Implications of Climate Change For Rhode Island

Grover Fugate

Executive Director

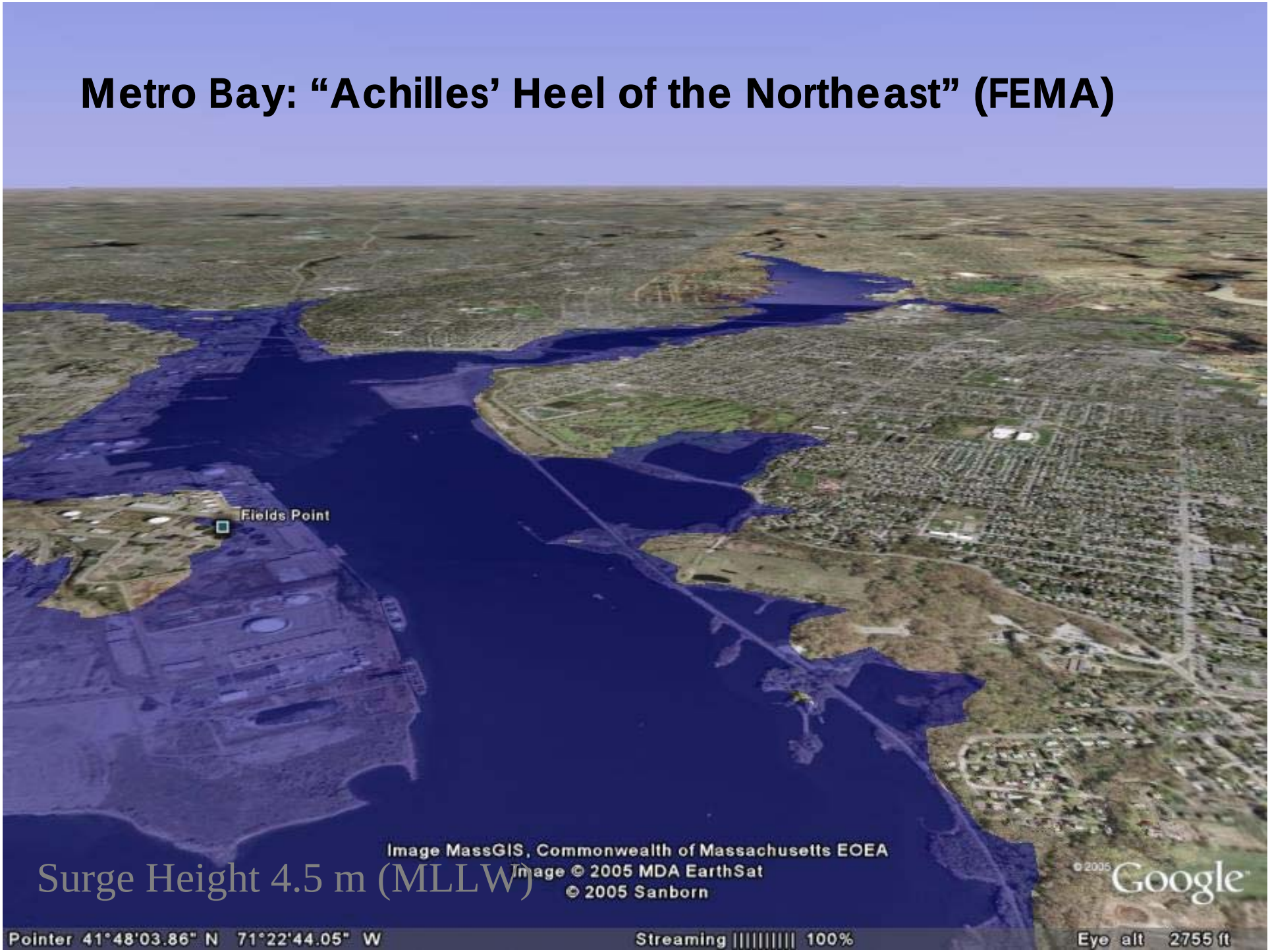
Coastal Resource Management Council

State of Rhode Island

CRMC
COASTAL RESOURCES MANAGEMENT COUNCIL

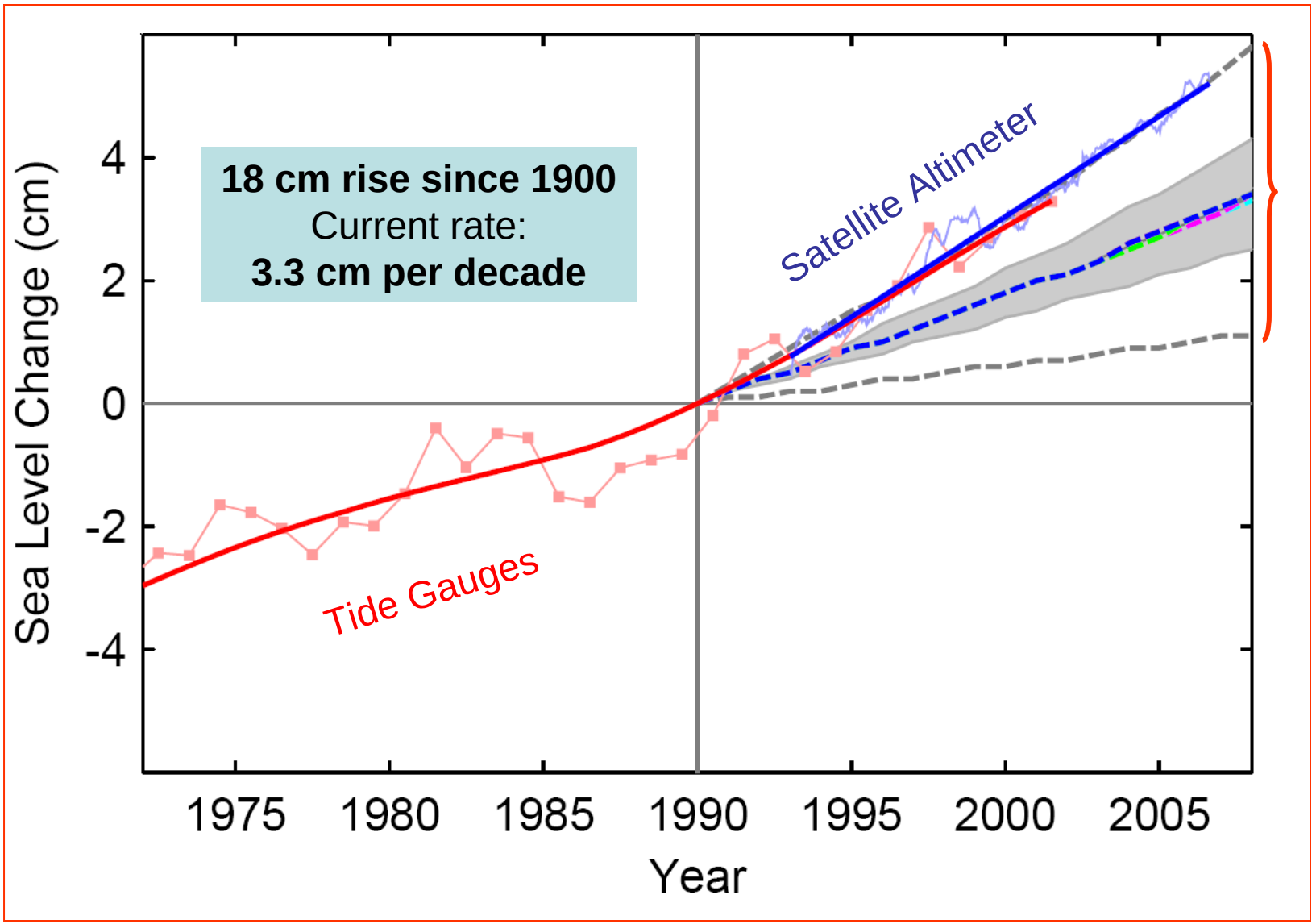
Climate Change and Sea Level Rise
Where's The Beach??

Metro Bay: “Achilles’ Heel of the Northeast” (FEMA)



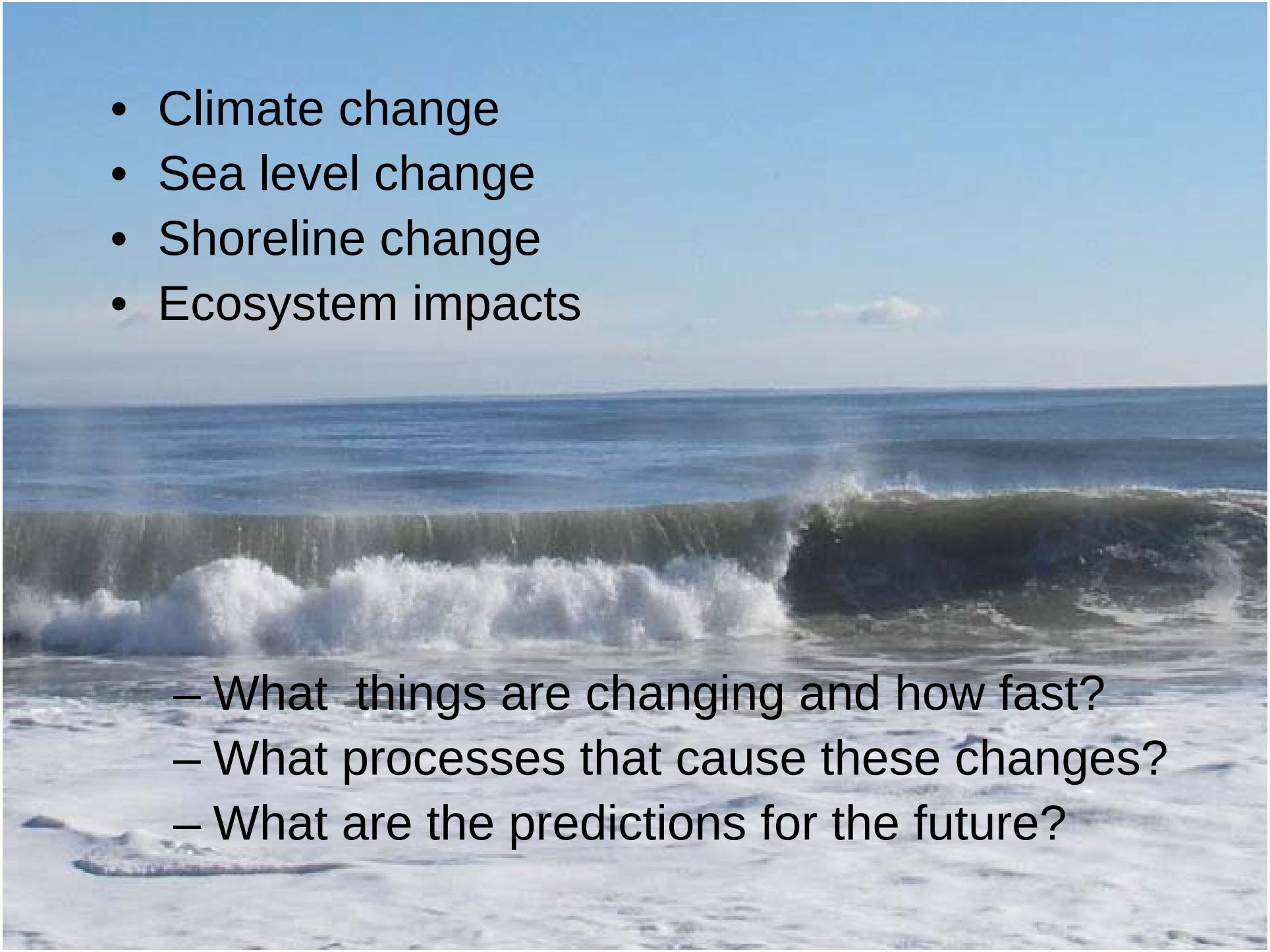
Surge Height 4.5 m (MLLW)

Observed Global Sea Level Rise



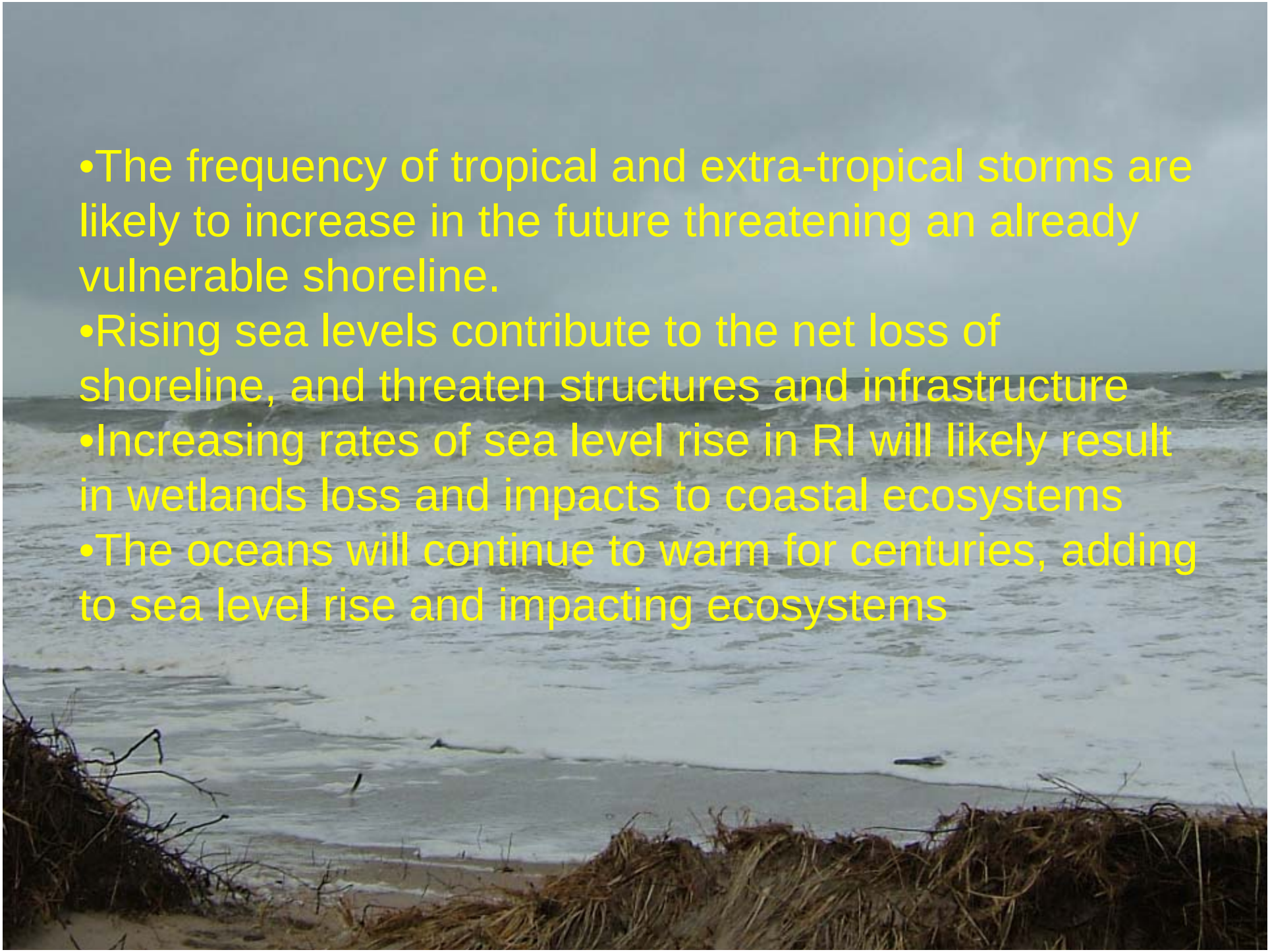
IPCC 2001 estimate

Rahmstorf, Cazenave, Church, Hansen, Keeling, Parker and Somerville (Science 2007)



- Climate change
- Sea level change
- Shoreline change
- Ecosystem impacts

  - What things are changing and how fast?
  - What processes that cause these changes?
  - What are the predictions for the future?


•The frequency of tropical and extra-tropical storms are likely to increase in the future threatening an already vulnerable shoreline.
•Rising sea levels contribute to the net loss of shoreline, and threaten structures and infrastructure
•Increasing rates of sea level rise in RI will likely result in wetlands loss and impacts to coastal ecosystems
•The oceans will continue to warm for centuries, adding to sea level rise and impacting ecosystems

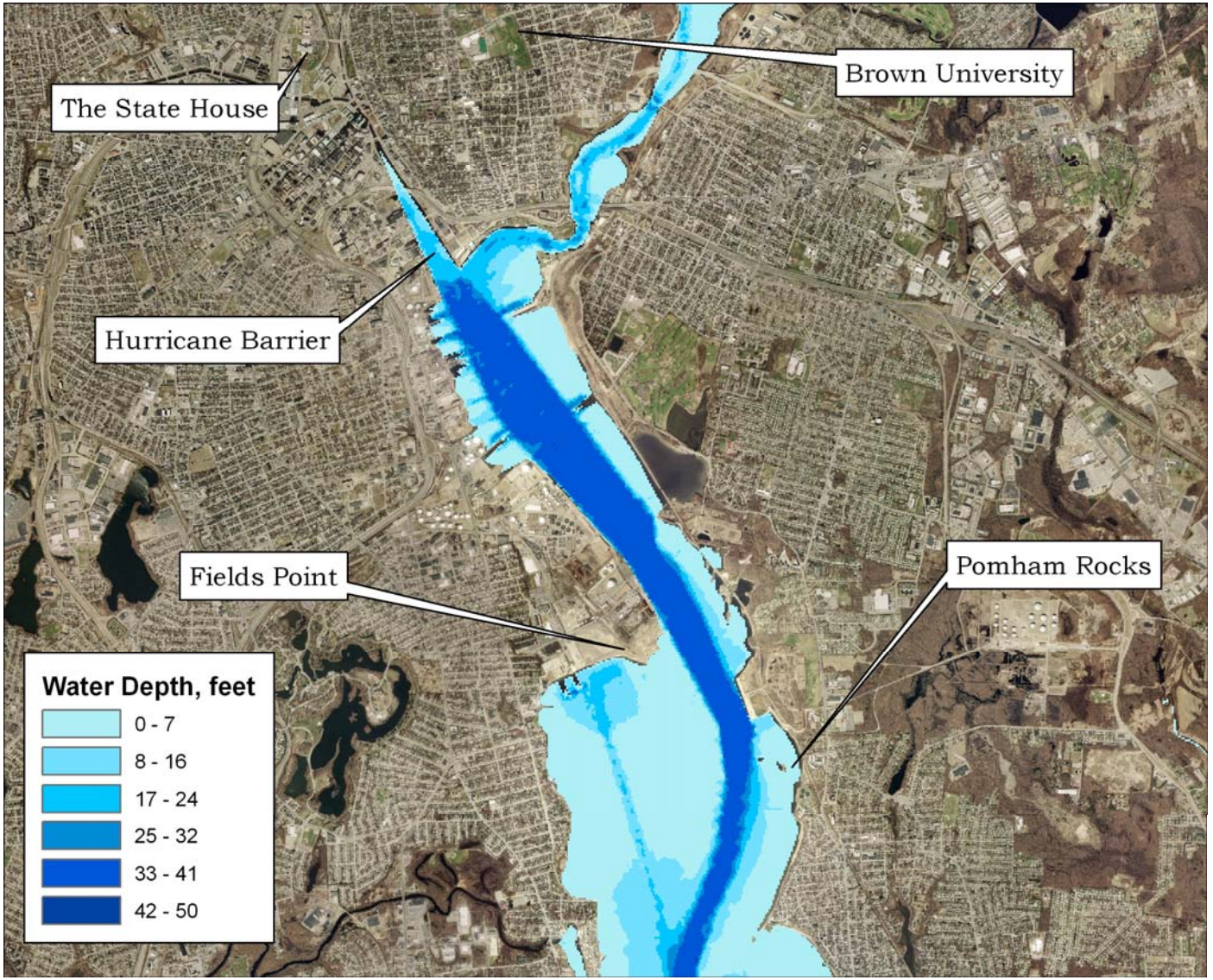
Browning Three Cottages – Patriots Day 2007

RE Hehre

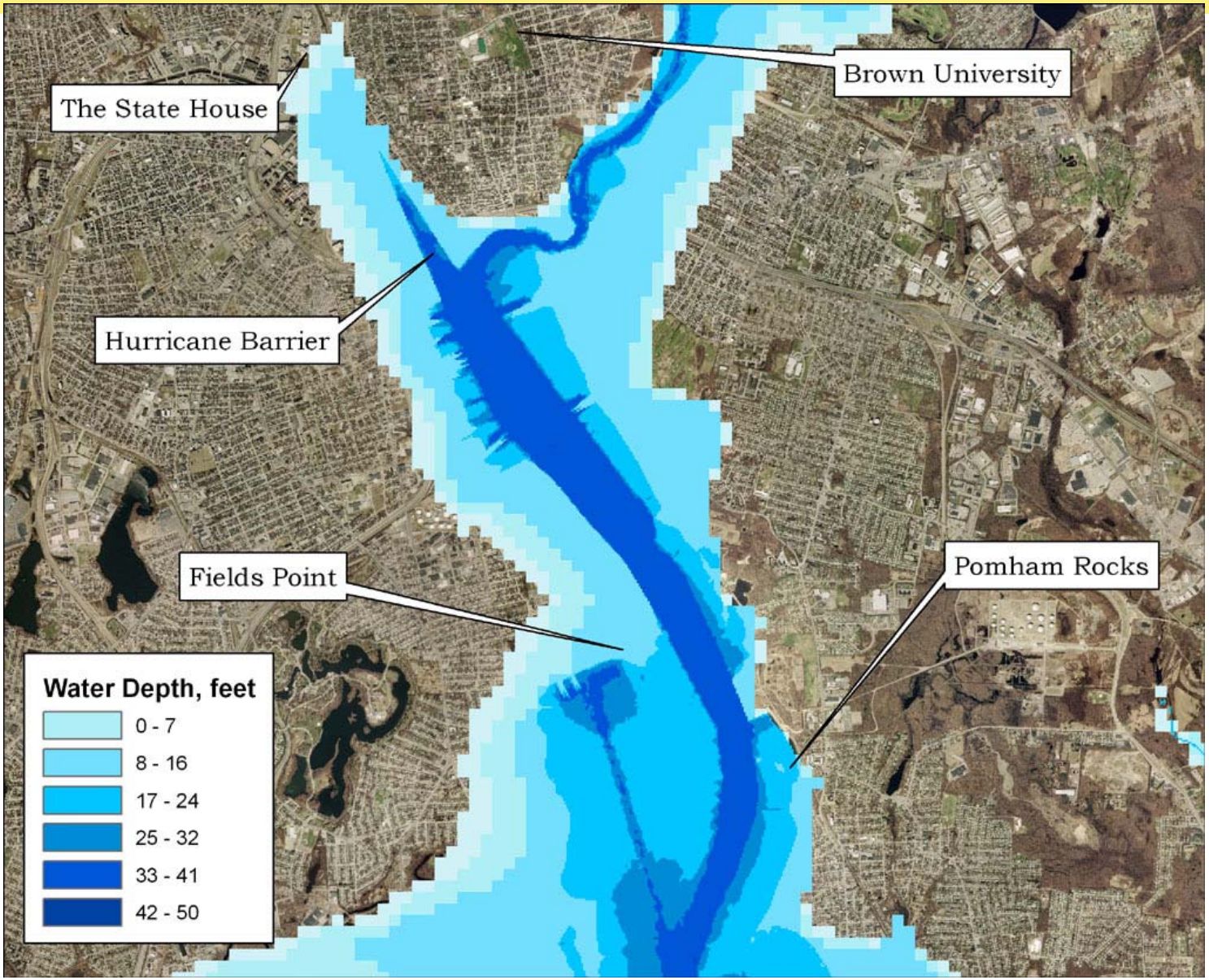
Browning Three Cottages – Frontal Erosion

BA Oakley

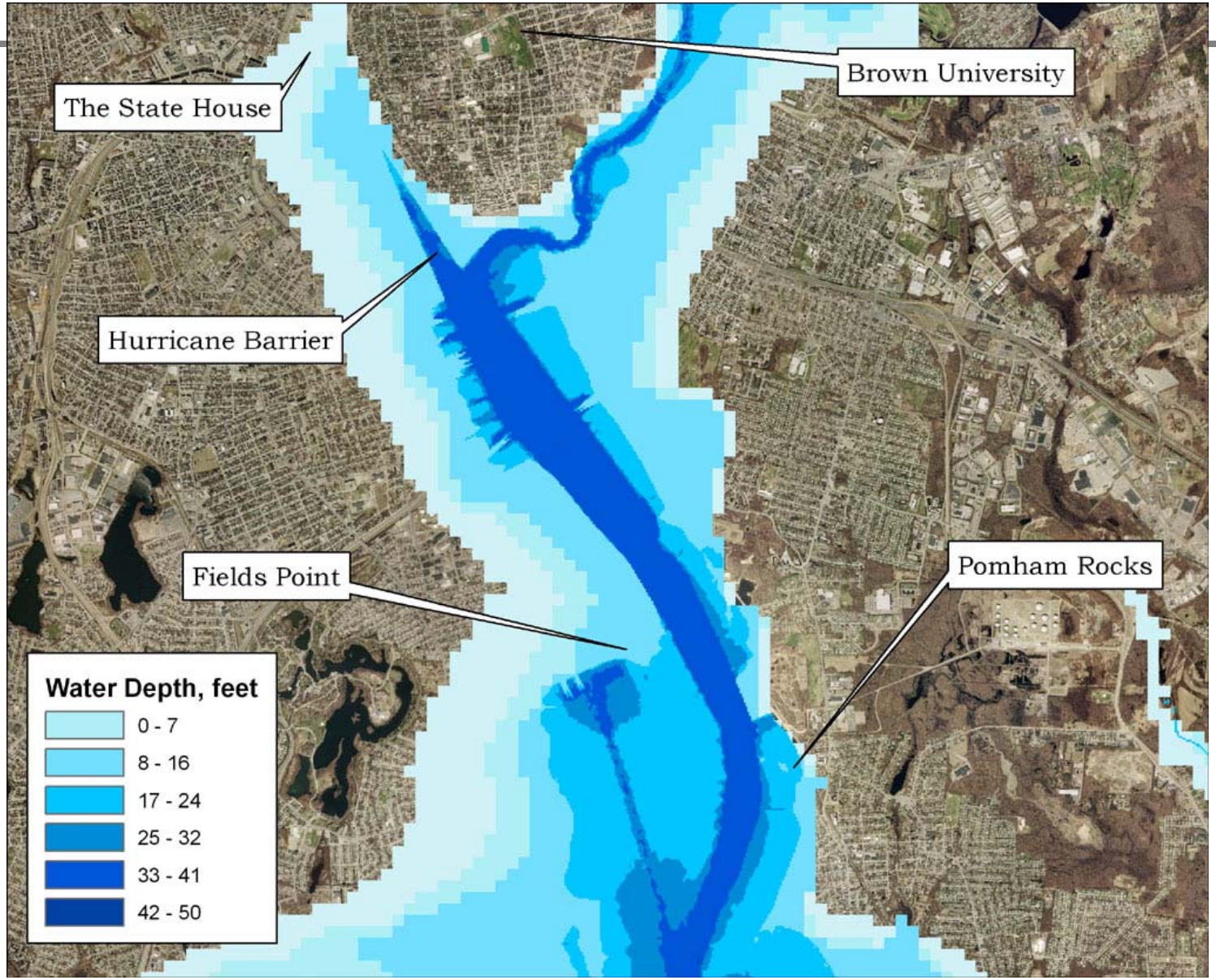
Providence: present sea level



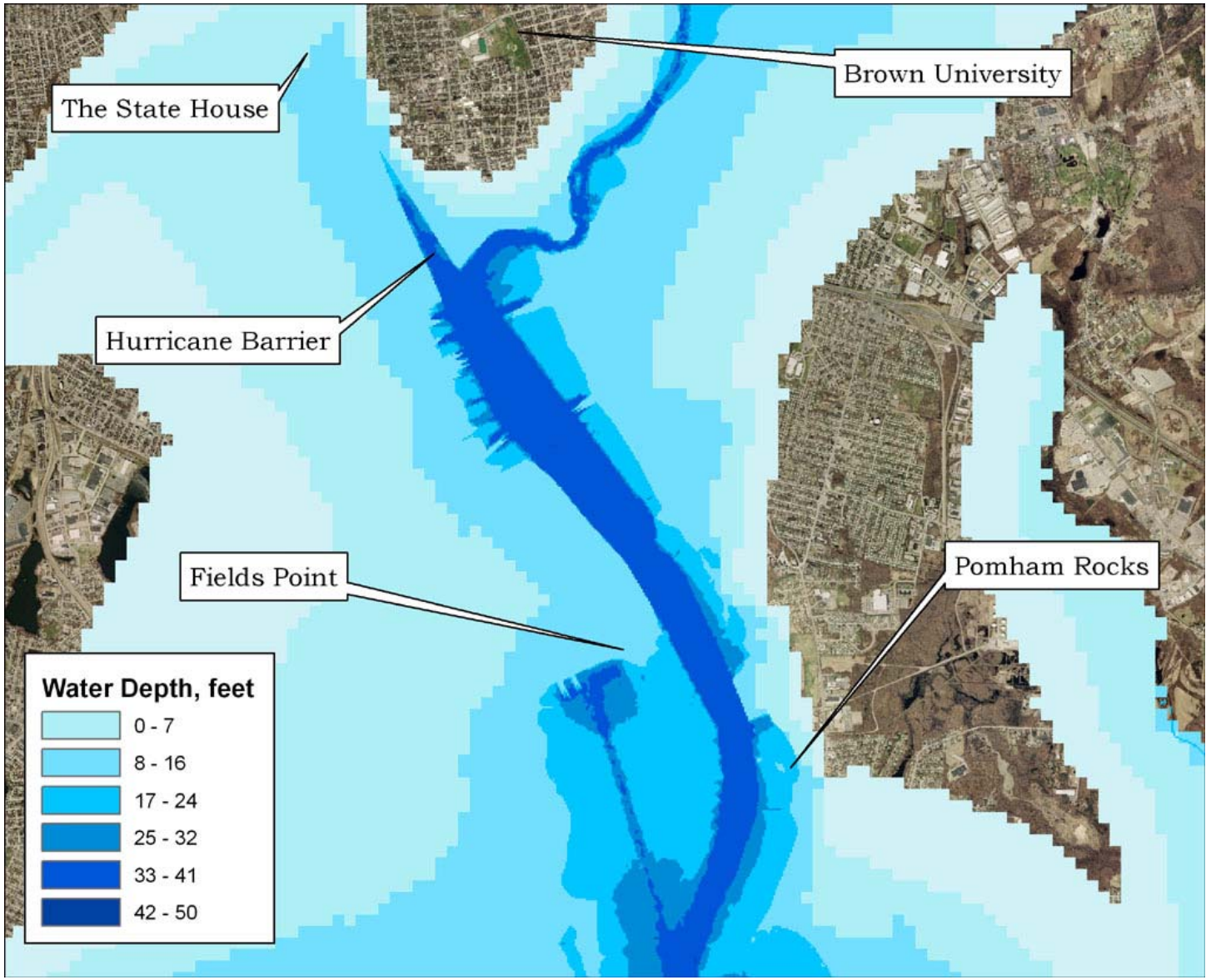
Providence: 3 ft. sea level rise



Providence: 5 ft. sea level rise



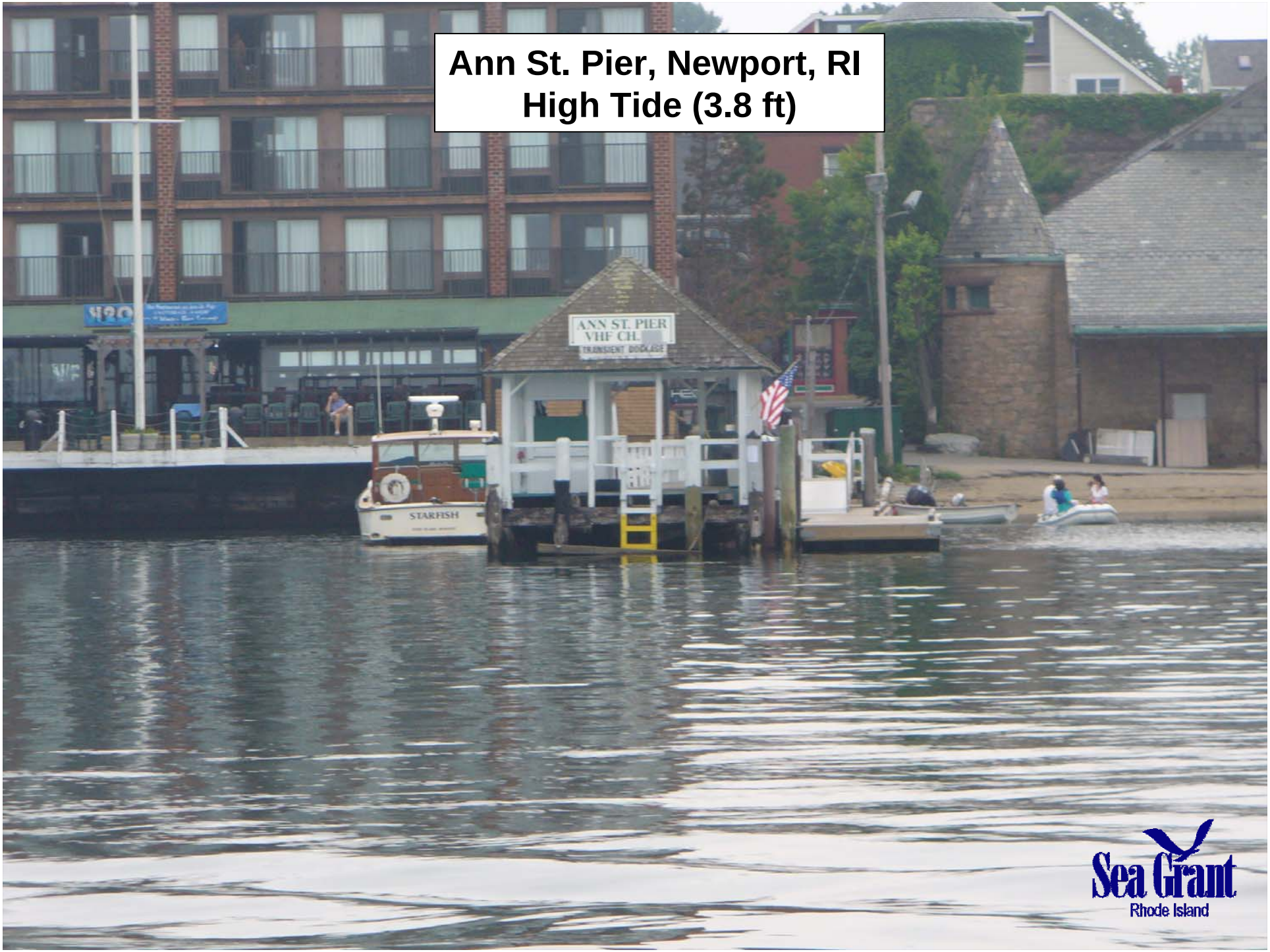
Providence: 20 ft. sea level rise

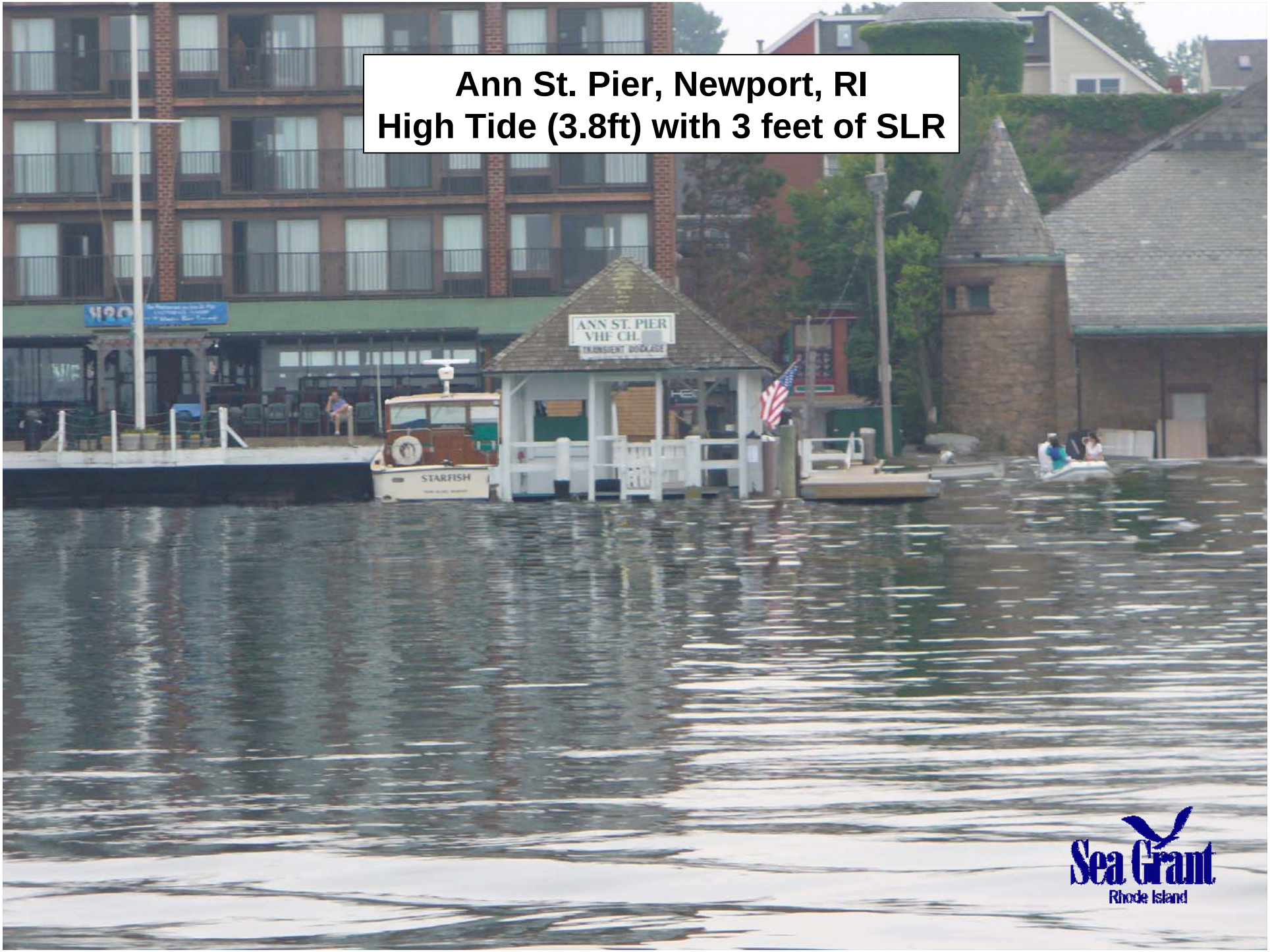


Quonnie Pond: present sea level

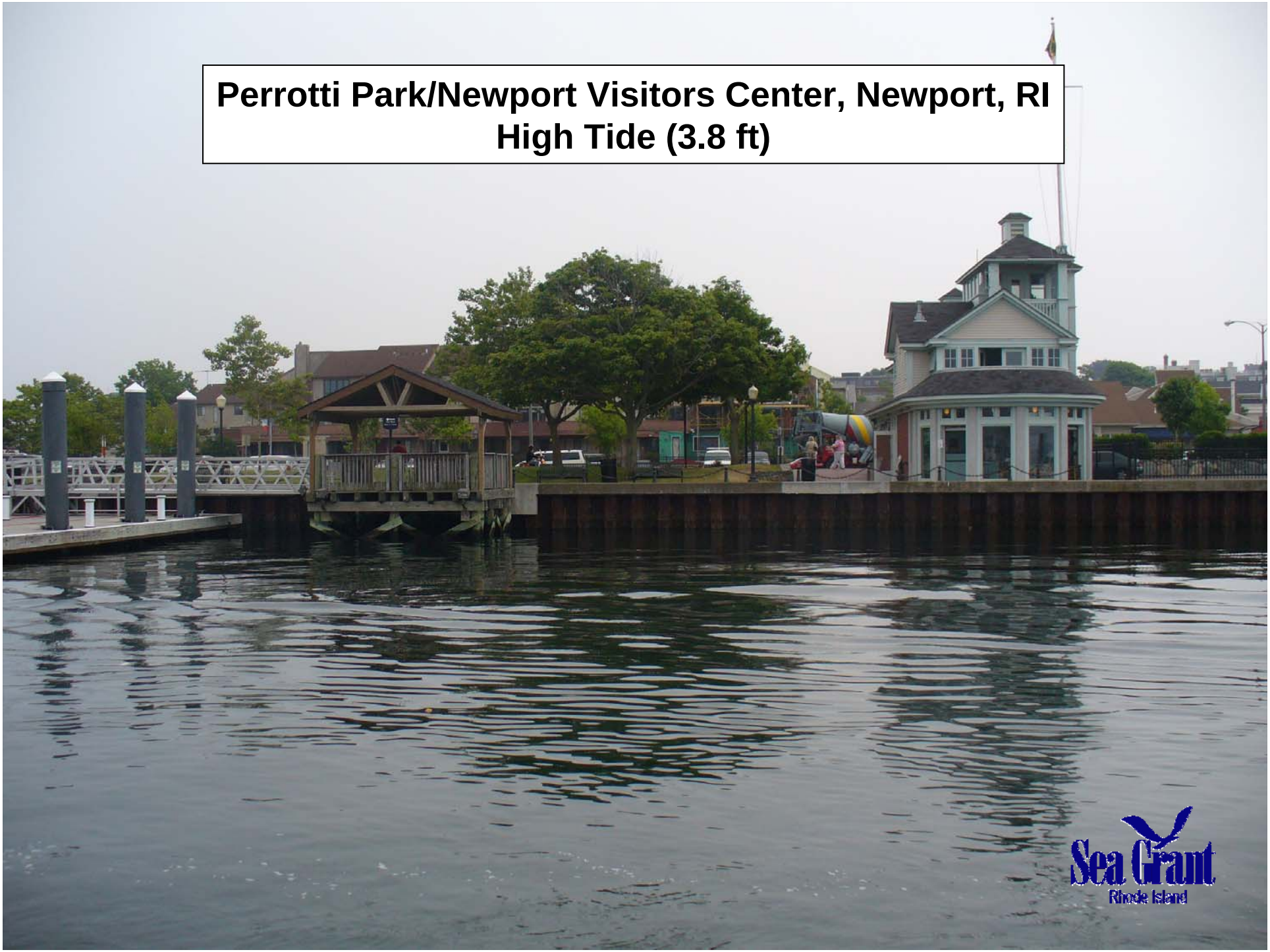
Quonnie Pond: 3 ft. sea level rise

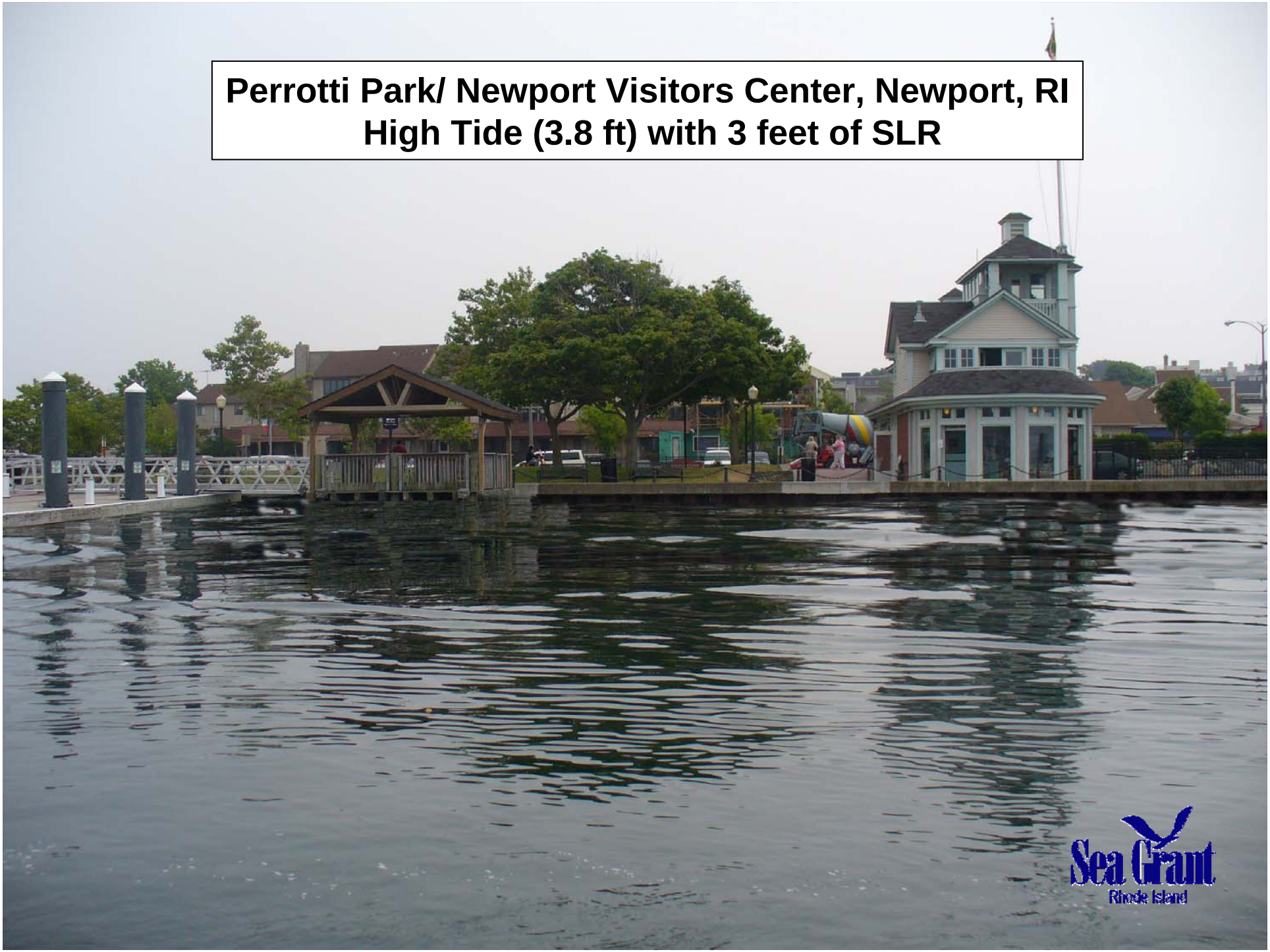
Quonnie Pond: 20 ft. sea level rise


Ann St. Pier, Newport, RI
High Tide (3.8 ft)
ANN ST. PIER
VHF CH.
STARFISH
Sea Grant
Rhode Island


Ann St. Pier, Newport, RI
High Tide (3.8ft) with 3 feet of SLR
ANN ST. PIER
VHF CH.
TRANSIENT DOCKAGE
STARFISH
Sea Grant
Rhode Island

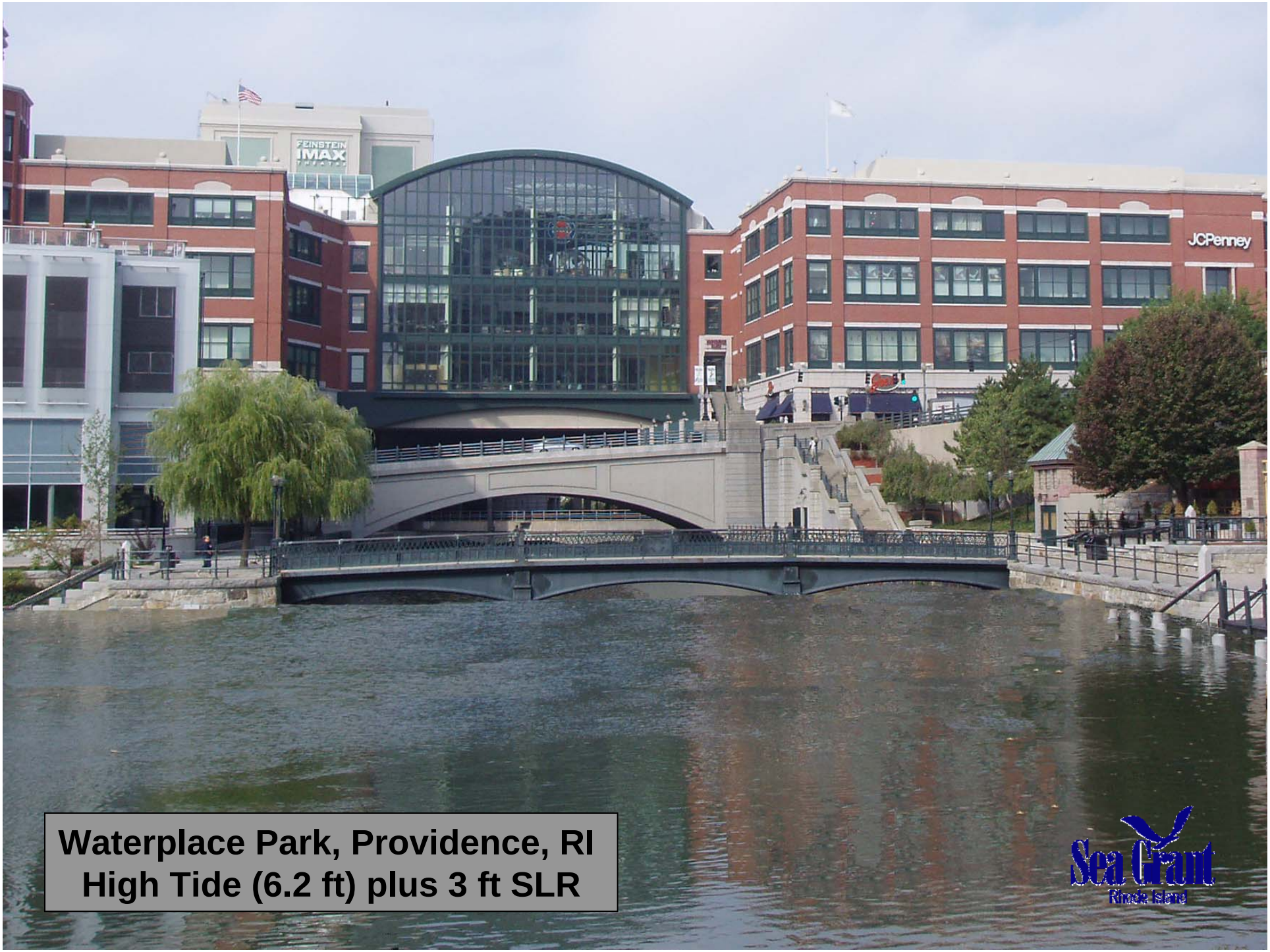

Ann St. Pier, Newport, RI
Average Spring Tide 1997- 2007 (7.03ft)
with 3 feet of SLR
ANN ST. PIER
VHF CH.
TRANSIENT DOCKAGE
STARFISH
Sea Grant
Rhode Island


Perrotti Park/Newport Visitors Center, Newport, RI
High Tide (3.8 ft)
Sea Grant
Rhode Island


Perrotti Park/ Newport Visitors Center, Newport, RI
High Tide (3.8 ft) with 3 feet of SLR
Sea Grant
Rhode Island

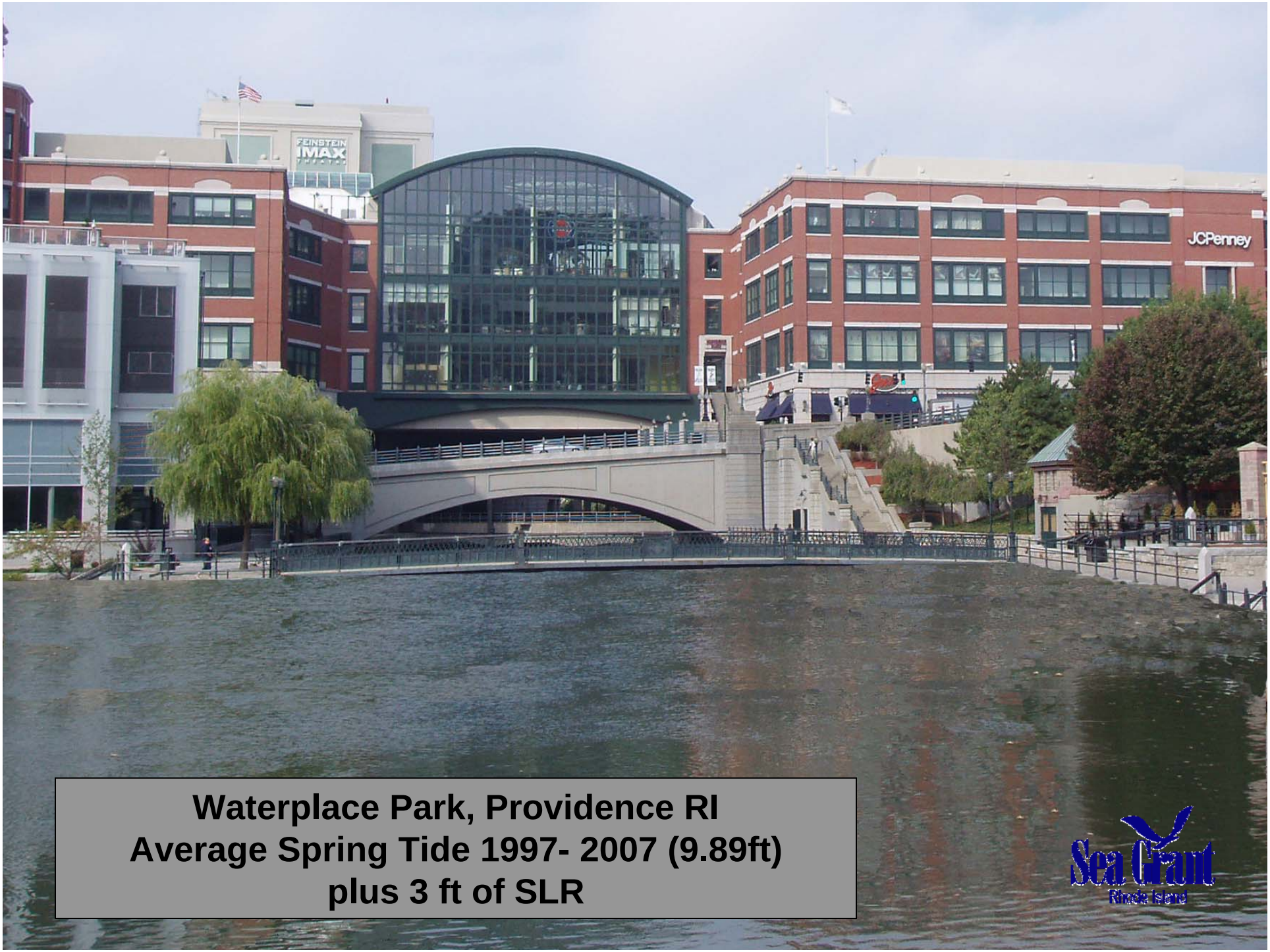

Perrotti Park/ Newport Visitors Center, Newport, RI
Average Spring Tide 1997- 2007 (7.03ft)
plus 3 feet of SLR
Sea Grant
Rhode Island

Waterplace Park, Providence, RI
High Tide (6.2 ft)



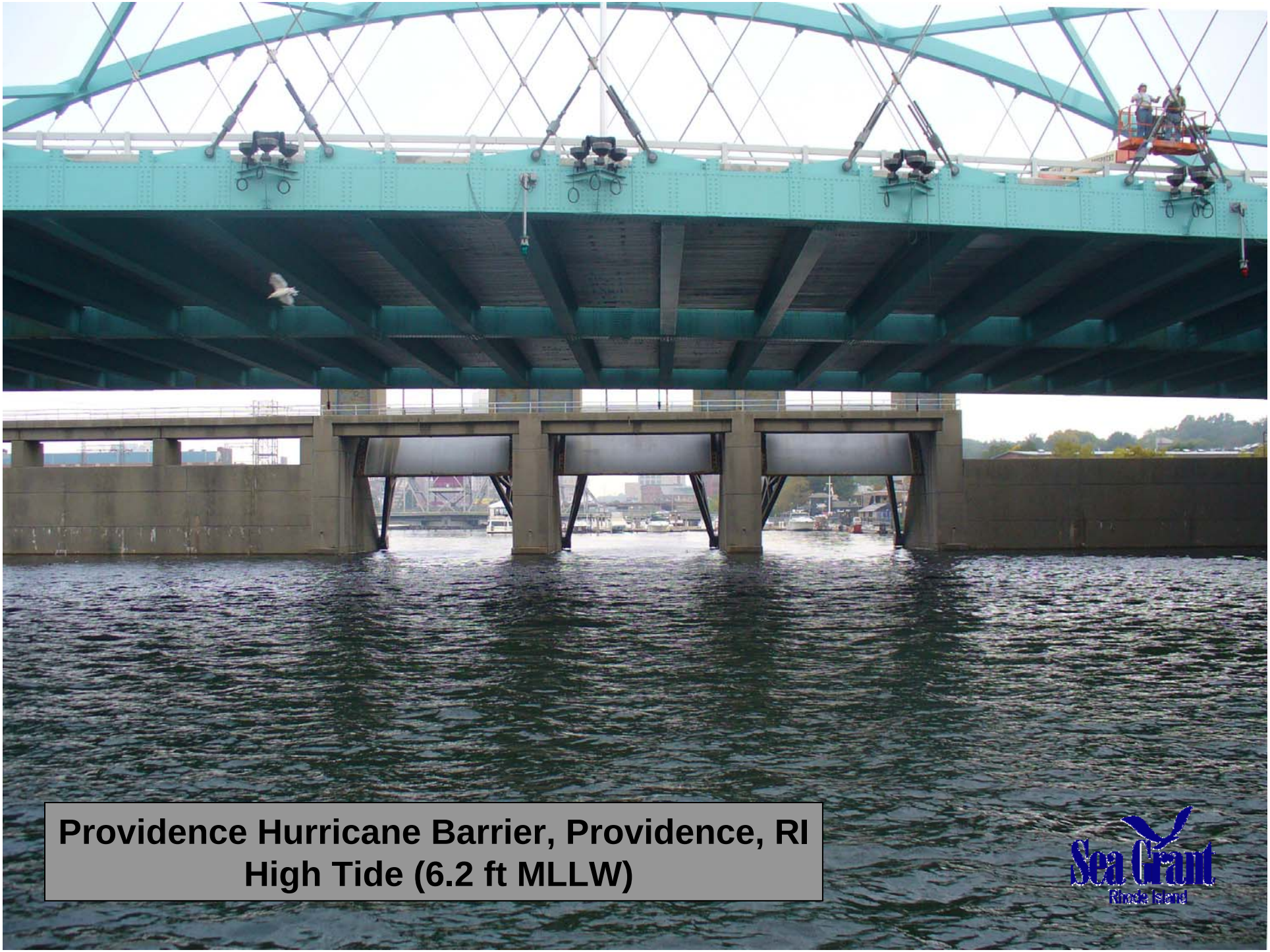
Waterplace Park, Providence, RI
High Tide (6.2 ft) plus 3 ft SLR

Sea Grant
Rhode Island

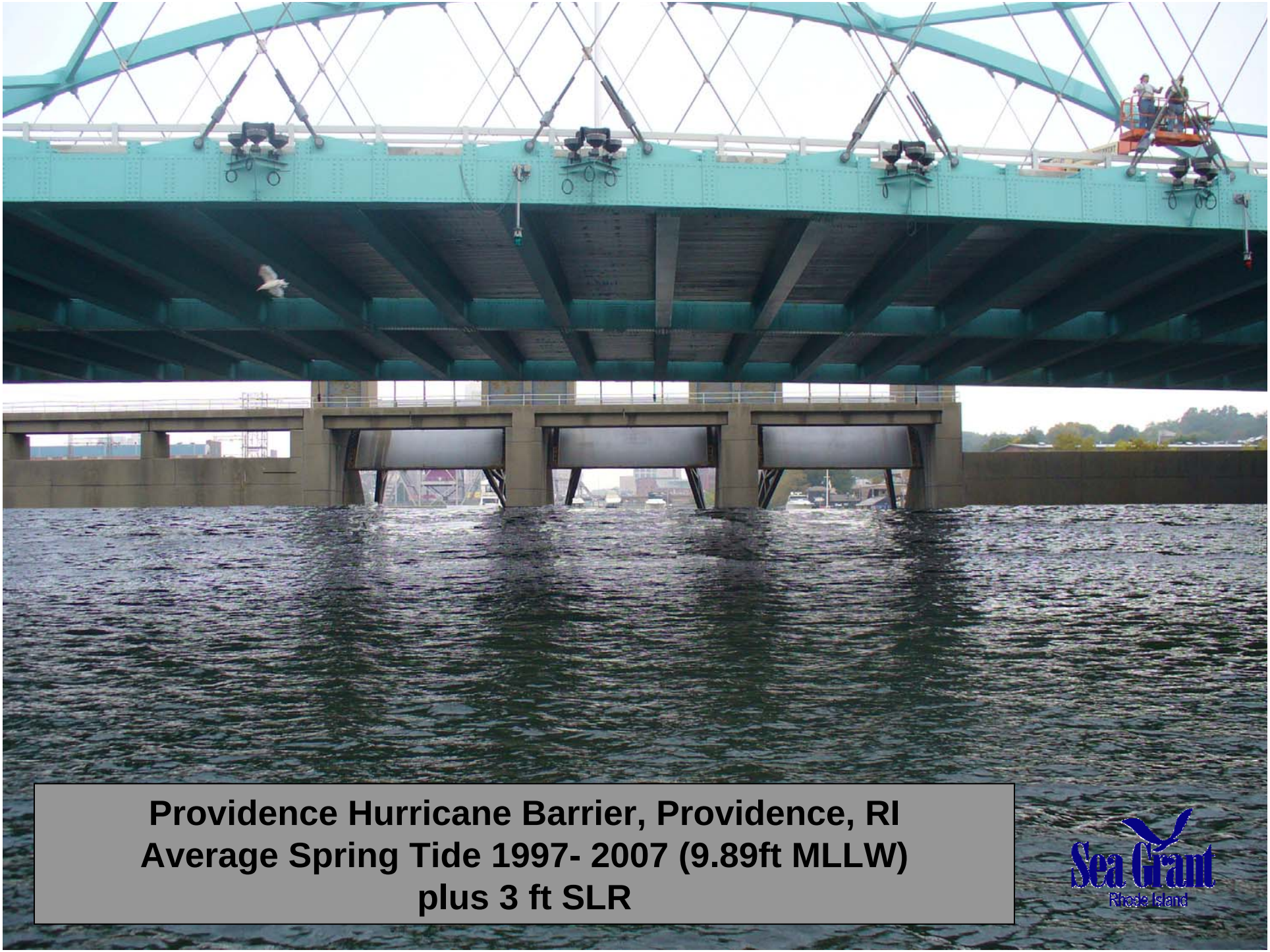


Waterplace Park, Providence RI
Average Spring Tide 1997- 2007 (9.89ft)
plus 3 ft of SLR

Sea Grant
Rhode Island


Providence Hurricane Barrier, Providence, RI
High Tide (6.2 ft MLLW)
Sea Grant
Rhode Island


Providence Hurricane Barrier, Providence, RI
High Tide (6.2 ft MLLW) plus 3 ft of SLR
Sea Grant
Rhode Island



Providence Hurricane Barrier, Providence, RI
Average Spring Tide 1997- 2007 (9.89ft MLLW)
plus 3 ft SLR

Sea Grant
Rhode Island


Providence Hurricane Barrier, Providence, RI
Storm Surge (17.5 ft MLLW) Hurricane of 1938
Sea Grant
Rhode Island

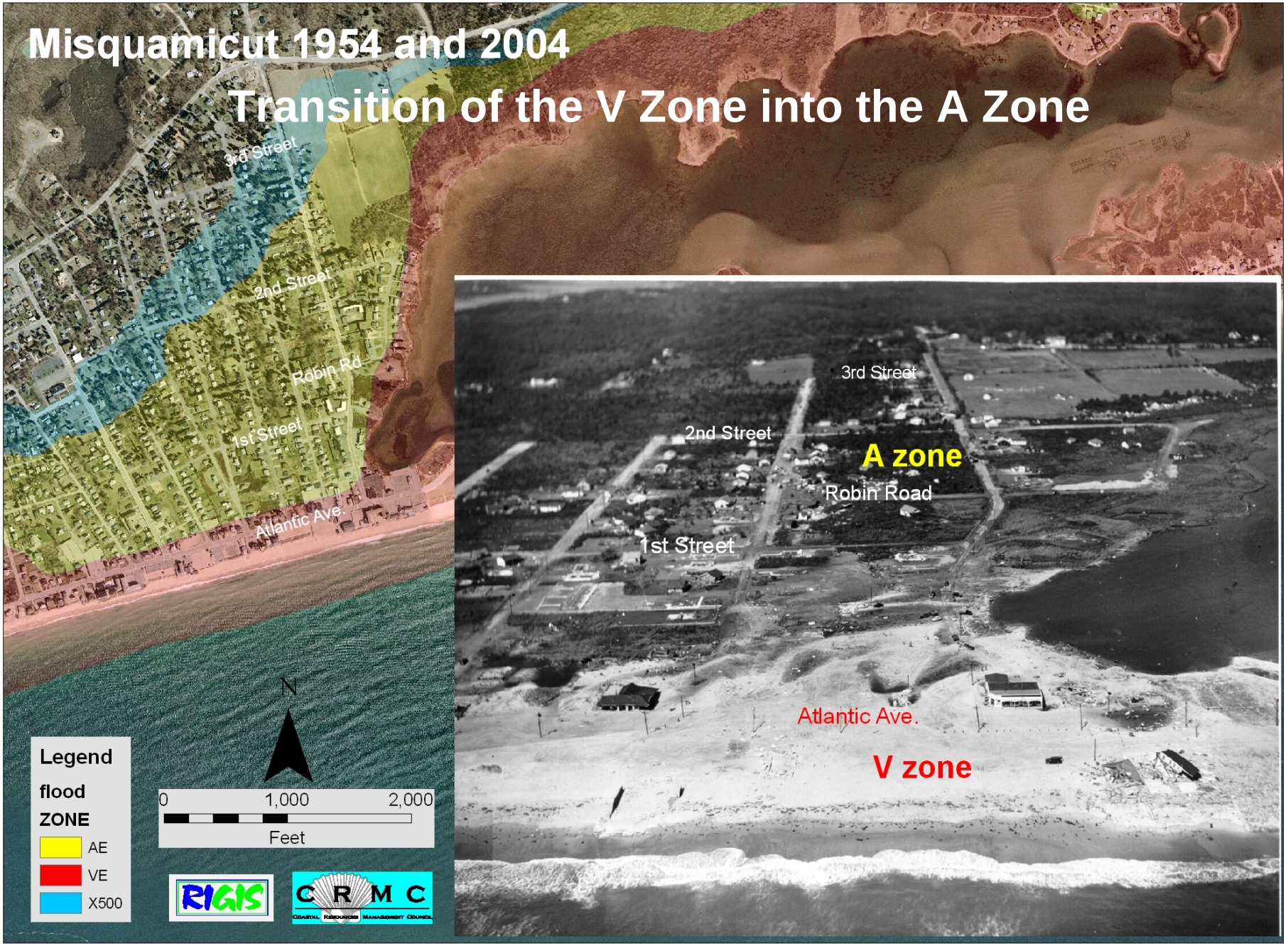

Providence Hurricane Barrier, Providence, RI
Storm Surge (17.5 ft MLLW) Hurricane of 1938
Plus 3 ft of SLR
Sea Grant
Rhode Island

Sea Level Rise

- Increased erosion
- Salt water intrusion
  - Groundwater contamination
  - ISDS failure
- More susceptibility to storm surge
  - Effect properties further inland
  - Effect properties that are now elevated out of the perceived harms way

Misquamicut 1954 and 2004

Transition of the V Zone into the A Zone

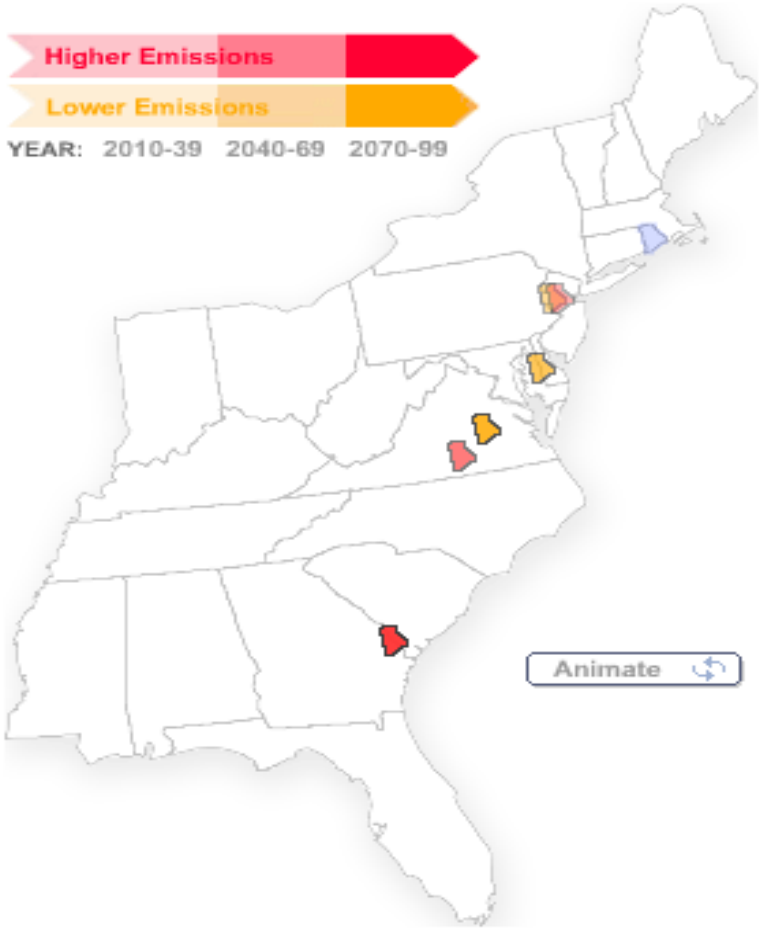


Approaches to Sea Level Rise Management

- **Accommodation**
  - Building Elevation, Flood Preparation, Salt Tolerant technology
- **Retreat**
  - Anticipatory land regulation, Building Codes
- **Protection**
  - Structural (sea walls, dikes) or Non-structural (beaches, vegetation)

J.C. Boothroyd

IMPACTS ▸ Dramatically Changing Climates



Summer in Rhode Island could feel like the typical summer in coastal South Carolina or Georgia by the end of the century unless we take action to reduce heat-trapping emissions today.

Lower-Emissions Scenarios: *a shift away from fossil fuels in favor of clean energy technologies, causing heat-trapping emissions to decline by mid-century*

Higher-Emissions Scenarios: *continued heavy reliance on fossils fuels, causing heat-trapping emissions to rise rapidly over the century*

Sea Level Rise Policy

Section 145.
Climate Change and Sea Level Rise

A. Definition

1. Climate is the long-term weather average observed within a geographic region, and climate change refers to fluctuations in the Earth's climate system as a result of both natural and anthropogenic causes. Generally, climate change is evidenced by rising global temperatures; increasing extremes within the hydrologic cycle resulting in more frequent floods and droughts; and rising sea level.

2. Sea level rise refers to the change in mean sea level over time in response to global climate and local tectonic changes. Sea level is the height of the sea with respect to a horizontal control point, or benchmark (e.g. The National Geodetic Vertical Datum of 1929 or NGVD 29; The North American Vertical Datum of 1988 or NAVD 88) and averaged over a period of time sufficient to smooth out fluctuations caused by waves and tides.

3. Vertical datums are either fixed benchmarks such as NGDV 29 and NAVD 88 or site specific tidal datums such as mean high water, mean low water and mean sea level. NGVD 29 is based on the local mean sea level in 1929, which has changed over time. NAVD 88 is now the official civilian vertical datum for surveying and mapping activities in the United States. The conversion to NAVD 88 should be accomplished on a project-by-project basis. Tidal datums, such as mean sea level (MSL) or mean high water (MHW) vary according to the specific location, and represent the mean heights observed over the National Tidal Datum Epoch. Conversions between the datums can be made at www.tidesandcurrents.noaa.gov or calculated through the US Army Corps of Engineers CORPSCON, http://crunch.tec.army.mil/software/corpscon/corpscon.html.

4. Sea level rise includes eustatic contributions - global changes responsible for worldwide variations in sea level (e.g. thermal expansion of seawater, melting glacial ice sheets), and isostatic effects - regional changes in land surface elevations that are related to the tectonic response to ice or sediment loading, and land subsidence due to extraction of water or oil. The combination of eustatic and isostatic effects at a particular location is known as relative sea level rise.

B. Findings

1. On very long (geologic) time scales, sea level naturally fluctuates in response to variations in astronomical configurations that cause changes in the Earth's climate system. Since the Last Glacial Maximum (approximately 20,000 years ago), global sea level has risen by over 390 feet (120 meters), as water that was previously trapped in continental ice sheets has made its way into the global ocean.

2. Sea level rise is a direct consequence of global climate change. Greenhouse gas emissions to the atmosphere increase surface warming, which in turn increases the volume of ocean water due to thermal expansion, and accelerates the melting of glacial ice. Atmospheric greenhouse gas concentrations are already higher than levels at the last interglacial period, when sea levels were 13 to 19 feet (4 to 6 meters) higher than at present (Overpeck et al., 2006). Greenhouse gas concentrations are expected to continue to increase through 2100.

3. Human activities and increased concentrations of greenhouse gasses in the atmosphere have accelerated the historic rate of eustatic sea level rise. Over the last 100 years, sea levels have risen 0.56 feet (0.17 m) globally. The average rate of rise during the years between 1961 and 2003 was 0.71 in per year (1.8 mm/yr), and between 1993 and 2003 the rate nearly doubled to 1.2 in per year (3.1 mm/yr) (IPCC, 2007).

4. In addition to rising global sea levels, the land surface in Rhode Island is subsiding at a rate of approximately 6 inches (15 cm) per century (Douglas, 1991). The combination of these two effects is evident from the long-term trend recorded by the Newport tide gauge (Figure 1), which indicates a rate of 10.1 in +/- 1.2 in (25.7 cm +/- 3.1 cm) of relative sea level rise over the last century.

5. The rate of sea level rise is accelerating. Future sea level rise, like the recent rise, is not expected to be globally uniform or linear. Some regions will become more substantially inundated than the global average, and others less. Of foremost concern is the trend in eustatic rise as observed from tide-gauge records over the past century. The rate of rise during the past 20 years is 25% faster than the rate of rise in any 20 year period that exists in the instrumental record (Church and White, 2006; Rahmstorf et al., 2007).

6. Model-simulated projections of global sea level over the 21st century also clearly demonstrate accelerated progression. Predictions have ranged from 4 inches (10 cm) to several feet above current levels. As a rule, sea level estimates are increasing as the science of modeling becomes more developed. .

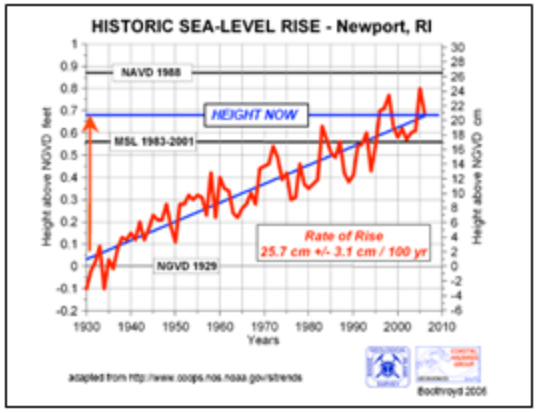
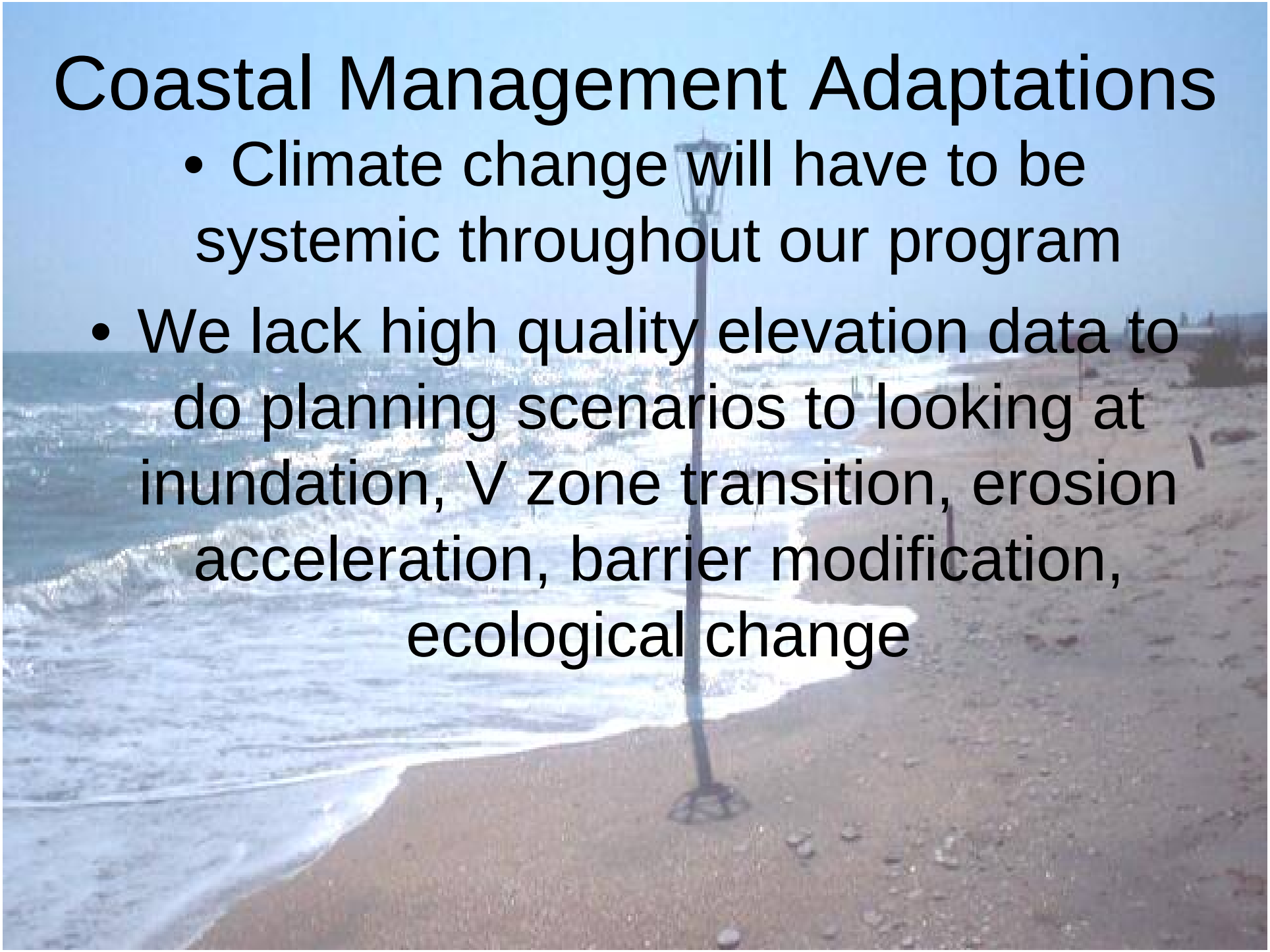


Figure 1 – Historic Sea Level Rise in Newport, RI shows an increase of approximately .64 feet between 1930 and 2006.



Coastal Management Adaptations

- Climate change will have to be systemic throughout our program
- We lack high quality elevation data to do planning scenarios to looking at inundation, V zone transition, erosion acceleration, barrier modification, ecological change

Coastal Management Adaptations

- Legal Analysis to develop new tools- rolling setbacks
- Upgrade existing polices based on scenarios and legal analysis- setbacks, etc.
- Adaption will require a new way of look at what we do.

Living Shorelines for Low Energy Shorelines

Benefits from living shorelines may include:

- **Less bank erosion and property loss, especially during storms**
- **Lower erosion control construction costs**
- **Natural and visually pleasing views**
- **A beach for boat launching, sunbathing and swimming**
- **Restored marine habitat and spawning area for fish and shellfish**
- **Improved water quality.**

Coastal Management Adaptations

- Ocean SAMP –offshore renewables
  - ADAPTATION


Ocean Planning

CRMC and SAMPs

- **The term '‘Special Area Management Plan'' means**
  - A **comprehensive plan** providing for natural resource protection and reasonable coastal-dependent economic growth containing a detailed and comprehensive statement of policies;
  - **Standards and criteria** to guide public and private uses of lands and waters; and,
  - **Mechanisms for timely implementation** in specific geographic areas within the coastal zone.

CRMC and SAMPs

- **(B) Special Area Management Plans**
  - **(i) The council shall adopt such special area management plans as deemed necessary and desirable to provide for the integration and coordination of the protection of natural resources, the promotion of reasonable coastal-dependent economic growth, and the improved protection of life and property in the specific areas designated council as requiring such integrated planning and coordination.**
  - **(ii) The integrated planning and coordination herein specified shall include, but not be limited to, federal agencies, state agencies, boards, commissions, and corporations, including specifically the economic development corporation, and cities and towns, shall utilize to the extent appropriate and feasible the capacities of entities of higher education, including Rhode Island Sea Grant, and shall provide for the participation of advocacy groups, community-based organizations, and private persons.**

CRMC
Coastal Resources Management Council

Planning Authorities

- Federal (CZMA)
  - SAMPs are a preferred management tool
- State (§ 46-23)
  - Water Types
    - Innovative management tool that is Recognized nationally and internationally
  - Exclusive manager of submerged lands
  - Public Trust resource manager

An Ocean SAMP

- The Planning Process
  - Mapping exercise of existing uses and critical resources/transportation zones
  - Site Selection Screening Criteria
  - Conflict Analysis
  - Reach Agreement with ACOE & MMS on study parameters
  - More Intensive Studies On Selected Areas

An Ocean SAMP

- Develop For Public Review
  - Public Agreement On Screening Criteria
  - Ocean Zoning Map
  - Regulatory program for project development
  - Regulatory program for resource protection
  - Development, Operation, Decommissioning Standards To Blend With Federal Standards.

An Ocean SAMP

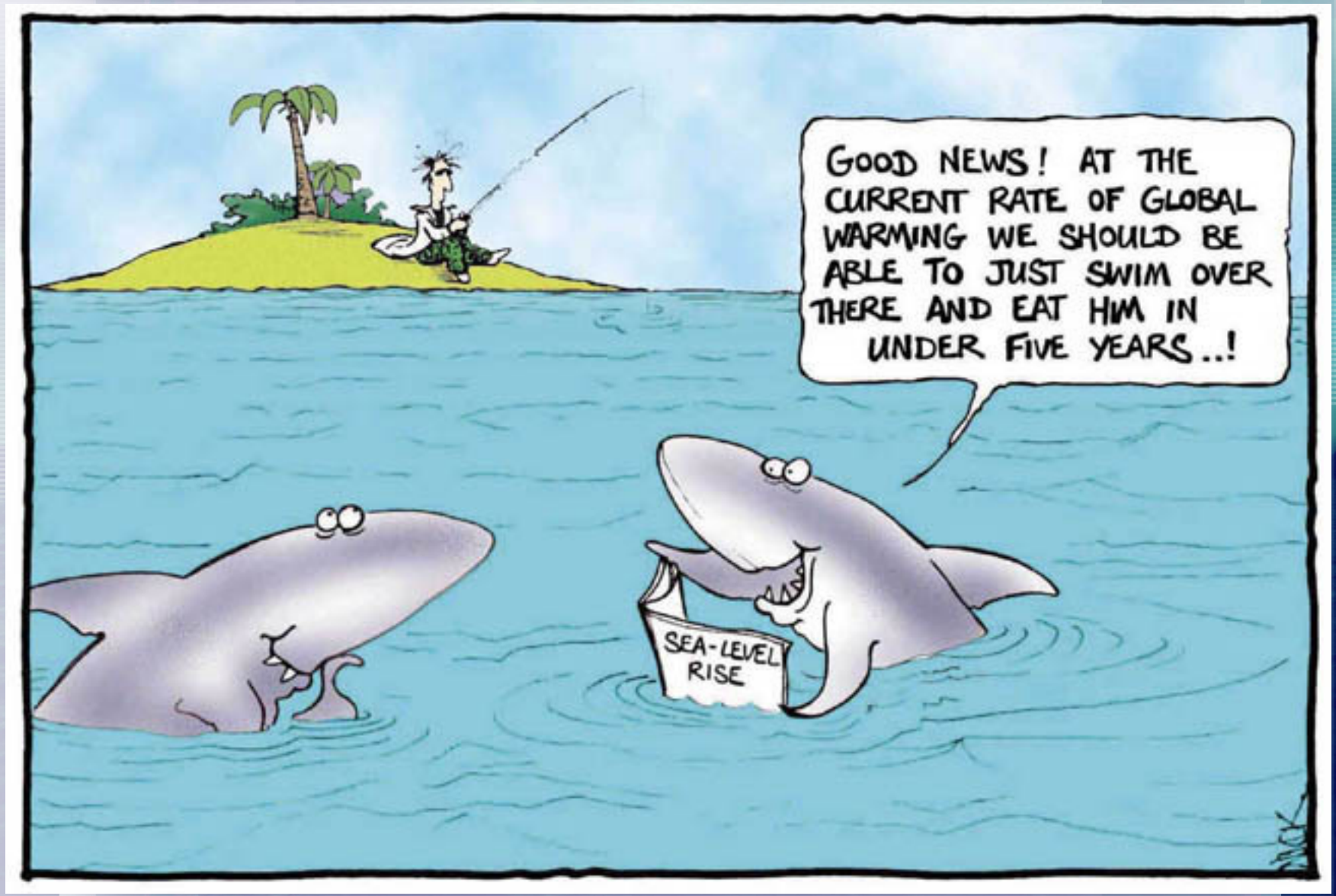
- The Result:
  - Pre-selected sites
  - Environmental accountability
  - Public and government support
  - Permitting predictability
- Similar successful model
  - UK Crown Estate for Renewable Energy
- Consistent with proposed legislation to amend the CZMA for renewable energy

An Ocean SAMP

- The **ACOE** under Regulatory Guidance Letter 92-03 and 89-10 allows for **simplified permitting if they participate in the SAMP development**.
- The process has been designed to be consistent with MMS's process.
- MMS and ACOE have joined the planning team and are assisting in the development of the plan.

An Ocean SAMP

- Thus the plan should have the desired result of **“buy in” at the federal level** simplifying and coordinating permitting between state and federal partners.
- Result in a First In The Nation Ocean Zoning Plan


GOOD NEWS! AT THE CURRENT RATE OF GLOBAL WARMING WE SHOULD BE ABLE TO JUST SWIM OVER THERE AND EAT HIM IN UNDER FIVE YEARS..!
SEA-LEVEL RISE