Temperate seagrass bed metabolism and carbon sequestration

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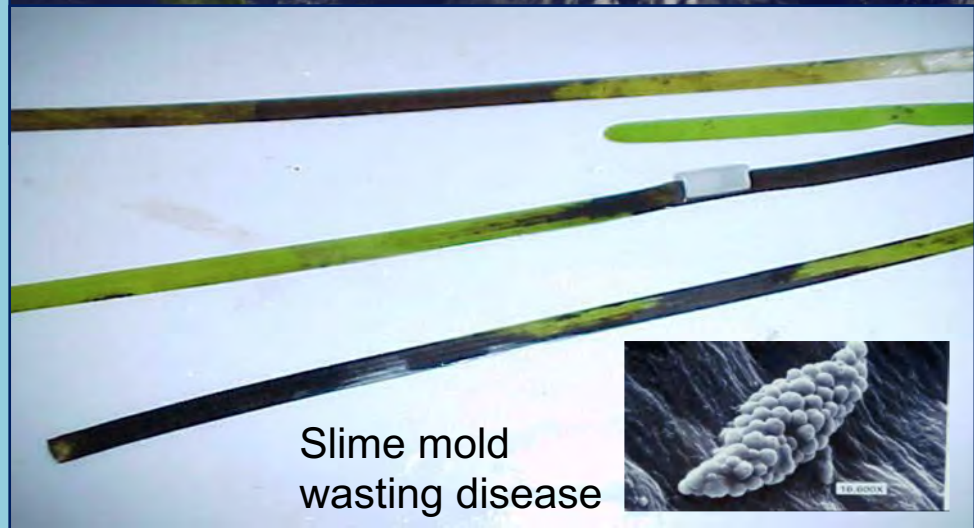
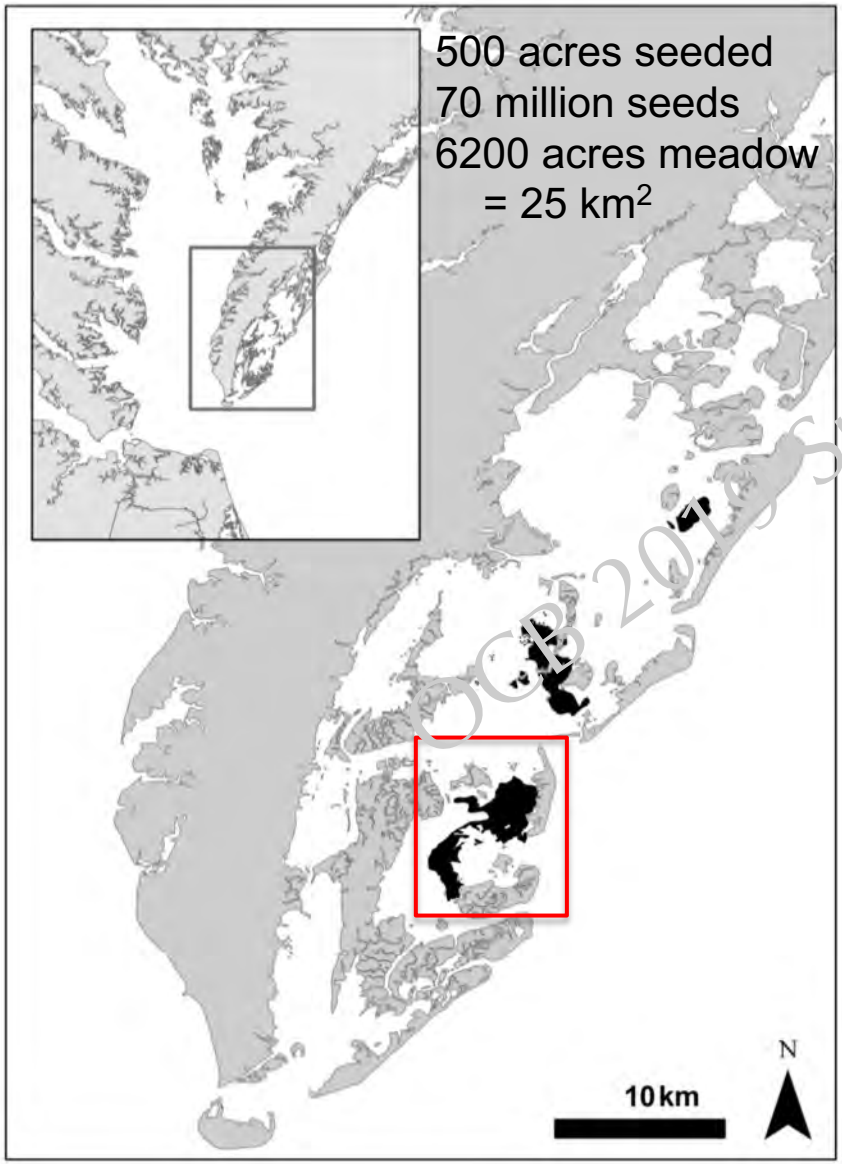
VCR loss due to pandemic wasting disease and “Great Storm” of 1933



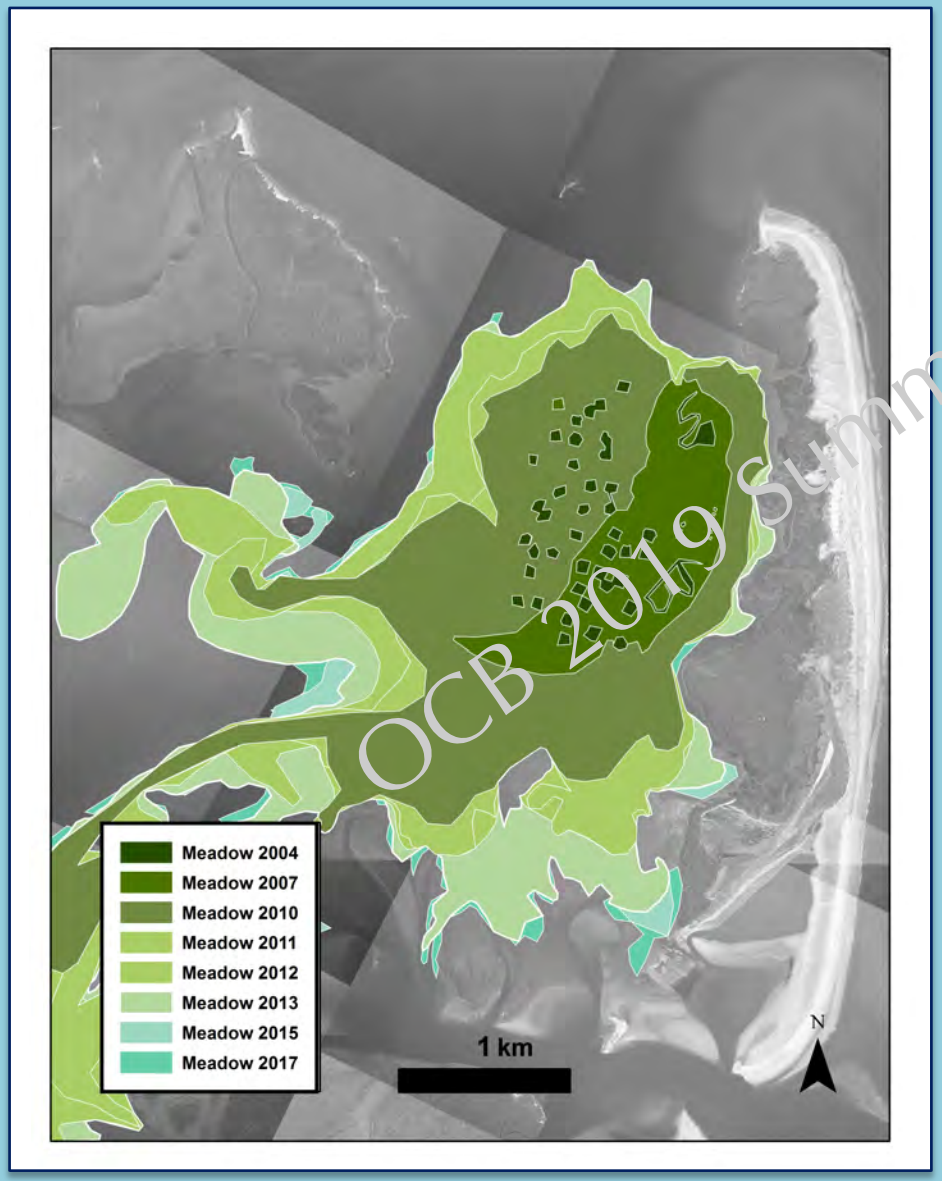
Slime mold wasting disease

Landscape-scale restoration



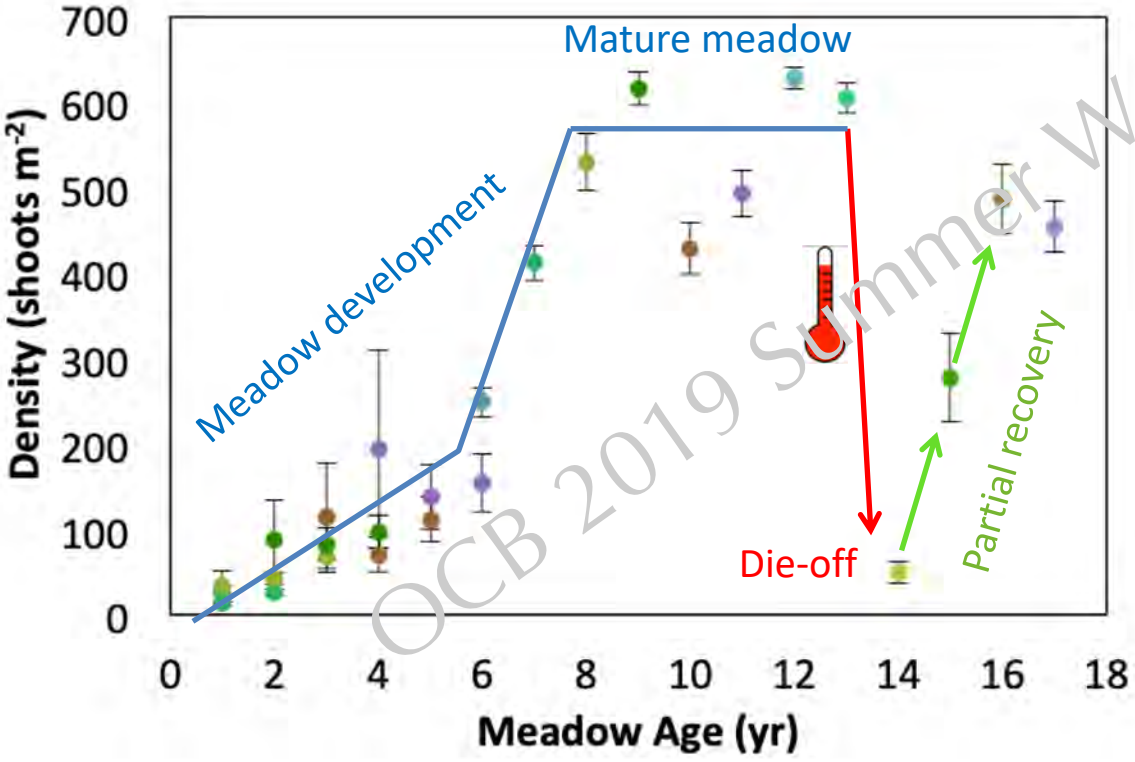
Orth Lab, VIMS; The Nature Conservancy

Landscape-scale restoration

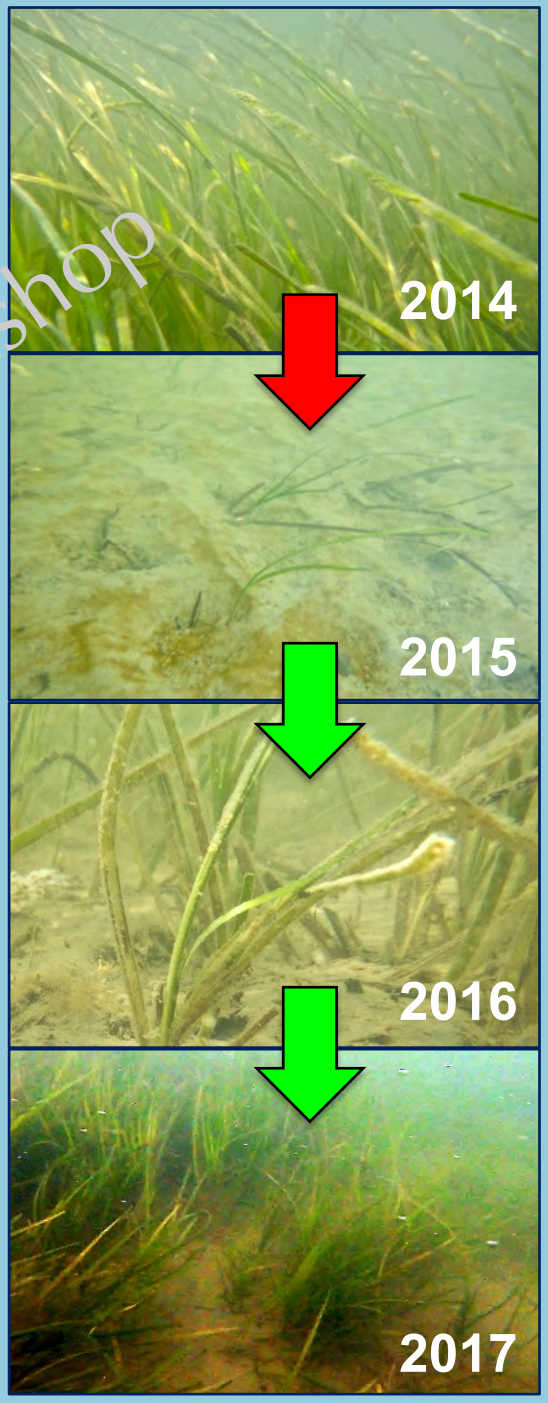


http://web.vims.edu/bio/sav/

Long-term seagrass study



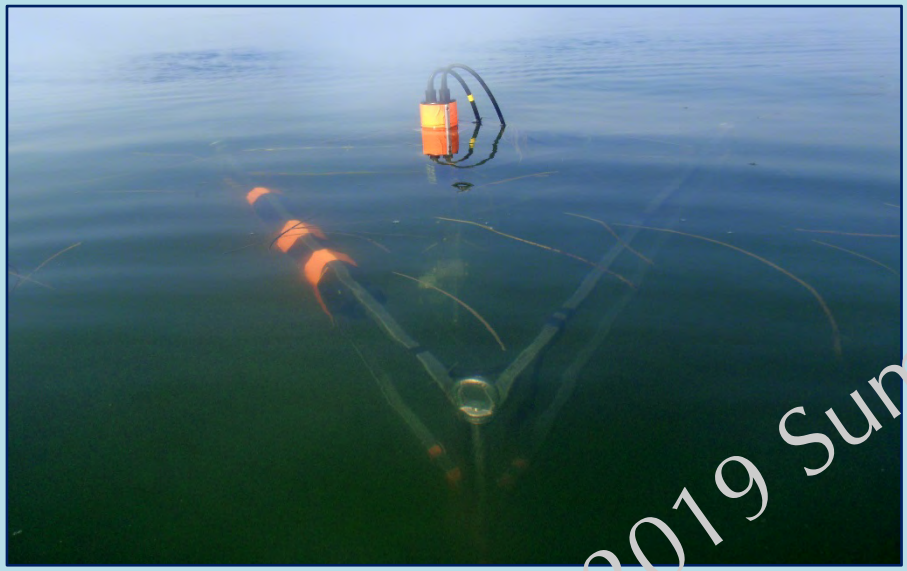
High temperatures in June 2015 caused large-scale die-off

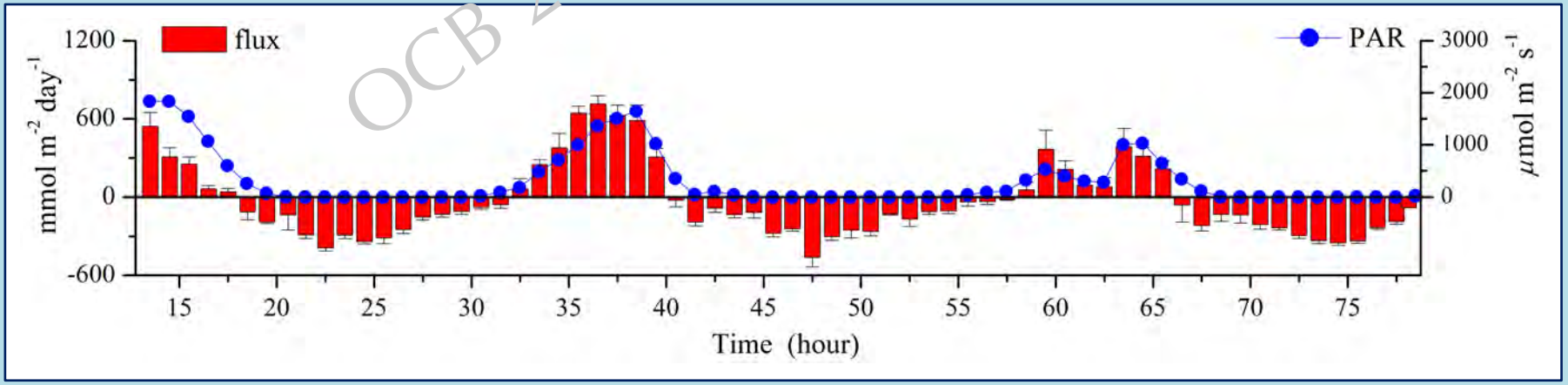


Aquatic eddy covariance technique

Photo: AWI Sea Ice Physics group

Aquatic eddy covariance technique



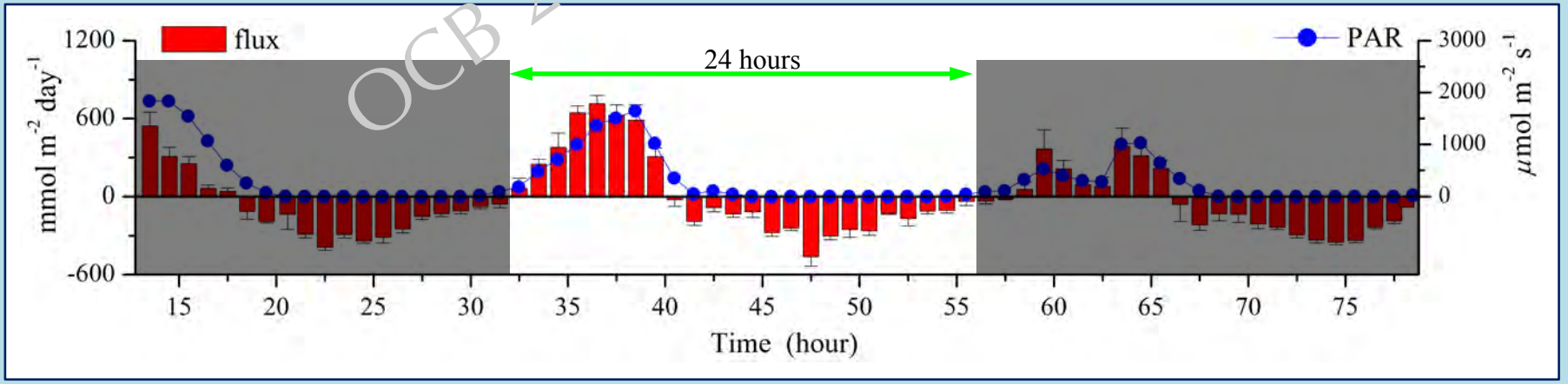


Berger et al. (*in review*)

Aquatic eddy covariance technique

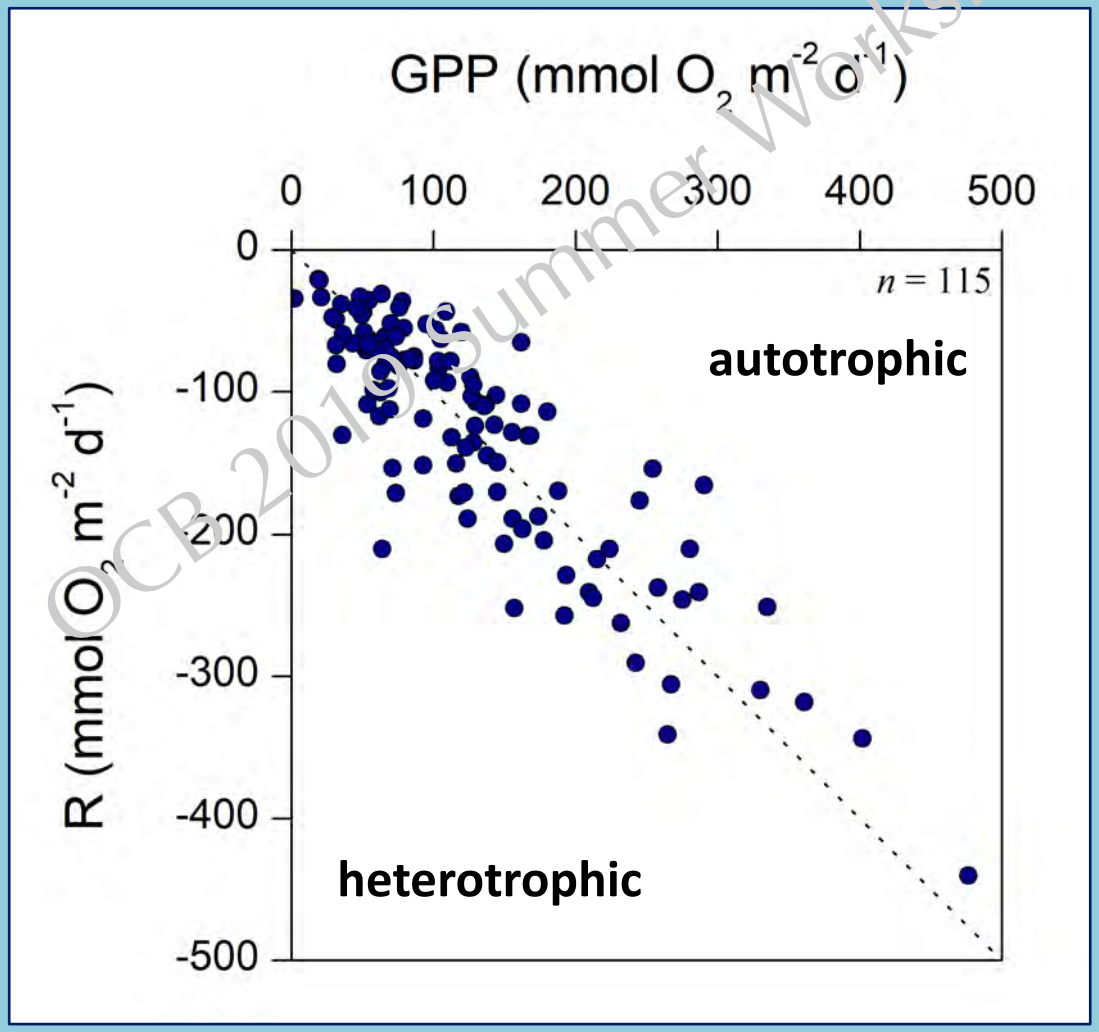
- $R = \frac{1}{24}\left(\sum flux_{dark} + \frac{\sum flux_{dark}}{h_{dark}} h_{light}\right)$
- $GPP = -\frac{1}{24}\left(\sum flux_{light} + \frac{|\sum flux_{dark}|}{h_{dark}} h_{light}\right)$

Hume et al. (2011) L&O



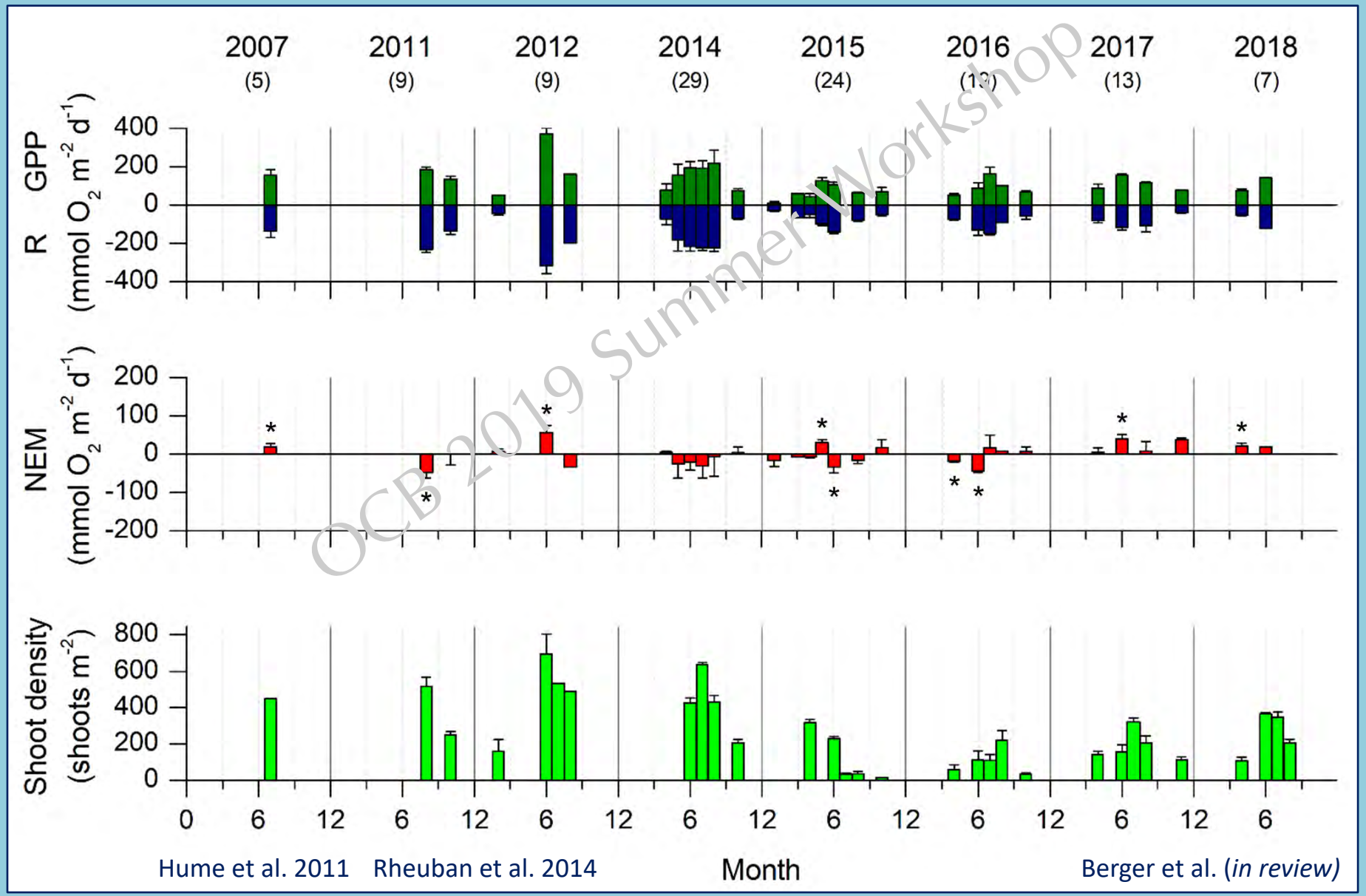
Berger et al. (*in review*)

Highly dynamic, but overall balanced seagrass metabolism

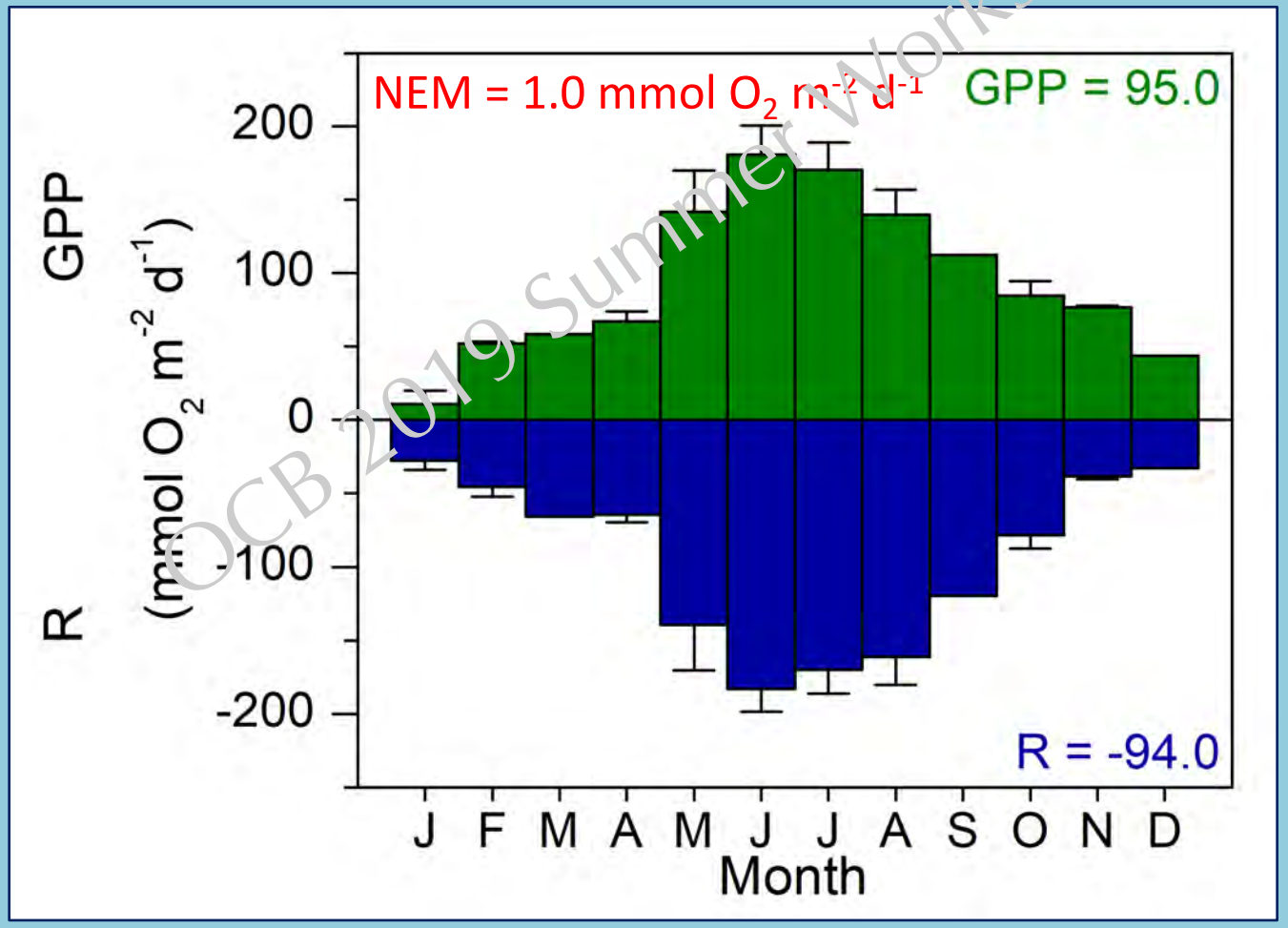


Berger et al. (*in review)*

Long-term record of seagrass metabolism

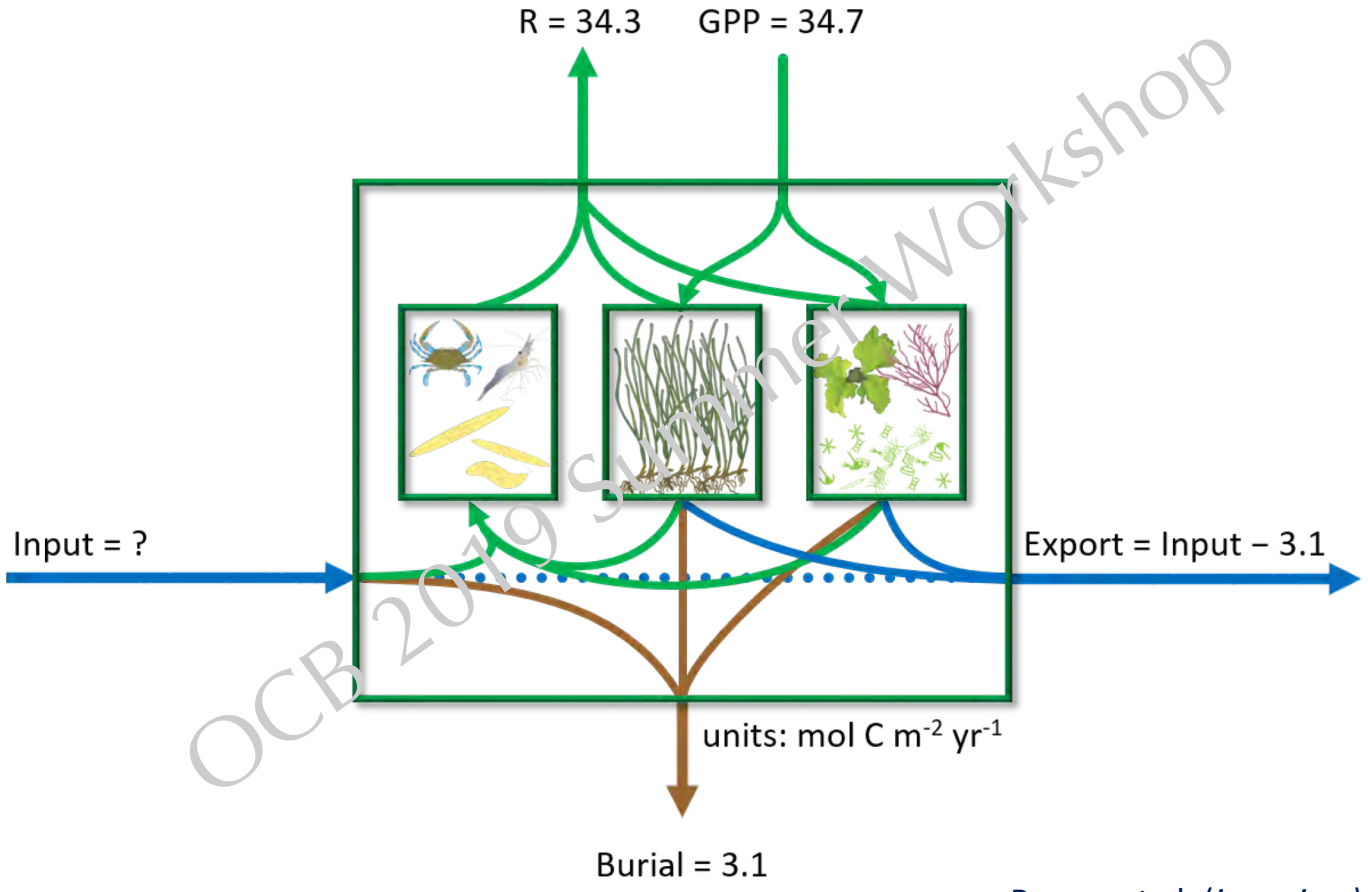


Highly dynamic, but overall balanced seagrass metabolism

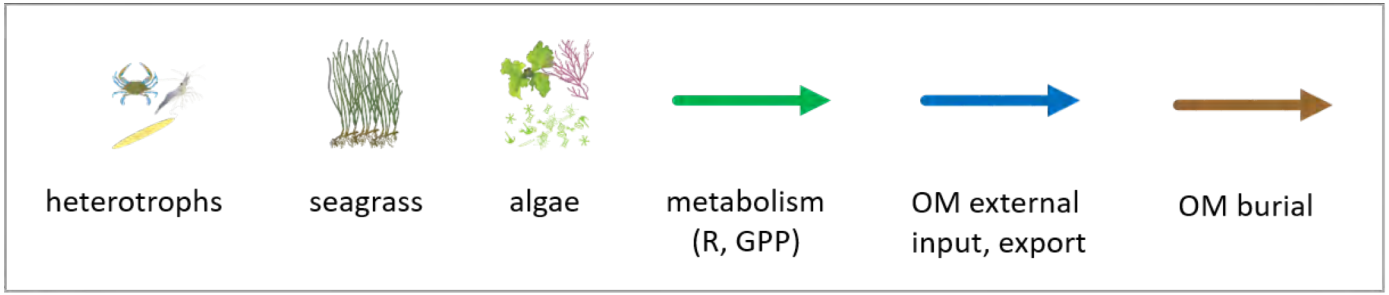


Berger et al. (*in review)*

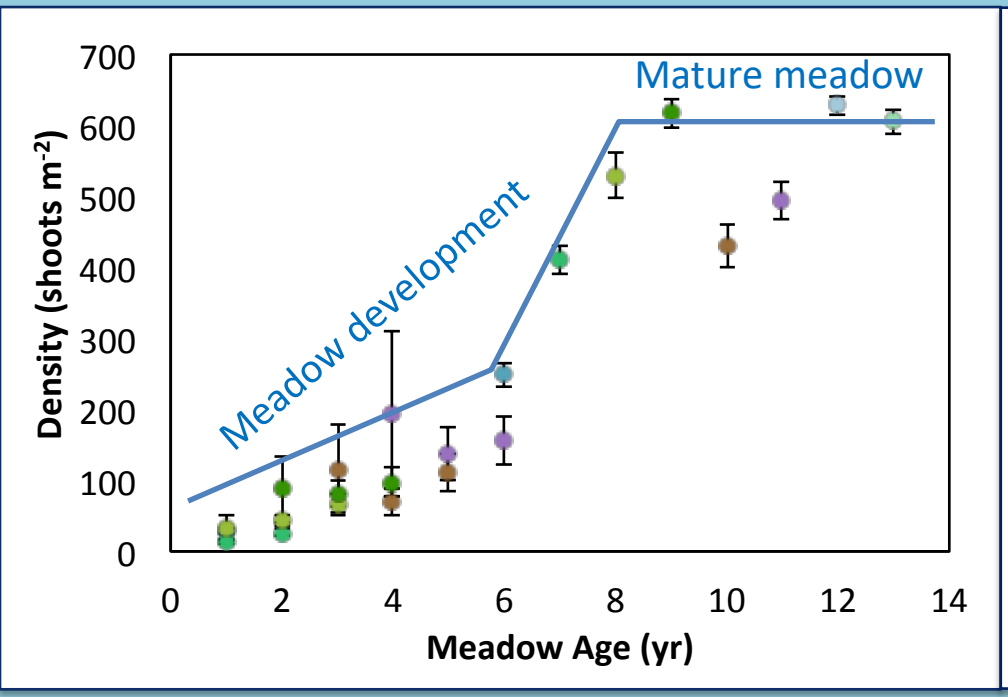
Annual carbon budget

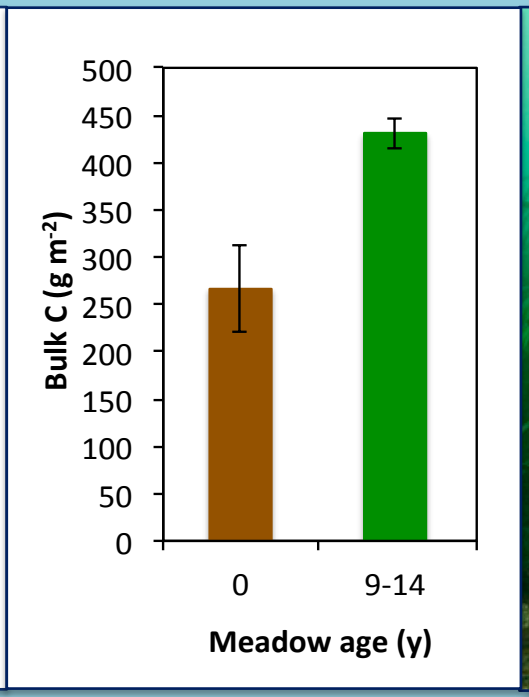


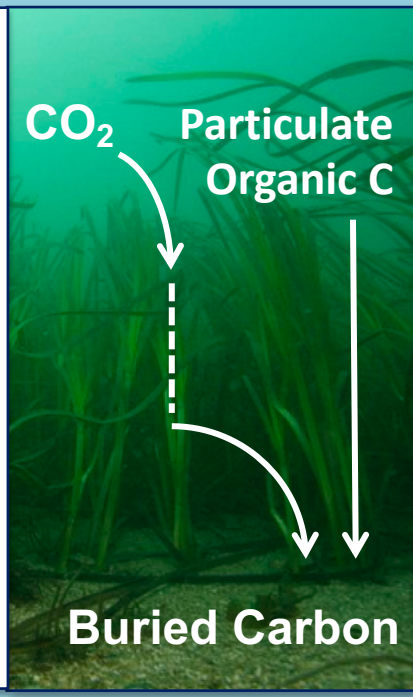
Berger et al. (*in review*)



Restoration reinstates C storage in sediments



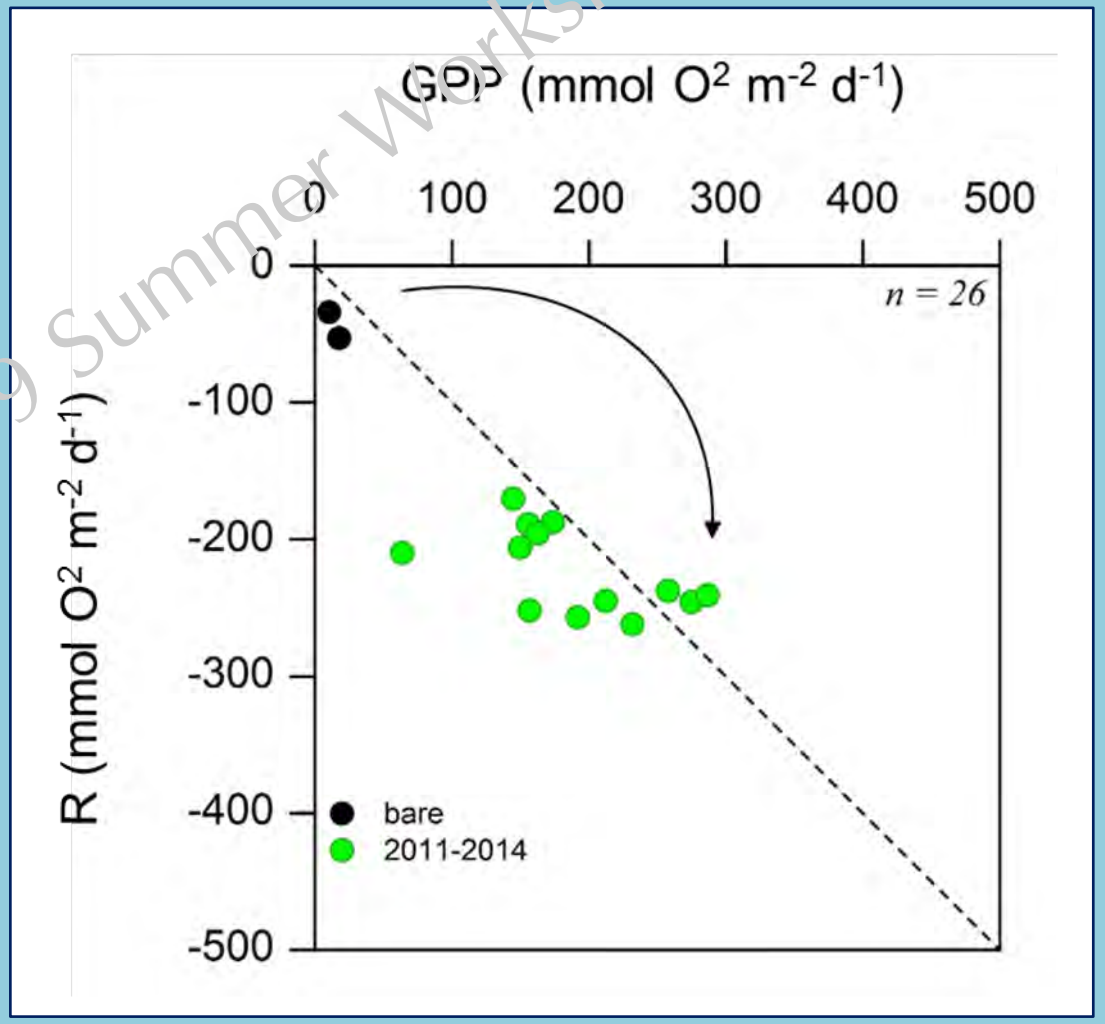




- Within 12 years, C burial within range of natural systems
- ~half seagrass C; half algal C produced *in situ*

Greiner et al. 2013, Greiner et al. 2016, Oreska et al. 2017a,b

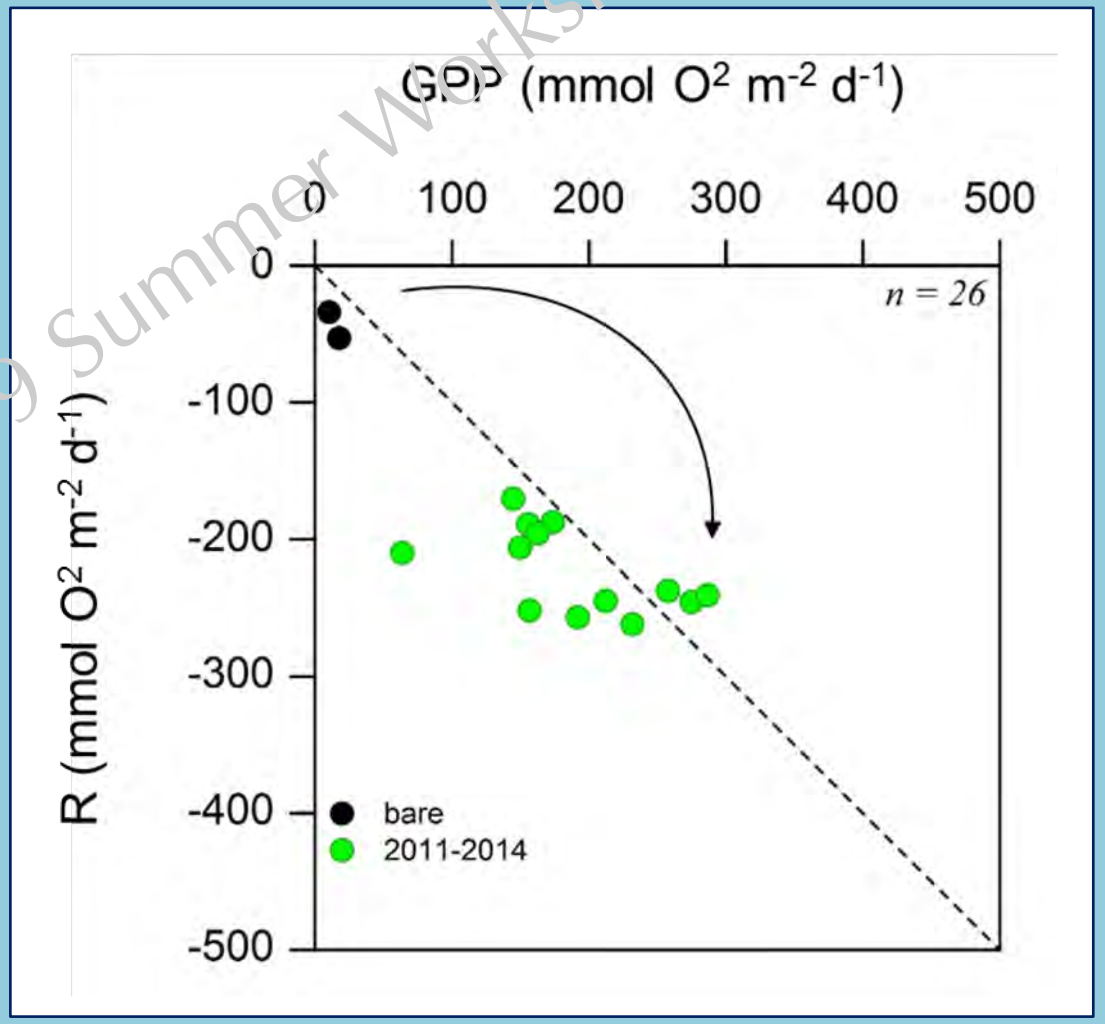
Restoration reinstates C sequestration in plant biomass



Berger et al. (*in review)*

Disturbance caused a shift in trophic status

Trophic status: balanced



Berger et al. (*in review)*

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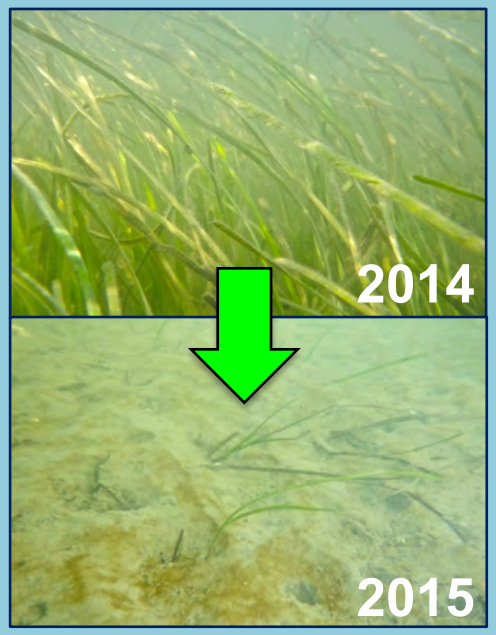
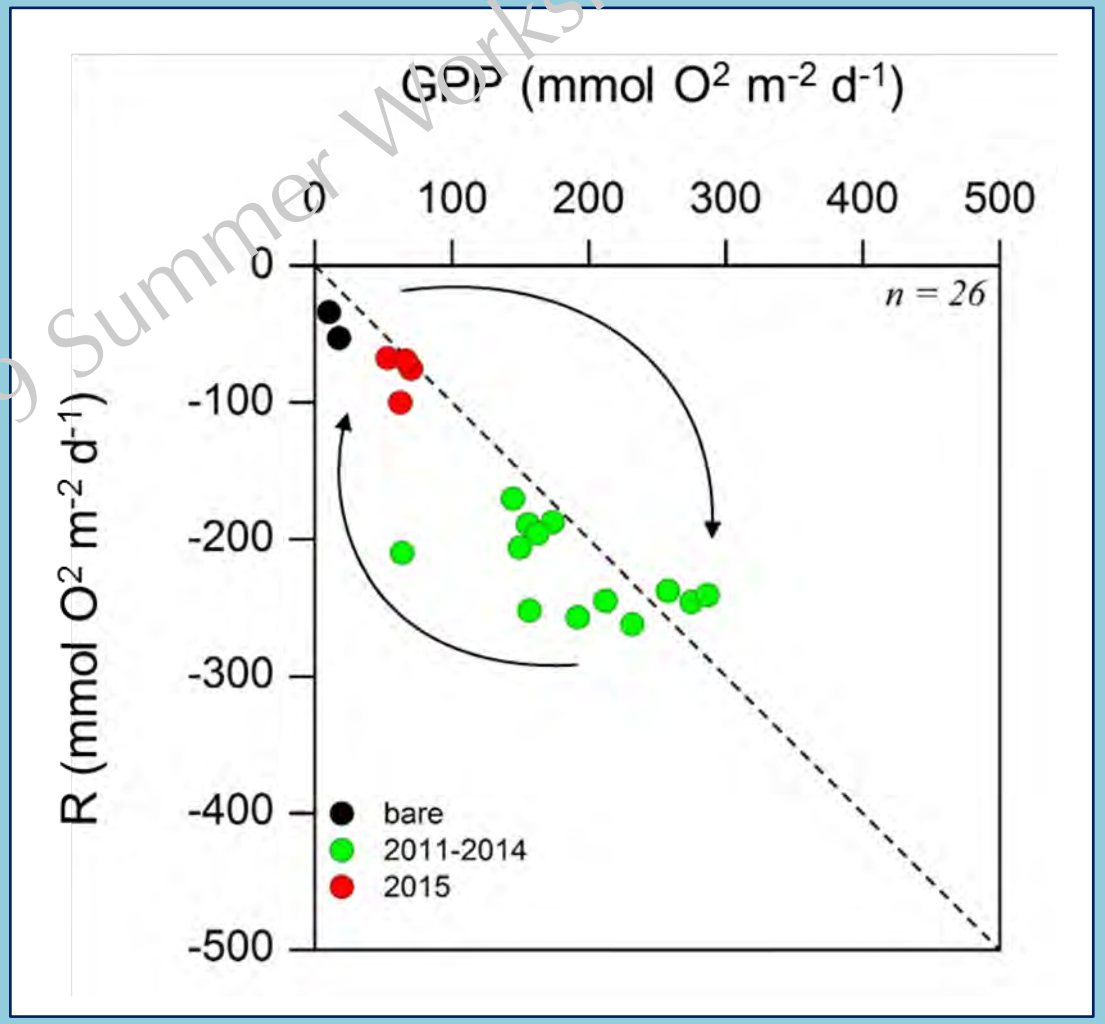
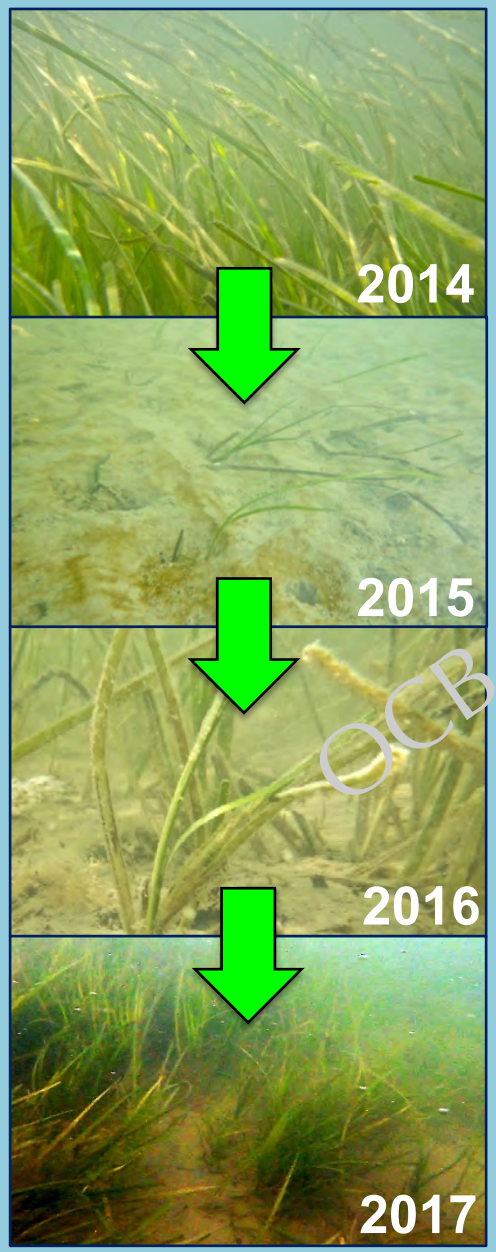


Trophic status: heterotrophic

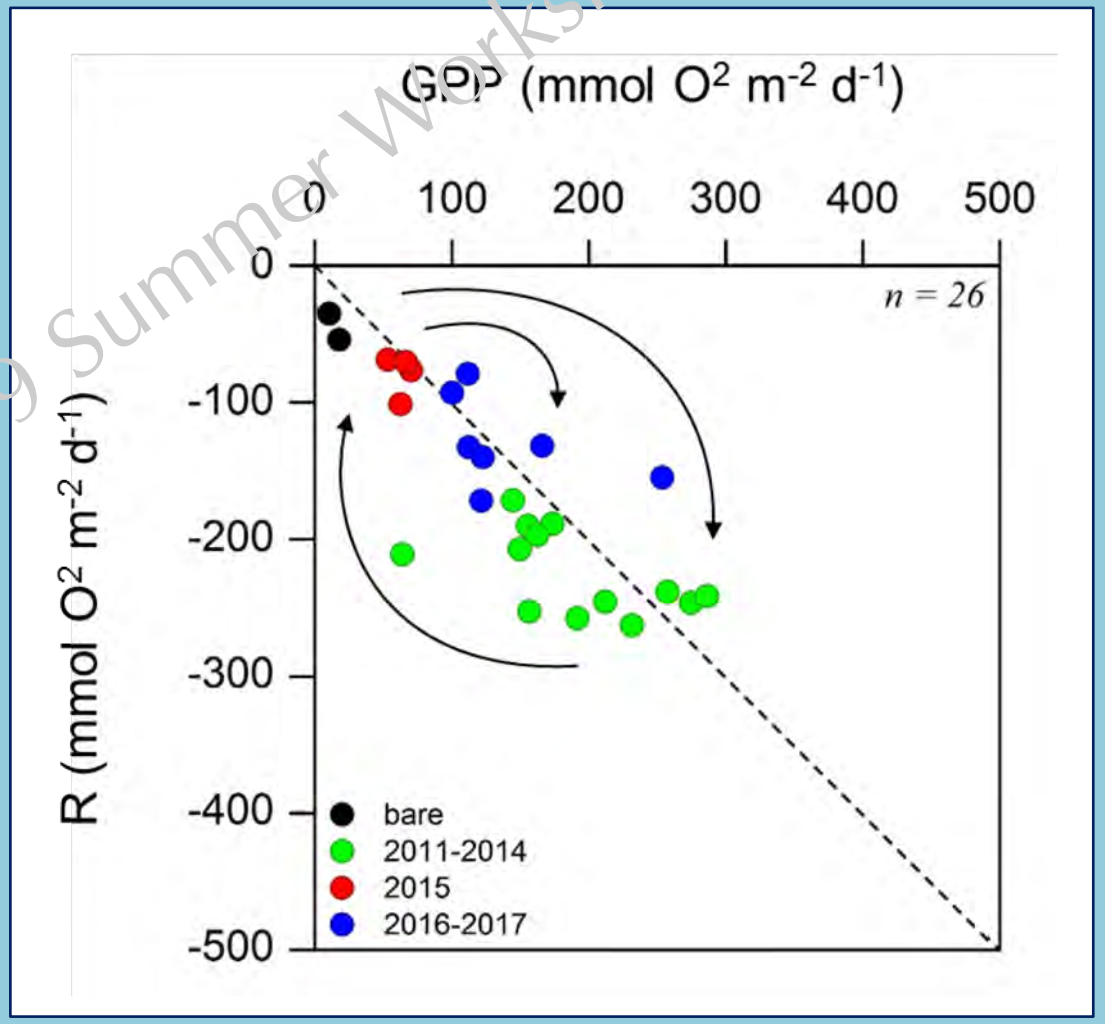


Berger et al. (*in review)*

Disturbance caused a shift in trophic status

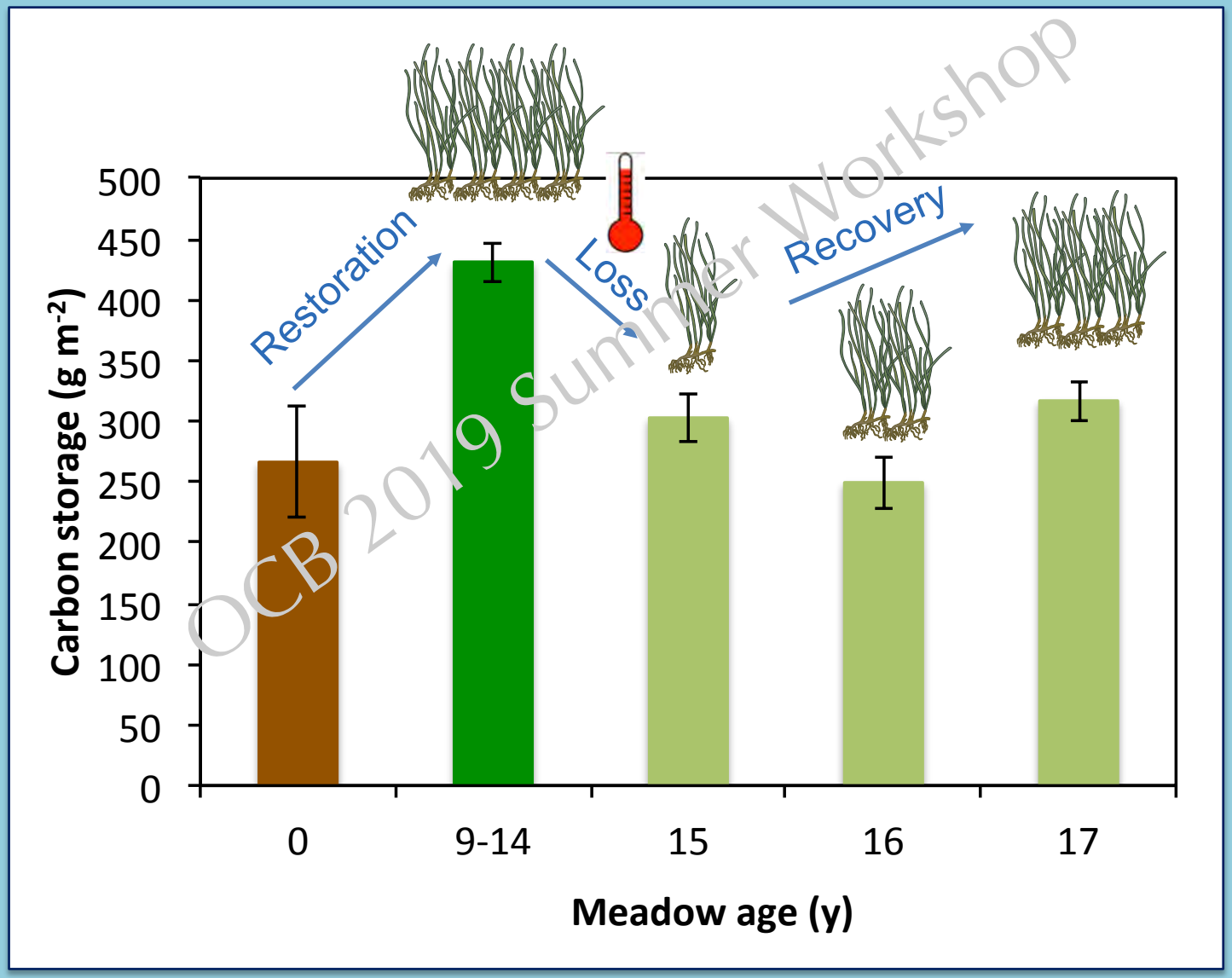


Trophic status: autotrophic

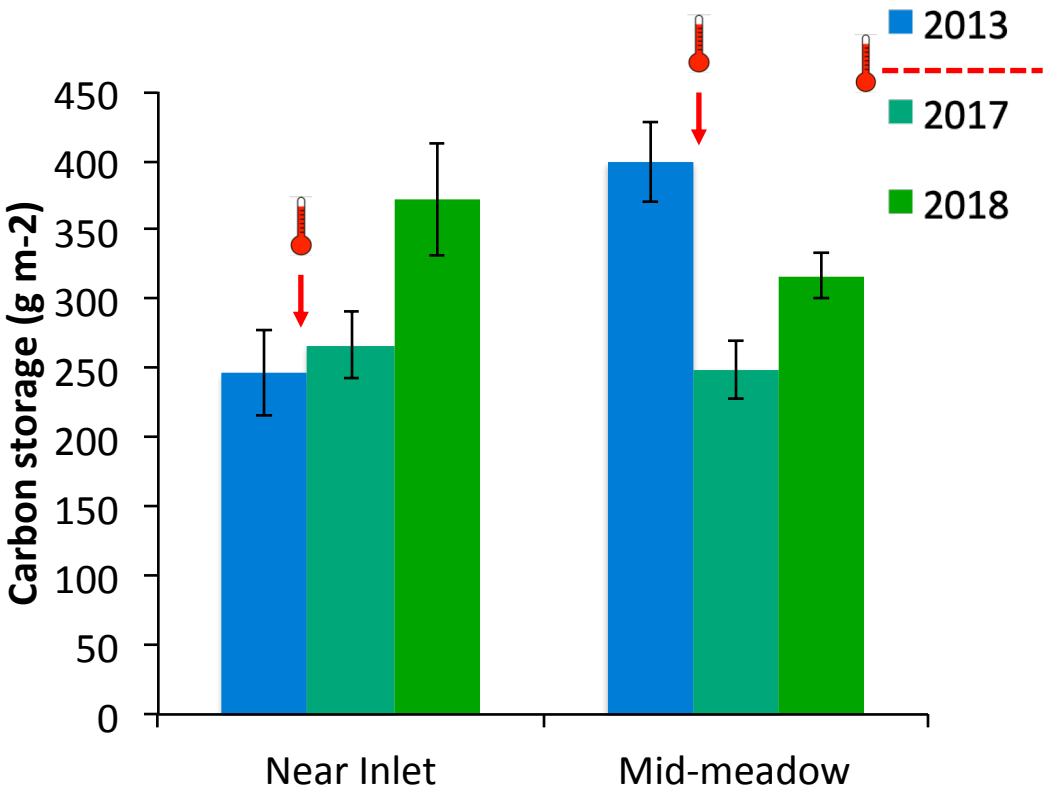


Berger et al. (*in review*)

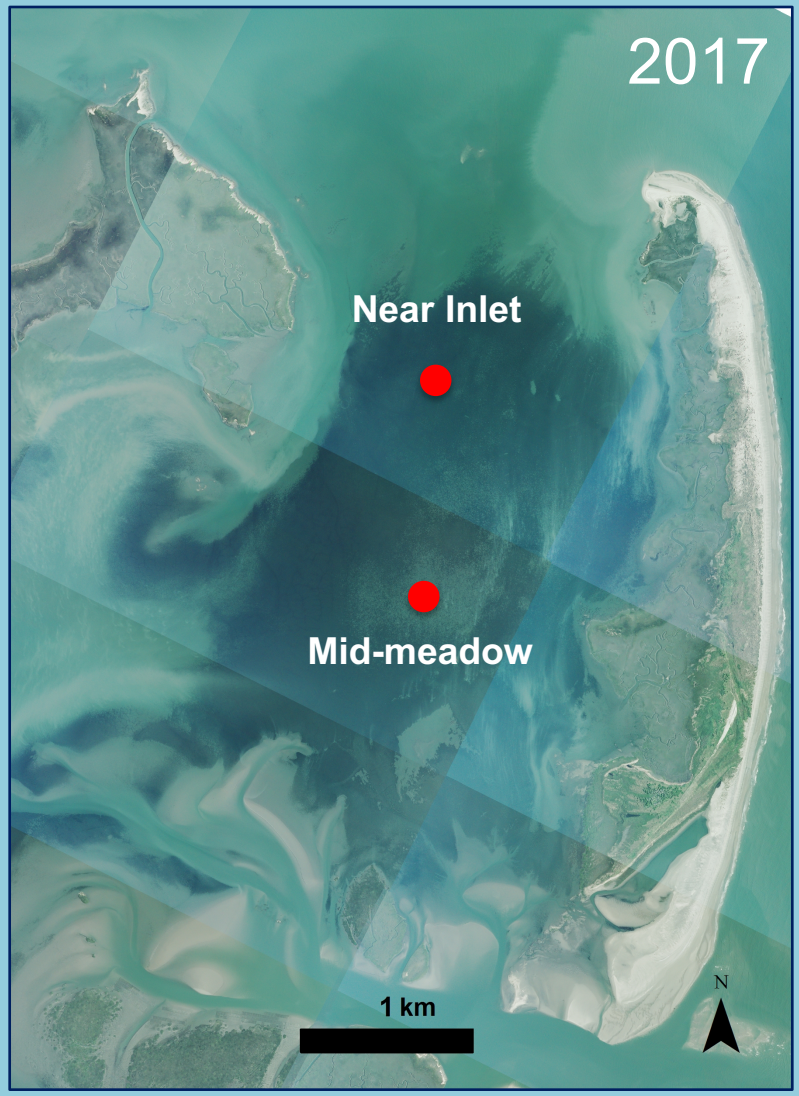
Seagrass loss affects C storage



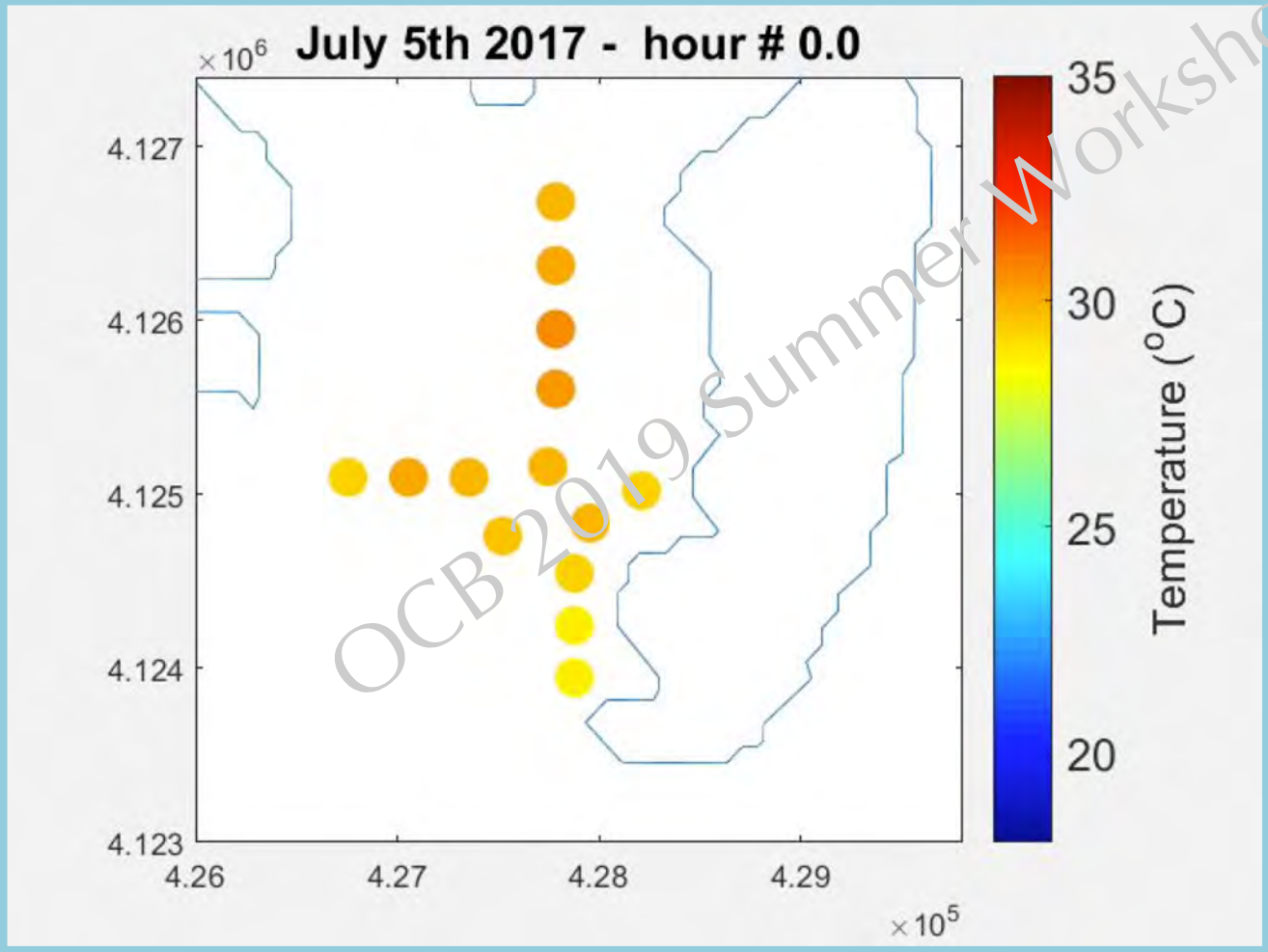
Landscape-scale variation affects C loss



No carbon loss near inlet



Link to exposure to temperature stress



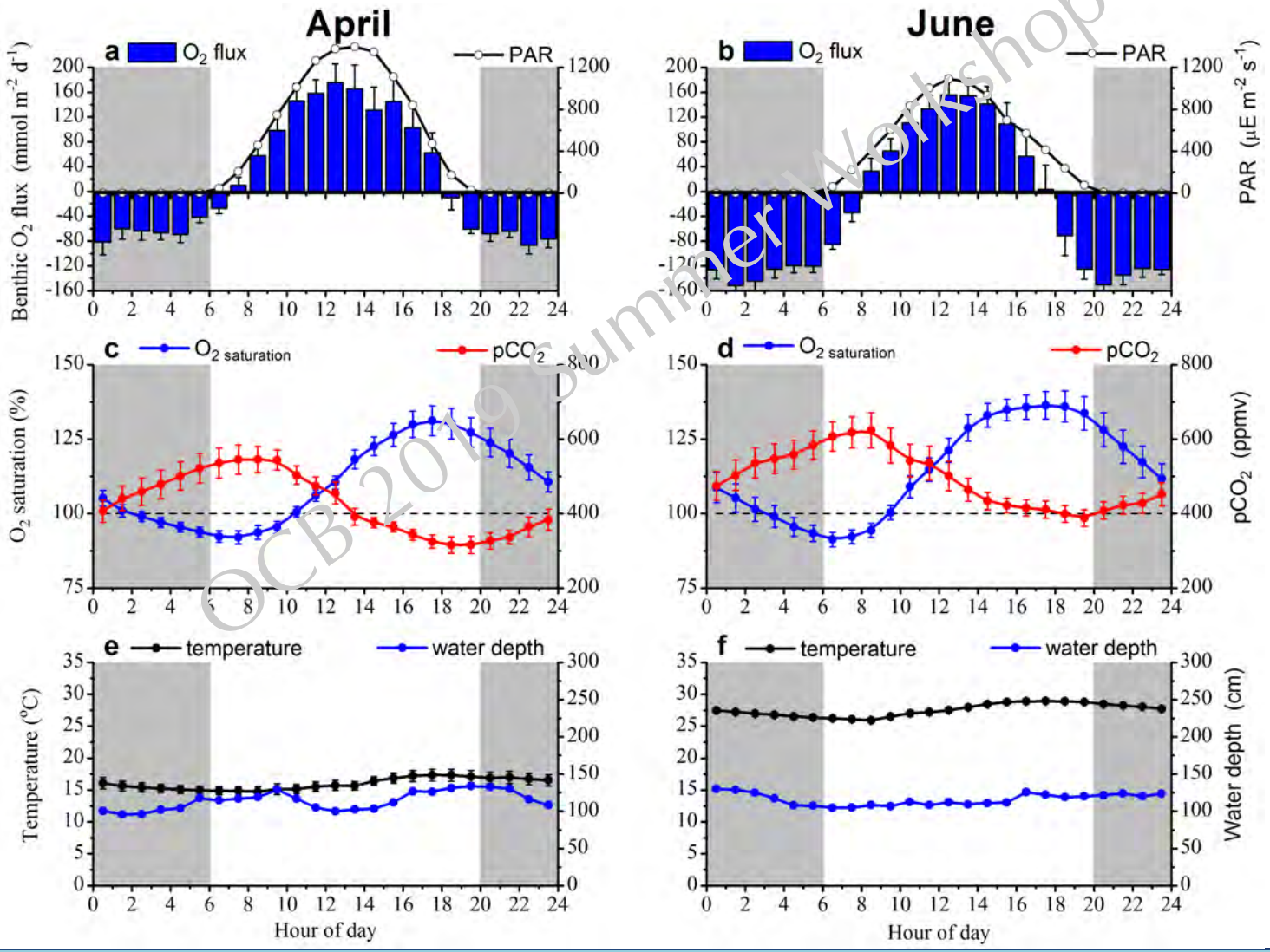
High flushing, Short residence time

+

Higher resilience

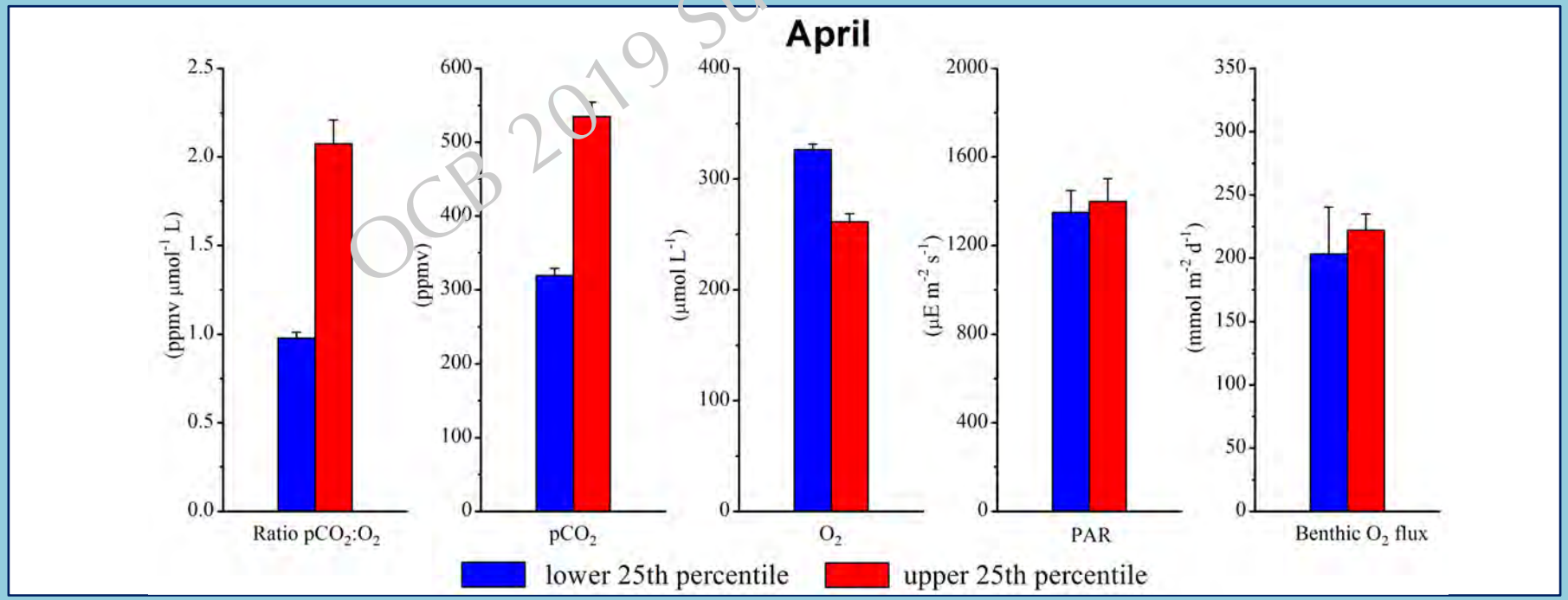
Berger et al. (*in prep)*

Limitation by low CO_2 or high O_2?



Berg et al. (2019) L&O

No limitation by low CO_2 or high O_2



Berg et al. (2019) L&O

Conclusions

- Restoration reinstates C storage and sequestration
- Sediment C stocks are vulnerable to shoot losses from temperature stress
- Seagrass loss and recovery causes shifts in trophic status, but the meadow is metabolically balanced overall → most C retention = in sediment
- Meadows are resilient at the landscape scale
- No stimulation of photosynthesis at high CO_2 concentrations

Dieback and C loss is patchy at plot scale