Evaluating vulnerability of coastal ecosystems & communities using long-term data sets in the Mission-Aransas Reserve

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Evaluating Vulnerability of Coastal Ecosystems and Communities Using Long-term Data Sets in the Mission-Aransas Reserve
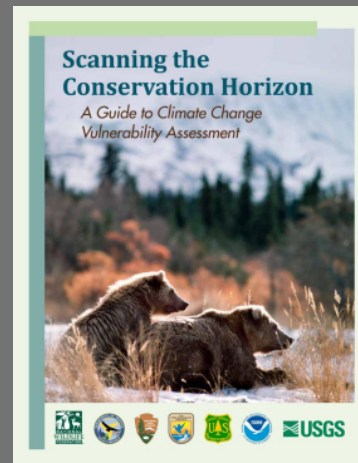
OBJECTIVE 1:

Synthesize and analyze long-term data sets from the Mission-Aransas Reserve and partner organizations to understand the sensitivity of habitats and species to climate variables.
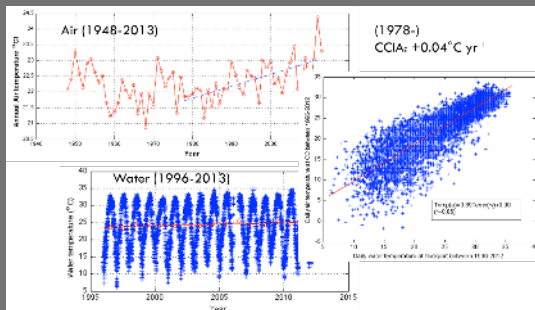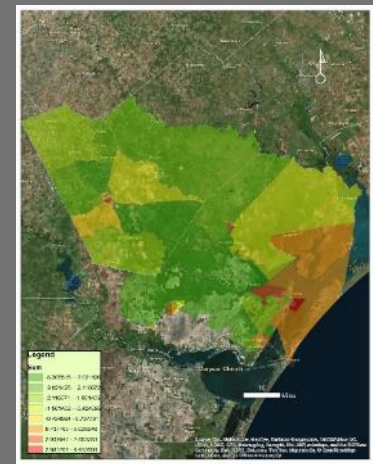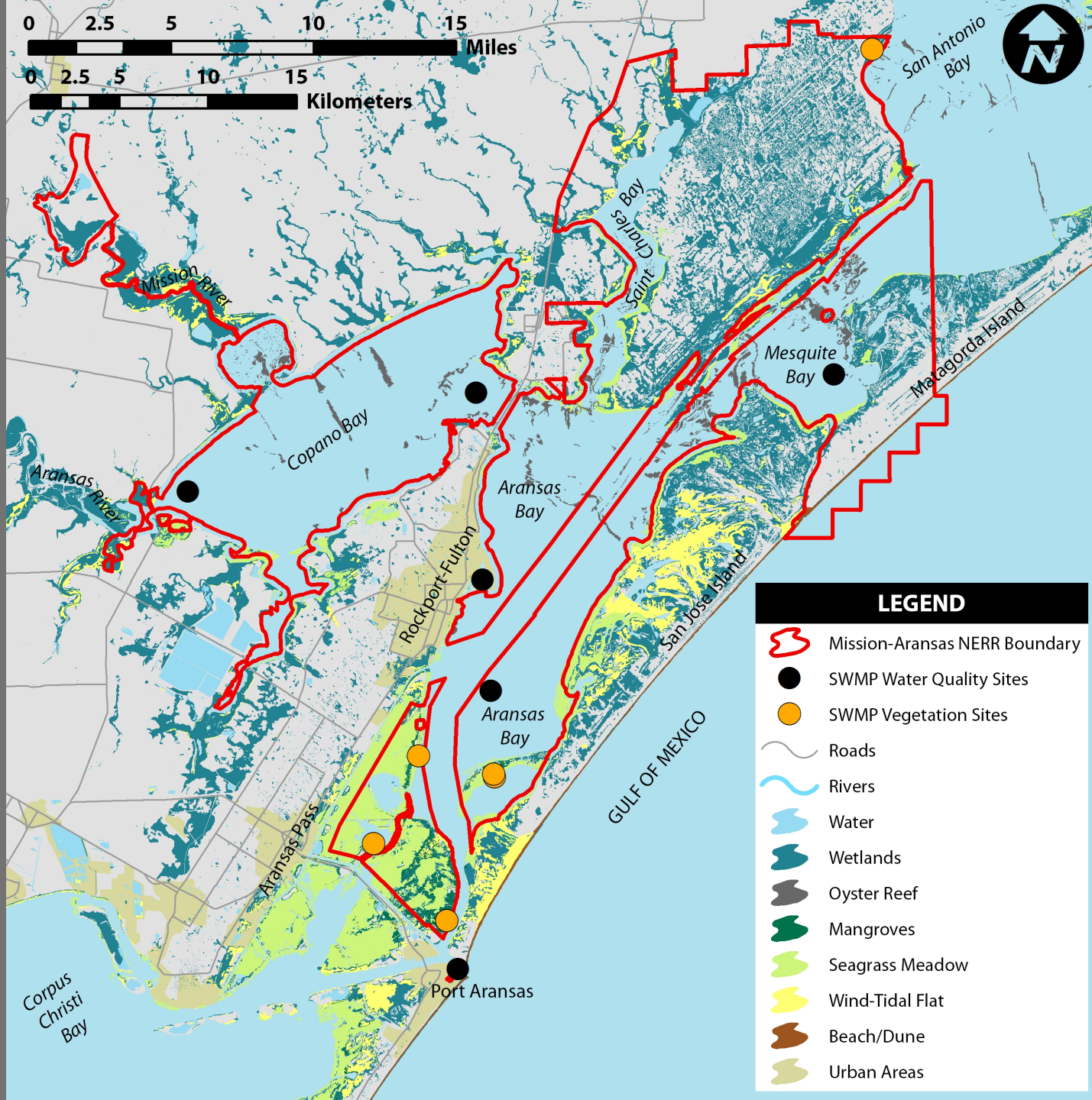
OBJECTIVE 2:

Assess the vulnerability of the Reserve's marsh, seagrass, and oyster habitats to climate change using the Standardized Index of Vulnerability and Value
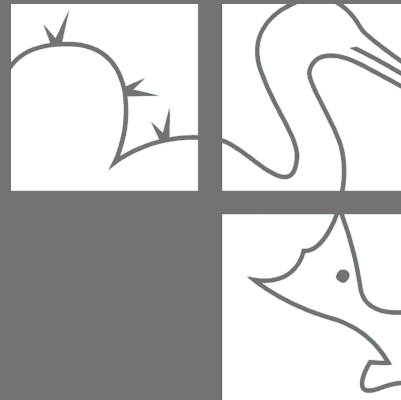
OBJECTIVE 3:

Assess social vulnerability of communities within the Mission-Aransas Reserve watershed to potential climate change hazards.

Scale bars:
0 · 2.5 · 5 · 10 · 15 Miles
0 · 2.5 · 5 · 10 · 15 Kilometers

San Antonio Bay

San Charles Bay

Mission River

Mesquite Bay

Matagorda Island

Aransas River

Copano Bay

Aransas Bay

Rockport-Fulton

Aransas Bay

San Jose Island

Aransas Pass

GULF OF MEXICO

Corpus Christi Bay

Port Aransas

LEGEND

- Mission-Aransas NERR Boundary
- SWMP Water Quality Sites
- SWMP Vegetation Sites
- Roads
- Rivers
- Water
- Wetlands
- Oyster Reef
- Mangroves
- Seagrass Meadow
- Wind-Tidal Flat
- Beach/Dune
- Urban Areas

OBJECTIVE 1: HISTORICAL DATA
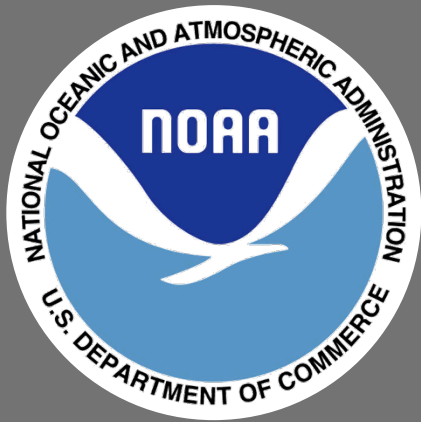
CLIMATE

Annual Air Temperature

Coldest Week

CLIMATE

Annual Precipitation
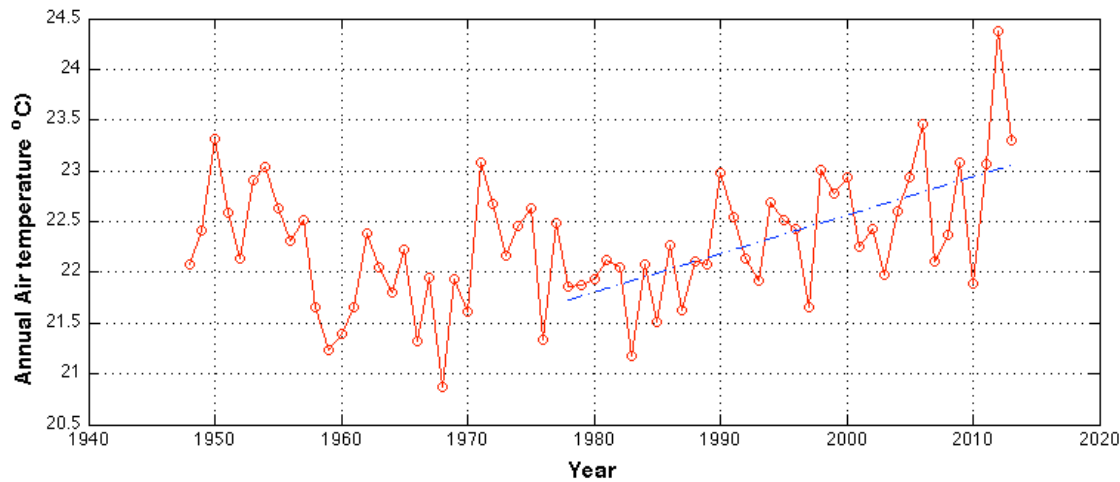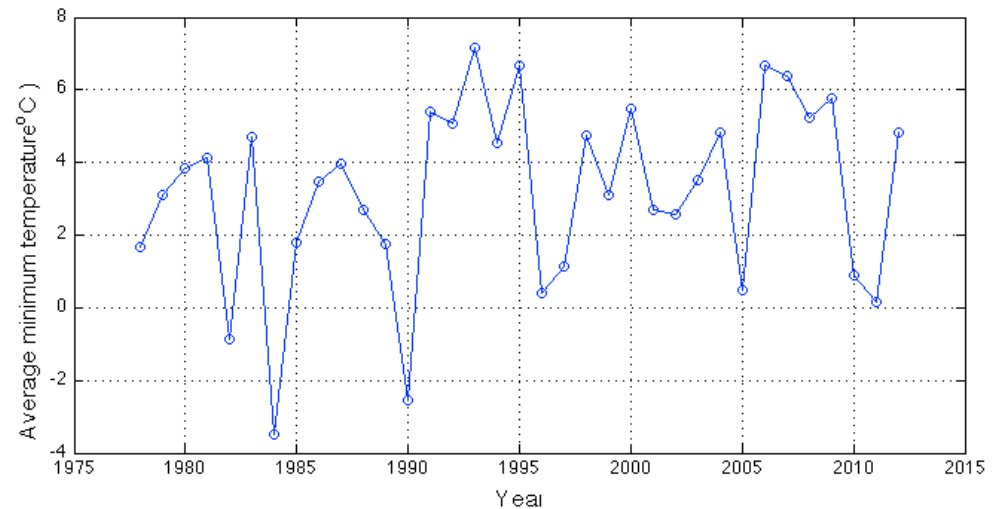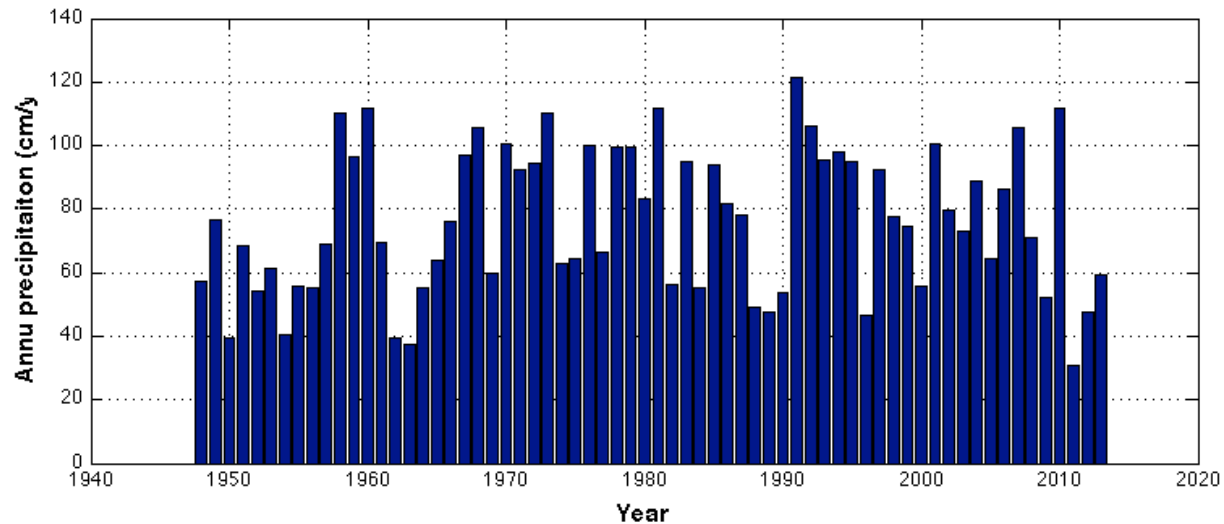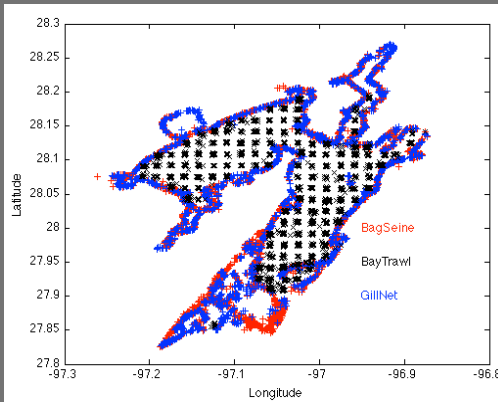
Heavy vs. Light Precipitation

Year	No. of light rainfall months (Precipitation<0.76 cm mo^{-1})	No. of heavy rainfall months (Precipitation>26.7 cm mo^{-1})
1954-1965	23	3
1966-1977	22	4
1978-1989	15	4
1990-2001	15	2
2002-2013	30	4

FISHERIES

*Six out of 21 species identified as those more affected by either winter freeze and summer drought.

Species	winter freeze		summer drought		winter freeze & summer drought	
	catch abundance	length	catch abundance	length	catch abundance	length
Brown shrimp						
Pink shrimp						
white shrimp						
Atlantic croaker	✔		✔	✔	✔	✔
Bay anchovy				✔		
Blue crab				✔		✔
Gulf menhaden	✔			✔		
Pinfish				✔		
Spot						
Striped mullet			✔			
Black drum	✔					
Red Drum	✔		✔		✔	
Sheepshead	✔		✔	✔	✔	
Sand seatrout	✔	✔	✔		✔	
Spotted seatrout	✔	✔		✔	✔	✔
Southern flounder		✔		✔		✔
Alligator						
Gafftopsail						
Gizzard						
Hardhead catfish						
Ladyfish						

BIRDS

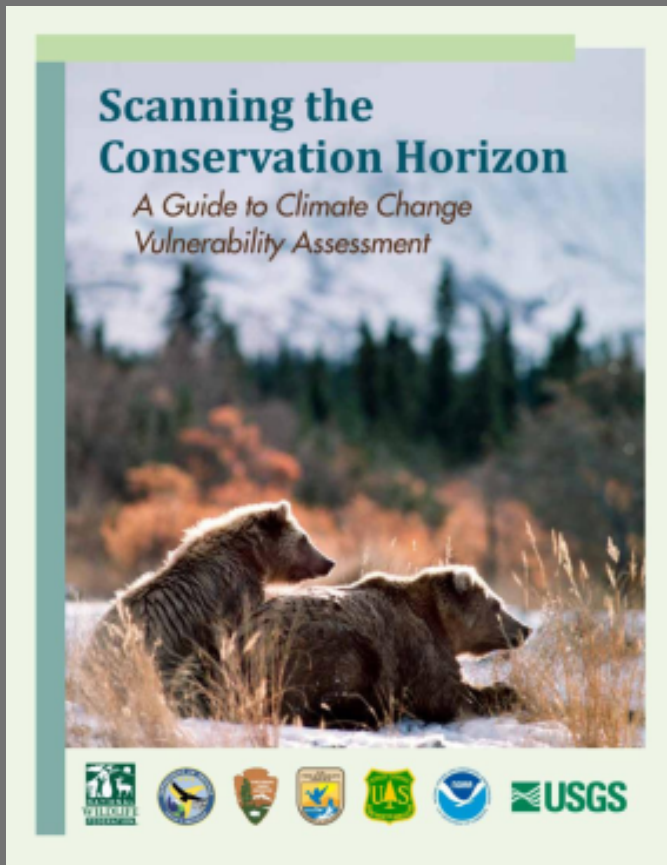*Nineteen out of 28 bird species are identified as those more affected by either winter freeze and second half year drought.
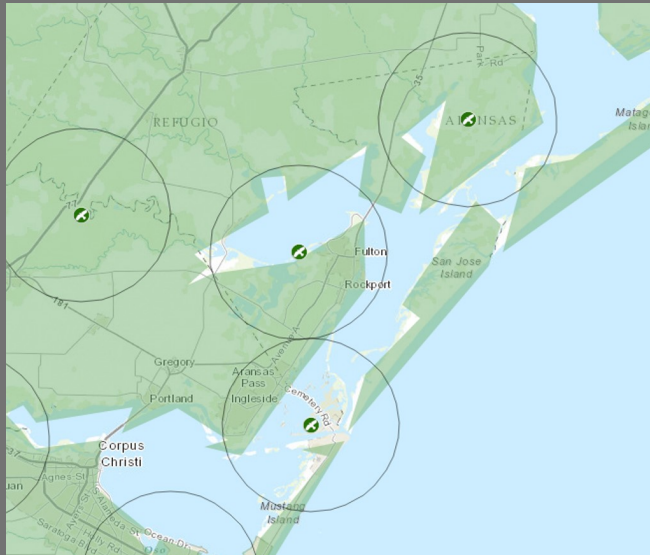
bird name	winter freeze		second half year drought	
	limit	promote	limit	promote
Doubled-crested cormorant	✔		✔	
Eared grebe			✔	
Herring gull				
Forster's tern	✔		✔	
Royal tern				
Gull-billed tern				
Caspian tern		✔		
Black skimmer			✔	
Great blue heron		✔		
Black-bellied plover		✔	✔	
Piping plovers	✔			✔
Brown pelican		✔		
American oystercatcher				
Laughing gull		✔		
Sanderling			✔	
Red knot				
American Robin		✔		
American White Pelican				
American Wigeon		✔		
dowitcher sp.		✔	✔	
duck sp.				
Great-tailed Grackle		✔		
Northern Pintail		✔		
Red-winged Blackbird				✔
Redhead				✔
Western Sandpiper	✔		✔	
Whooping Crane				

OBJECTIVE 2: VULNERABILITY OF HABITATS AND/OR SPECIES

Glick et al. (2011)

Exposure
The change in climate the *habitat* is likely to experience

Sensitivity
How the *habitat* is likely to be affected by climate exposure.

Potential Impact

Adaptive Capacity
The potential to ameliorate the effects of *exposure* or *sensitivity*

Vulnerability
The degree to which the *habitat* is susceptible to adverse effects of climate change.
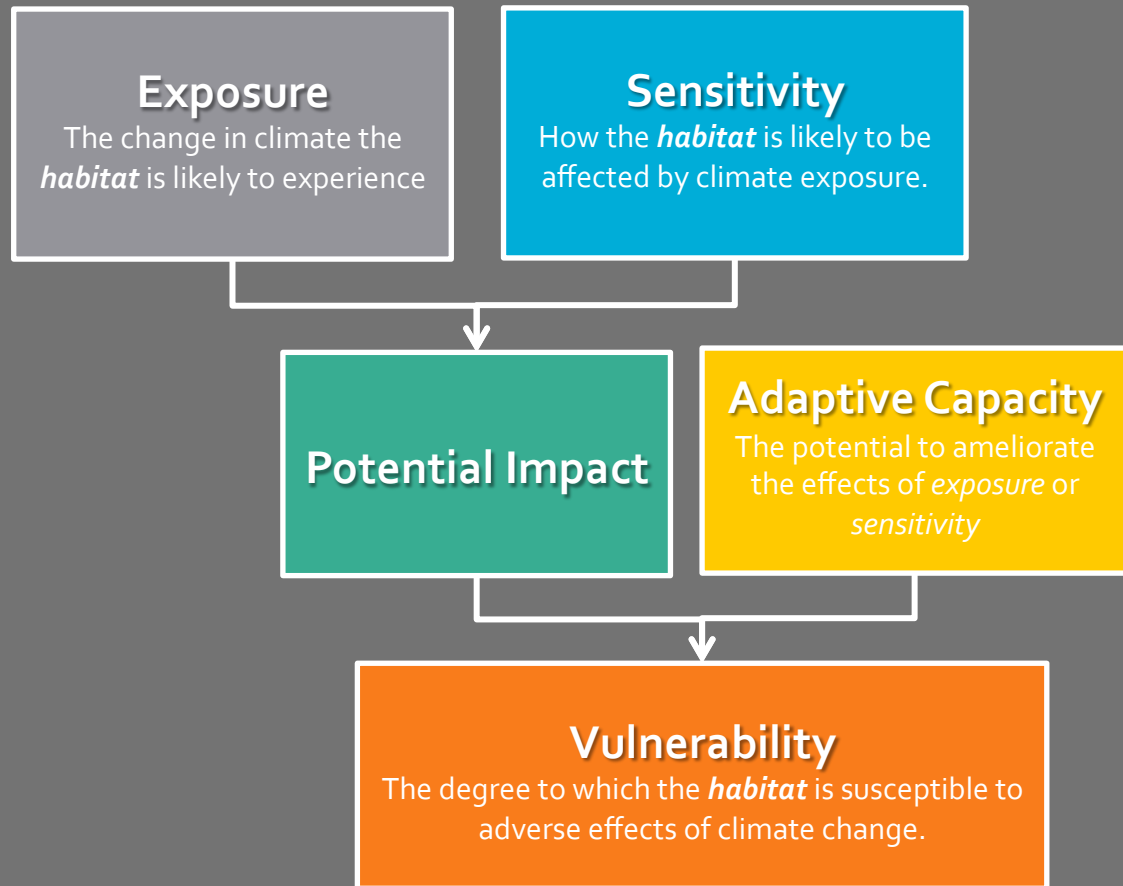
VULNERABILITY ASSESSMENT STEPS

1. Determine objectives and scope

2. Gather relevant data and expertise

3. Assess the components of vulnerability

4. Apply assessment results in adaptation planning

Nov 13, 2014 Workshop

OBJECTIVES AND SCOPE

Saltwater Emergent Wetland

Photo Credit: Liz Smith

Oyster Reefs

Photo Credit: Perdue.edu

Freshwater Emergent Wetland

Photo Credit: Liz Smith

Seagrass Beds

Photo Credit: Sara Wilson

OBJECTIVES AND SCOPE

Asessment Targets	Geographic Scale	Time Period	Emissions Scenario
Saltwater Emergent Wetland	NERR Boundary *	2050	A2 / RCP 8.5
Freshwater Emergent Wetland			
Oyster Reefs			
Seagrass Beds			

CLIMATE CHANGE VULNERABILITY ASSESSMENT TOOLS

NatureServe Climate Change Vulnerability Index (CCVI)

NatureServe Habitat Climate Change Vulnerability Index (H-CCVI)

Climate Change Vulnerability Assessment of Shorebird Habitat (CCVASH)

Climate Change Vulnerability Assessment Tool for Coastal Habitats (CCVATCH)

Standardized Index of Vulnerability and Value Assessment (SIVVA)

SIVVA

- CC and non-CC stressor (i.e., invasive species) interactions

- Explicit attention to SLR

- Based on expert opinion

- A flexible system of scoring

- Metrics for both vulnerability and conservation value

- Quantitative and transparent accounting of multiple sources of uncertainty (i.e., Monte Carlo simulations)

PROJECT SYNERGIES

Gulf Coast Vulnerability Assessment

Gulf Coast Prairie LCC

Gulf Coast Vulnerability Assessment
Mangrove, Tidal Emergent Marsh, Barrier Islands, and Oyster Reef

Abstract

Climate, sea level rise, and urbanization are undergoing unprecedented levels of combined change and are expected to have large effects on natural resources—particularly along the Gulf of Mexico coastline (Gulf Coast). Management decisions to address these effects (i.e., adaptation) require an understanding of the relative vulnerability of various resources to these stressors. To meet this need, the four Landscape Conservation Cooperatives along the Gulf partnered with the Gulf of Mexico Alliance to conduct this Gulf Coast Vulnerability Assessment (GCVA). Vulnerability in this context incorporates the aspects of exposure and sensitivity to threats, coupled with the adaptive capacity to mitigate those threats. Potential impact and adaptive capacity reflect natural history features of target species and ecosystems. The GCVA used an expert opinion approach to qualitatively assess the vulnerability of four ecosystems: mangrove, oyster reef, tidal emergent marsh, and barrier islands, and a suite of wildlife species that depend on them. More than 50 individuals participated in the completion of the GCVA, facilitated via Ecosystem and Species Expert Teams.

Of the species assessed, Kemp's ridley sea turtle was identified as the most vulnerable species across the Gulf Coast. Experts identified the main threats as loss of nesting habitat to sea level rise, erosion, and urbanization. Kemp's ridley also had an overall low adaptive capacity score due to their low genetic diversity, and higher nest site fidelity as compared to other assessed species. Tidal emergent marsh was the most vulnerable ecosystem, due in part to sea level rise and erosion. In general, avian species were more vulnerable than fish because of nesting habitat loss to sea level rise, erosion, and potential increases in storm surge.

Assessors commonly indicated a lack of information regarding impacts due to projected changes in the disturbance regime, biotic interactions, and synergistic effects in both the species and habitat assessments. Many of the assessors who focused on species also identified data gaps regarding genetic information, phenotypic plasticity, life history, and species responses to past climate change and sea level rise. Regardless of information gaps, the results from the GCVA can be used to inform Gulf-wide adaptation plans. Given the scale of climatic impacts, coordinated efforts to address Gulf-wide threats to species and ecosystems will enhance the effectiveness of management actions and also have the potential to maximize the efficacy of limited funding.

Authors

This was a team effort led to completion by a Core Planning Team coordinated by Amanda Watson. Ecosystem and Species Expert Teams were established for each of the four ecosystems evaluated: Mangrove work was led by Laura Geselbracht (The Nature Conservancy); Tidal Emergent Marsh by Mark Woodrey (Grand Bay NERR/Mississippi State University); Oyster Reef

SIVVA – NATURAL COMMUNITIES

- Questionnaire completed as a Microsoft Excel worksheet

- SIVVA contains 4 "modules":

    1. Ecosystem Status

    2. Vulnerability

    3. Conservation Value

    4. Conservation Rank

- Criteria within each module resulted from extensive review of the threats considered and valuations used in previous conservation planning exercises.

SALTWATER EMERGENT WETLAND
SEPTEMBER 18, 2015

Ecosystem Status
61%

Vulnerability
66%

Conservation Value
77%

Natural Heritage Rank
20%

**WEIGHTED AVG
66%**

Vulnerability:
- Proportion of habitat area likely to be lost to SLR (5)
- Vulnerability to current or expected extent to fragmentation (4)
- Vulnerability to altered hydrology (4)
- Constraints on range shifts (4)
- Other factors that would degrade abiotic environment (i.e., oil spill) (4)
- Other factors that would alter biotic environment (i.e., mangrove encroachment) (4)

Conservation Value:
- Habitat harbors more endemic, highly disjunct, or evolutionary distinct species than other habitats (5)
- Provides ecosystem services (6)

Photo Credit: Liz Smith

FRESHWATER EMERGENT WETLAND
SEPTEMBER 18, 2015

Ecosystem Status
42%

Vulnerability
69%

Conservation Value
70%

Natural Heritage Rank
20%

**WEIGHTED AVG
64%**

Vulnerability:
- Vulnerability of habitat to altered disturbance regime (i.e., fire) (5)
- Vulnerability of habitat to altered hydrology (5)
- Vulnerability of habitat to invasive species (5)
- Constraints on range shifts (6)

Conservation Value:
- Habitat harbors more endemic, highly disjunct, or evolutionary distinct species than other habitats (5)
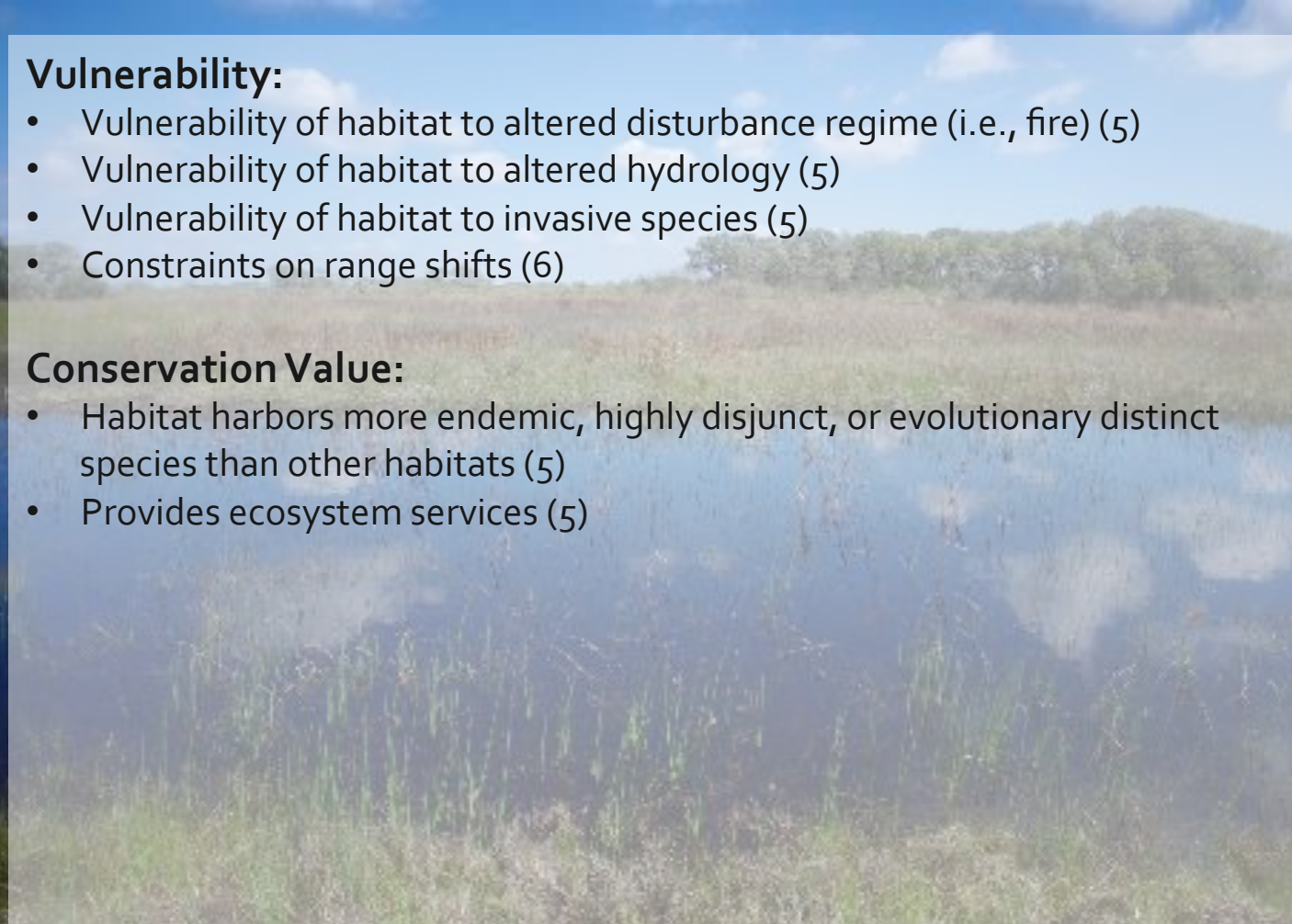- Provides ecosystem services (5)

Photo Credit: Liz Smith

OYSTER REEFS
SEPTEMBER 21, 2015

Ecosystem Status
71%

Vulnerability
71%

Conservation Value
70%

Natural Heritage Rank
20%

WEIGHTED AVG
69%

Vulnerability:
- Vulnerability of habitat to altered disturbance regime (i.e., low salinity, sedimentation during storm events) (4)
- Vulnerability of the habitat to altered hydrology (4)
- Constraints on range shifts (4)
- Other factors that would alter biotic processes and interactions (i.e., harvesting) (6)

Conservation Value:
- Provides ecosystem services (6)

Photo Credit: Perdue.edu

SEAGRASS
SEPTEMBER 21, 2015

Ecosystem Status
67%

Vulnerability
66%

Conservation Value
63%

Natural Heritage Rank
40%

**WEIGHTED AVG
64%**

Vulnerability:
- Proportion of habitat area likely to be lost directly to SLR (4)
- Vulnerability to current or expected extent to fragmentation (5)
- Constraints on range shifts (5)
- Other factors that would degrade abiotic environment (i.e., light availability, nutrient inputs) (4)
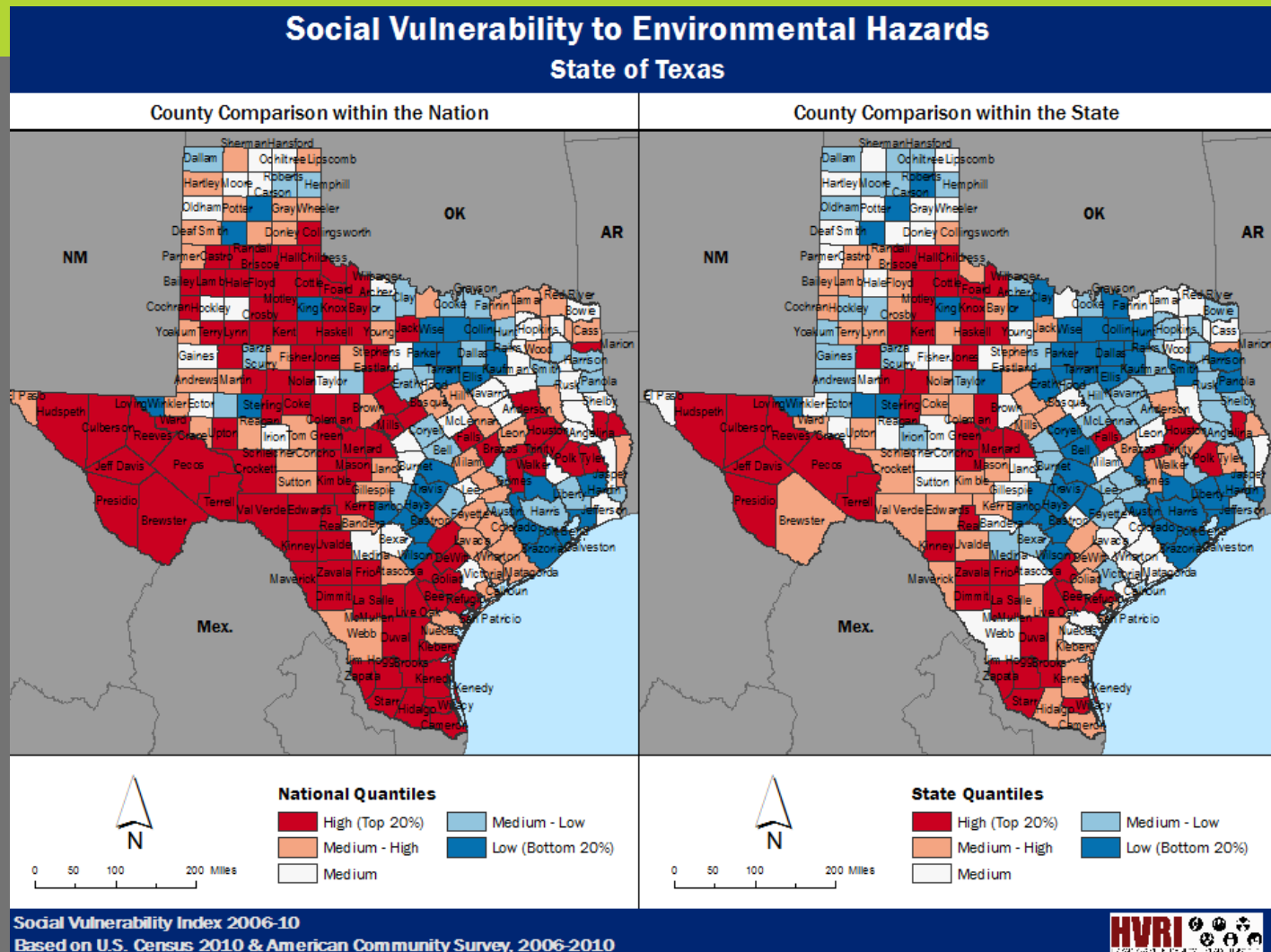
Conservation Value:
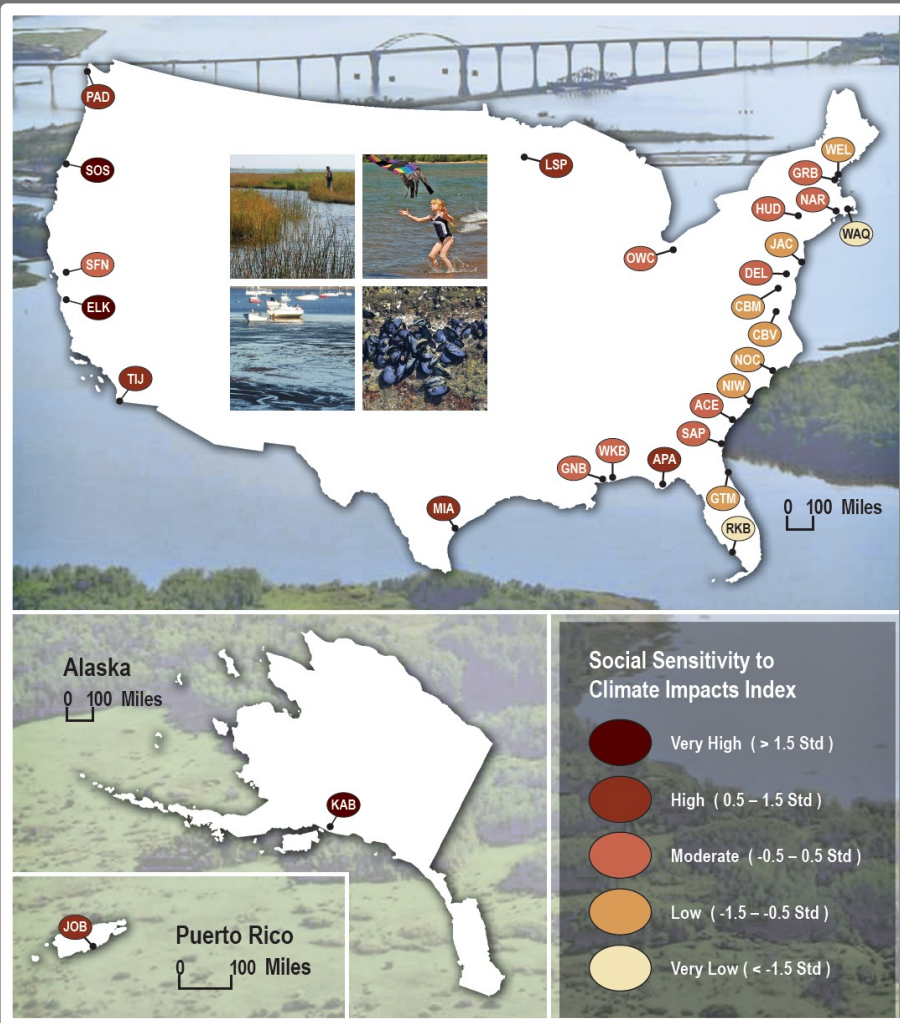- Provides ecosystem services (6)

Natural Heritage Rank:
- Global Rank = Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors. (4)

Photo Credit: Sara Wilson

OBJECTIVE 3: SOCIAL SENSITIVITY

- Race and class
- Wealth
- Elderly residents
- Hispanic ethnicity
- Special needs individuals
- Native American ethnicity
- Service industry employment

Social Vulnerability to Environmental Hazards
State of Texas

County Comparison within the Nation — County Comparison within the State

National Quantiles
- High (Top 20%)
- Medium - High
- Medium
- Medium - Low
- Low (Bottom 20%)

State Quantiles
- High (Top 20%)
- Medium - High
- Medium
- Medium - Low
- Low (Bottom 20%)

Social Vulnerability Index 2006-10
Based on U.S. Census 2010 & American Community Survey, 2006-2010

SOCIAL SENSITIVITY

RESERVE LEVEL

- Housing characteristics and tenancy

- Labor characteristics and status

- Wealth

- Household composition

- Cultural barriers and natural resource dependence

- Recent movers
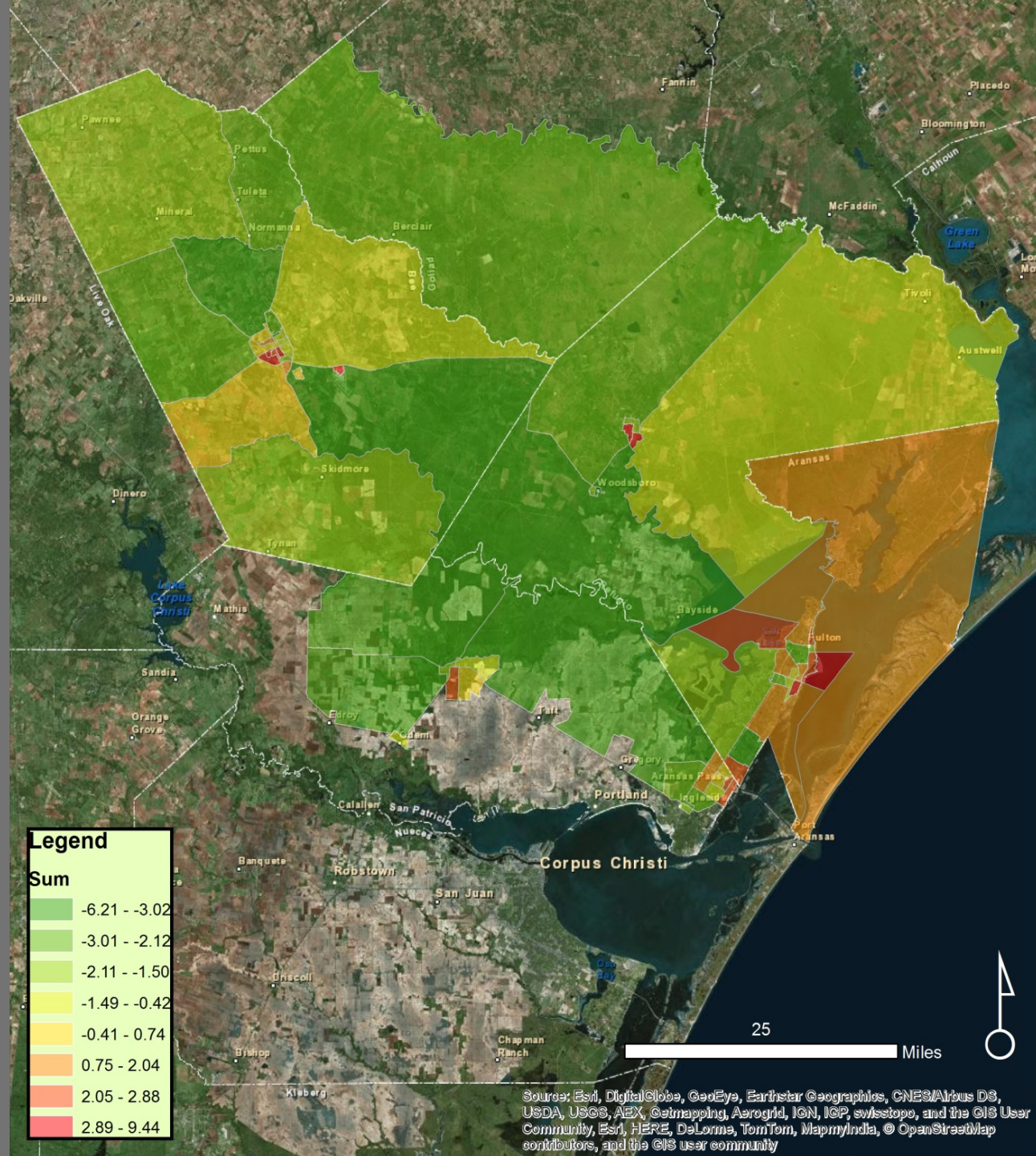
2010 Census

American Communities Survey

Infrastructure (Shepherd et al., 2012)

Principal Component	Name	Cardinality	Percent Variation Explained	Dominant Variables (Component Loading)
1	Age and Housing	+	22	Median age (0.905) Persons per occupied housing unit (-0.877) Age 65 and over (0.857) Seasonal housing units (0.842) Percent Hispanic (-0.839) Percent non-Hispanic white (0.828) Age 5 and under (-0.74)
2	Demographic	+	16	Housing unit year built (-0.969) Percent female (-0.947) Senior group quarters (0.883) Percent black (0.78) Married couple families with children (0.771)
3	Density	+	6	Housing density (0.876) Population density (0.622)
4	Cultural Barriers	+	5	Percent mobile homes (-0.597) Non-English speaking (0.519)
5	Wealth	-	9	Median income (-0.774) Per capita income (-0.714) Rich households (-0.682) Median house value (-0.673) Below poverty (0.577)
6	Natural Resource Dependent	+	5	Employment in extractive industry (-0.815) Employment in service industry (0.648)
7	Asian	+	4	Percent Asian (-0.803) Median gross rent (-0.639)
8	Tenancy	+	8	Renter occupied housing (0.775) Renters (0.769) Single parent (0.56) Length of residency (0.527)
9	Socially Dependent	+	5	Public assistance (0.844) Limited English proficiency (0.498)

Most Sensitive

Least Sensitive

Legend

Sum

- -6.21 - -3.02
- -3.01 - -2.12
- -2.11 - -1.50
- -1.49 - -0.42
- -0.41 - 0.74
- 0.75 - 2.04
- 2.05 - 2.88
- 2.89 - 9.44

25 Miles

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

CHASE FIELD CRIMINAL JUSTICE CENTER. BEE

SOUTH ROCKPORT, ARANSAS

SOUTHWEST REFUGIO. REFUGIO

| Geoid	County	Principal Components with High Loadings	Major Vulnerability	Index Score
480259502011	Bee	2, 8	Ethnicity, Families with Children, Renters	9.44
480079504001	Aransas	8,9	Public Assistance, Renters	8.63
483919502003	Refugio	4,8	Non-English Speaking, Renters	7.13
483919502004	Refugio	4,8,9	Non-English Speaking, Poverty, Renters	7.06
480259505005	Bee	4,6	Non-English Speaking, Employment in Service Industry	6.6
480079502001	Aransas	1,3	Age, Percent over 64, Housing Density	5.49
480259505002	Bee	4,9	Non-English Speaking	3.19
480259505003	Bee	3,5	Income and Poverty	2.91

Sea Level Rise
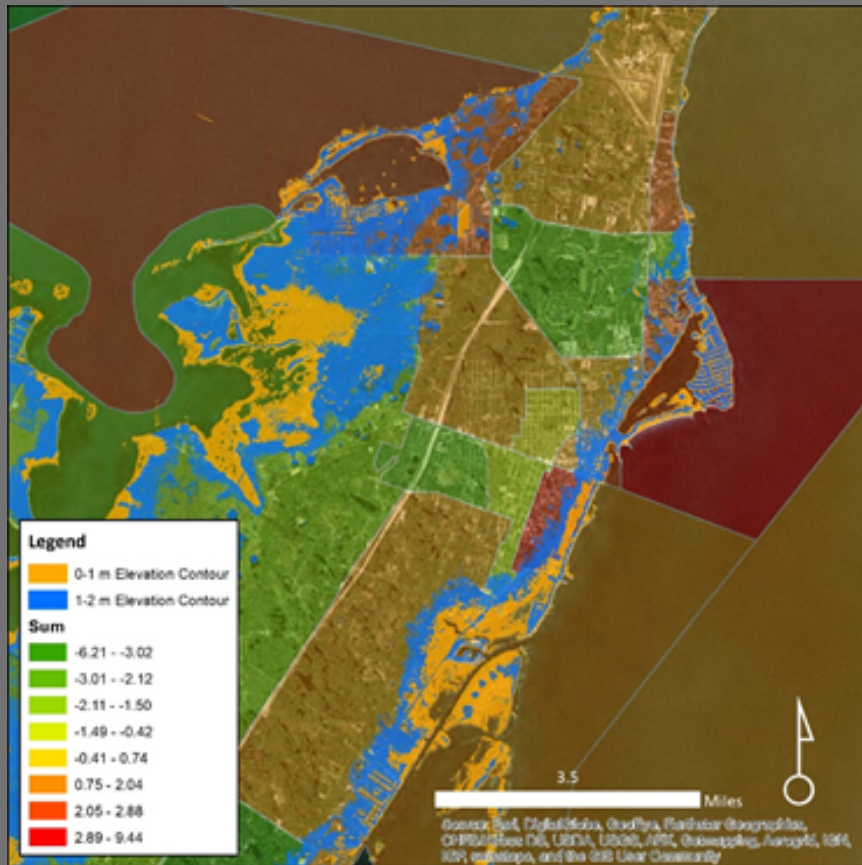
Figure 2. Map of social sensitivity index scores overlaid with 0-1 m (orange) and 1-2 m (blue) elevation contours.
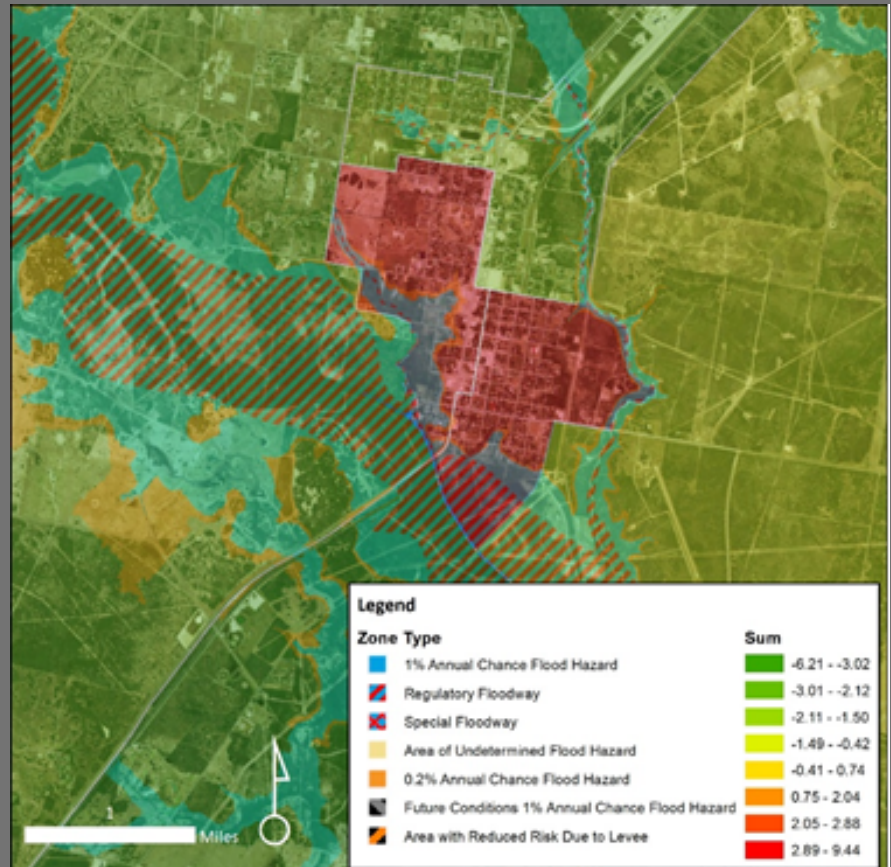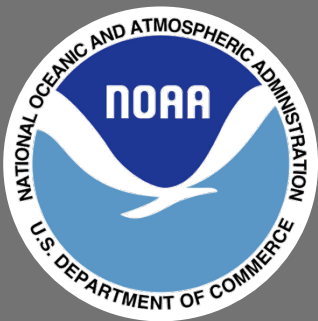
Flood Hazard Zones

Figure 3. Map of social sensitivity index scores overlaid with special flood hazard zones.

QUESTIONS?

http://missionaransas.org/climate-change