# Economic Value Of Salt Marshes Under Uncertainty Of Sea Level Rise: A Case Study of the Narragansett Bay

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Prepared for

The Resilient Coastal Wetlands Workshop – A Look Across Regional Approaches

May 24, 2022

# MOTIVATION

- Salt marshes provide many services including:
  - Shoreline protection
  - Water filtration
  - Recreational activities
  - Carbon sequestration

- Degradation and loss of historically abundant marshes have accelerated worldwide within the last century (Crooks et al. 2011; Mcowen et al. 2017).

- Sea level rise (SLR) is the leading cause of marsh degeneration (US EPA 2006).

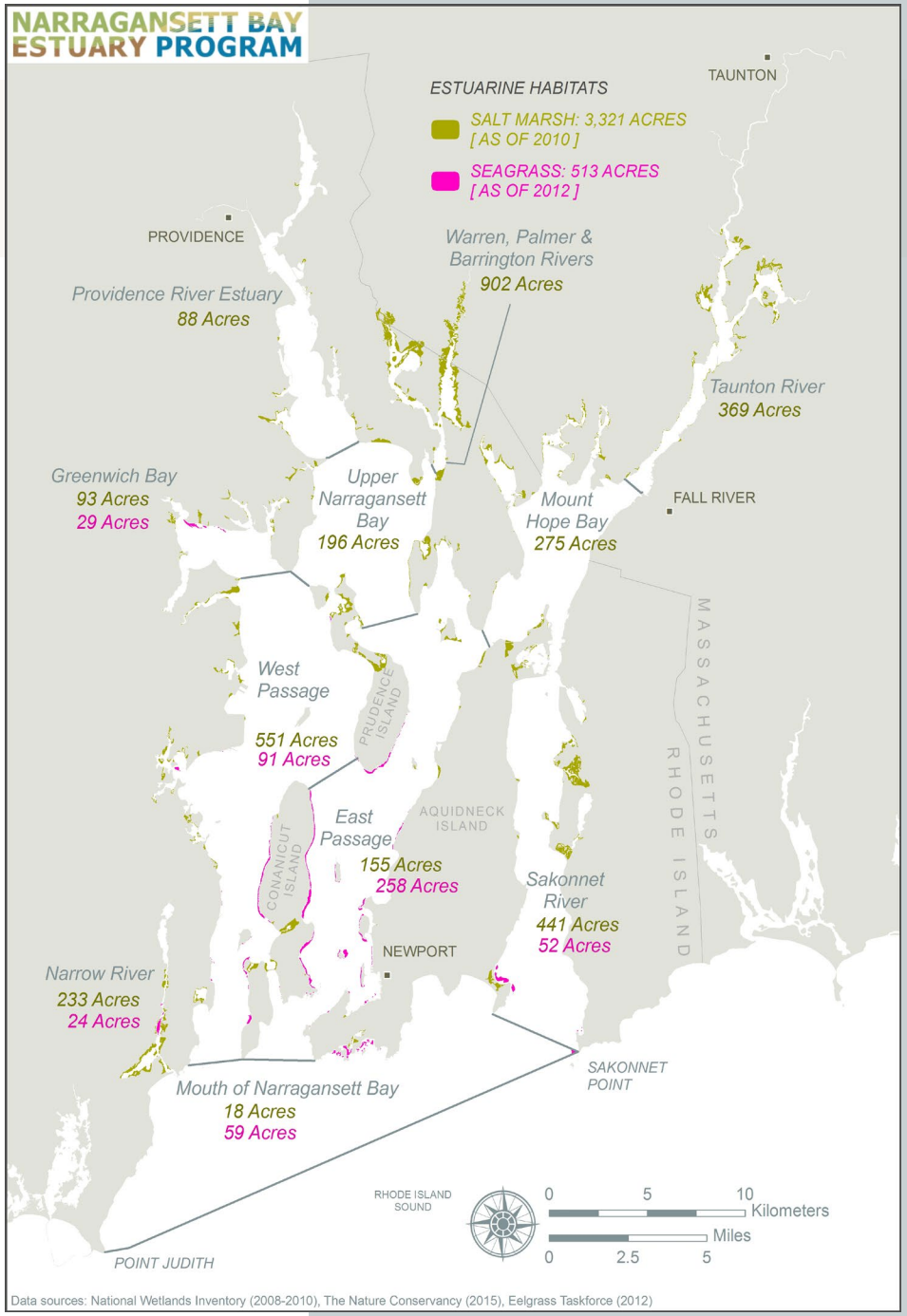
- Regional value estimates are crucial for effective coastal management

# GOAL OF THIS STUDY

Quantify economic values of ecosystem services from salt marshes in the Narragansett Bay

- Per acre values of carbon/non-carbon benefits + combined value
- SLR scenarios with different assumptions
- Address uncertainty in parameter values in ecological and economic modeling

# METHODS




# THE NARRAGANSETT BAY

- The largest estuary in New England (NBEP 2017)
- More than 50% of historical salt marshes have been lost due to anthropogenic drivers
- The region is experiencing SLR rates much higher than the global average (Oppenheimer et al. 2019)

# SIX SALT MARSH SCENARIOS USING SLAMM

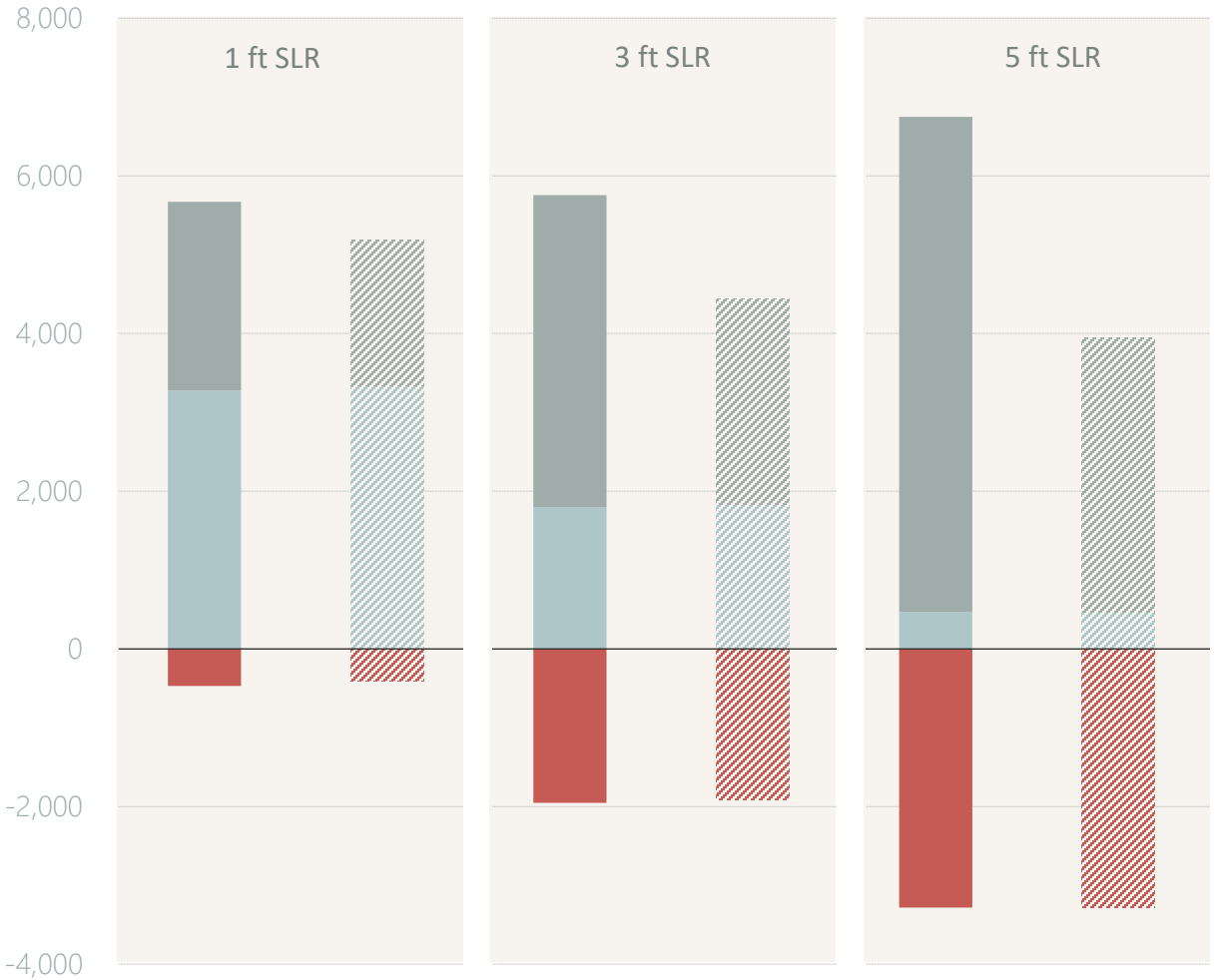
## Sea Level Rise:

*Three levels*:
1 ft, 3 ft, 5 ft

## Marsh conditions:

*Unrestricted*:
assumes the uninhibited capacity for marsh migration inland over newly submerged landscapes that are hardened by human-built

*Restricted*:
assumes migrating marshes are deprived the opportunity to take root on developed coastlines




**Net Change in Acres Between 2010 and 2100**

## Marsh type:

*Migrated* marsh area:
acreage of migrated marsh that is projected to propagate

*Persistent* marsh area:
acres of currently existing marsh that is expected to survive the 90-year time horizon

*Lost* marsh area:
acreage that will drown in place

# VALUATION METHODS

## Carbon values

*Step 1*: Predict **carbon storage and sequestration** (top 1m of soil, living biomass, annual carbon sequestration)

*Step 2*: Apply fixed **market price** (mean clearing price of carbon credit auctions by the Regional Greenhouse Gas Initiative (RGGI) in 2016-2018)

## Values of other benefits (Non-Carbon): benefit function transfer approach

*Step 1*: Identify the most relevant **meta-regression study** based on wetland type and benefits, geographical area: Brander et al. (2006)

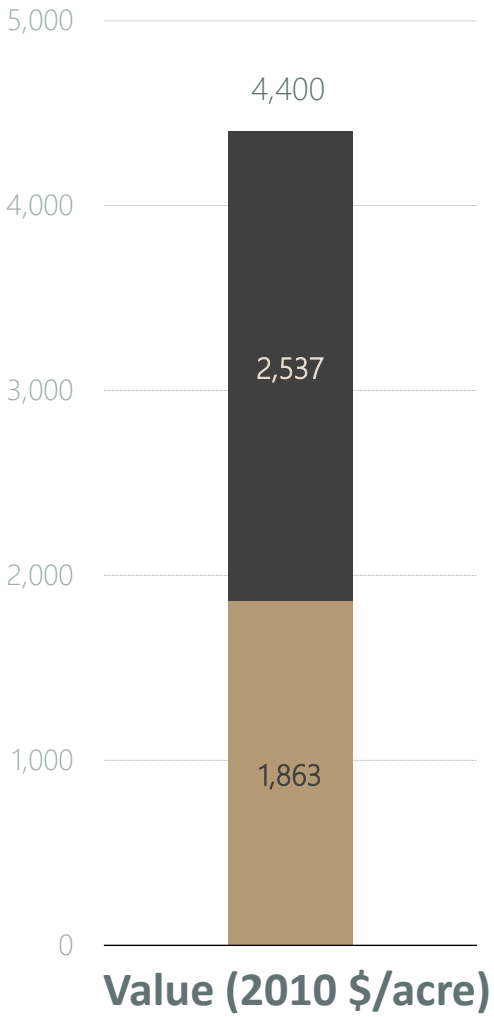
*Step 2*: Adjust to the **context of Narragansett Bay** (wetland type, types of ecosystem services, median income and population density)

# RESULTS

# PER ACRE VALUE OF CARBON AND NON-CARBON SERVICES

**Salt marsh services:**

- *Non-carbon services*
- *Carbon services*



# TOTAL ECONOMIC VALUE OF SALT MARSHES FOR ALL SCENARIOS

**Salt marsh services:**

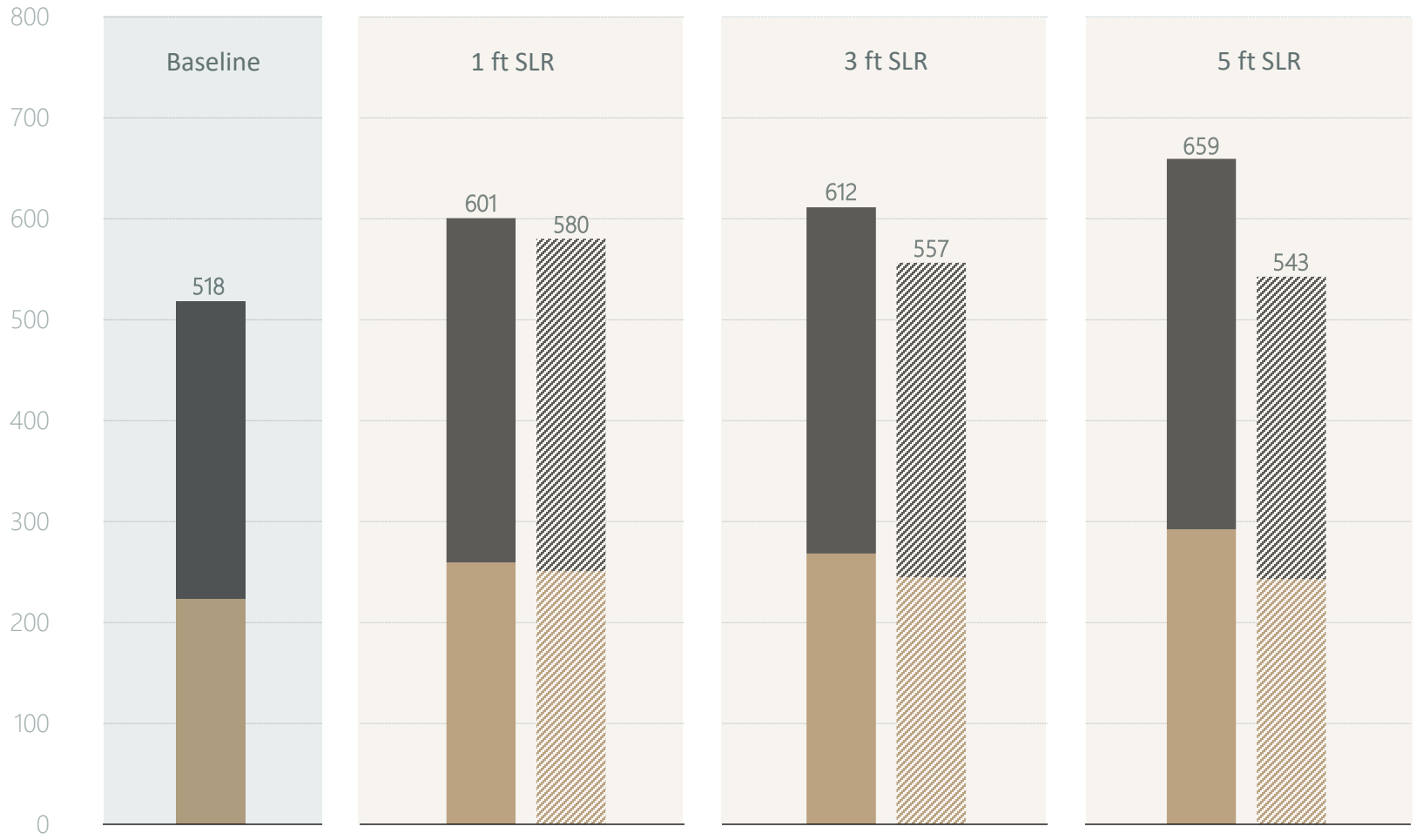
- *Non-carbon services*
- *Carbon services*

**Sea Level Rise:**

- *Baseline*
- *1 ft, 3 ft, 5 ft*

**Marsh conditions:**

- *Unrestricted*
- *Restricted*




**Value (in millions, 2010 $)**

SDR= 3%

Time horizon = 90 years

# SPATIAL DIFFERENCE OF SALT MARSH VALUE ACROSS THE BAY

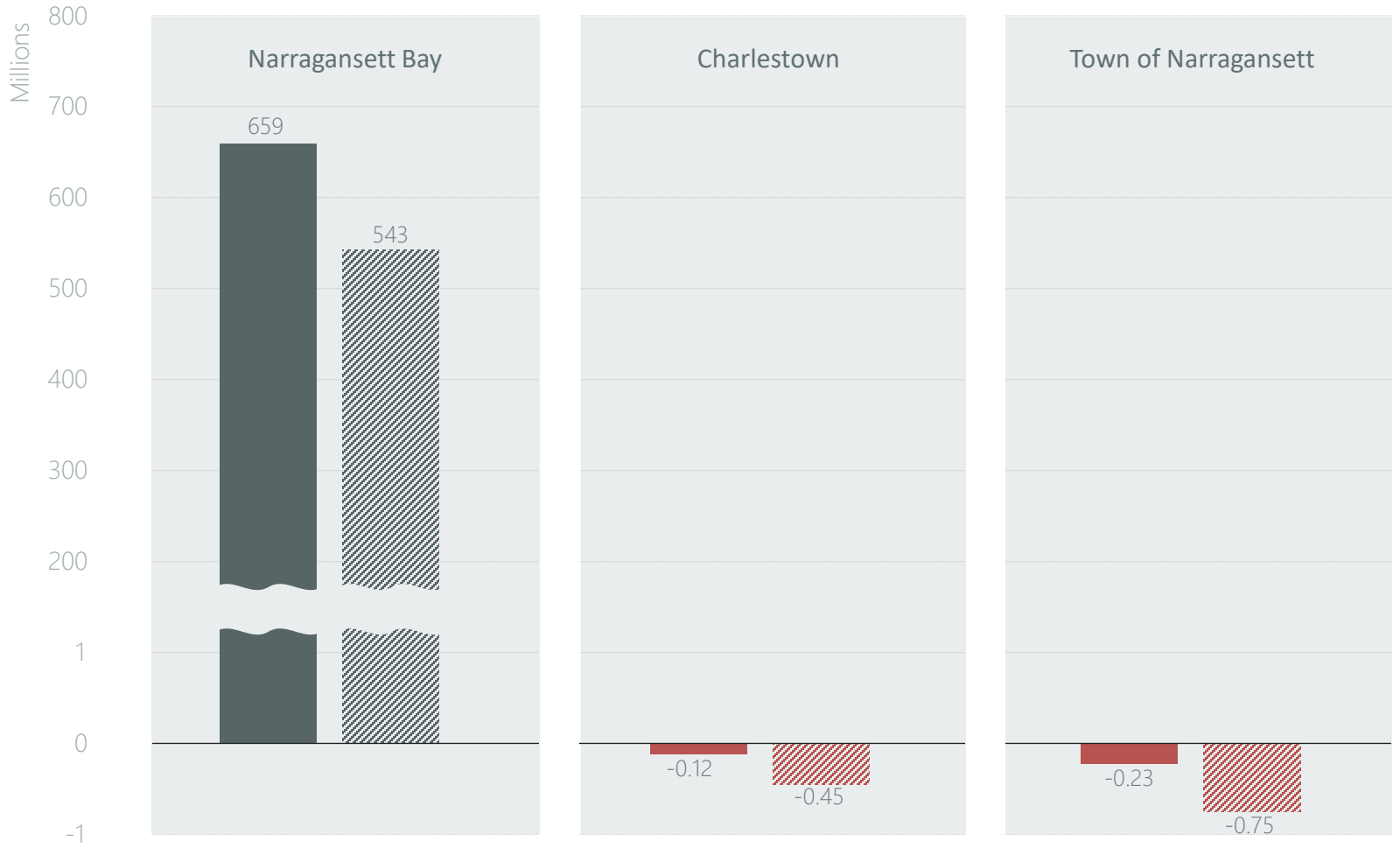
**Marsh conditions:**

*Unrestricted*

*Restricted*

**Location:**

*Municipality*



# MONTE CARLO ANALYSIS

# SIMULATION ASSUMPTIONS

## Scenarios

| Sea Level Rise | 1 ft | 3 ft | 5 ft |
|---|---|---|---|
| Probability | 10% | 40% | 50% |

## Parameter ranges

| | Annual Sequestration Rate *(tCO2e/acre/year)* | Annual Methane Emission Rate *(tCO2e/acre/year)* | Value of Other Services *(2010 $/acre)* | RGGI Price *(2010 $/t CO2e)* |
|---|---|---|---|---|
| Lower bound | 0.607 | -0.040 | $2,136.37 | $2.24 |
| Upper bound | 3.036 | -0.567 | $2,937.31 | $4.61 |

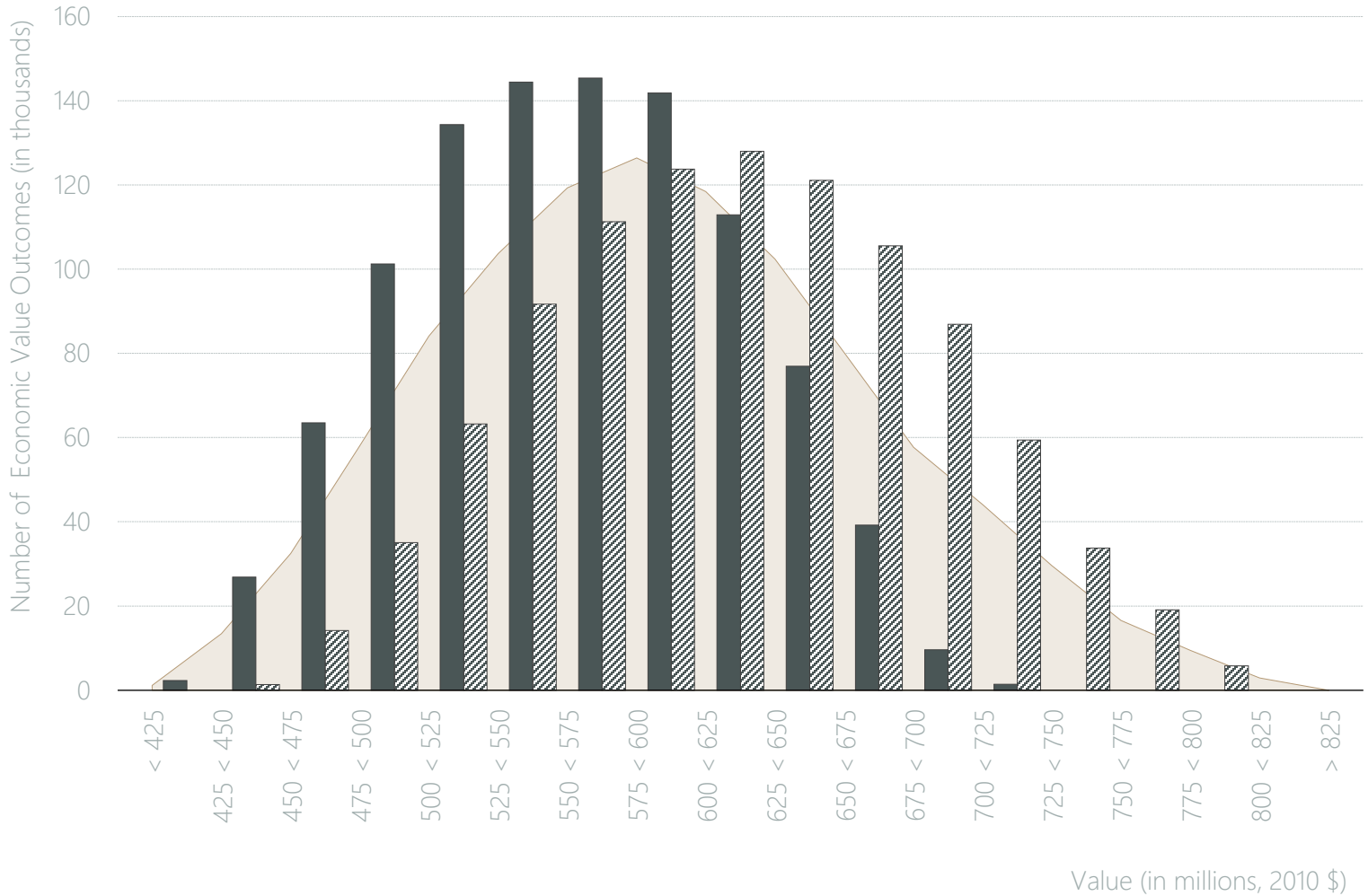
# RANGE OF DISCOUNTED ECONOMIC VALUES ACROSS SLR & MIGRATION SCENARIOS

**Marsh conditions:**

- *Unrestricted*
- *Restricted*
- *Combined*

**Values across SLR:**

- *Mean Unrestricted = $637M*
- *Mean Restricted = $554M*
- *Mean Combined = $596M*



# RANGE OF DISCOUNTED ECONOMIC VALUE FOR CARBON VERSUS NON-CARBON VALUES

**Salt marsh services:**

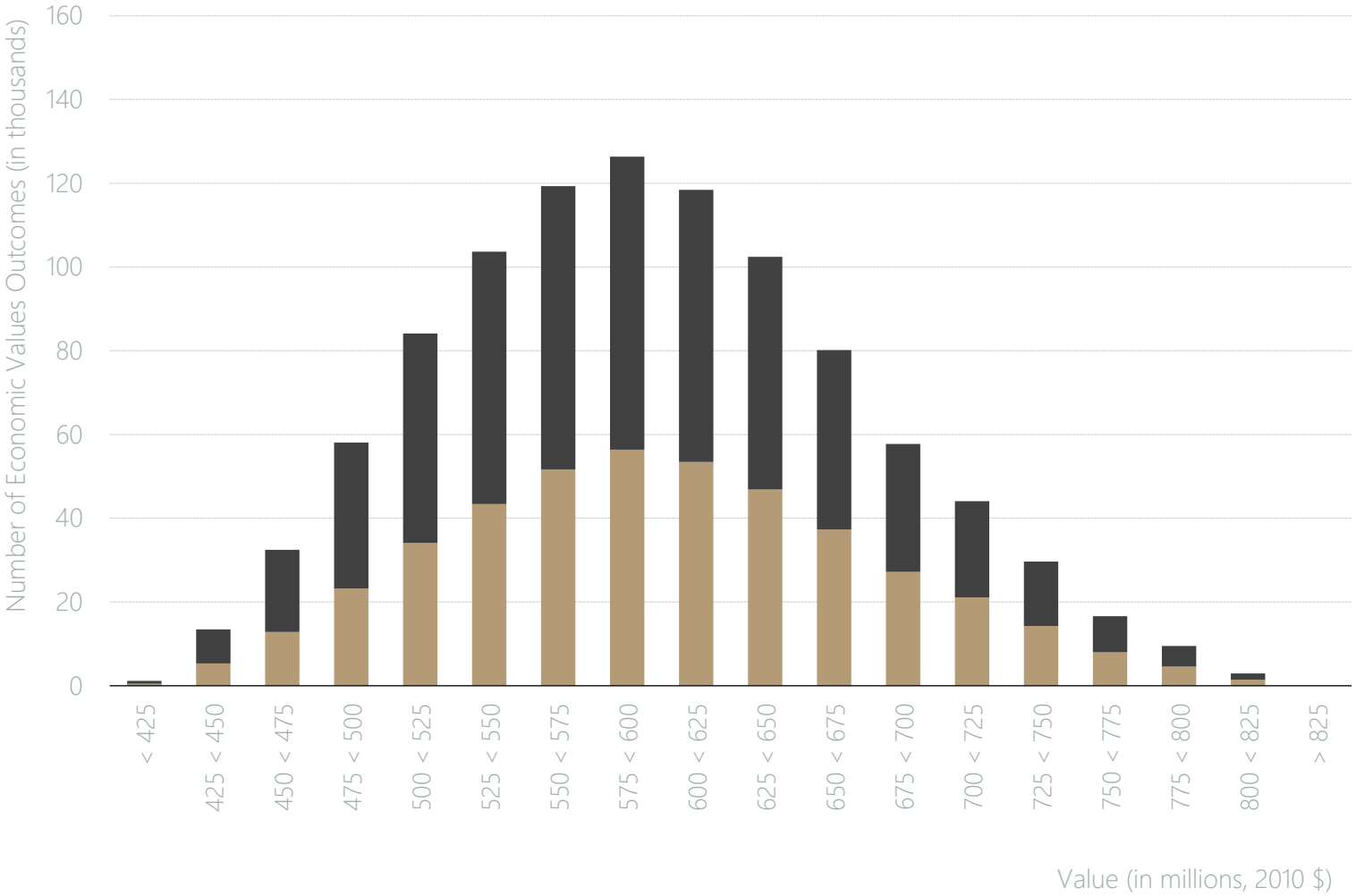
*Non-carbon services*

*Carbon services*

**Combined values across SLR and marsh conditions:**

*Mean Non-carbon = $331M*

*Mean Carbon = $265M*



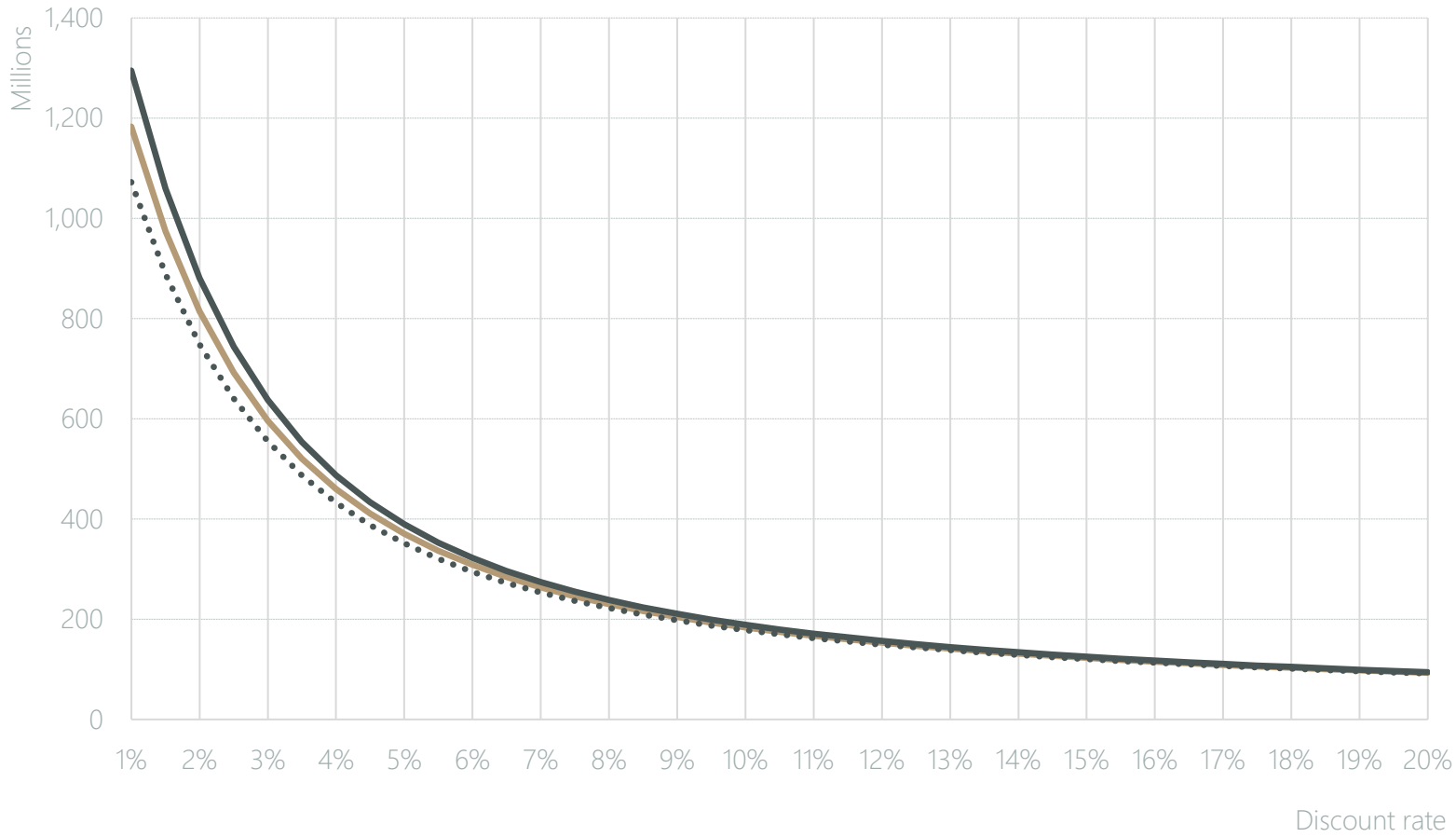
# ECONOMIC VALUE SENSITIVITY TO DISCOUNT RATE

**Marsh conditions:**

- *Unrestricted*
- *Restricted*
- *Combined*

**Present value:**

- *Max Unrestricted = $1,295M*
- *Max Restricted = $1,072M*
- *Max Combined = $1,183M*



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- Per-unit values for carbon and non-carbon benefits can be used as a cost-benefit input for any salt marsh program proposals
- Robust estimates that local planners can utilize in the face of climate change uncertainty
- Estimates can be used to communicate to the public the importance of human development in influencing future resiliency

# THANK YOU

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ACKNOWLEDGEMENTS

We thank Teresa Crean, Caitlin Chaffee, and Kenneth Raposa for helpful suggestions during this project. This work was supported by the URI Coastal Institute, the U.S. EPA (SE00A00252), National Science Foundation (#OIA-1655221) and the NSF (#OIA-1655221). The views expressed in this project are solely those of the authors. It has not been formally reviewed by the EPA or other funding agencies.