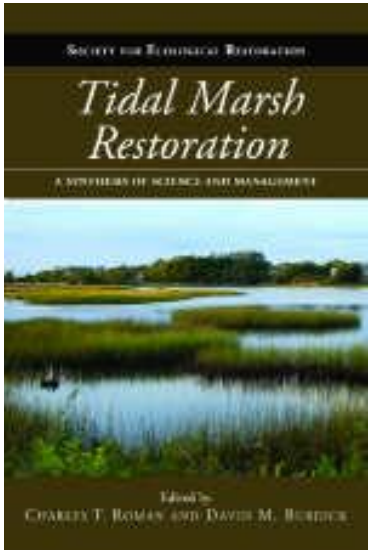
What can our salt marshes tell us about climate change and sea level rise?

David Burdick
Jackson Estuarine Laboratory
Dep't of Natural Resources & the Environment
School of Marine Science and Ocean Engineering
University of New Hampshire, Durham, USA



NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

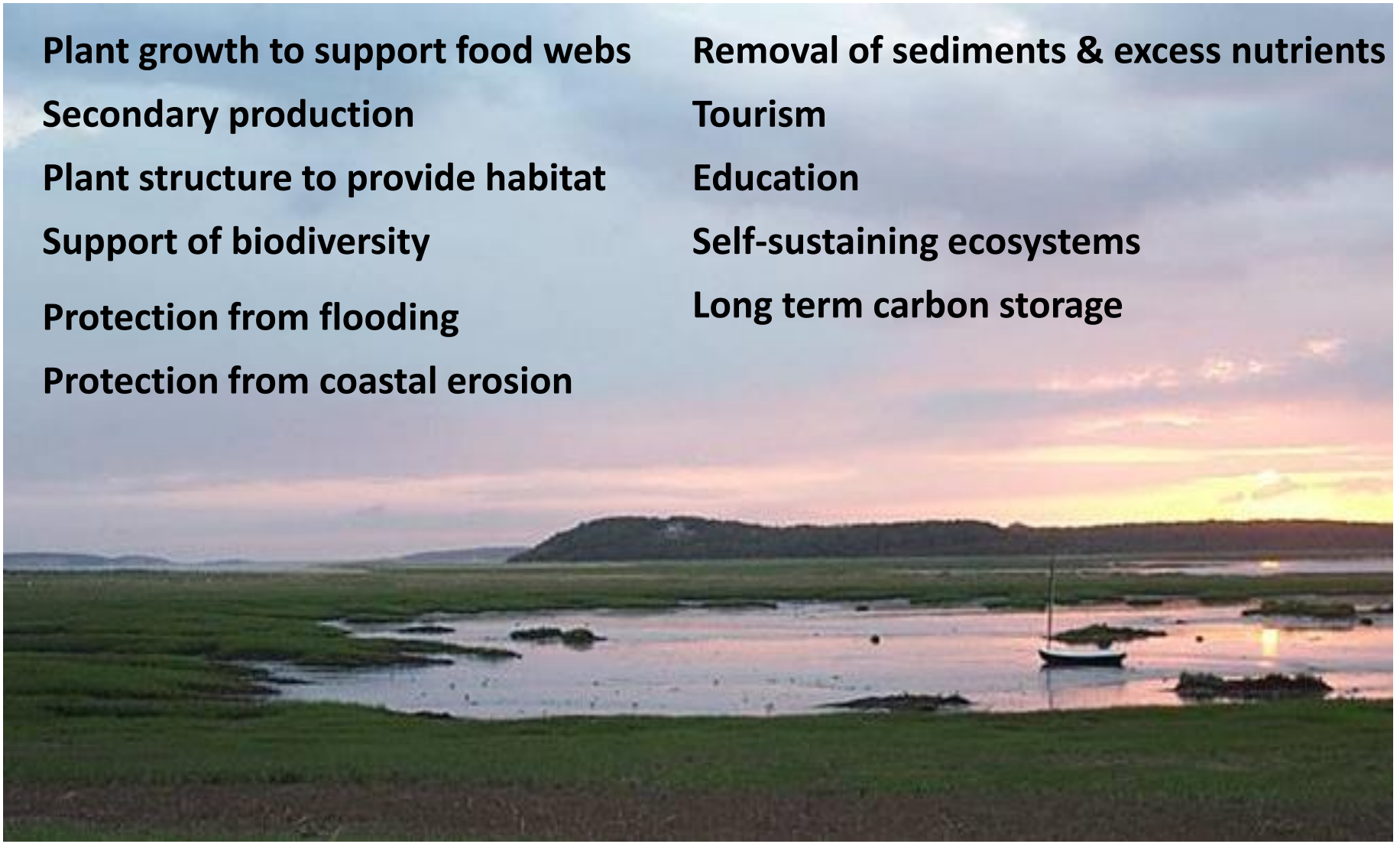
U.S. FISH & WILDLIFE SERVICE DEPARTMENT OF THE INTERIOR

NEW HAMPSHIRE COASTAL PROGRAM

GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE

NH

What do salt marshes do for us?

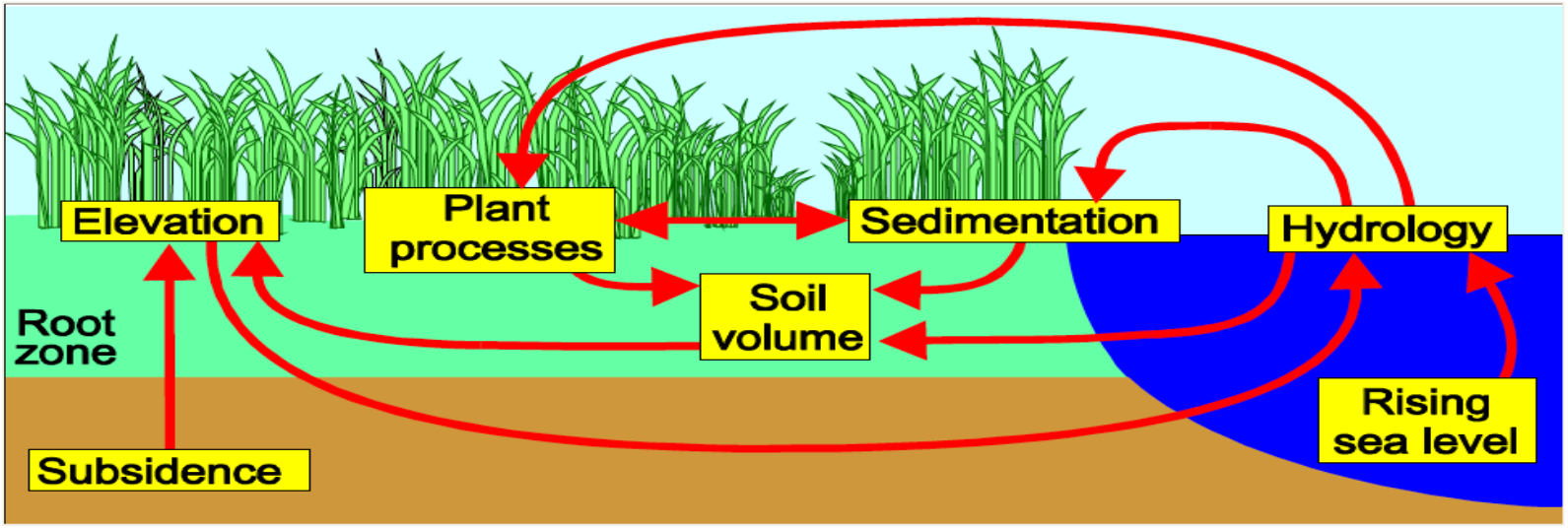


Salt marshes are among our most productive and valuable ecosystems

How do salt marshes work?

Salt Marshes are Poised Systems

- Reflect a dynamic balance of building processes;
  - Sediment trapping and binding
  - Root production and limited decomposition - peat
  - Sea Level Rise (up to 5 mm /yr)



Cahoon and Lynch

- . . . and eroding processes
  - Compaction (by floods and ice)
  - Decomposition of roots and peat (Oxygen, Temperature, Nitrogen)
  - Physical exposure to waves and ice

WHAT ARE THE MOST IMPORTANT COMPONENTS OF CLIMATE CHANGE FOR TIDAL MARSHES?

Climate Change Impacts to Wetlands

- Increased sea level and storm activity
  - Seaward edges will retreat
  - Lower elevations will drown
- Temperature increases
  - Range expansions
  - Loss of forb pannes
  - Increased decomposition rates

How do salt marshes respond to climate change?

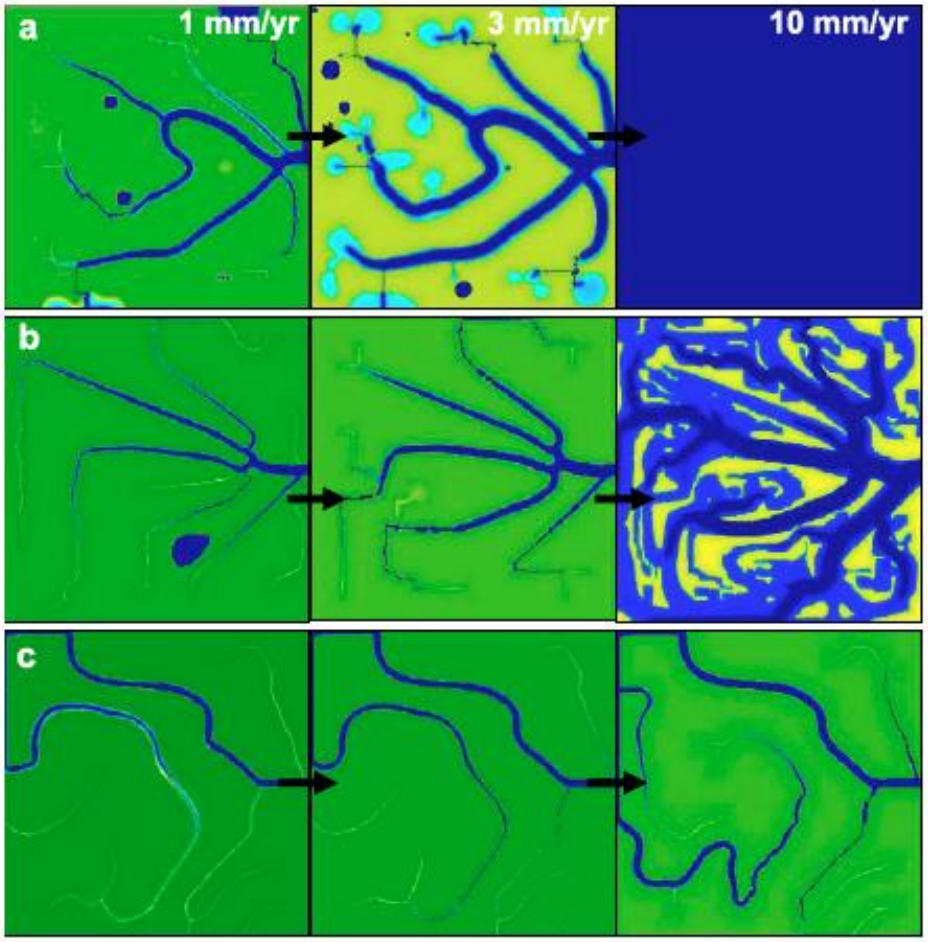
Marsh Responses to three SLR rates under three Tidal Ranges

Tidal Range

0.4 M

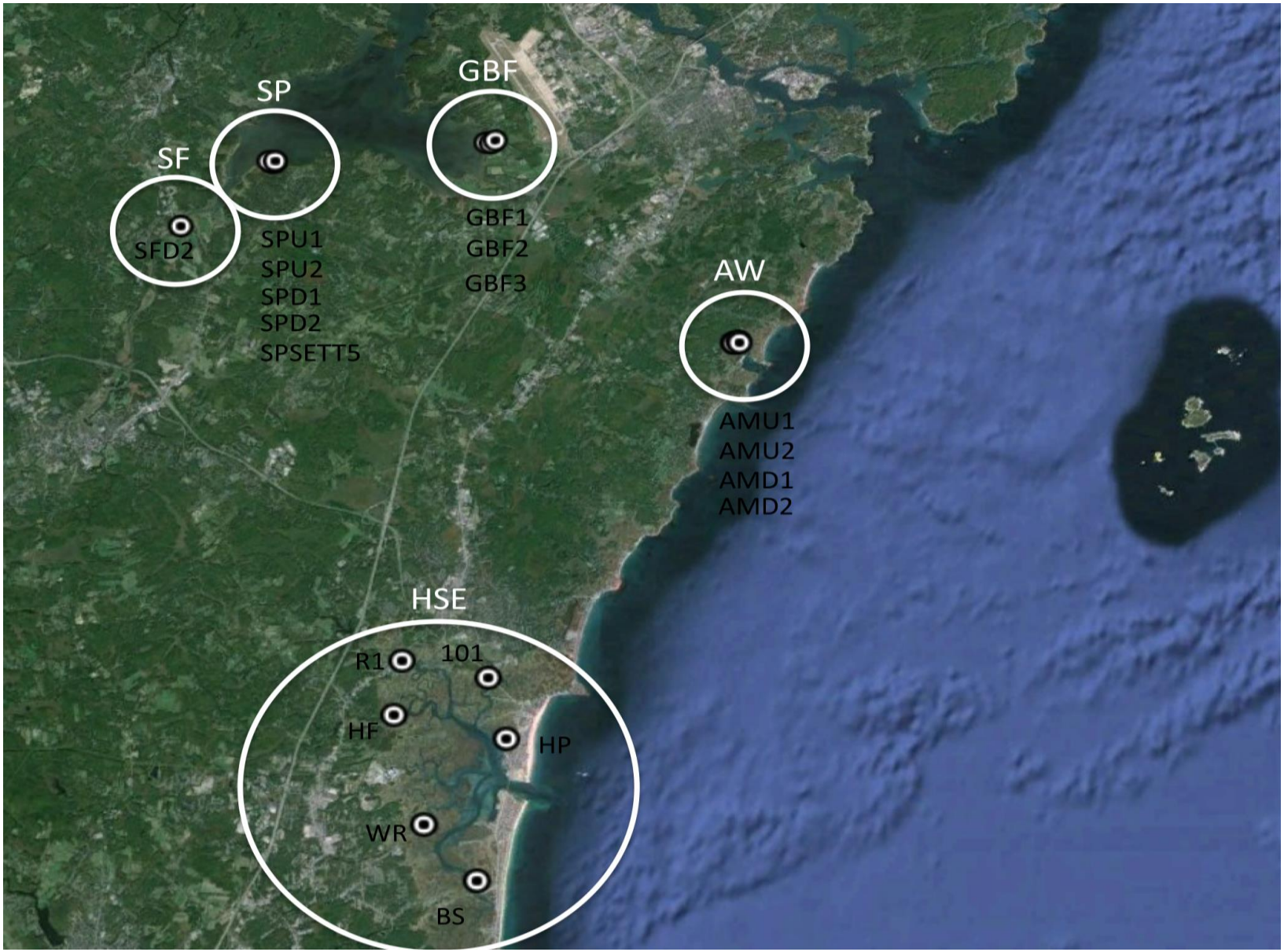
1.0 M

2.0 M



Matt Kirwan and Glen Guntenspergen, 2009

SETs in New Hampshire



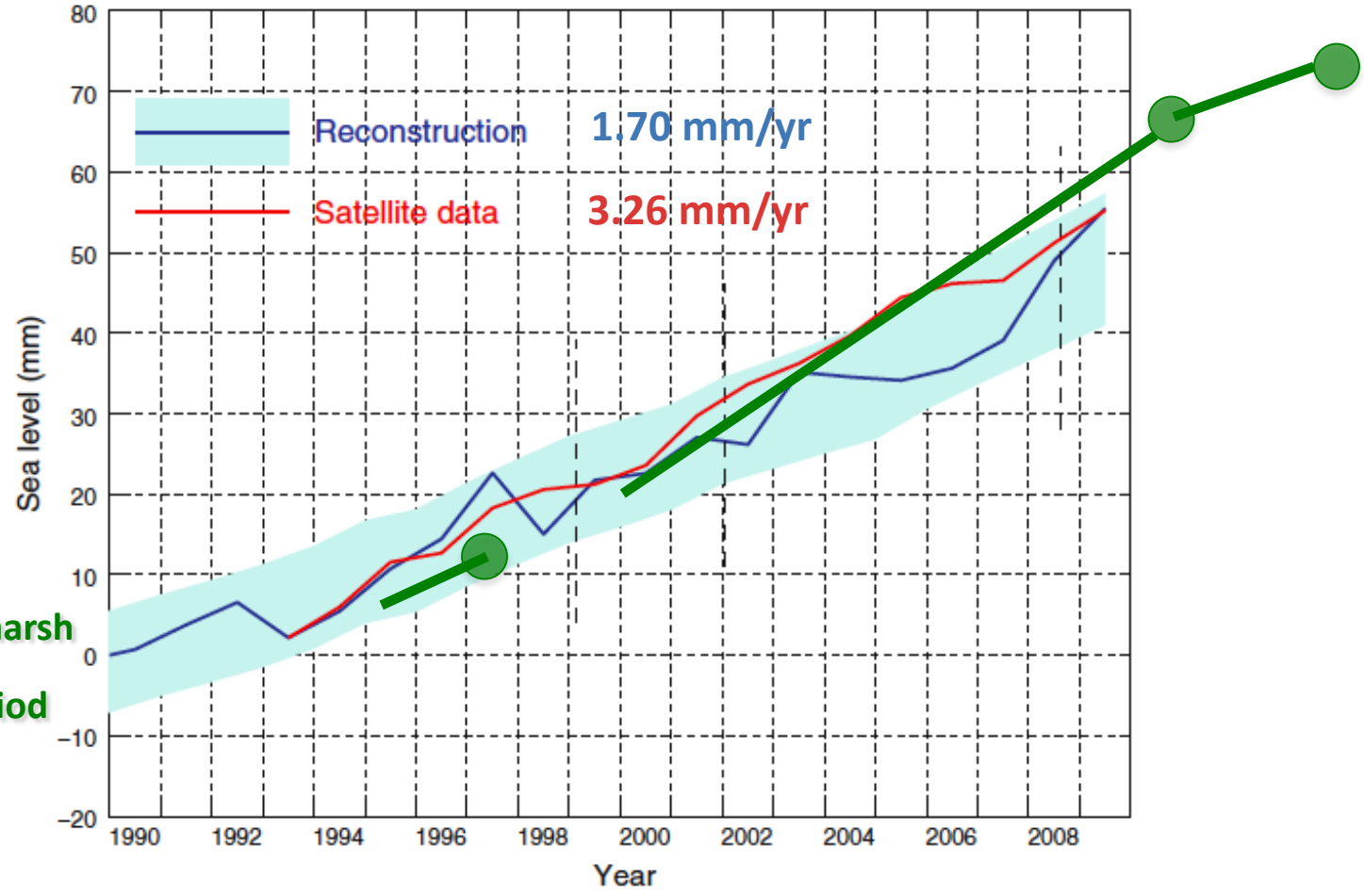
Global Sea Level Rise Measurements (Church & White 2011) Reflected in Salt Marsh Responses Found in Great Bay

Great Bay marsh elevation change:
1.7 mm/yr 1995-97
4.3 mm/yr 2000-11
2.0 mm/yr 2011-14

Portsmouth tide gauge: 1.76 mm/yr 1927-2001

Elevation of salt marsh

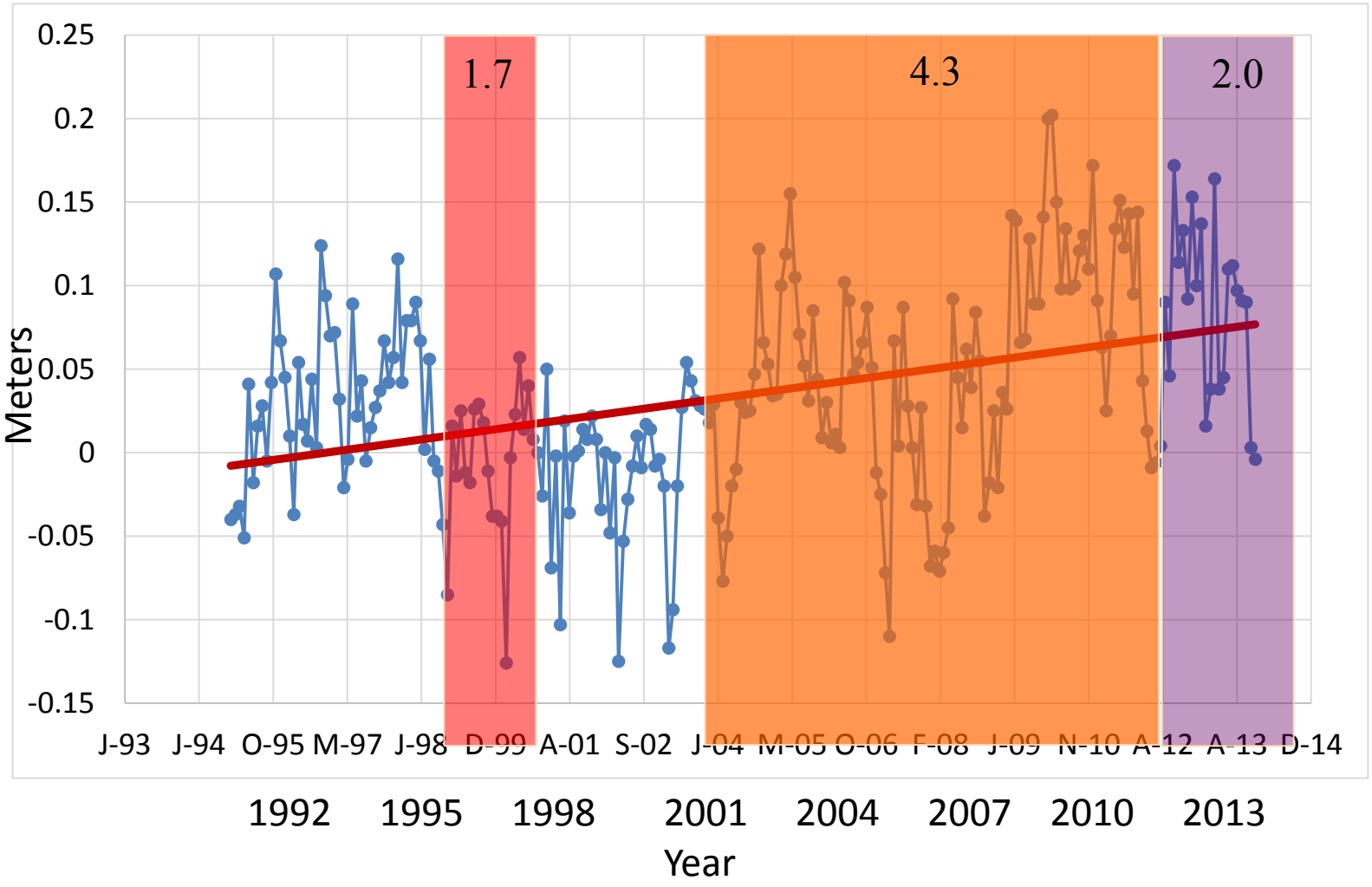
Measurement period



Church, J. A. and N.J. White. 2011. Sea-level Rise from the Late 19th to the early 21st Century. Survey Geophysics 32:585-602

Fig. 4 Global average sea level from 1990 to 2009 as estimated from the coastal and island sea-level data (*blue* with one standard deviation uncertainty estimates) and as estimated from the satellite altimeter data from 1993 (*red*). The satellite and the in situ yearly averaged estimates have the same value in 1993 and the in situ data are zeroed in 1990. The *dashed vertical lines* indicate the transition from TOPEX Side A to TOPEX Side B, and the commencement of the Jason-1 and OSTM/Jason-2 records

1990-2013
Monthly MSL vs. Time at Portland, Maine



What have we learned from our tidal marshes?

- Build from 1-5 mm/year as sea level rises
- Respond to changes in sea level over years to decades
- As seaward edges of marshes drown, landward edges can expand over uplands (Marsh Migration)

WHAT CAN WE DO TO PROTECT OURSELVES FROM COASTAL EROSION, STORM SURGES, SLR

AND . . . MAINTAIN HEALTHY MARSHES, COASTAL PRODUCTION, FISHERIES, ETC.?

Actions to Maintain Healthy Marshes and Coastal Communities

- Federal level
  - Advise/guidance and funds $
- State Level
  - Guidance - new or modify federal for region
  - Develop programs for marsh health:
    - restoring full tides to restricted marshes
    - marsh migration
    - justify all existing /planned coastal structures via sea level rise permit

Actions to Maintain Healthy Marshes and Coastal Communities

- Local Towns
  - New sea level rise zoning ordinances
  - Wider buffers
  - DPW culvert and bridge replacement plan
- Homeowners
  - Re-evaluate any shoreline structures (removal? can marsh be used to control erosion?
  - Do not mow or fill the marsh, lawn clippings, etc.
  - Support local and state plans to adapt to SLR

With contributions and help from many students of marsh ecology, and:
Roel Boumans
Michele Dionne
Larry Ward
Chris Peter
Susan Adamowicz
Semme Dijkstra
Paul Stacey and Rachel Stevens

Thank You!

2011-2014 Rates of Accretion and Elevation Change in NH from SETs