Shoreline Change in Response to Sea Level Rise on Florida's Panhandle Coast

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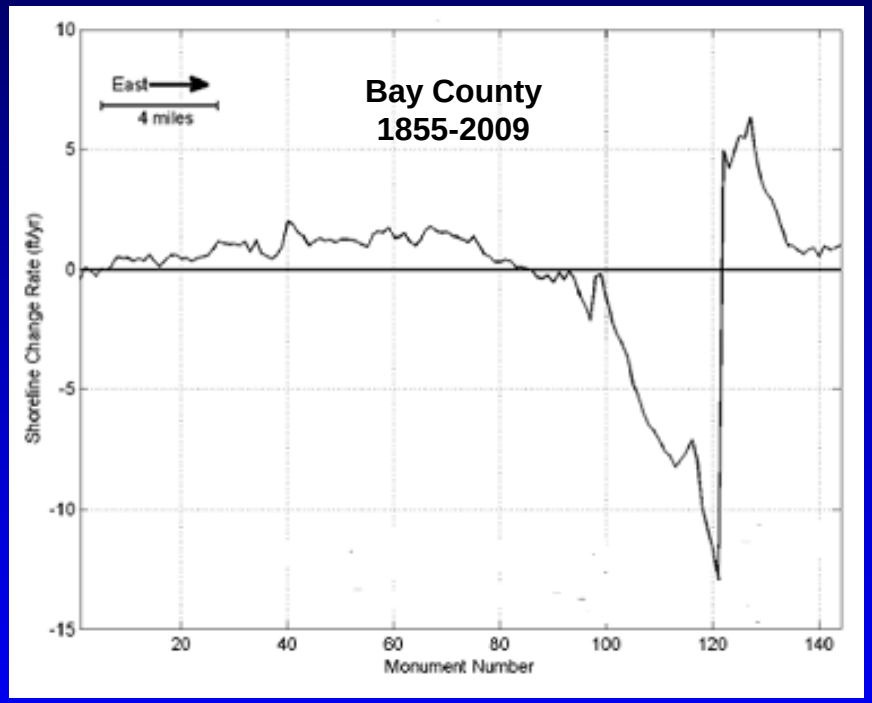
Approach

- Calculate historical shoreline change by county (1867- 2015)
- Determine causes of the change
- Project future shoreline change with increased rates of sea level rise

- Analyze whether beach nourishment can counter future sea level rise

To Project Shoreline Change

- Must consider all phenomena significantly affecting the change – typically not done
- Sea level rise is ignored in
  - Most sediment budget studies
  - Florida DEP (2015) "Strategic Beach Management Plans"!
- Equally invalid, EPA ignored everything except sea level rise in a report to Congress on shoreline change



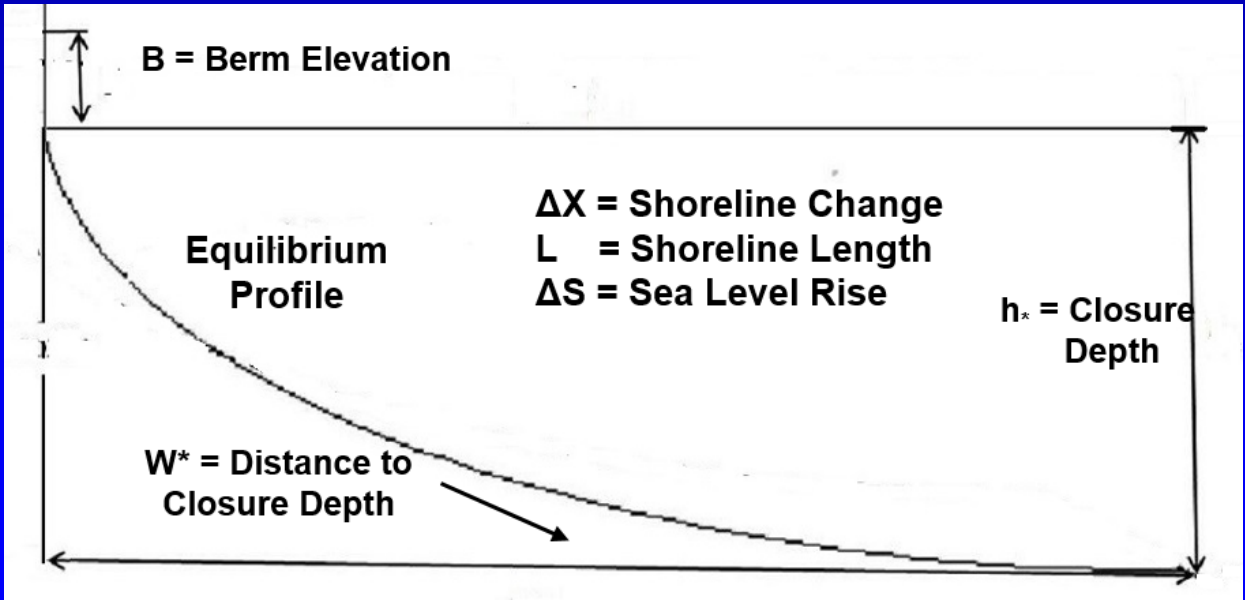
Shoreline Change

$$L\Delta X = -L\Delta S\left(\frac{W_*}{h_* + B}\right) - \frac{\Delta V_{sink}}{(h_* + B)} + \frac{\Delta V_{source}}{(h_* + B)} - \frac{L\Delta T}{(h_* + B)}\frac{dQ}{dy} + \frac{L\Delta T\phi}{(h_* + B)}$$

Measured Shoreline Area Change	Sea Level Rise (Bruun Rule)	Sink (e.g., Passes)	Source (e.g. Beach Nourishment)	Longshore Transport	Long-Term Onshore Transport

Dean and Houston, 2016. Determining Shoreline Response to sea level rise, *Coastal Engineering*, 114, 1-8

- **Considers all phenomena significantly affecting shorelines**



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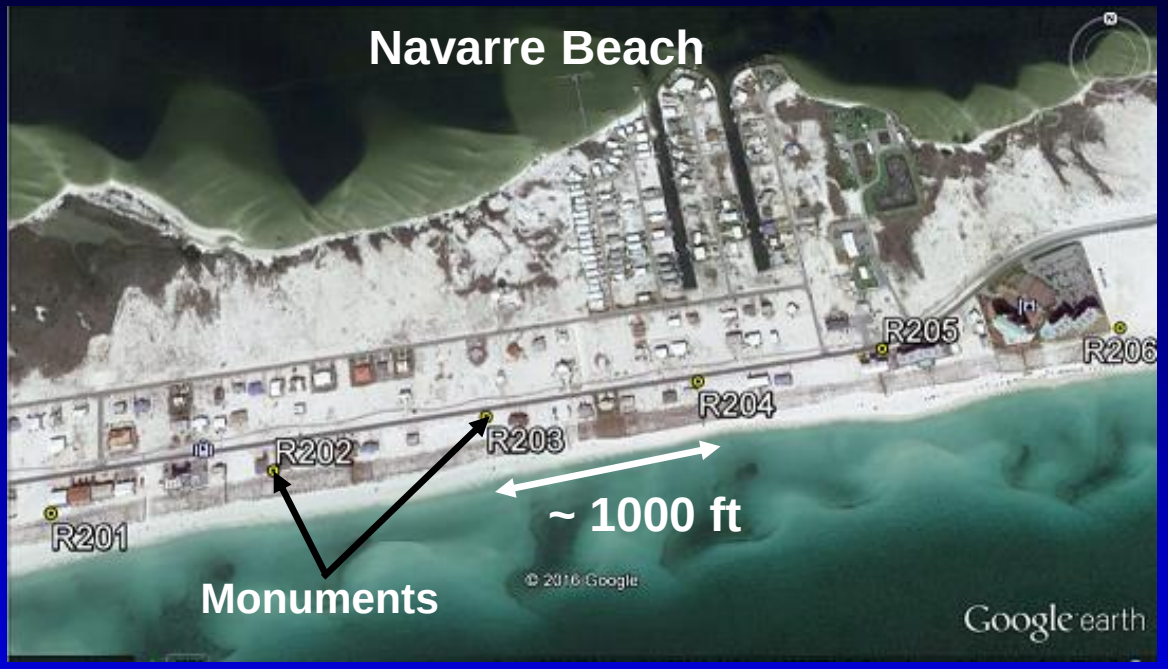
Measured Shoreline Area Change	Sea Level Rise (Bruun Rule)	Sink (e.g., Passes)	Source (e.g. Beach Nourishment)	Longshore Transport	Long-Term Onshore Transport

(Dean and Houston, 2016)

Measured Historical Shoreline Change

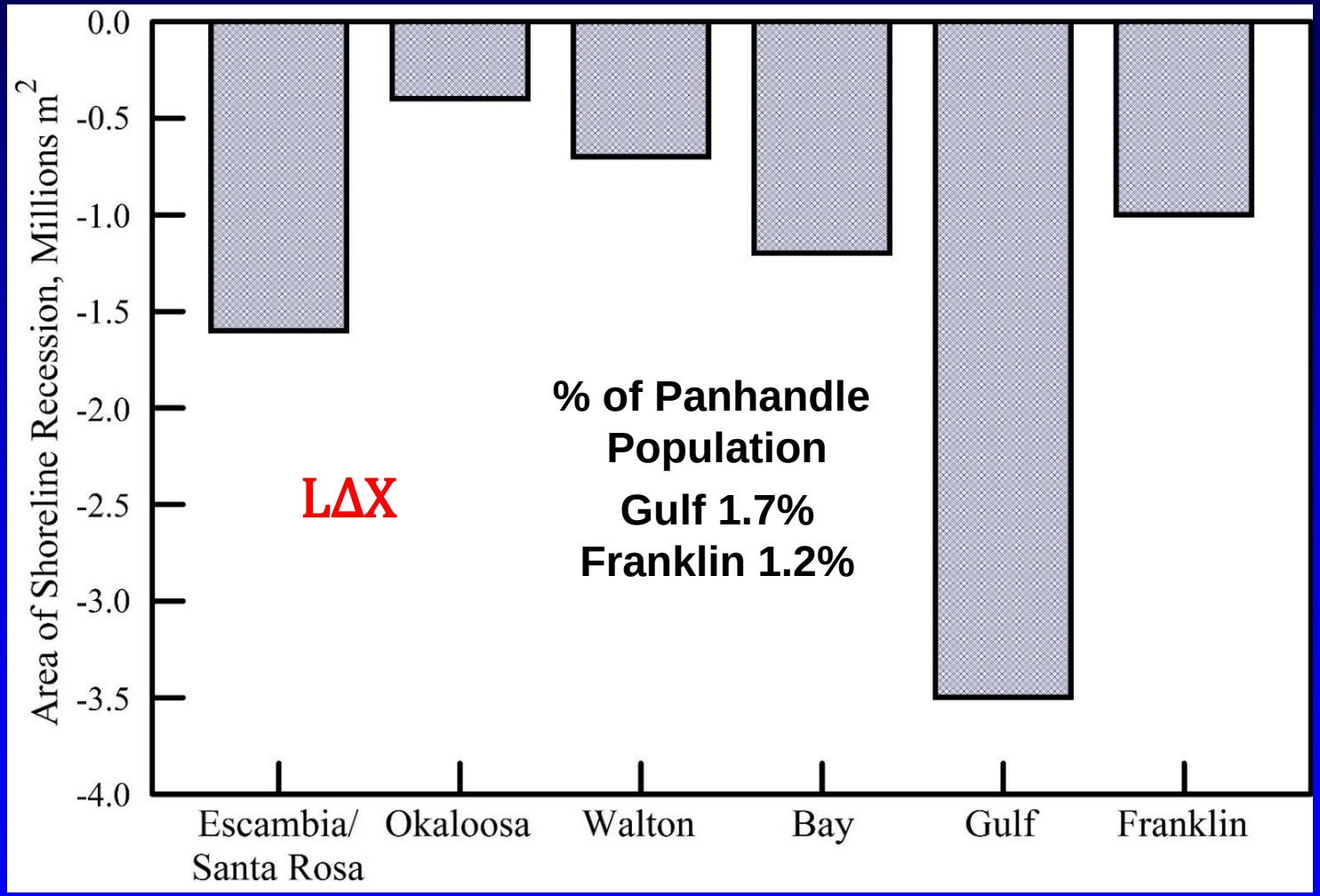
- Shoreline position measured at 1080 monuments from about 1867
- Determined shoreline change rates at the monuments using the least squares regression method



Escambia and Santa Rosa Counties are recorded jointly in the historical shoreline change data base

Coast	Years	Shoreline Change (ft)
East	1869 - 2007	+ 158 (Houston & Dean, 2014)
Southwest	1872 - 2007	+ 120 (Houston, 2015)
Panhandle	1867 - 2015	- 25

Measured Historical Shoreline Recession Since About 1867



Shoreline Change

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Measured Shoreline Area Change	Sea Level Rise (Bruun Rule)	Sink (e.g., Passes)	Source (e.g. Beach Nourishment)	Longshore Transport	Long-Term Onshore Transport

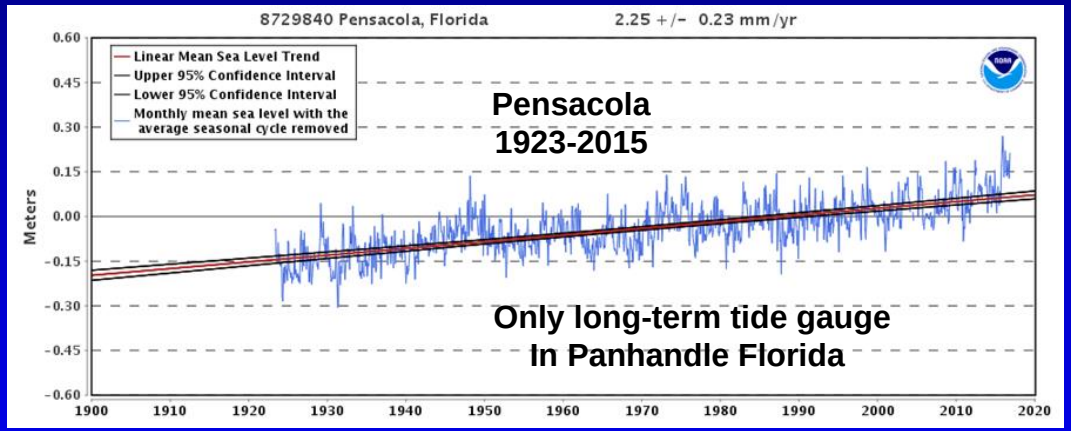
- **Sea level rise, ΔS =**

  1923-2015 at 2.25 mm/yr

  +

  1867-1923 at 1.70 mm/yr

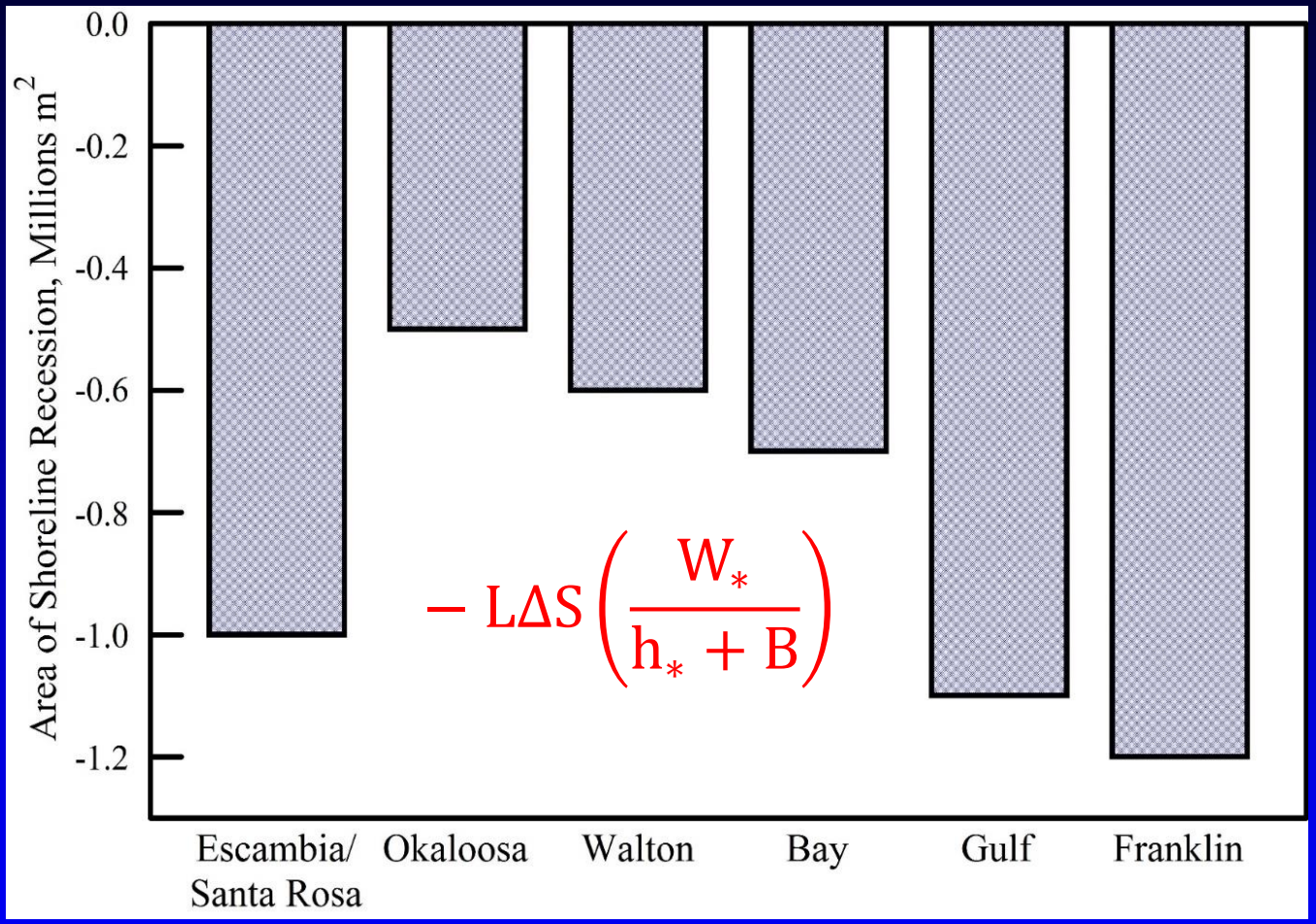
  = ~ 1 ft from 1867-2015



References:

- **Church and White (2016), NOAA (2016), Systeme d'Observation du Niveau des Eaux Littorales (2016)**

Area Recession from Sea Level Rise



L = Shoreline length **h_* = Closure depth** **W_* = Distance**
ΔS = Sea level rise **B = Berm elevation** **B to h_***

Shoreline Change

$$L\Delta X = -L\Delta S\left(\frac{W_*}{h_* + B}\right) - \frac{\Delta V_{sink}}{(h_* + B)} + \frac{\Delta V_{source}}{(h_* + B)} - \frac{L\Delta T}{(h_* + B)}\frac{dQ}{dy} + \frac{L\Delta T\phi}{(h_* + B)}$$

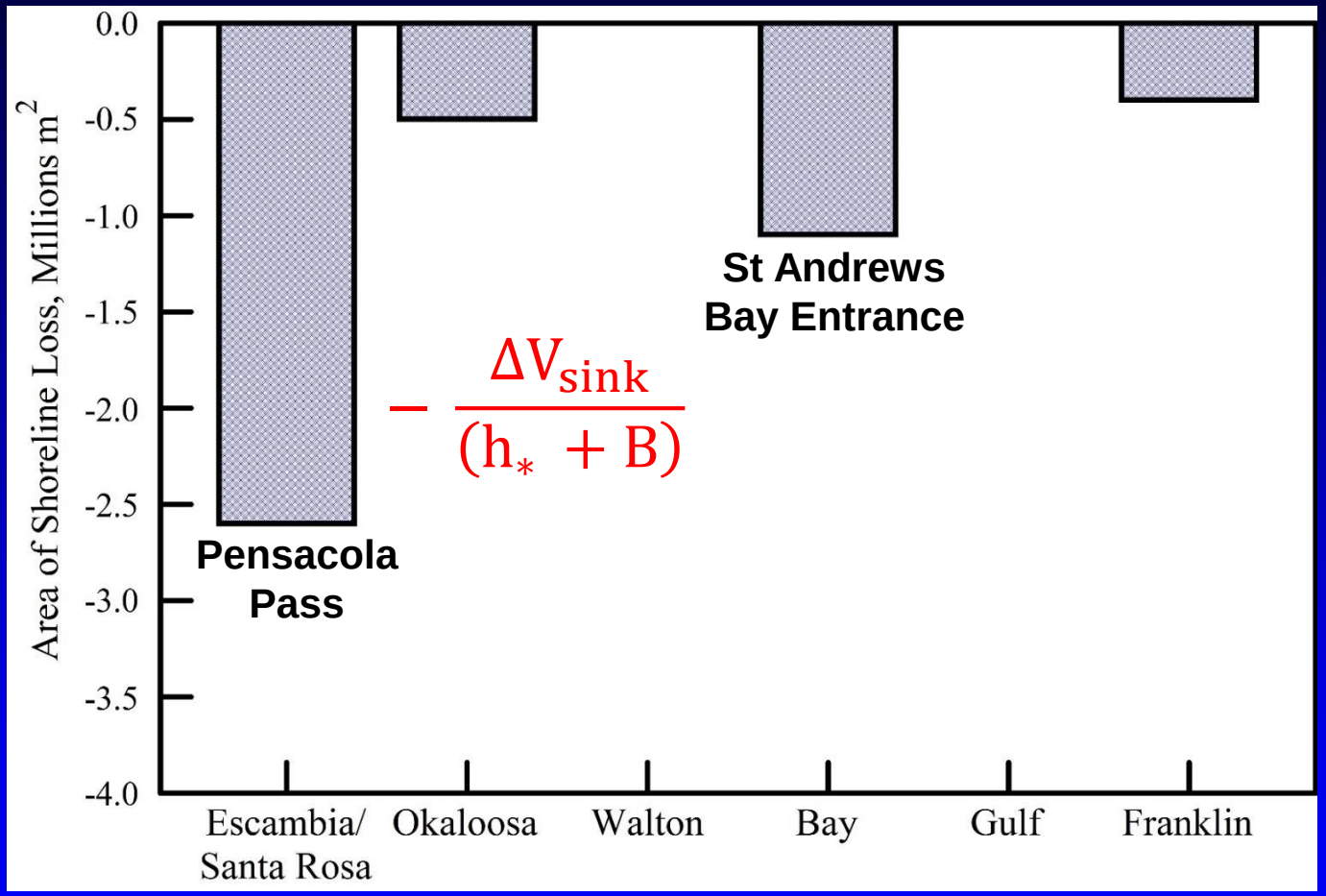
Measured Shoreline Change	Sea Level Rise (Bruun Rule)	Sink (e.g., Passes)	Source (e.g. Beach Nourishment)	Longshore Transport	Long-Term Onshore Transport


Pensacola Pass


St Andrews Bay Entrance

Area Change from Passes in the Past

- **Losses due to:**
  - **Offshore disposal of dredged sediment**
  - **Shoal growth from passes modified for navigation**



References:

- **Browder and Dean (1999), Hine et al (1986), Dean and O'Brien (1987), Corps of Engineers (2015)**

Shoreline Change

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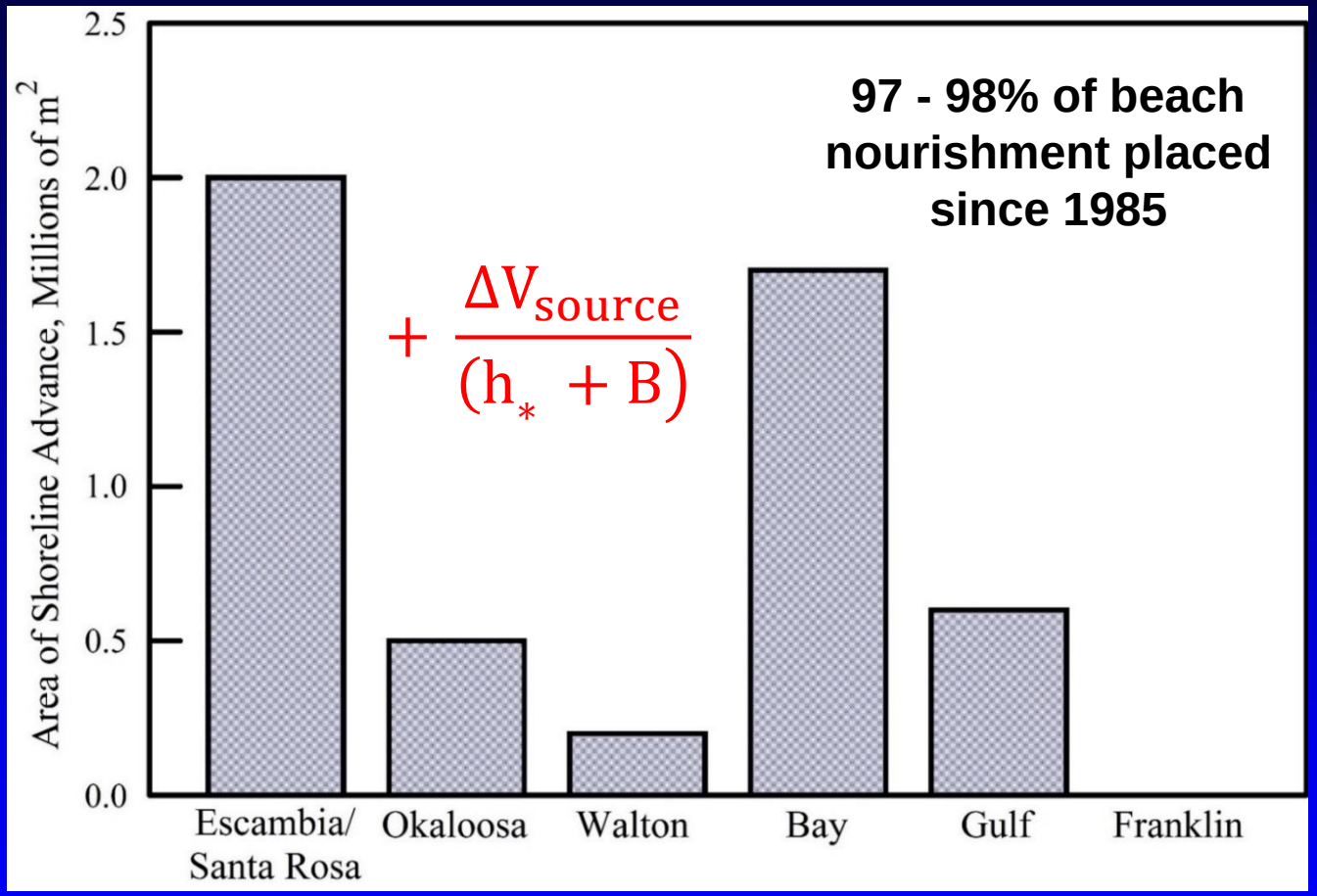
Measured Shoreline Change	Sea Level Rise (Bruun Rule)	Sink (e.g., Passes)	Source (e.g. Beach Nourishment)	Longshore Transport	Long-Term Onshore Transport

Area Change from Beach Nourishment 1985 - 2015



Primary Reference:

- **Florida Department of Environmental Protection (2015)**

Shoreline Change

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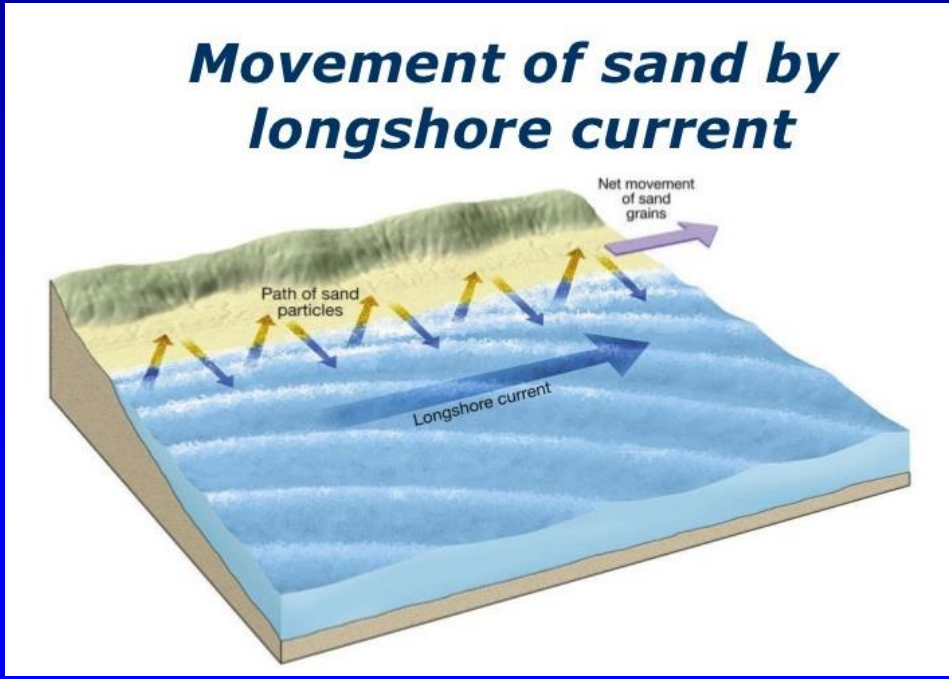
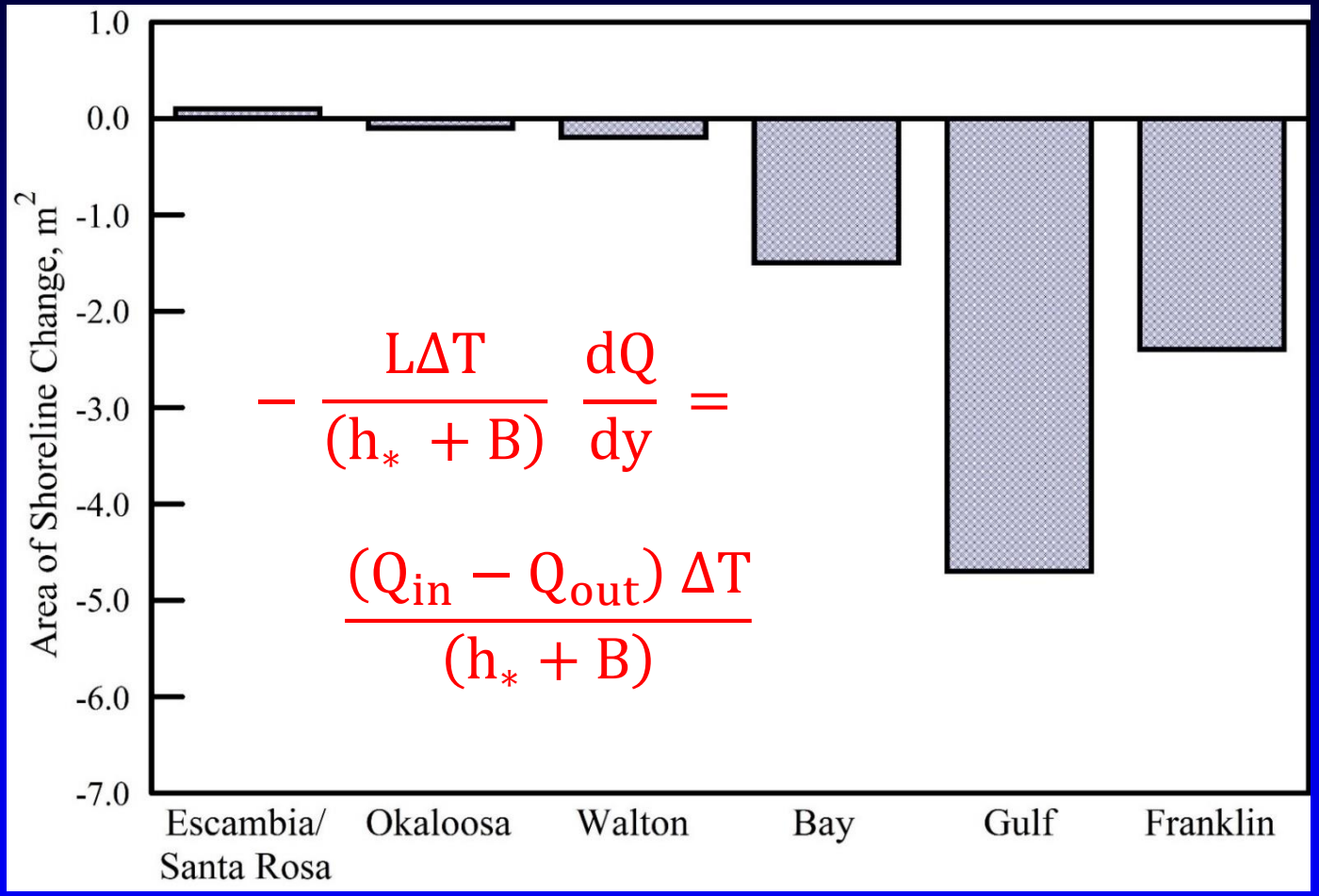


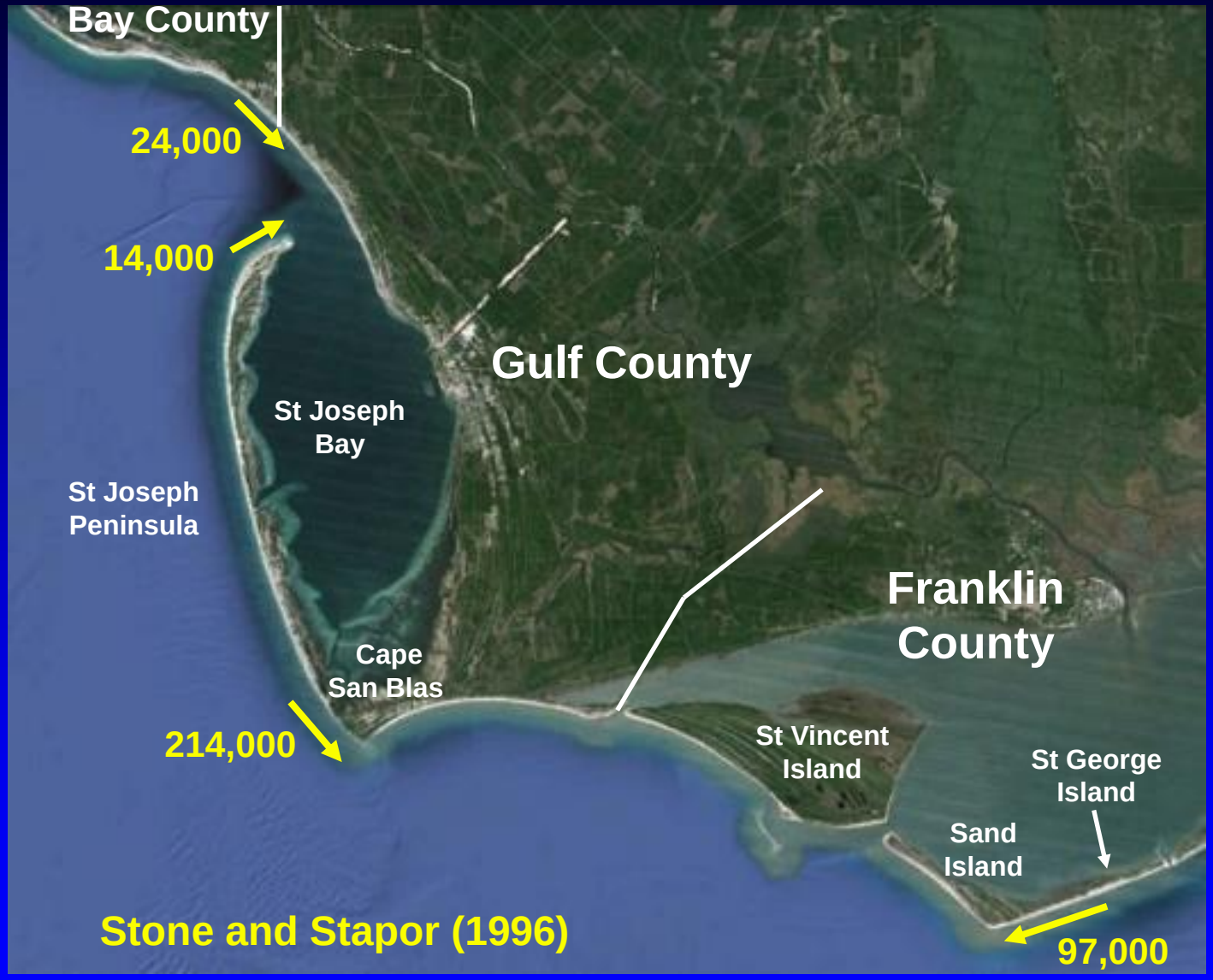
Area Change from Longshore Transport



References:

- Stone and Stapor (1996), Corps of Engineers (2010)

Longshore Transport



Shoreline Change

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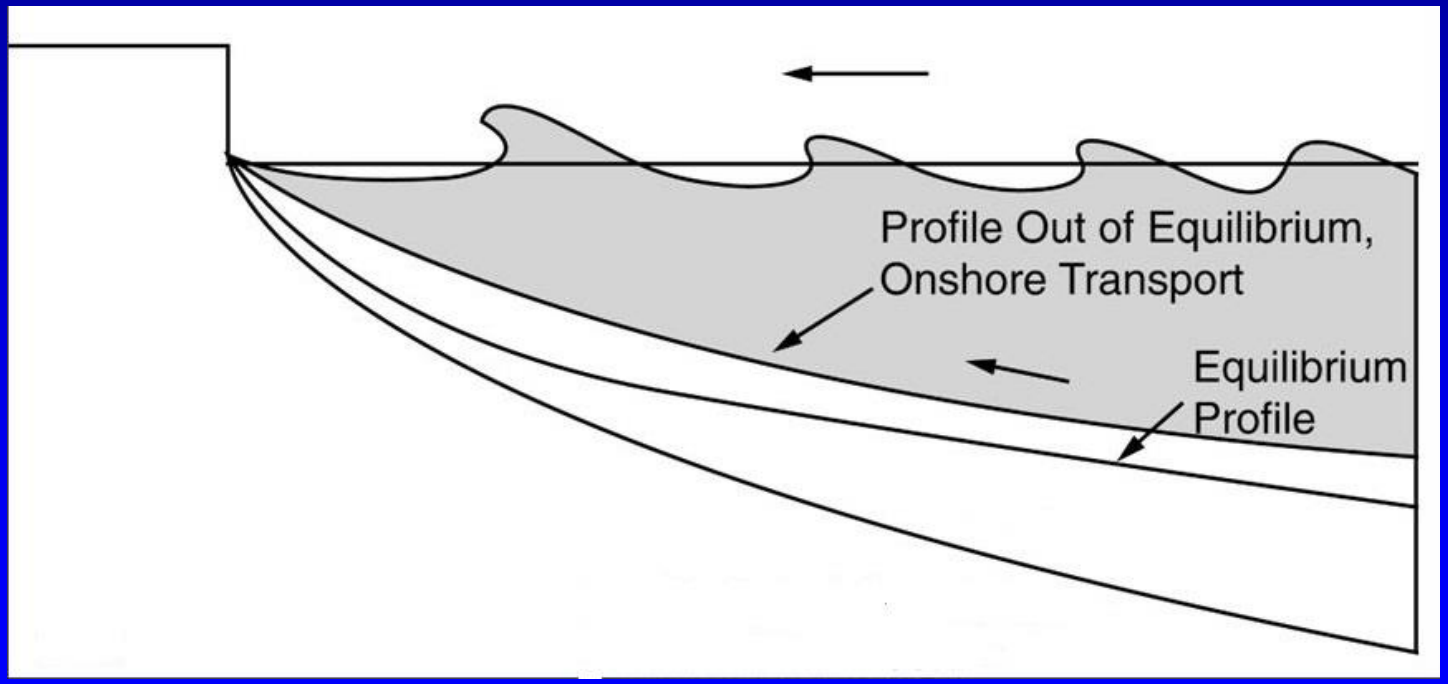
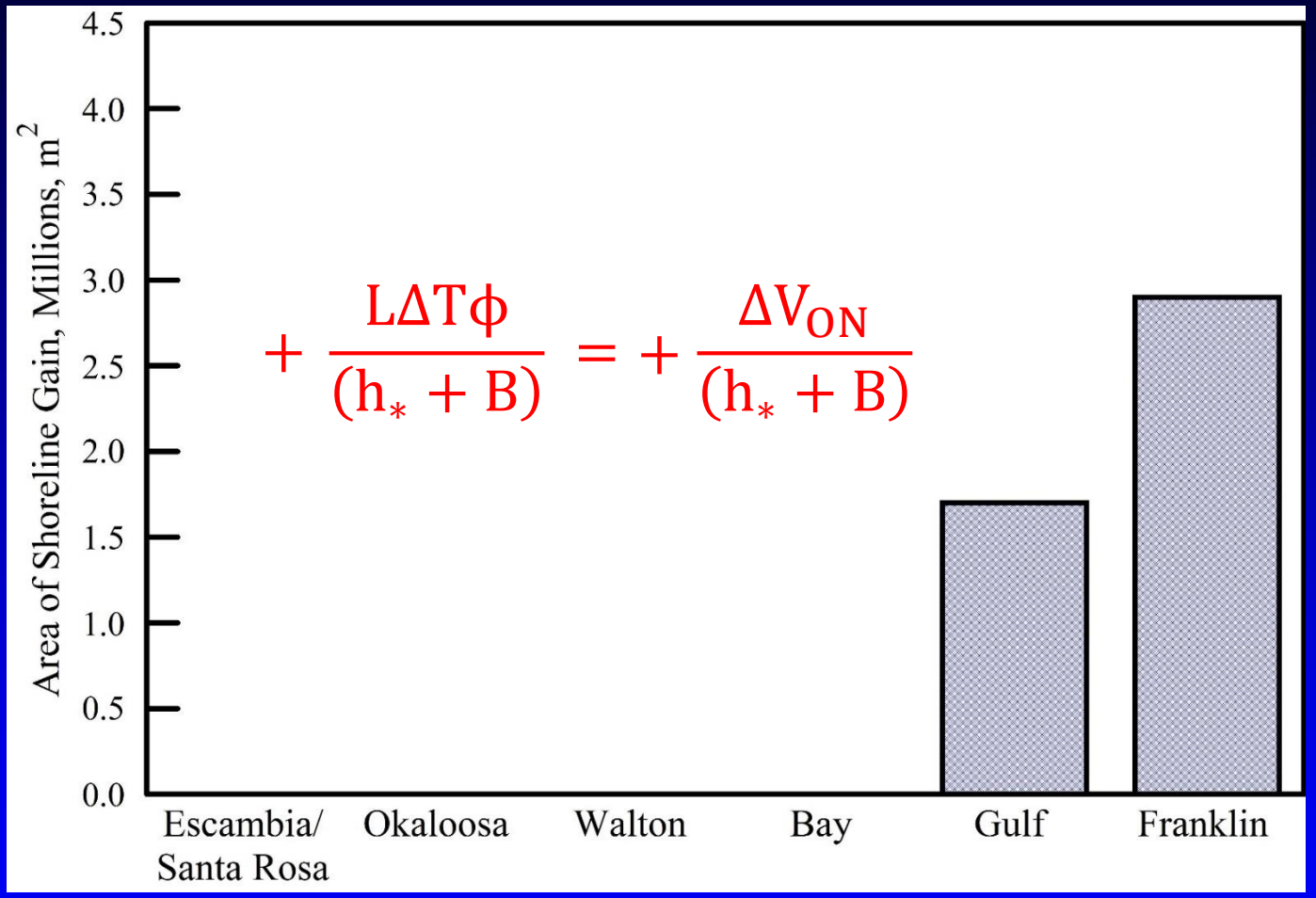
Measured Shoreline Change	Sea Level Rise (Bruun Rule)	Sink (e.g., Passes)	Source (e.g. Beach Nourishment)	Longshore Transport	Long-Term Onshore Transport

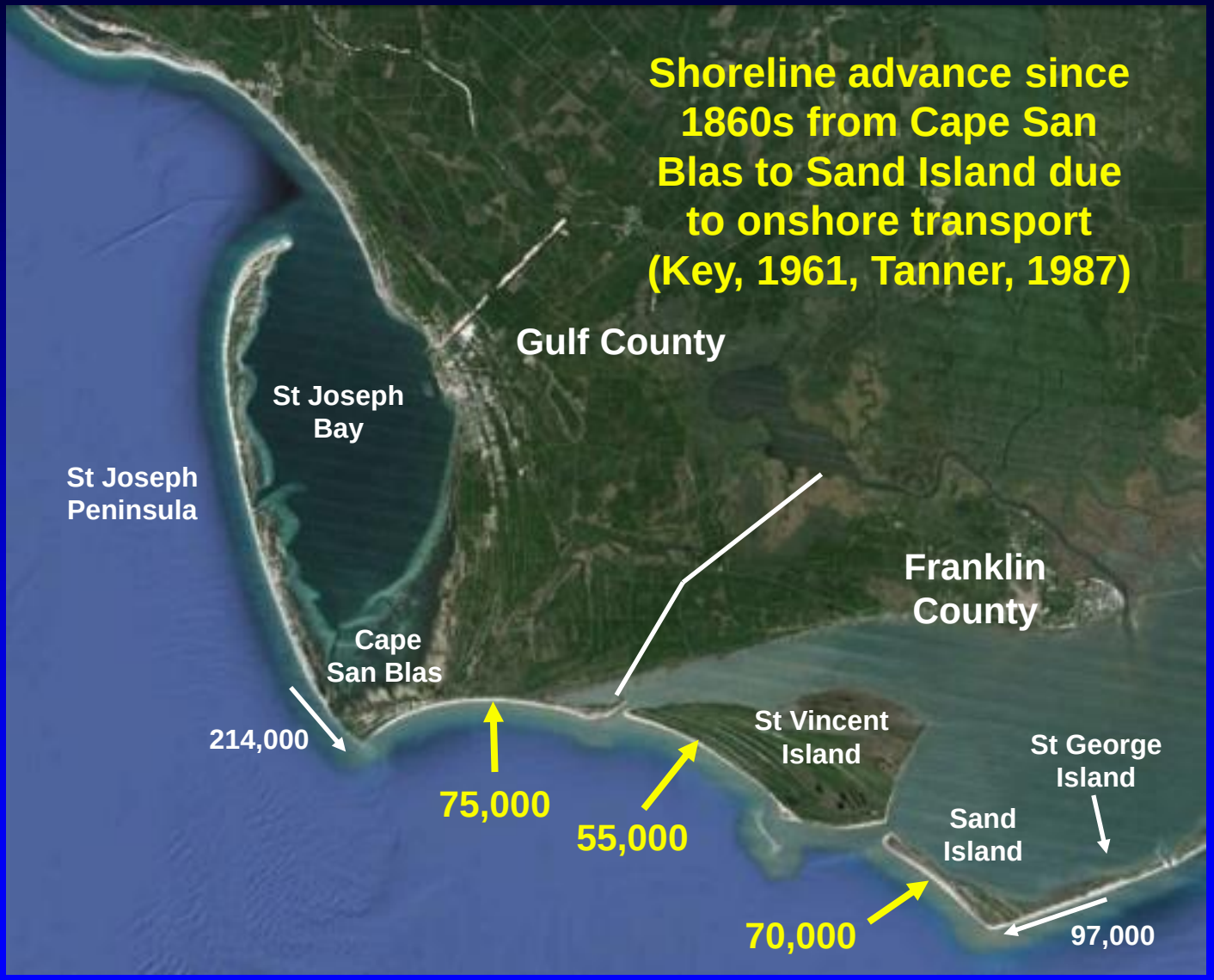


Area Change from Onshore Transport

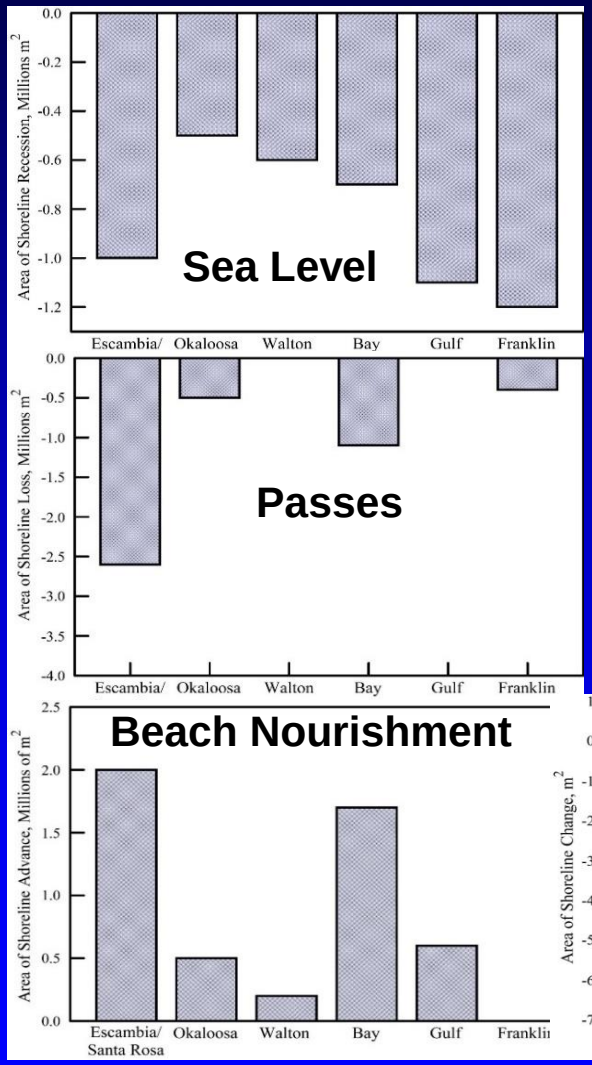


- Shoreline accretion at Cape San Blas, St Vincent Island, and Sand Island

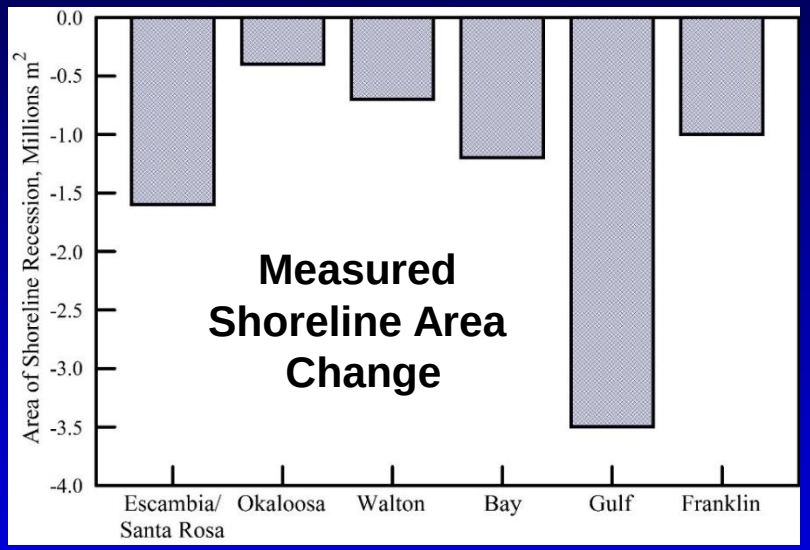
Onshore Transport

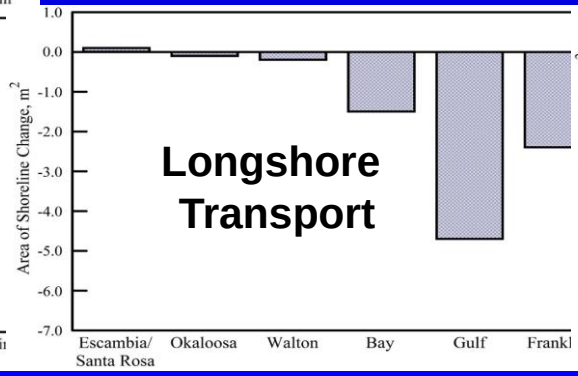


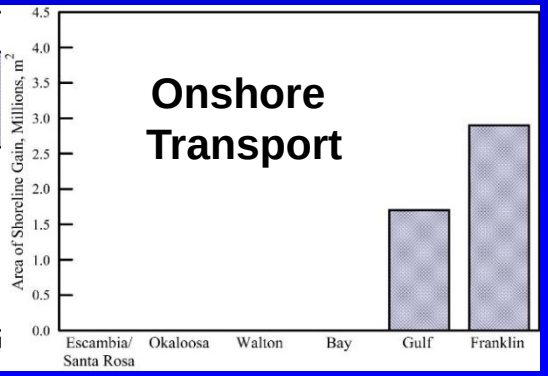
Compare Sum of Contributions to Measured Shoreline Area Change



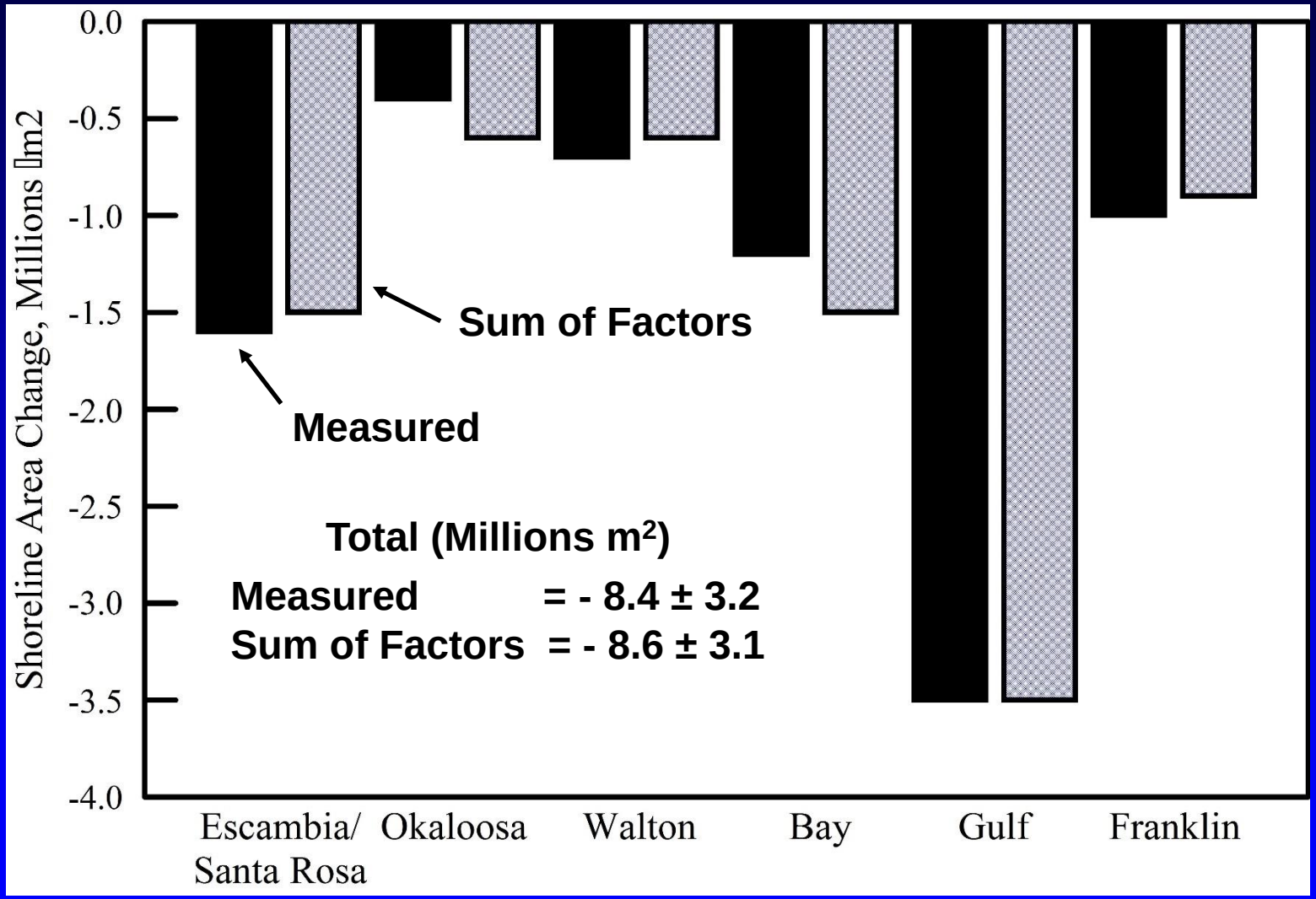
Compare



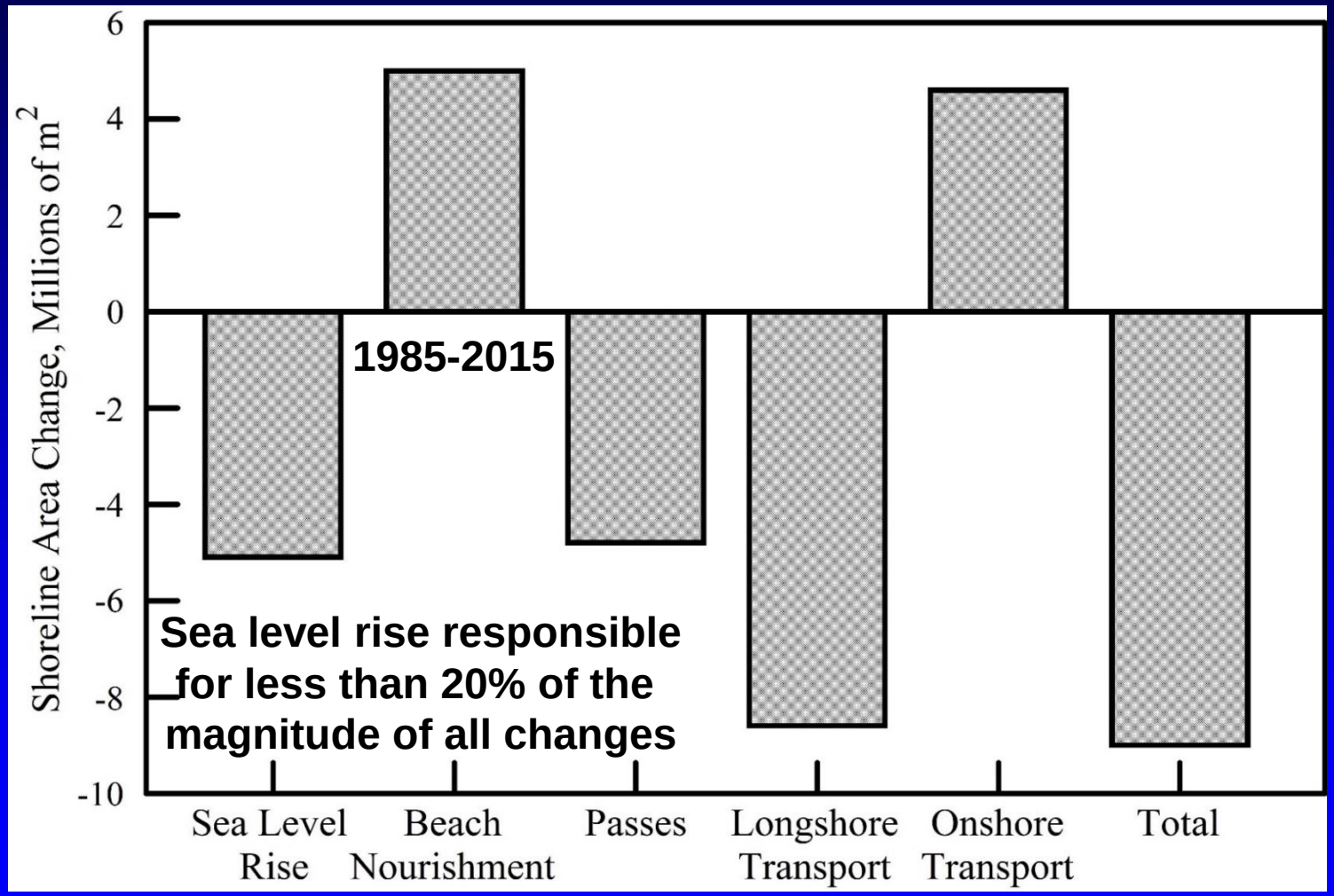




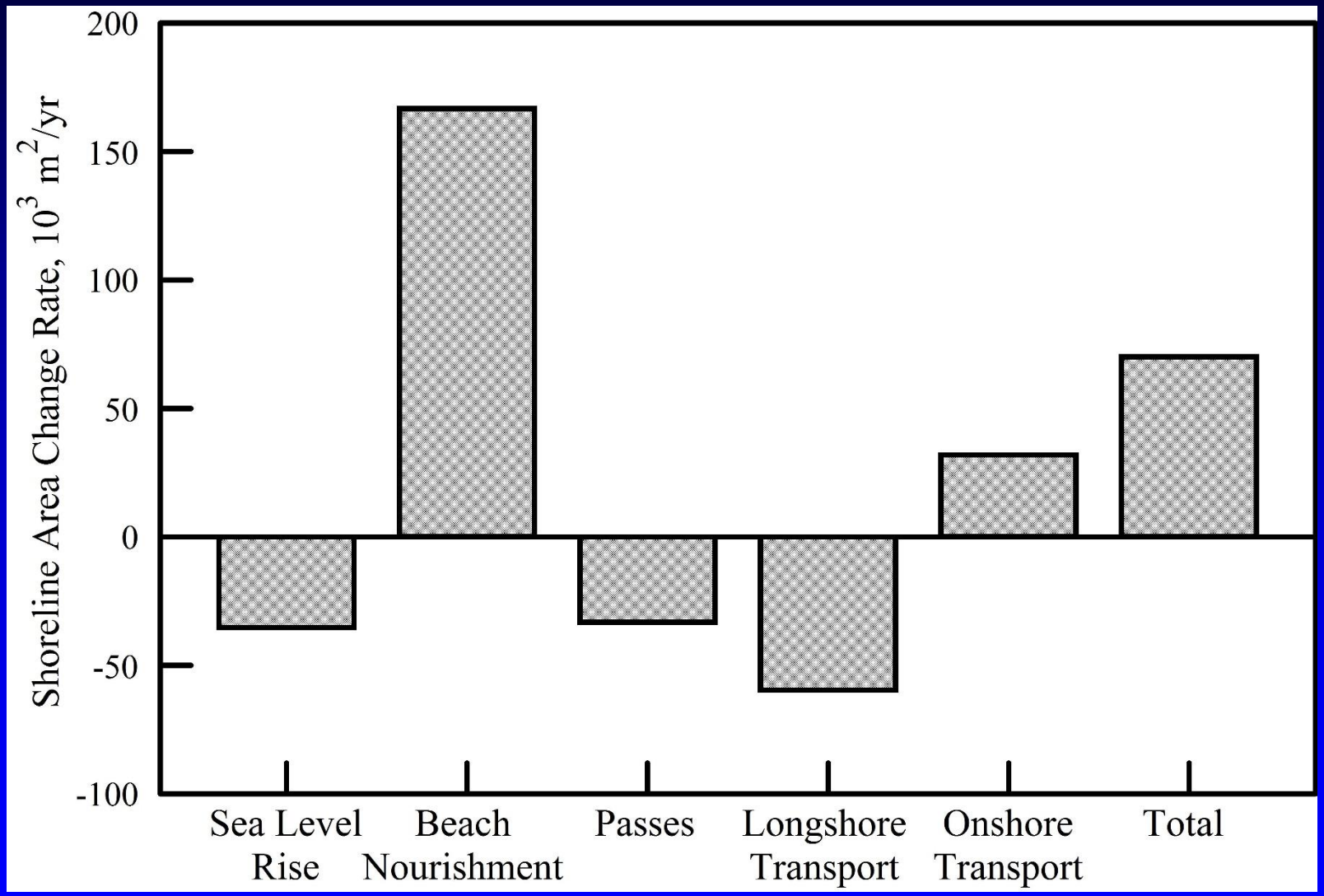
Measured Versus Sum of Factors



Past Shoreline Area Change (1867-2015)

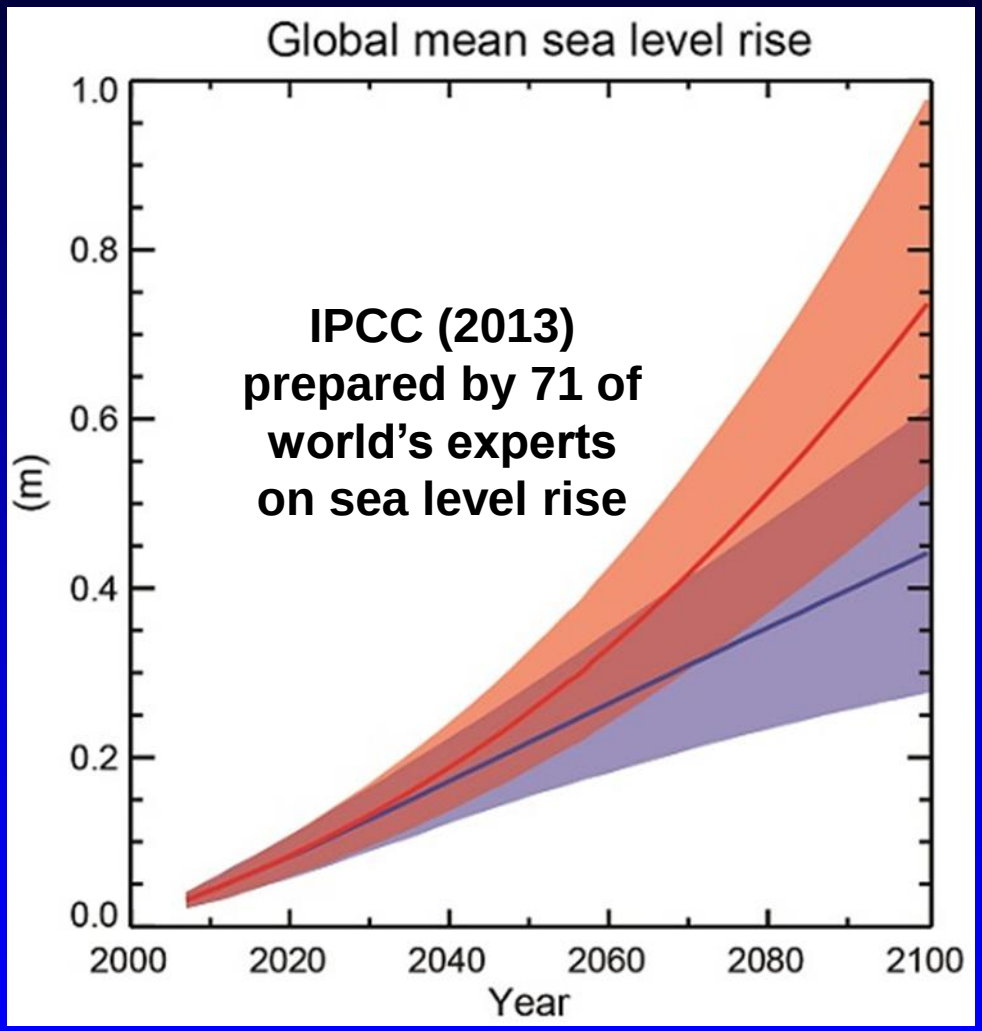


Past Shoreline Area Change Rate



Shoreline Change Projections

- **Sea level rise**
  - **Projections by the Intergovernmental Panel on Climate Change (IPCC, 2013)**
  - **IPCC has four climate scenarios RCP 2.6, 4.5, 6.0, 8.5**
  - **Projections from 2016-2065 and 2016-2100**



- **Beach nourishment**
  - **Initially assume rate = past rate from 1985-2015**

Shoreline Projections

- **Passes**
  - **Present**
    - * Beach quality sand is no longer disposed beyond the littoral zone
    - * Dombrowski and Mehta (1996) showed that shoals of modified inlets stabilize after 30 years
  - **Future**
    - * Assume shoals rise with sea level to maintain equilibrium with pass hydrodynamics


Pensacola Pass

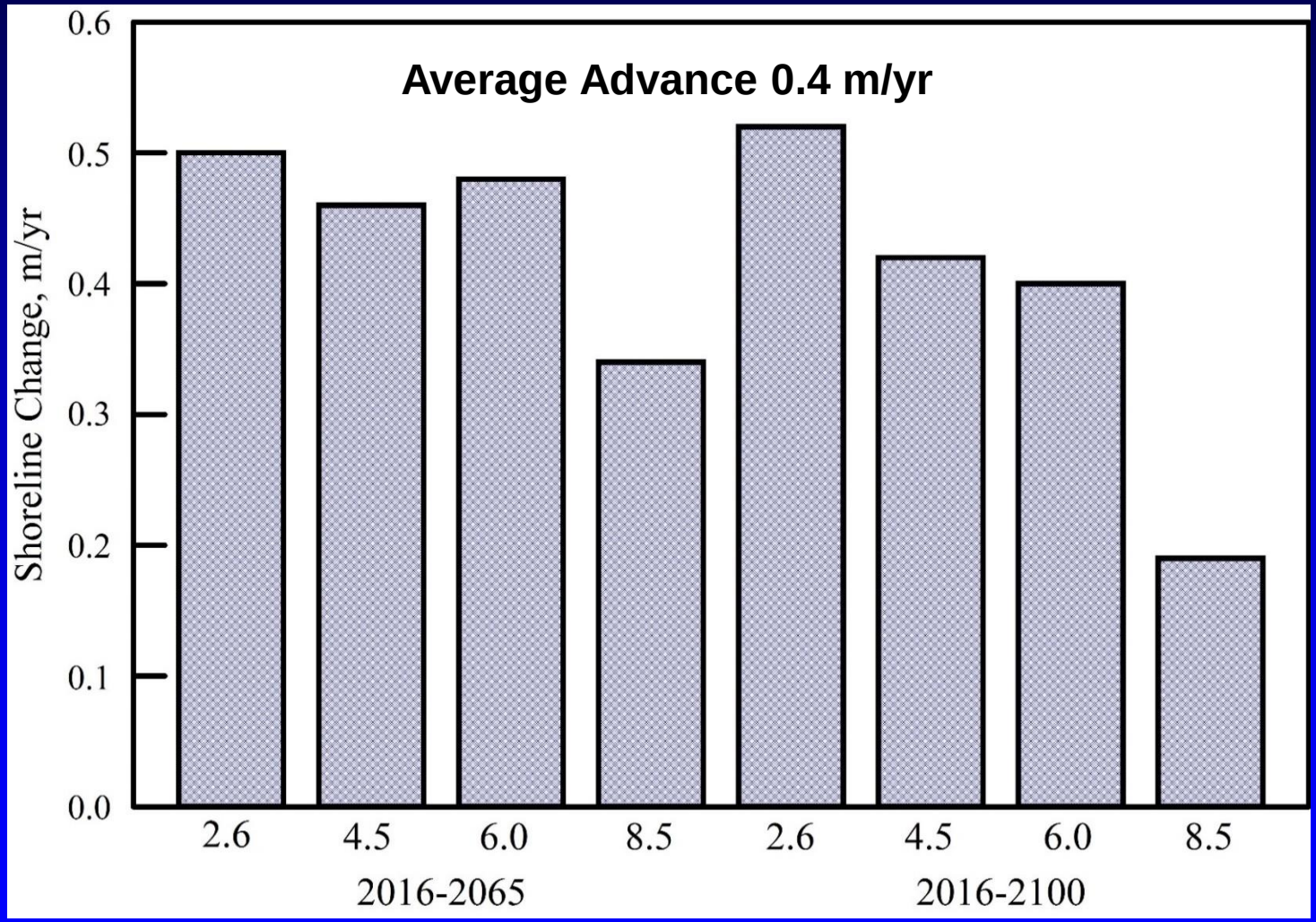

St Andrews Bay Entrance

Shoreline Projections

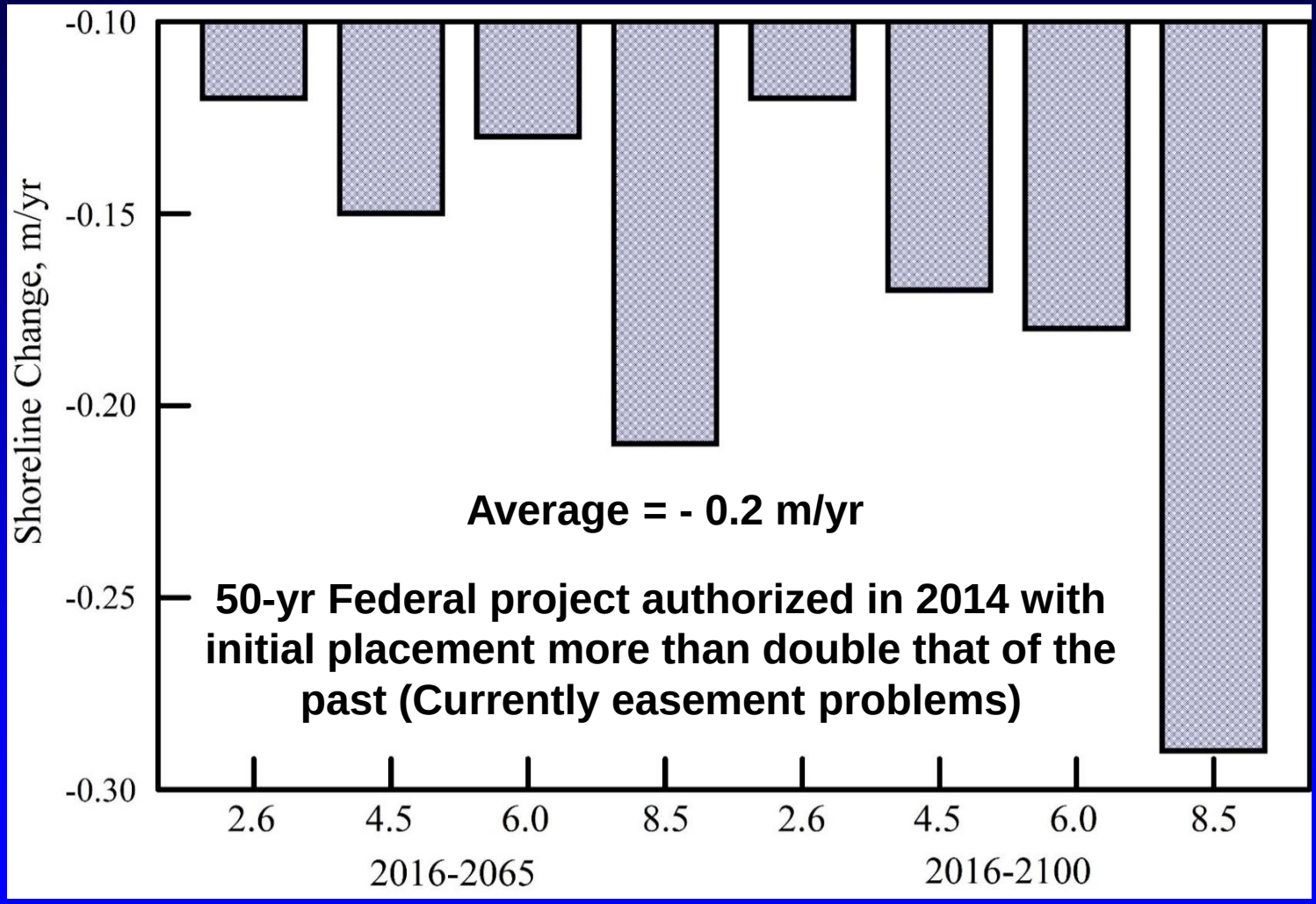
- Assume longshore transport at past rates (Shimura et al, 2011)

- Assume onshore transport at past rates because of massive and continuously fed offshore shoals

Escambia/Santa Rosa County Beach Nourishment at Rate 1985 - 2015



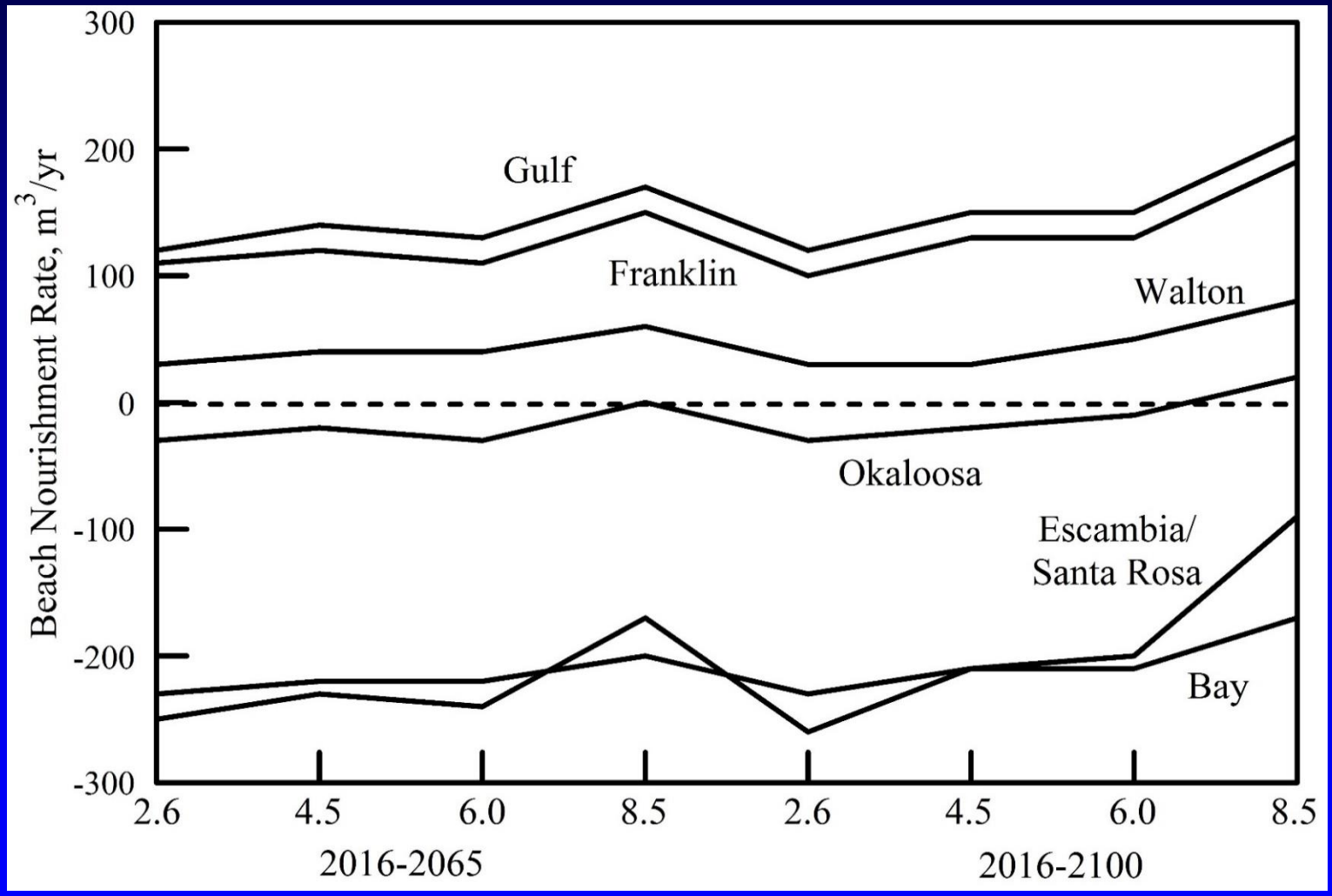
Walton County
Beach Nourishment at Rate 1985 - 2015



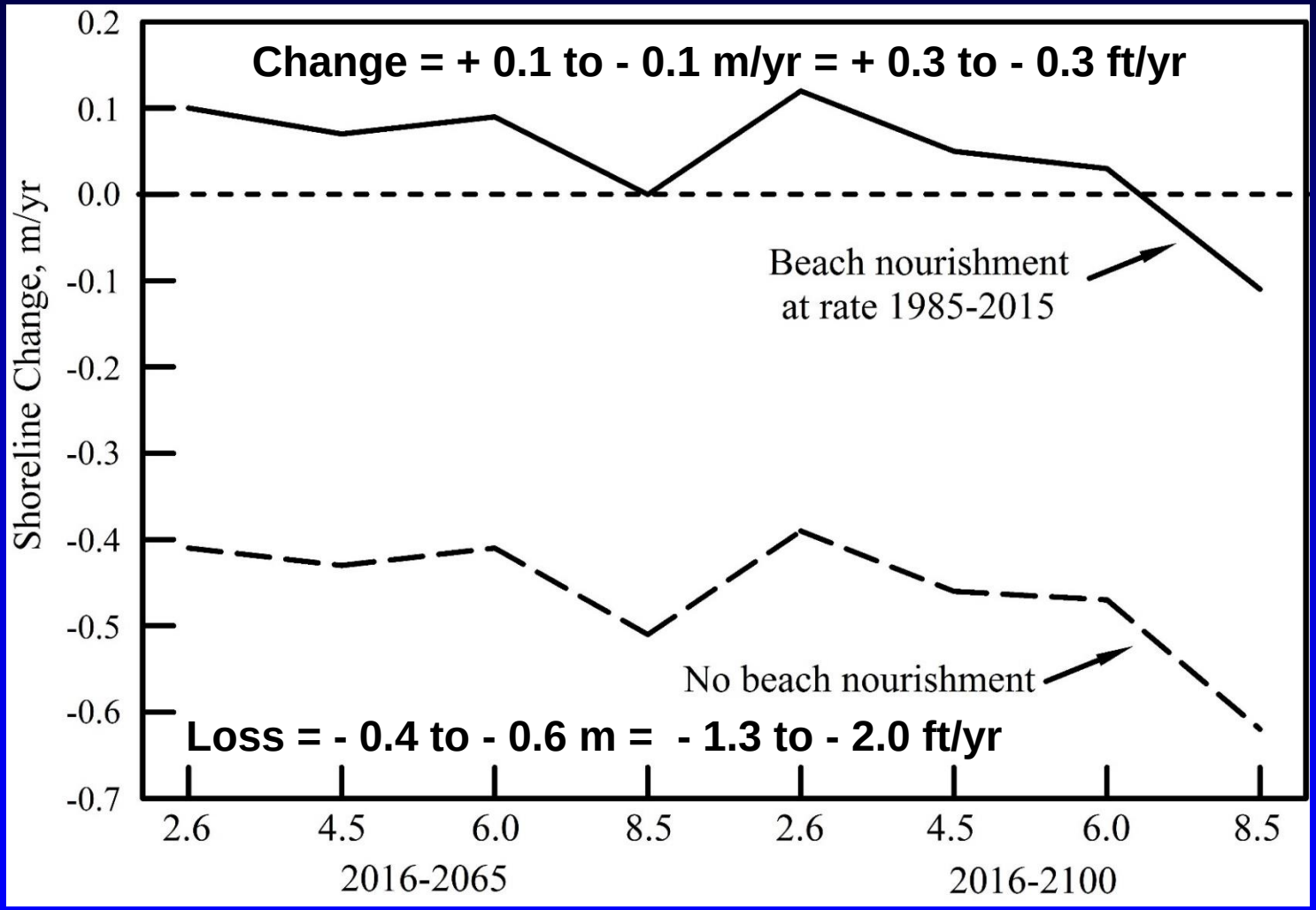
Beach Nourishment Above or Below 1985-2015 Rate for Stability (0.0 m/yr)

Nourishment Must be Increased

Nourishment Can be Reduced



With and Without Beach Nourishment



Conclusions – Florida Panhandle

- Shoreline projections must consider all significant phenomena
- Without beach nourishment, Panhandle beaches will erode significantly and face disaster
- At past rates, the shoreline will be stable on average until 2065, but for the worse case scenario a 20% increase in nourishment would be required to 2100

s

Conclusion – For All of Florida

- **Beach nourishment at past rates can offset sea level rise**

Florida Southwest Coast

Dean and Houston, 2016. Determining shoreline response to sea level rise, *Coastal Engineering*, 114, p. 1-8

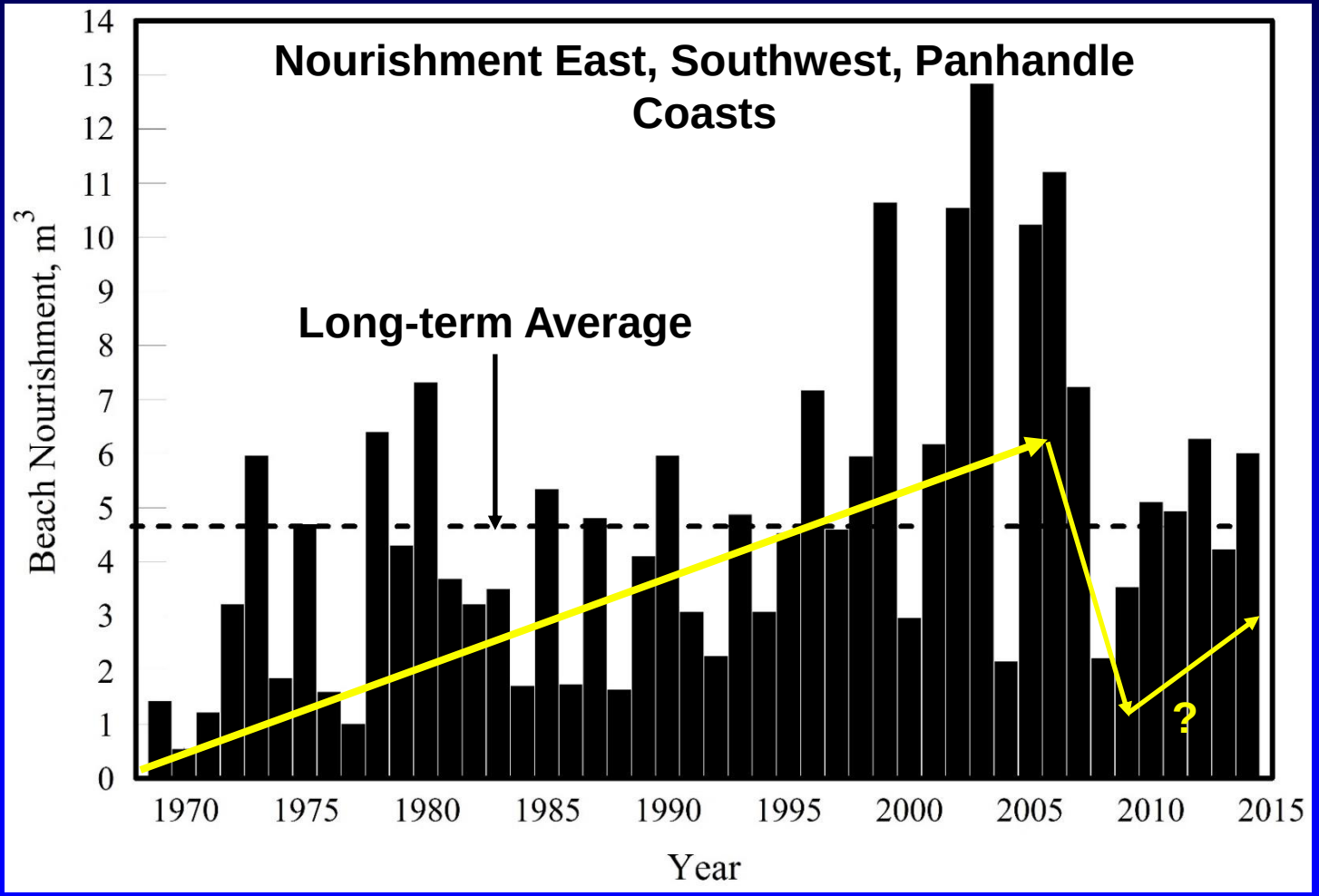
Florida East Coast

Houston, 2016. Beach nourishment as an adaptation strategy for sea level rise: A Florida east coast perspective. *Shore and Beach*, 84 (10), p. 3-12

Florida Panhandle Coast

Houston, 2016. Shoreline Change on the Florida West Coast with Projected Sea Level Rise, *Journal of Coastal Research* (submitted)

Caveat - Nourishment Must Continue at Past Rates




The End