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Extreme pCO₂ Variability in a Macrotidal Eelgrass Meadow Mediated by Tidal and Diurnal Cycles

Brooke Love

Western Washington University, brooke.love@wwu.edu

Colleen O'Brien

Eckerd College

Douglas A. Bulhuis

Padilla Bay National Estuarine Research Reserve (Agency : U.S.)

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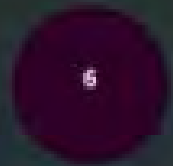
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Extreme pCO₂ Variability in a Macrotidal Eelgrass Meadow – Padilla Bay

Brooke Love, Colleen O'Brien, Doug Bulthuis, Nicole Burnett, Heath Bohlmann



Padilla Bay Eelgrass
pCO₂



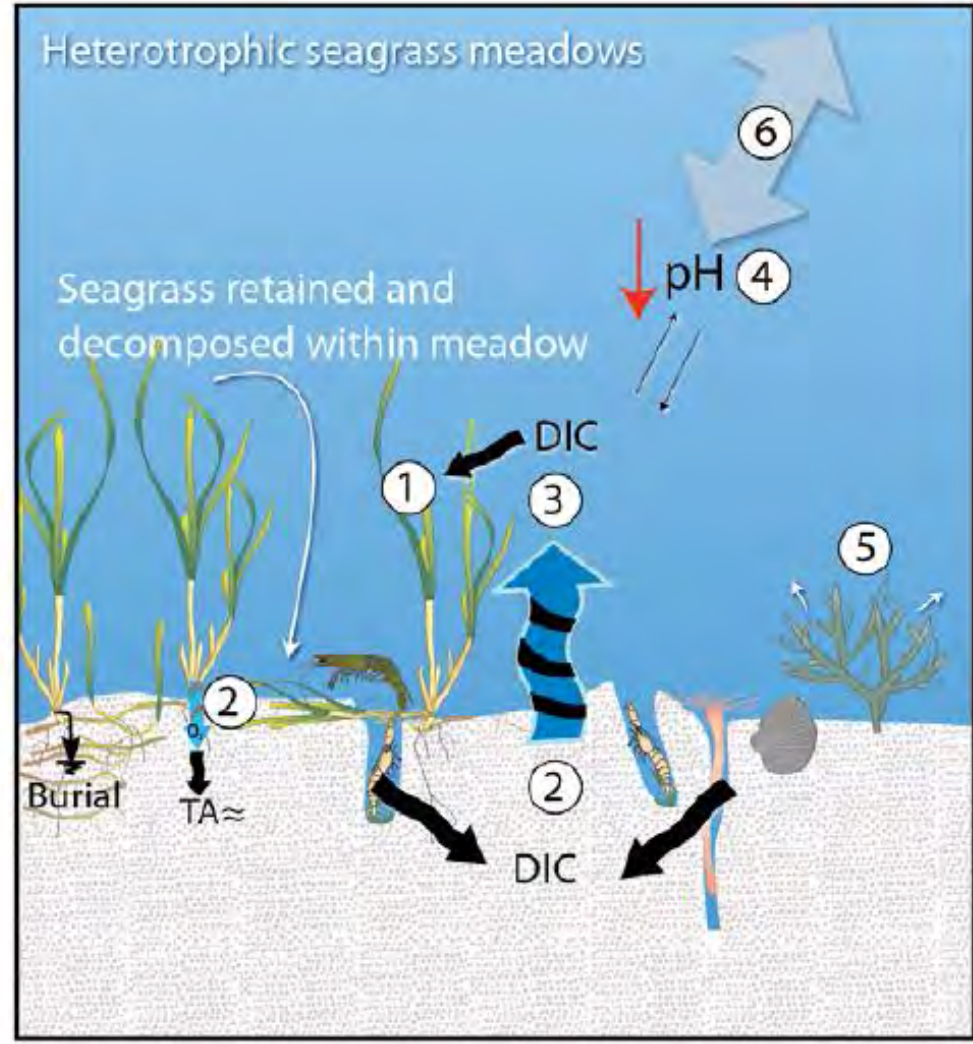
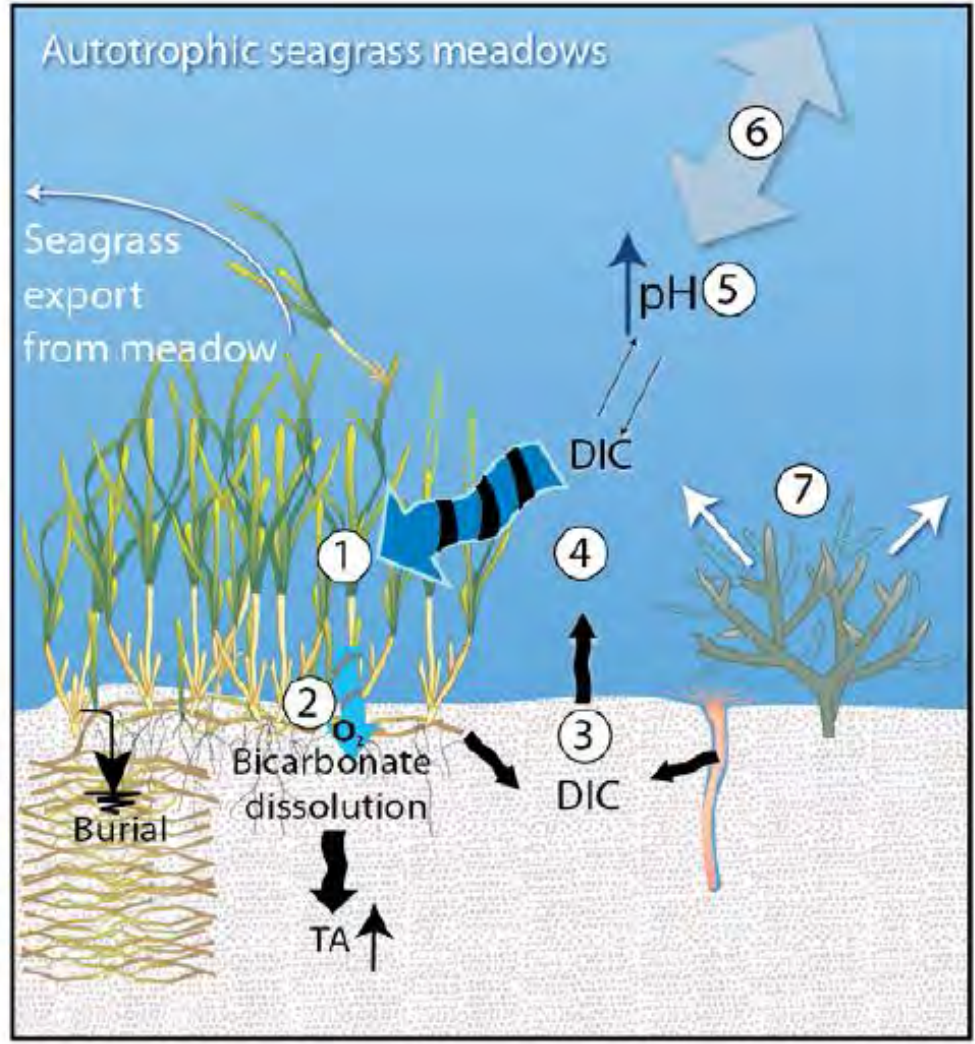
Google earth

49°32'32.15" N 122°52'07.45" W elev. -4 ft eye alt. 6592 ft

Two reasons that we might care about pCO₂ in eel grass meadows:

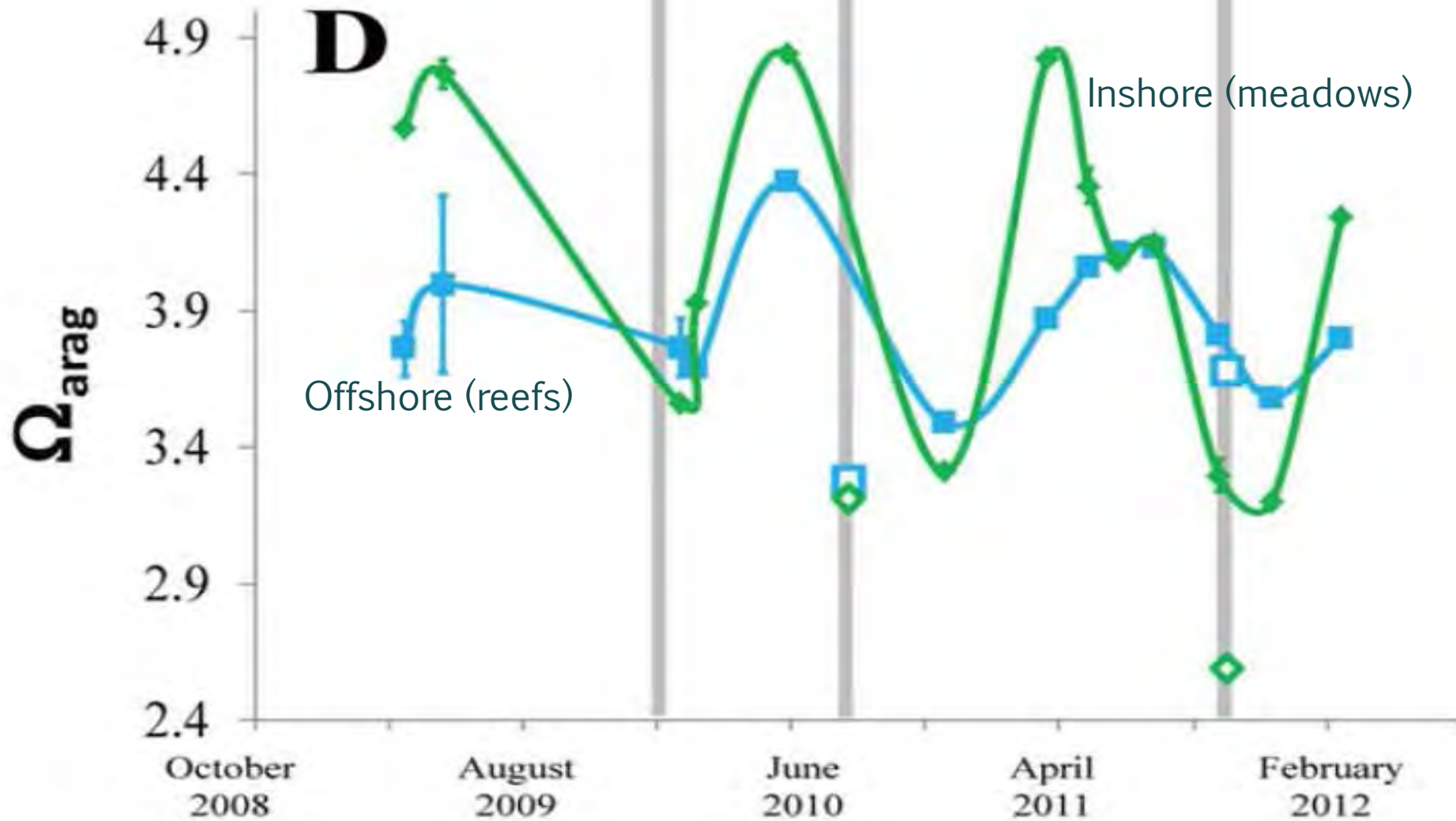
Refugia – does meadow serve as an area of refuge? (Ω)

Variability – characterization helps us understand the factors that drive it and how we might approach OA questions differently in the coastal ocean/nearshore.



Ocean Acidification Refugia of the Florida Reef Tract

Derek P. Manzello^{1,2*}, Ian C. Enochs^{1,2}, Nelson Melo^{1,2}, Dwight K. Gledhill³, Elizabeth M. Johns²



Sweetening the Waters

The Feasibility and Efficacy of Measures to Protect Washington's Marine Resources from Ocean Acidification

By Eric Scigliano

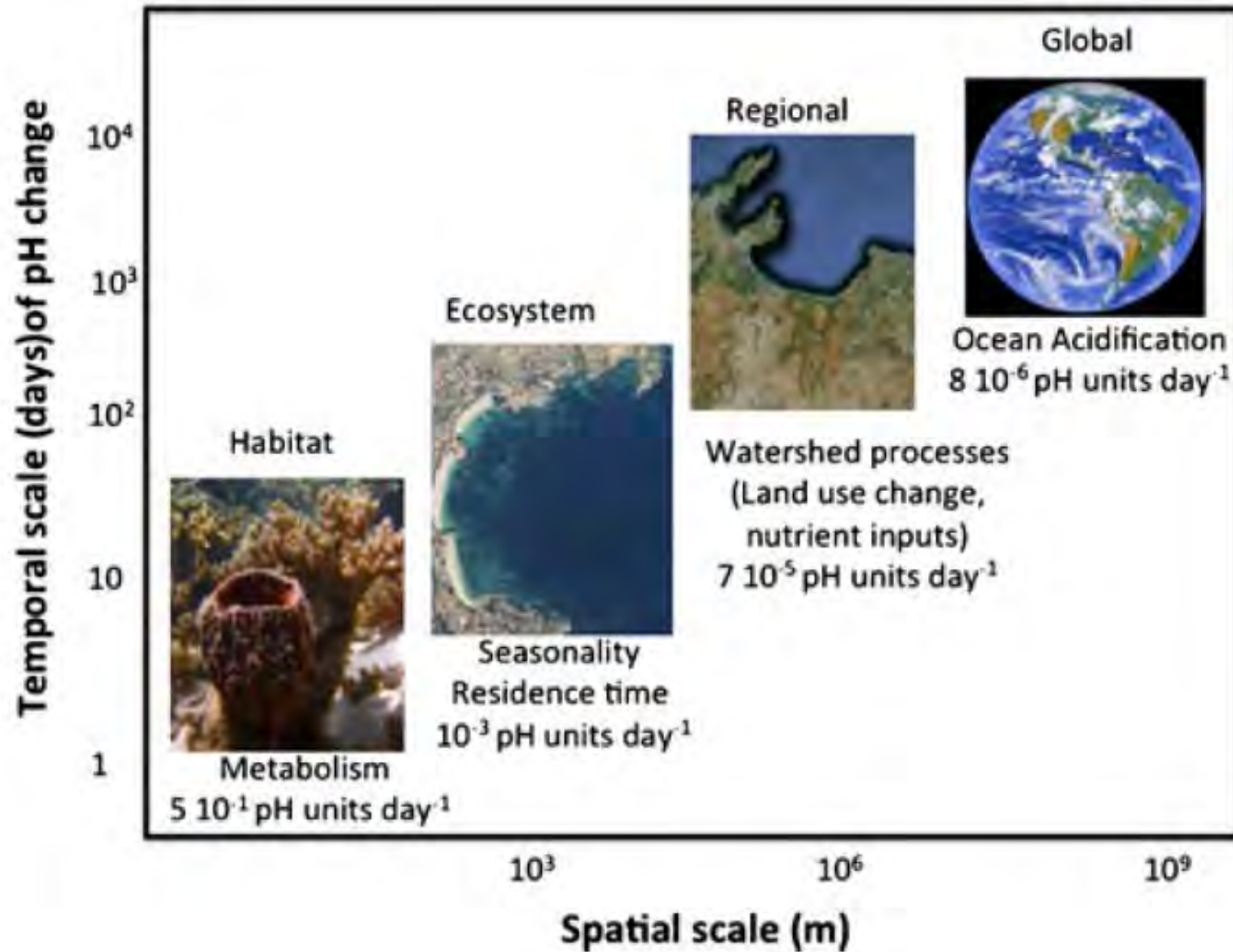
November 2012

Remediation

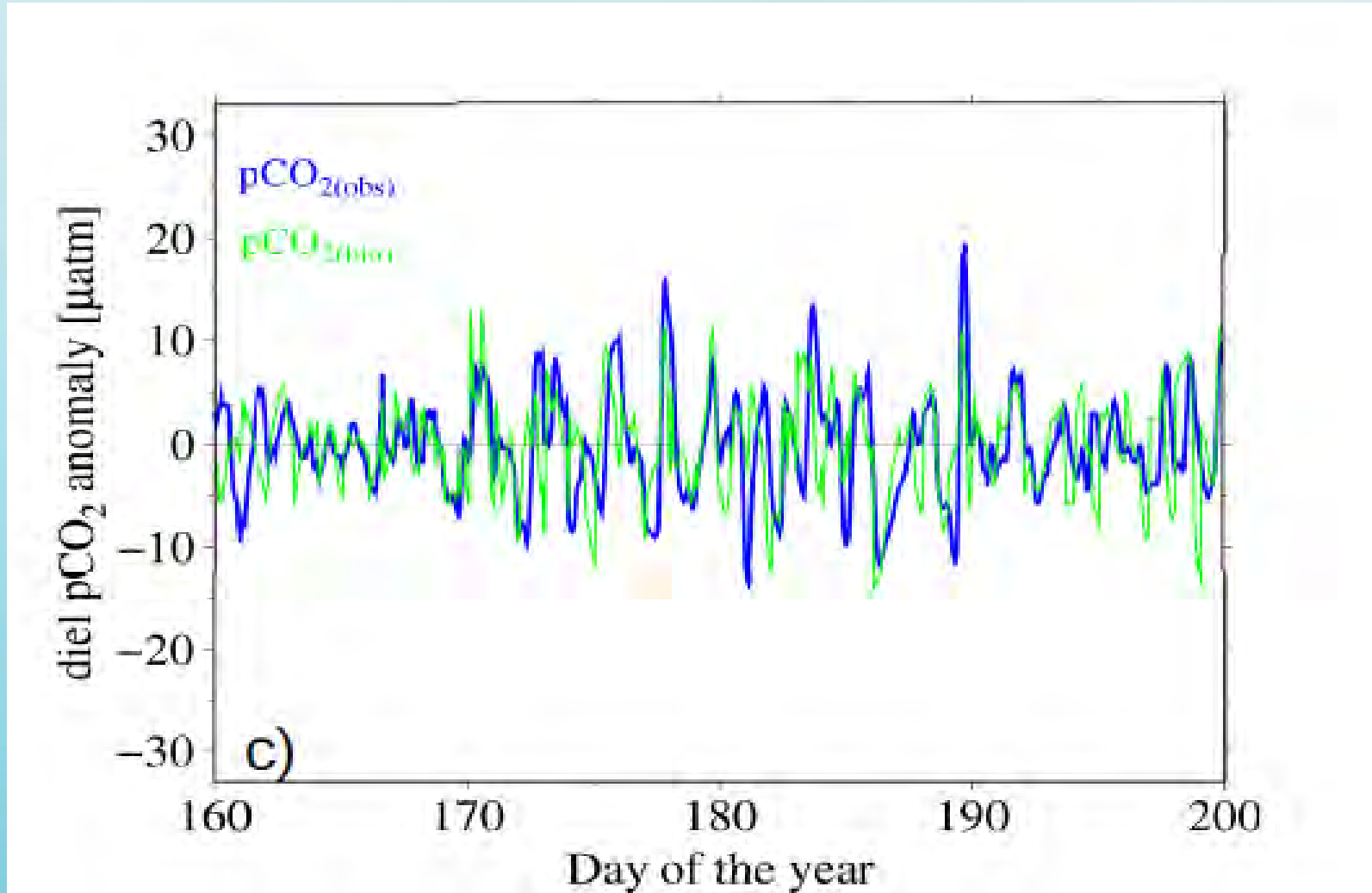
Cultivating seagrass and shellfish together to help protect both and counteract acidification of local waters.

Can growing and harvesting macroalgae remediate coastal eutrophication and corrosive oceanic upwellings?

An analysis commissioned by the Global Ocean Health Program, a joint project of the National Fisheries Conservation Center and the Sustainable Fisheries Partnership, to assist the Washington State Blue Ribbon Panel on Ocean Acidification and citizens seeking options to tackle the problem.



Scotian Shelf – coastal $p\text{CO}_2$ variability is moderate (tens of ppm)



Thomas et al. 2012

Mixed macrophytes in 3 meters of water have high variability (hundreds of ppm)

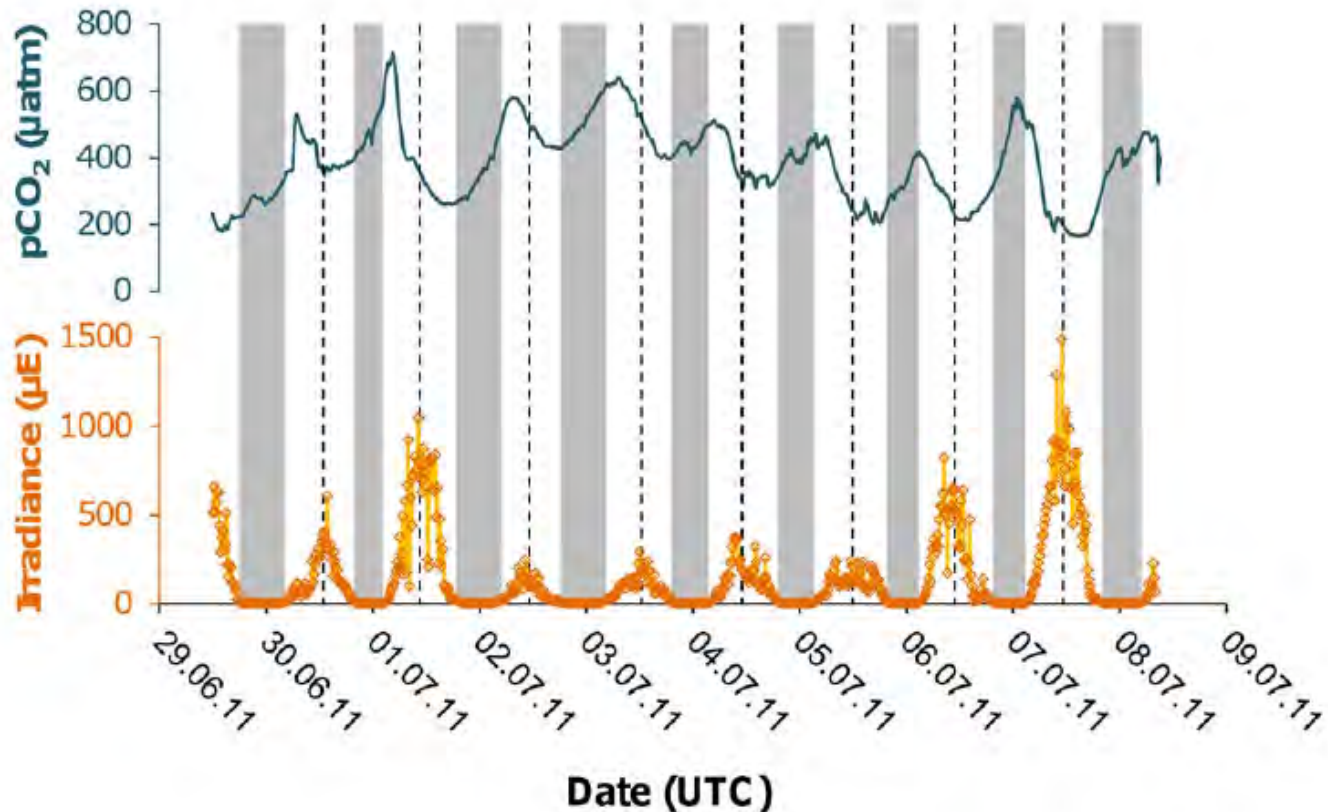


Figure 2. Comparison between Light and pCO₂ series in July. Dark bands: period of darkness. Dashed lines: estimated center of the daylight distribution.

Is Ocean Acidification an Open-Ocean Syndrome? Understanding Anthropogenic Impacts on Seawater pH

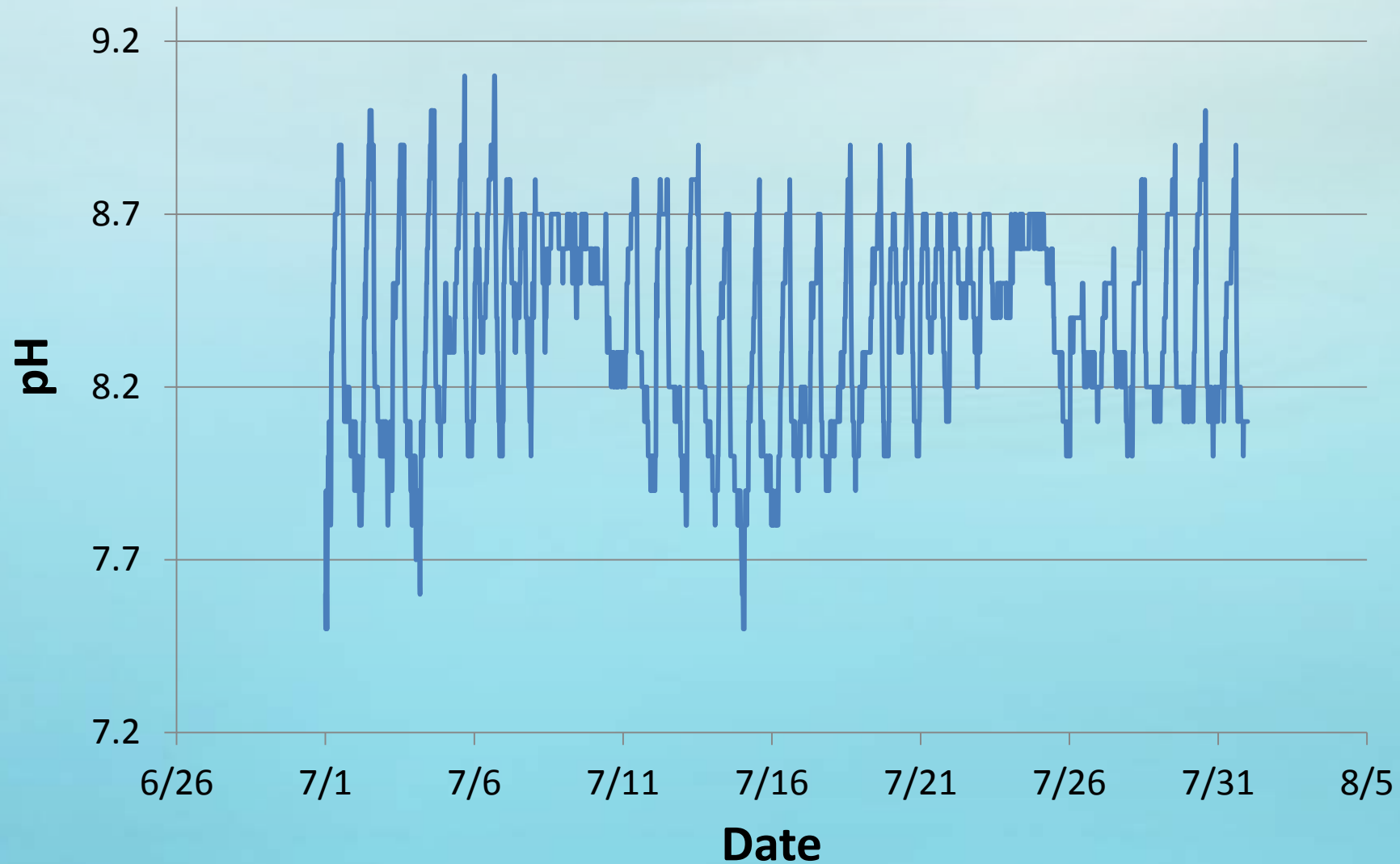
Carlos M. Duarte • Iris E. Hendriks • Tommy S. Moore •
Ylva S. Olsen • Alexandra Steckbauer • Laura Ramajo •
Jacob Carstensen • Julie A. Trotter • Malcolm McCulloch

2013
Estuaries and Coasts

System	Location	Variability	pH range	pH (min–max)	Depth	Reference	
Seagrass	Posidonia	Mediterranean	Diurnal	0.3	8.15–8.45	1 m	Invers et al. (1997)
Seagrass	–	Mediterranean	Diurnal	0.17	8.34–8.17	4 m	Invers et al. (1997)
Seagrass	–	Mediterranean	Diurnal	0.24	7.91–8.15	5–12 m	I. Hendriks, unpublished
Seagrass	Cymodocea	Mediterranean	Diurnal	0.48	8.11–8.59		Invers et al. (1997)
Seagrass	<i>Thalassia testudinum</i>	Bermuda	Diurnal	0.29	8.06–8.35		Schmalz and Swanson (1969)
Seagrass	Tropical	Chwaka Bay, Tanzania	Diurnal	1			Semesi et al. (2009)



Variability of pH – Ploeg Channel: July 2012

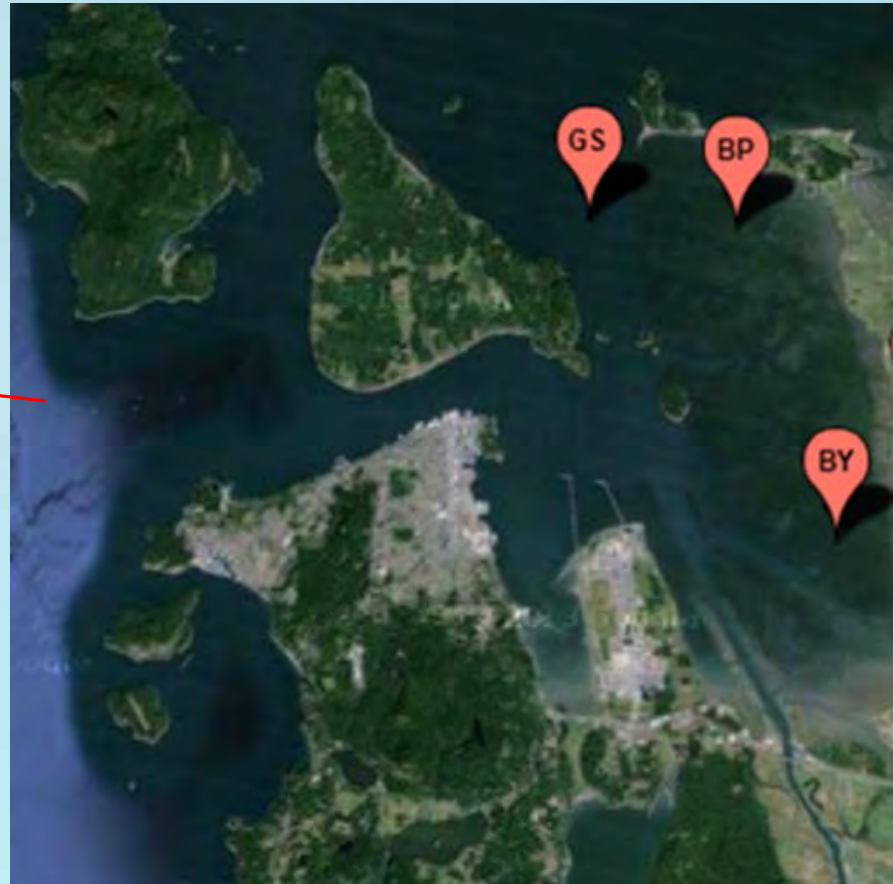


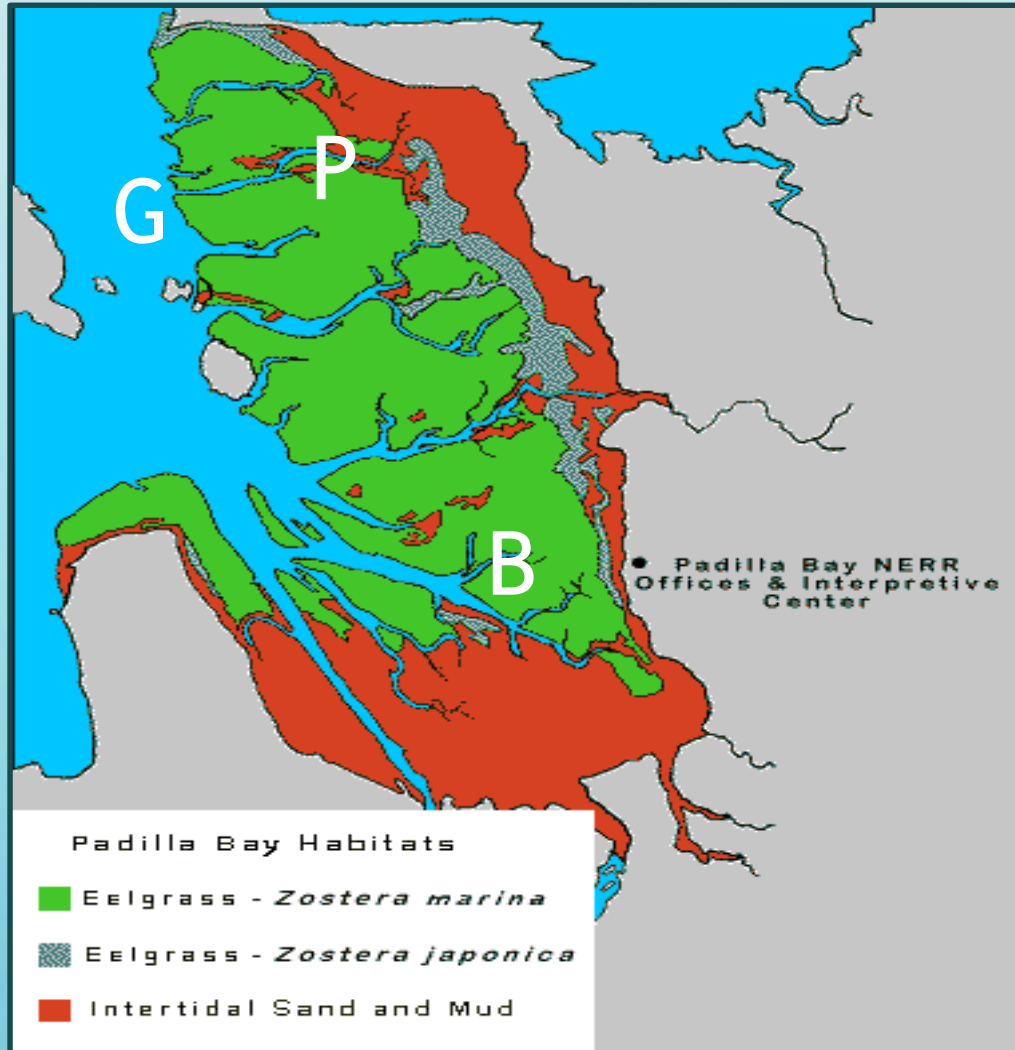
Average
Daily
Range,
0.4 to 0.8



Padilla Bay may represent a local end member for diurnal variability and/or an important area of refuge.

Extensive eel grass cover and shallow depth (especially at low tide) combine to make large modifications to water chemistry.





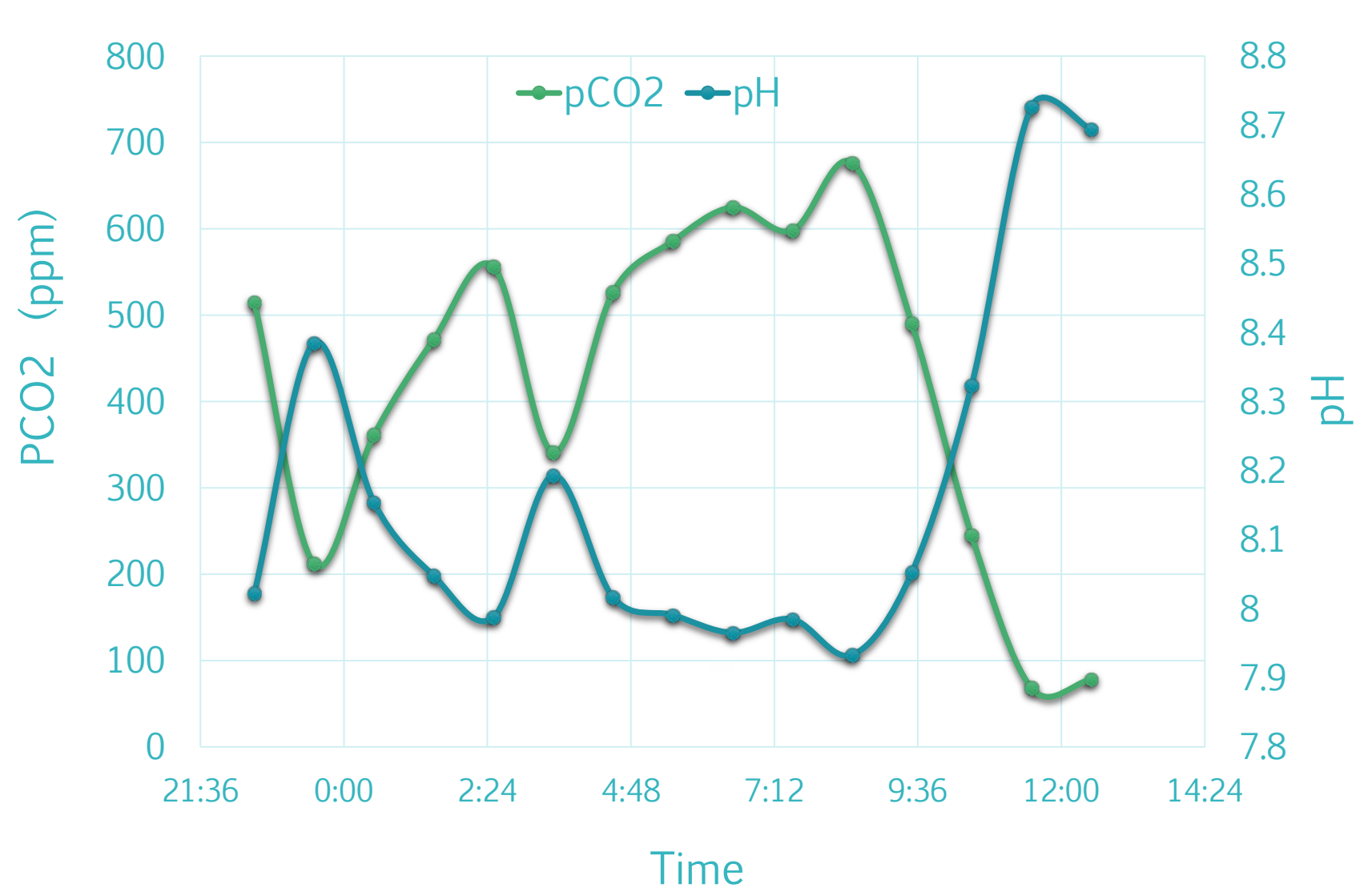
- Bayview and Ploeg stations are located in shallow water channels, on the edge of eelgrass beds and the Gong surface buoy is located in open water that is 20m deep.
- Covers over 11,000 acres of a shallow, intertidal embayment and is part of the Salish Sea. Contains 8,000 acres of two species eelgrass: *Zostera Marina* and the non-native species *Zostera Japonica*.
- Semi-diurnal tides with a range of up to 12 feet during spring tides

(Maps from www.padillabay.gov)

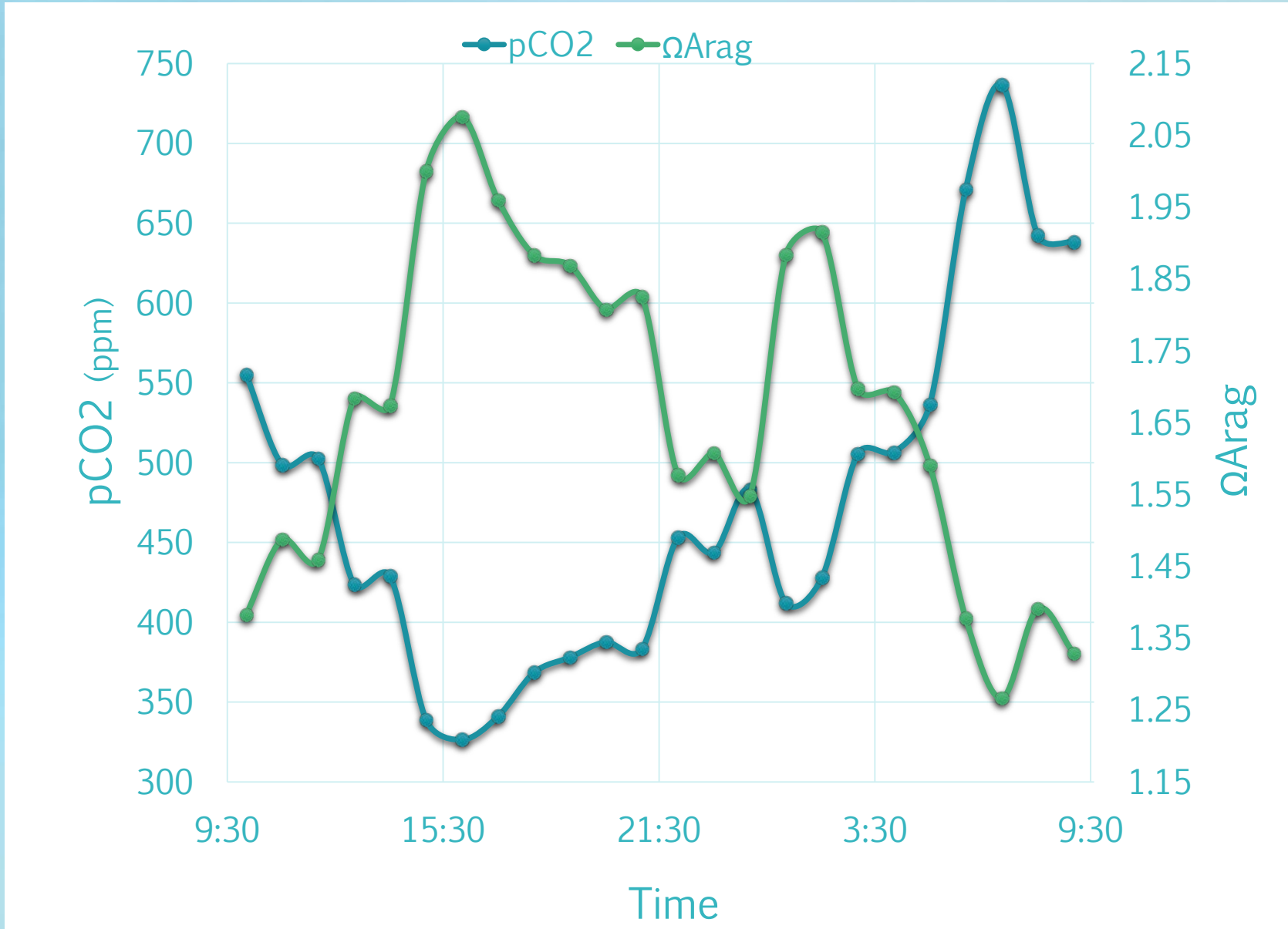
Methods



15 hour cycle during July 2013

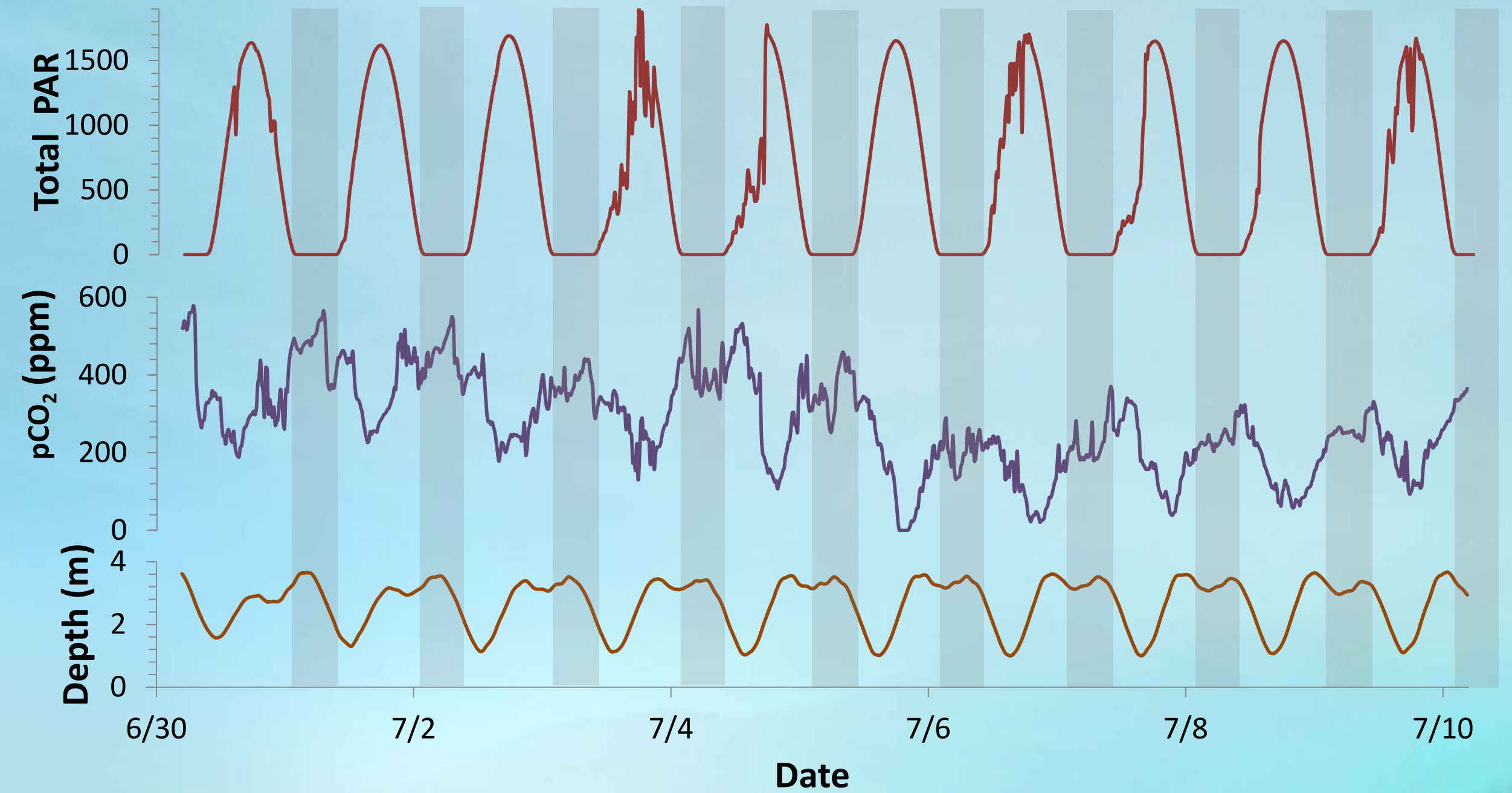


Tides dominated on this day



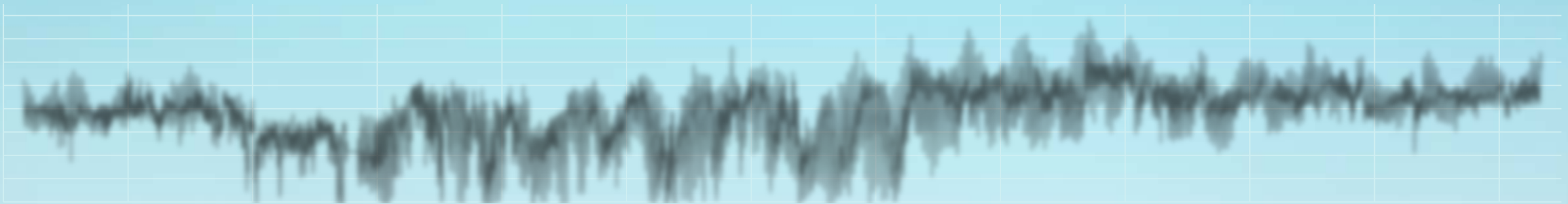
What is driving these changes?

Used Padilla Bay NERR data sonde records to make a simple linear model that predicted $p\text{CO}_2$ using PAR and water depth.



More to do

Additional (durafet) pH sensors
Additional discrete samples
In Situ pCO₂ sensor



Acknowledgements



All the staff at SPMC

Dr. Stephen Sulkin

Gene Mckeen

Capt. Nate Schwarck

Natasha Borgen

Padilla Bay Staff



Model Validation

