

# SEA LEVEL RISE IN THE FLORIDA KEYS

## Vulnerabilities FOR 2030 and 2060



**FKNMS FQWQPP**  
**Steering Committee Meeting**  
**March 12, 2015**  
**Presentation by**  
**Rhonda Haag, Monroe County**  
**Chris Bergh, TNC**



# THE PROJECT TEAM

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Chris Bergh, The Nature Conservancy



VHB/Miller Sellen



Catalysis Adaptation Partners



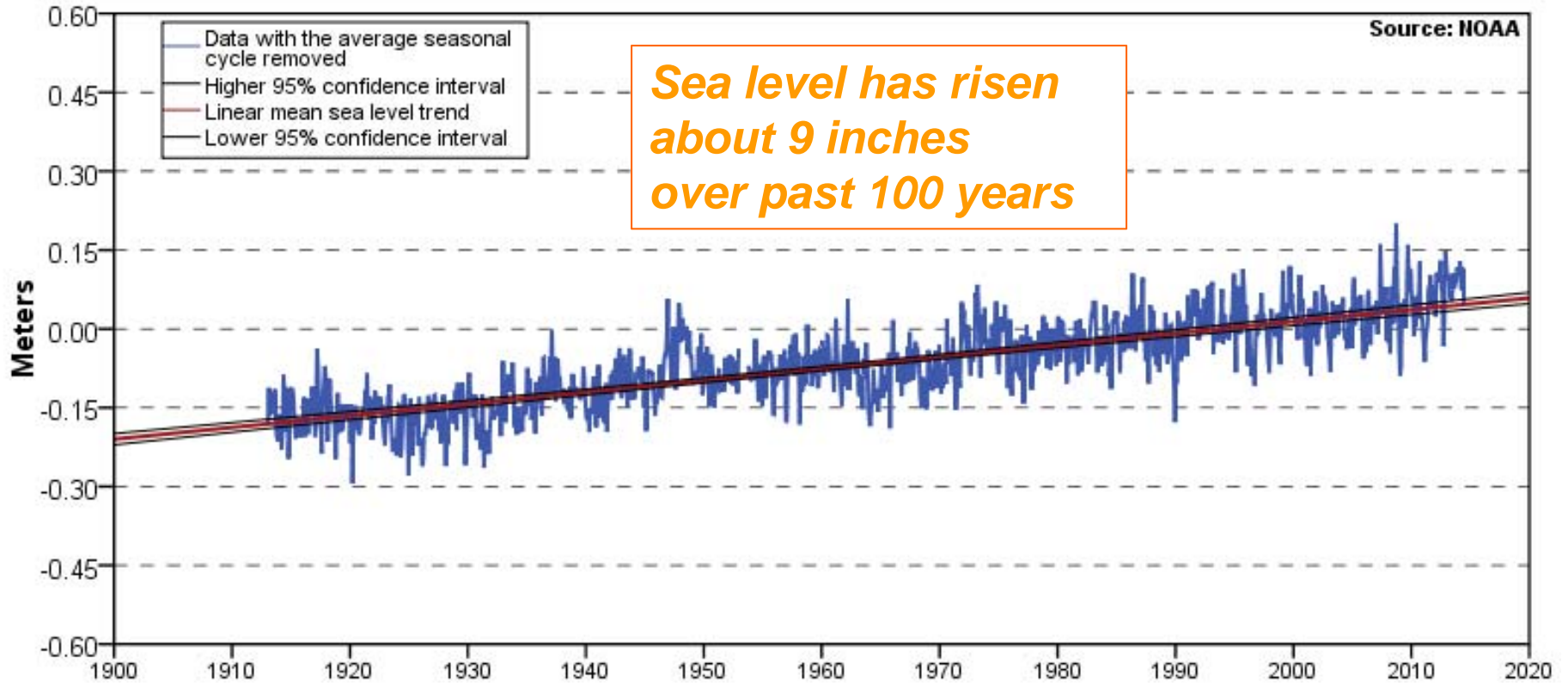
Quest Ecology

EcoSmart



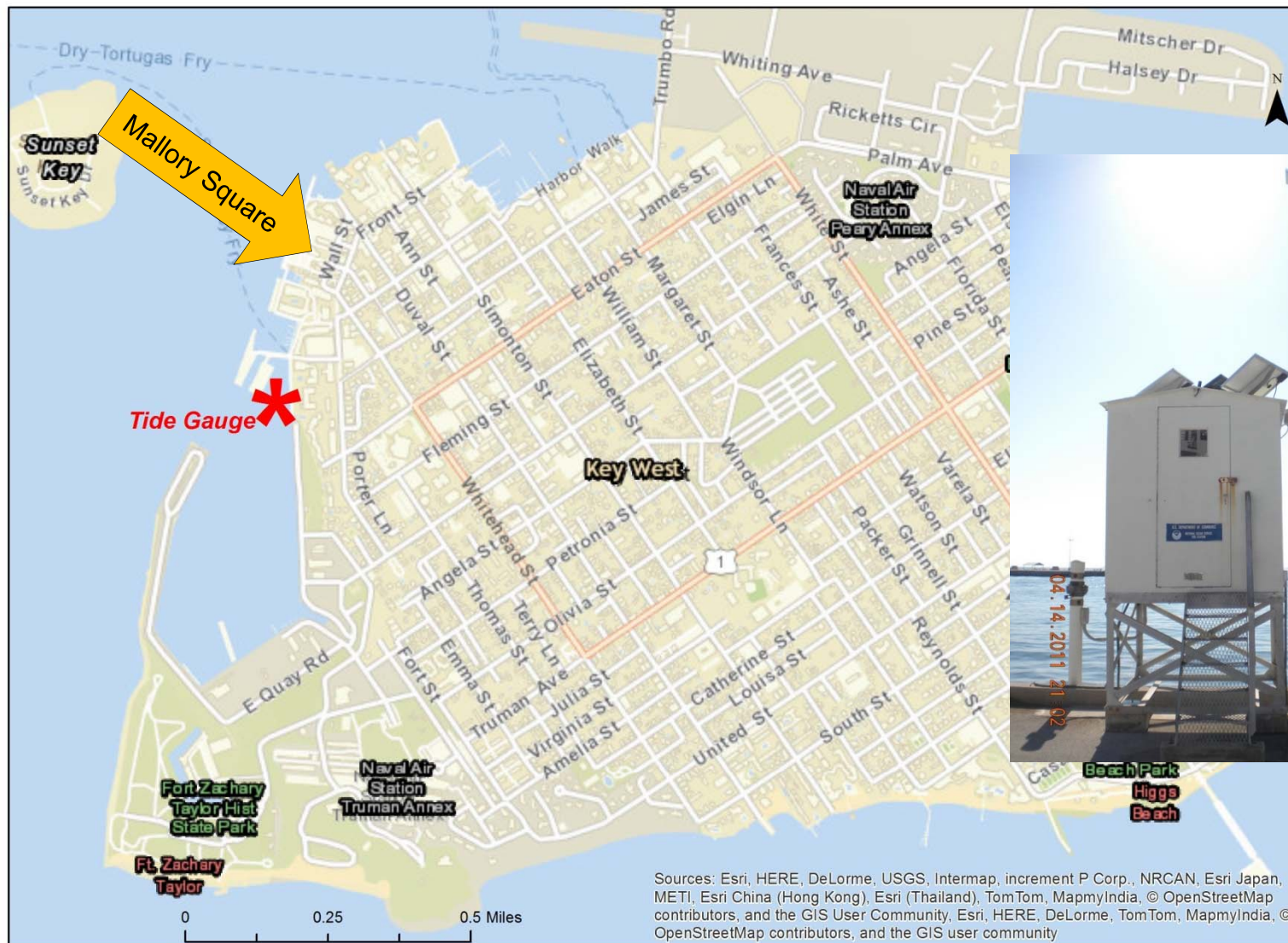
# SEA LEVEL RISE IN MONROE COUNTY

Key West, FL 2.24 +/- 0.16 mm/yr



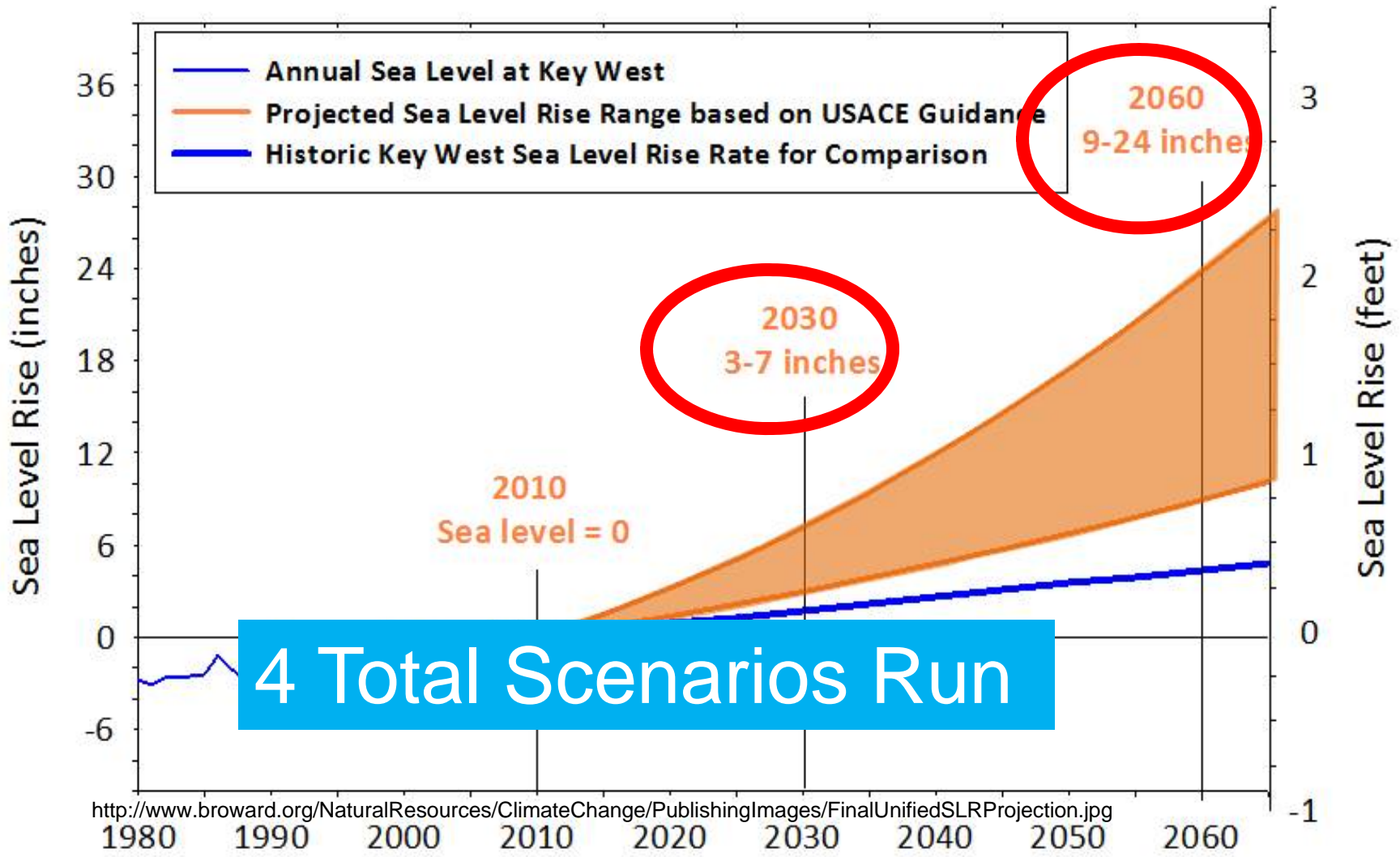


# NOAA KEY WEST TIDE GAUGE



# SEA LEVEL RISE SCENARIOS

*Adopted by Southeast Florida Regional Climate Compact*



# THE **BURNING** QUESTIONS RELATED TO SEA LEVEL RISE



**1. What impacts to County assets, infrastructure and habitat will occur from sea level rise in 2030 (at 3” and 7”) and in 2060 (9” and 24”)?**

- **Today’s presentation**

**2. How can the County address those impacts?**

- **Next phase of analysis**



# THE APPROACH TO THE ANALYSIS: WHAT SEA LEVEL RISE IMPACTS ARE EXPECTED WHEN?

Step 1

- Analyze what's been done & **DETERMINE "GAPS"**
- Determine

Step 2

- **C**
- **w**

Step 3

- **A**
- **W**
- **M**

Step 4

- Confirm use of best tools to show **COUNTY-SPECIFIC IMPACTS**
- Use **TOOLS** that have support of agencies / organizations
- Provide feedback and **IMPROVE TOOLS AND INPUTS**

No **single** analytical tool can determine individualized sea level rise impacts to Monroe County habitat and infrastructure.

Team used **multiple analytical tools** and approaches

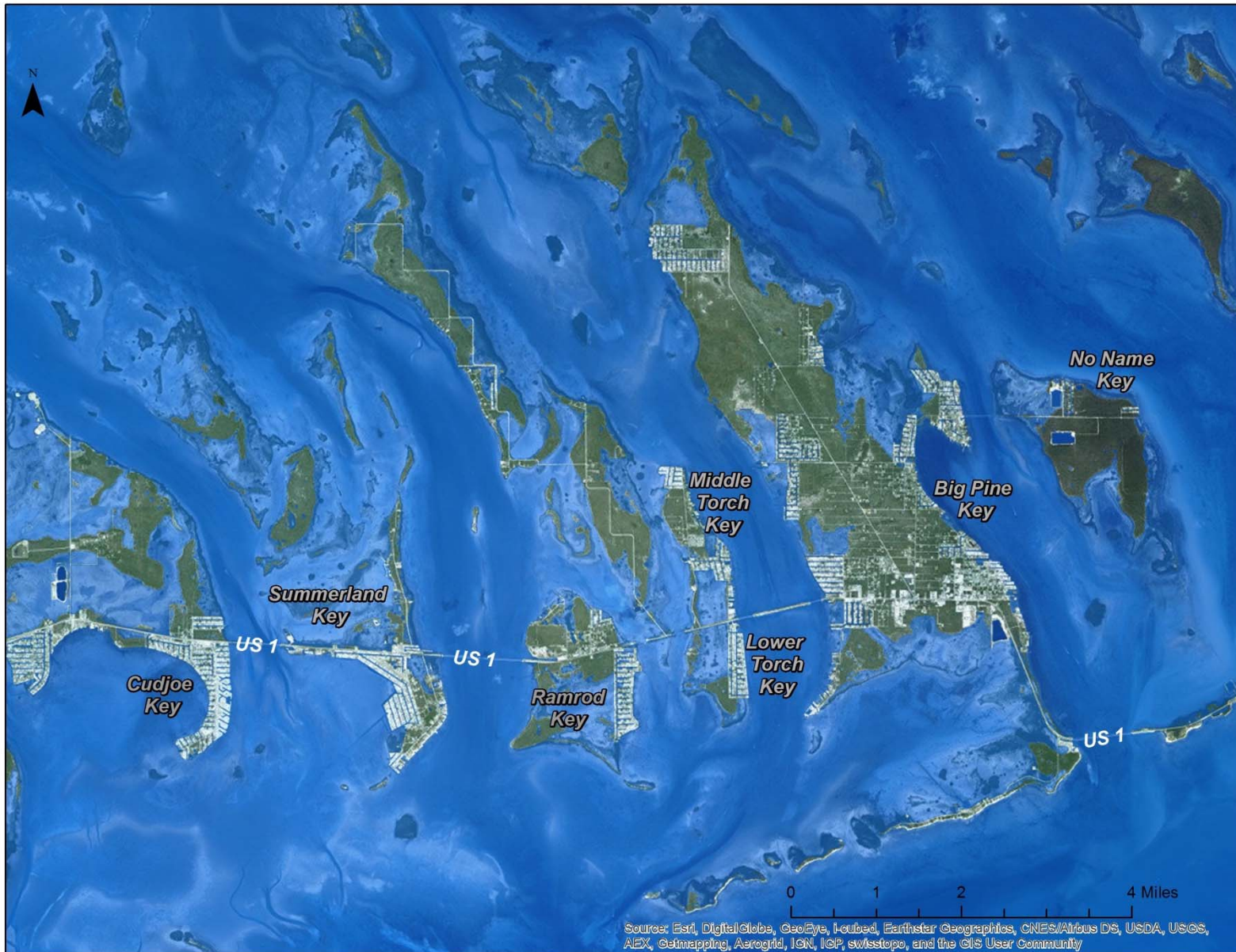


# INUNDATION



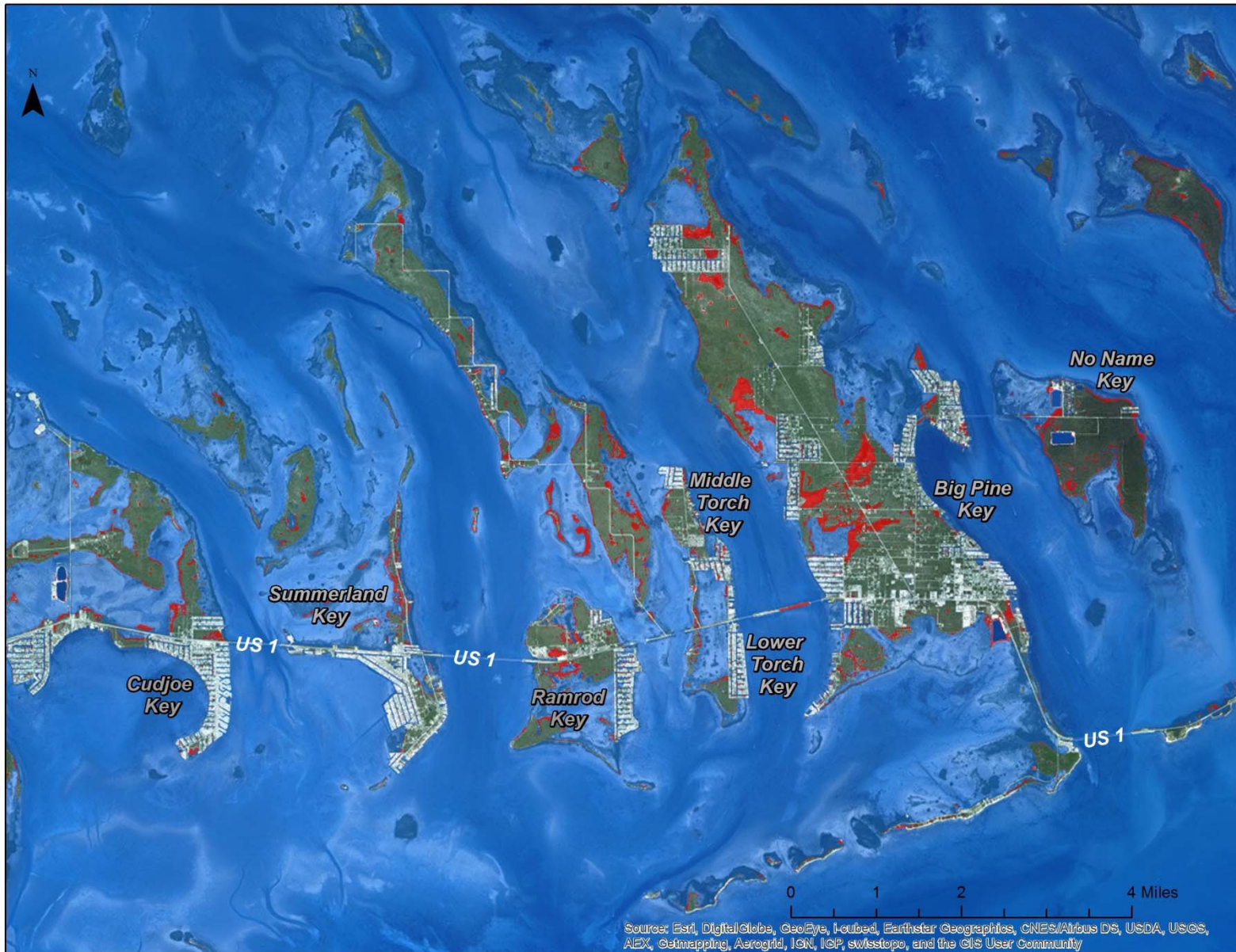


# BIG PINE KEY AND VICINITY, PRESENT DAY



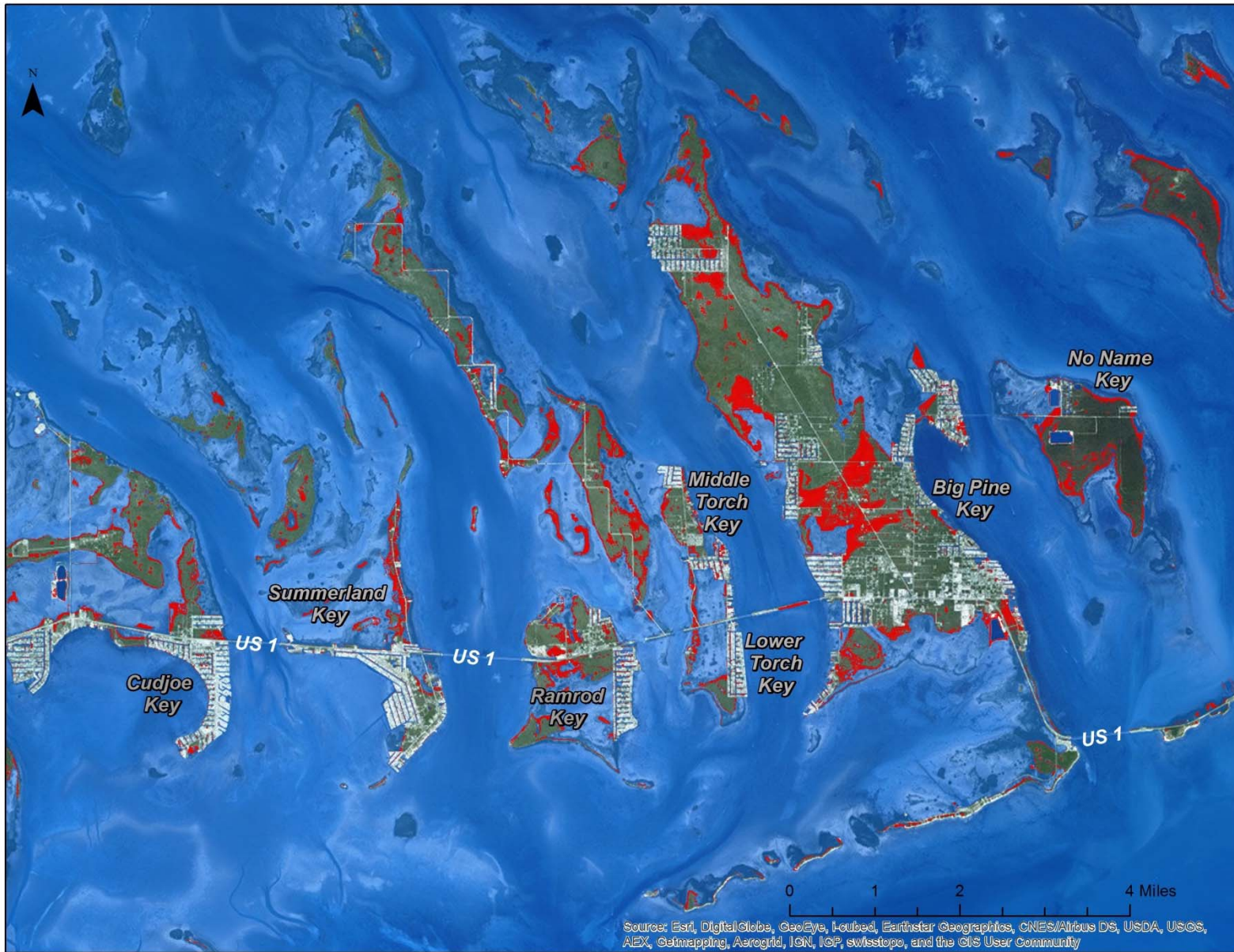


# Big Pine Key and vicinity, **3 inches** Sea Level Rise (2030, Low Scenario)



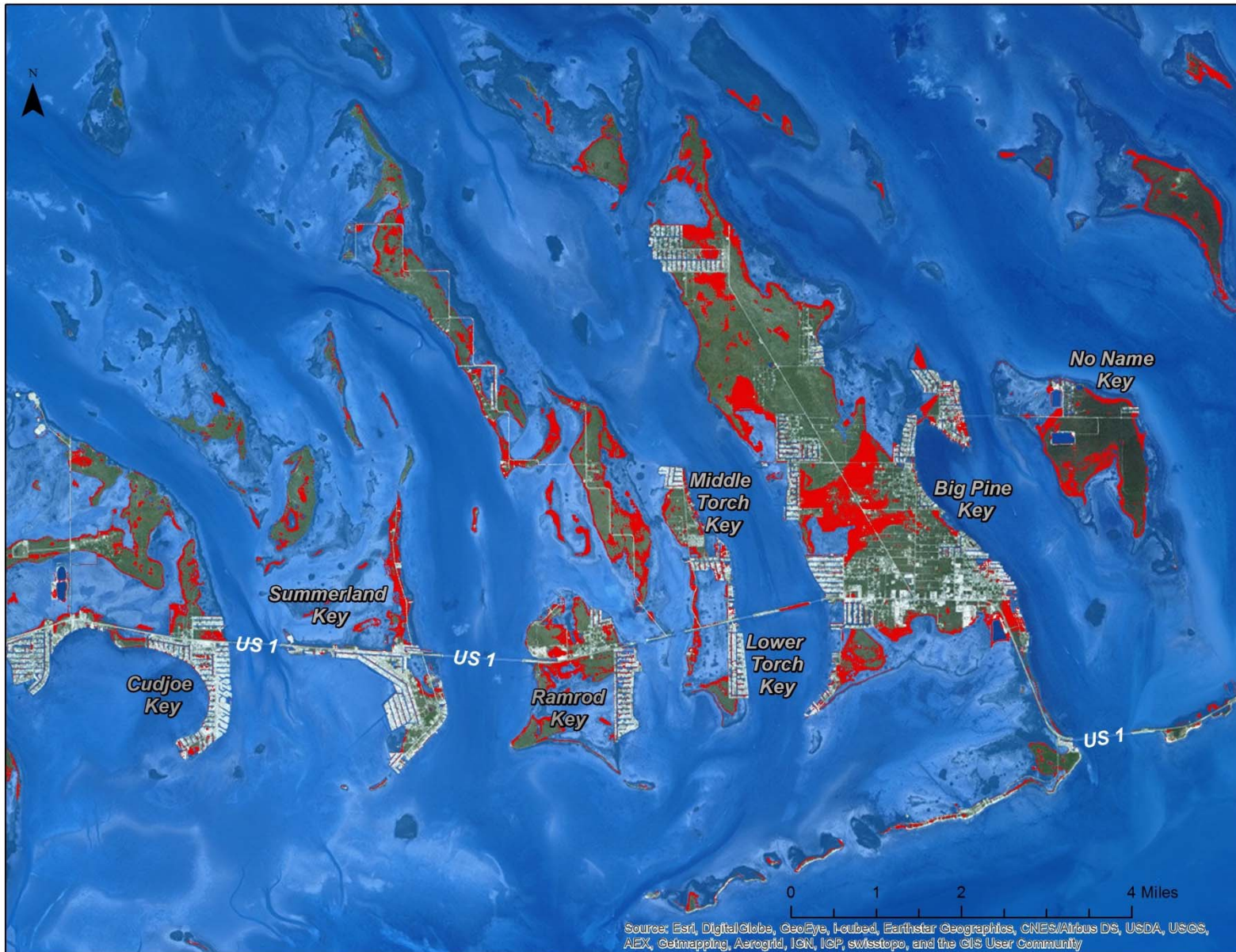


# Big Pine Key and vicinity, **7 inches** Sea Level Rise (2030, High Scenario)



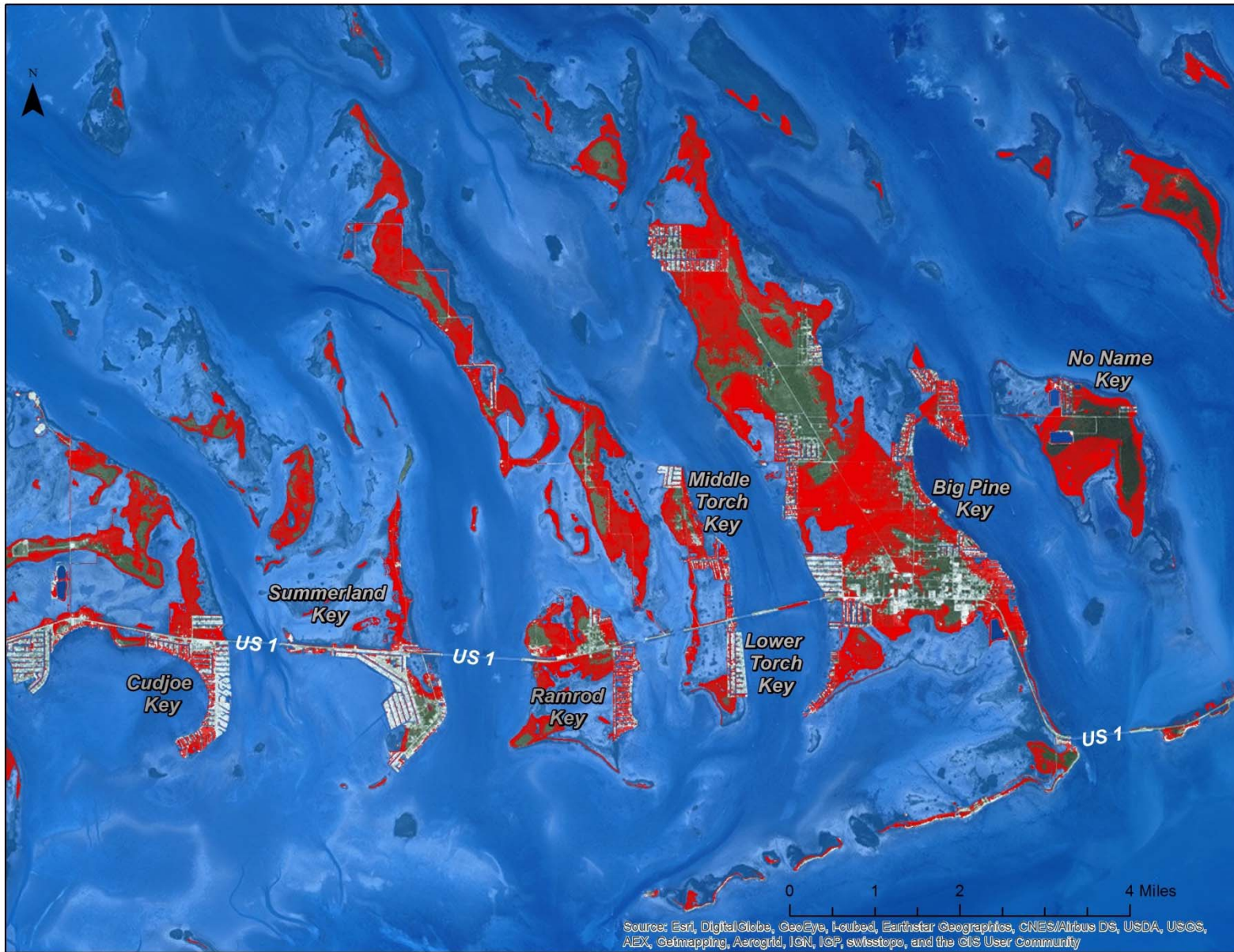


# Big Pine Key and Vicinity, 9 inches Sea Level Rise (2060, Low Scenario)





# Big Pine Key and vicinity, **24 inches** Sea Level Rise (2060, High Scenario)



# WHAT IS NUISANCE FLOODING?



High-tide flooded road on Big Pine Key



Duval Street high tide flooding

***Defined by NOAA as 1.08 feet above Mean Higher High Water (MHHW) at the Key West tide gauge***



# NUISANCE VS. WILMA AT KEY WEST



Duval Street high tide flooding



[http://cdn1.vtourist.com/4/2436059-Pics\\_of\\_Key\\_West\\_Hurricane\\_Wilma\\_Key\\_West.jpg](http://cdn1.vtourist.com/4/2436059-Pics_of_Key_West_Hurricane_Wilma_Key_West.jpg)

# INCREASE IN “NUISANCE FLOODING”



1980-1982

**.67 per year**



2010-2012

**2.3 per year**



2030 at 3”

**20 per year**



2030 at 7”

**78 per year**



2060 at 9”

**139 per year**



2060 at 24”

**672 per year**

**Flooding More Than 1x Per Day**

# FREQUENCY OF WILMA-LIKE TIDES

***With 24 inches of sea level rise, a tide as high as recorded by NOAA during Wilma can be expected to occur at Key West about two times a year***





# ROADS ANALYSIS

## DEVELOPMENT OF A GEOGRAPHIC INFORMATION SYSTEM (GIS) TOOL FOR THE PRELIMINARY ASSESSMENT OF THE EFFECTS OF PREDICTED SEA LEVEL AND TIDAL CHANGE ON TRANSPORTATION INFRASTRUCTURE

Based on FDOT Sea Level Rise Sketch Tool \*

*Developed by University of Florida*

<http://sls.geoplan.ufl.edu/documents-links/>



FDOT Contract# BDK75 977-63  
September 2013  
Final Report

**UF** UNIVERSITY of FLORIDA

Prepared by  
Alexis Thomas  
Dr. Russell Watkins  
The GeoPlan Center  
Department of Urban & Regional Planning  
University of Florida



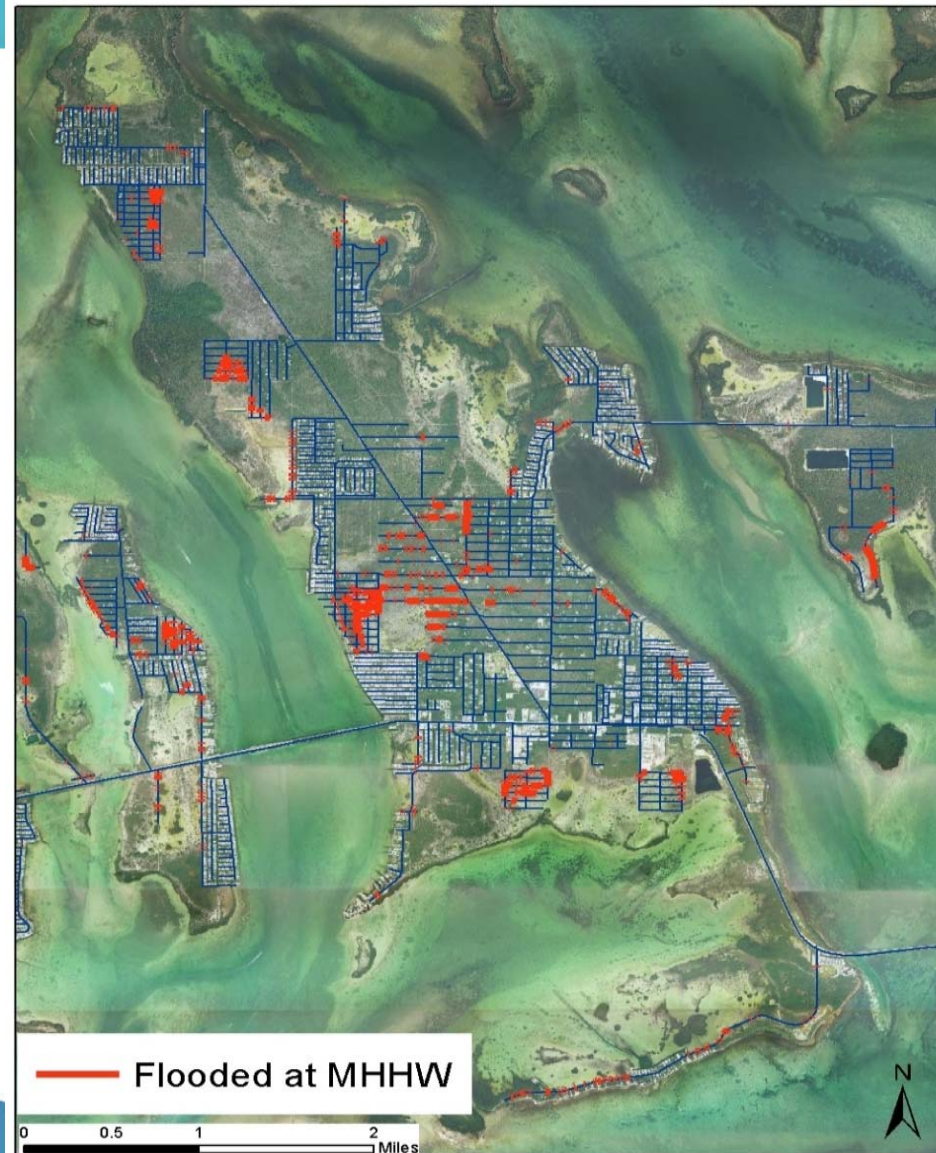
Funded by  
Florida Department of  
Transportation

*\*General planning assessment tool requires additional data for use in site-level decisions*

# Big Pine Key

## 2060 LOW SCENARIO 9 INCHES SEA LEVEL RISE

*Road centerlines and aerial imagery:  
Monroe County  
Property Appraiser's Office*





# Big Pine Key

## 2060 HIGH SCENARIO 24 INCHES SEA LEVEL RISE

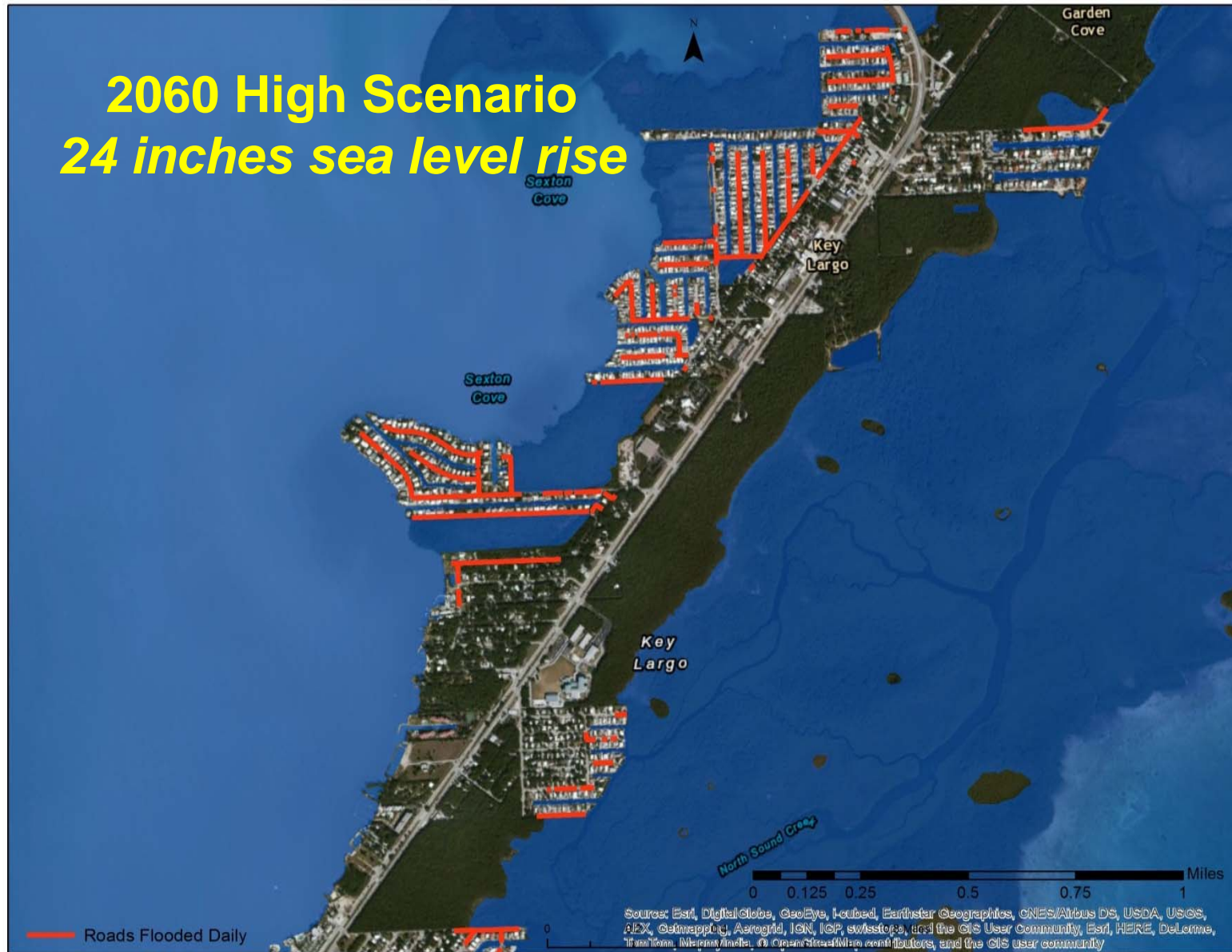
*Road centerlines and aerial imagery:  
Monroe County Property Appraiser's  
Office*





# KEY LARGO ROADS

**2060 High Scenario**  
**24 inches sea level rise**



# US1 near White Marlin Blvd. Lower Matecumbe Key





# US1 near White Marlin Blvd. Lower Matecumbe Key

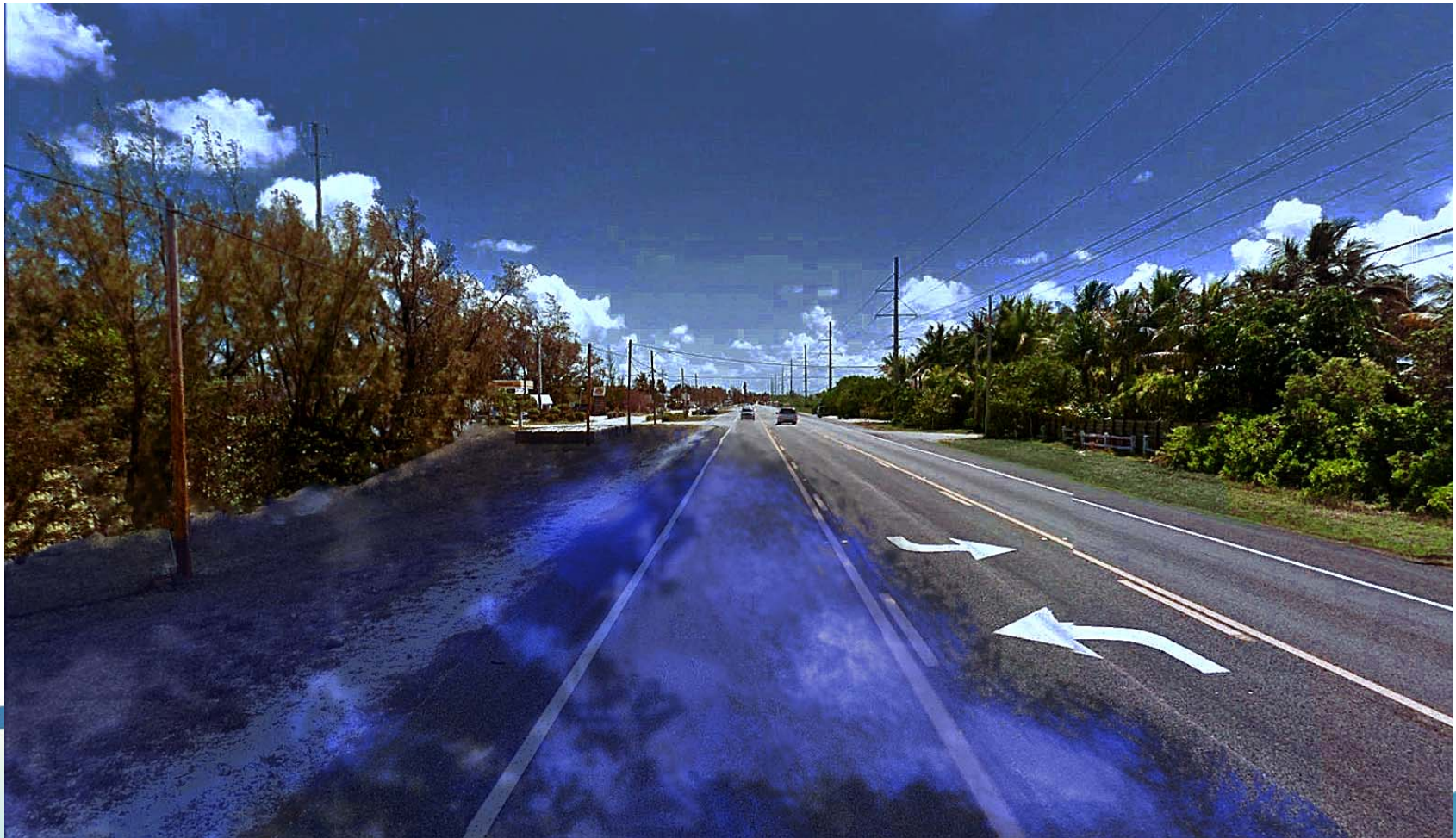
**2030 Low Scenario**  
***3 inches sea level rise***





**US1 near White Marlin Blvd.  
Lower Matecumbe Key**

**2060 High Scenario  
24 inches sea level rise**





## Key Largo Community Modeling



# Scenario 1: Elevate and Floodproof

The suggestion would model:

- Elevation in V-Zones (red)
- Floodproofing in A-Zones (green)
- Action to different heights.  
*>> subject to group input.*
- 100% of parcels are protected.  
*>> subject to group input.*



Elevate



Floodproof

## Scenario 2: Construct Breakwater

The suggestion would model:

- 1) Two 1-mile constructed barriers.
- 2) At water level.  
*>> subject to group input.*
- 3) Near to shore.  
*>> subject to group input.*



**Note: will not protect against sea level rise. Will only protect against some wave action during extreme flooding events, and only for some parcels.**



## Scenario 3: Relocate Over Time

A form of rolling easement where:

- Voluntary buyouts are offered in two phases across the Key.
- Phase 1: for parcels expected to have high tide at their center in 2030 (red).
- Phase 2: for parcels expected to have high tide at their center in 2045 (green).
- 100% of land owners accept the buyout in each phase.

*>> subject to group input.*



**Parcels in red = lost to sea level rise 2010-2030.**

**Parcels in green = Parcels lost to sea level rise 2030-2060.**

**Note: No title transfer until 2045 or when the “high” Four-County Compact sea level rise scenario hits 14” – whichever comes first. Voluntary buyouts not offered for undeveloped land.**

# Avoided Damages by 2060 – With High or Low SLR

	Avoided Damages Low SLR (9")	Avoided Damages High SLR (24")
<b>Scenarios Considered</b>	(\$ Millions)	(\$ Millions)
<b>Action 1: Elevate &amp; Floodproof</b>	<b>\$850.6</b>	<b>\$1,209.8</b>
<b>Action 2: Construct Breakwater</b>	<b>\$12.8</b>	<b>\$13.2</b>
<b>Action 3: Voluntary Relocation</b> 10% Participation Now; 50% Participation in 2030	<b>\$26.8</b>	Figures Discounted 3.3% <b>\$77.5</b>



# Cost Estimates By Year 2060 – For Each Action: COSTS

	Low Cost Estimate (\$ millions)	High Cost Estimate (\$ millions)
<b>Action 1: Elevate &amp; Floodproof</b>	<b>\$79.2</b>	<b>\$162.2</b>
<b>Action 2: Construct Breakwater</b>	<b>\$6.0</b>	<b>\$8.0</b>
<b>Action 3: Voluntary Relocation</b>		

Figures Discounted 3.3%

## Benefit Cost Ratios of Actions by Year 2060

	Benefit/Cost Ratios – Using Low Cost Estimate	
	Low SLR	High SLR
<b>Action 1: Elevate &amp; Floodproof</b>	<b>10.75</b>	<b>15.28</b>
<b>Action 2: Construct Breakwater</b>	<b>2.12</b>	<b>2.2</b>
<b>Action 3: Voluntary Relocation</b>		
<b>10% P in 2030</b>	<b>0.44</b>	<b>0.07</b>

Discounted 3.3%, Values over 1.0 are considered positive.



# NEXT STEPS

**1. MIDDLE KEYS OUTREACH MEETING**

**2. STOCK ISLAND OUTREACH MEETING**

## Rhonda insert

Short summary of roads and county buildings analysis, Key Largo Catalysis work, next steps (middle and lower Keys public engagement and final reporting)

Anything else?

I will then cover habitat and TNC's new tools.



# HABITAT



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2711076

Brandi Pierce | Dreamstime.com



# HABITAT CHANGE

**3 inches** of sea level rise (2030, Low Scenario) could bring **daily saltwater tides** into **19%** of Monroe County's **Freshwater Wetland Areas\***

*\*Analysis based on Monroe County Habitat dataset (2009)*



Freshwater pond on Big Pine Key

<http://rcrackliffe.com/images/FloridaVacation/2004-12-28-14.jpg>



# HABITAT CHANGE

**24 inches** of sea level rise (2060, High Scenario) could bring **daily saltwater tides** into **94%** of Monroe County's **Freshwater Wetland Areas**\*



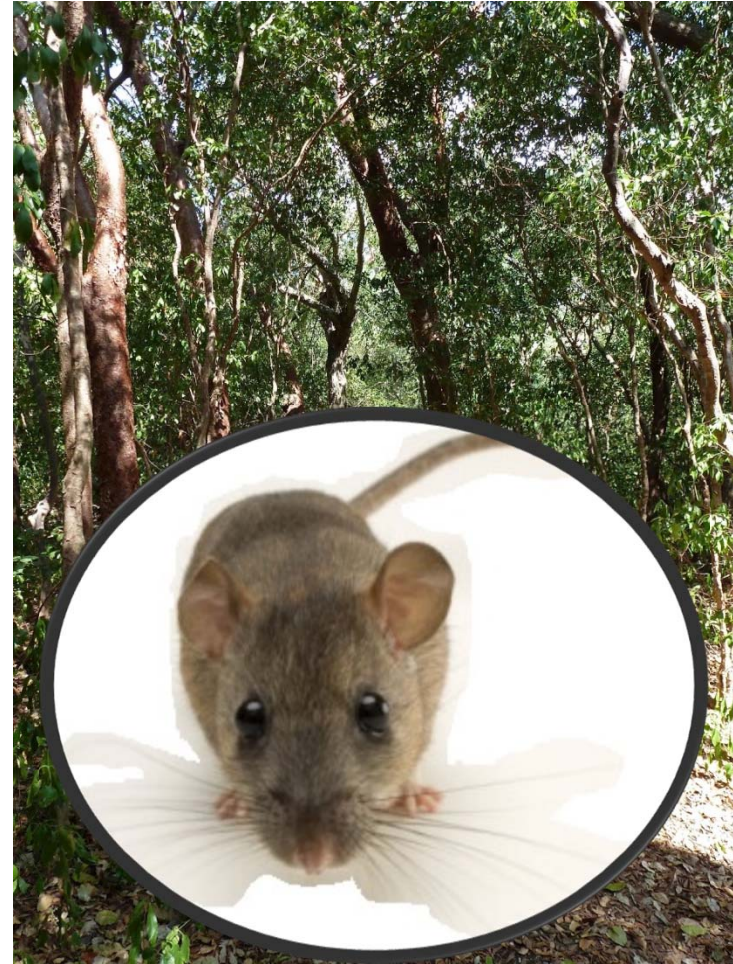
Key deer on Big Pine Key  
<http://s3.amazonaws.com/trazler-images/af/1505/00.jpg>

*\*Analysis based on Monroe County Habitat dataset (2009)*

# HABITAT CHANGE

**3 inches** of sea level rise (2030, Low Scenario) could bring **daily saltwater tides** into **2.3%** of Monroe County's remaining **Tropical Hardwood Hammock\***

*\*Analysis based on Monroe County Habitat dataset (2009)*



Tropical hardwood hammock  
Lignumvitae State Park

<http://3.bp.blogspot.com/-16rkce85yql/T5QYIYE2dZI/AAAAAAAAAFDk/7BHEUgYDDMY/s1600/LignumTrail.jpg>



# HABITAT CHANGE

**inches** of sea level  
(2060, High Scenario)  
could bring **daily**  
**water tides into 42%**  
Monroe County's  
remaining **Tropical**  
**Redwood Hammock\***



Trees killed by saltwater intrusion (Big Pine)

<http://www.worldviewofglobalwarming.org/risingseas/FLKeysPinesKilledSaltSLRWeb.jpg>

*Analysis based on Monroe County Habitat  
Inventory (2009)*

# QUESTIONS?

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