Climate-resilient Coasts

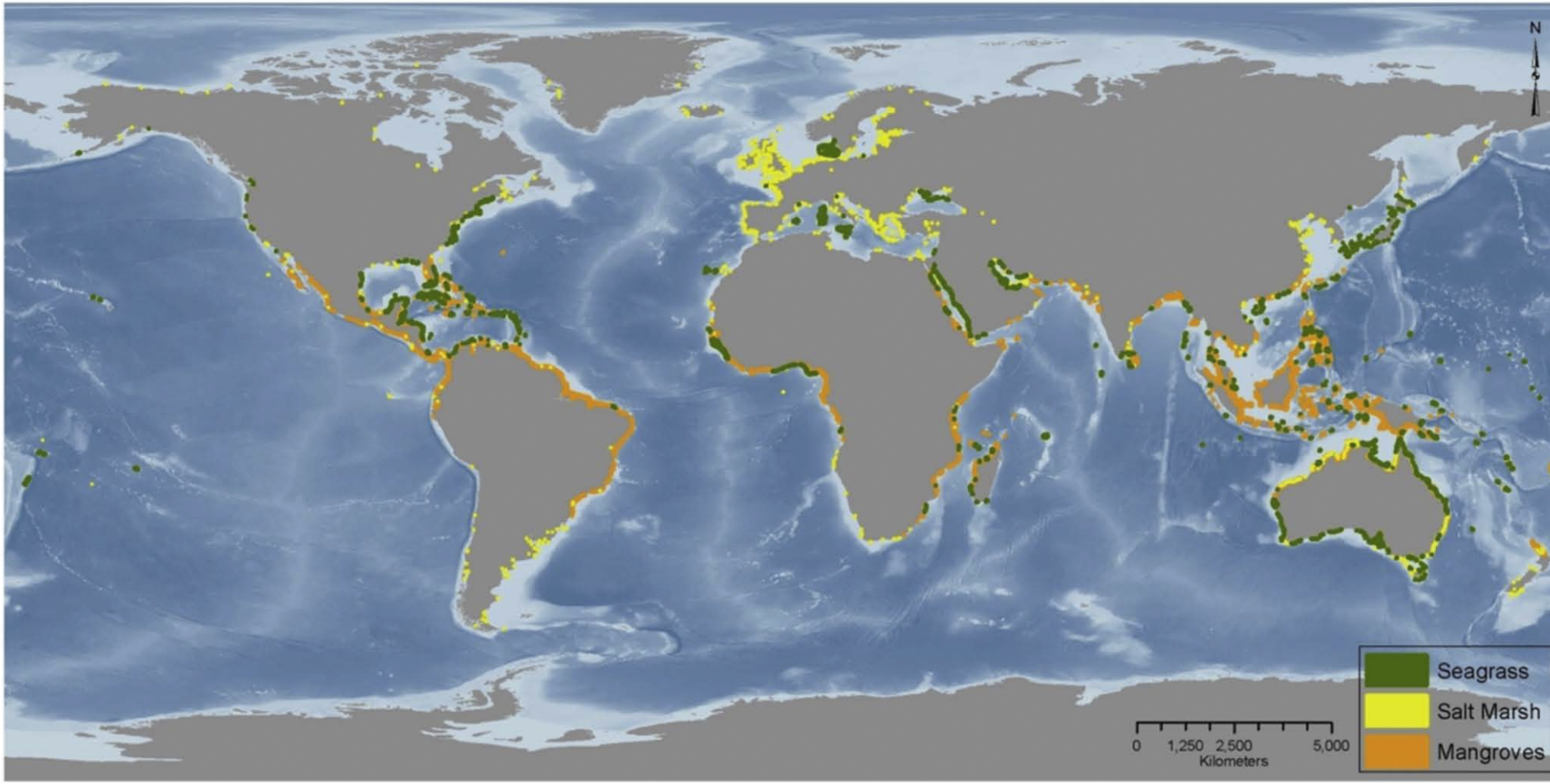
How long-term research and restoration informs management

Karen McGlathery
University of Virginia
Virginia Coast Reserve LTER

VCR LTER:

Causes and consequences of non-linear ecosystem state change

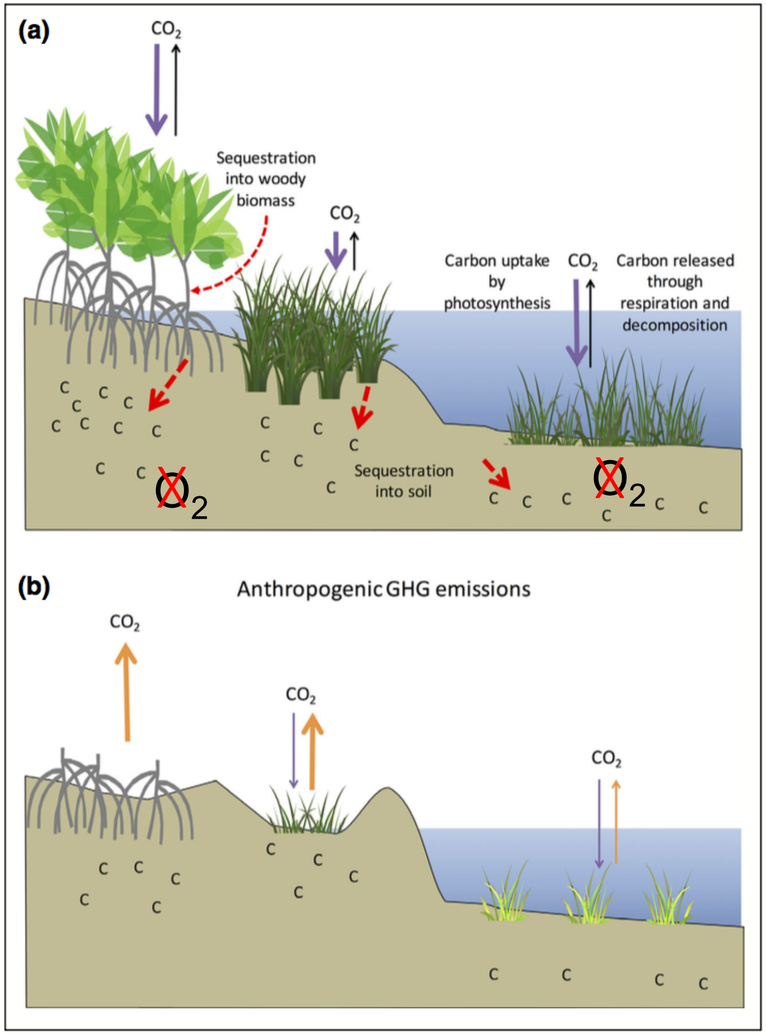
Coastal Blue Carbon Systems



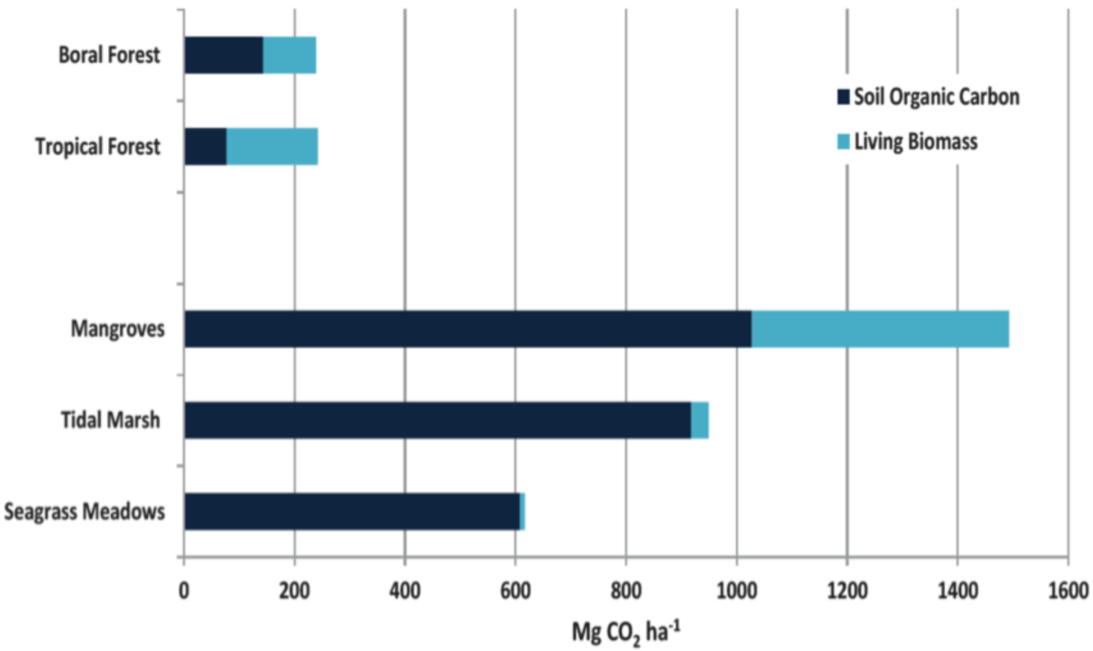
Challenges to incorporating blue carbon in global models:

- Estimating stocks and sequestration rates
- Understanding effects of habitat loss and recovery

Coastal habitats are global hotspots for blue carbon storage

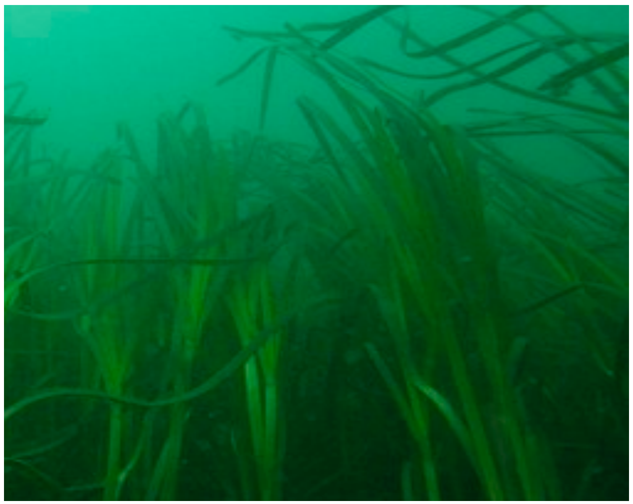


Global stock estimates led by LTER scientists



Adapted from Fourqurean et al 2012, Pan et al 2011, Pendleton et al 2012

LTER site contributions to quantifying blue carbon stocks



Carbon stores in seagrass meadows 4x bare sediments

McGlathery et al. 2012

Carbon burial rates in Marshes exceeds forests

Drake et al. 2015

Carbon stores in mangrove forests 3x terrestrial forests

Jerath et al. 2016

Including blue carbon, ocean sequestration equals forests

Fate of anthropogenic CO_2 emissions (2006-2015)

91%

9%

Sources = Sinks

44%

31%

32%

~~26%~~

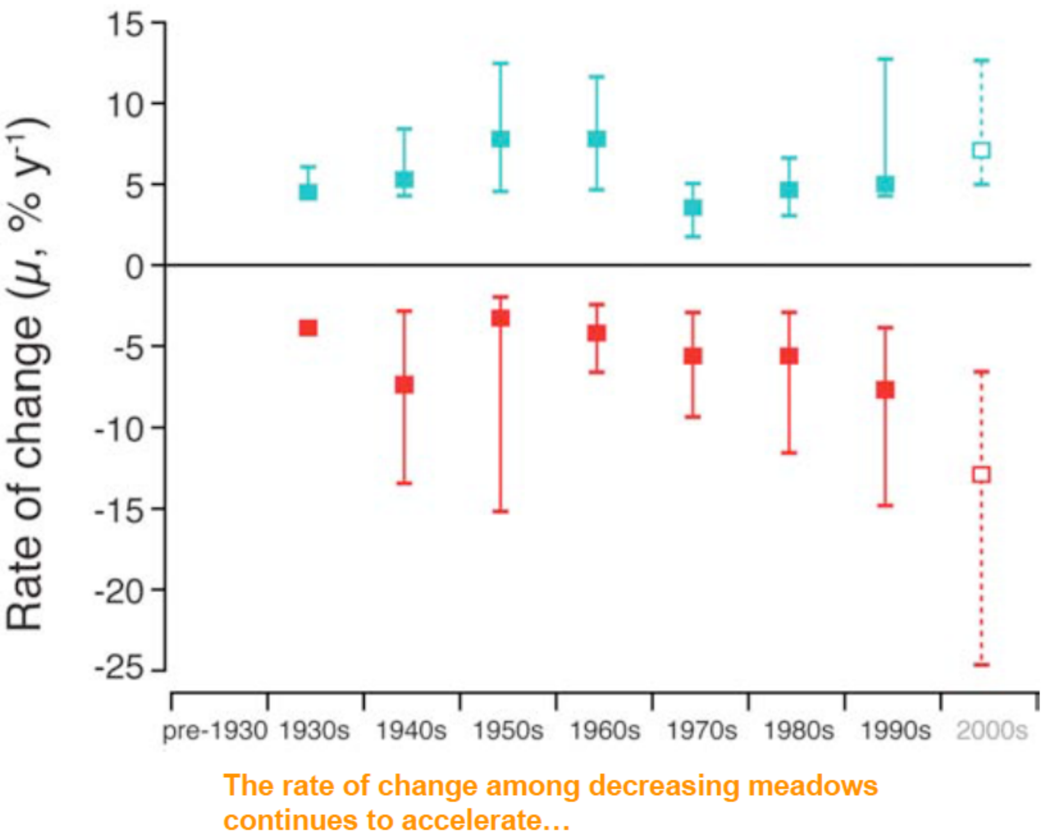
Blue Carbon = 25% ocean sequestration

Source: CDIAC; NOAA-ESRL; Houghton et al 2012; Giglio et al 2013; Le Quéré et al 2016; Global Carbon Budget 2016

Virginia Coast Reserve: Loss and recovery

Rate of seagrass loss has accelerated

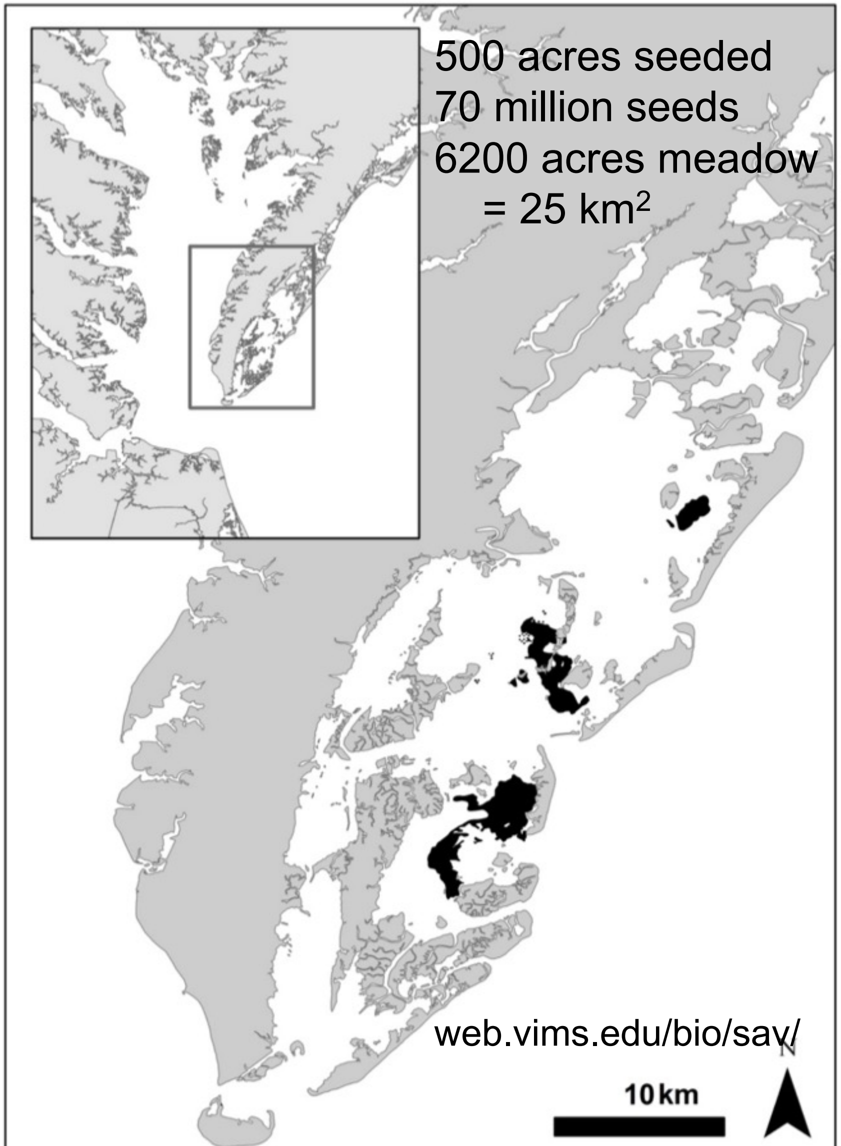
29% loss since 1880’s; 1.5% per year



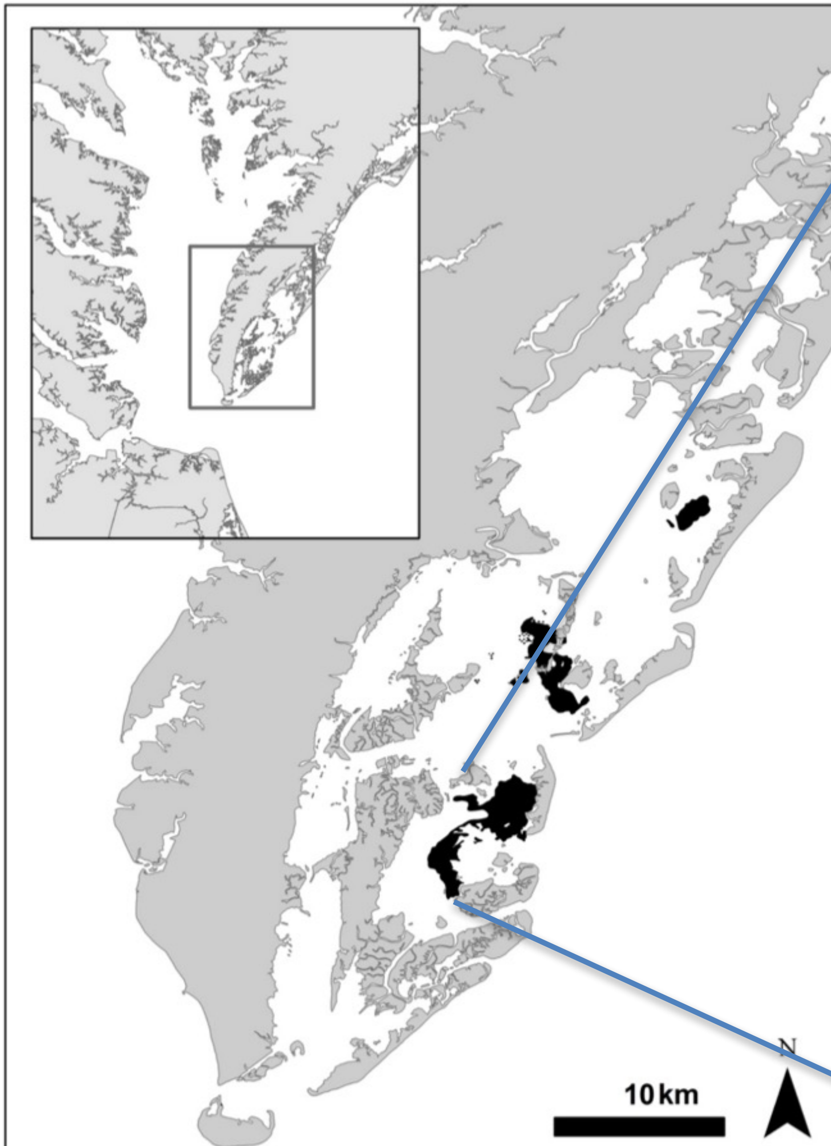
Waycott et al (2009)
215 studies, 126 years of data

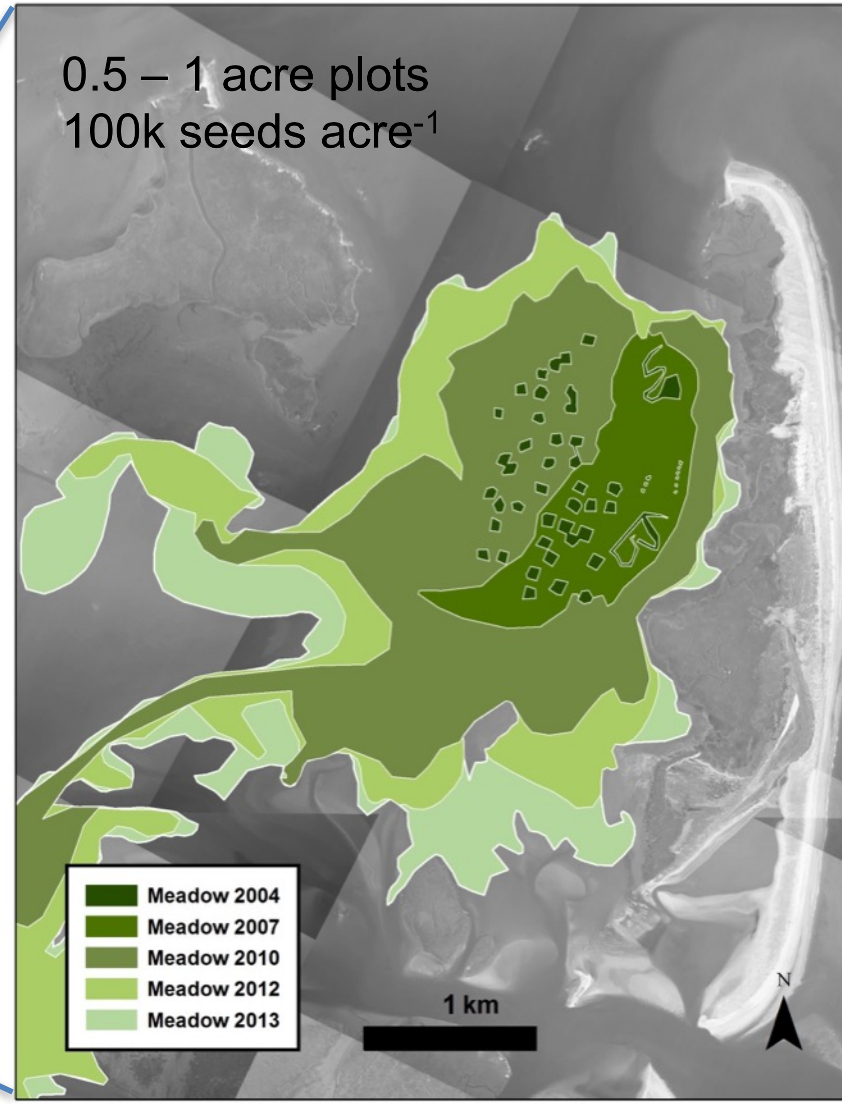
VCR loss due to pandemic wasting disease and "Great Storm" of 1933

Reversing the state change

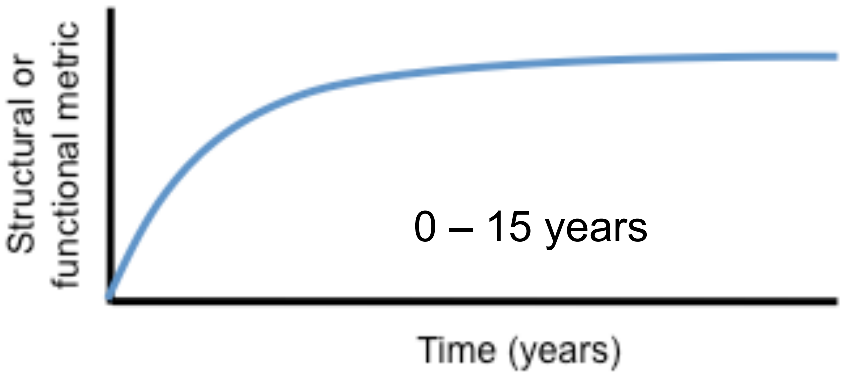


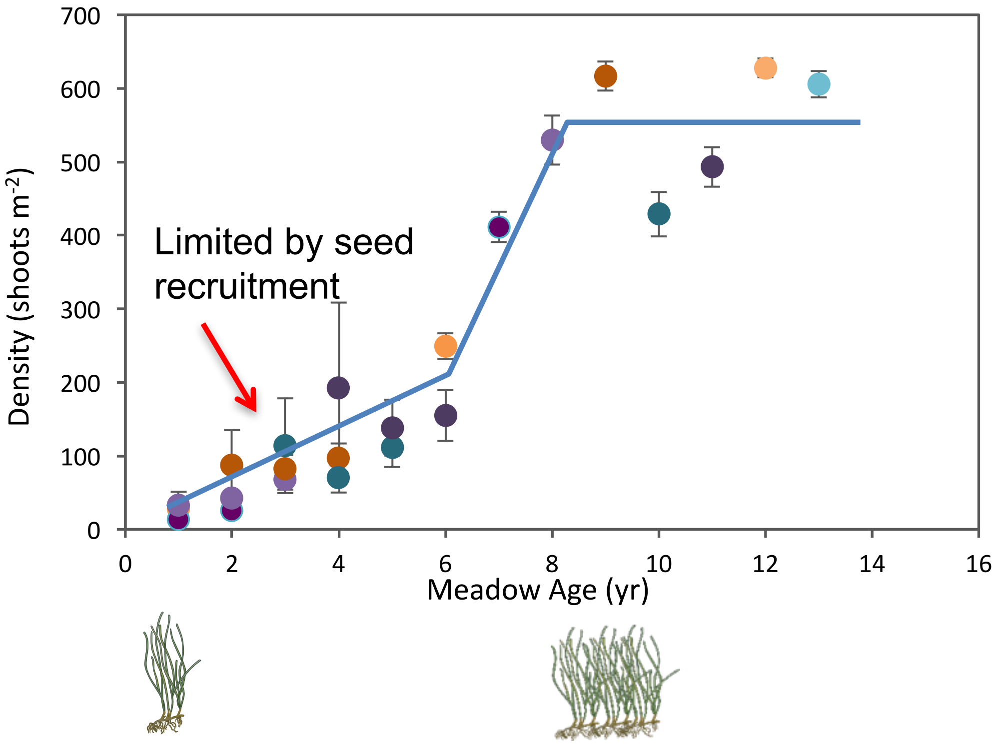
Reversing the state change





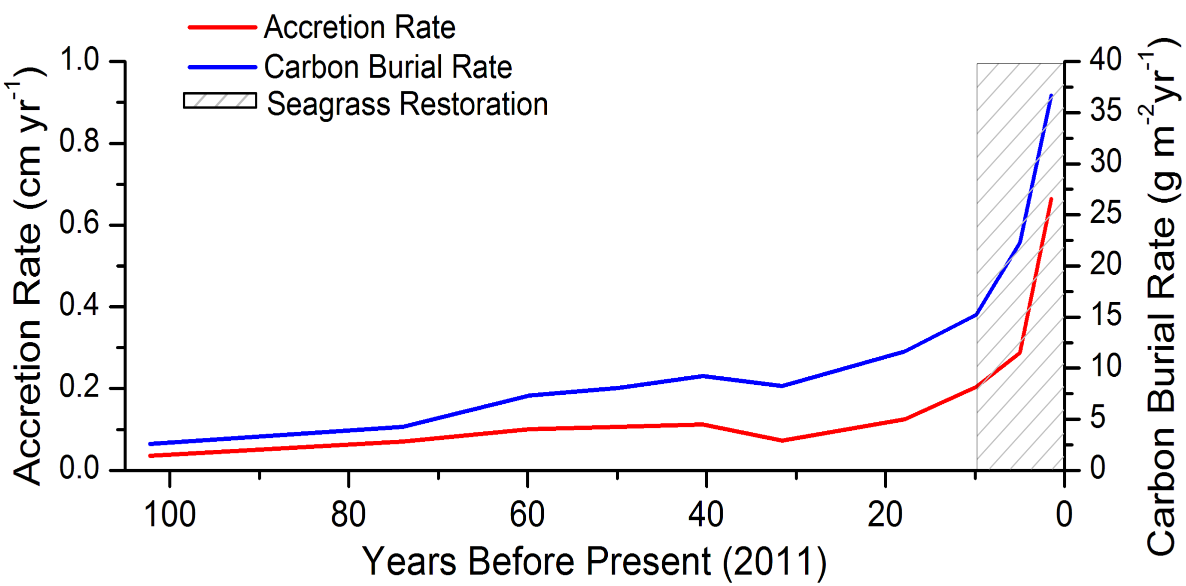
Recovery is non-linear



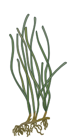


Restoration reinstates soil carbon stores

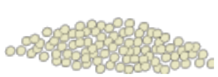
Plant density drives burial rates



After 12 yr, burial within range of natural systems

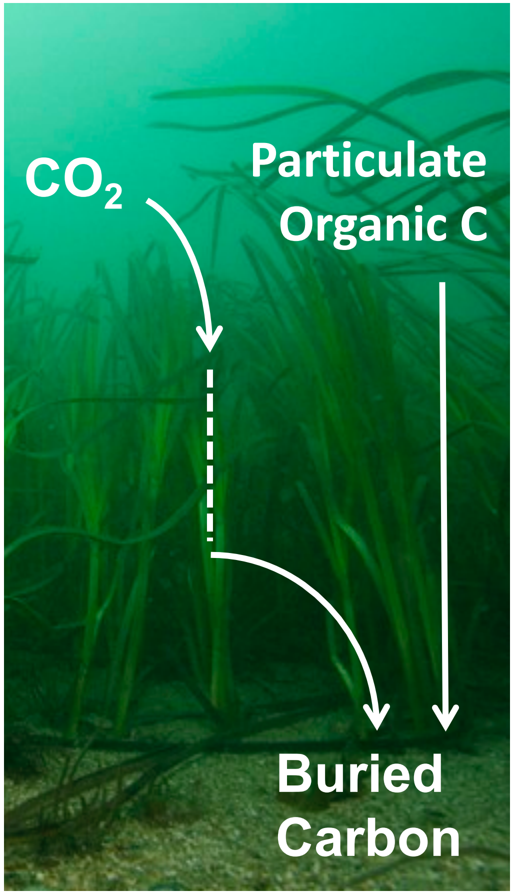


40% Seagrass



50% Benthic microalgae

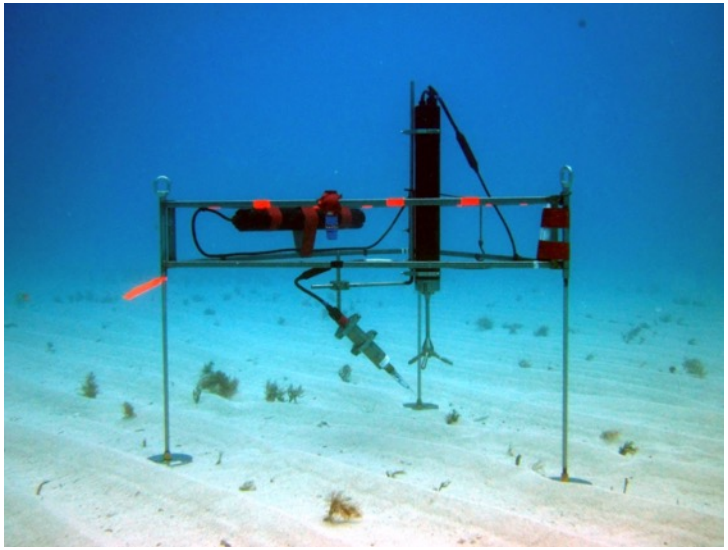
10% Marsh

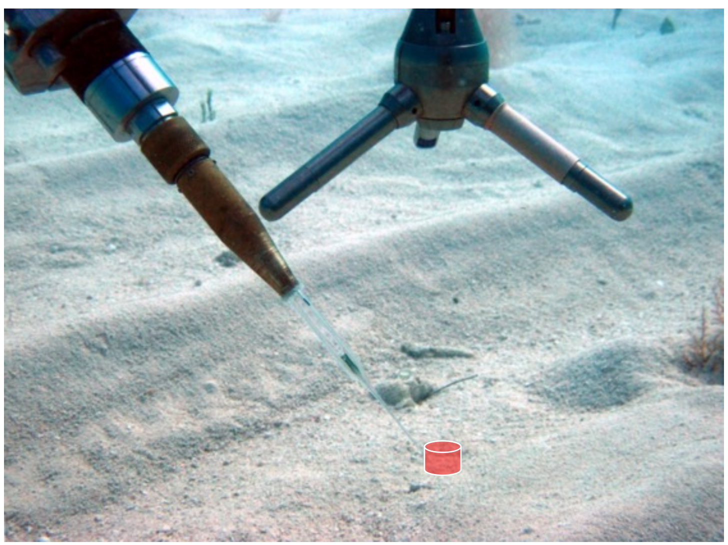


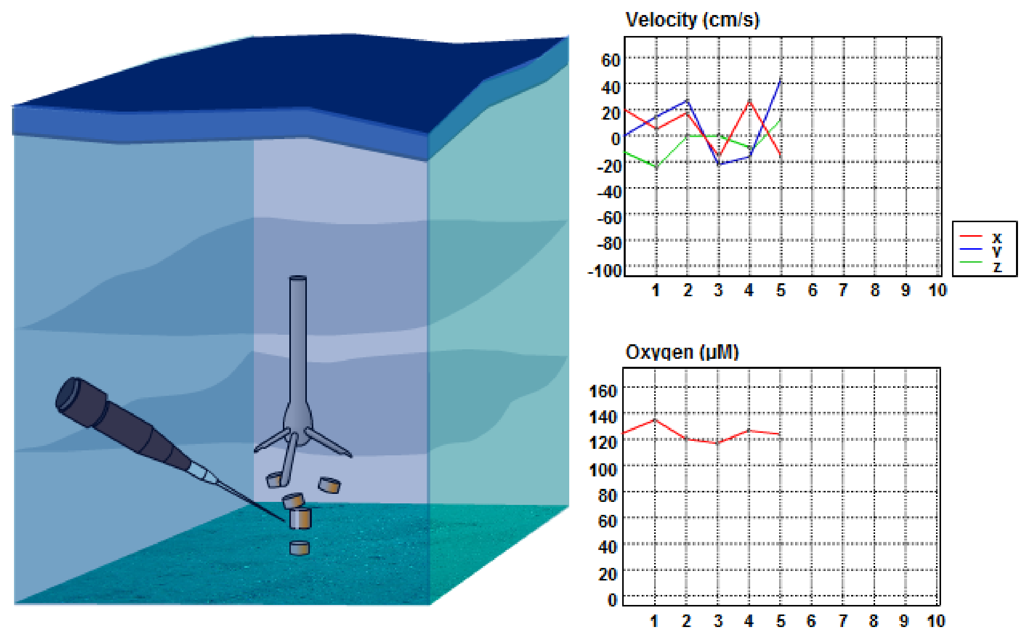
Greiner et al. 2013

Carbon sequestration in plant biomass

Measured by Aquatic Eddy Covariance





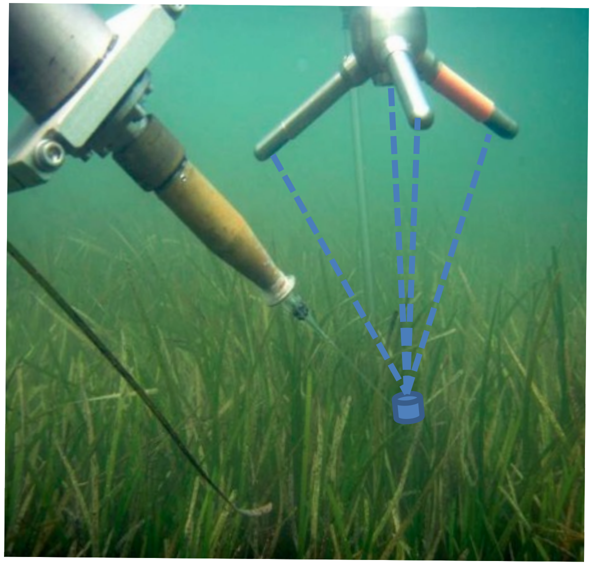


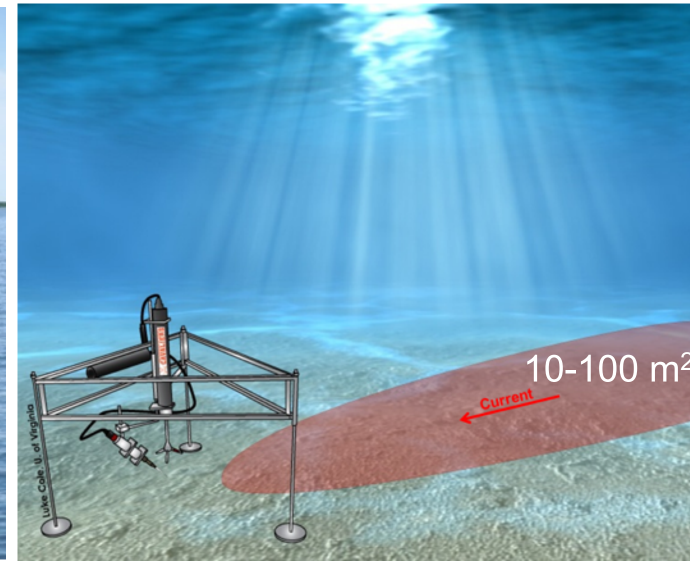
Data typically recorded at 32 - 64 Hz,
5 - 30 cm above benthic surface

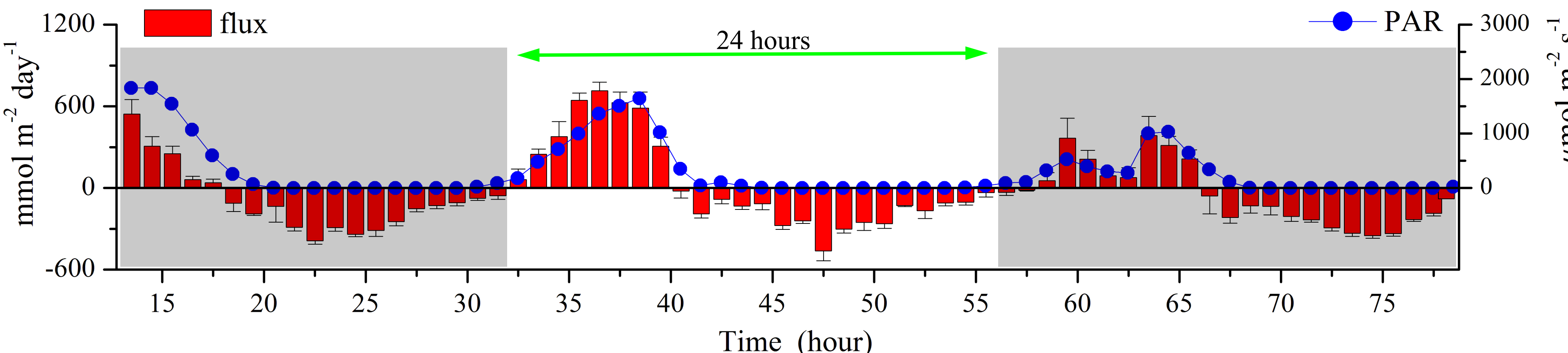
Peter Berg

Carbon sequestration in plant biomass

Measured by Aquatic Eddy Covariance



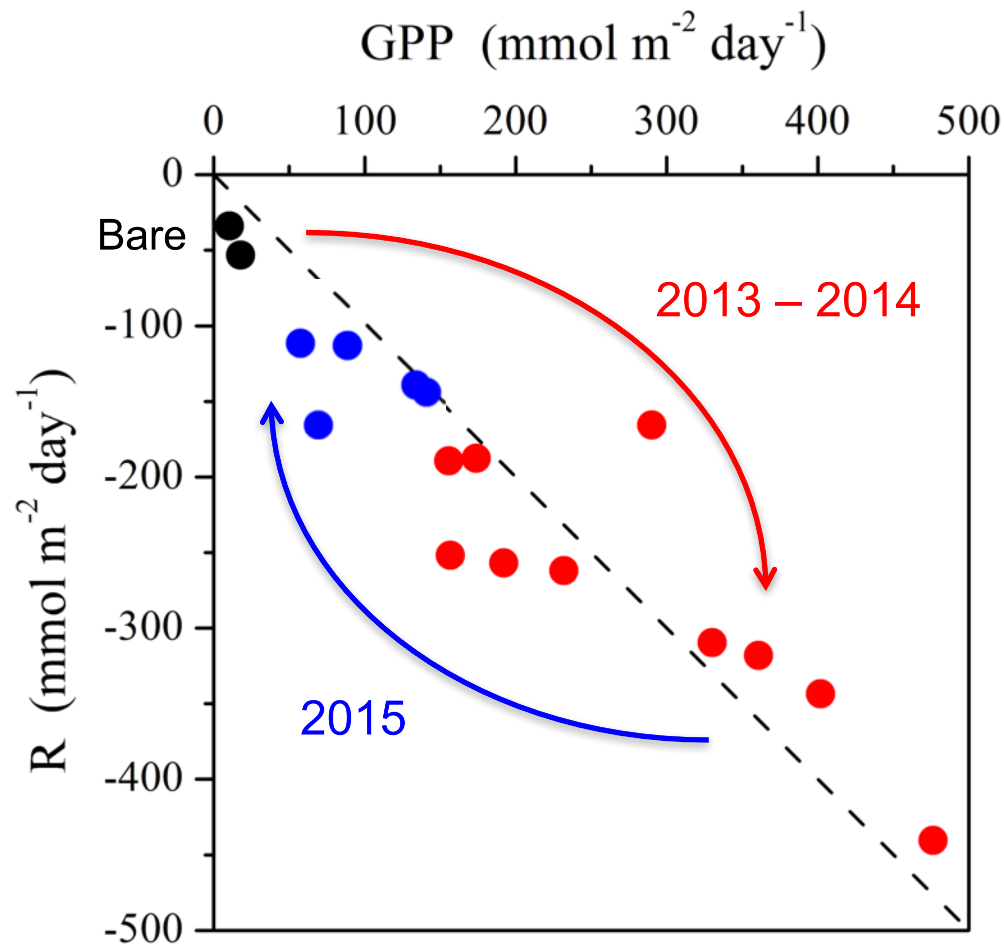




Delgard, Berg, McGlathery

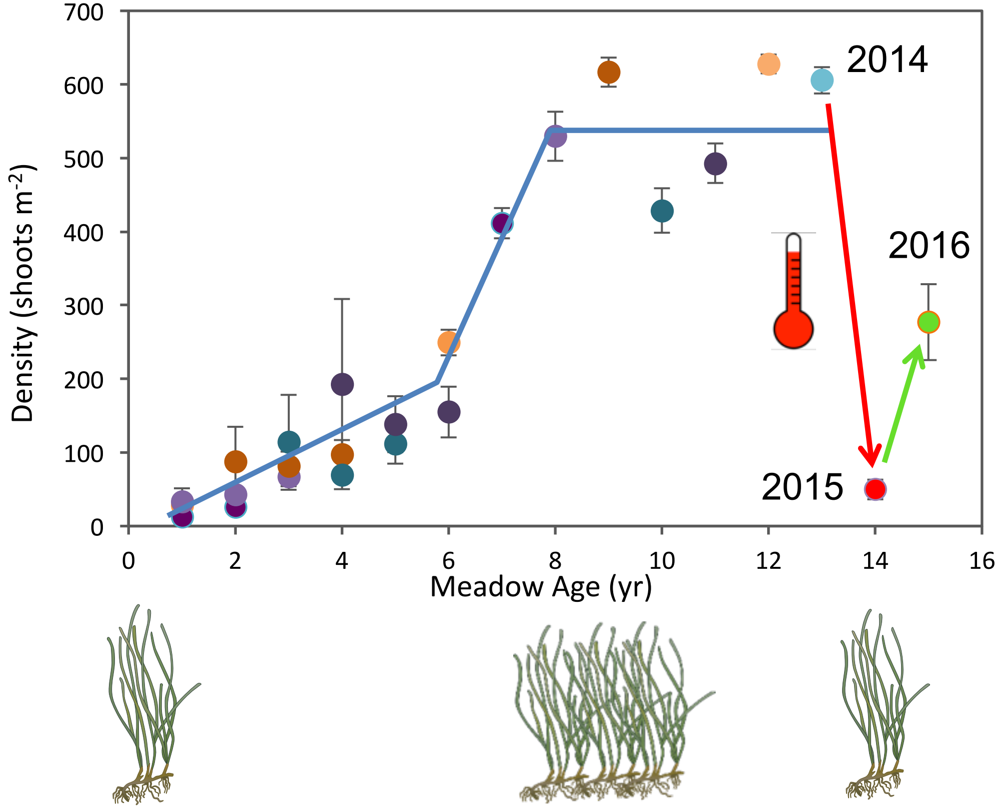
For each 24-hour period, calculate GPP and R

Changes in metabolism with restoration

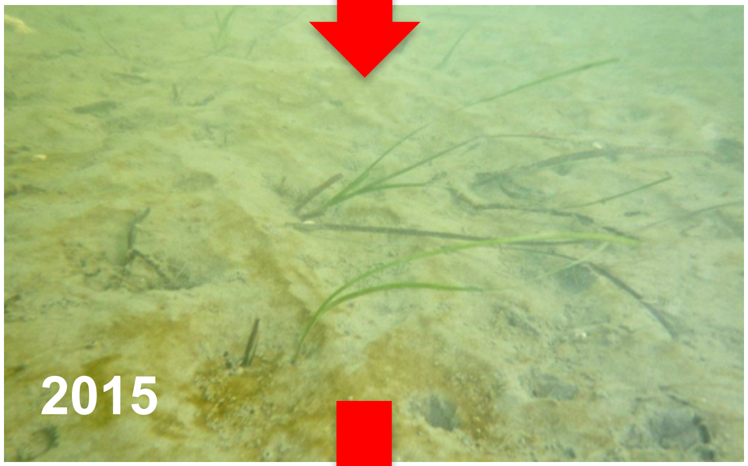


Summer

How resilient are these systems?

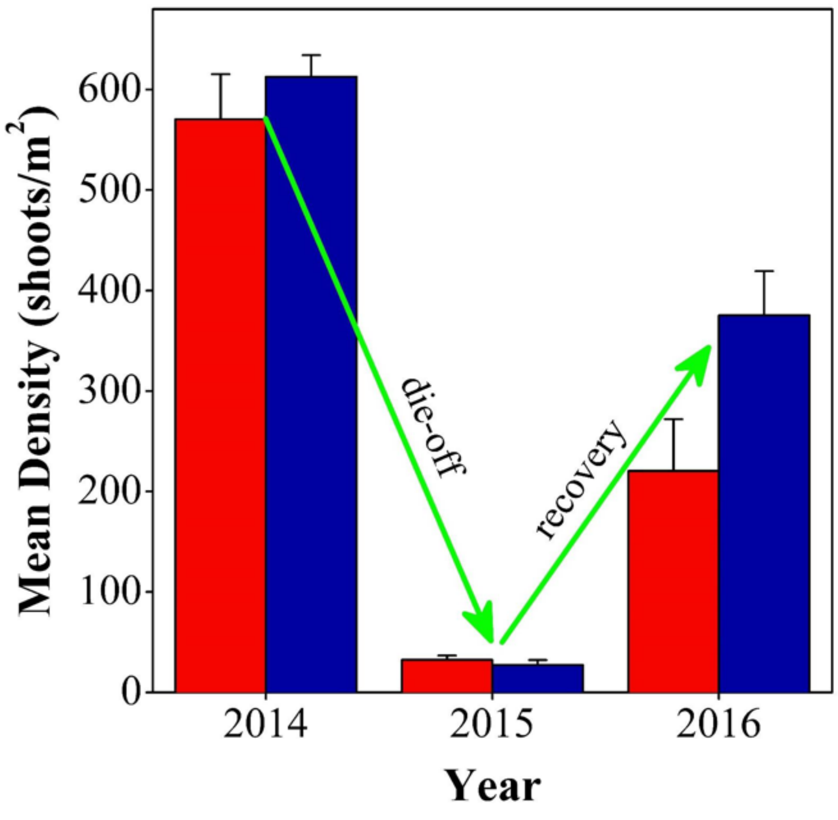


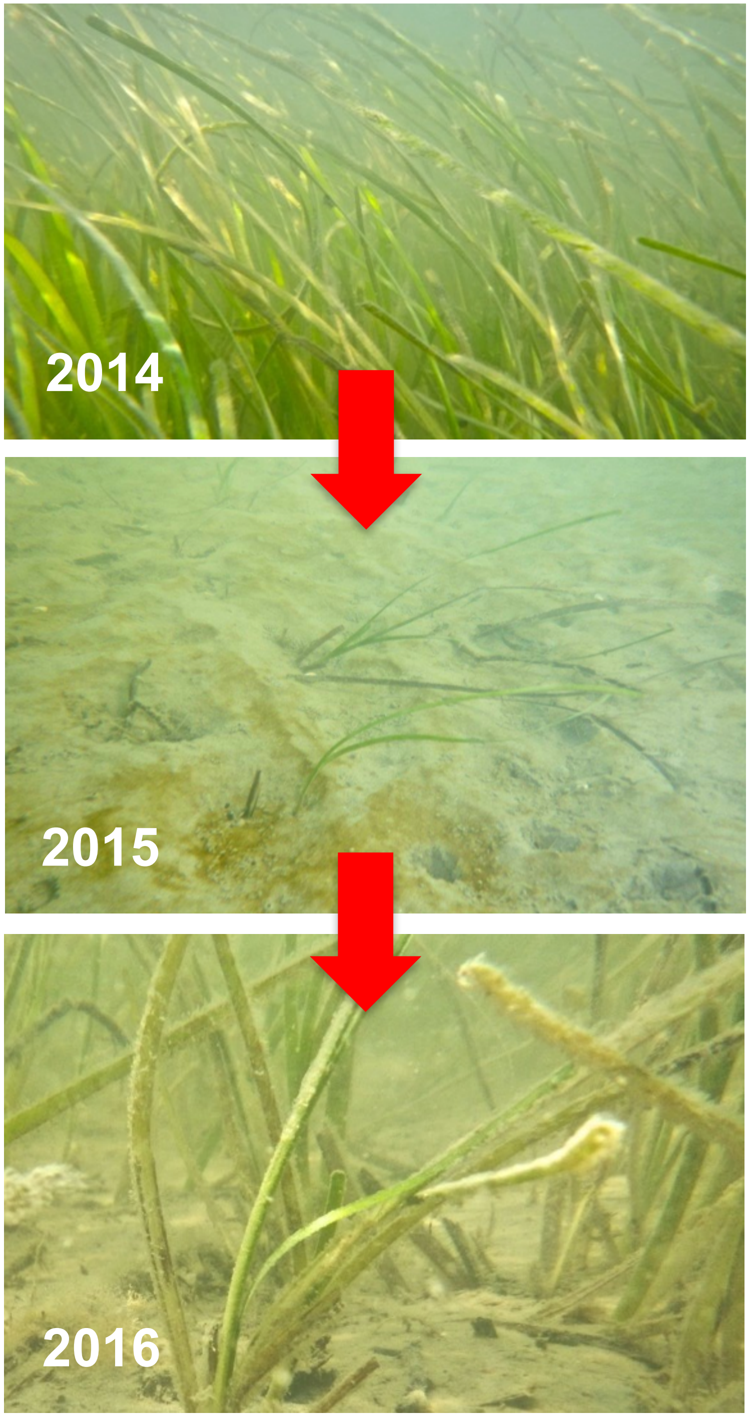
High temperatures cause dieback



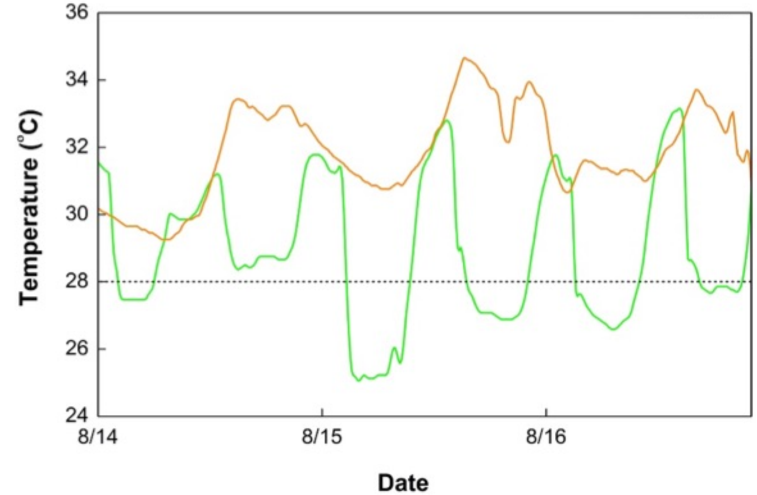
How resilient are these systems?

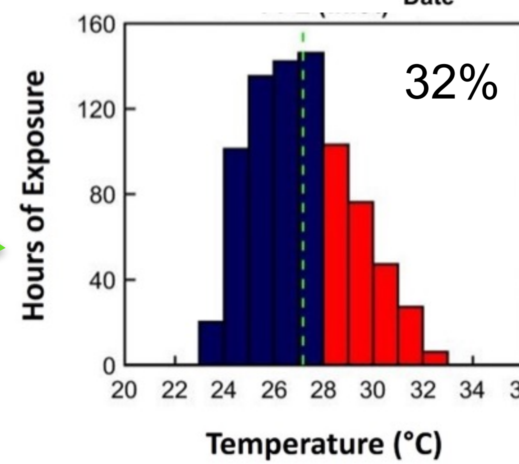
Rate of recovery varies spatially

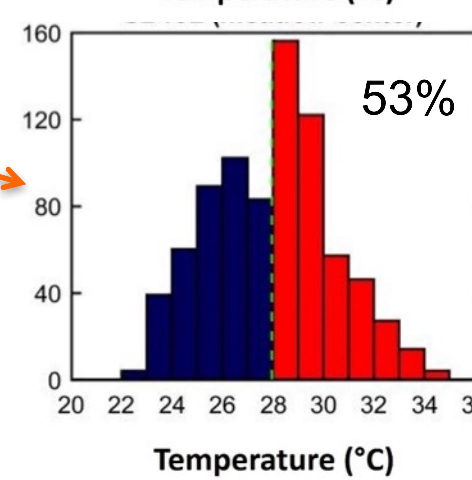




Temperature also drives recovery



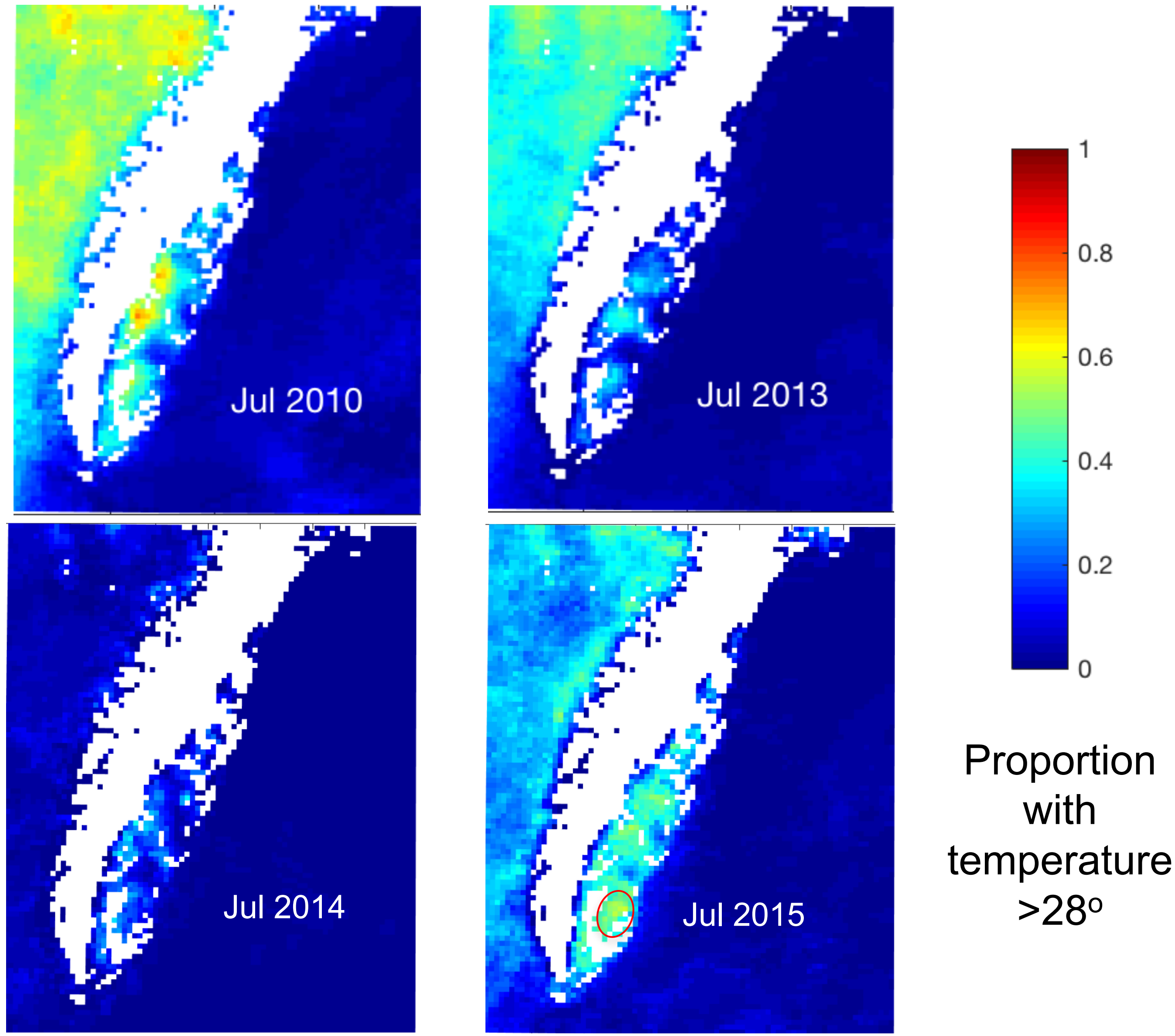




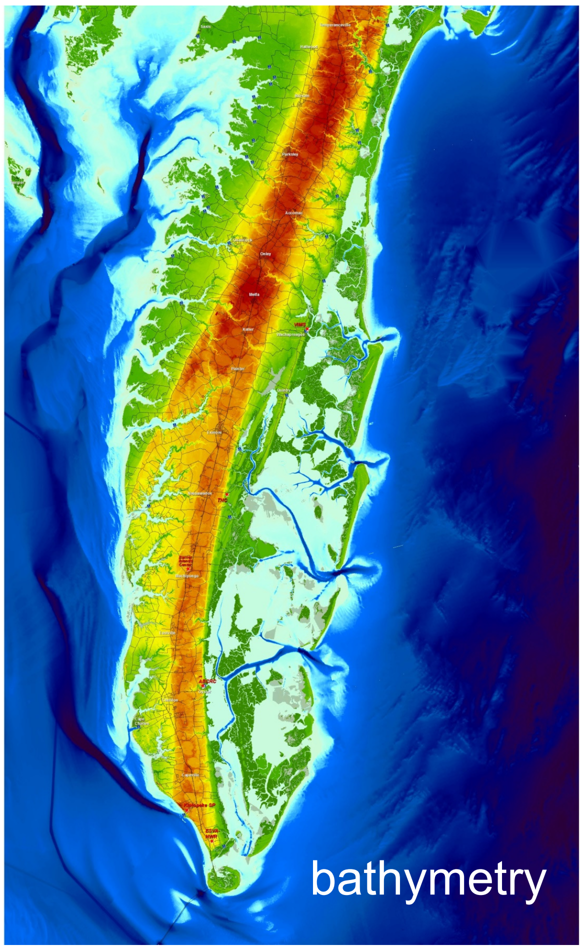
28 ^{o}C is maximum temperature threshold

High temperatures cause dieback

In 2105 temperatures exceeded 28 ^{o}C threshold 50% of the time



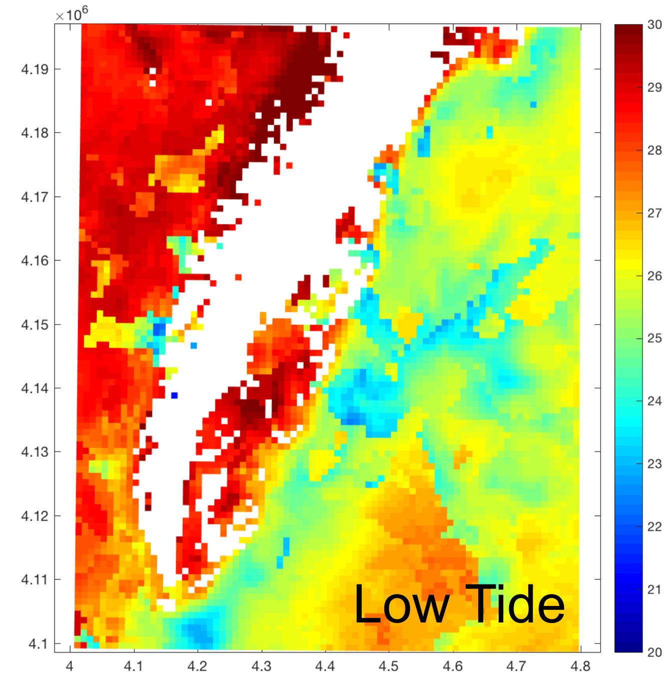
High tides relieve temperature stress

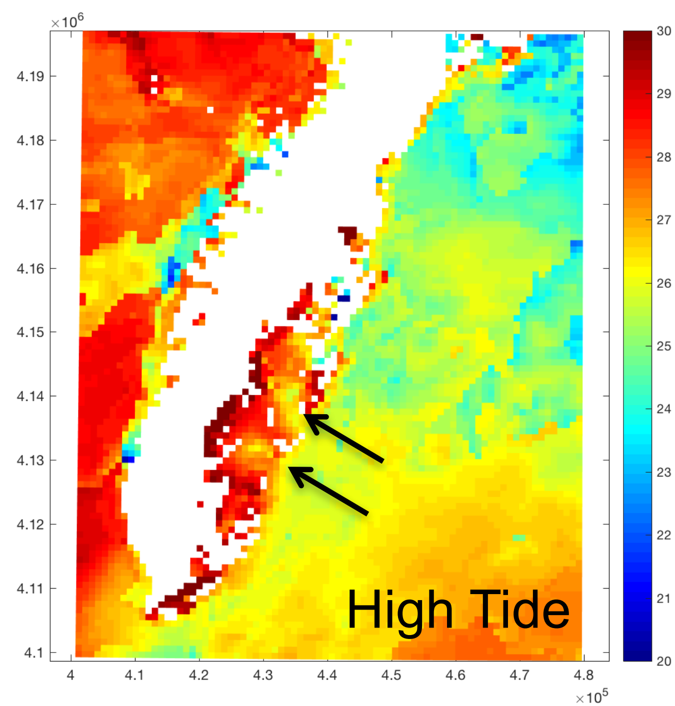


High flushing,
Short
residence time

+

Higher resilience





VCR contributions to blue carbon

- Stocks and sequestration returned within decade
- Temperature drives resilience and recovery
- Can provide guidance for management

LTER has unique capability to provide answers

- Combine long-term data with process studies to understand mechanisms
- Long-term trends and landscape scales needed to understand resilience
- Network of sites allows comparison to reveal generality

University of Virginia

VCS Voluntary Carbon Standard

VCR LTER