

Inundation Analysis Using GIS and Hydrodynamic Modeling

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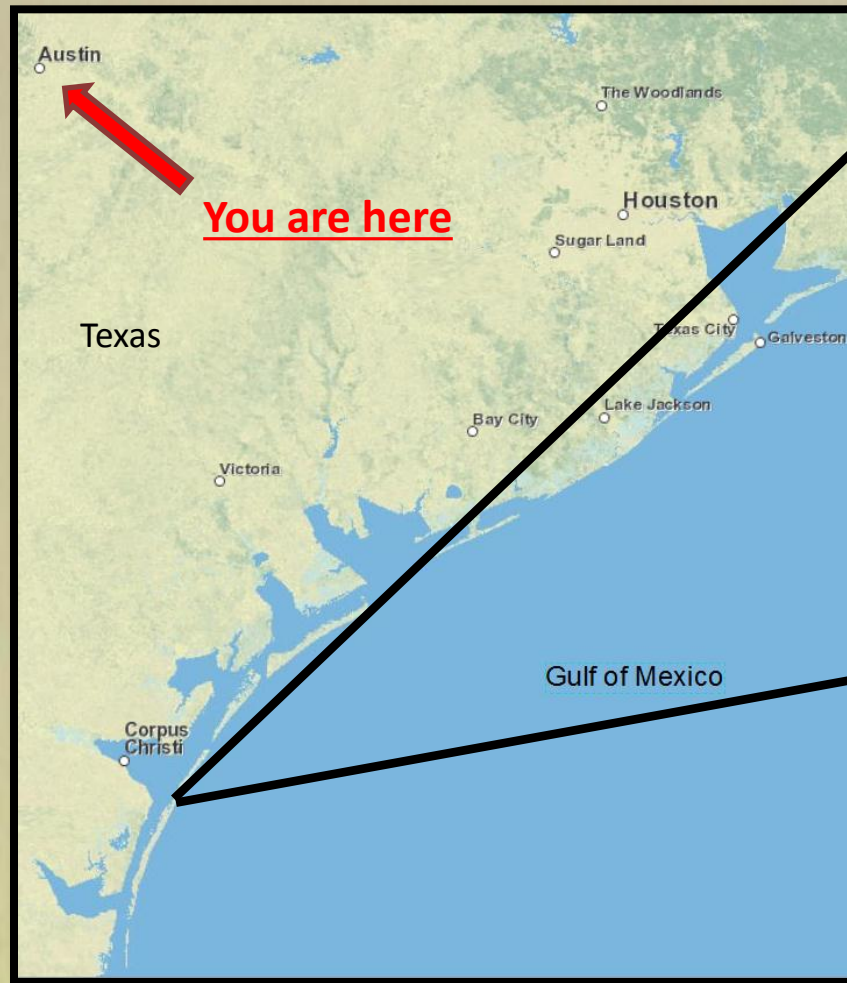
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Project Overview

- implement a hydrodynamic model (Coastal Modeling System - CMS) for the study area using available water level, wind and bathymetry data
- develop a methodology to quantify the accuracy of the model inundation predictions through the use of geospatial techniques (GPS, aerial and satellite imagery)
- if the model predicts inundation accurately, the method can be applied to predict present and future tidal flat inundation including shorebird habitat

Mollie Beattie and Packery Channel Area



Mollie Beattie Coastal Habitat Community is a tidal flats area located north of Packery Channel, off of TX 361 highway. This area was set aside by the Texas General Land Office for conservation of Piping Plover and other shorebirds. It serves as a great test area to see how well the Coastal Modeling System can predict flooding/drying due to the area's gradual elevation change.



**Friday
(1/27/12)**
flooding occurs
during a cold
front
(strong NW winds)



**Saturday
(1/28/12)**
the water
significantly
recedes

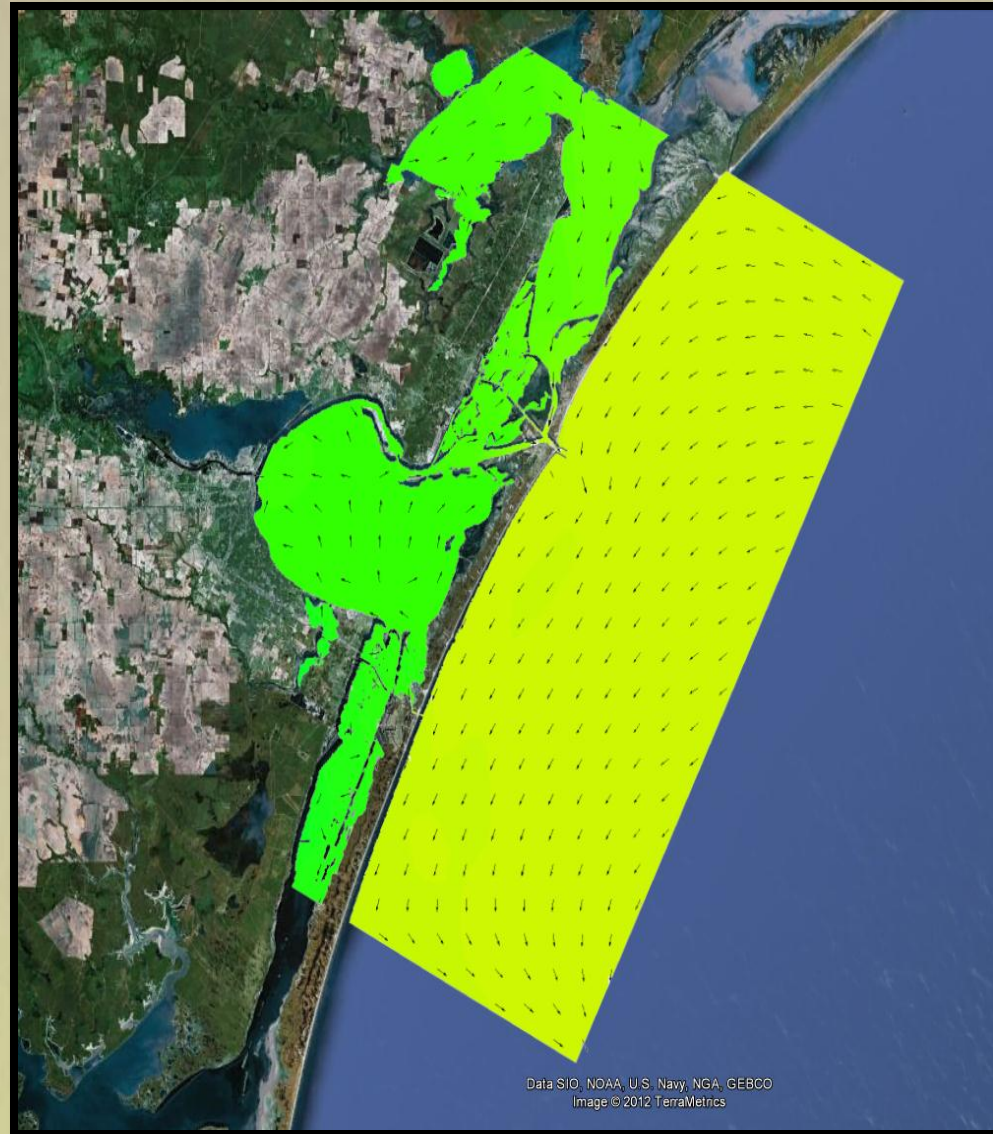


Data

- GPS elevation surveys to define the model's bathymetry
 - collected in respect to NAVD 88 and NAD 83 State Plane Texas South (January 2012)
 - additional elevation data acquired from the Packery Channel Monitoring Project
- Water level and wind data to define the model's forcings
 - acquired from the Texas Coastal Ocean Observation Network (TCOON)
- Aerial and Satellite Imagery
 - acquired from DigitalGlobe Inc., Texas Natural Resources Information System (TNRIS) and Lanmon Aerial Photography Inc.

Coastal Modeling System (CMS)

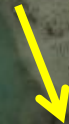
- hydrodynamic predictive model developed by the USACE, simulates water levels, currents, sediment transport and salinity
- previously implemented for the Coastal Bend, used to predict water levels
- provides vertical water level change in respect to a defined vertical datum
- provides prediction outputs with coordinates assigned to the centroid of each computation cell based on a defined horizontal reference frame



Bay Forcing



**Flooding / Drying
Analysis Area**



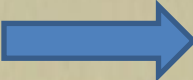
**Current
Meter**



Gulf Forcing



Model Simulation: July 2008

Model Input 

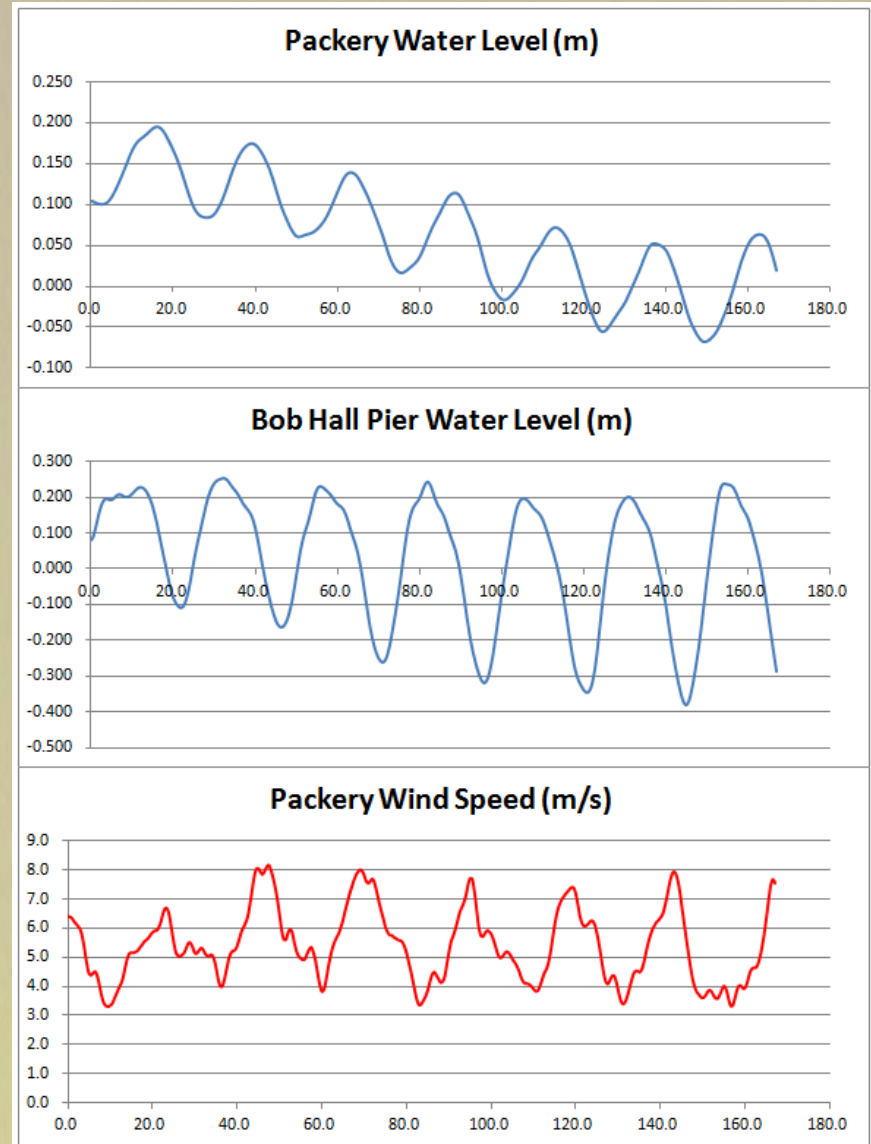
Simulation Info

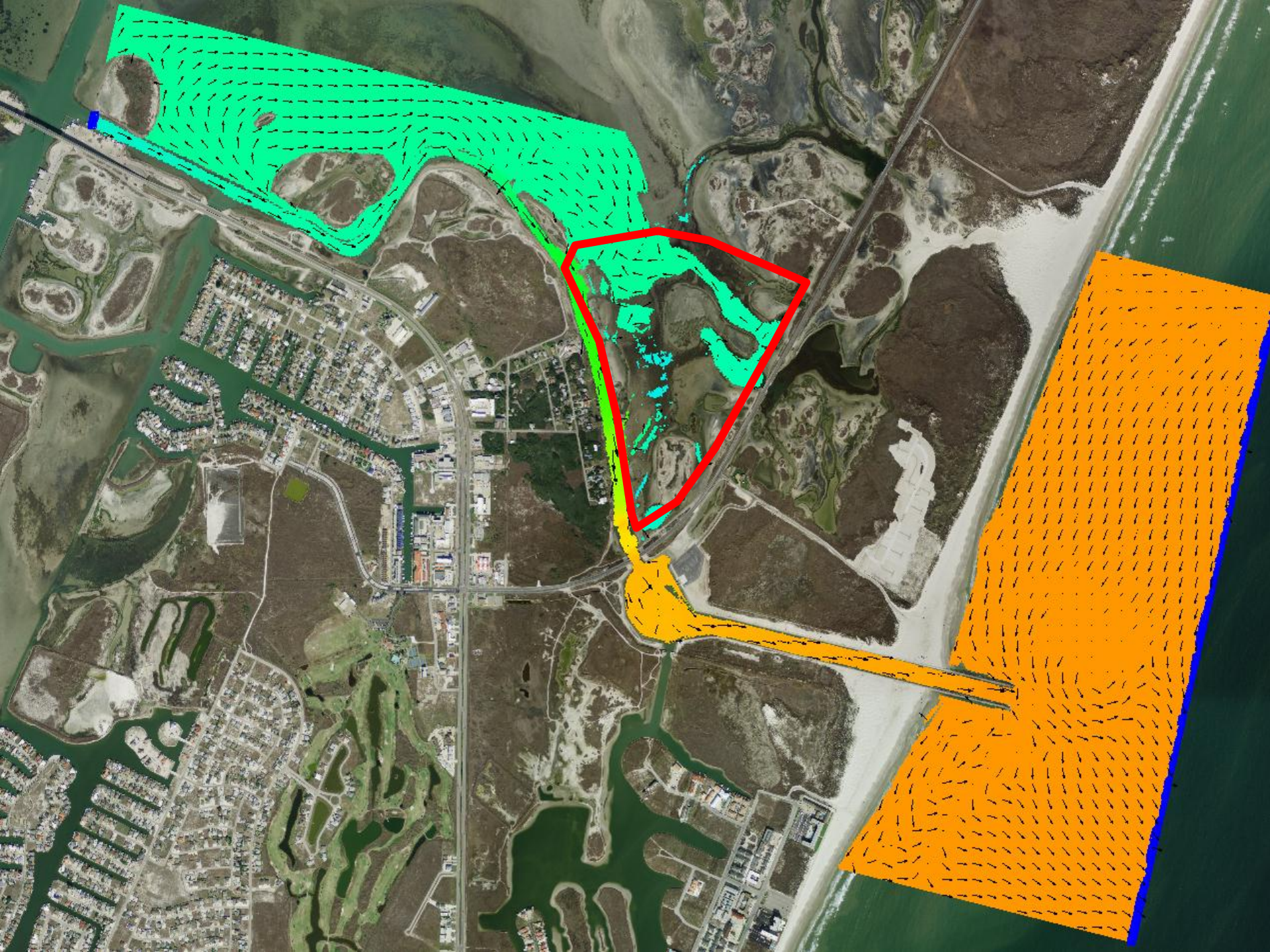
Run Date: 7/10/08 – 7/20/08

Simulation Time: 260 hours

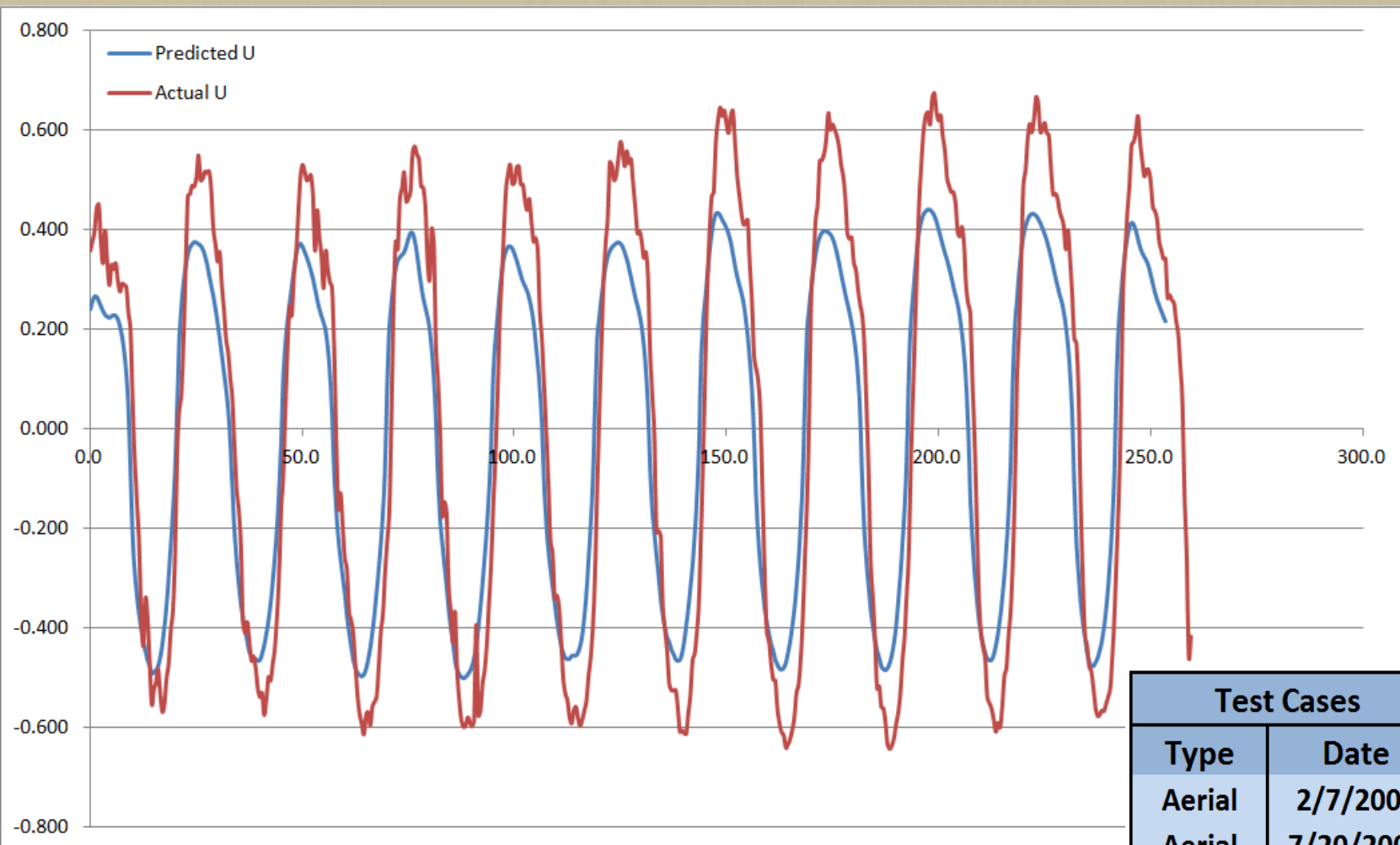
Image Taken: 6 pm on 7/20/08

Number of Cells: 377, 762



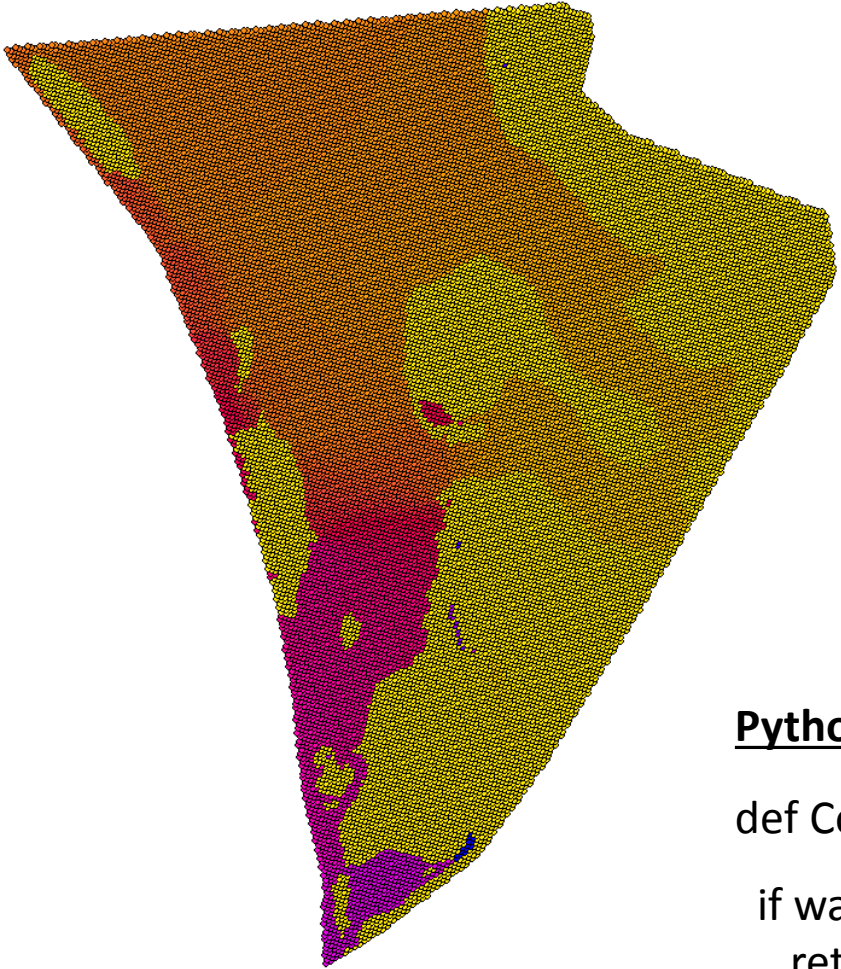


July 2008 - X Current Velocity Analysis



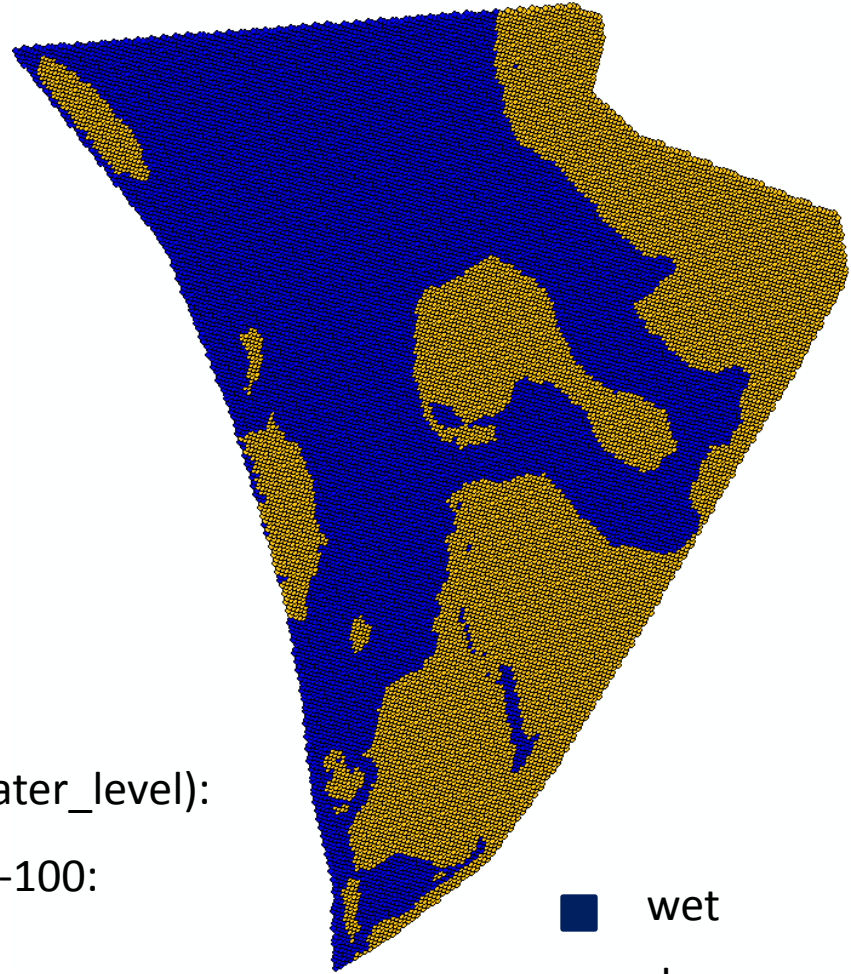
Test Cases		Vx
Type	Date	AAE (m/s)
Aerial	2/7/2008	0.181
Aerial	7/20/2008	0.155
Aerial	1/12/2009	0.198
Aerial	8/4/2009	0.156
Satellite	8/12/2012	0.088
GPS	12/20/2012	0.111

CMS Output to Binary (Wet/Dry)



Python Script

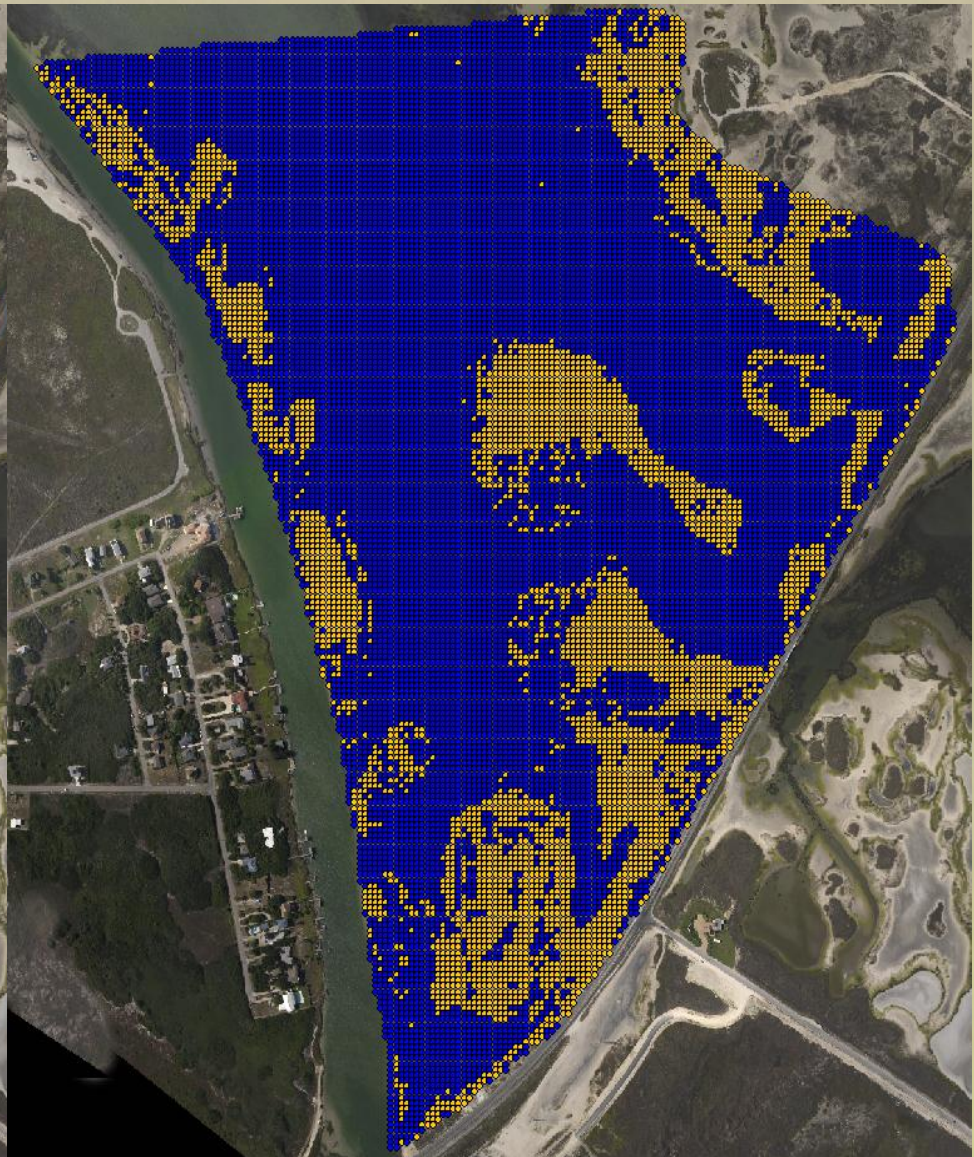
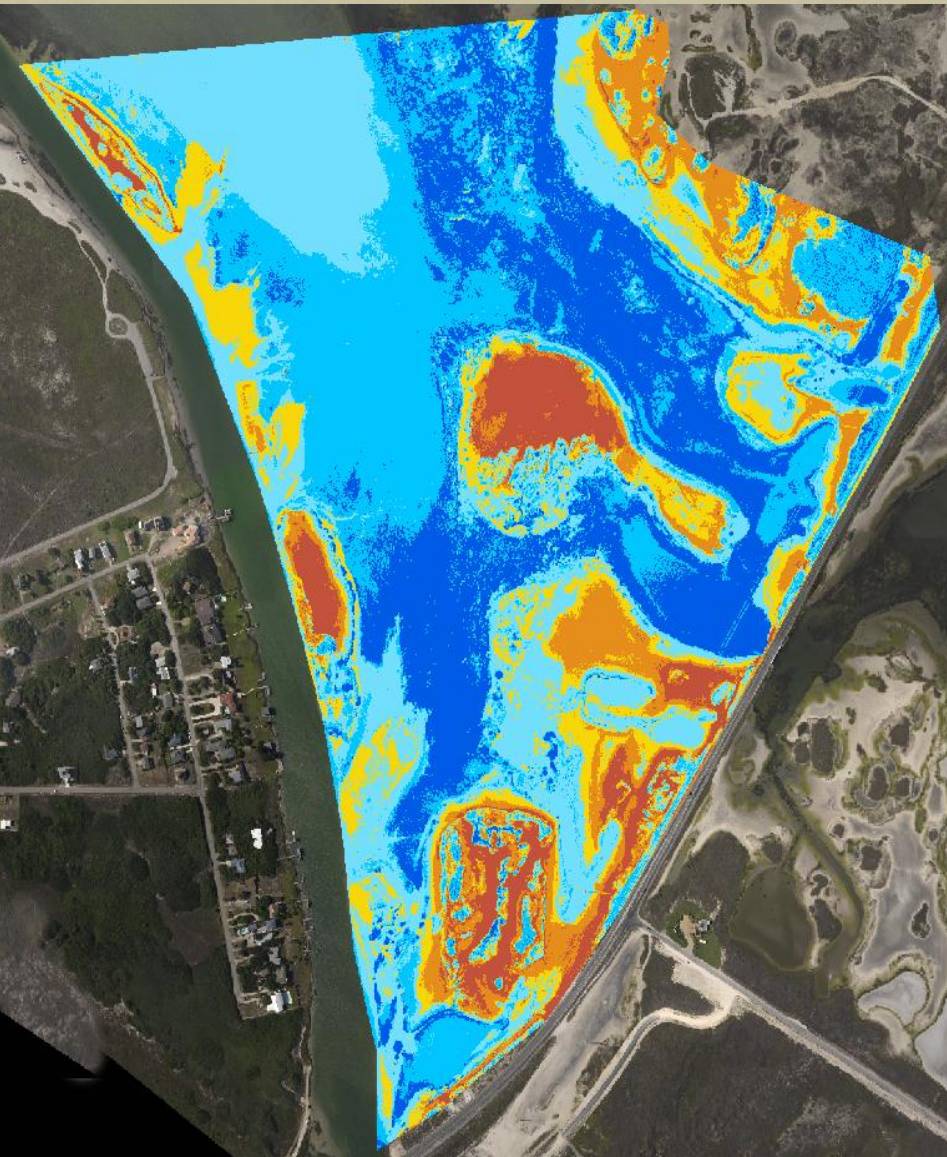
```
def Condition (water_level):  
    if water_level < -100:  
        return 0  
    else:  
        return 1
```



■ wet
■ dry

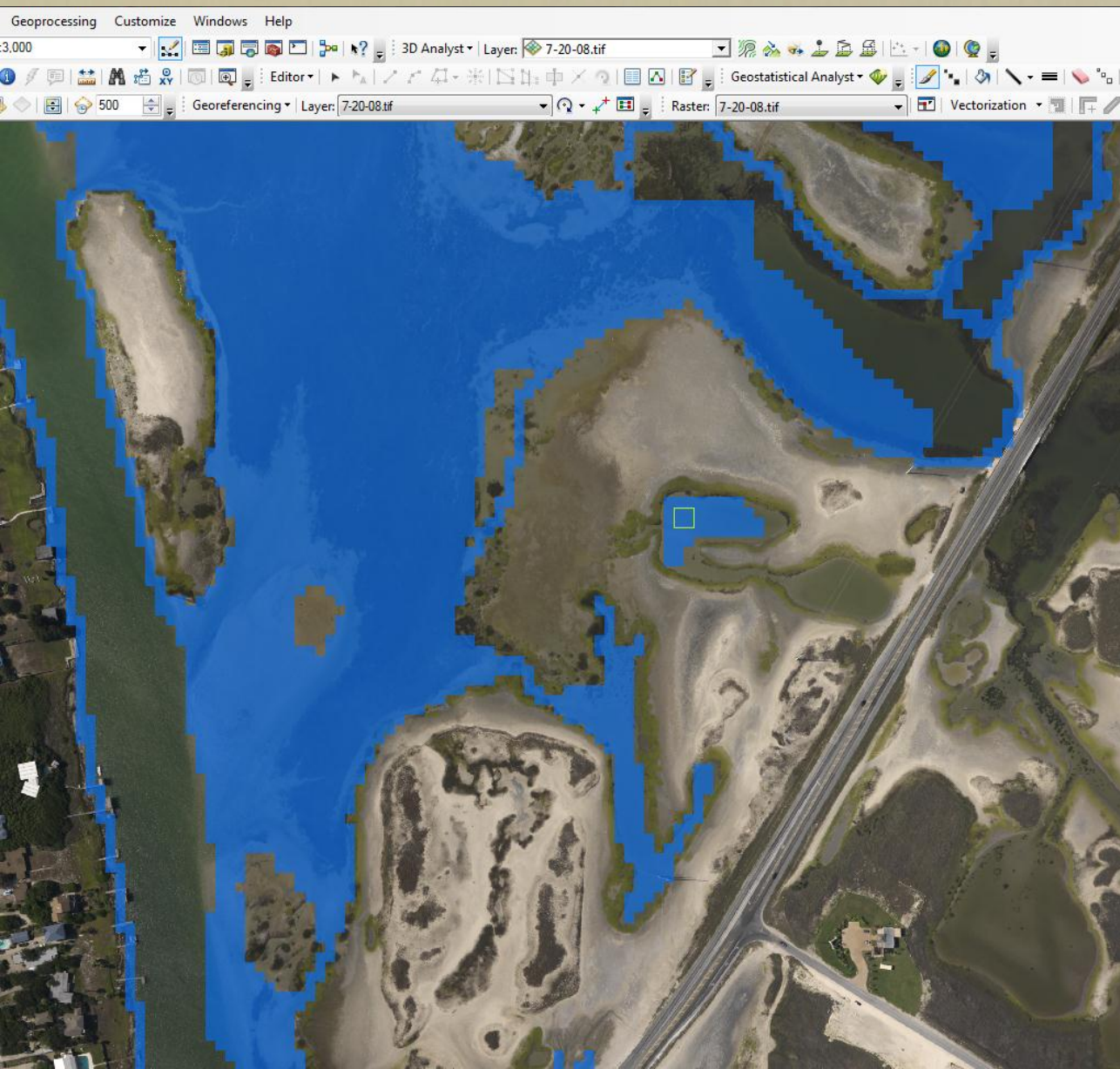
Aerial and Satellite Image Classification

Classification Tool (ArcMap)

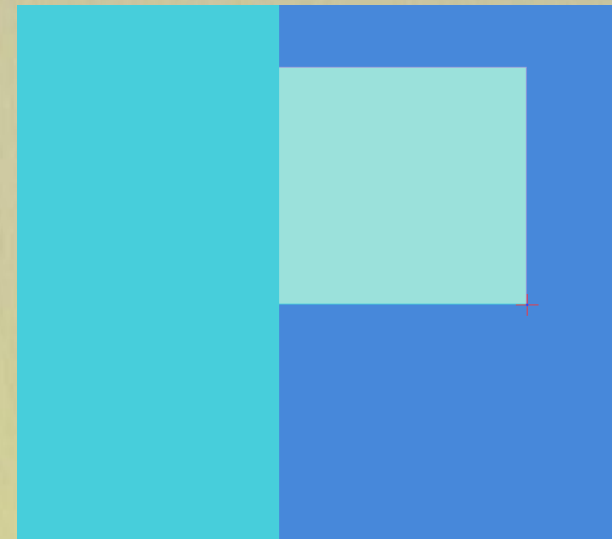
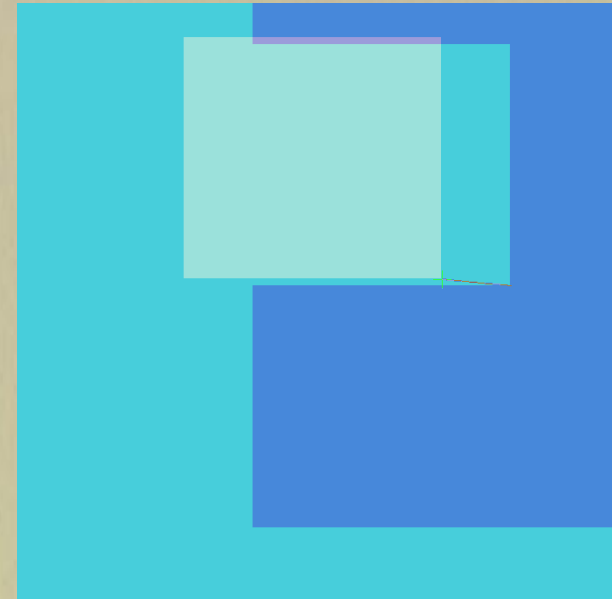


Manual Image Classification (ArcMap)

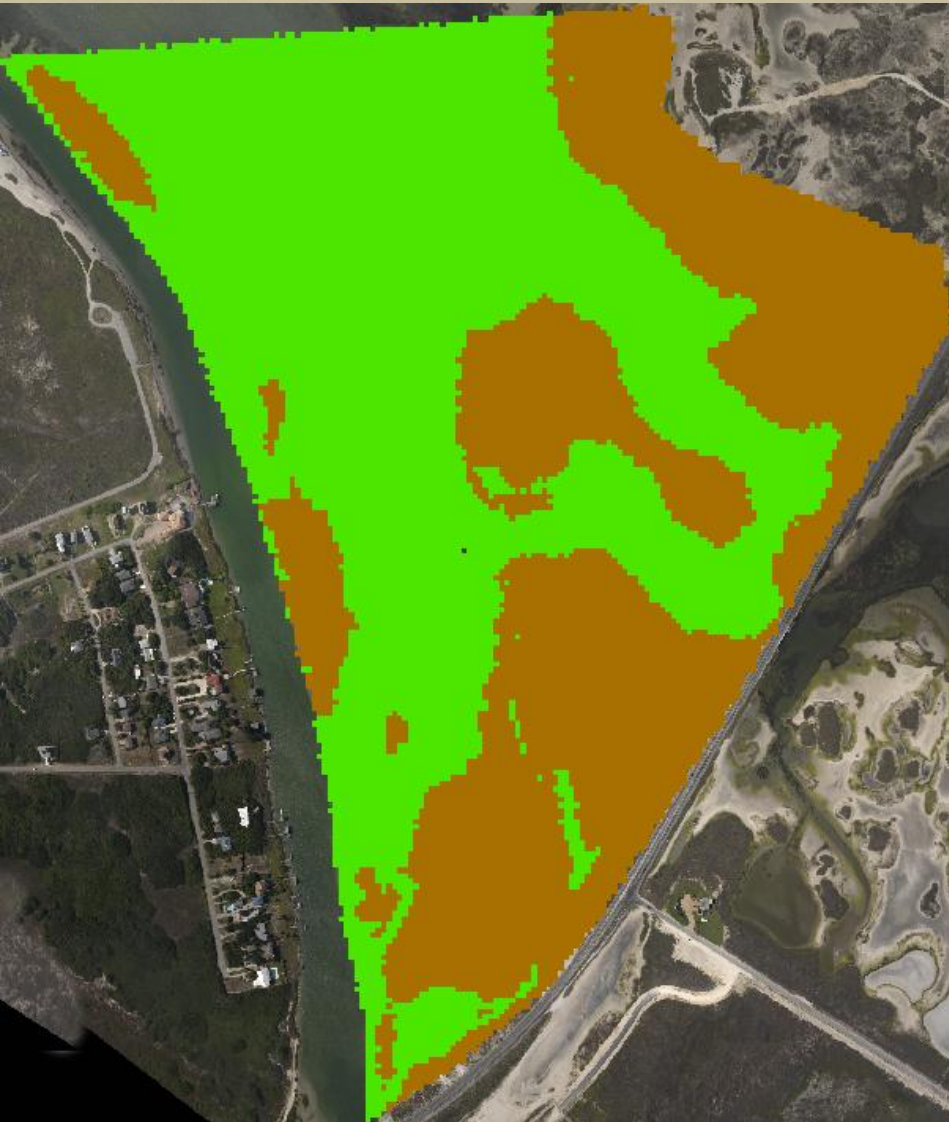
DIGITIZE



GEOREFERENCE



Binary (Wet/Dry) Rasters (July 08)



CMS



Aerial Image

“First Glance” CMS Inundation Accuracy (Jul 08)

RASTER ADDITION:

1	1	1	1
0	0	1	1



1	0	1	0
1	0	0	0

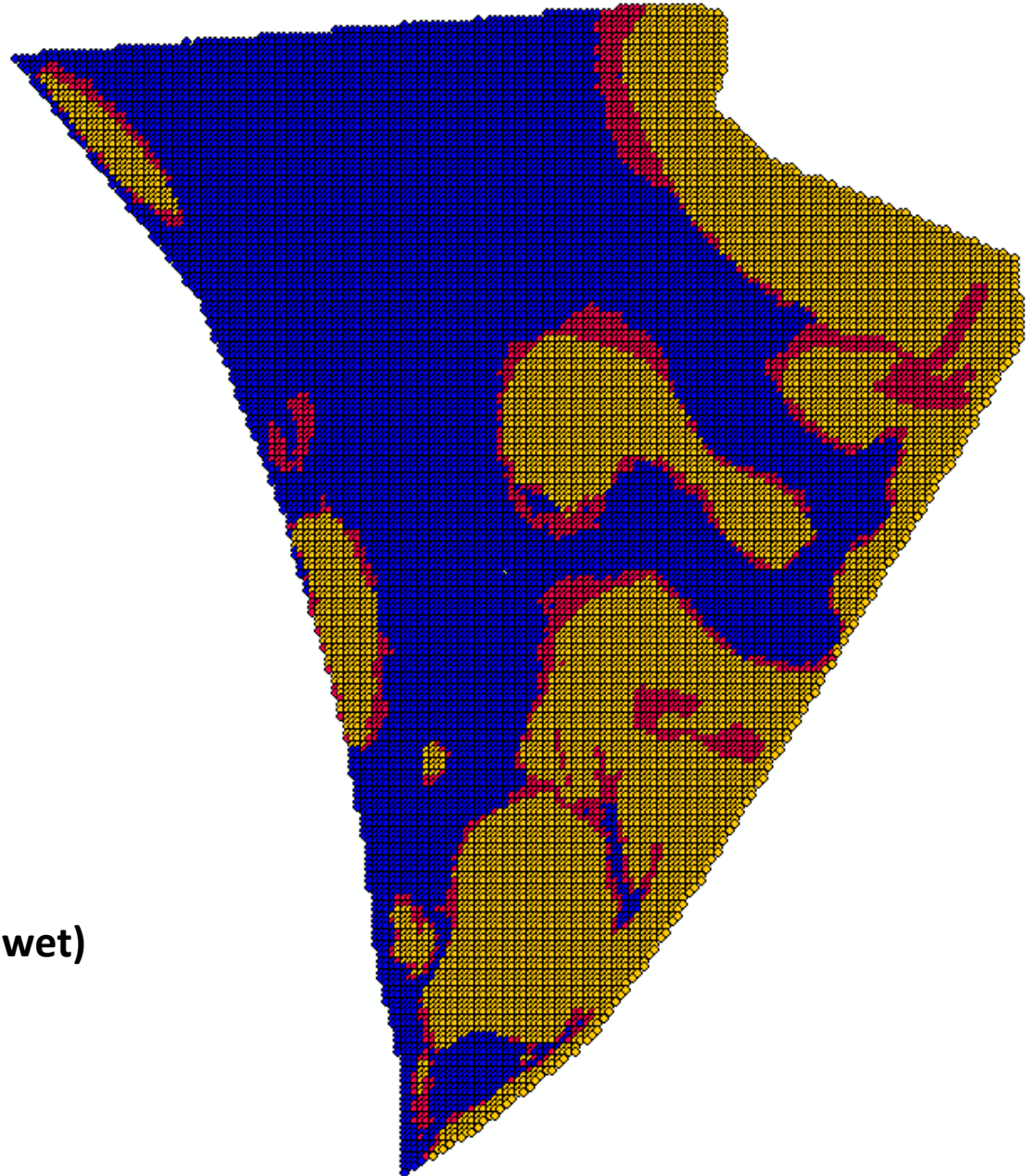


2	1	2	1
1	0	1	1



GRID_CODE

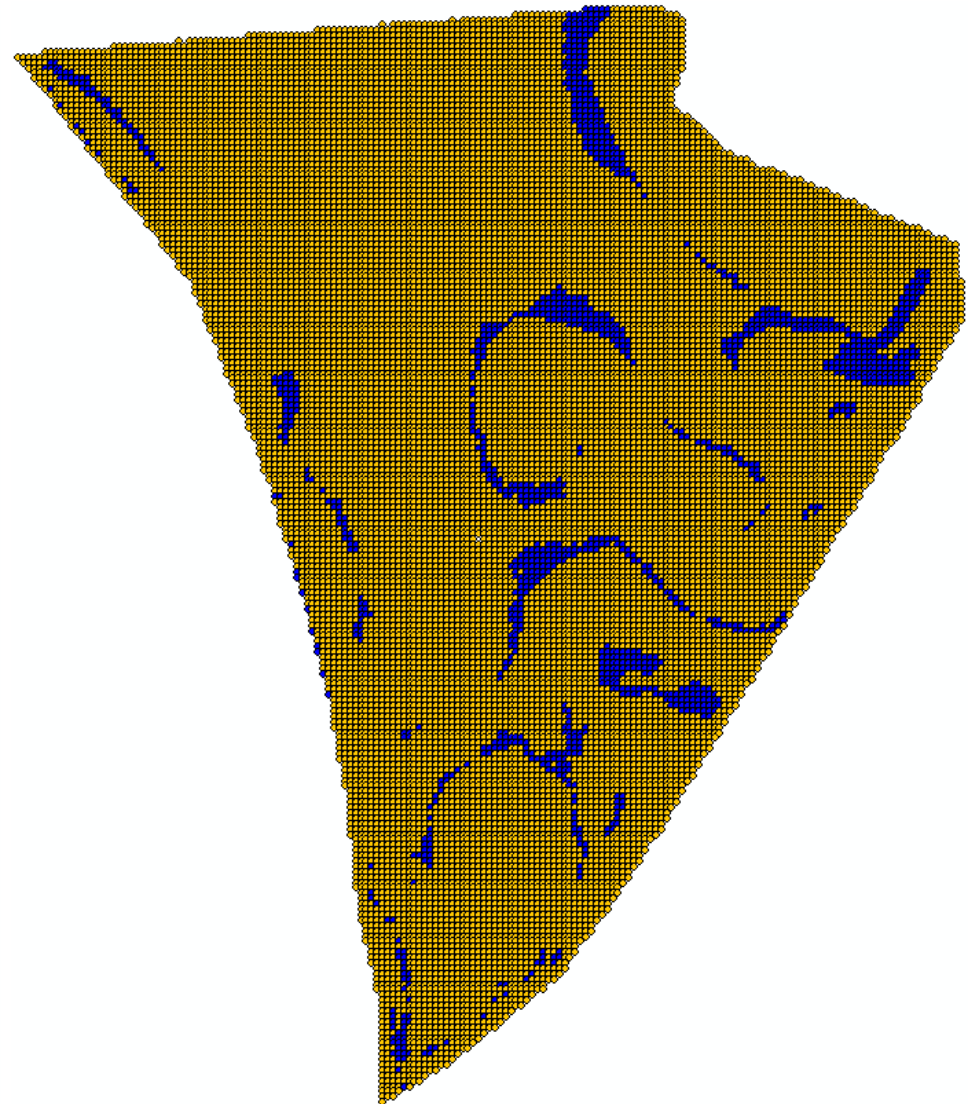
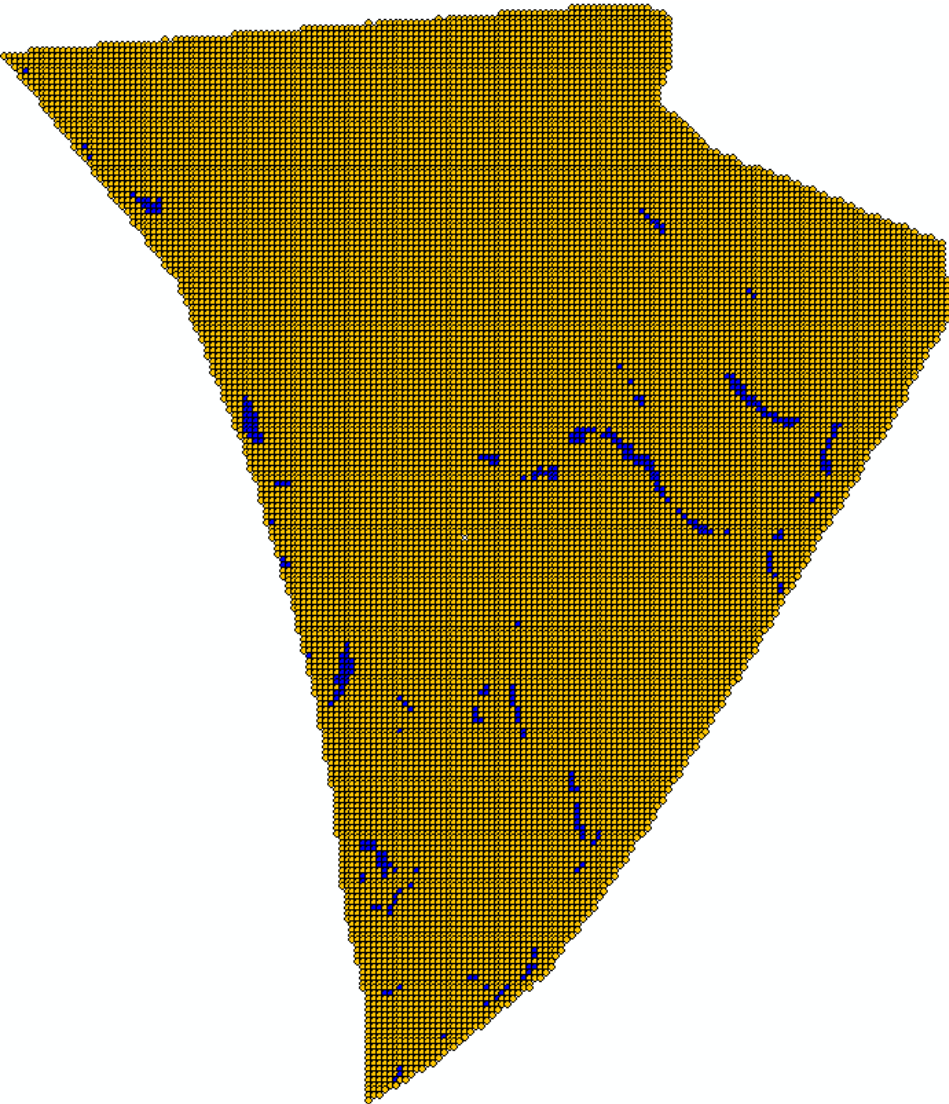
- 0 Accurate (both dry)
- 1 Error (one dry, other wet)
- 2 Accurate (both wet)



Error Pattern: CMS is under-predicting (Jul 08)

■ CMS predicting flooding where it's actually dry land

■ CMS predicting dry land where It's actually flooding



July 2008 Case - Contingency Table Analysis

Packery Inundation				
		Aerial Image		
		Wet	Dry	
CMS	Wet	9994	291	10285
	Dry	1322	6535	7857
		11316	6826	18142



Packery Inundation				
		Aerial Image		
		Wet	Dry	
CMS	Wet	55.1%	1.6%	56.7%
	Dry	7.3%	36.0%	43.3%
		62.4%	37.6%	1

		Observed	
		Yes	No
Forecast	Yes	A	B
	No	C	D



Accuracy	
% Correct	91.1%
% Incorrect	8.9%
Bias	
Wet	0.91
Dry	1.15

Contingency Table Analysis

February 7, 2008

Accuracy	
% Correct	87.8%
% Incorrect	12.2%
Bias	
Wet	0.89
Dry	1.15

August 4, 2009

Accuracy	
% Correct	88.9%
% Incorrect	11.1%
Bias	
Wet	0.91
Dry	1.11

July 20, 2008

Accuracy	
% Correct	91.1%
% Incorrect	8.9%
Bias	
Wet	0.91
Dry	1.15

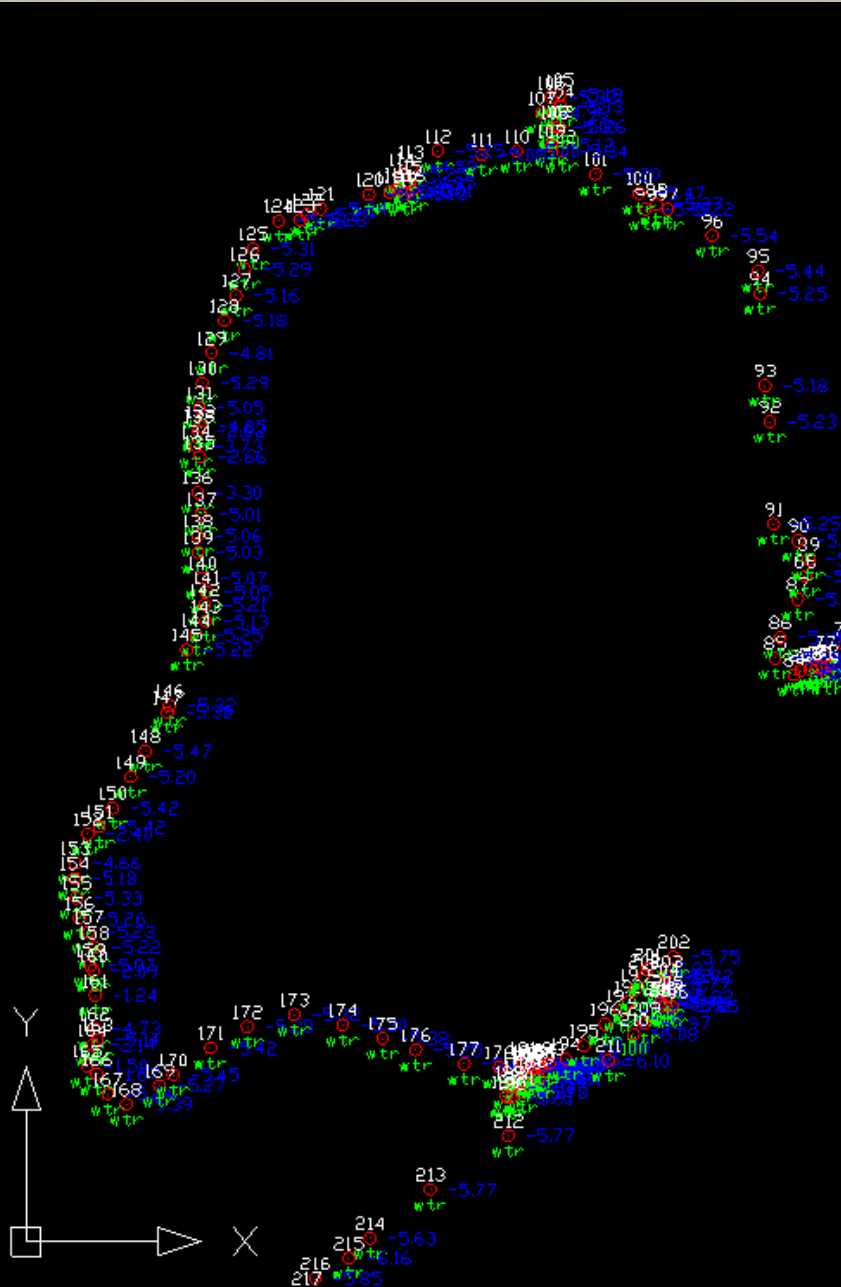
August 12, 2012

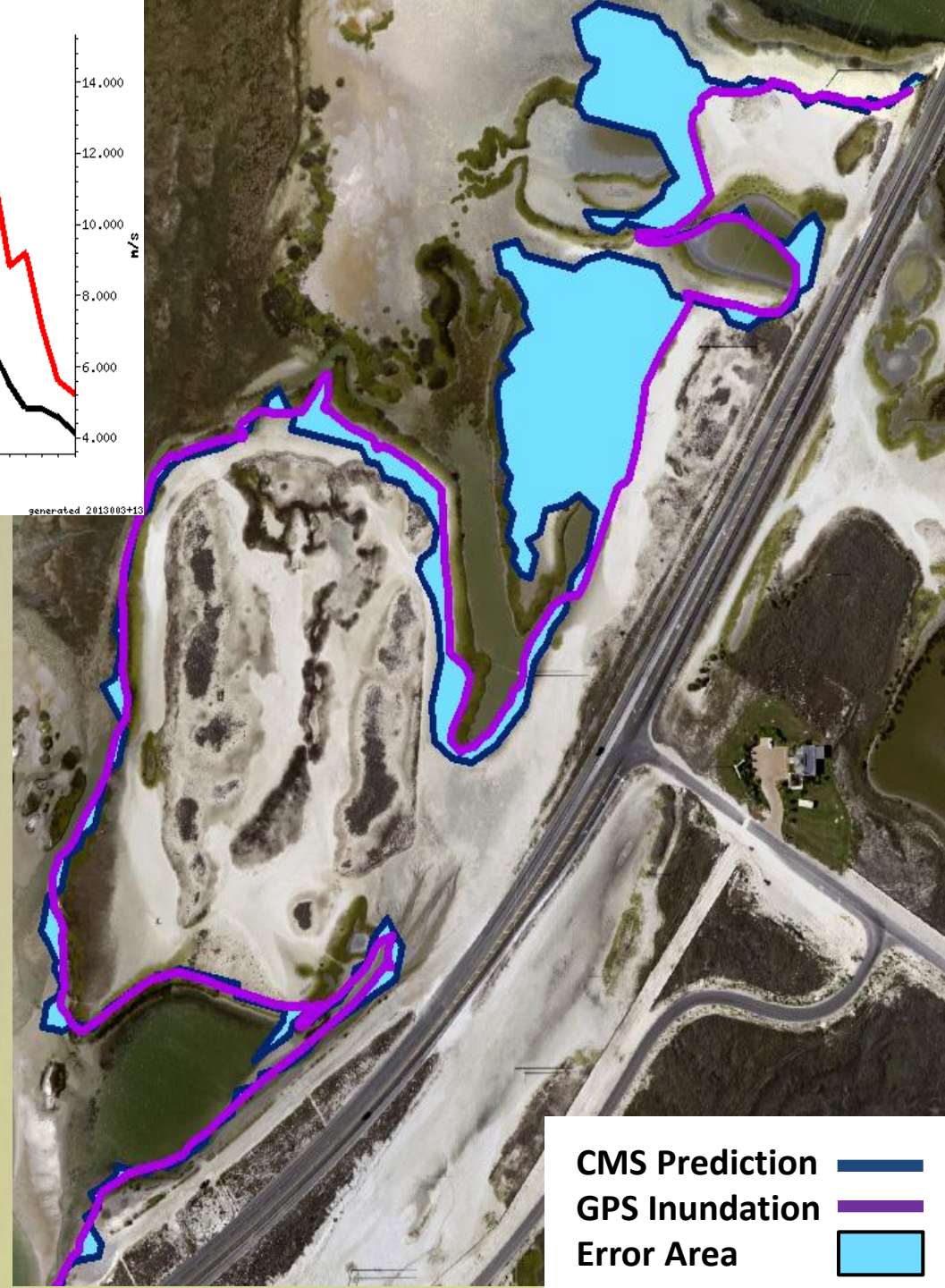
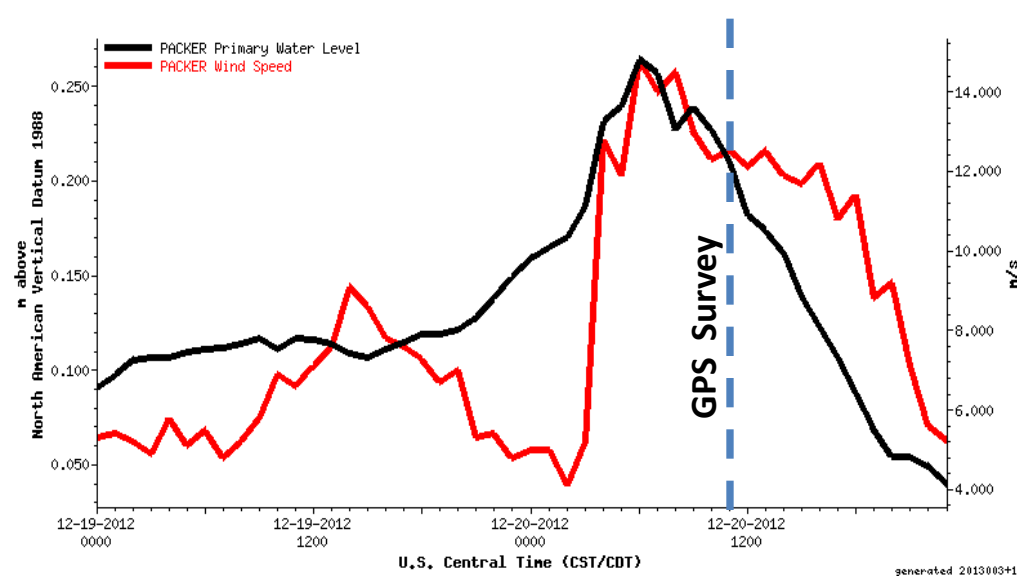
Accuracy	
% Correct	91.4%
% Incorrect	8.6%
Bias	
Wet	1.01
Dry	0.98

January 12, 2009

Accuracy	
% Correct	85.6%
% Incorrect	14.4%
Bias	
Wet	0.94
Dry	1.06

GPS Delineation Analysis





Date: 12/20/2012 ~11 am
***Note: GPS Survey was conducted during a cold front**
Error Area: 24.97m²
Total Study Area: 941.92m²
Avg GPS Elevation: -.34m (NAVD 88)

Conclusions

- CMS model optimization and verification
 - currents and water levels
- multiple test cases in various seasonal conditions
 - 5 test cases with accuracies of 86% - 91%
- extend implementation for other coastal areas and more test cases
- sea level rise flooding delineation
- seasonal and extreme weather flooding delineation
- shoreline habitat reduction

**Questions?
Comments?
Concerns?**

