# Evaluating Pest Risk in Cotton by Using Spatial Mapping Tools


**Amandah Reyes[1], Michael Brewer[2], Darwin J. Anderson[2], Alby L. Cartwright[2], and Jonda Halcomb[1]**

**[1]Del Mar College, Corpus Christi, TX, [2]Texas A&M AgriLife Research., Corpus Christi, TX**


## ABSTRACT


We established an initial pest risk model using ArcGIS spatial mapping tools and crop data layers from USDA NASS by relating crop system diversity (Shannon's Diversity Index [SDI]) to verde plant bug (*Creontiades signatus*) density observed in 21 south Texas cotton fields from 2010-2013. We used the relationship to estimate "expected risk" for verde plant bugs in a new set of 13 cotton fields sampled in 2014. The model's "expected risk" matched 6 of 13 observations (46%) 'spot on' on the first observation during bloom, and 9 of 13 observations (69%) 'spot on' during the second observation during late bloom. The match increased to 85% and 100% using a 'close' match criteria. Bloom is this time period when pest management decisions are made. The good overall match provided evidence that using spatial GIS tools with landscape analysis can assist in predicting pest risk potential and guide crop consultants to focus their efforts on the highest risk fields.


## VERDE PLANT BUG AND BOLLS DAMAGED

ADULT

PUNCTURE

STAIN

OPEN BOLL DAMAGE

## INTRODUCTION

The verde plant bug is a relatively new insect pest of cotton grown along the Texas Gulf Coast (Armstrong, et al, 2013). Yield losses caused by this pest occur from the abortion of small fruit (squares & bolls) and damage to the bolls that remain on the crop. Where should pest managers look for this pest and focus their pest management resources in a large production area like south Texas, where 300,000 to 500,000 acres of cotton are grown annually? Mapping and landscape analysis tools are available that may be able to address this question.

Here we show the results of an updated working pest risk model for the verde plant bug in cotton using the relationship between a crop landscape variable (Shannon's Diversity Index) and verde plant bug densities (Obj.1). We conducted a validation exercise of the model using 13 new cotton fields in 2014 by comparing the "expected risk" generated by the model to the "observed risk" recorded in the field (Obj.2).

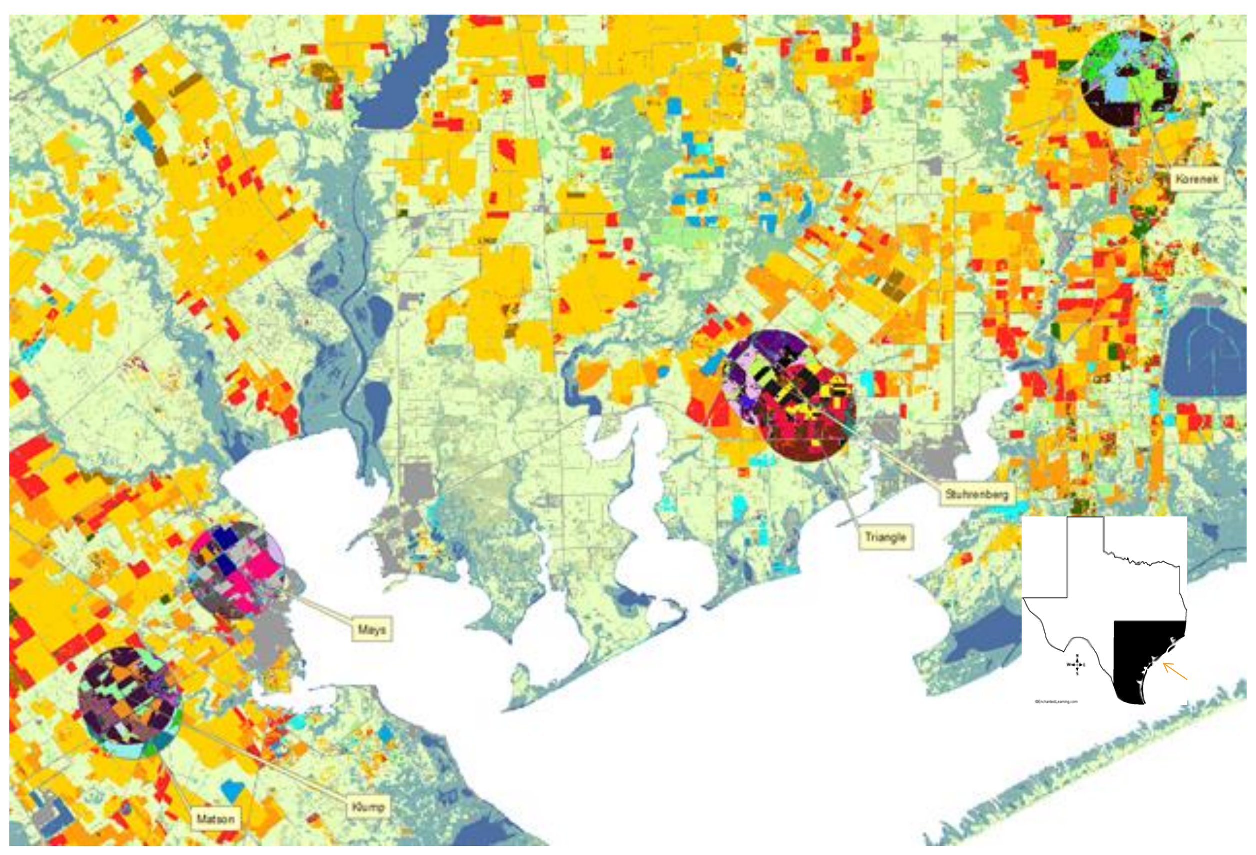

Fig. 2. Buffers of 28 sq. km. surrounding 6 fields sampled in 2013. These fields were included in the calculations of landscape metrics collected for the linear regression model in Table 1.

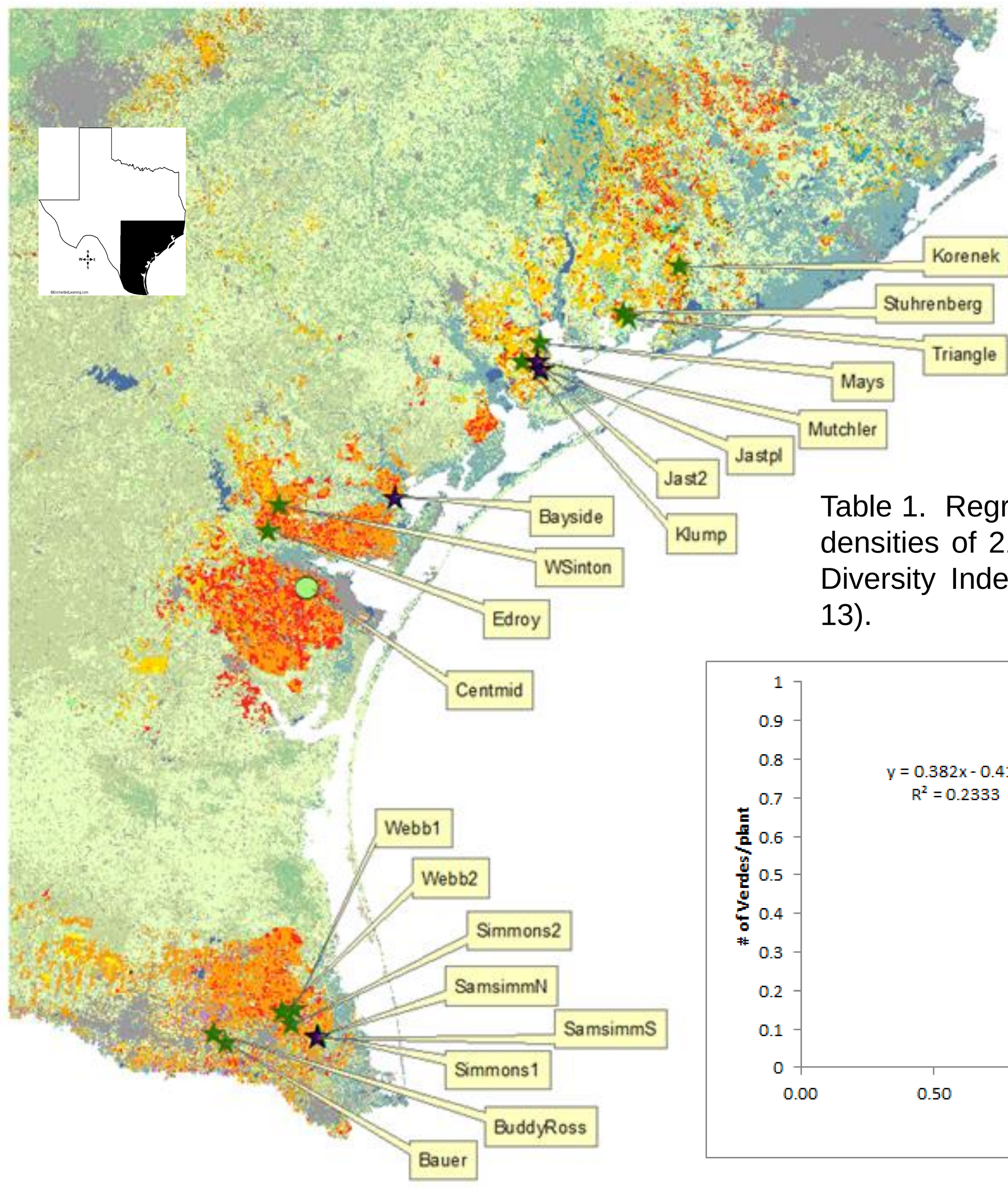





Fig. 1. Geographic locations of 21 fields sampled along the Texas gulf coast for the verde plant bug during 2010-13, resulting in data used for regression in Table 1.

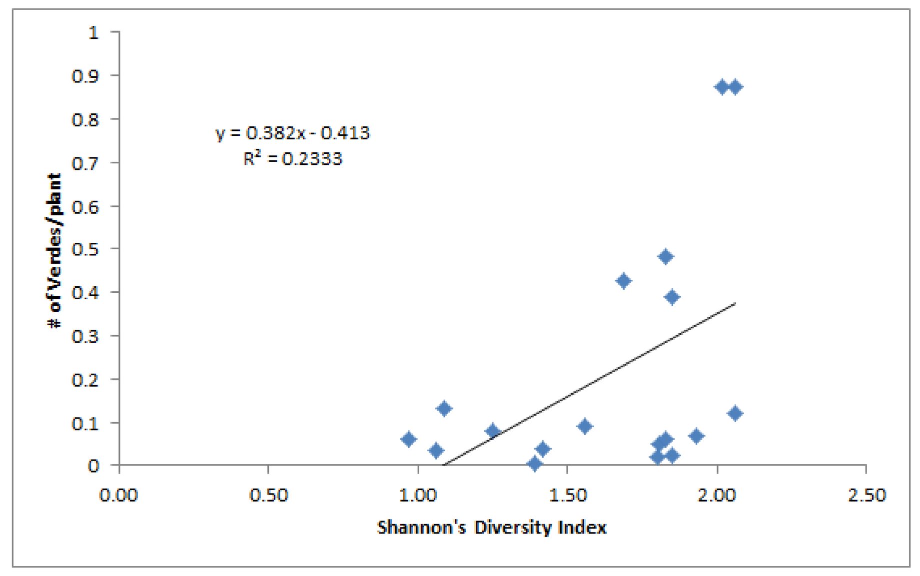



Table 1. Regression analysis of verde plant bug densities of 21 cotton fields and the Shannon's Diversity Index of a 28 sq. km. buffers (2010-13).

## EXPERIMENTAL APPROACH

**OBJECTIVE 1:** To develop a pest risk model by using regression analysis of verde plant bug densities against Shannon's Diversity Index of a 28 sq.km. circular buffer from 21 fields sampled 2010-2013.

**OBJECTIVE 2:** To conduct a validation test of the pest risk model by applying "expected risk" results from the pest risk model to observations from 13 new fields sampled in 2014.

**Initial Study Model:** A regression analysis was conducted (Table 1) regressing verde plant bug densities of 21 cotton fields along the Texas Gulf Coast (Fig 1) over a four-year period (2010-2013) (y-axis) against Shannon's Diversity Index (SDI) (x-axis). The SDI was calculated from 28 sq.km. circular buffers cut from a USDA (Cropscape) crop data layer that corresponds to the year and location where the verde plant bug density data was taken (Fig. 2). The verde plant bug density (insects per plant) was calculated from a field sample taken during early to peak bloom from a minimum of 200 plants per location (Brewer et al. 2013). The SDI was calculated using the FRAGSTAT function of ArcMap 10 centered upon the field location. The detailed methodology can be found at http://ccag.tamu.edu/files/2013/01/Pruter-2013-Beltwide-Poster.pdf). The resulting regression was y (verde plant bug per plant) = 0.382x (SDI) – 0.413 ($R^2$ of 0.23) (Table 1).

**Validation of initial model:** To conduct a validation of this pest risk model, a total of 13 new fields were selected from the Coastal Bend region of the Texas Gulf Coast during 2014. The FRAGSTAT function of ArcMap 10 was used to calculate the SDI for a 28 sq. km. circular buffer placed at the middle of the field site for the selected Cropscape crop data layer, base year 2014. The SDI for each new sampling site was substituted for "x" in the linear regression to calculate an expected verde plant bug density for the site. The expected verde plant bug density was then categorized as low, moderate, or high risk based upon previous established thresholds for verde plant bug density (Brewer et al. 2013). This formula designates a "LOW" risk as less than or equal to 0.11 verde per plant, a "MODERATE" risk as greater than 0.11 and less than 0.22 verde per plant, and "HIGH" risk as greater than or equal to 0.22 verde per plant (Table 2).

The 13 new fields (2014) were sampled three times (7 days apart) during bloom for verde plant bugs (200 plants sampled using the same beat bucket technique used before [Brewer et al. 2013) to generate an observed risk which was also categorized under the same criteria as the expected risk. A comparison was then made of the expected risk to the observed risk for each sampling date. Fields in which the two risks matched the same risk category were considered as "**SPOT ON**"; fields in which the expected and observed risk were off by only one risk category were considered as "**CLOSE**"; and fields in which the expected and observed risks differed by two categories (such as one high risk and the other low risk) were considered as "**WAY OFF**" (Table 2).

## RESULTS & DISCUSSION

- 85% of the risk estimates were "spot on" or "closer" during the first observation date. During the second and third observation dates, 100% of the risk estimates were "spot on" or "closer".
- In addition during the first observation, the model's "expected risk" never underestimated the field observations; an error to be avoided in field crop pest management.
- Insecticide decisions need to be made by peak bloom for verde plant bug (the first observation date here), so there is still room for improvement. But the good overall match provided evidence that using spatial GIS tools with landscape analysis can assist in predicting pest risk potential and guide crop consultants to focus their efforts on the highest risk fields.

**Next Steps:**

- Additional landscape metrics calculated with FRAGSTATS (such as mean distance to nearest cotton field, edge density), geographic data (distance from fresh and/or salt water sources, rangeland), and weather (rainfall, temperature) will be incorporated into the model using multiple regression techniques.

| LOCATION | | EXPECTED | | | VERDE PLANT BUG | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | FIRST OBSERVATION: Bloom 6/17-20/2014 | | | SECOND OBSERVATION: Late Bloom 6/26-27/2014 | | | THIRD OBSERVATION: Pre-harvest 7/1-3/2014 | | |
| FIELD NAME | REGION | SHANNONS DIVERSITY INDEX 1 $km^2$ | VERDE DENSITY EXPECTED (verdes/plt) | RISK EXPECTED[1] | Verdes per Plant | RISK | COMPARISON[2] of EXPECTED vs. OBSERVED RISK | Verdes per Plant | RISK | COMPARISON[2] of EXPECTED vs. OBSERVED RISK | Verdes per Plant | RISK | COMPARISON of EXPECTED vs. OBSERVED RISK |
| 1 | Coastal Bend | 1.58 | 0.191 | MODERATE | 0.01 | LOW | CLOSE | 0.13 | MODERATE | SPOT ON | 0.06 | LOW | CLOSE |
| 2 | Coastal Bend | 1.81 | 0.278 | HIGH | 0.04 | LOW | WAY OFF | 0.57 | HIGH | SPOT ON | 0.15 | MODERATE | CLOSE |
| 3 | Coastal Bend | 1.47 | 0.149 | MODERATE | 0.01 | LOW | CLOSE | 0.08 | LOW | CLOSE | 0.05 | LOW | CLOSE |
| 4 | Coastal Bend | 1.29 | 0.080 | LOW | 0.01 | LOW | SPOT ON | 0.10 | LOW | SPOT ON | 0.05 | LOW | SPOT ON |
| 5 | Coastal Bend | 1.54 | 0.175 | MODERATE | 0.02 | LOW | CLOSE | 0.03 | LOW | CLOSE | 0.06 | LOW | CLOSE |
| 6 | Coastal Bend | 1.29 | 0.080 | LOW | 0.06 | LOW | SPOT ON | 0.02 | LOW | SPOT ON | 0.05 | LOW | SPOT ON |
| 7 | Coastal Bend | 0.93 | -0.058 | LOW | 0.06 | LOW | SPOT ON | 0.04 | LOW | SPOT ON | 0.02 | LOW | SPOT ON |
| 8 | Coastal Bend | 1.58 | 0.191 | MODERATE | 0.04 | LOW | CLOSE | 0.20 | MODERATE | SPOT ON | 0.04 | LOW | CLOSE |
| 9 | Coastal Bend | 1.06 | -0.008 | LOW | 0.11 | LOW | SPOT ON | 0.07 | LOW | SPOT ON | 0.17 | MODERATE | CLOSE |
| 10 | Coastal Bend | 1.35 | 0.103 | LOW | 0.11 | LOW | SPOT ON | 0.07 | LOW | SPOT ON | 0.17 | MODERATE | CLOSE |
| 11 | Coastal Bend | 1.05 | -0.012 | LOW | 0.03 | LOW | SPOT ON | 0.07 | LOW | SPOT ON | 0.14 | MODERATE | CLOSE |
| 12 | Coastal Bend | 1.56 | 0.183 | MODERATE | 0.08 | LOW | CLOSE | 0.24 | HIGH | CLOSE | 0.20 | MODERATE | SPOT ON |
| 13 | Coastal Bend | 1.70 | 0.236 | HIGH | 0.02 | LOW | WAY OFF | 0.12 | MODERATE | CLOSE | 0.15 | MODERATE | CLOSE |

| [1] RISK CODE | RISK |
|---|---|
| If y is < or = 0.11 verdes/plt | Low |
| If y is 0.11 < y < 0.22 verdes/plt | Moderate |
| If y is > or = to 0.22 verdes/plt | High |

| [2] COMPARISON | Comparison is |
|---|---|
| If Risk Expected is = to Risk Observed | SPOT ON |
| If Risk Expectedis ≠ by factor of 1 Risk Observed | CLOSE |
| If Risk Expectedis ≠ by factor of 2 Risk Observed | WAY OFF |

Table 2. Comparison of expected and observed risk and boll damage for verde plant bug of 13 sampled cotton fields along the Texas Gulf coast (2014). Two of the fields that were "close" on the first sample date were "spot on" on the second sample date; one field that was "way off" on the first sample date was "spot on" on the second sample date. One field that was "way off" on the first sample date was "close" on the second sample data. One field that was "close" on the second and third sample date was "spot on" on the third sample date.

## REFERENCES


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Additional information of this material can be found at the AgriLife Research Entomology website: http://ccag.tamu.edu/entomology/.