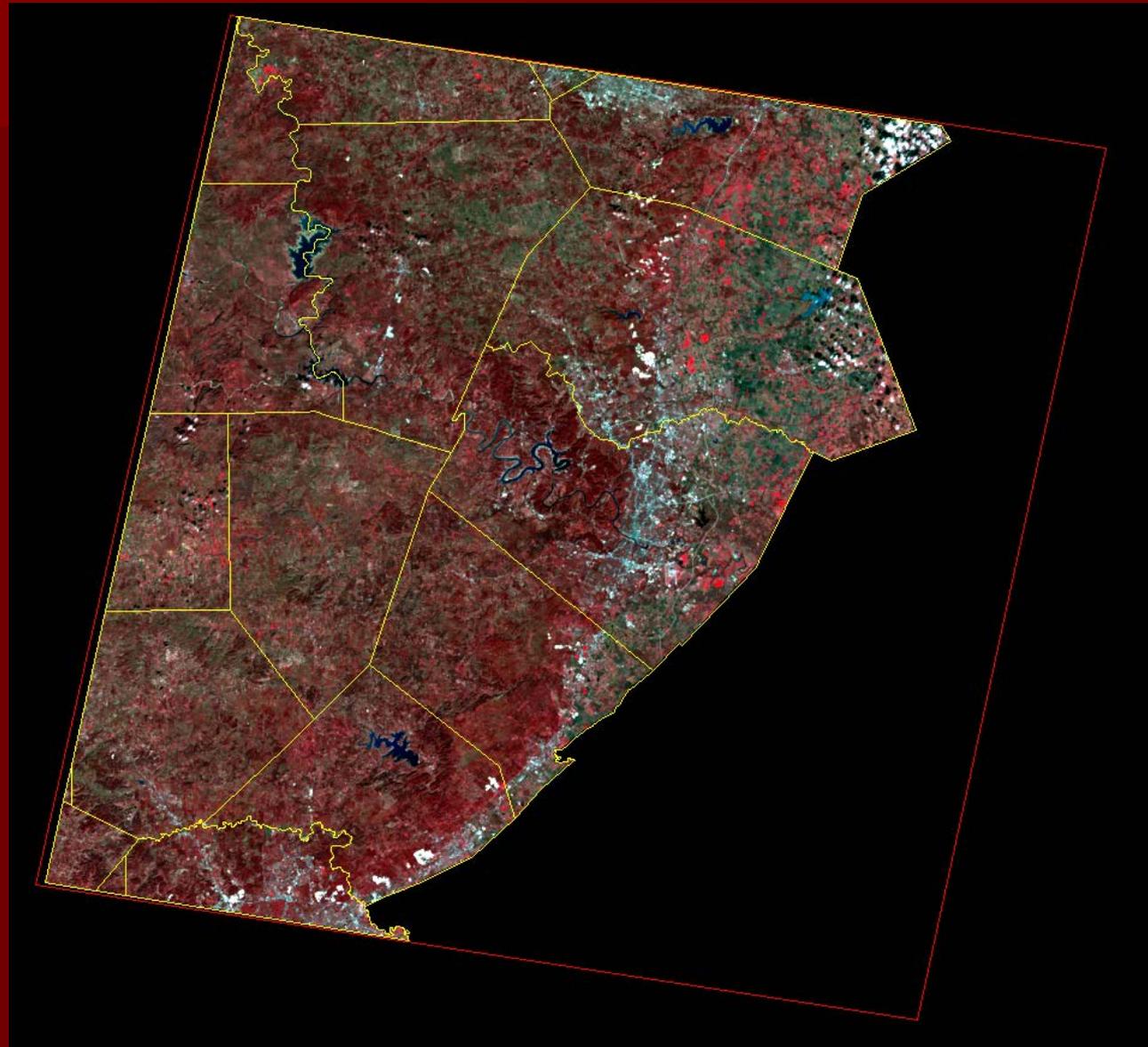


Study area

- Approximately 2,000,000 ha area surrounding Austin, Travis county

Because

- Austin – one of the fastest growing areas
- Westward urban sprawl & Development
- Resulting in accelerated GCWA habitat loss
- Loss is mitigated somewhat by BCCP





Modeling GCWA Habitat

- Typical Nesting Habitat: Ashe juniper-oak woodland (Mixed habitat)
- Only mature junipers (20-30 yrs; 4.5 m tall) produce shredding bark for nesting

Prefers

- thick canopy
- dense forests
- large tracts
- >100m from edges



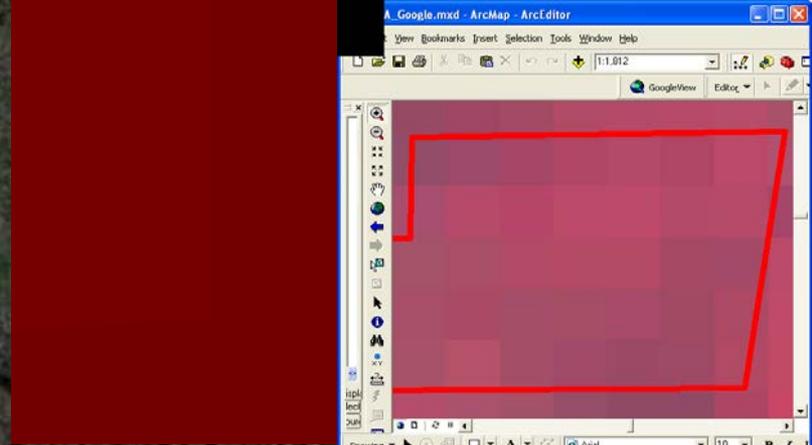


Methodology

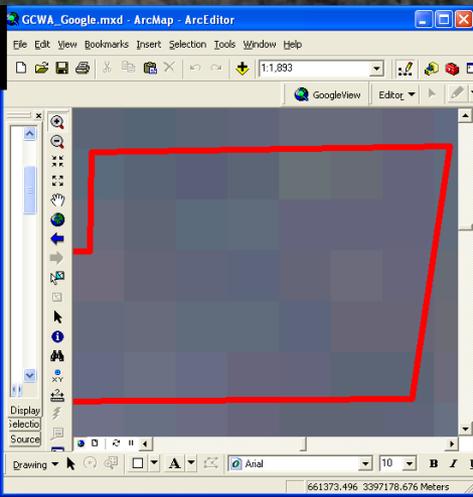
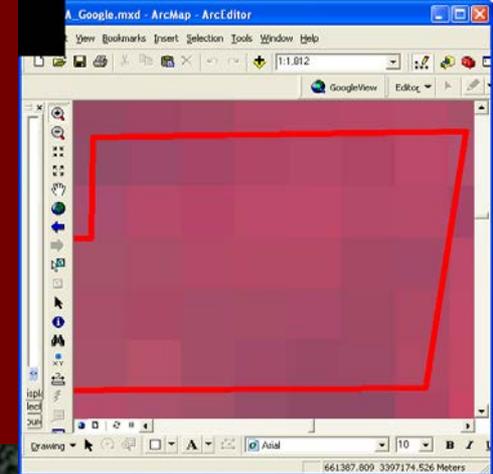
- Select summer & winter satellite images
- Conduct supervised classifications of stacked images separately for each decade
- Conduct Accuracy analysis
- Identify gains and losses in GCWA habitat through time



Winter



Summer

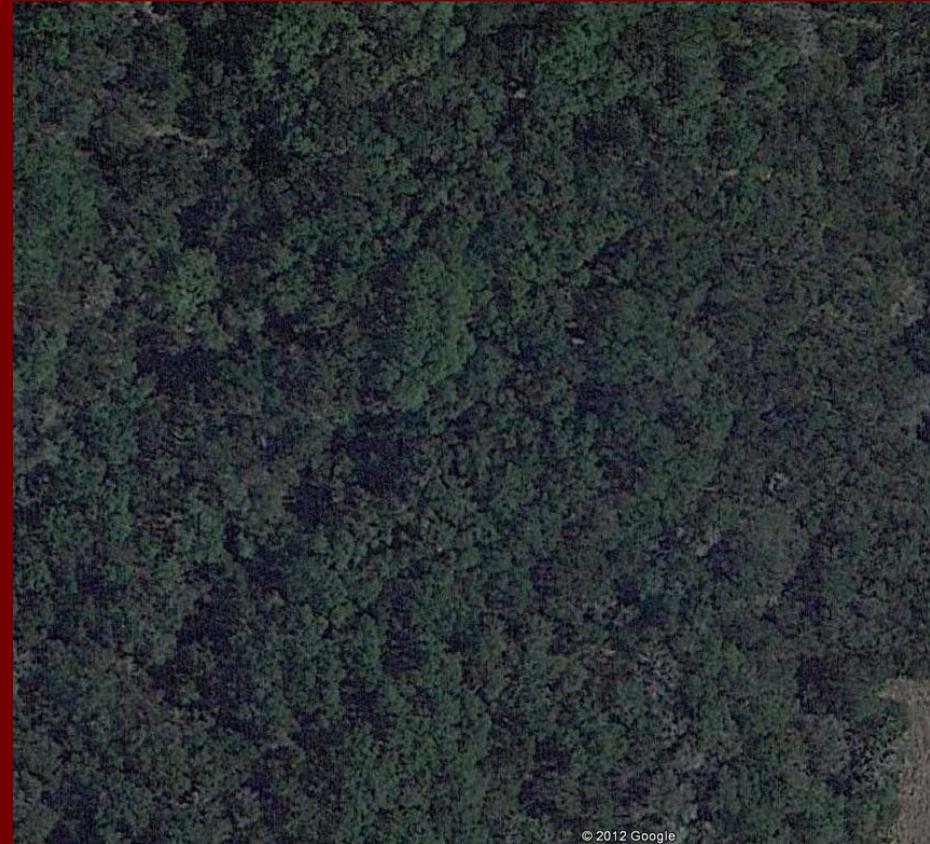




Mixed Habitat



Winter



Summer



Landsat dates

Decade	Winter Image	Late Summer Image
1980s	27 December 1986	25 September 1987
1990s	14 December 1993	28 September 1994
2000s	12 December 2004	26 September 2005
2010s	24 December 2014	5 August 2015



Land Classes

Open Water

Urban

Barren

Deciduous forest

Evergreen forest

Mixed Forest

Shrubland

Grassland

Agriculture



Classification

- ERDAS Imagine
- Stacked summer and winter images
- Spectral signatures created; assessed spectral patterns
- Supervised classification



Solutions

- Classification products needed to be comparable across decades

- Google Earth as a cost effective way to “ground truth” classification
 - For present 2014-15 data
 - As well as for 2004-05 data in our previous analysis

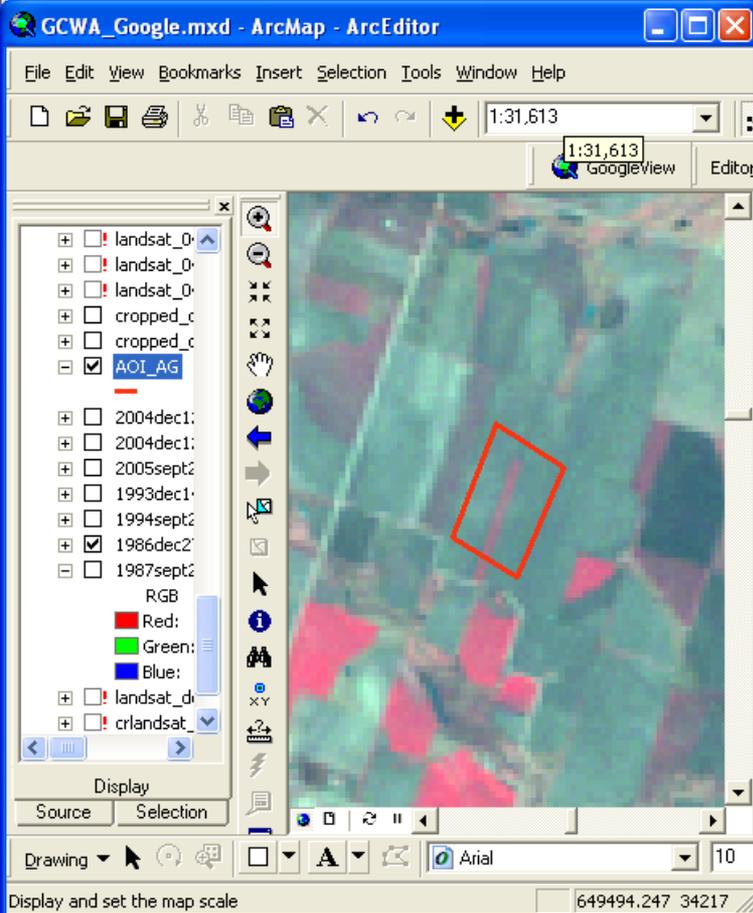
- Used the same training areas (AOIs) for 1986 to 2005; and then for 2005 to 2015



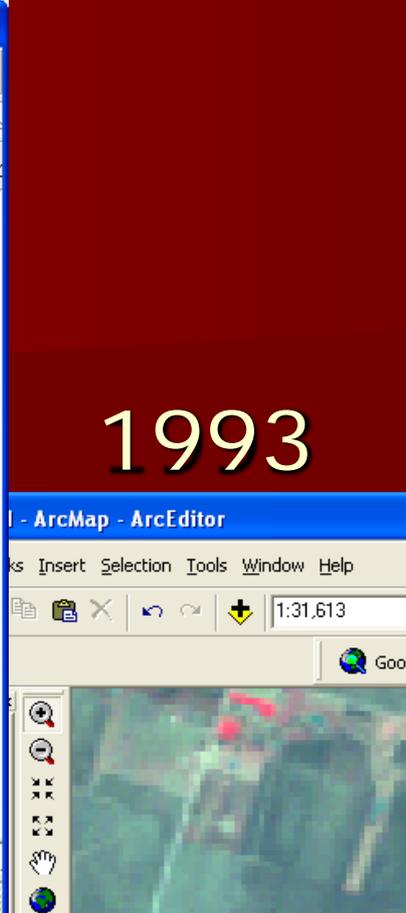
Generating AOIs

The screenshot displays the Google Earth interface. The main window shows a false-color satellite image of a landscape. A blue river flows through the center. Several red dots are scattered across the terrain, likely representing points of interest or data points. The interface includes a toolbar on the left with various navigation and editing tools. The top menu bar shows 'GoogleView' and 'Editor'. The bottom status bar displays the coordinates '523846.803 3470167.268 Meters'. The text 'Agriculture' is overlaid on the bottom left of the image.

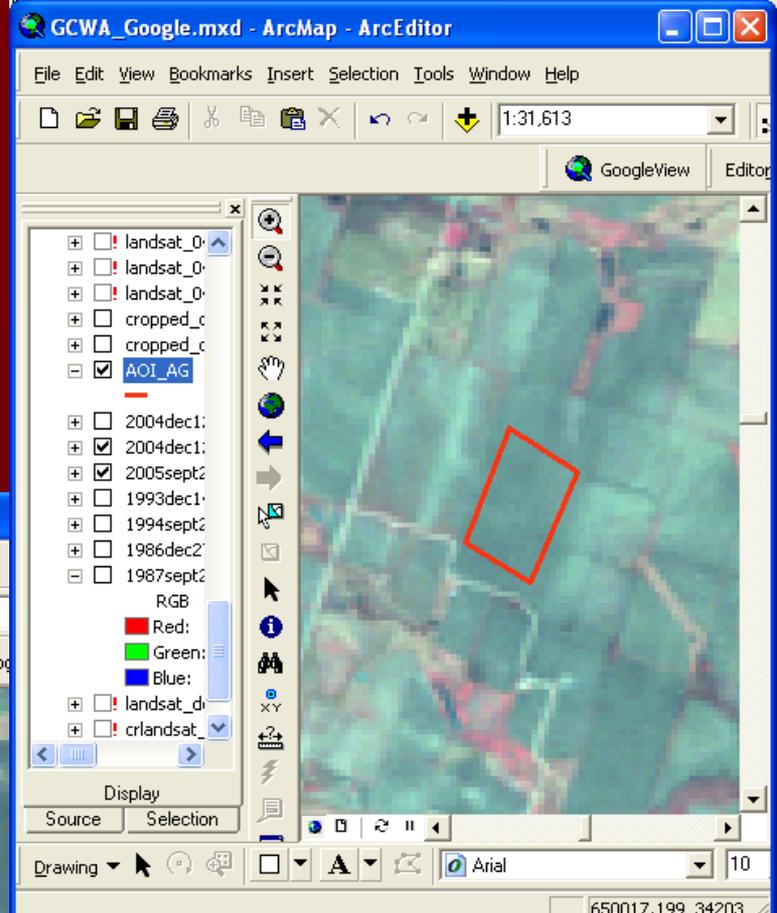
Agriculture



1986

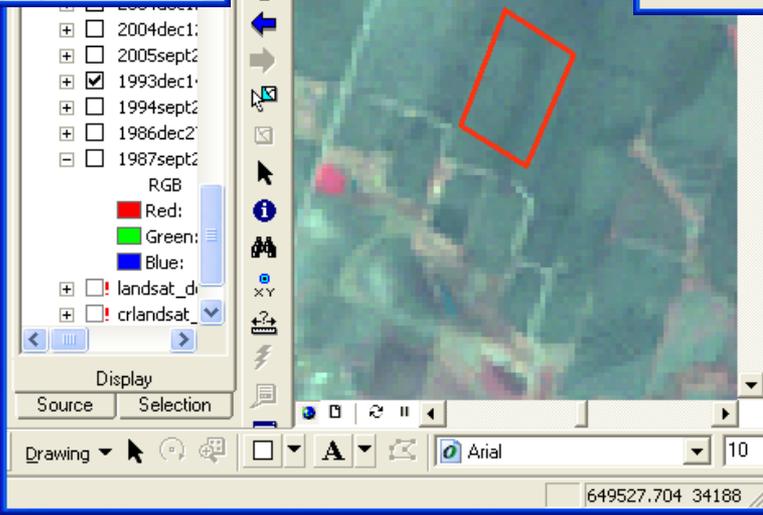


1993



2004

Agriculture



649527.704 34188



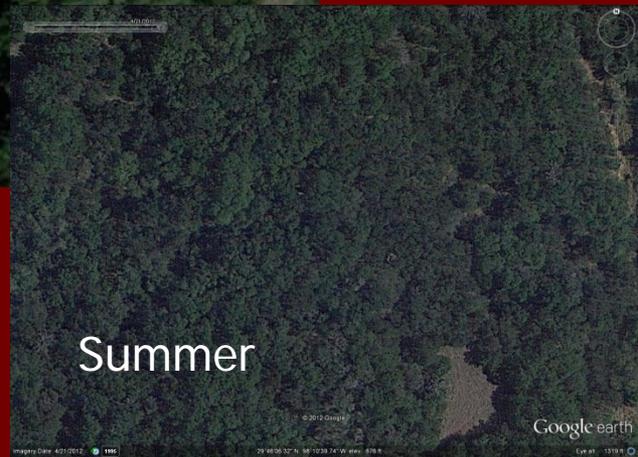
Winter

© 2012 Google

Imagery Date: 1/29/2010  1995

29°46'06.32" N 98°10'39.74" W elev 876 ft

Mixed Habitat



Summer

© 2012 Google

Imagery Date: 4/21/2012  1995

29°46'06.32" N 98°10'39.74" W elev 876 ft

Google earth

Eye Alt: 13179 ft



A_Google.mxd - ArcMap - ArcEditor

File View Bookmarks Insert Selection Tools Window Help

1:2,895,882

GoogleView Editor

- AOI_EG_New
- AOI_Deciduo
- AOI_Deciduo
- BastropPines
- AOI_Junipers
- AOI_Juniper
- AOI_Evergre
- AOI_LiveOak
- AOI_LiveOak
- AOI_Mixed
- AOI_Mixed_F
- AOI_Mixed_S
- AOI_Mixed_r

Display

Source Selection

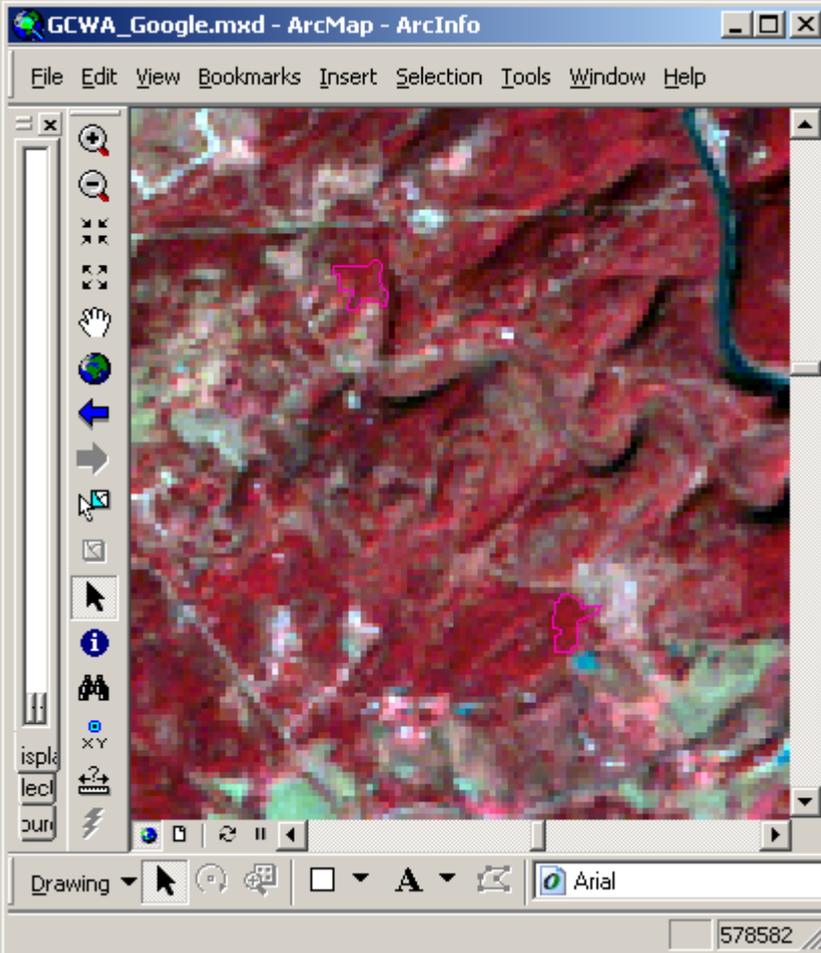
Drawing

Arial 10 B I U

661099.757 3494847.655 Meters

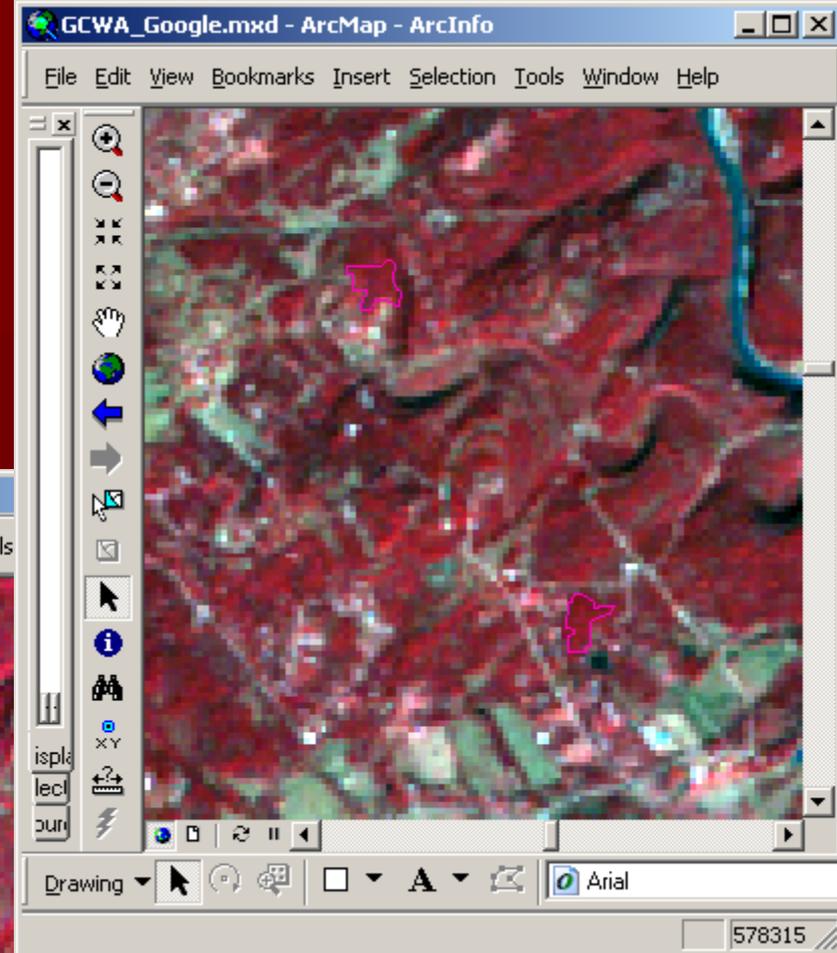
The screenshot shows the ArcMap interface with a map of Bastrop Parish, Louisiana. The map is a false-color composite of satellite imagery, with red representing vegetation, blue representing water, and white/grey representing urban areas. Several red dots are scattered across the map, likely representing specific points of interest or sampling locations. The left-hand side contains a 'Table of Contents' with a list of layers, including 'AOI_Mixed' which is checked. The top of the window shows the title bar and menu options. The bottom status bar displays the current coordinates in meters.

Mixed

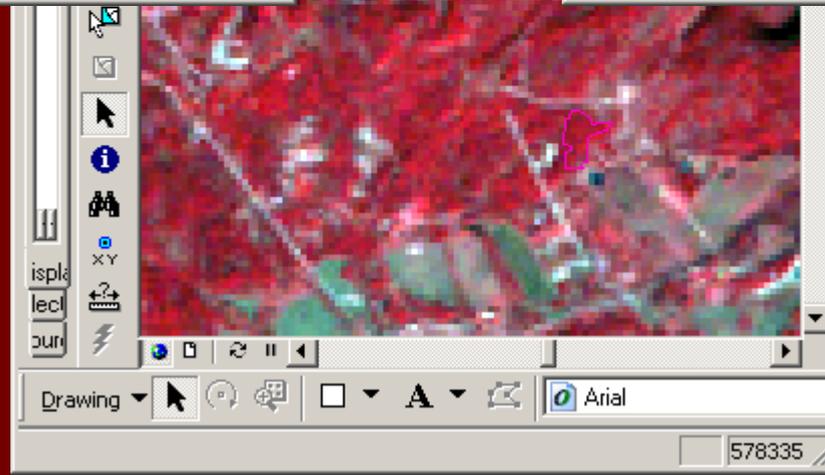


1987

1994



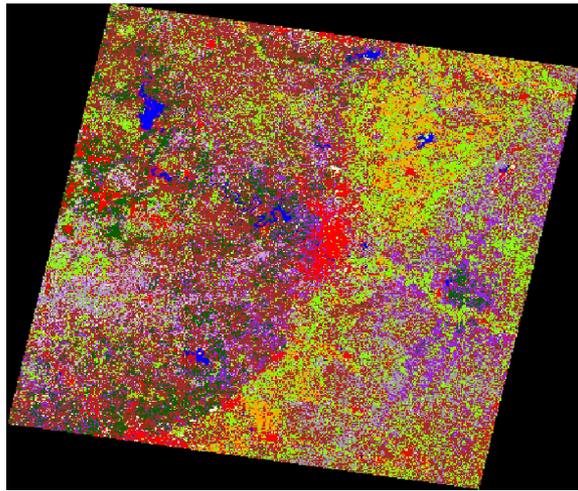
2005



Mixed



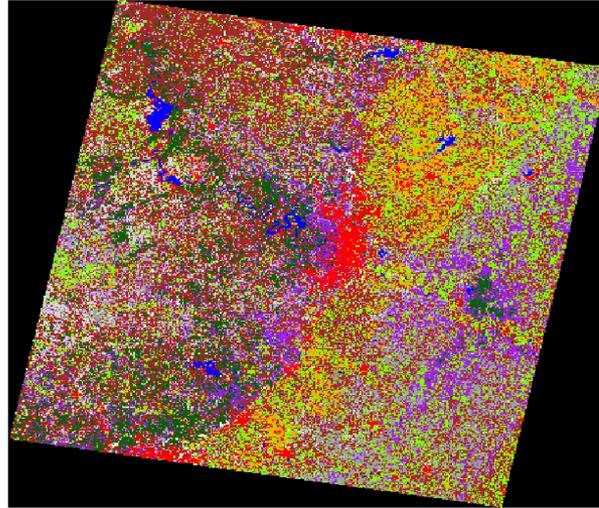
Classifications



0 15 30 60 Kilometers

1985-86 Land Classification

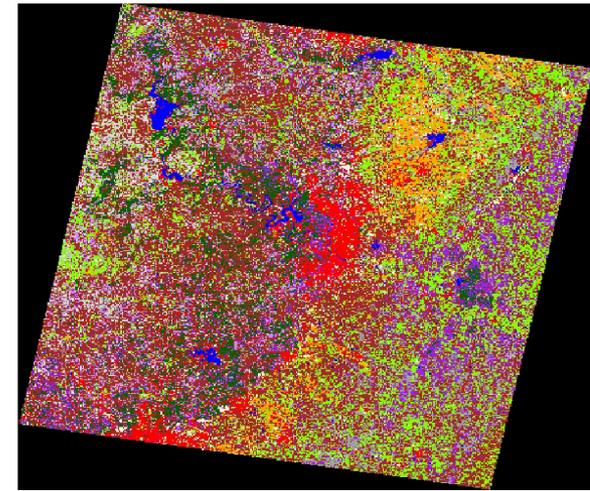
- Unclassified
- Water
- Urban
- Barren
- Deciduous
- Evergreen
- Mixed
- Shrub
- LQ Deciduous
- LQ Mixed
- Grass
- Agriculture



0 15 30 60 Kilometers

1993-94 Land Classification

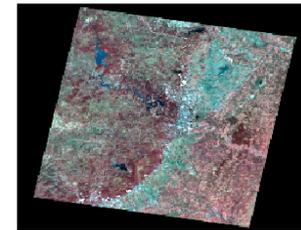
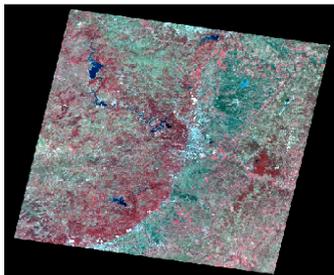
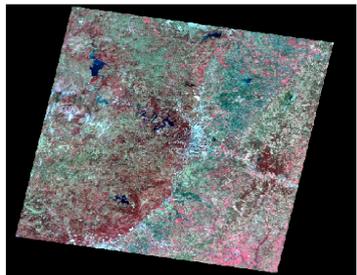
- Unclassified
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0 15 30 60 Kilometers

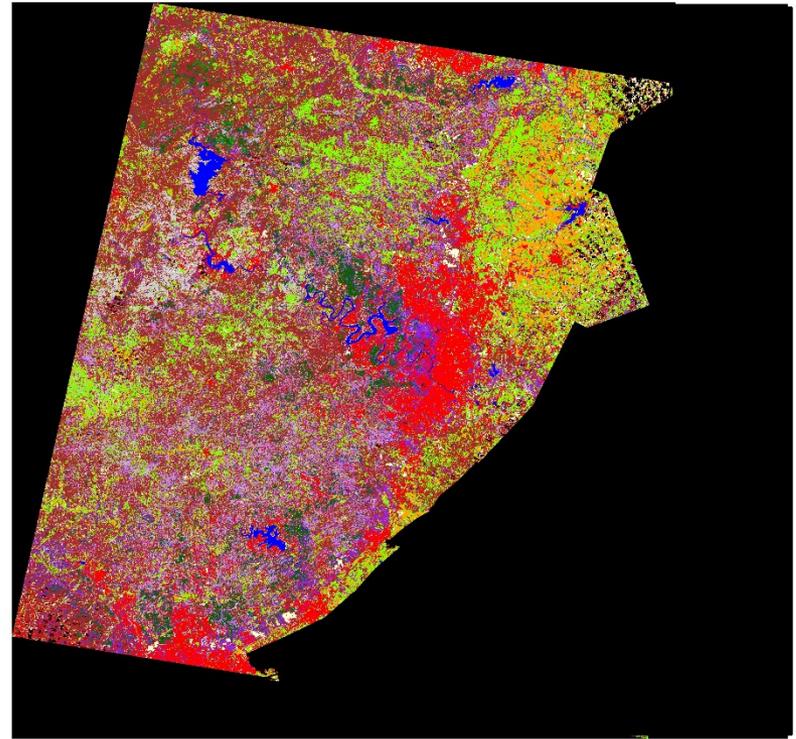
2004-05 Land Classification

- Unclassified
- Water
- Urban
- Barren
- Deciduous
- Evergreen
- Mixed
- Shrub
- LQ Deciduous
- LQ Mixed
- Grass
- Agriculture





Classification 2014-15



0 15 30 60 Kilometers



2014-15 Land Classification

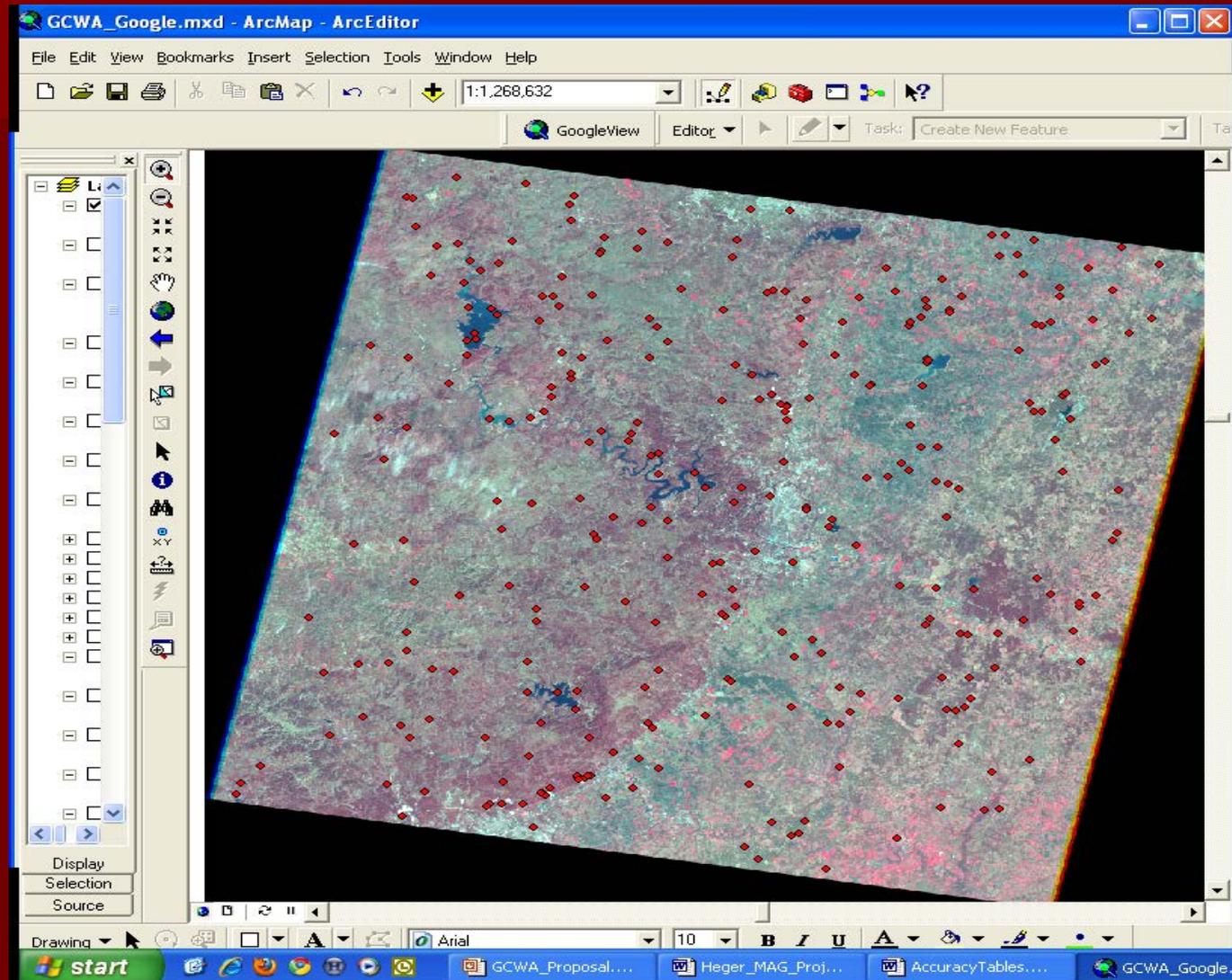
-  Unclassified
-  Water
-  Urban
-  Barren
-  Deciduous
-  Evergreen
-  Mixed
-  Shrub
-  LQ Deciduous
-  LQ Mixed
-  Grass
-  Agriculture



Accuracy Assessment

Stratified Random Points

- Overall Accuracy
84 %-
87%;
Kappa
82%-
85%





Habitat Modeling

- Model based on Diamond (2007) model C
- Includes both landscape context and edge effects
- Diamond's model weighted evergreen or evergreen in close proximity to mixed or deciduous higher than other land classes
- Weighted denser forests
- Penalizes areas near edges



Diamond's Model C

Recoding

- Evergreen forest = 1
- Deciduous or mixed forest within 100m of evergreen = 1
- Code everything else 0

Landscape context and edge effects

- % forest within a circle of radius 200m ranked as follows:
 - 0 (worst 0-20% forest)
 - 1 (20-40% forest)
 - 2 (40-60% forest)
 - 3 (60-80% forest)
 - 4 (best 80-100% forest)
- subtract 1 if area is <50m from an edge



Our Models - Recoding

Evergreen and mixed-based model

- mixed or evergreen forest = 1
- deciduous forest within 100m of mixed or evergreen = 1
- everything else = 0

Landscape context and edge effects

- % forest within a circle of radius 7 cells (210m) ranked as follows:
 - 0 (worst 0-20% forest)
 - 1 (20-40% forest)
 - 2 (40-60% forest)
 - 3 (60-80% forest)
 - 4 (best 80-100% forest)
- subtract 1 if area is <100m from an edge



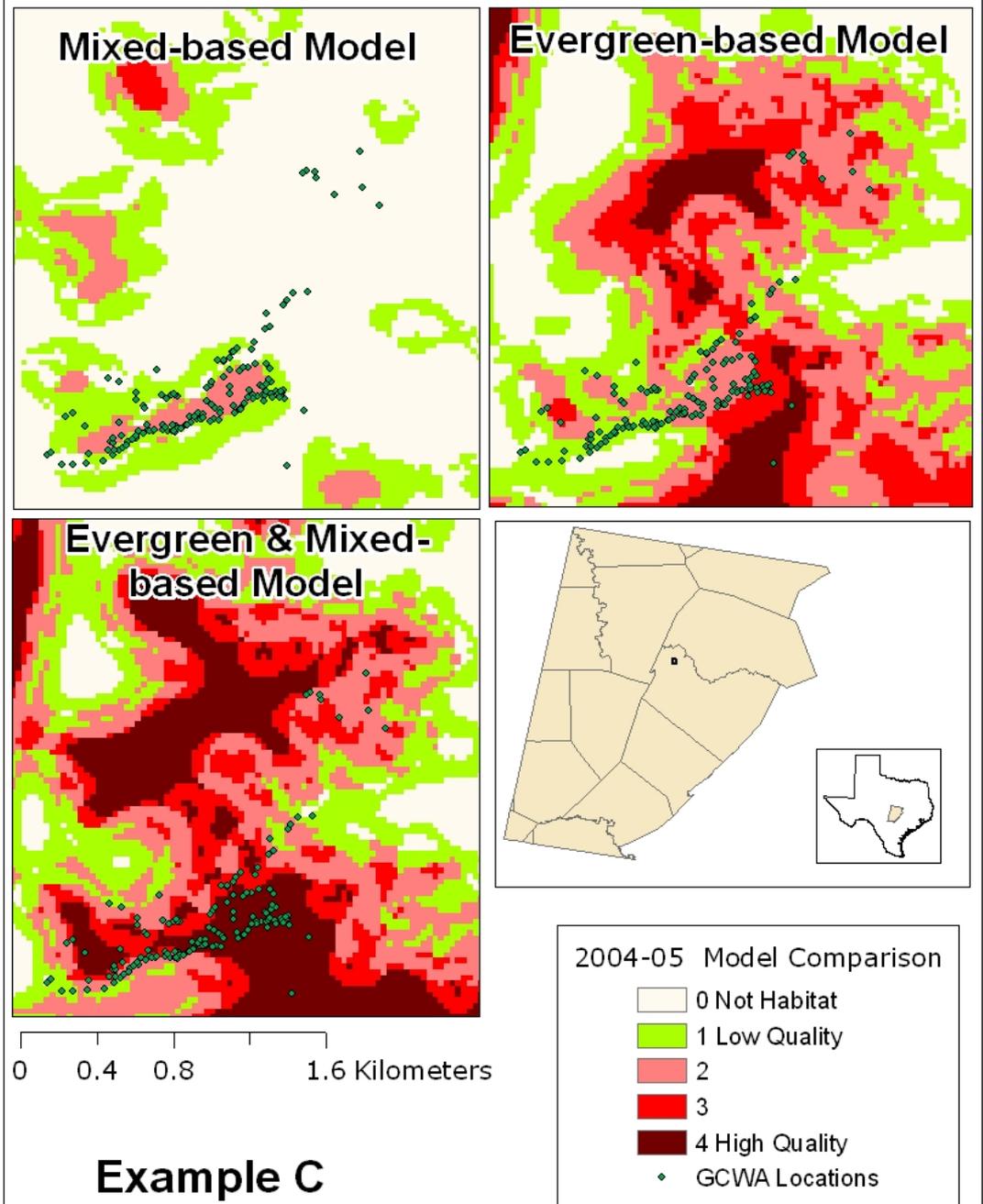
Model Evaluation

- Model predictions were compared to USFWS GCWA data
- Accuracy assessment
- Interesting trends seen while assessing classification accuracy...

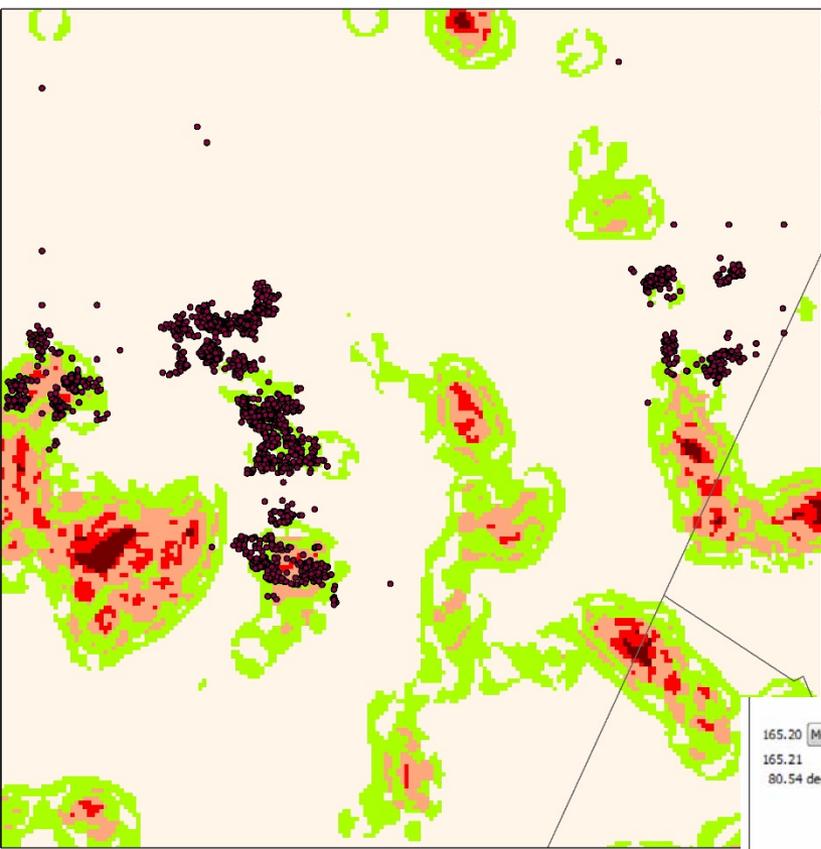


Evergreen & Mixed-based model deemed best in our last study

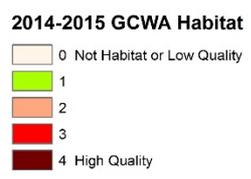
Researchers need to indicate whether their evergreen category includes live oak or not



WA Sites 014-15

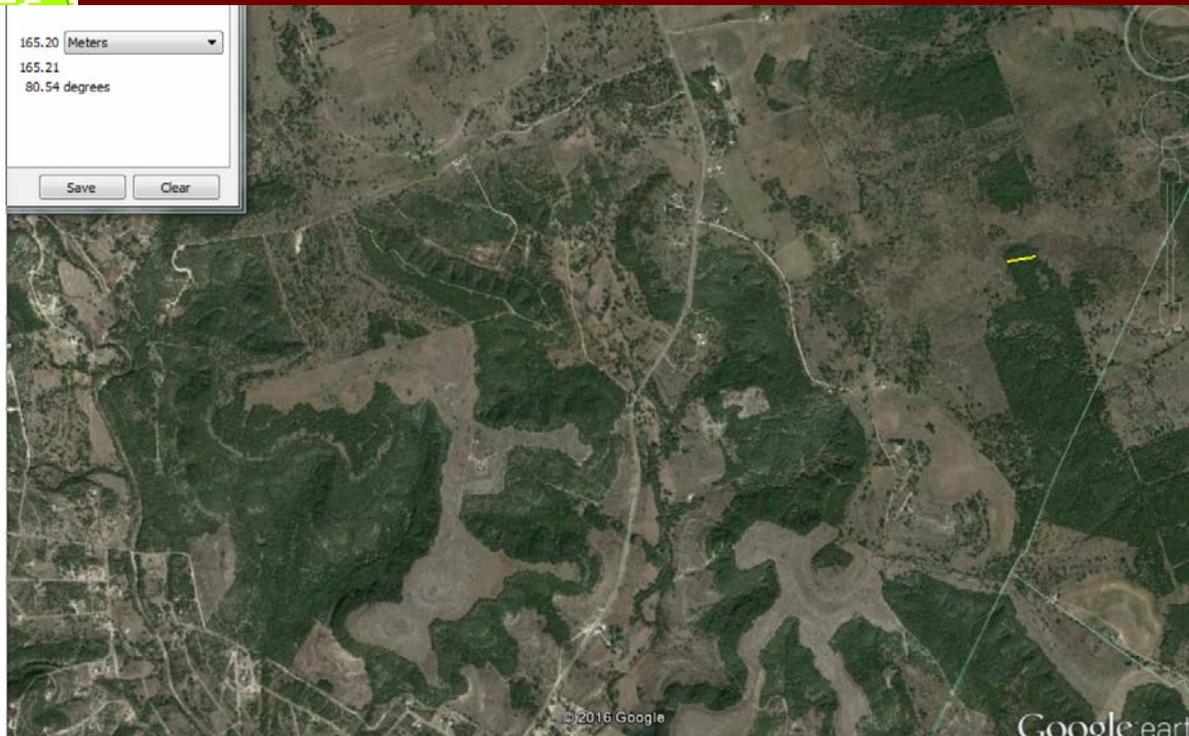


0.125 0.5 Kilometers



165.20 Meters
165.21
80.54 degrees

Save Clear

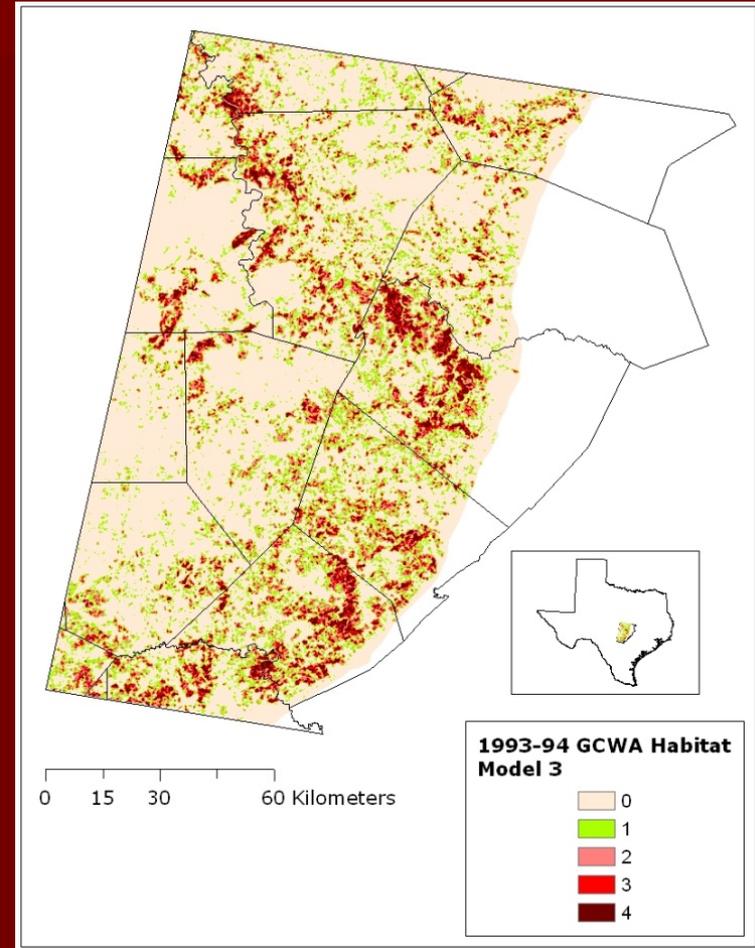
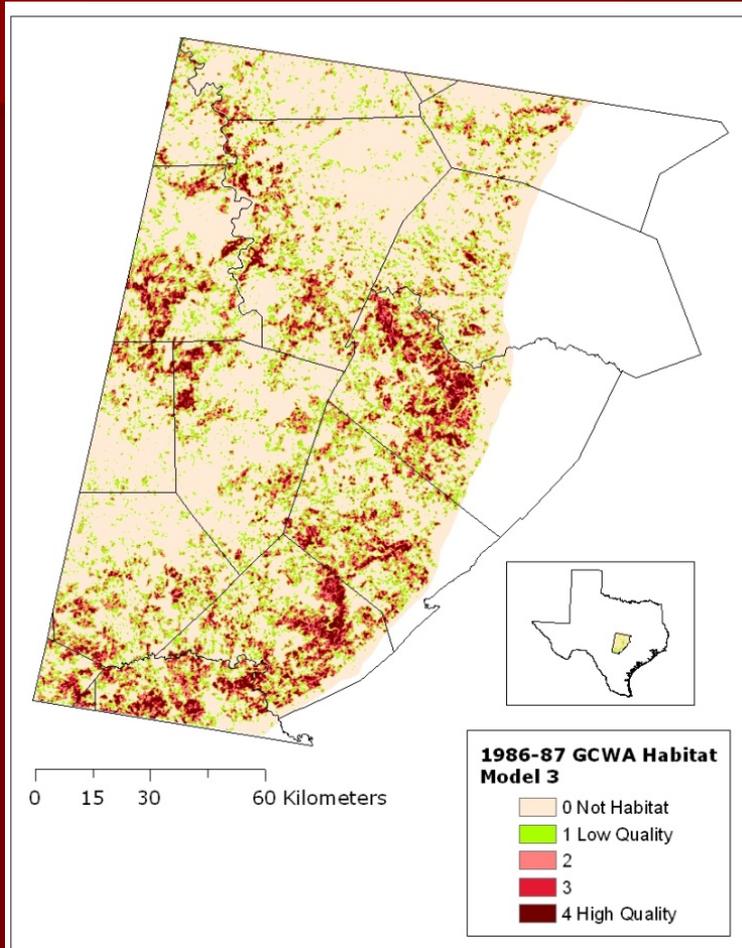




Assessing Change

1. Overall percent of each class
2. Change between decades assessed by rank differences (-4 to +4)
 - Positive indicates gains
 - Negative indicates losses

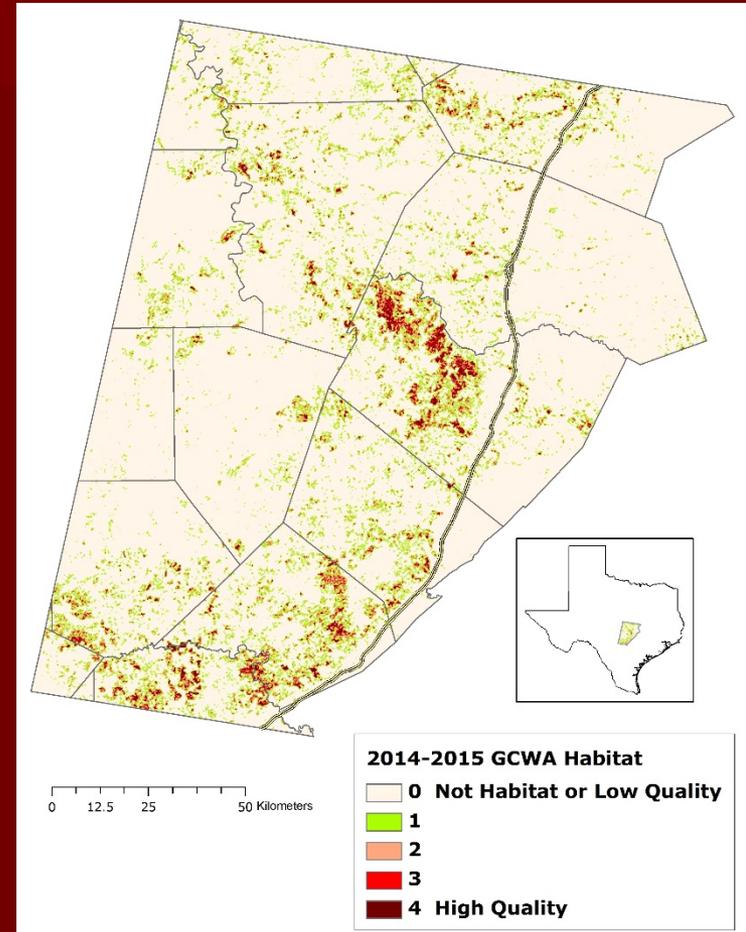
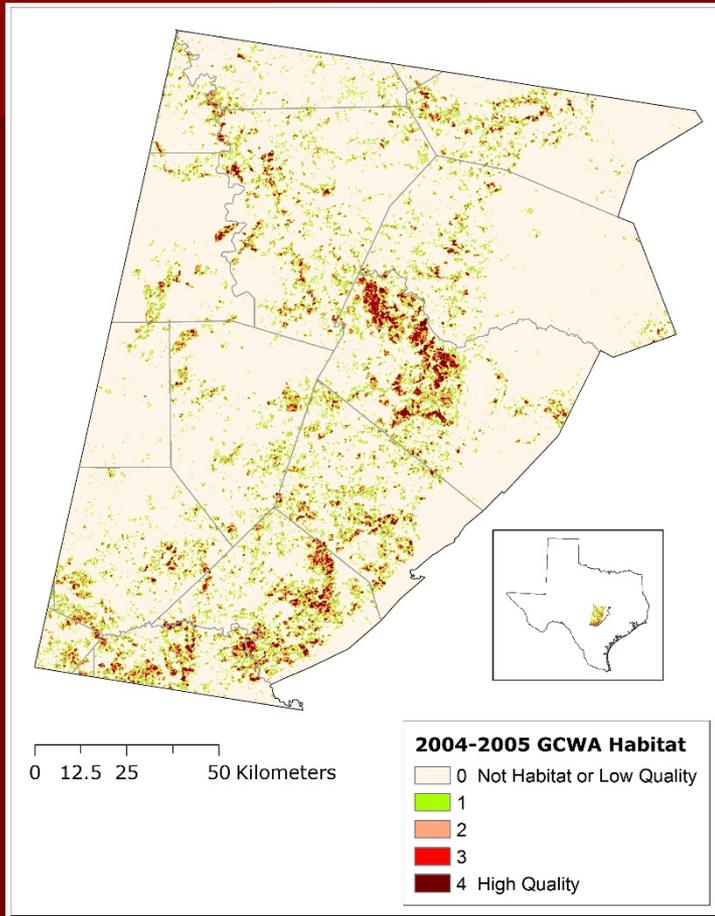
Model Results: Habitat Quality



Red and Dark red = best quality habitat



Model Results



Red and Dark red = best quality habitat



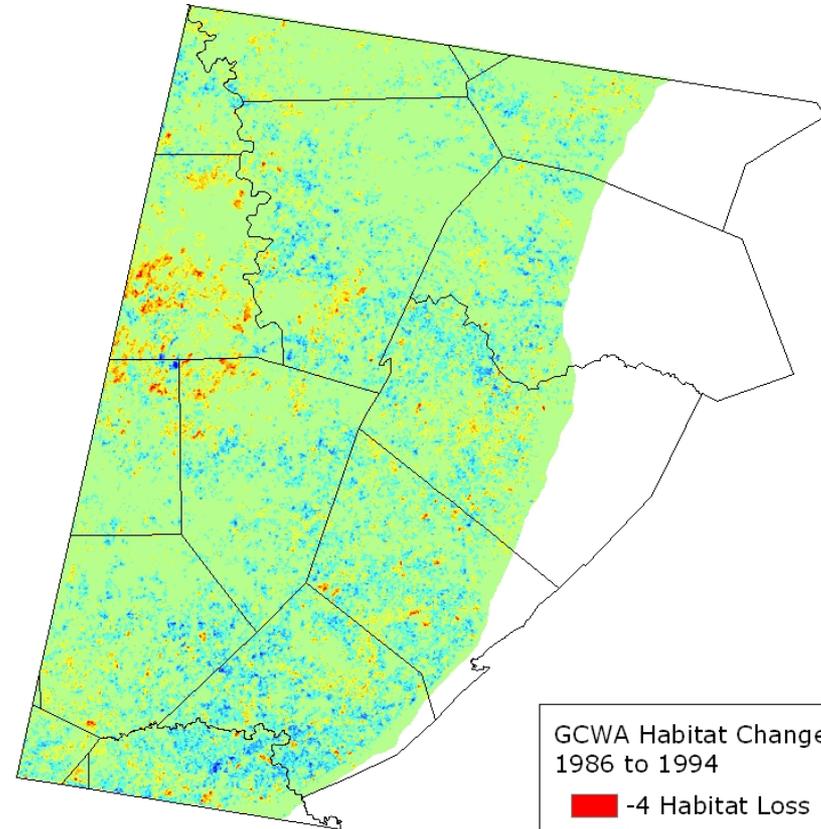
Percent Change

- Ranking differ significantly through time ($\chi^2 = 56.14$, $df = 8$, $P < 0.001$ for 1986 to 2005;
- $\chi^2 = 123.39$, $df = 4$, $P < 0.001$ for 2005 to 2015)
- Cell Adjusted standardized residuals indicate
 - No significant habitat changes between 1980s and 1990s, but there was between the 1990s and 2000s and again from 2000s to 2010s
 - Rank 0 increased from 1993-94 to 2004-05
 - Ranks 2, 3, & 4 decreased from 1993-94 to 2004-05
 - Likewise, this same trend continued from 2004-5 to 2014-15

Thus,

- Non-GCWA habitat increased through time
- Marginal to high quality GCWA habitat decreased through time

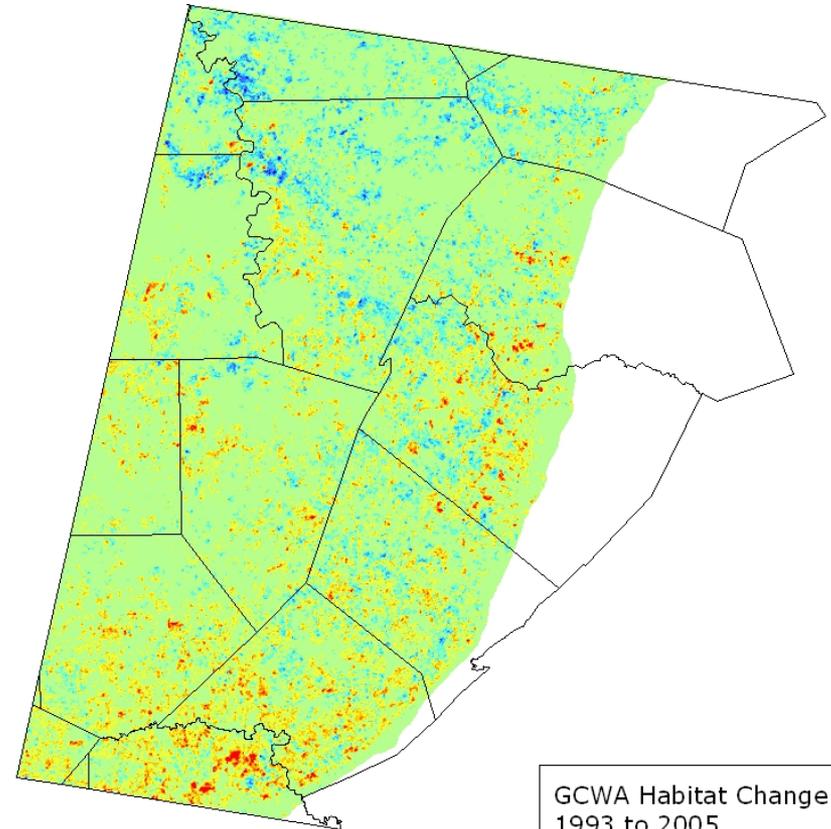
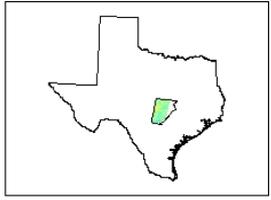
Change Between Decades



0 15 30 60 Kilometers

GCWA Habitat Change 1986 to 1994

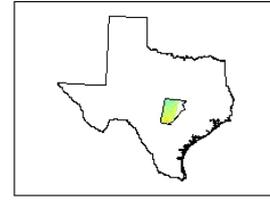
- 4 Habitat Loss
- 3
- 2
- 1
- 0
- 1
- 2
- 3
- 4 Habitat Gain



0 15 30 60 Kilometers

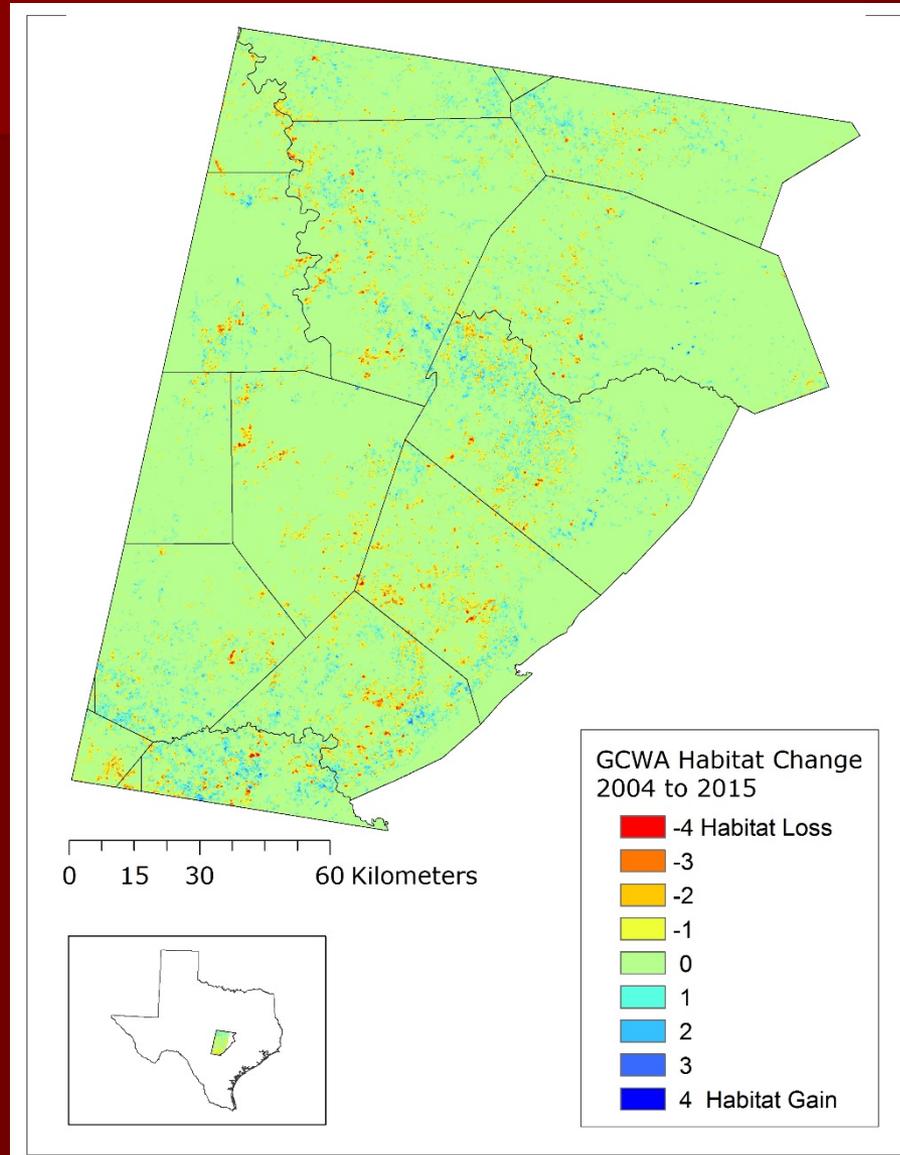
GCWA Habitat Change 1993 to 2005

- 4
- 3
- 2
- 1
- 0
- 1
- 2
- 3
- 4

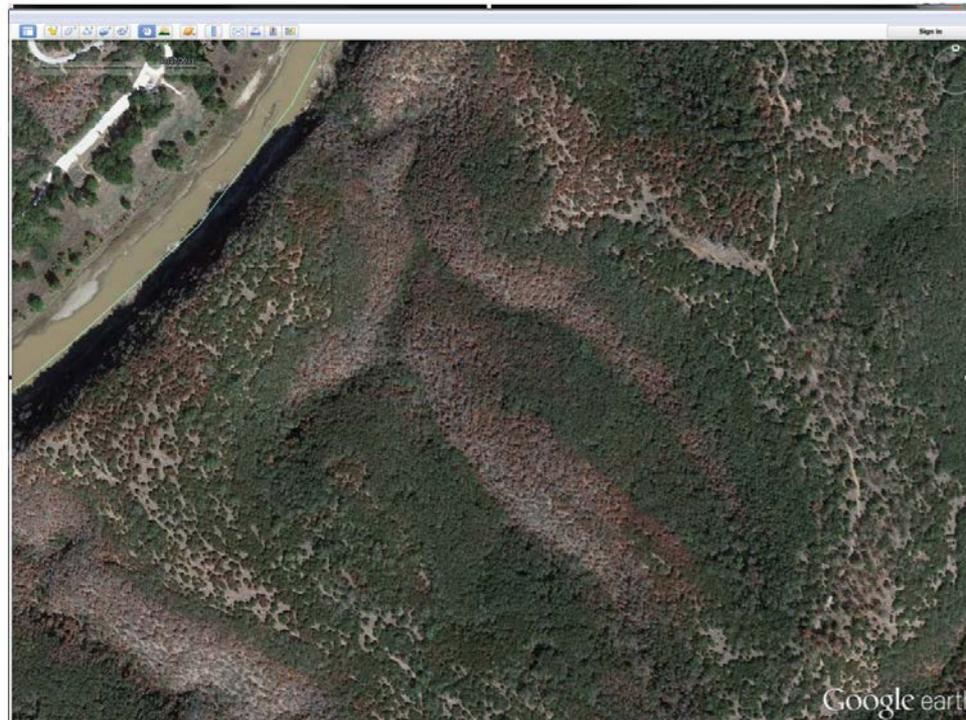
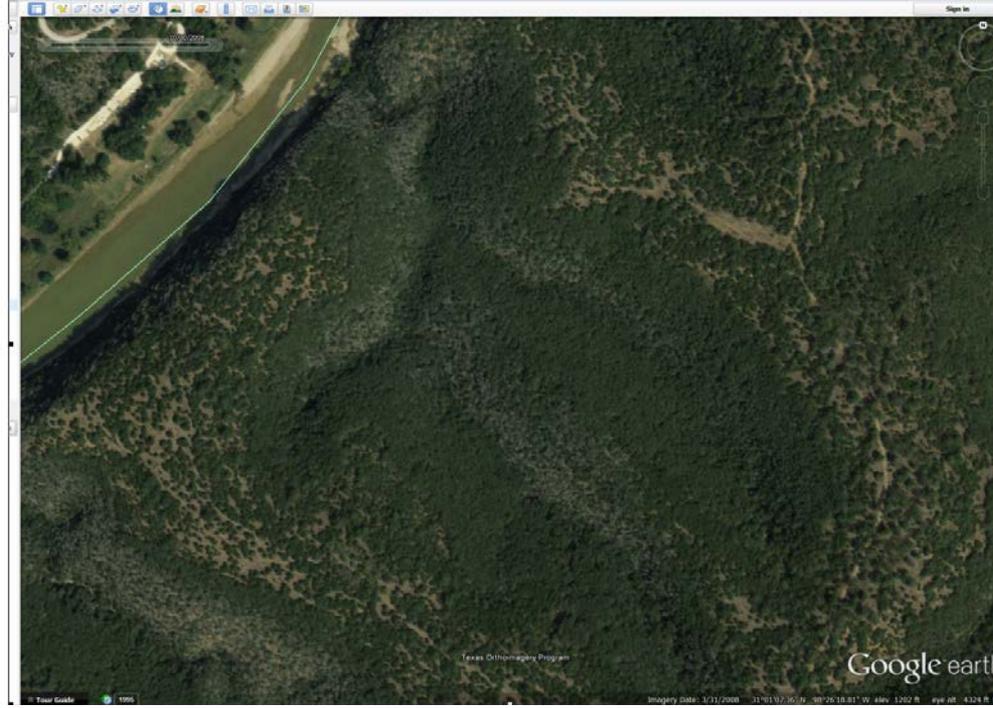




Change Between 2000s-2010s

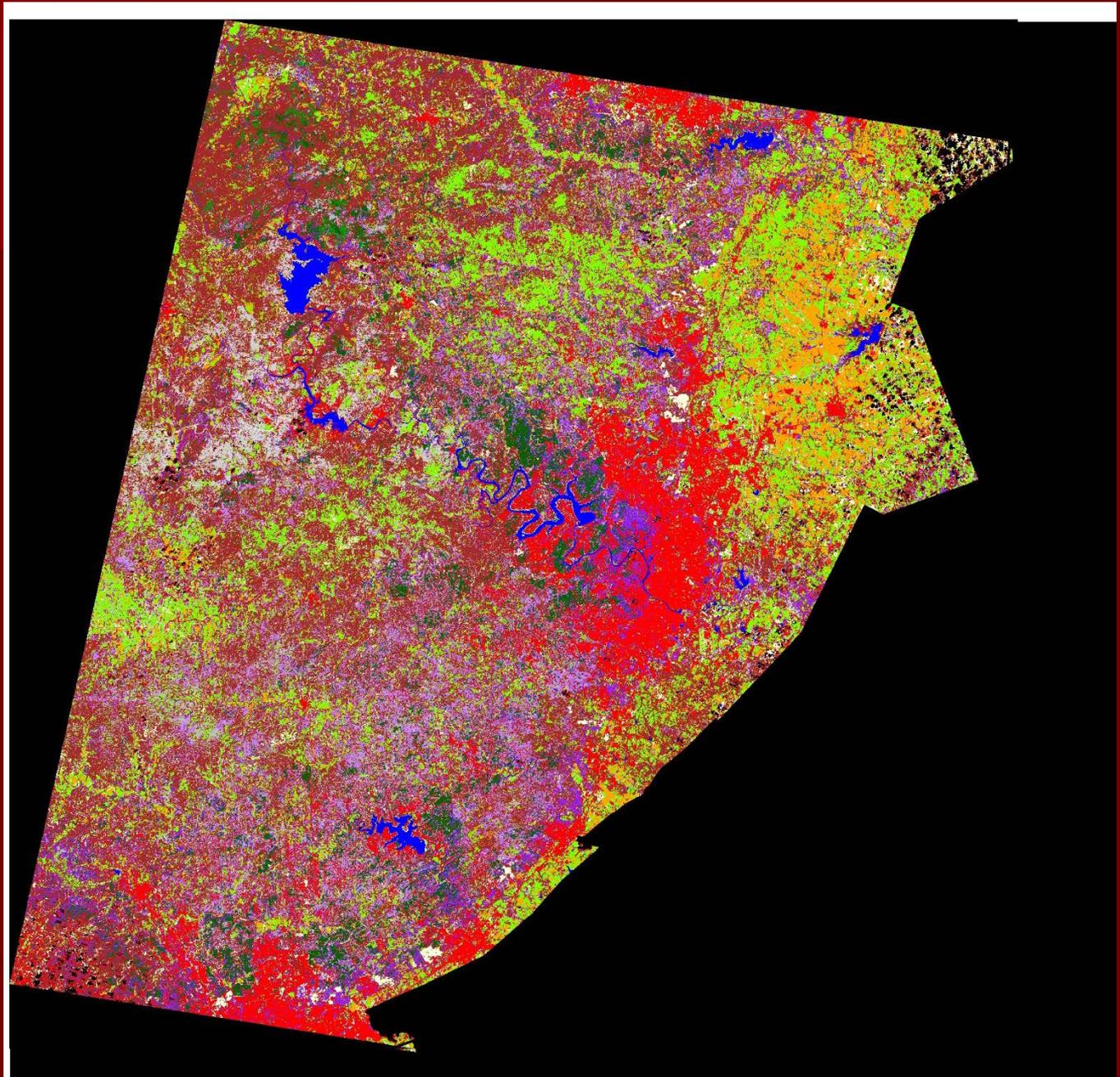


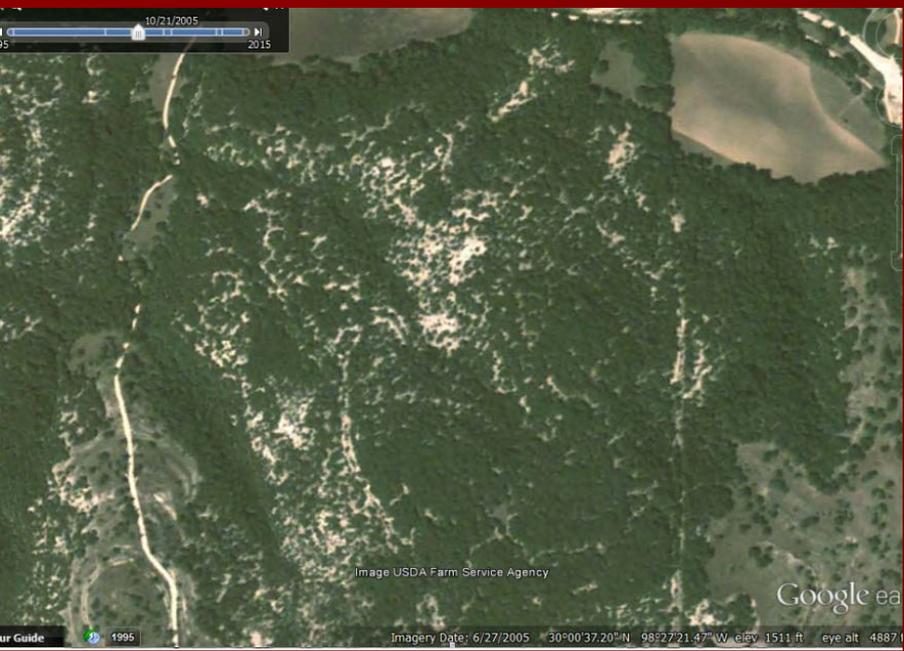
Oct 2010
Oct 2011 - Drought
Jan 2014



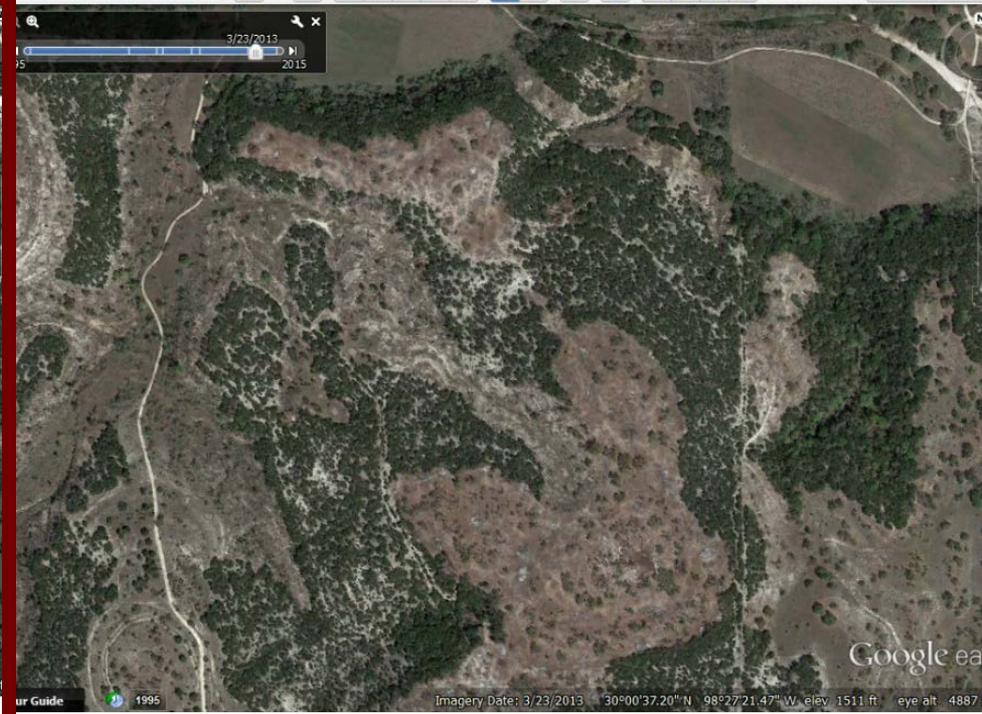
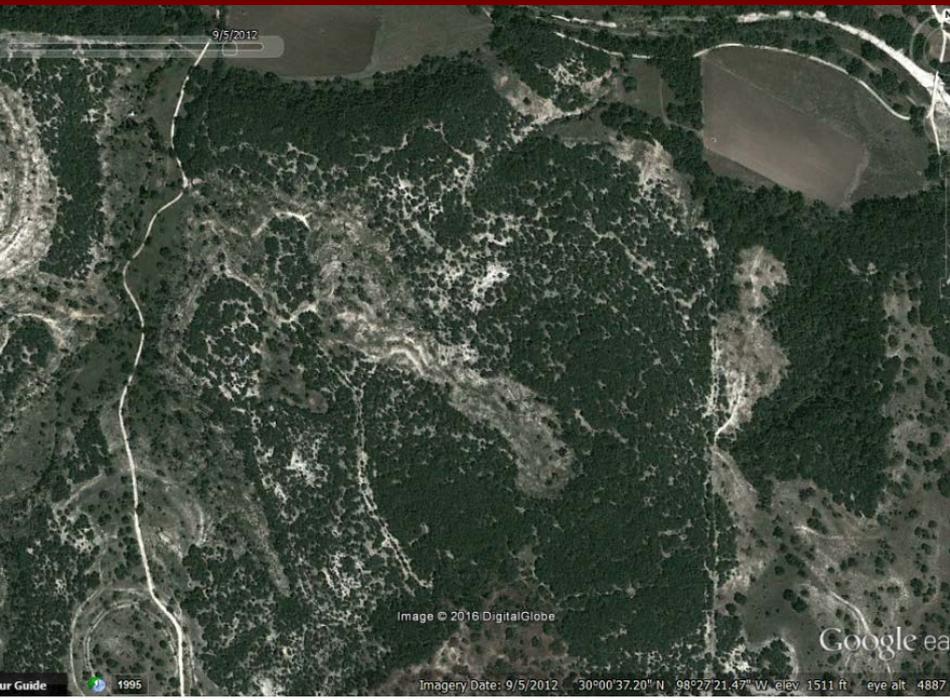


Drought-
killed
comes up as
shrubland in
classification





Oct 2005
Sept 2012
Mar 2013





Significance

- Information on gains and losses helps to
 - Access where to focus GCWA habitat restoration/preservation efforts
 - Access effectiveness of past management

- Protecting GCWA also
 - Protects others species
 - Protects the Edwards aquifer



Conclusions

- Losses in GCWA habitat have accelerated from 1993-94 to 2004-05 and also from 2004-5 to 2014-15
- Losses in higher quality GCWA habitat are seen most abundantly near the Austin-San Antonio I-35 corridor
- Losses are mitigated somewhat by the BCCP
- Even so, losses substantially exceed gains



Photo Sources

- Title slide Male GCWA – USFWS
- Austin Environmentalist – Kim Ludeke, TPWD
- Oak-Juniper woodland – TPWD, GIS Lab
- Lost Maples, Oak-Juniper – scilogis.com
- GoogleEarth



Questions?





Model References

- DeBoer, T. S. & Diamond, D. D. 2006. Predicting presence-absence of the endangered golden-cheeked warbler (*Dendroica chrysoparia*). *Southwestern Naturalist* 51:181-190.
- Diamond, D. D. 2007. Range-wide modeling of Golden-cheeked warbler habitat. Unpublished report to TPWD. Columbia, Missouri : University of Missouri.
- Loomis Austin. 2008. Mapping potential golden-cheeked warbler breeding habitat using remotely sensed forest canopy cover data. Report LAI Project No. 051001. Austin, TX: Loomis Austin.
- Magness, D. R., Wilkins, R. N. & Hejl, S. J. 2006. Quantitative relationships among golden-cheeked warbler occurrence and landscape size, composition, and structure. *Wildlife Society Bulletin* 34:473-479.

GCWA Photo source: U.S. Fish and Wildlife Service