

# Assessing Implications of Sea Level Rise to the Built and Natural Environment Cape May County, NJ

Advanced Environmental Geomatics Class 2009

# Cape May County, NJ

- Southern most county of New Jersey
- Supports one of the largest concentrations of migratory birds in North America
- Home to many species of threatened and endangered wildlife
- Permanent resident population of over 102,000 residents
- Generates 5.1 billion dollars annually
- Victorian Cape May is a National Historic Landmark

# Objective

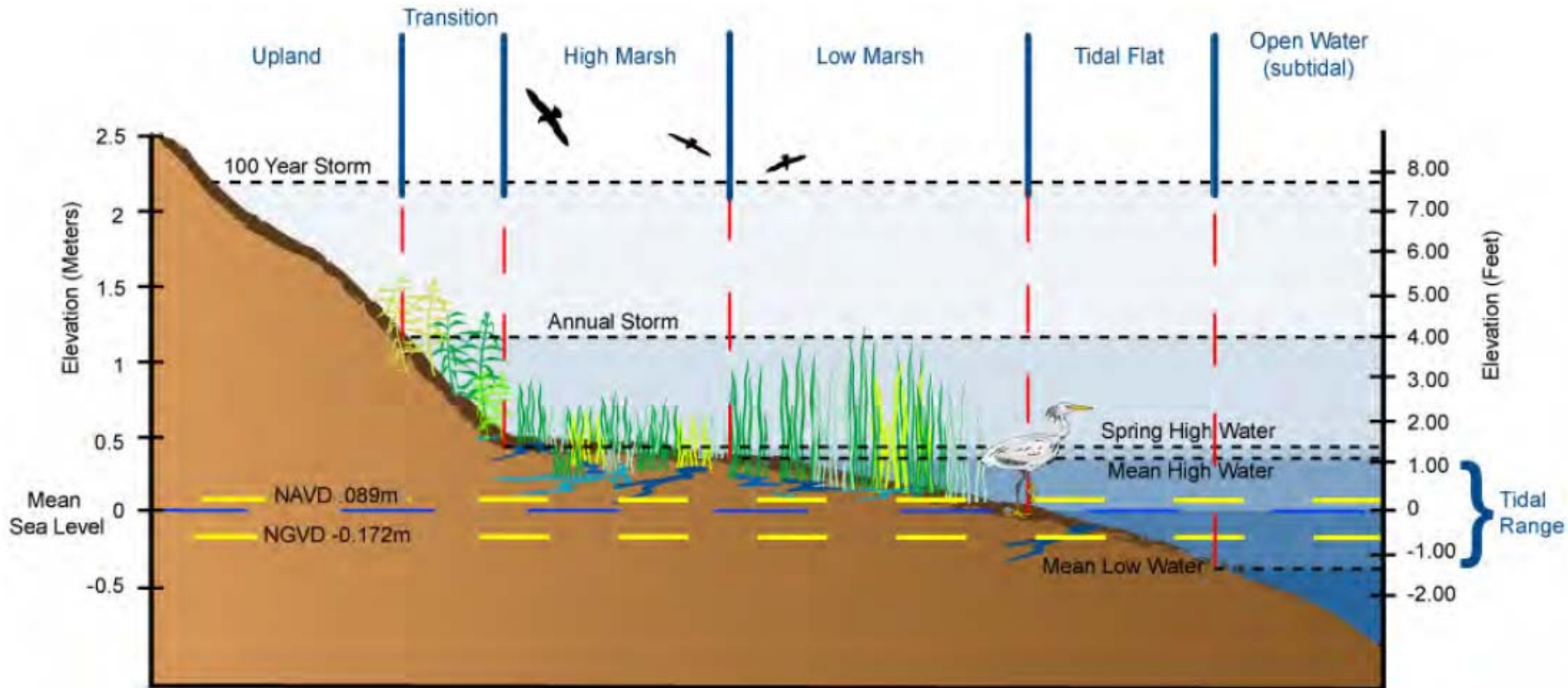
- Identify the components of sea level rise on natural habitat and human infrastructure.
- Apply geospatial analytical approaches to enhance place-based decision making.

# Sea Level Rise

- Sea Level is expected to rise due to ocean thermal expansion and melting of the ice sheets
- Recent historical levels of sea level rise along the NJ coast is generally thought to be about 3-4 mm/yr, while predicted future rates are expected to increase to 6 mm/yr
- Estimates of projected median sea level rise are on the order of 0.6 to 1.2 meters in the next 100 years.

Sea level rise estimates, International Panel on Climate Change (IPCC), 2009

NJ coast predictions, Psuty, 2002



**Figure 1.1.2. Relationship between tides, wetlands, and reference elevations for an example estuarine shore profile. The example elevations are based on the Hampton Roads (Virginia) Tide Station. See Gill and Schultz 2001. The wetland characterizations are based on Kana et al. 1988.<sup>11</sup>**

# Storm Tidal Surge

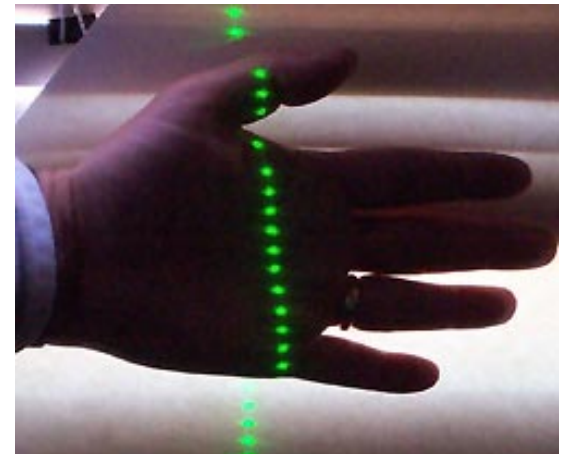
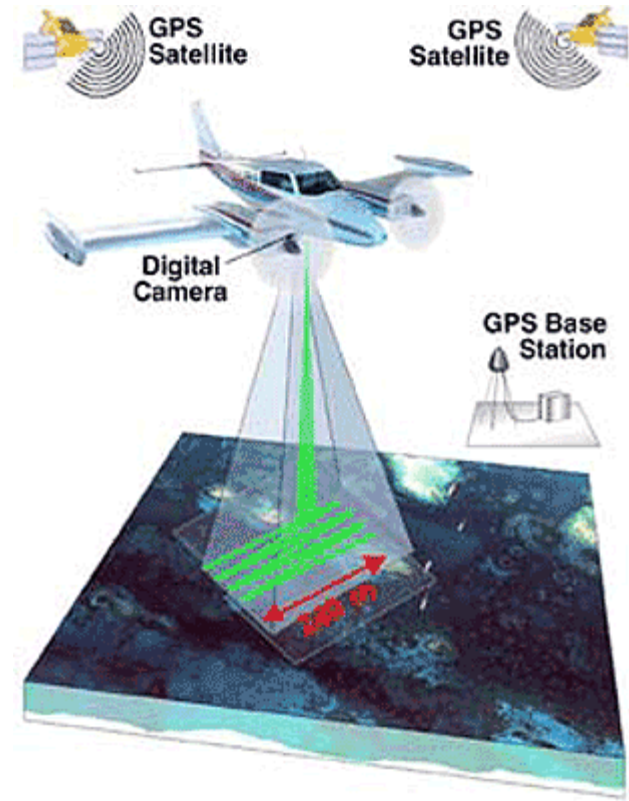
## FEMA estimates

- 30-yr FEMA tidal surge of 2.3m (7.9 ft)
- 100-yr storm tidal surge of 2.9m (9.6 ft)
- Mean sea level National Geodetic Vertical Datum 1988
- At Spring High Tide, add another 0.7m (2.4 ft)

# Light Detection And Ranging (Lidar)

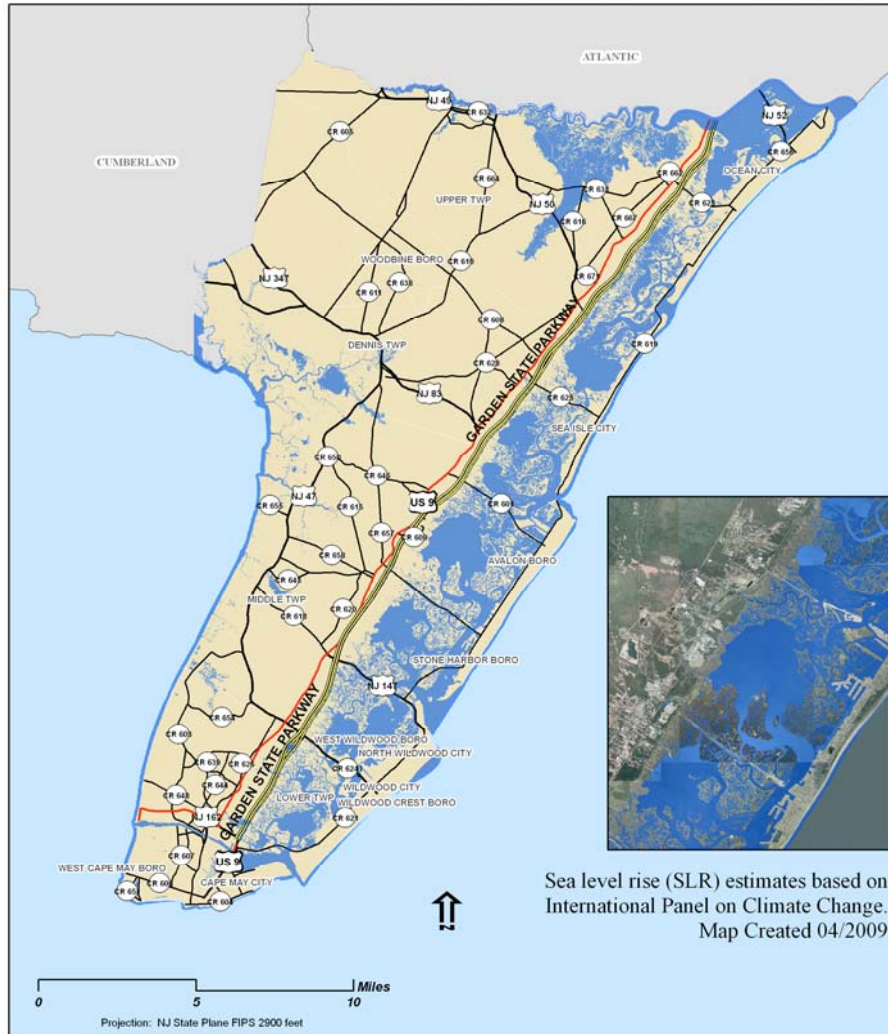
- Mapping elevation in terrestrial zone and bathymetry in nearshore zone
- Flown in helicopter or fixed wing aircraft
- 13cm vertical accuracy
- 2m horizontal resolution

*Financial assistance for the acquisition of LiDAR data was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.*



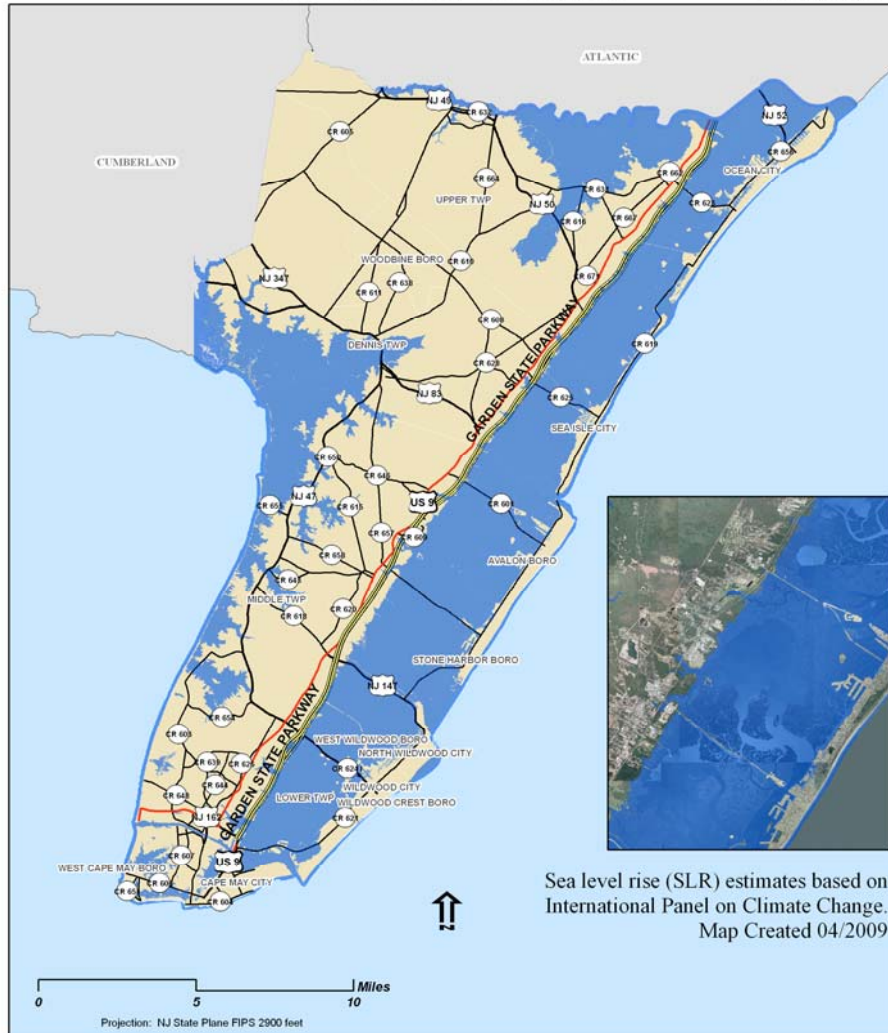
Images from <http://soundwaves.usgs.gov/>

# 0.6m Sea Level Rise for Cape May County, NJ



Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

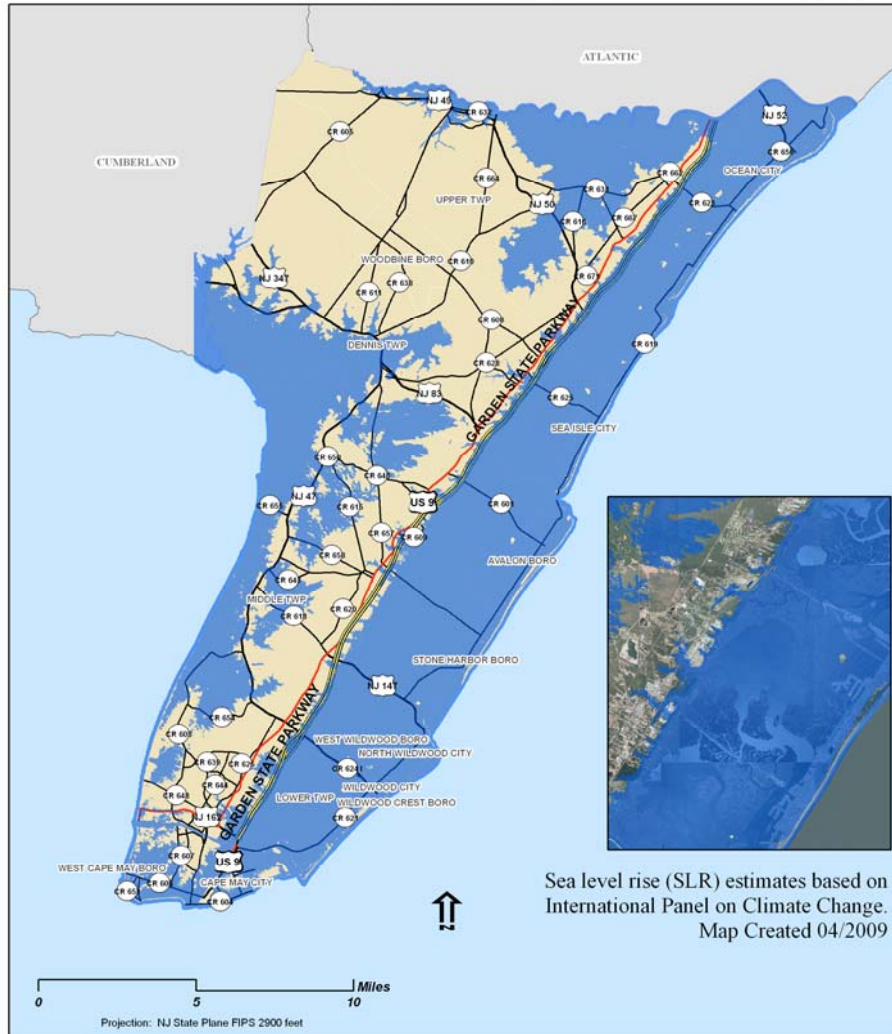
# 1.2m Sea Level Rise for Cape May County, NJ



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# 0.6m Sea Level Rise and 30 Year Storm Surge for Cape May County, NJ

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and Biological Sciences

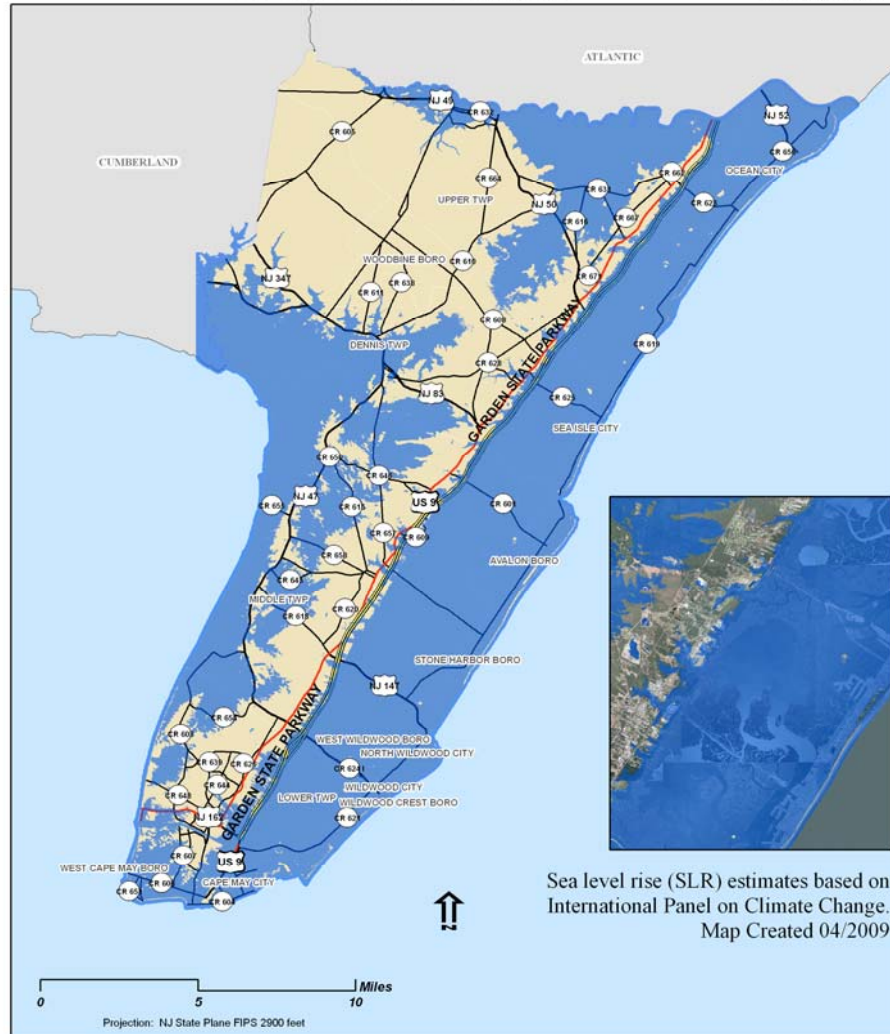


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GLOBAL POSITIONING  
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# 0.6m Sea Level Rise and 100 Year Storm Surge for Cape May County, NJ

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Sea level rise (SLR) estimates based on  
International Panel on Climate Change.  
Map Created 04/2009

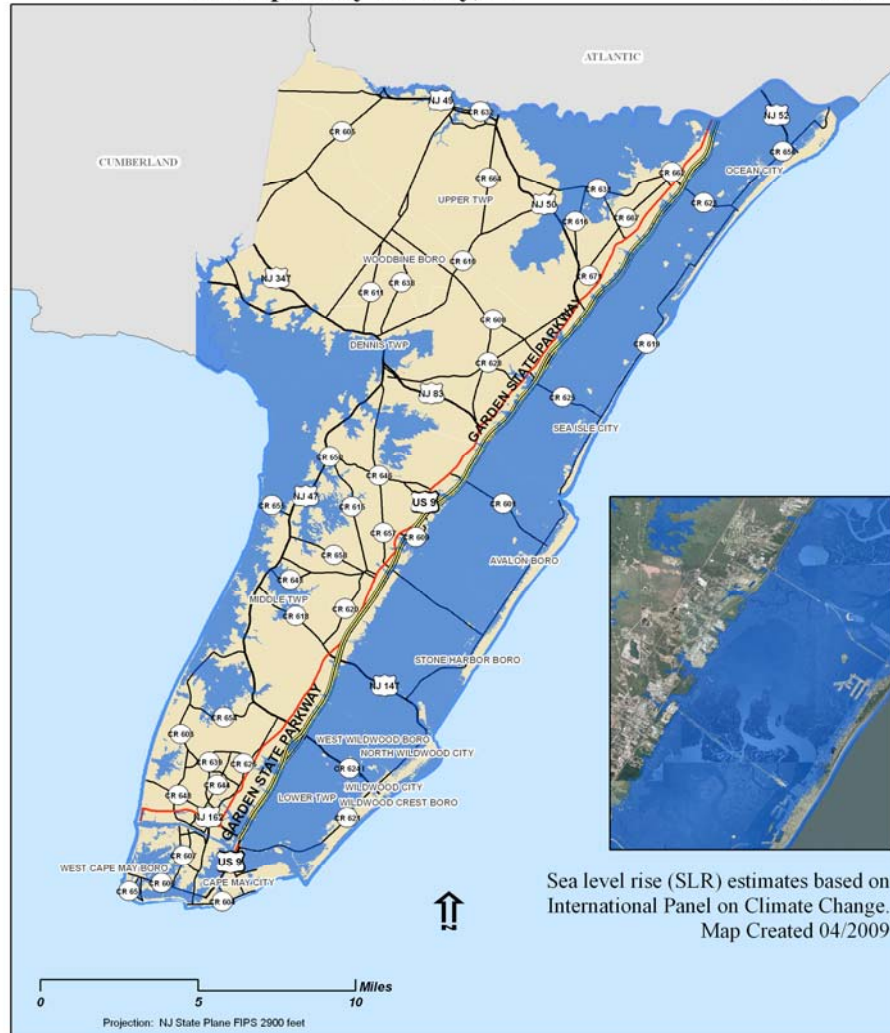
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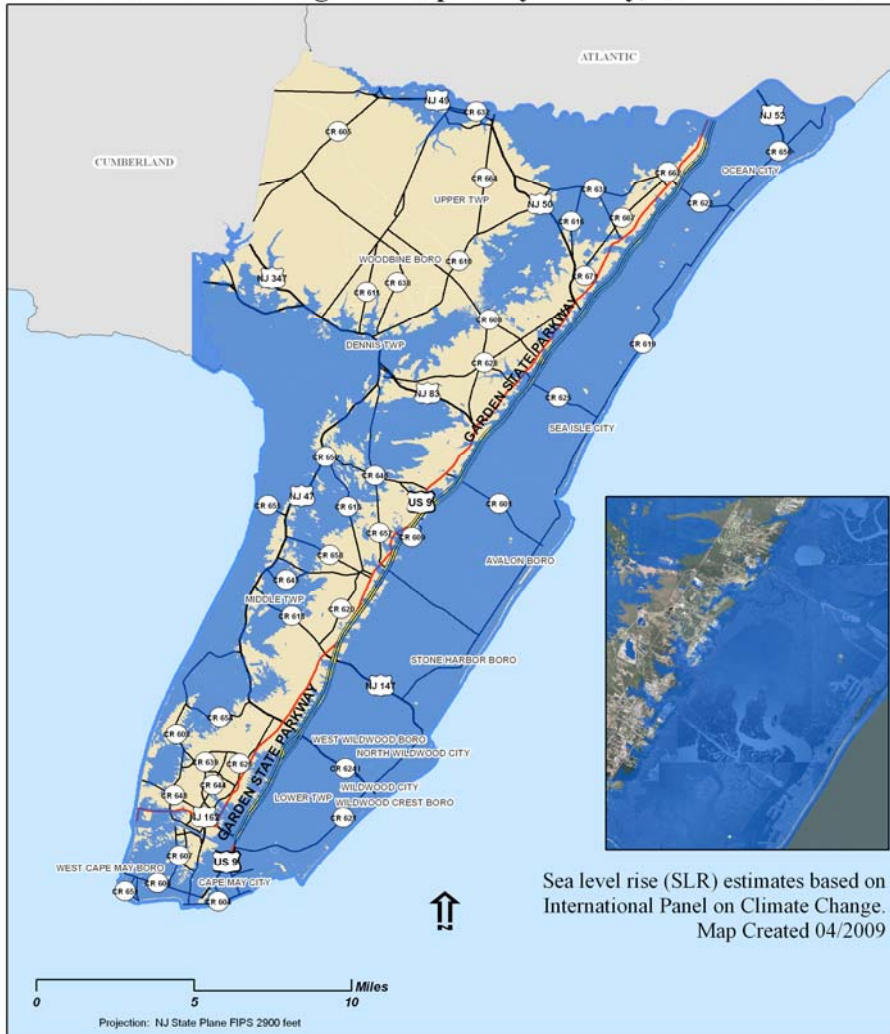


# 1.2m Sea Level Rise and Spring High Water Mark for Cape May County, NJ



Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

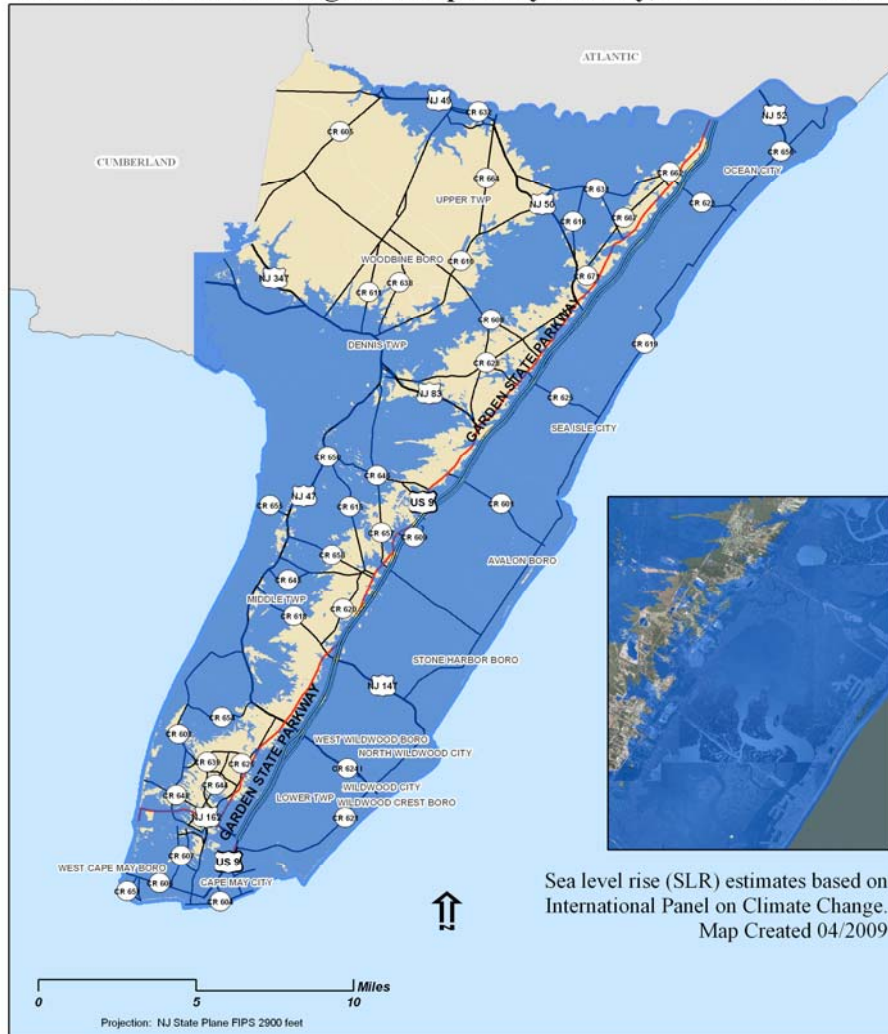
# 0.6m Sea Level Rise, Spring High Water Mark and 30 Year Storm Surge for Cape May County, NJ



Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.



# 1.2m Sea Level Rise, Spring High Water Mark and 100 Year Storm Surge for Cape May County, NJ



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Map Created 04/2009

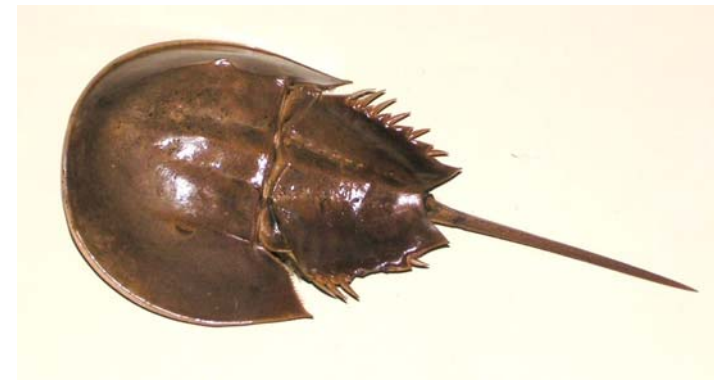
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# Ecological Implications

- Spawning Habitat Change for Horseshoe Crabs
- Feeding Habitat for Migratory Shorebirds
- Nesting Habitat Change For Piping Plovers
- Salt Marsh Retreat
- Nesting Habitat Change for Northern Diamondback Terrapins

# Assessing The Impact of Sea Level Rise on Horseshoe Crab Habitat in Cape May, NJ

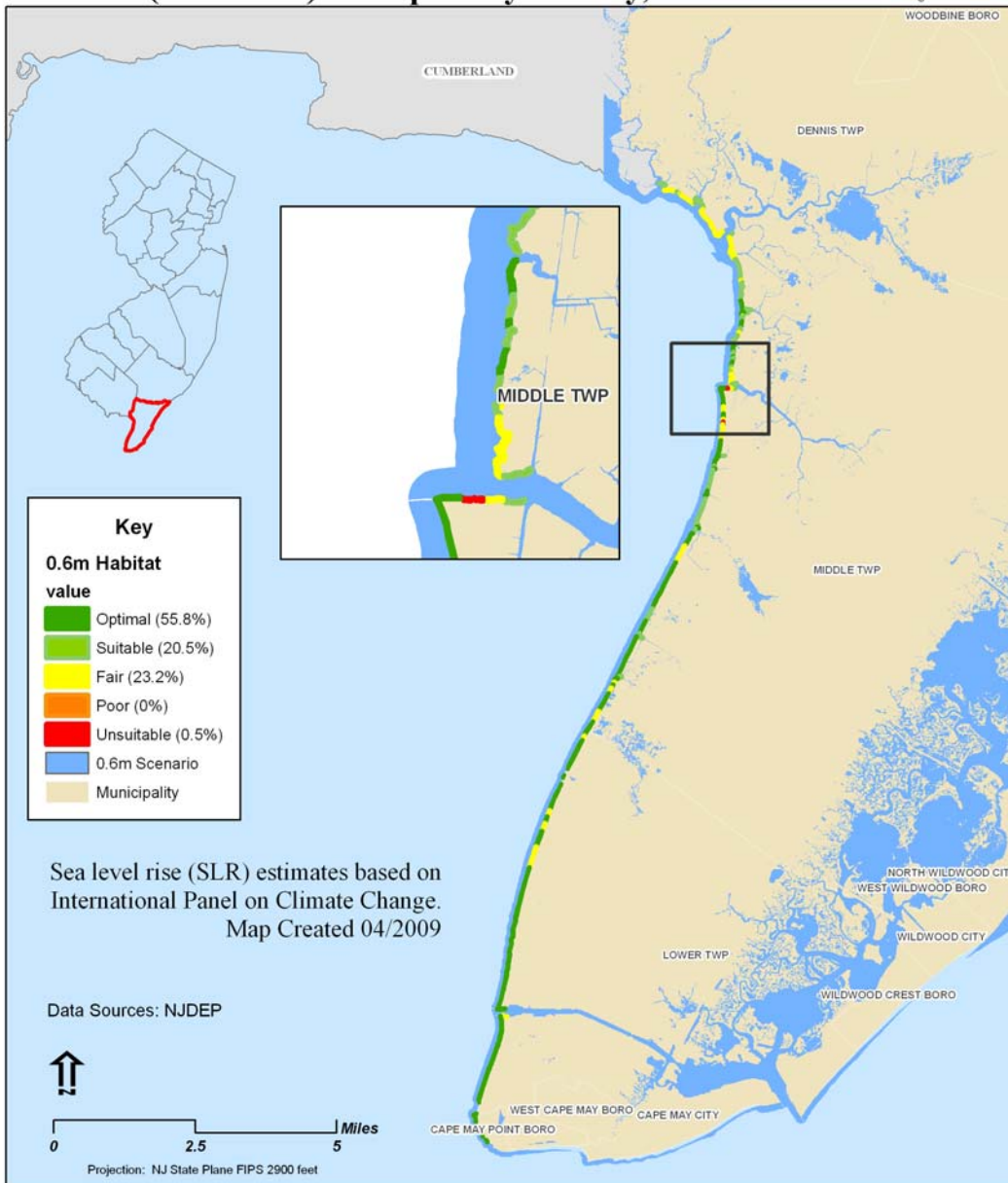
Erik Czaja



# Objective & Methods

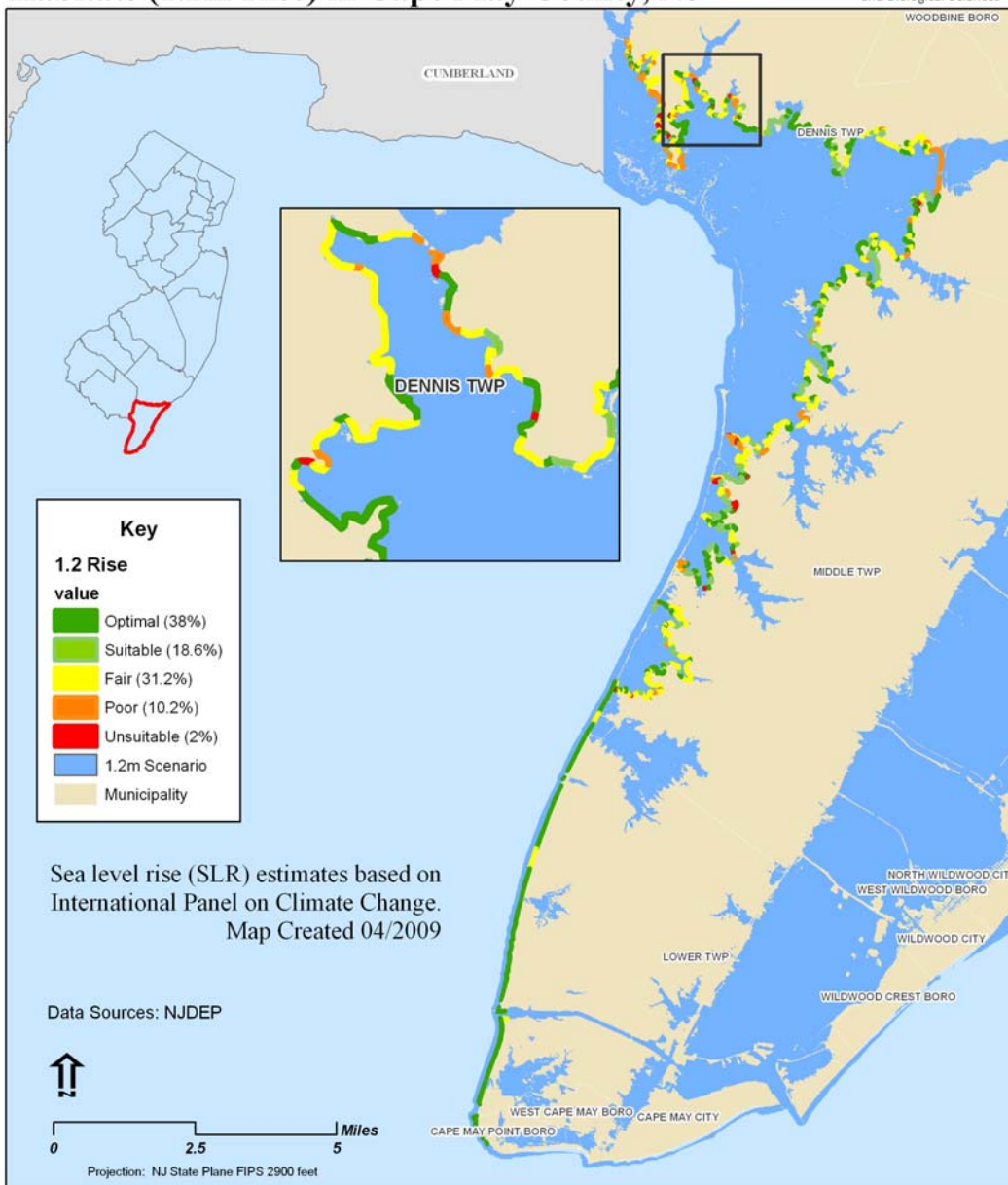
- To assess future habitat of Horseshoe Crabs at the sea level rise estimates of 0.6m and 1.2m
- Identified and outlined areas of potential Horseshoe crabs
- Classified and applied values

# Impacts of Sea Level Rise on Horseshoe Crab Habitats (0.6m Rise) in Cape May County, NJ



Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

# Impacts of Sea Level Rise on Horseshoe Crab Habitats (1.2m Rise) in Cape May County, NJ



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# Impact of Sea Level Rise on Feeding Habitats for Migratory Shorebirds in Cape May County, New Jersey



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Laura Stern

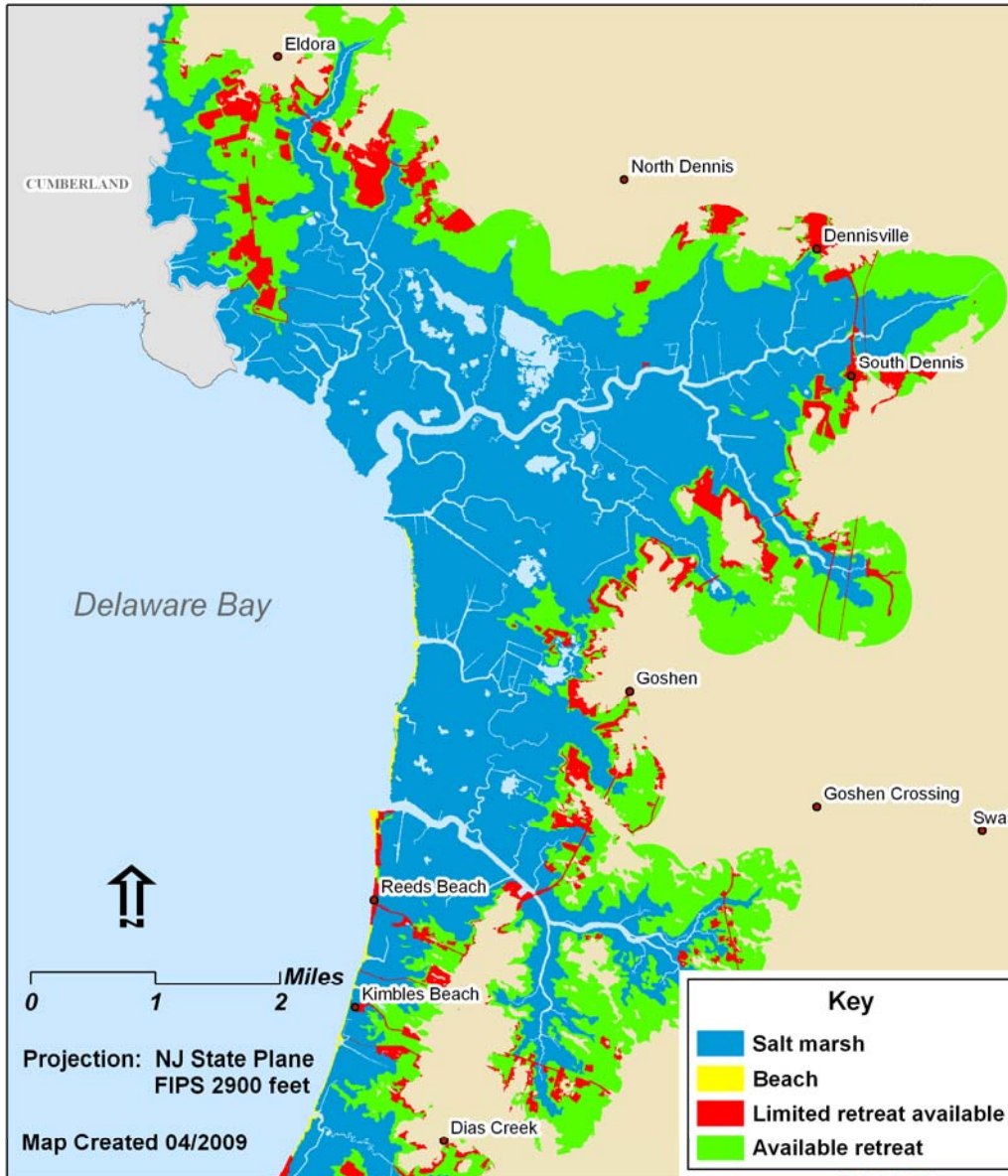
# Objective

- Assess the impact of sea level rise on migratory shorebird habitat
- Three different scenarios of sea level rise will be displayed to show habitat loss
  - 0.6m above mean sea level: low end SLR
  - 1.2m above mean sea level: high end SLR
  - 3.0m above mean sea level: high end SLR  
+ 5 year storm surge

# Methods

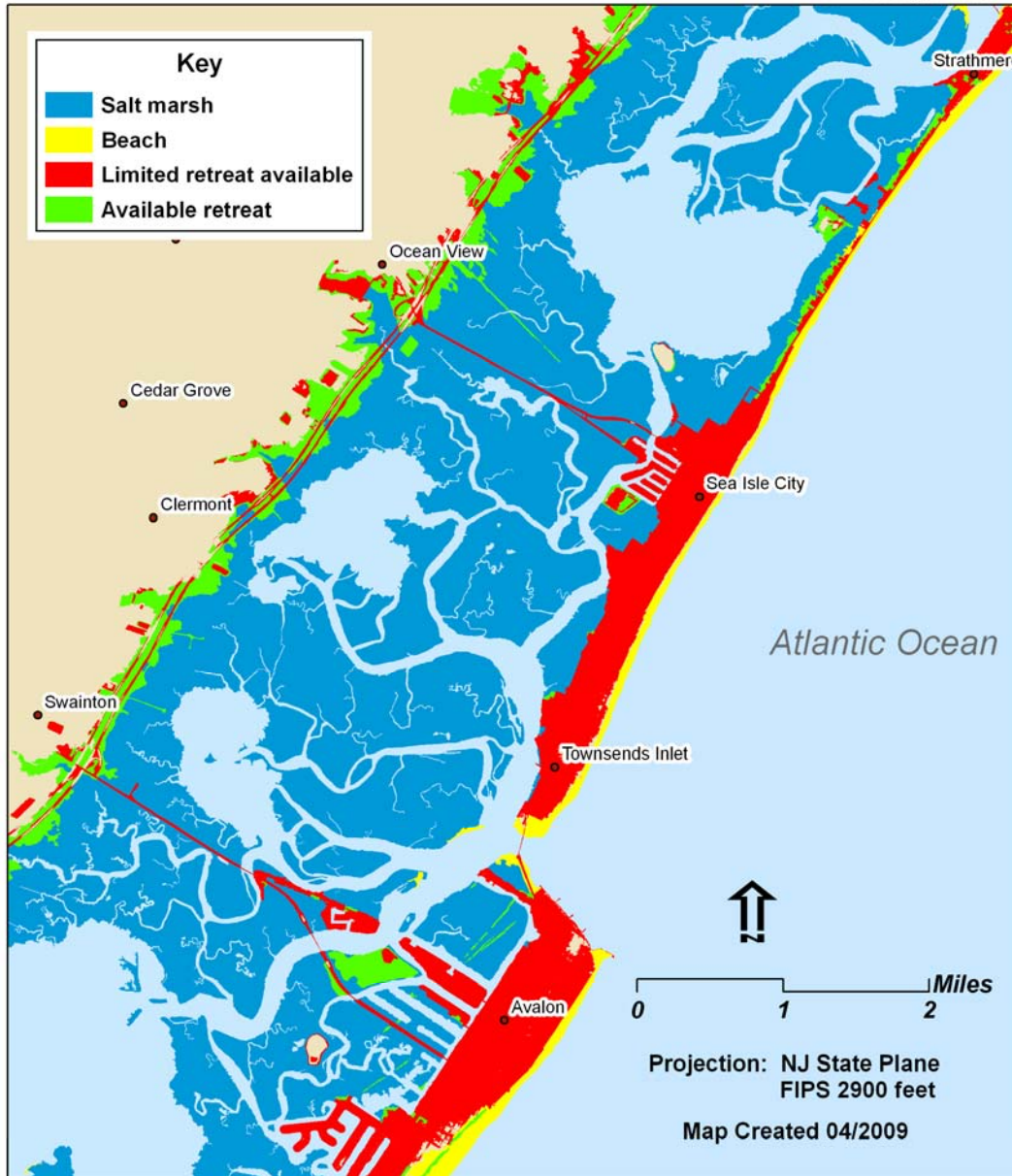
- NJDEP 2002 land use (LU) data:
  - 500 meter buffer around shorebird habitat to determine possible habitat retreat zones
  - Buffer restricted to elevations less than 3 meters
- Habitat with retreat zone buffer was overlaid with each sea level rise scenario to determine area of habitat loss

# Migratory Shorebird Habitat in Cape May County, NJ



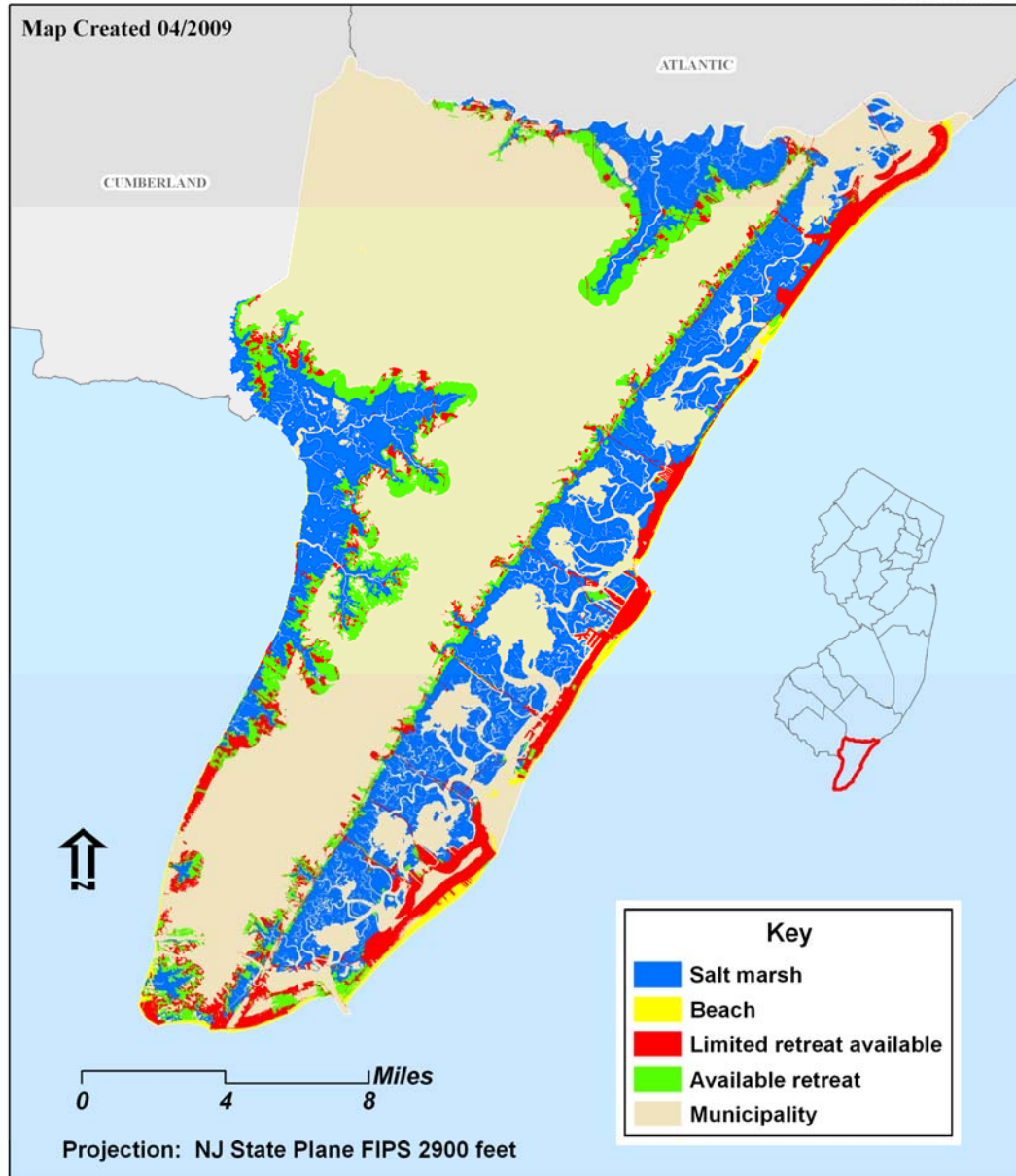
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# Migratory Shorebird Habitat in Cape May County, NJ



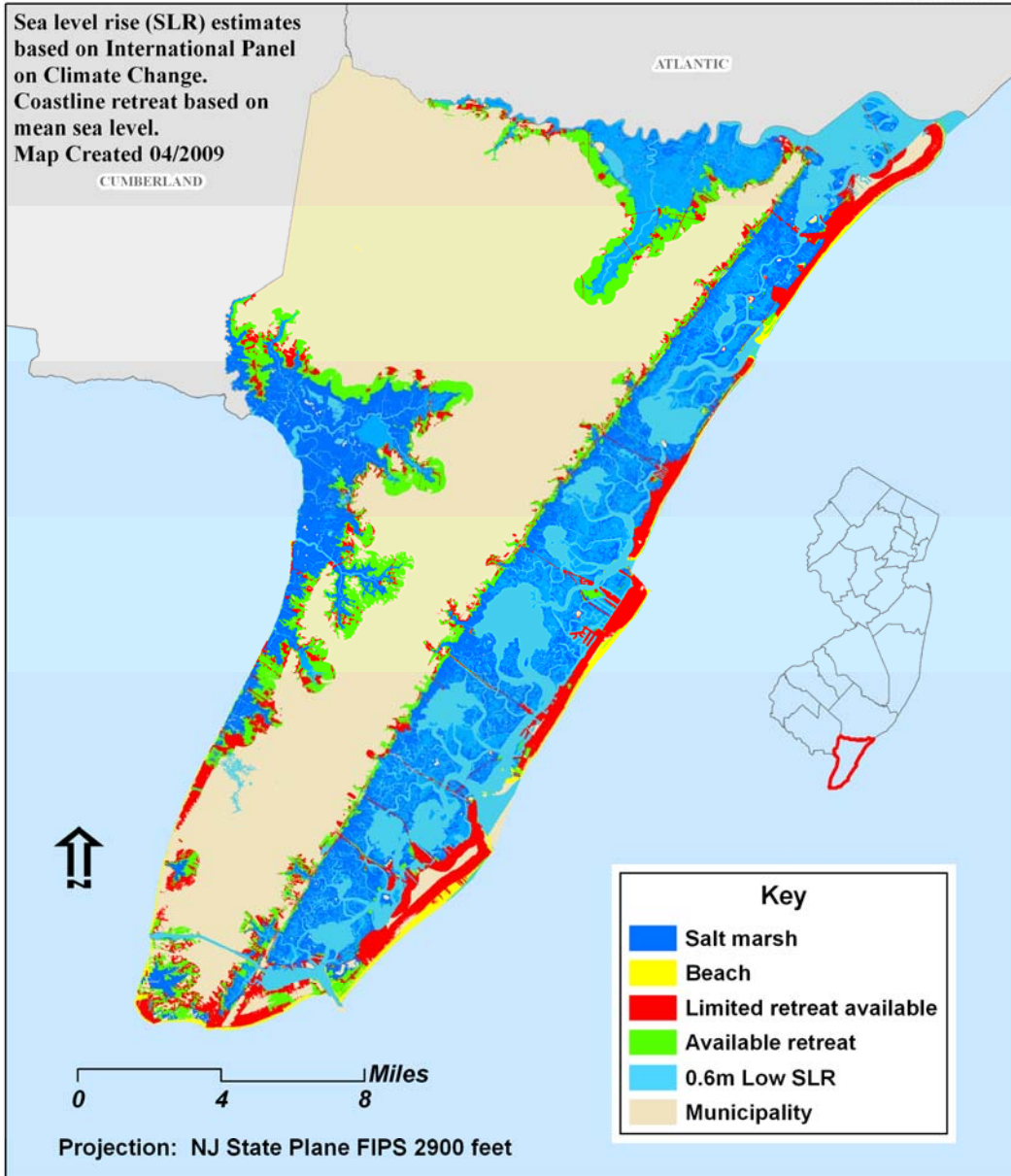
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# Current Migratory Shorebird Habitat and areas available for inland migration of habitat in Cape May County, NJ



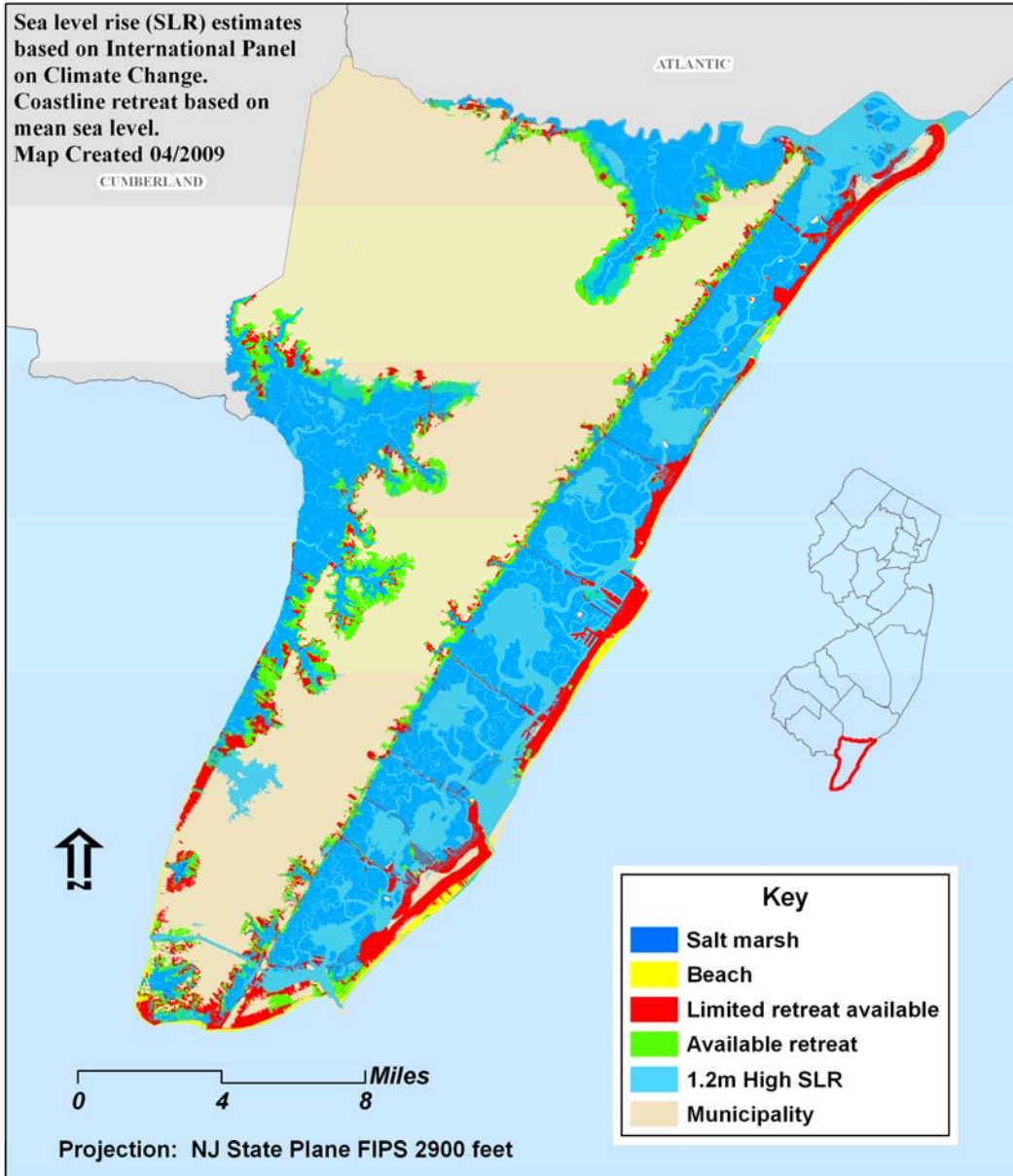
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# Impact of 0.6m Sea Level Rise on Migratory Shorebird Habitat in Cape May County, NJ



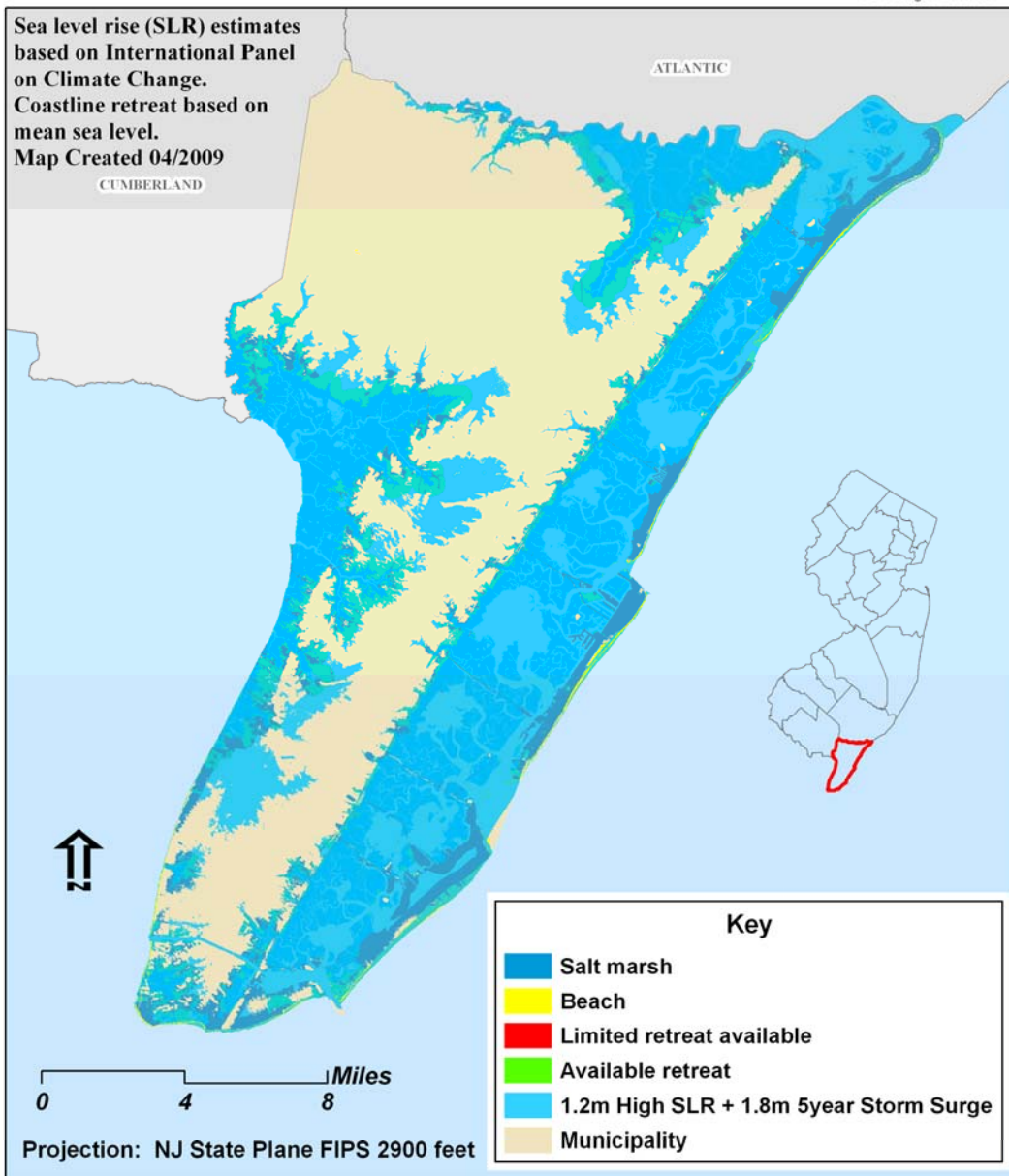
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# Impact of 1.2m Sea Level Rise on Migratory Shorebird Habitat in Cape May County, NJ



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# Impact of 3m Sea Level Rise on Migratory Shorebird Habitat in Cape May County, NJ



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# Results

## Shorebird habitat

SLR (m)	Area (acres)	Area Lost
0	43,800	
0.6	18,130	41%
1.2	41,800	95%
3	43,350	99%

## Habitat Retreat

SLR (m)	Area (acres)	Area Lost
0	13,260	
0.6	215	2%
1.2	4190	32%
3	13,260	100%

# Plover Habitat and Sea Level Rise

A GIS analysis of sea level rise using LiDAR data and piping plover nesting habitat

By  
Thomas Thorsen

# Digitization of Nesting Habitat

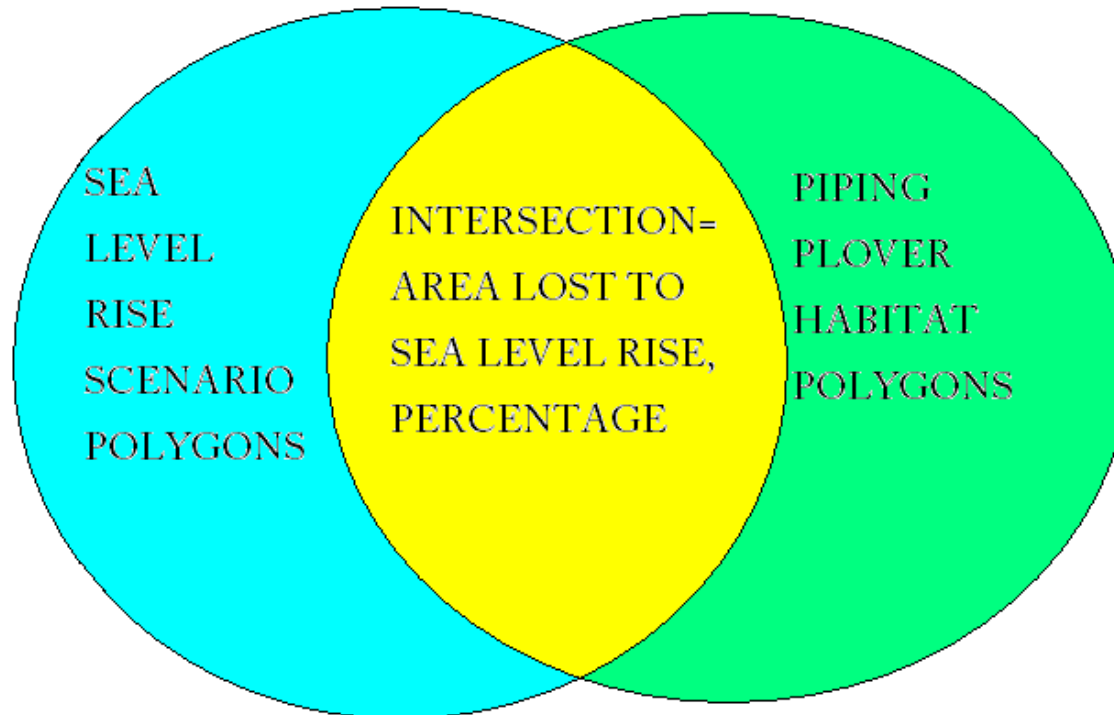
- Plover Nest Coordinates compliments of NJ Fish and Wildlife were used along with aerial photography to digitize nesting habitat
- Considerations:
  - Nesting habitats impinged by infrastructure versus natural areas without seawalls, jetties, groins, or development are classified.
  - Feeding habitat included until present mean sea level, and dune areas not developed are also included in the digitization to show possible new habitat.

# Goals

- The analysis was designed to display the effect of sea level rise on plover beach nesting sites.
- Three different scenarios of sea level rise will be displayed to show habitat loss
  - 0.6m, low end sea level rise on mean sea level
  - 1.2m, high end sea level rise on mean sea level
  - 2.4m, low end sea level rise and a 5 year storm surge.

# Determining Plover Habitat Inundation With Sea Level Rise Scenarios

GIS ANALYSIS



The three scenarios each yielded three striking percentages of plover habitat which will become inundated.

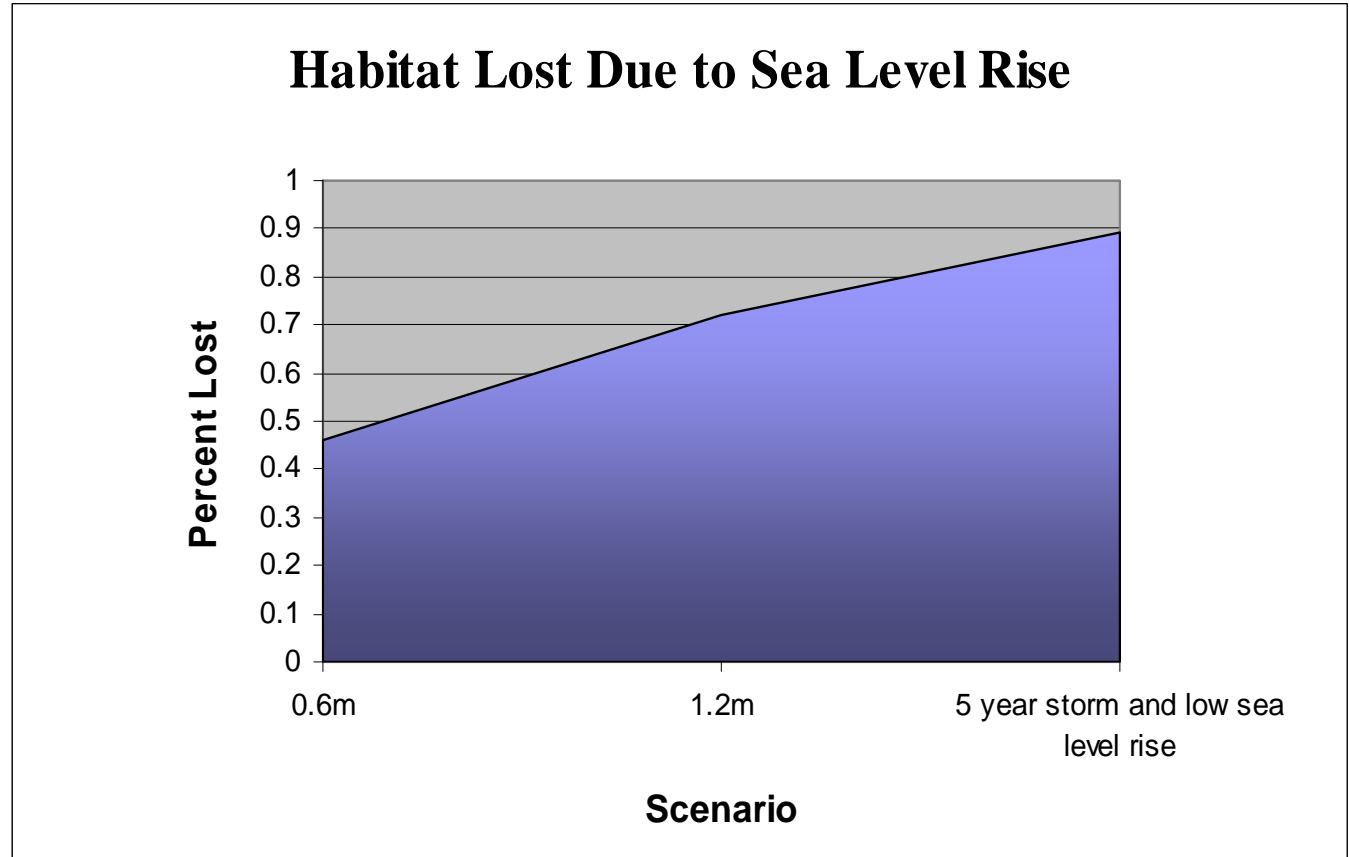
# Results

The results are significant because of natural areas that are low in elevation.

0.6m is the low end sea level rise scenario

1.2m is the high end SLR scenario.

Storms are expected to increase in intensity and frequency.



# Impacts of Sea Level Rise and Storm Surge Events on Piping Plover Nest Habitat, Cape May County, NJ



Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NO S4190228 and NA07NO S4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 BMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.



# Salt Marsh Retreat in Cape May County

**A Brief Analysis of Salt Marsh Retreat Dynamics  
Based on the Effects of Sea Level Rise in Cape May**

By Manfredi Giliberti



# Objective

This study's objective is to apply a GIS approach in identifying areas of Cape May that are available for salt marsh retreat given two sea level rise scenarios:  
0.6 meter and 1.2 meter



# Methods

- Identify salt marsh and developed land in Cape May county
- Define a retreat area upland of the salt marsh
- Remove developed areas from the defined retreat zone
- Apply sea level rise scenario
- Measure change in size of salt marsh and retreat area cause by increased water level



# Results

## 0.6 Meter Sea Level Rise - Low End Scenario

47% Loss in Salt Marsh - 58485.13 acres remaining

2% Loss in Retreat Area - 41977.46 acres remaining

## 1.2 Meter Sea Level Rise - High End Scenario

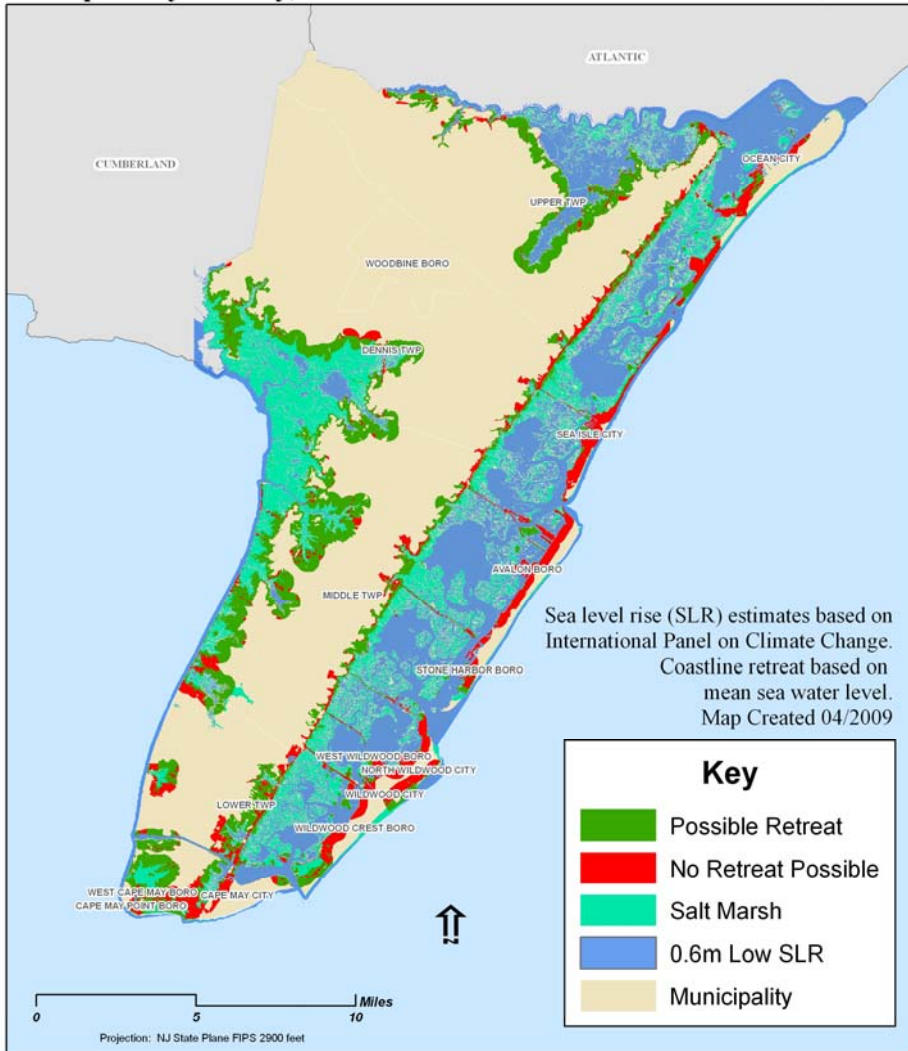
100% Loss in Salt Marsh - No salt marsh remaining

32% Loss in Retreat Area - 29127.22 acres remaining

After Additional 500 meter Buffer

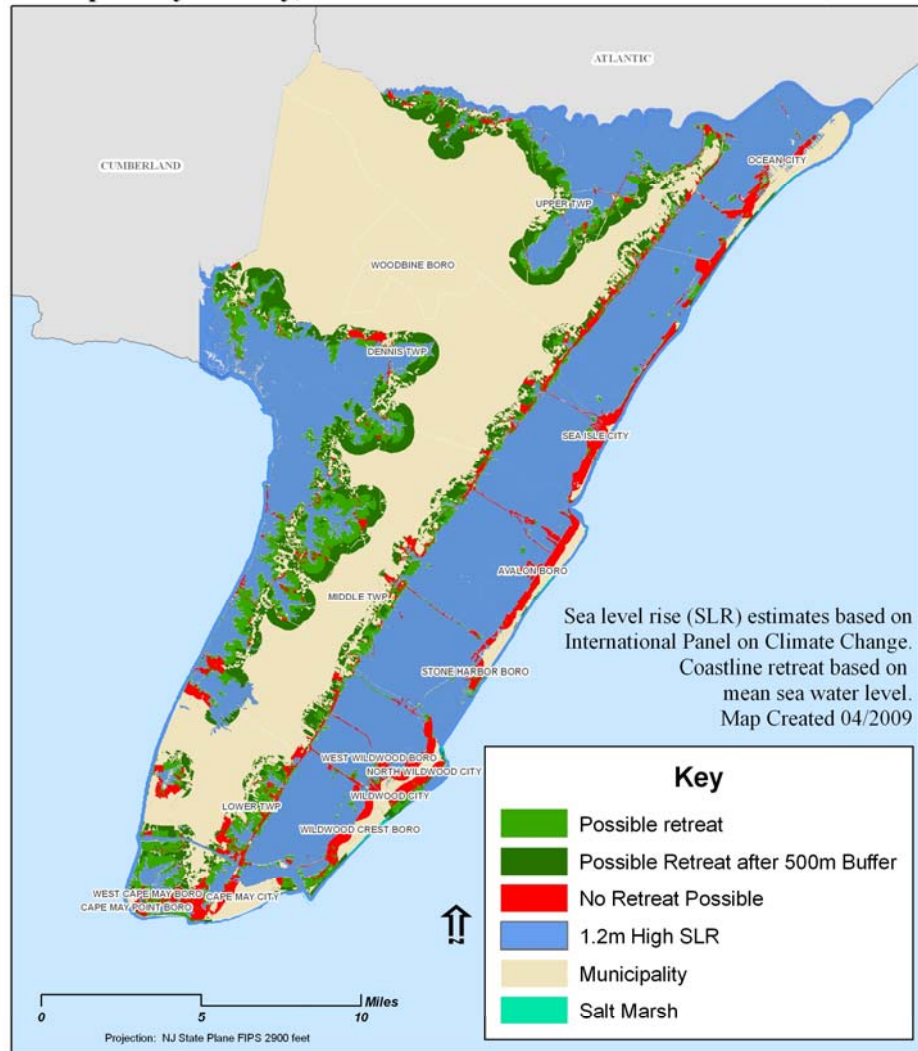
Retreat Area -57747.24 acres

# Impacts of Sea Level Rise on Salt marsh Retreat in Cape May County, NJ - 0.6 m Scenario



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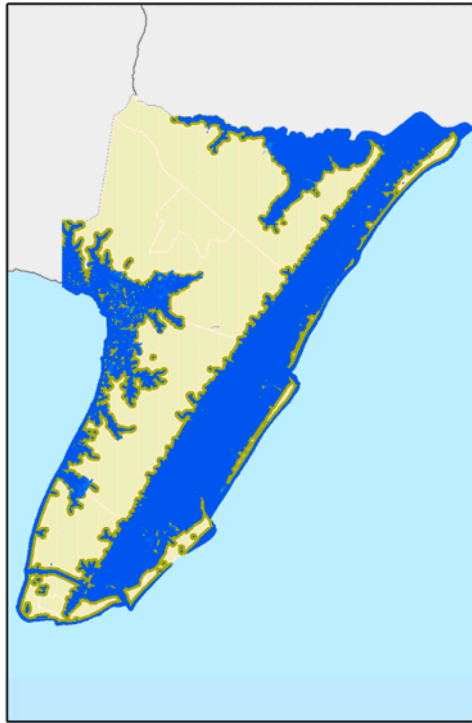
# Impacts of Sea Level Rise on Salt marsh Retreat in Cape May County, NJ - 1.2 m Scenario



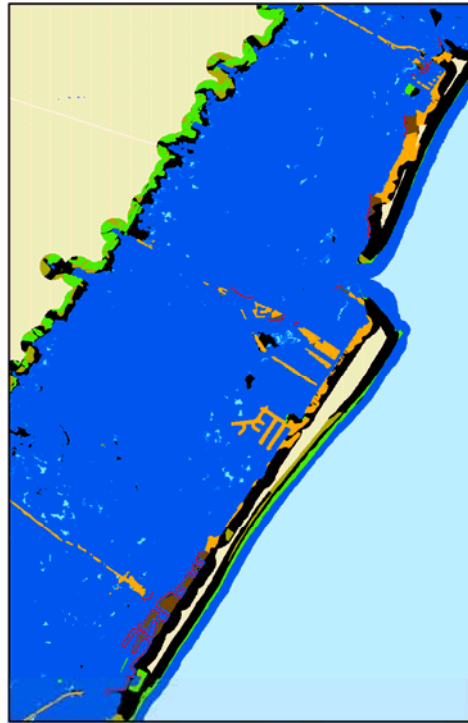
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# The Effects of Sea Level Rise on Nesting Sites of Diamondback Terrapins (*Malaclemys terrapin*) in Cape May County New Jersey

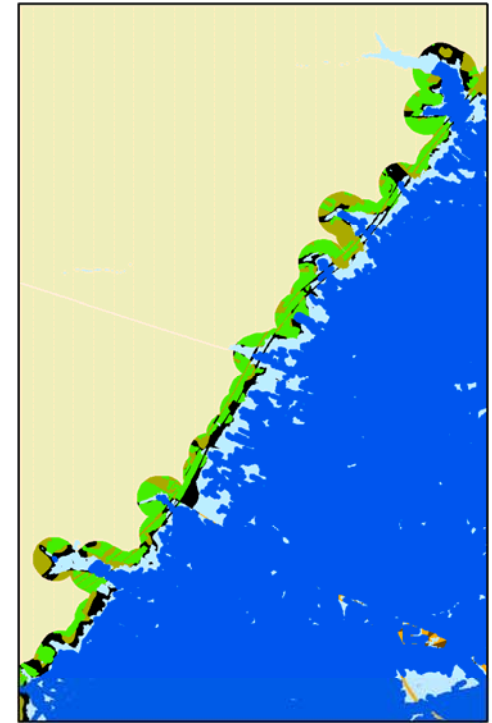




**The diamondback terrapin is a highly aquatic turtle and will not travel more than 250m to find suitable nesting sites.**

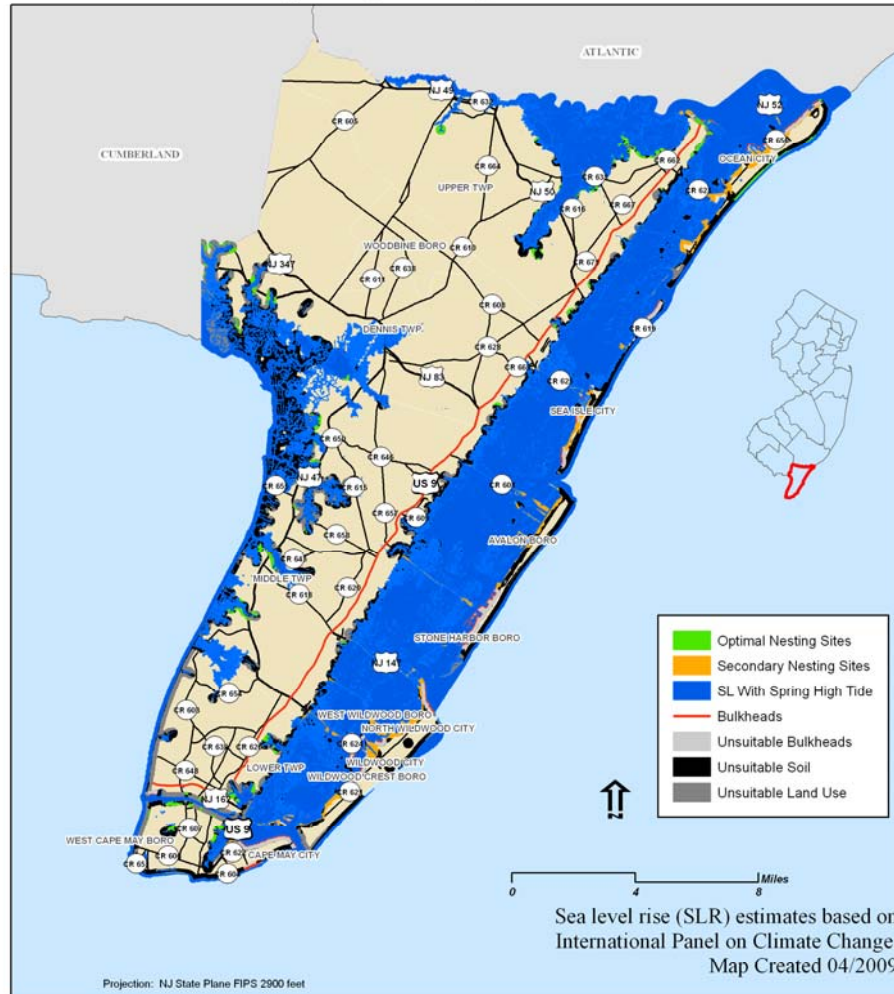


**The terrapin requires sandy well drained soils out of the tidal zone with specific land use and cover. Due to the decrease in natural nesting sites the terrapin has begun nesting in the loose roadside soil of Cape May County.**



**Optimal nesting sites are the areas within 250m from the water level that are out of the Spring High Tide zone, with the correct soil type and land use and cover, and are represented with Bright Green. Secondary nesting sites are represented in orange and are the roadside soils the terrapins have begun nesting in**

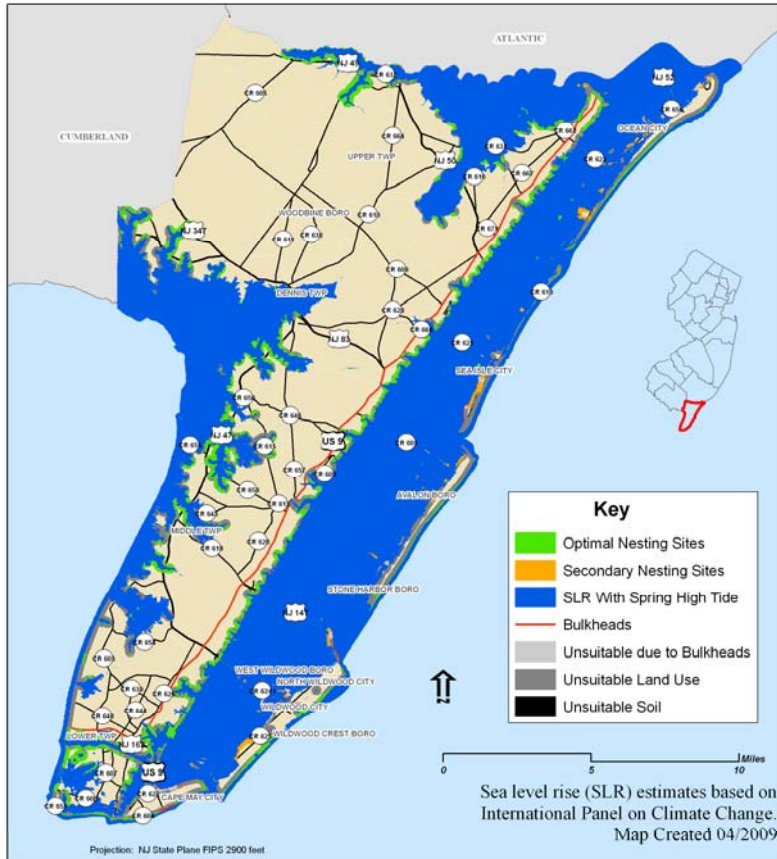
# Accessing Diamondback Terrapin Nesting Site Suitability for Cape May County, NJ



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# Accessing The Implications of 0.6m Sea Level Rise on **RUTGERS** Diamondback Terrapin Nesting Site Suitability for Cape May County, NJ

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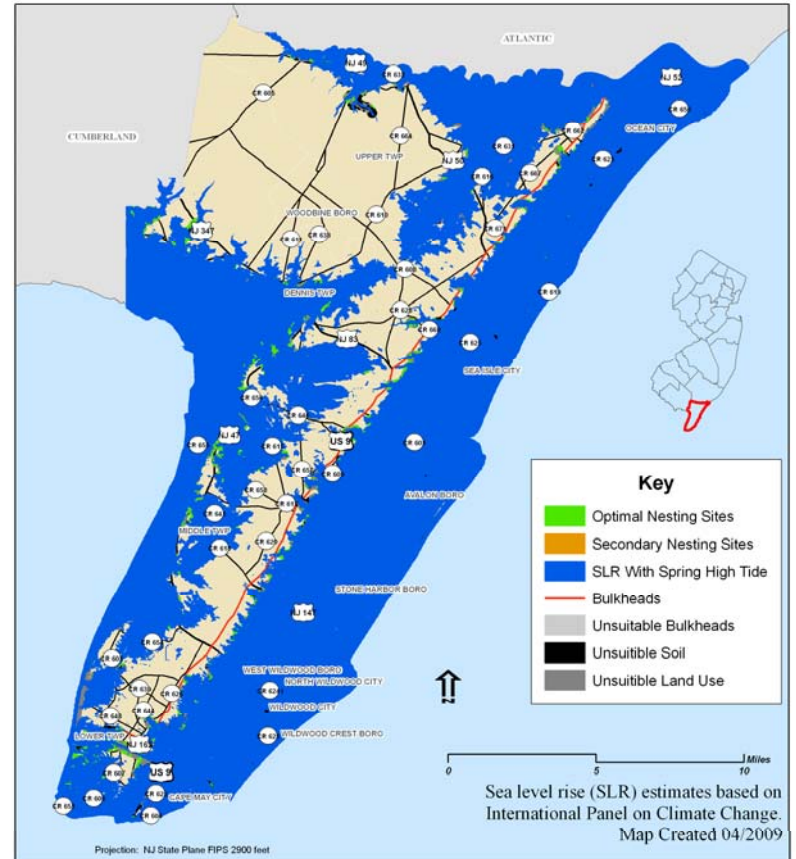


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# Accessing The Implications of 1.2m Sea Level Rise on **RUTGERS** Diamondback Terrapin Nesting Site Suitability for Cape May County, NJ

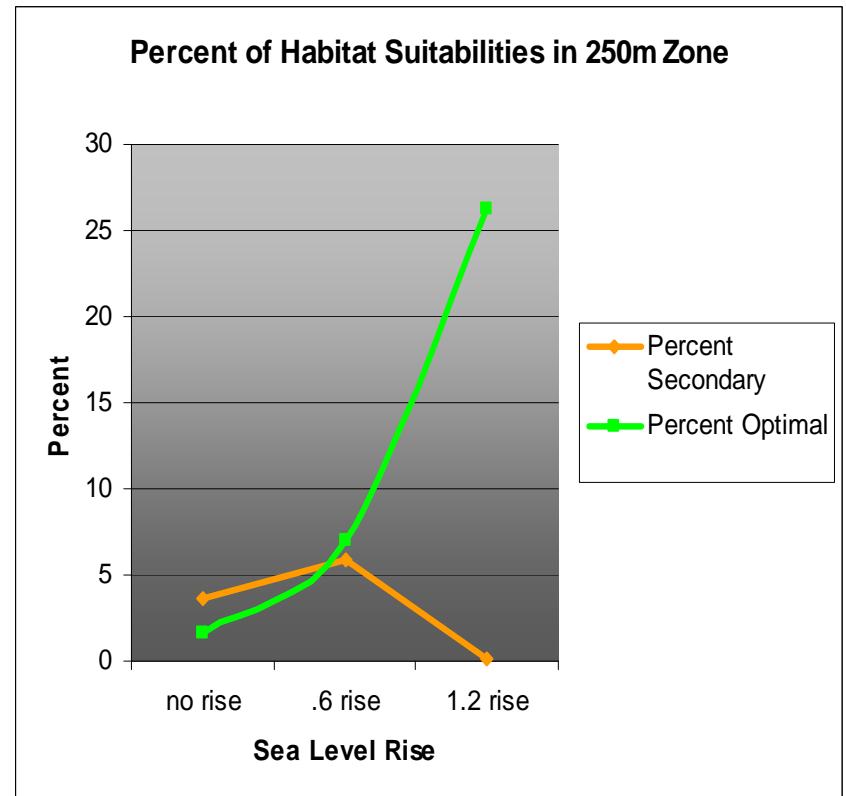
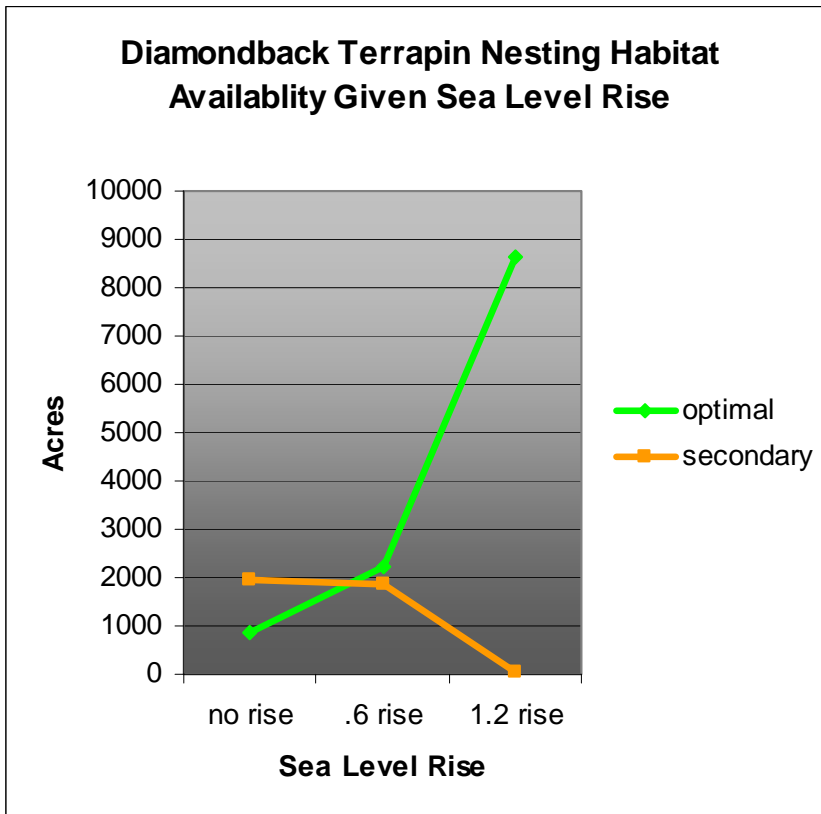
School of Environmental and Biological Sciences



Financial assistance for this project was provided by the New Jersey Coastal Management Program through C2M Grant Awards #A06N054190228 and #A07N054190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geological Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.



# Results



# Impacts of Sea Level Rise and Storm Surge Events on Human Infrastructure

- Tourism and Commerce
- Property Value and Tax Revenue
- Social Vulnerability
- Critical Facilities and Infrastructure
- Evacuation Route

# Effects of Sea Level Rise and Storm Surge Events on Tourism and Commerce in Cape May County, NJ

Megan Hajduk

# Tourism



Tourism in New Jersey is a \$38 billion industry with more than 80% coming from the four counties that run along the Atlantic Ocean.

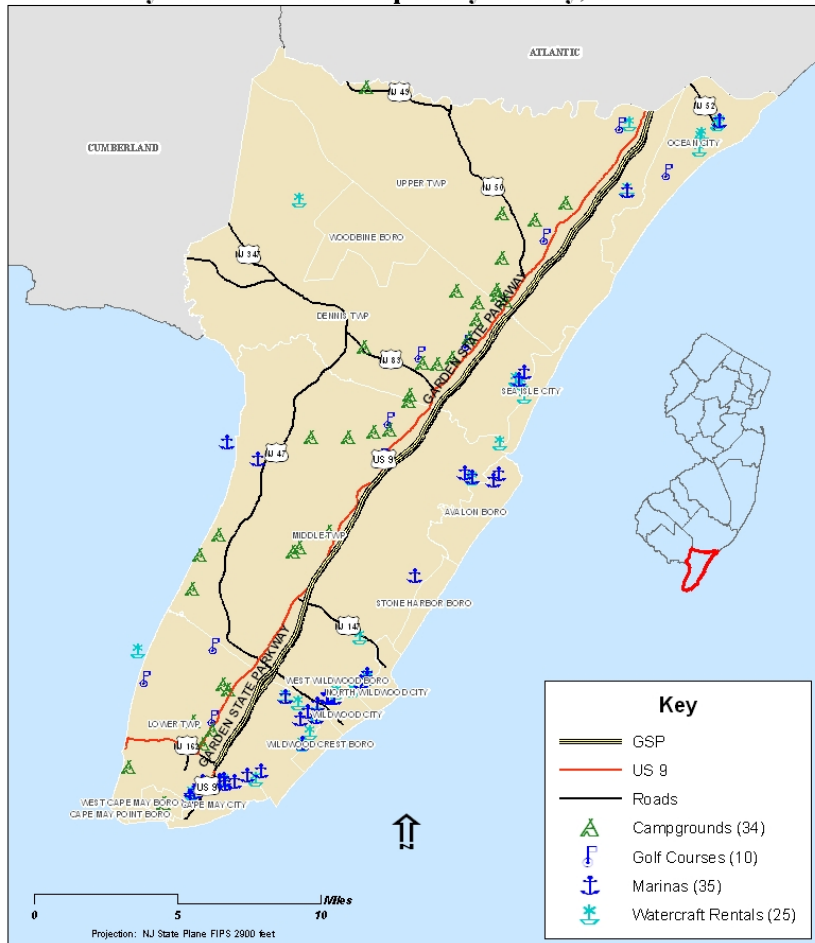
Tourism economic expenditures for Cape May County in 2007 amounted to \$5.1 billion, which is about 13% of the state's total tourism expenditures.

Cape May, Ocean City and the Wildwoods lead in economic expenditures for the county since they are the largest resorts with the most tourism inventory.

# Some Key Areas for Tourism

Impacts of Sea Level Rise and Storm Surge Events on Economy and Tourism in Cape May County, NJ

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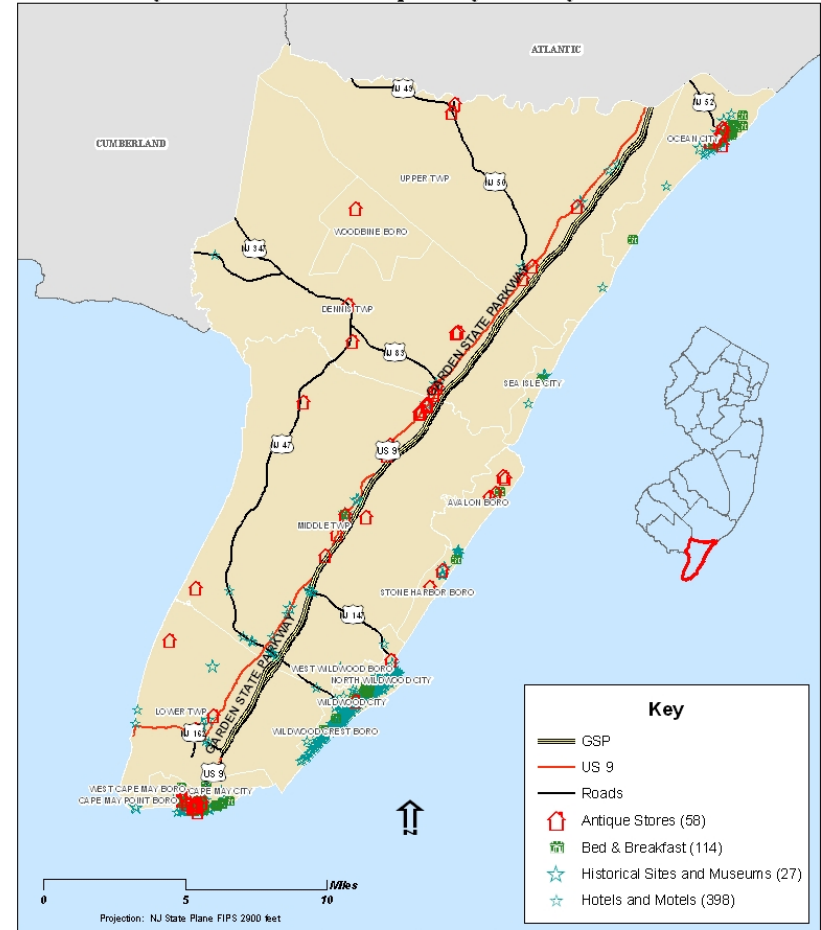


Financial assistance for this project was provided by the New Jersey Coastal Management Program through C2M Grant Awards #NA06NO S4190228 and NA07 NO S4190188 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the F12007 EMFG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

**CRSSA**  
Center for Resilient Seaside & Coastal Analysis

Impacts of Sea Level Rise and Storm Surge Events on Economy and Tourism in Cape May County, NJ

**RUTGERS**  
School of Environmental and Biological Sciences



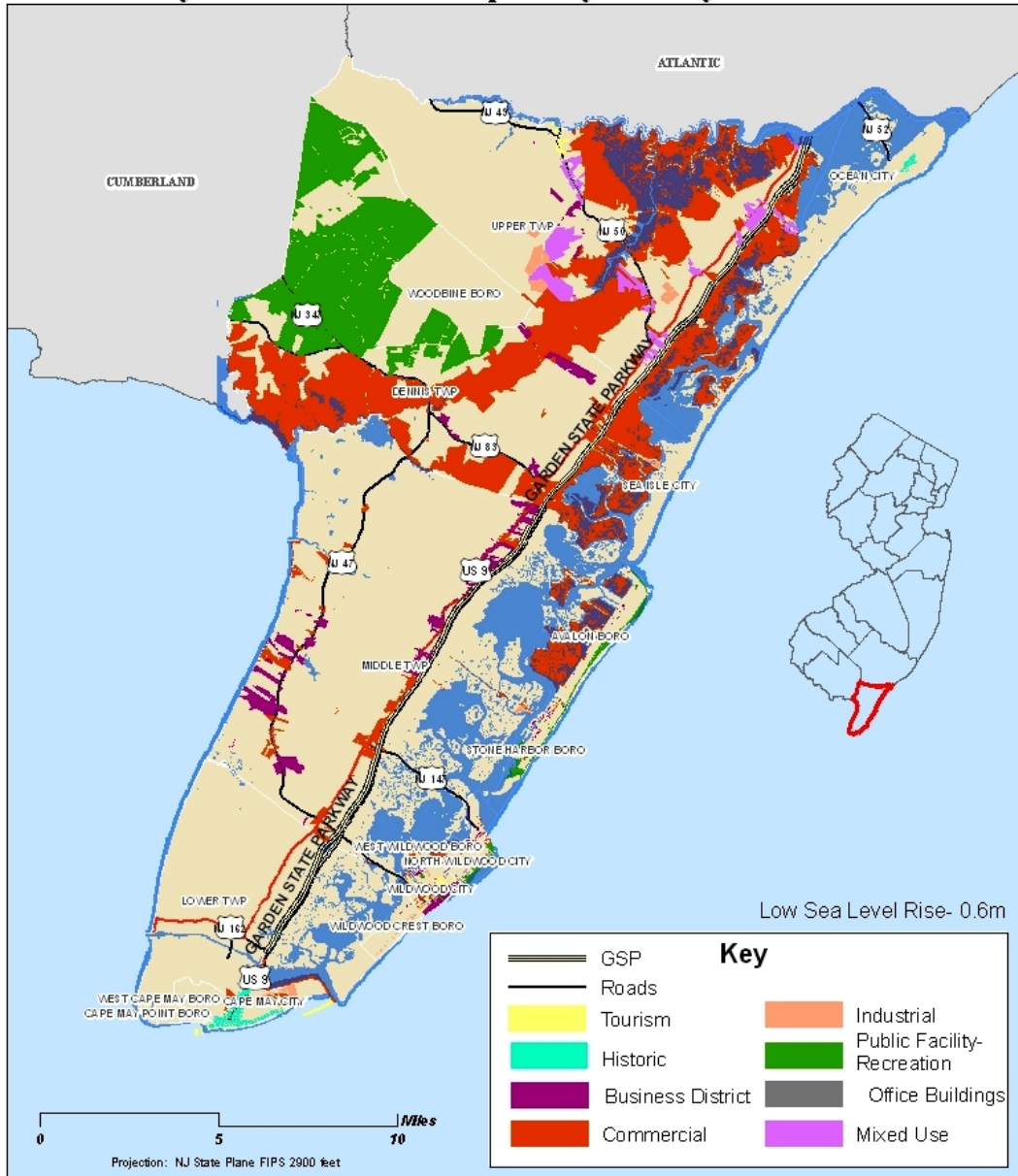
Financial assistance for this project was provided by the New Jersey Coastal Management Program through C2M Grant Awards #NA06NO S4190228 and NA07 NO S4190188 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the F12007 EMFG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

**CRSSA**  
Center for Resilient Seaside & Coastal Analysis

# Objectives

- Show all properties zoned for activities that would have effects on tourism and commerce.
- Establish areas of these zones affected by a low estimate of sea level rise of 0.6m, as well as 30- and 100-year storm surge events.
- Calculate percentage levels of tourism and commerce zones lost and find an estimate of total loss of tourism expenditures for the state of NJ.

# Impacts of Sea Level Rise and Storm Surge Events on Economy and Tourism in Cape May County, NJ



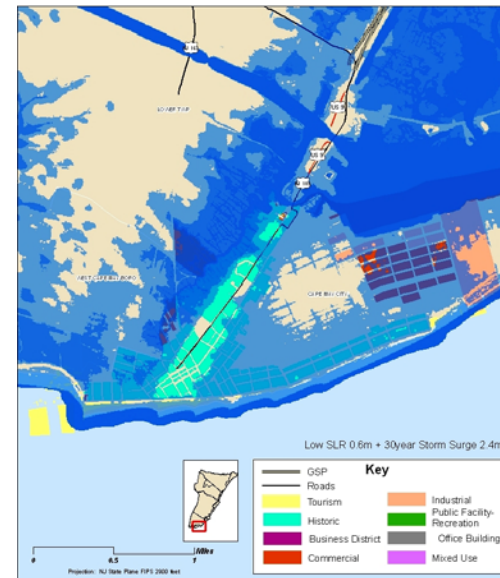
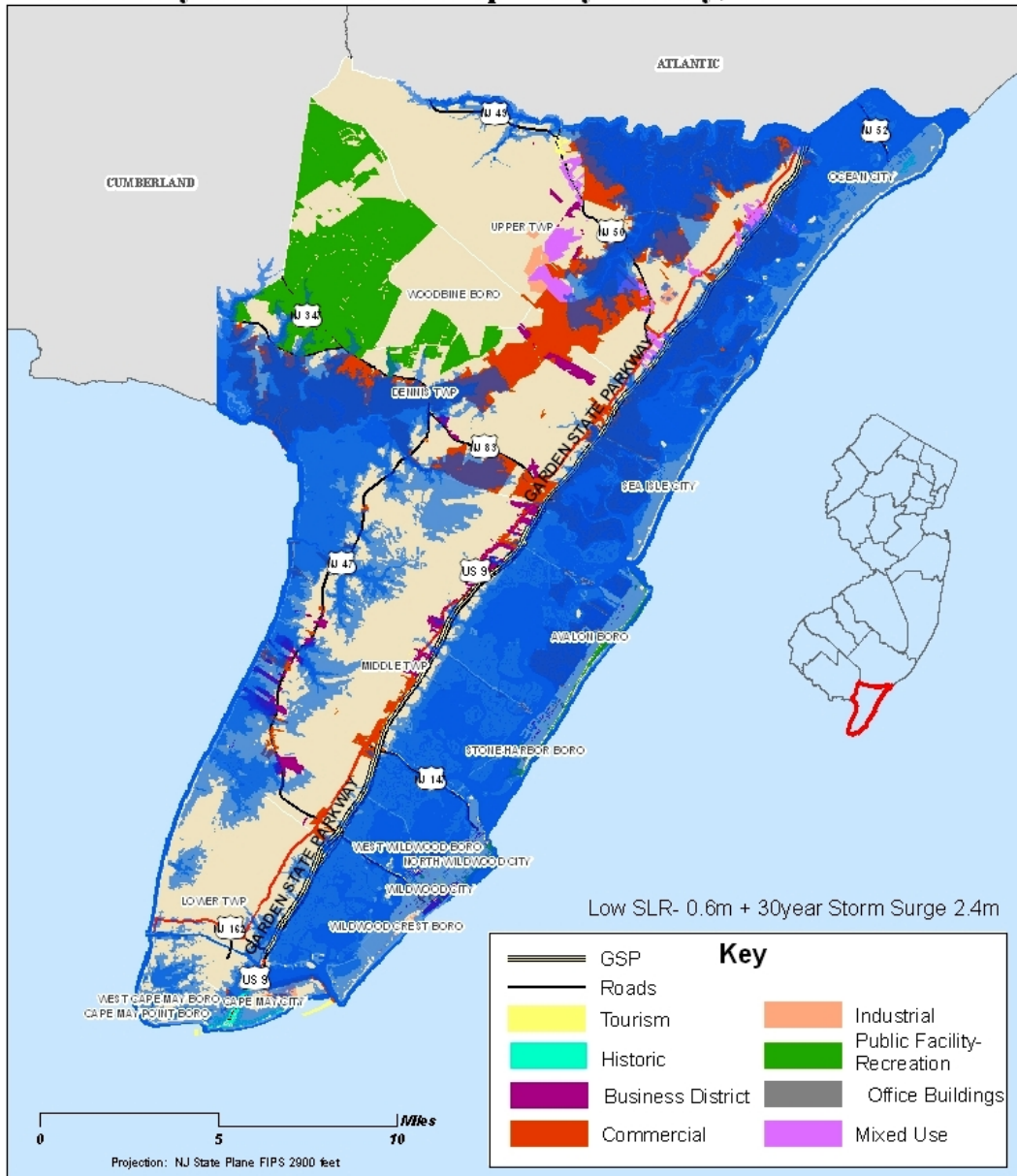
Cape May City



North Wildwood City and Wildwood City

13.2% land zoned for commerce and tourism lost with Low Sea Level Rise (0.6m)

# Impacts of Sea Level Rise and Storm Surge Events on Economy and Tourism in Cape May County, NJ



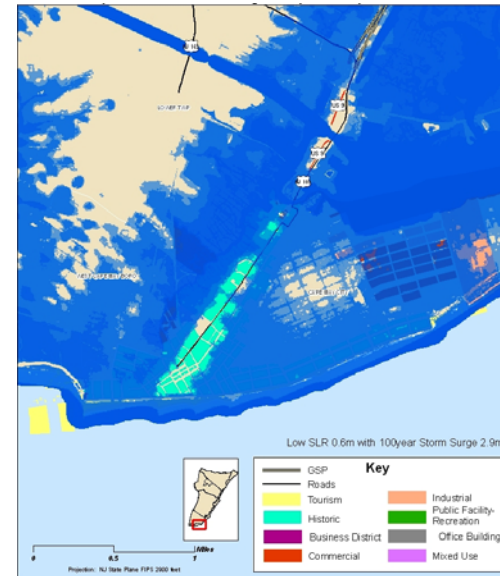
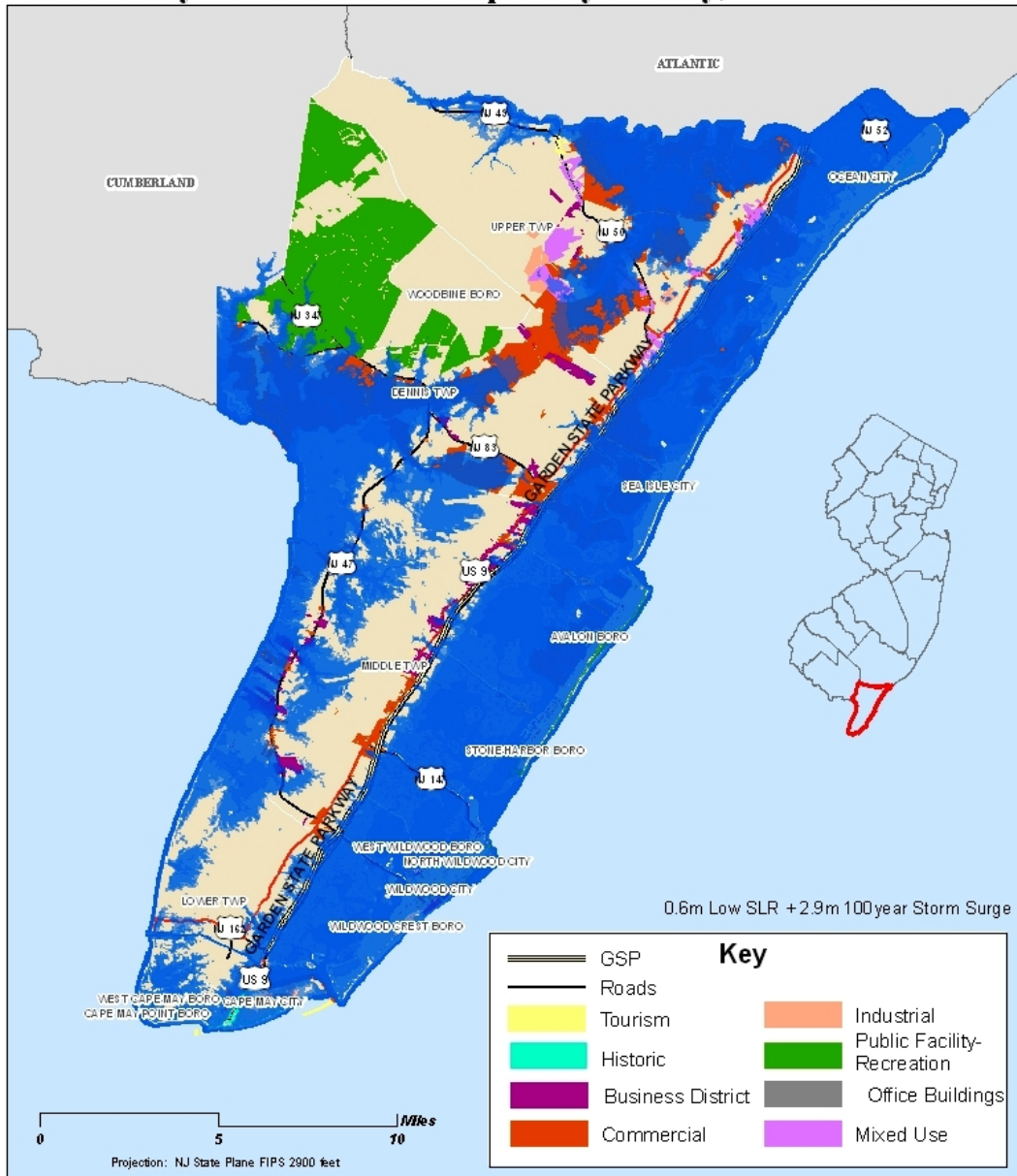
Cape May City

68.4% land zoned for commerce and tourism lost with 30-year storm surge



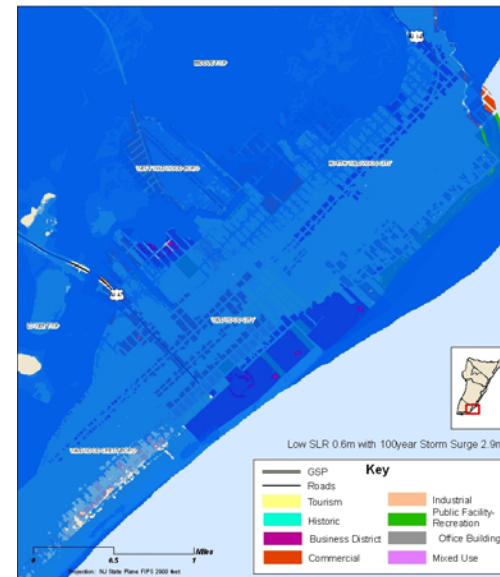
North Wildwood City and Wildwood City

# Impacts of Sea Level Rise and Storm Surge Events on Economy and Tourism in Cape May County, NJ



Cape May City

93.7% land zoned for commerce and tourism lost with 100-year storm surge



North Wildwood City and Wildwood City

# Conclusions

- **Low Sea Level Rise (0.6m)**- 13% loss of zoned Tourism and Commerce land, leading to a loss of approximately **\$6.63 million** in NJ tourism expenditures.
- **30-year Storm Surge (2.4m)**- 68.4% loss of land, leading to a loss of approximately **\$3.48 billion** in NJ tourism expenditures
- **100-year Storm Surge (2.9m)**- 93.7% loss of land, leading to a loss of approximately **\$4.78 billion** in NJ tourism expenditures.

# Effect of SLR on Property Values and Tax Revenues

Nathanael Kiert

# Objectives and Methods

Data for Analysis: ModIV (tax), parcel, and lu/lc

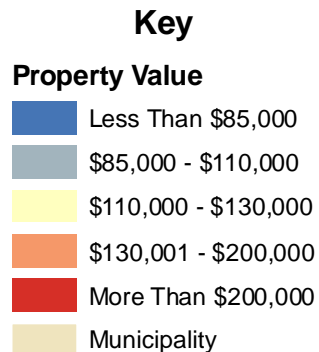
- Determine total property value lost to High estimate of SLR (1.2m)
- Determine total property value affected from new 30y and 100y flood levels
- Determine total tax revenue lost to high estimate of SLR (1.2m)
- Determine an estimate for new tax rates

# High Sea Level Rise (1.2m)

## West Wildwood Borough

99.3% of Developed Parcels

Lost from a 1.2m SLR



# 1.2m SLR (Property Value)

Municipality	Net Property Value	Net Value Lost	New Net Value
Avalon	\$7,666,325,500	<b>\$1,732,555,100</b>	\$5,933,770,400
Cape May City	\$2,135,274,010	<b>\$137,663,910</b>	\$1,997,610,100
Cape May Point	\$292,745,500	<b>\$35,798,800</b>	\$256,946,700
Dennis	\$976,044,400	<b>\$17,841,100</b>	\$958,203,300
Lower	\$4,453,581,800	<b>\$174,995,000</b>	\$4,278,586,800
Middle	\$3,409,674,800	<b>\$436,168,700</b>	\$2,973,506,100
North Wildwood	\$2,946,201,500	<b>\$596,360,100</b>	\$2,349,841,400
Ocean City	\$7,630,442,847	<b>\$1,620,169,047</b>	\$6,010,273,800
Sea Isle City	\$1,698,634,500	<b>\$304,459,400</b>	\$1,394,175,100
Stone Harbor	\$3,494,367,050	<b>\$793,482,850</b>	\$2,700,884,200
Upper	\$2,188,394,200	<b>\$217,912,600</b>	\$1,970,481,600
West Cape May	\$2,188,394,200	<b>\$54,694,600</b>	\$2,133,699,600
West Wildwood	\$182,754,900	<b>\$180,489,900</b>	\$2,265,000
Wildwood City	\$1,792,175,400	<b>\$338,884,600</b>	\$1,453,290,800
Wildwood Crest	\$1,028,934,400	<b>\$52,200,100</b>	\$976,734,300

Total Net Value of Property lost in Cape May County due to 1.2m SLR

**\$ 6,693,675,807**

# 1.2m SLR (Tax Revenue)

Municipality	Tax Rate	Tax Lost	Total Tax	New Tax Rate
Avalon	0.368	\$6,375,803	\$28,212,078	<b>\$0.48</b>
Cape May City	0.833	\$1,146,740	\$17,786,833	<b>\$0.89</b>
Cape May Point	0.791	\$283,169	\$2,315,617	<b>\$0.90</b>
Dennis	1.096	\$195,538	\$10,697,447	<b>\$1.12</b>
Lower	1.061	\$1,856,697	\$47,252,503	<b>\$1.10</b>
Middle	1.185	\$5,168,599	\$40,404,646	<b>\$1.36</b>
North Wildwood	0.785	\$4,681,427	\$23,127,682	<b>\$0.98</b>
Ocean City	0.676	\$10,952,343	\$51,581,794	<b>\$0.86</b>
Sea Isle City	0.518	\$1,577,100	\$8,798,927	<b>\$0.63</b>
Stone Harbor	0.529	\$4,197,524	\$18,485,202	<b>\$0.68</b>
Upper	1.158	\$2,523,428	\$25,341,605	<b>\$1.29</b>
West Cape May	0.945	\$516,864	\$4,481,405	<b>\$0.21</b>
West Wildwood	1.452	\$2,620,716	\$2,653,601	<b>\$117.16</b>
Wildwood City	1.657	\$5,615,318	\$29,696,346	<b>\$2.04</b>
Wildwood Crest	1.373	\$716,707	\$14,127,269	<b>\$1.45</b>

Total Municipal Tax Revenue lost due to 1.2m SLR

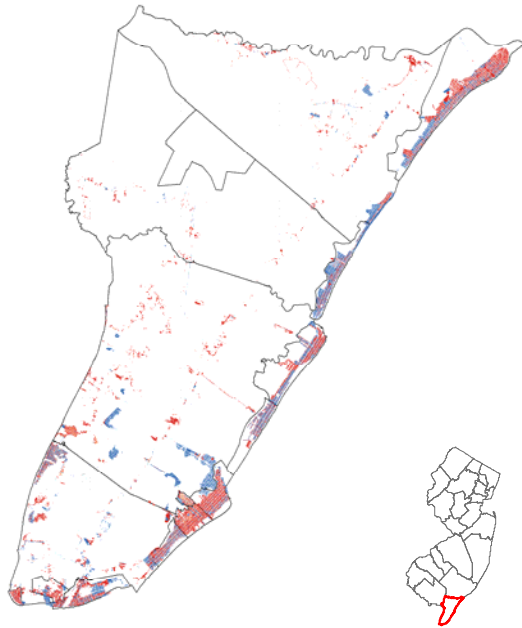
**\$ 48,427,970 Annually**

Total County Tax Revenue lost due to 1.2m SLR

**\$ 10,138,968 Annually**

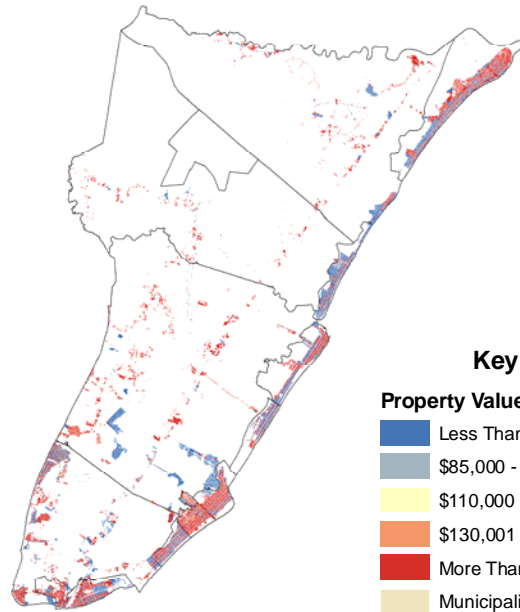
# Sea Level Rise and Storm Surges

Low SLR + 30y Storm Surge (1.2m)



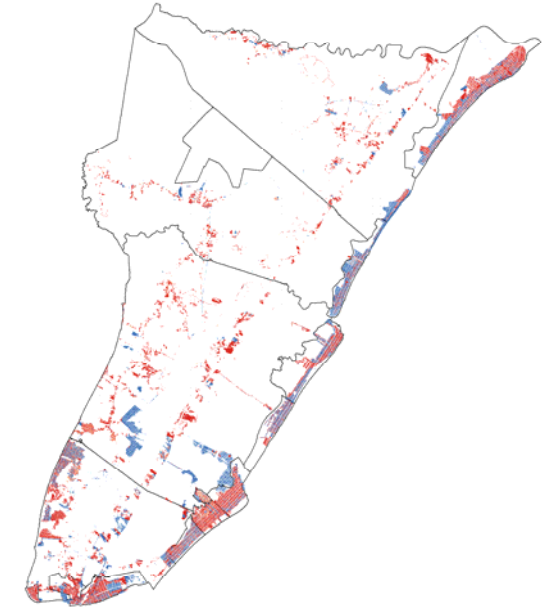
Net Value Effected  
**\$ 32,566,503,807**

Low SLR + 100y Storm Surge (3.0m)

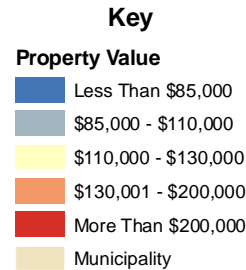


Net Value Effected  
**\$ 33,994,785,107**

High SLR + 100y Storm Surge (4.1m)



Net Value Effected  
**\$ 35,419,144,007**



# The Effects of Social Vulnerability on Coastal Mitigation Planning

Fredrick Shue

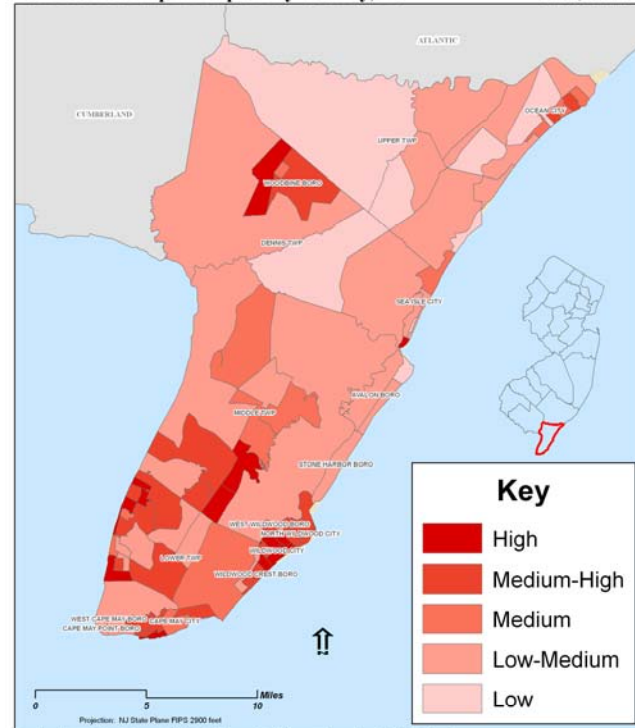
# Objective

- Develop vulnerability index map for Cape May county at the block group level
- Overlay with SLR and storm surge scenario to compose a social vulnerability map

# Method and Data

- Downloads data from census bureau at block group level
- Extracts needed data
- Data includes age of population, language speaking, and household income
- Gives weight for each category range from 0 to 10
- Sum up the weighted value to compose the map

### Household Income Weighted Index for Block Group in Cape May County, NJ



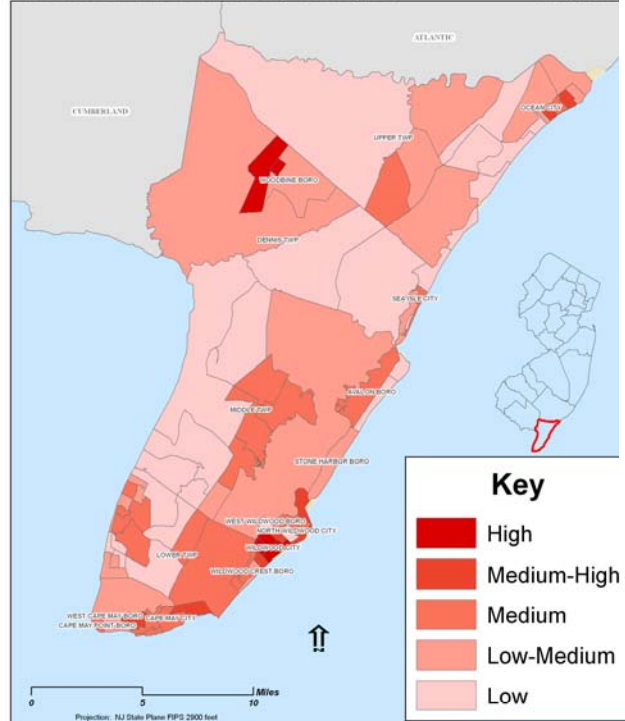
**Key**

- High
- Medium-High
- Medium
- Low-Medium
- Low

Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06N054190228 and NA07N054190196 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMFG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geological Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.



### Population of Language Weighted Index for Block Group in Cape May County, NJ



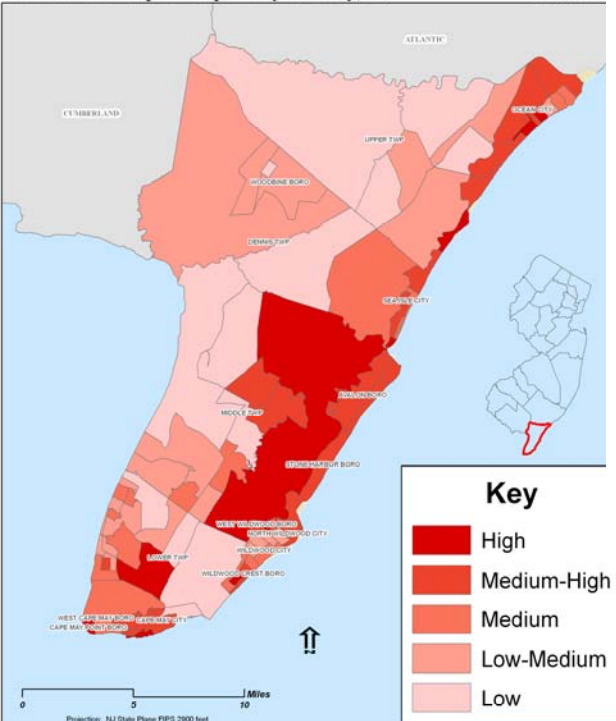
**Key**

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### Population of Age Weighted Index for Block Group in Cape May County, NJ



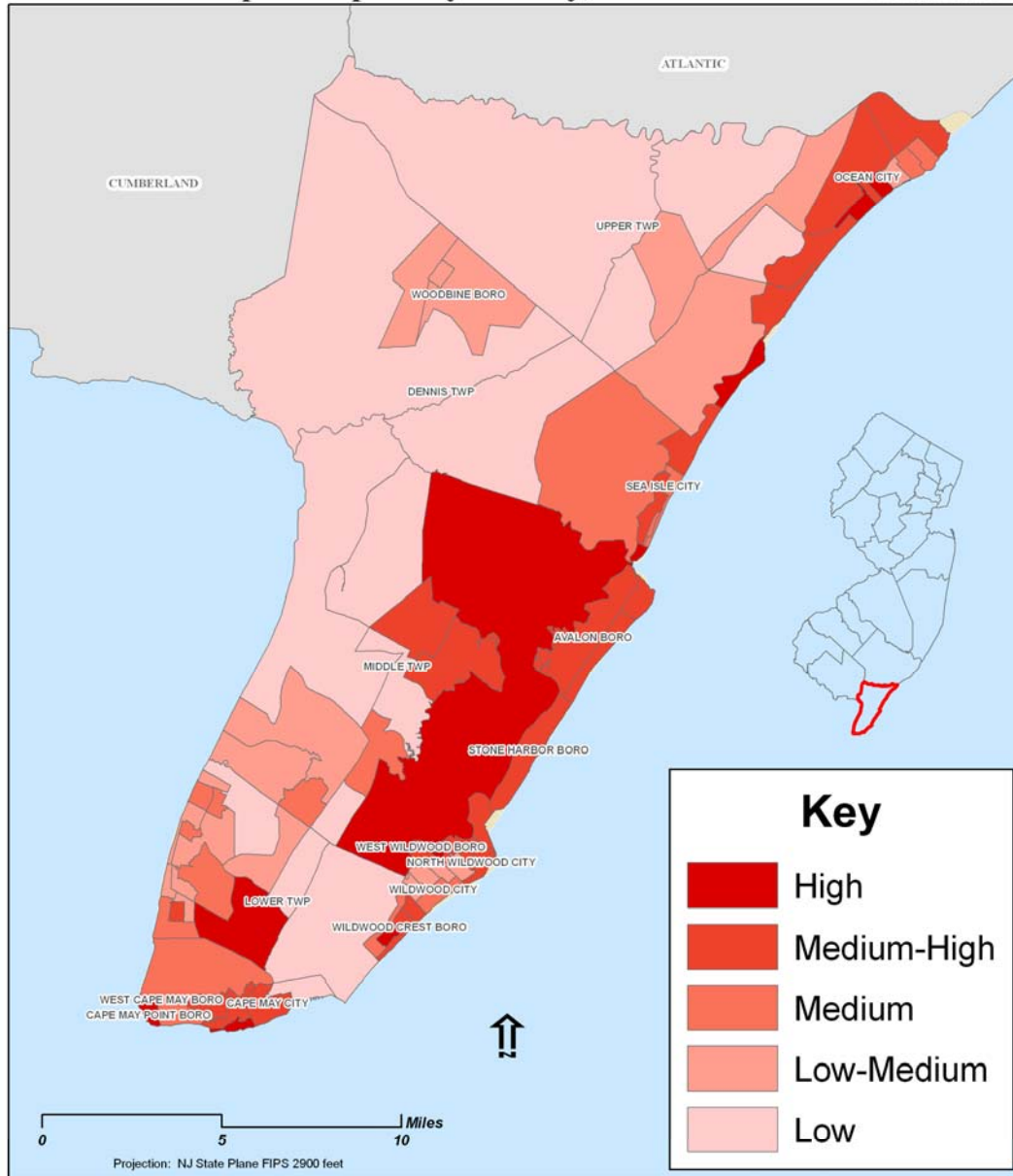
**Key**

- High
- Medium-High
- Medium
- Low-Medium
- Low

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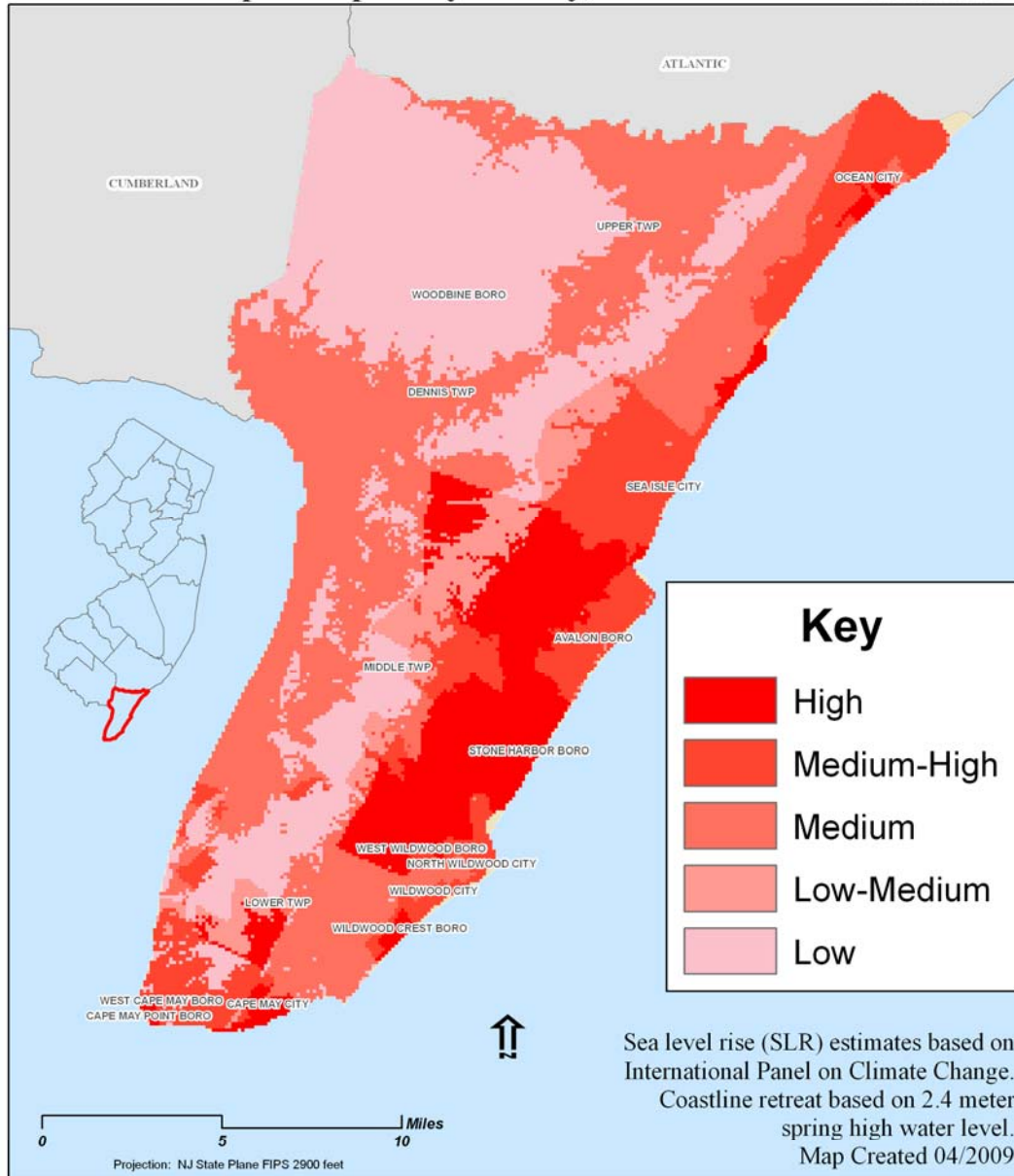


# Vulnerability Index for Social Characteristics for Block Group in Cape May County, NJ



Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

# Vulnerability Index in Sea Level Rise Events for Block Group in Cape May County, NJ



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# Critical Facilities / Infrastructure

Paul Lalancette

# Importance

- ❖ 311 facilities in Cape May categorized as critical.
- ❖ Schools, Law Enforcement, Government Buildings, Fire Stations, Hospitals, ect
- ❖ These facilities and services are important in disaster and non disaster situations.

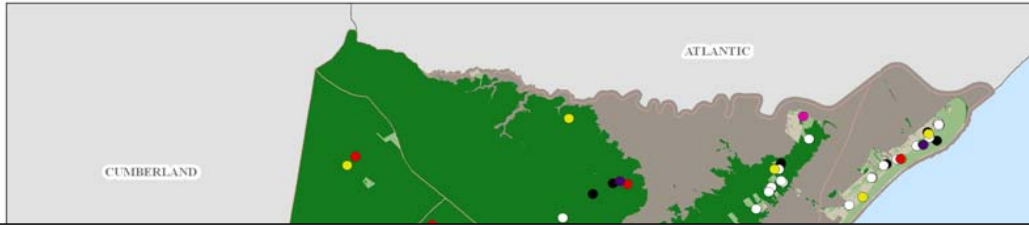
ex: meeting places for citizens to head  
in case of emergency.

# Objectives

- ❖ Determine percentages for total and individual loss of Critical Facilities based on Spring High Water levels.
- ❖ 1.3m: Low end Sea Level Rise
- ❖ 3.7m: 30 Yr Storm Surge+Low End SLR
- ❖ 4.8m: 100 Yr Storm Surge+High End SLR
- ❖ Display at risk facilities

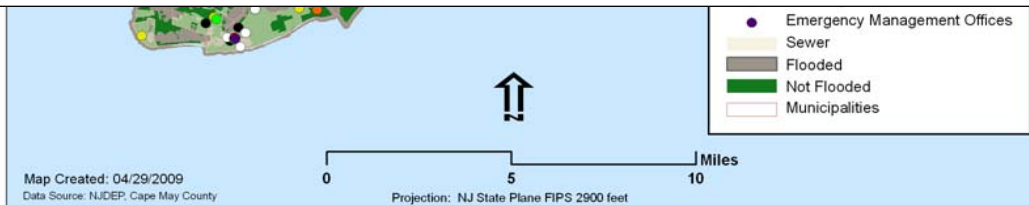
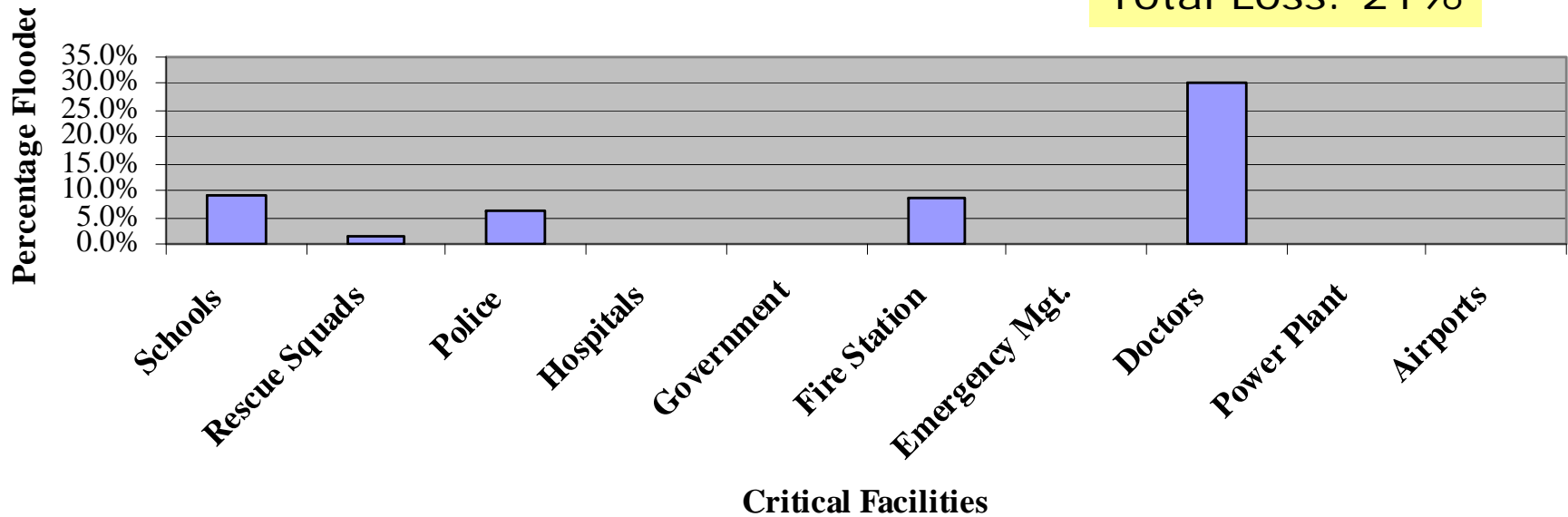
# Critical Infrastructure for Cape May County, NJ

## Low End Sea Level Rise: 1.3 Meters



### 1.3 Meters

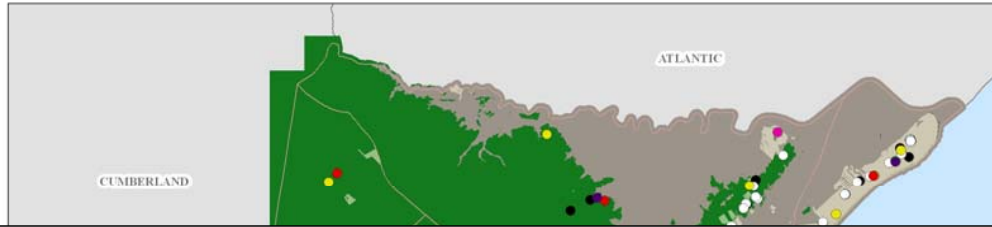
Total Loss: 21%



Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

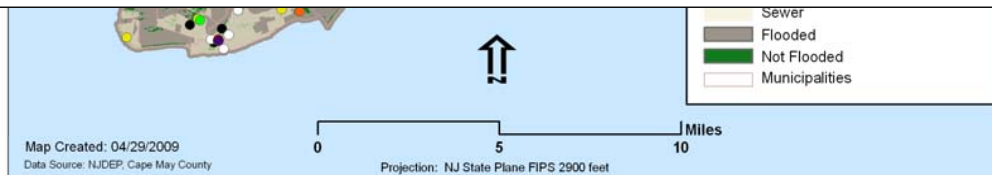
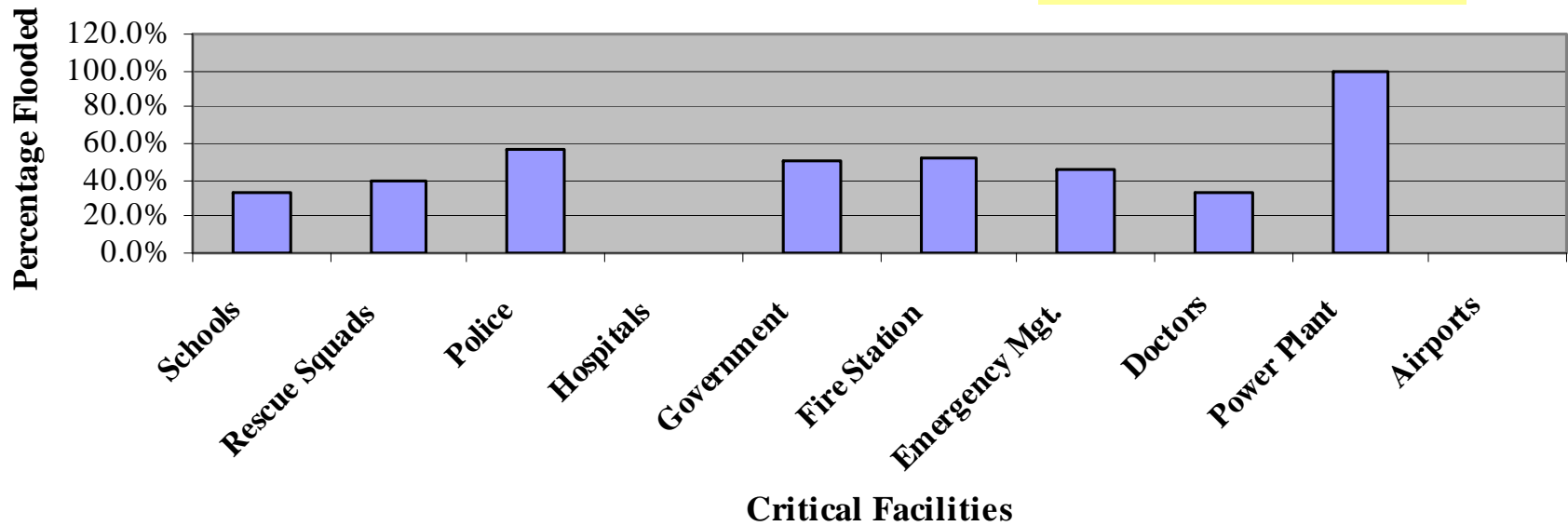
# Critical Infrastructure for Cape May County, NJ

## 30 Year Storm Surge and Low End Sea Level Rise: 3.7 Meters



### 3.7 Meters

Total Loss 55.3%

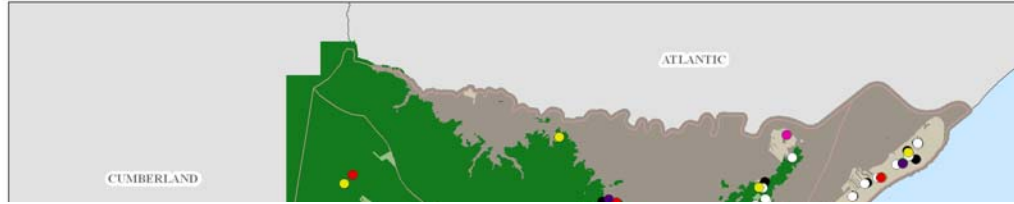


Map Created: 04/29/2009  
Data Source: NJDEP, Cape May County  
Projection: NJ State Plane FIPS 2900 feet

Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NAO7NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

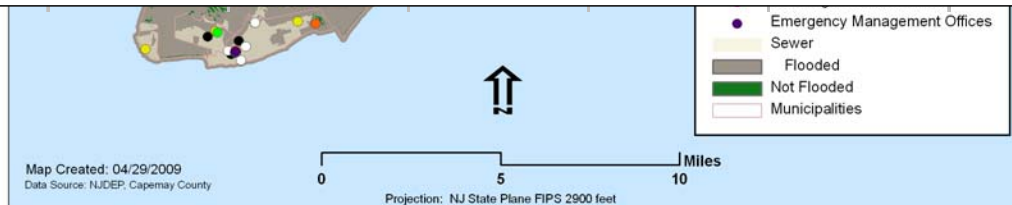
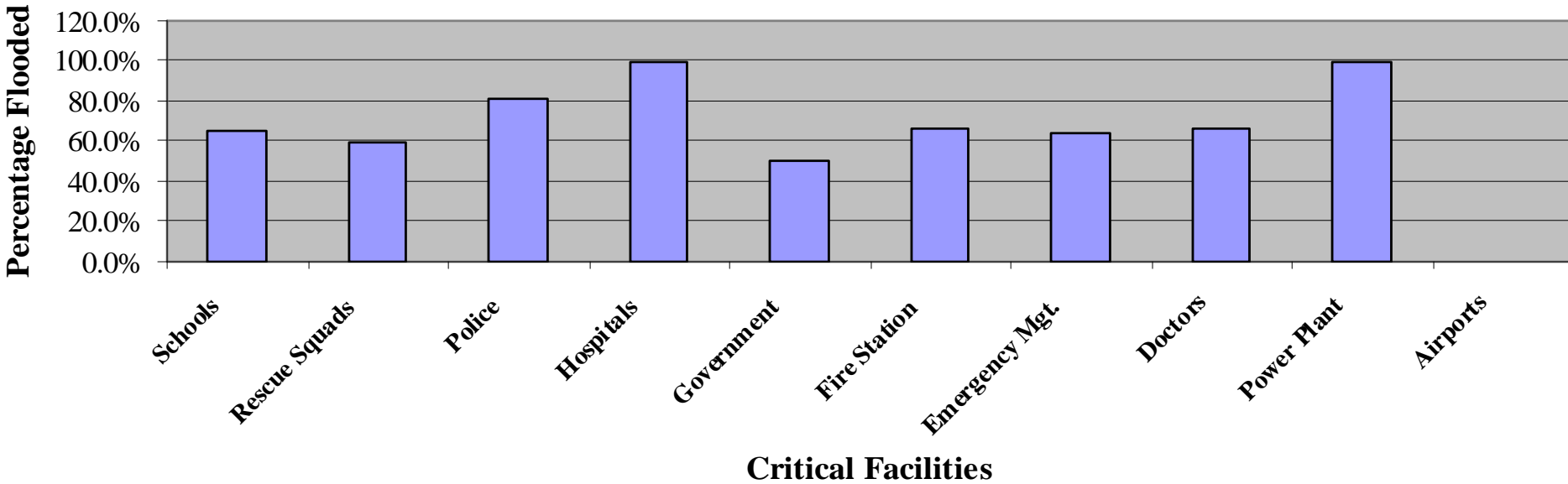
# Critical Infrastructure for Cape May County, NJ

## 100 Storm Surge and High End Sea Level Rise: 4.8 Meters



**4.8 Meters**

**Total Loss: 62.4%**



Financial assistance for this project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

# Emergency Management: Evacuation Routes

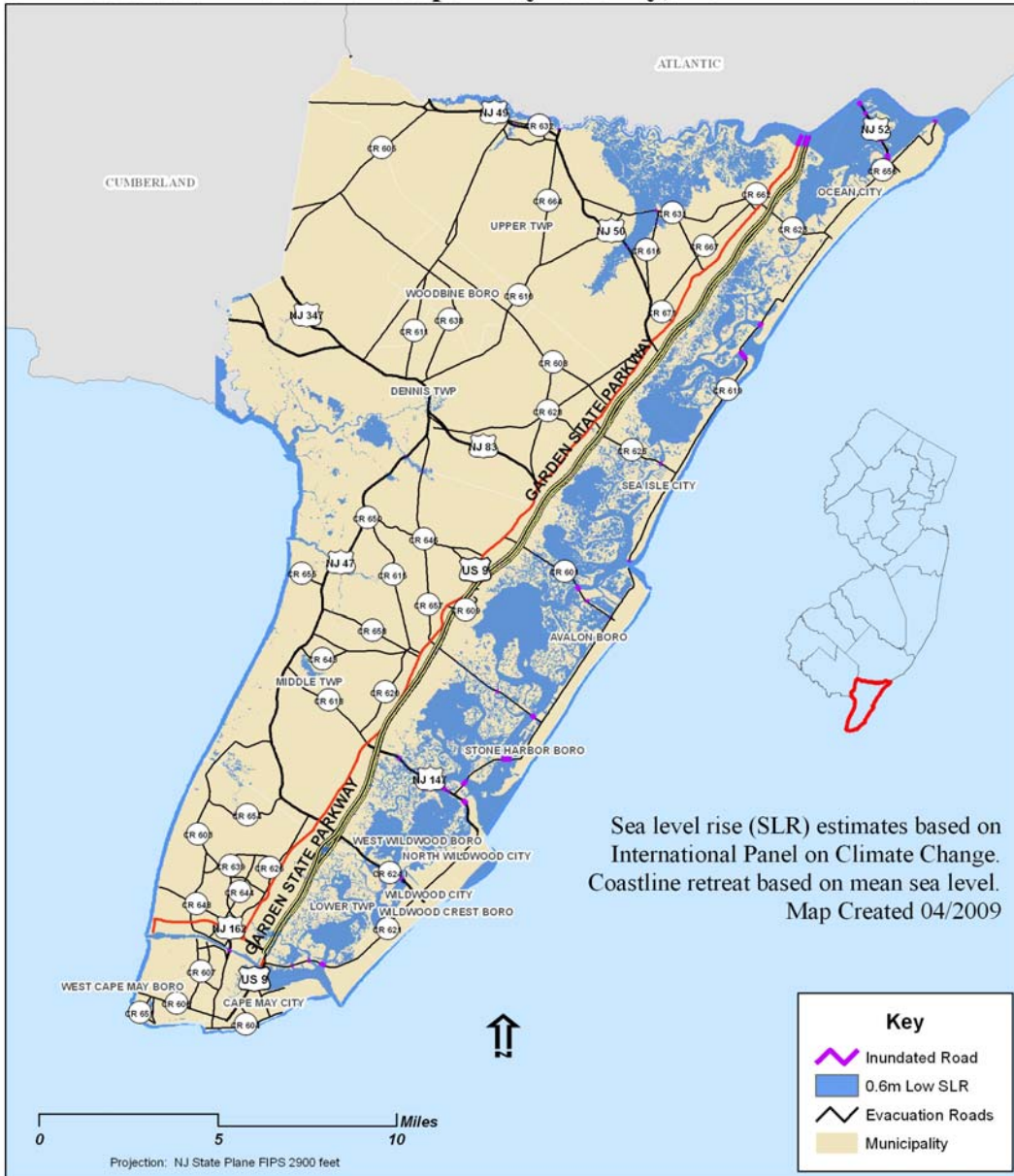
Geospatial analysis and quantification of  
evacuation route inundation for Cape May  
County, NJ

Joshua Rotteveel

# Objective

- Creation of spatial data subset from existing NJ Department of Transportation data to create an evacuation route roads layer for Cape May County, NJ
  - All county roads, state and US highways.
- Overlay all sea level rise and storm surge scenarios and evacuation route roads to identify inundated evacuation road segments and quantify total length of inundation.

# Impacts of IPCC Sea Level Rise Estimates on Evacuation Route for Cape May County, NJ



Total number of  
road segments  
inundated:

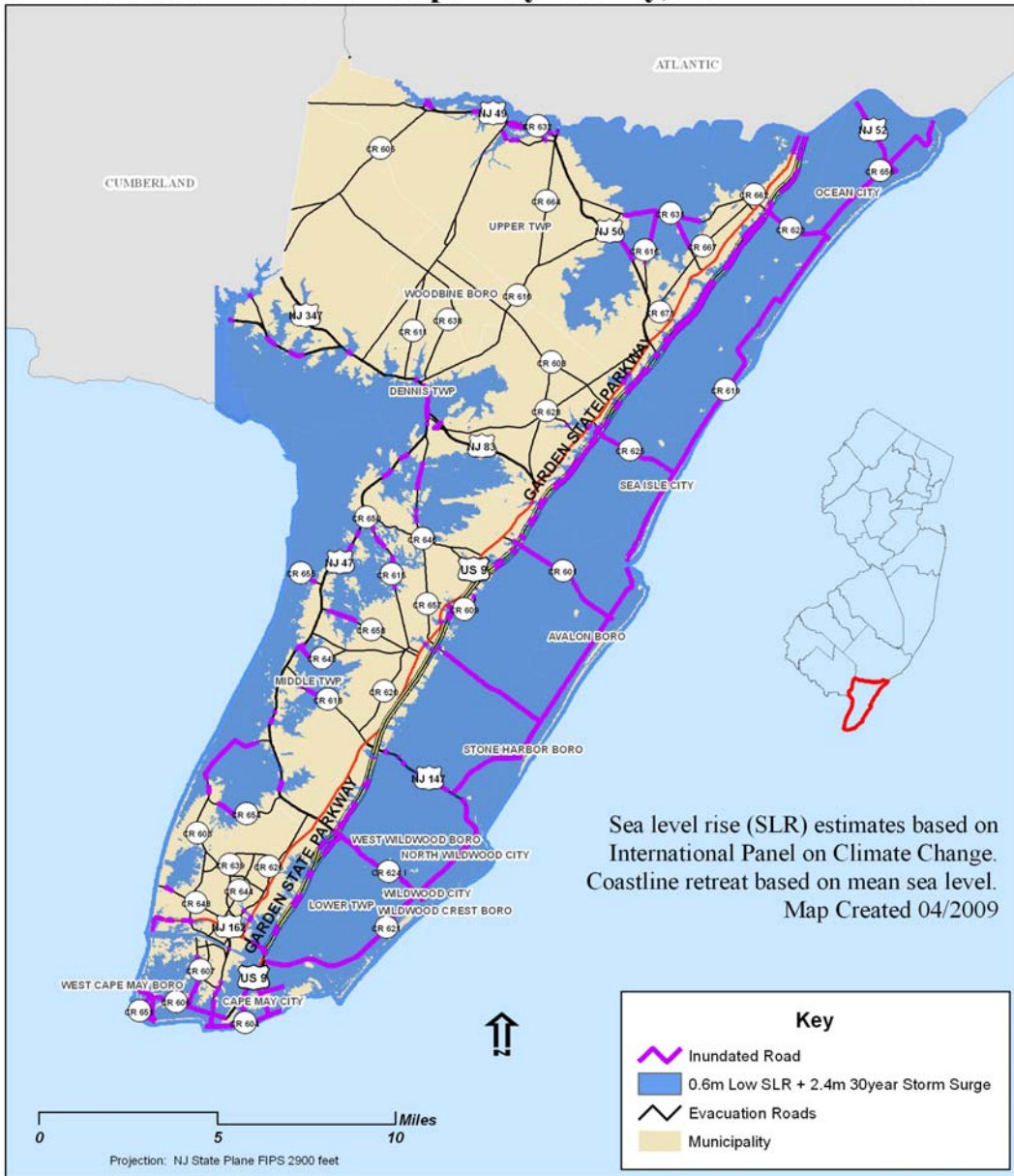
25

Total length of  
inundated road  
segments:

28,373.04 feet  
(5.37 miles)



# Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ



Total number of road segments inundated:

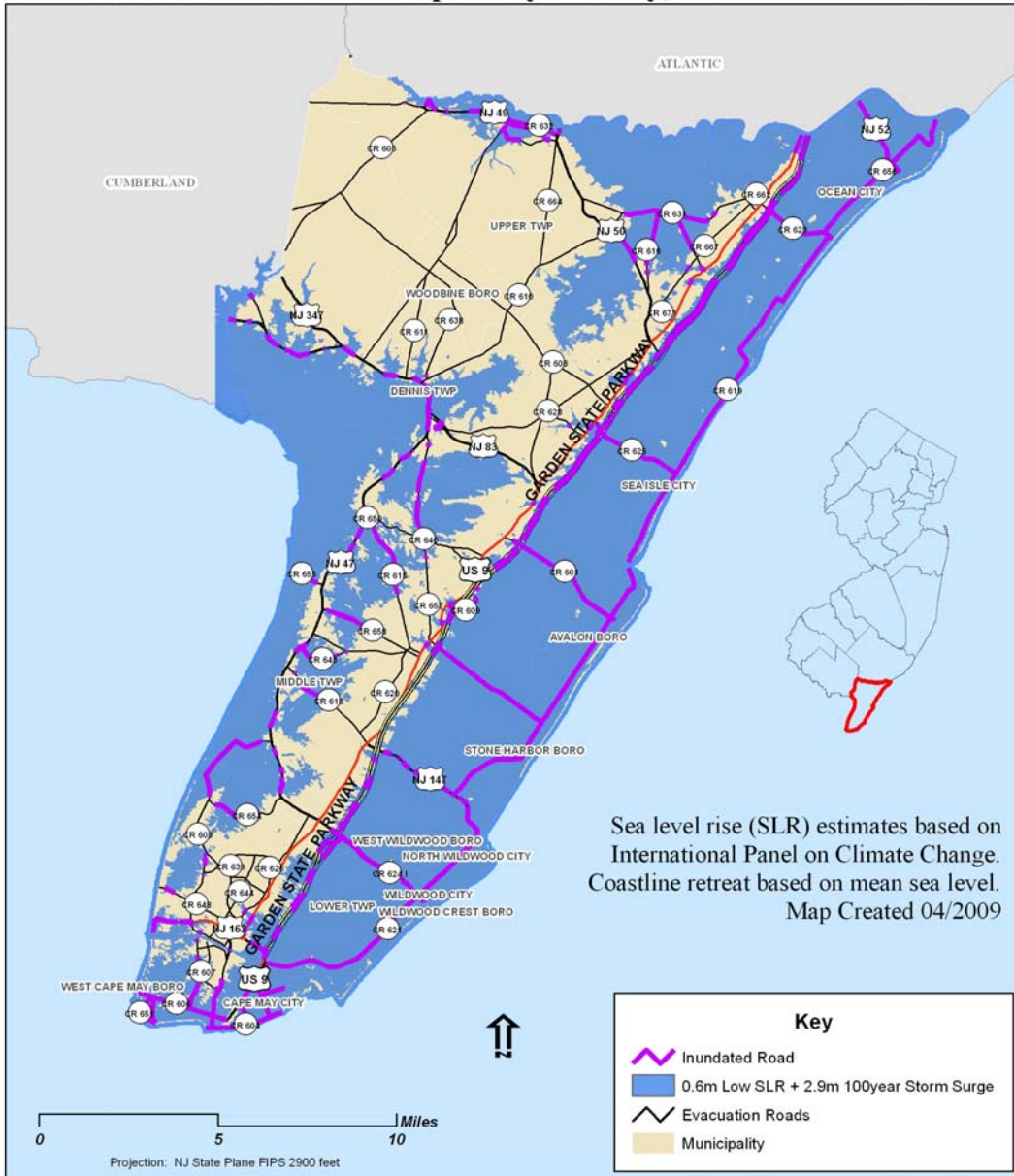
96

Total length of inundated road segments:

639,759.07 feet  
(121.17 miles)

Financial assistance for the LIDAR project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

# Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ



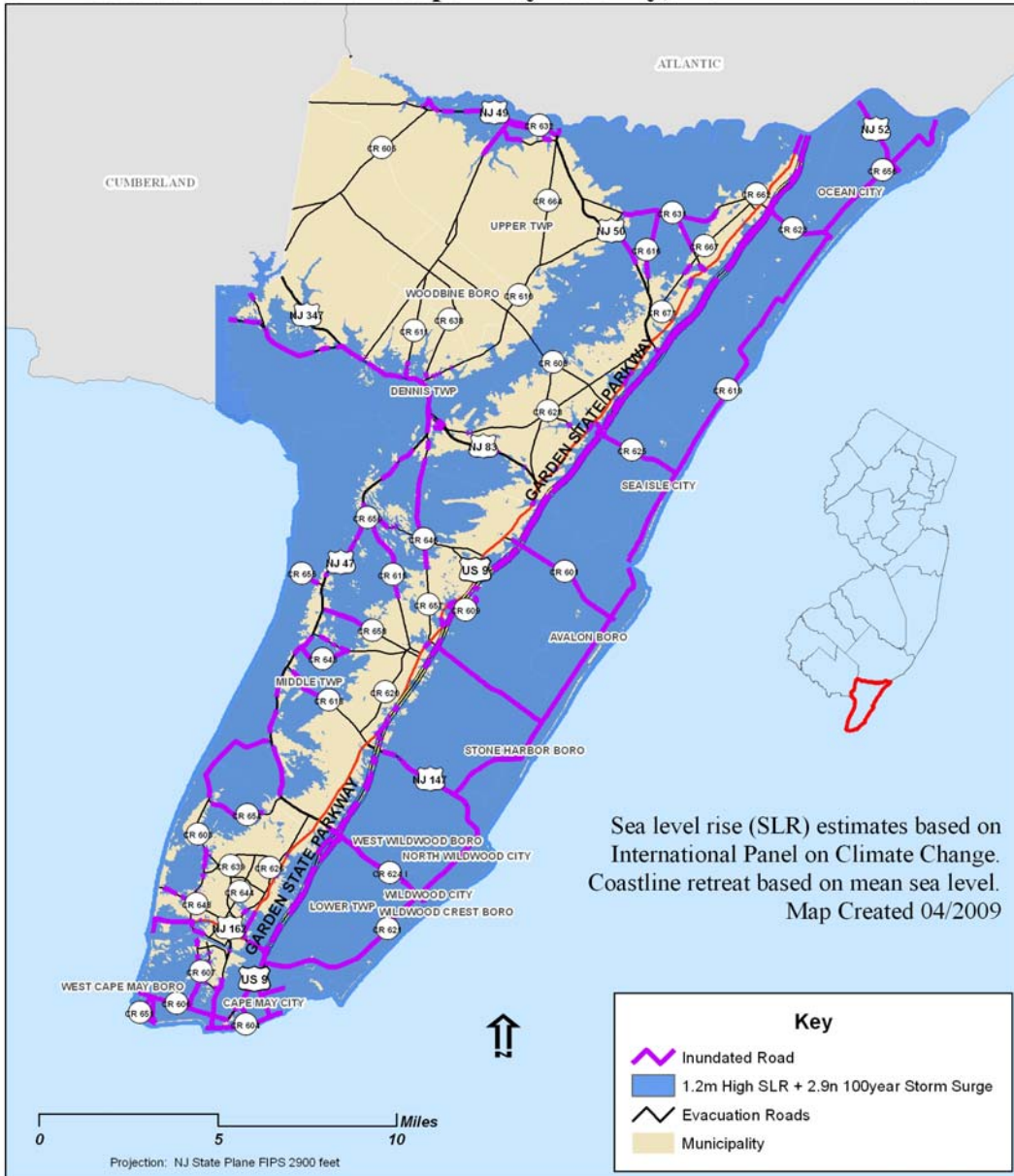
Total number of road segments inundated:

105

Total length of inundated road segments:

776,770.86 feet  
(147.12 miles)

# Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ



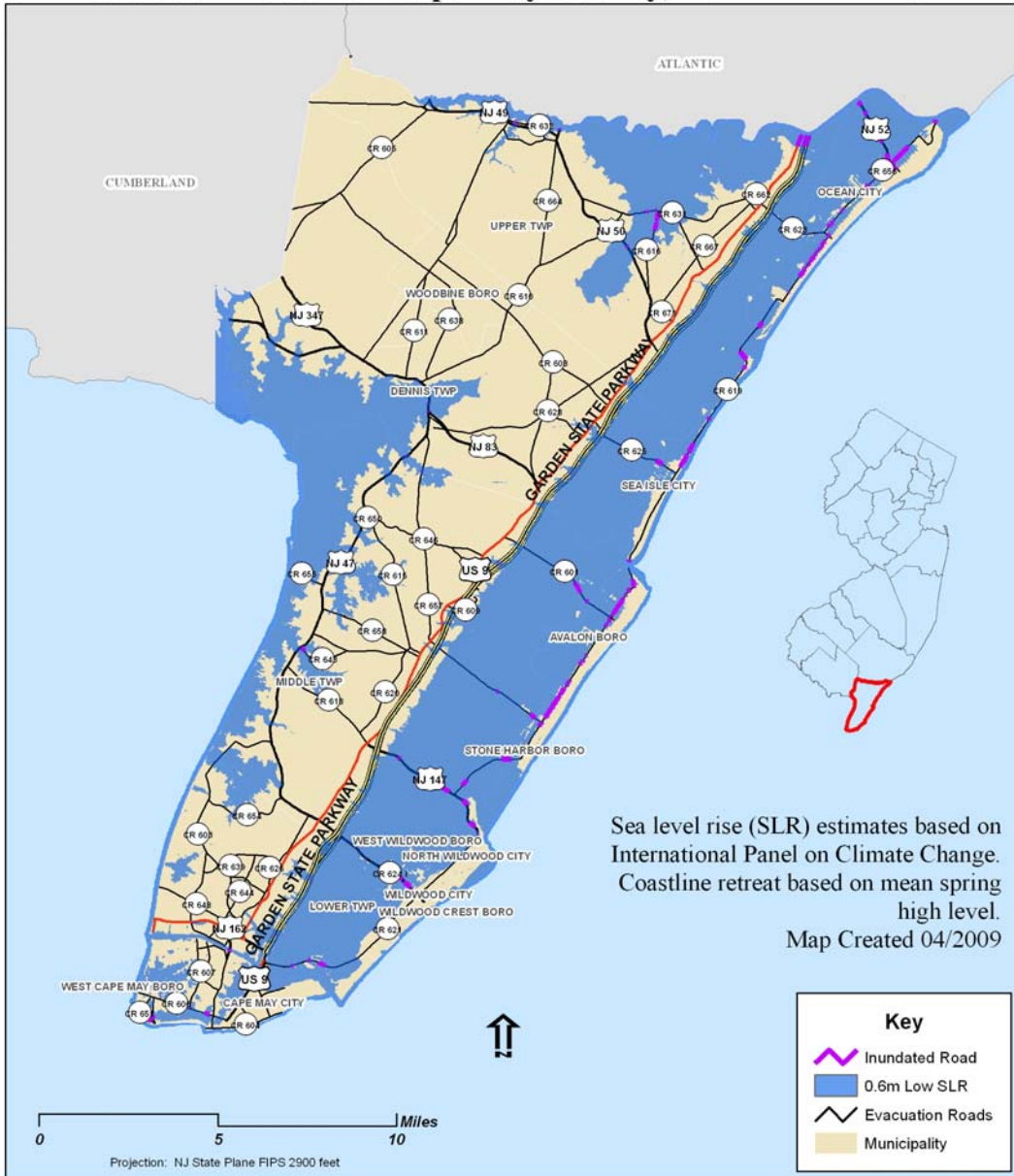
Total number of road segments inundated:

115

Total length of inundated road segments:

942,616.11 feet  
(178.53 miles)

# Impacts of IPCC Sea Level Rise Estimates on Evacuation Route for Cape May County, NJ



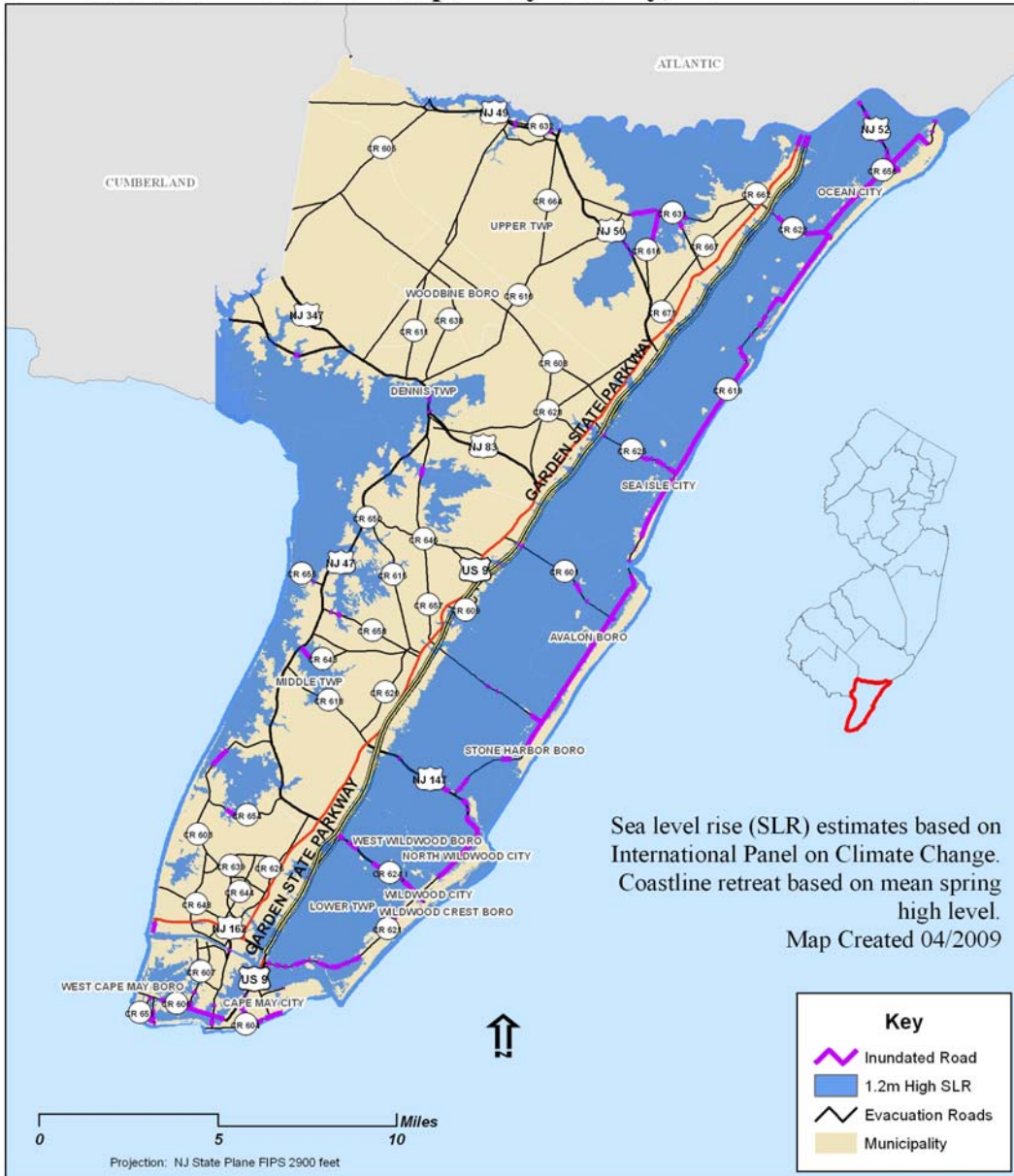
Total number of road segments inundated:

39

Total length of inundated road segments:

75,412.98 feet  
(14.28 miles)

# Impacts of IPCC Sea Level Rise Estimates on Evacuation Route for Cape May County, NJ



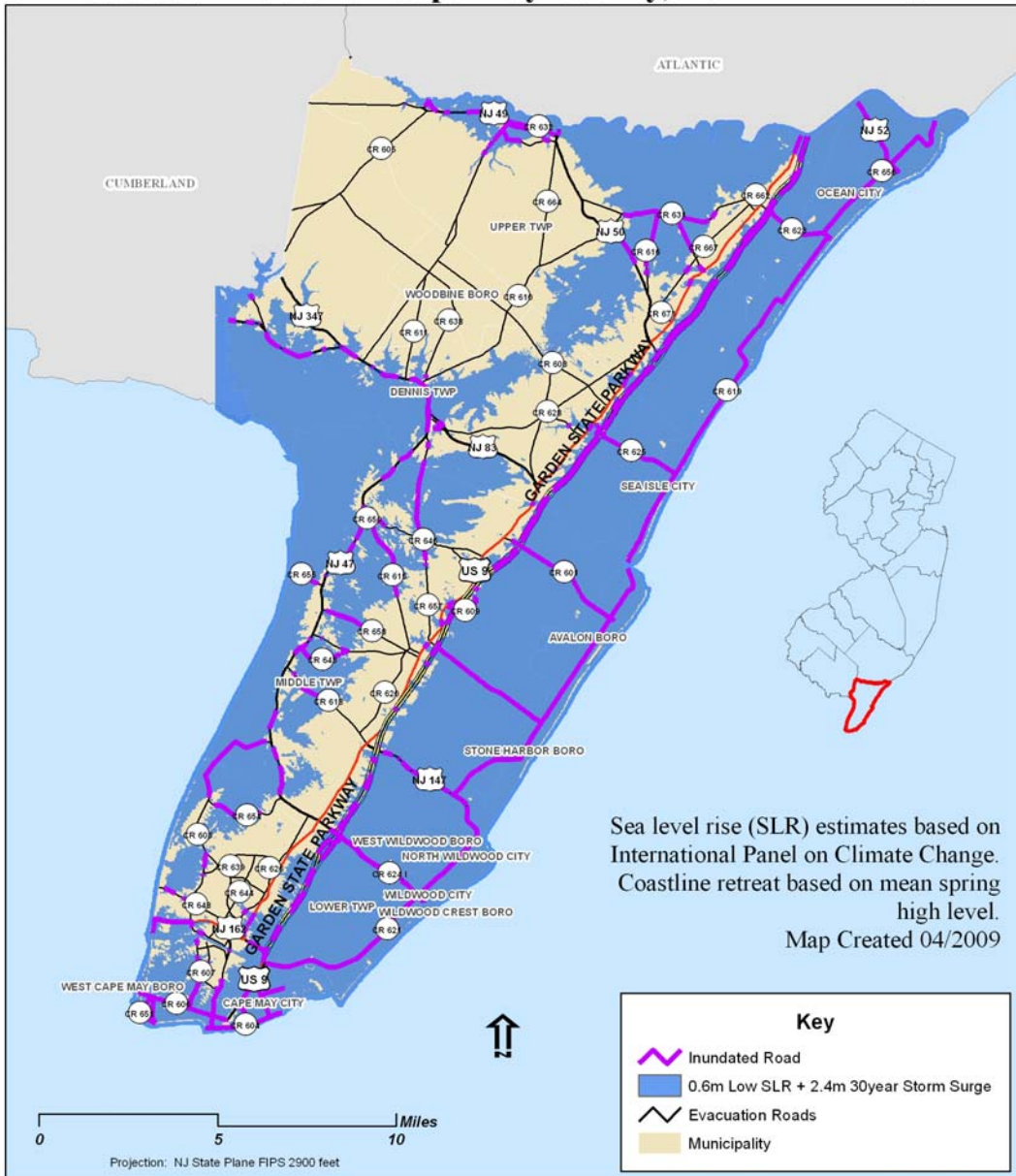
Total number of road segments inundated:

56

Total length of inundated road segments:

251,619 feet  
(47.66 miles)

# Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ



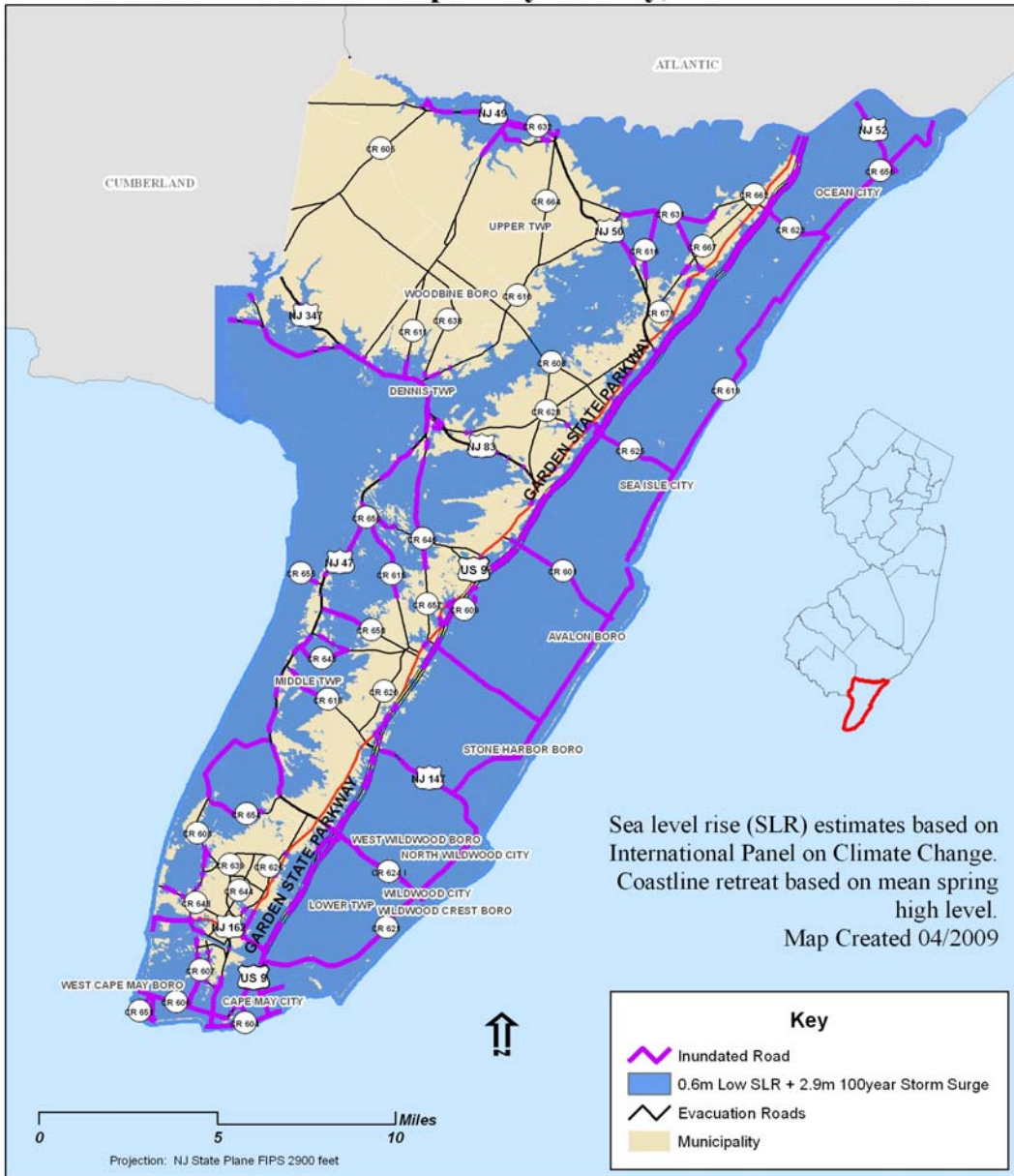
Total number of road segments inundated:

109

Total length of inundated road segments:

843,392.63 feet  
(159.73 miles)

# Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ



Sea level rise (SLR) estimates based on International Panel on Climate Change. Coastline retreat based on mean spring high level. Map Created 04/2009

**Key**

- Inundated Road
- 0.6m Low SLR + 2.9m 100year Storm Surge
- Evacuation Roads
- Municipality

Total number of road segments inundated:

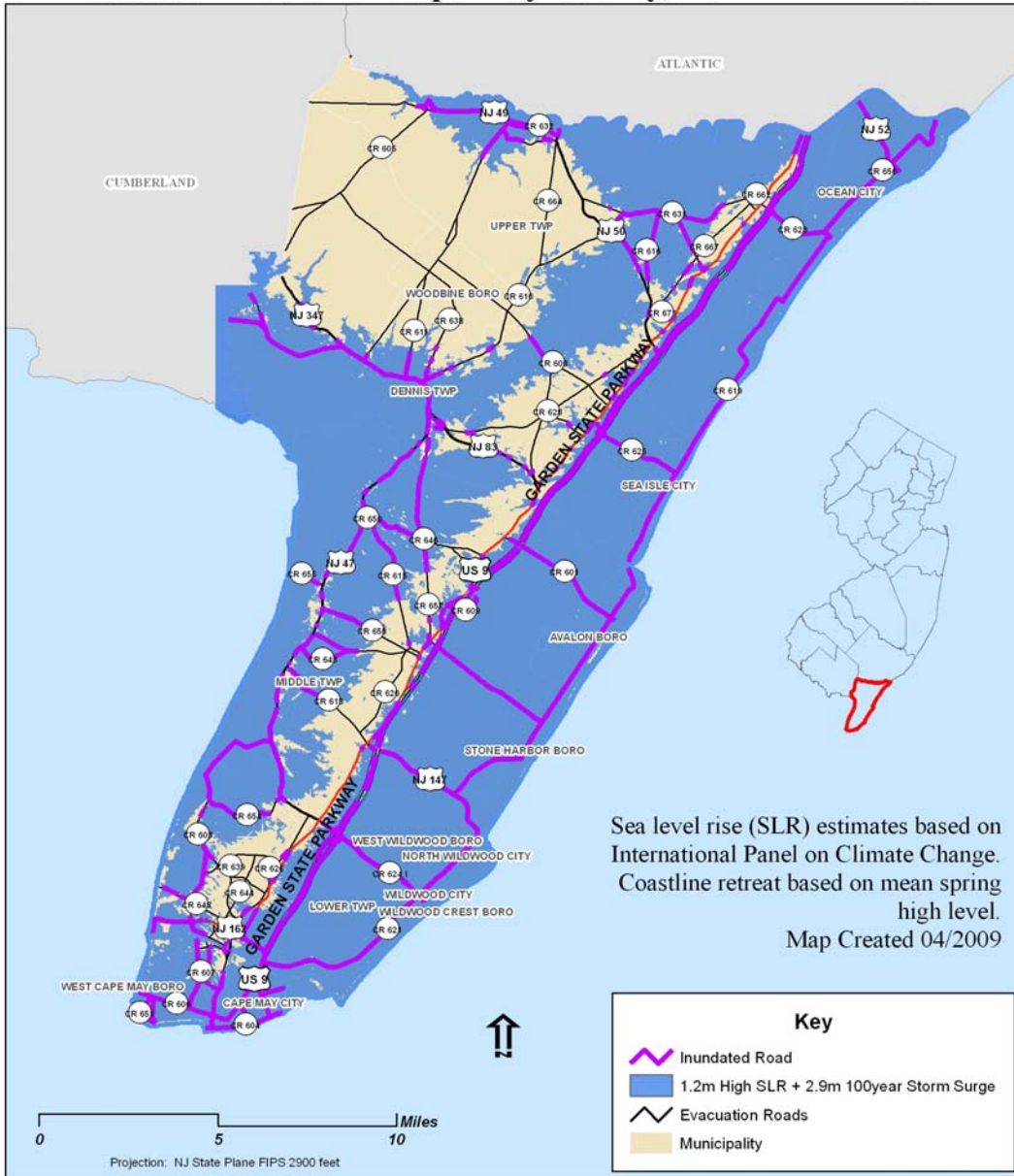
117

Total length of inundated road segments:

977,145.78 feet  
(185.07 miles)

Financial assistance for the LIDAR project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.

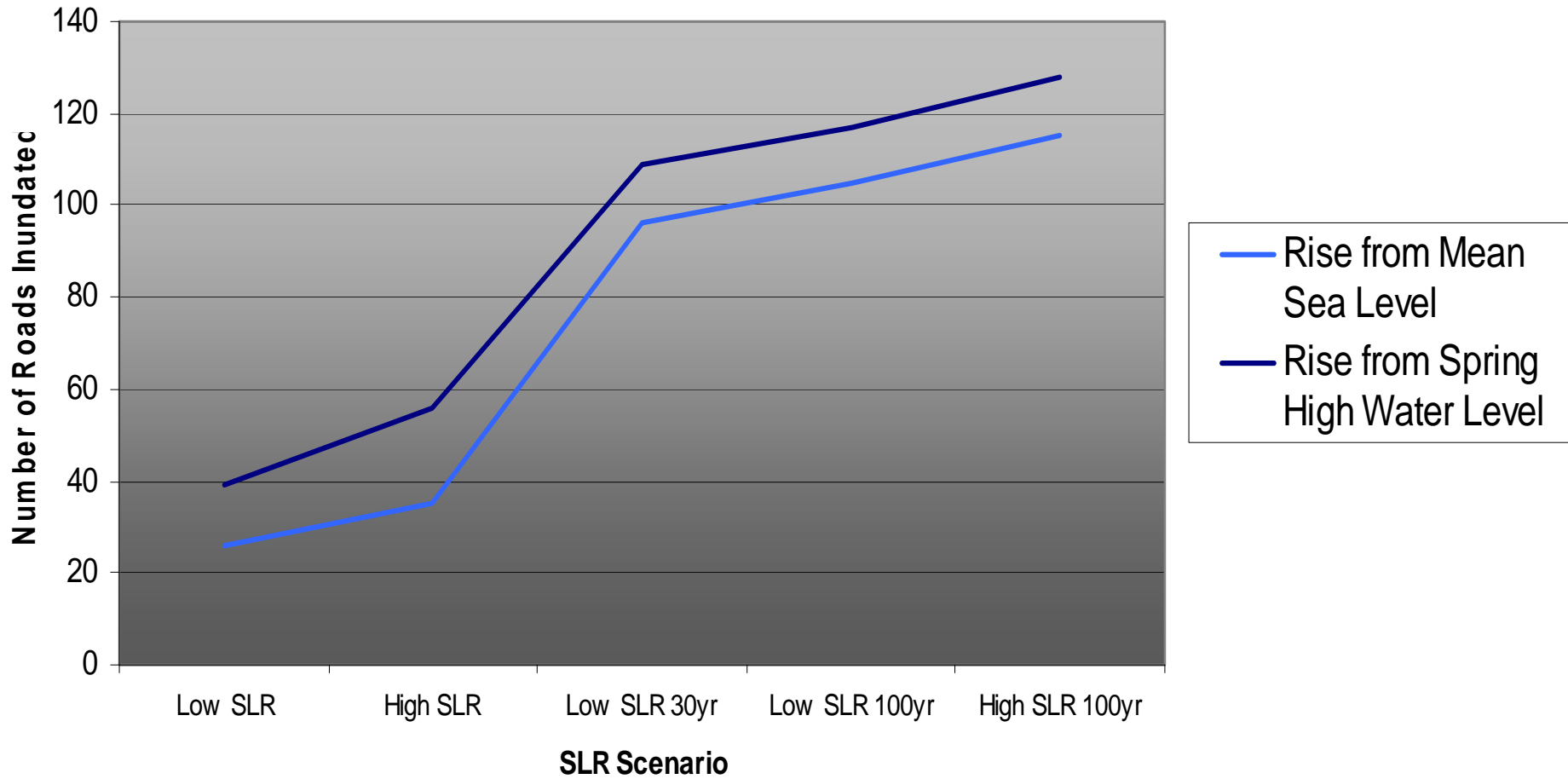
# Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ



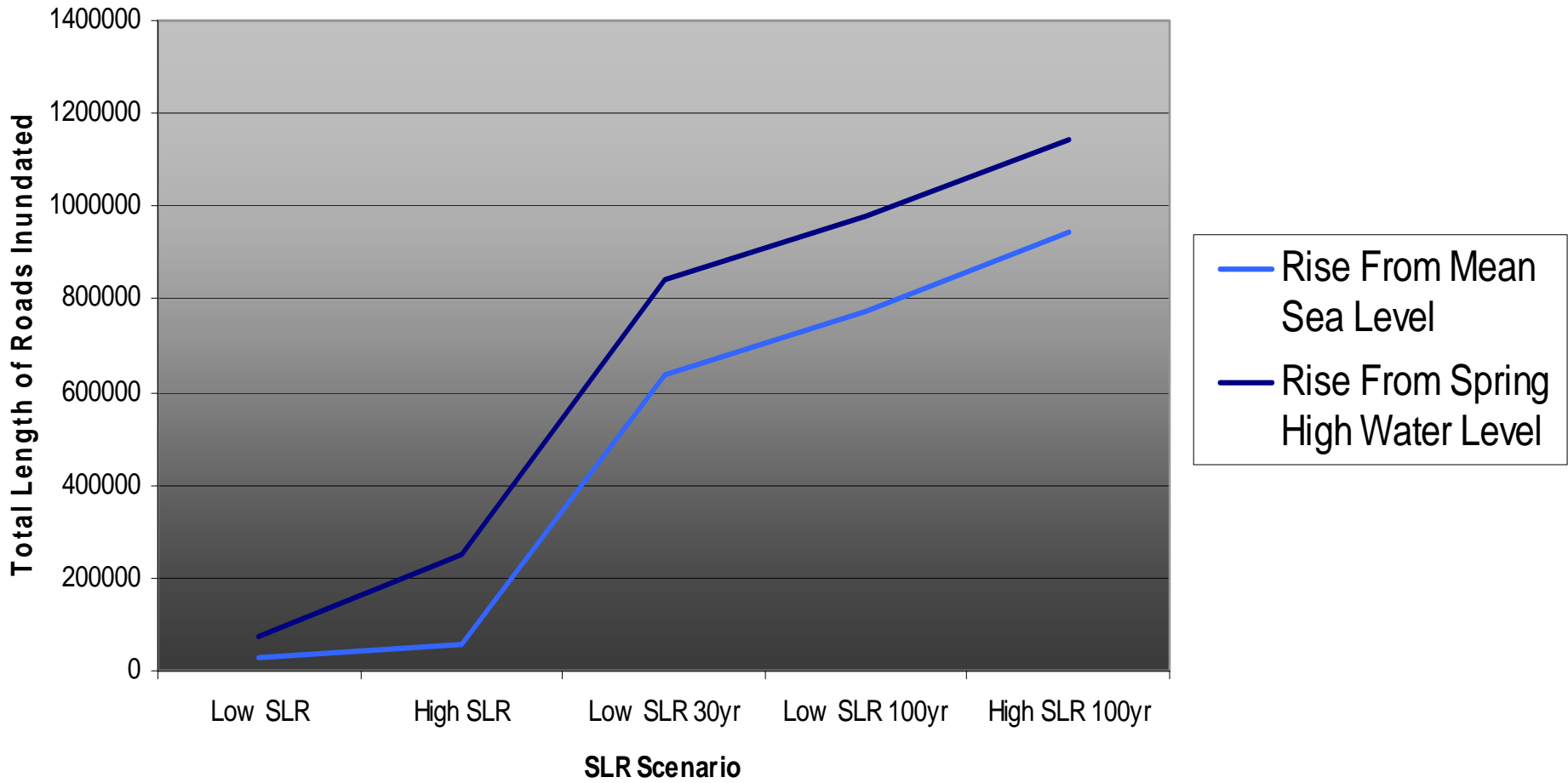
Total number of road segments inundated:  
128

Total length of inundated road segments:  
1,143,070.49 feet  
(216.49 miles)

## Number of Roads Inundated by SLR Scenarios



# Total Length of Roads Inundated by SLR Scenarios



# Recap

- Use of highly accurate elevation data, LIDAR
- Various geoprocessing methods used
- Incorporation of remote sensing and spatial analysis to assess effects that IPCC estimates for sea level rise and FEMA storm surge predictions will have on both natural habitat and human infrastructure.
  - Horseshoe crabs, piping plovers and other migratory shorebirds, terrapins, salt marsh retreat
  - Tourism, commerce, property value, tax revenue, social vulnerability, emergency management, critical facilities, evacuation routes
- GIS as an major component in the placed-based decision making process

# Cape May County, NJ

Implications of Sea Level Rise

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## More Information

- [CRSSA, Rutgers University](#)
- [Cape May County, New Jersey](#)
- [NJ Dept. of Environmental Protection](#)
- [NJ Division of Fish and Wildlife](#)
- [Littoral Society](#)
- [David Tulloch's Blog](#)
- [Other Resources](#)

RUTGERS

Advanced Geomatics 2009

**Objective:** Case study of the implications of sea level rise on Cape May, New Jersey. An analysis of human infrastructure and natural habitats effected by various sea level rise (SLR) scenarios were conducted to provide a comprehensive study. A range of projects were undertaken to explore the impact of SLR on both of these fields. With an application of various geospatial analytical approaches, the results gained will provide knowledge for placed based decision making.

RUTGERS

Cape May, New Jersey

Advanced Geomatics 2009

Cape May County is the southern most county in New Jersey and is home to over 100,000 residents. Its historic background and pristine fishing habitats, makes it a premiere tourist hotspot. The vast expanses of undeveloped land provide pristine habitat for numerous species.

# Acknowledgements

The following people shared their expertise and data with the class:

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- Joanna Burger, Rutgers University
- NJ Fish and Wildlife Endangered and Nongame Species Program
- NJ ASLA