What controls dissolved oxygen in Lower South Bay?

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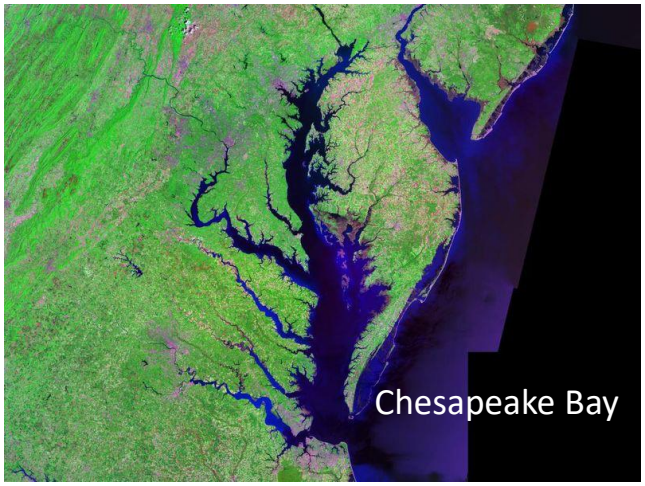
RMP

2017

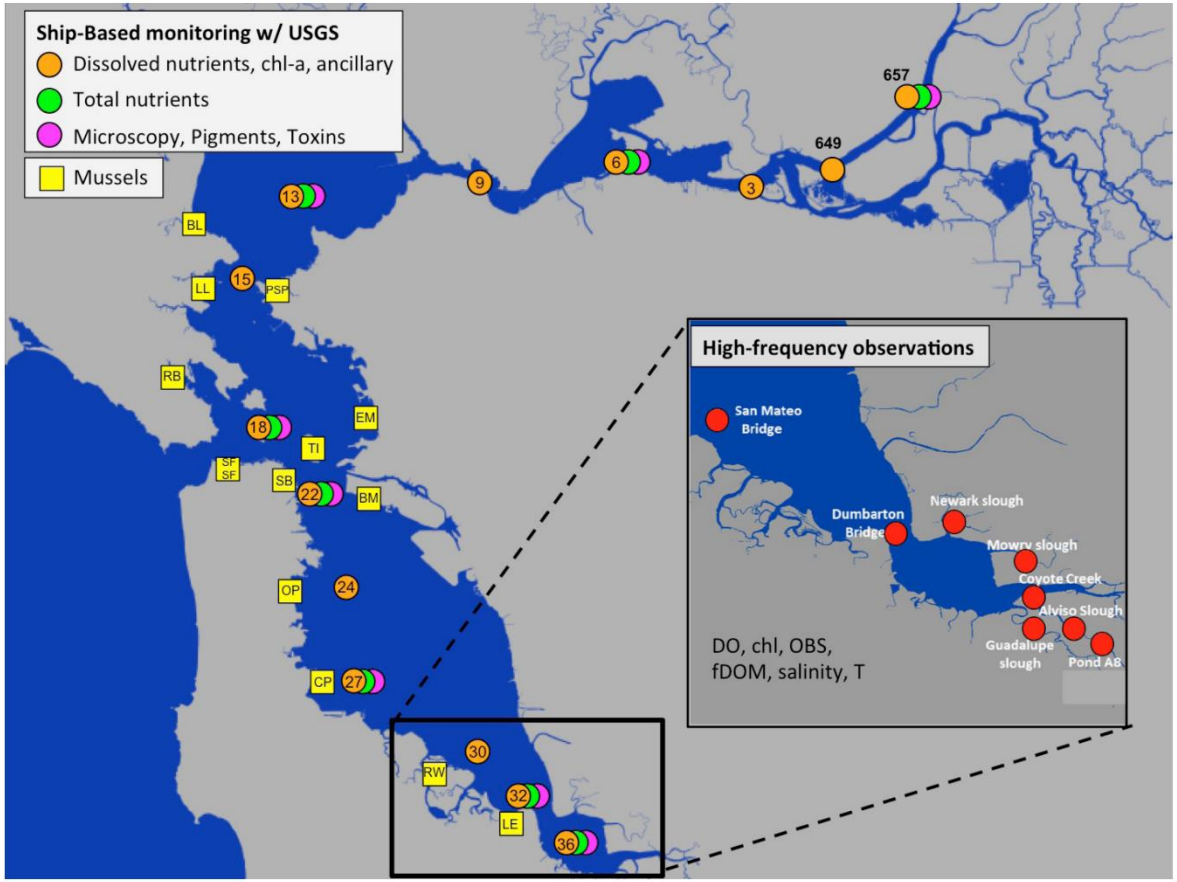
Why should we investigate DO in the Bay?

- In other systems, nutrient-enrichment has led to low DO conditions: ***an indication of ecological decline***.



Observing a unique system

- Urbanized watersheds
- Waste water inputs
- High sediment loads
- Strong tidal mixing
- Diverse habitats

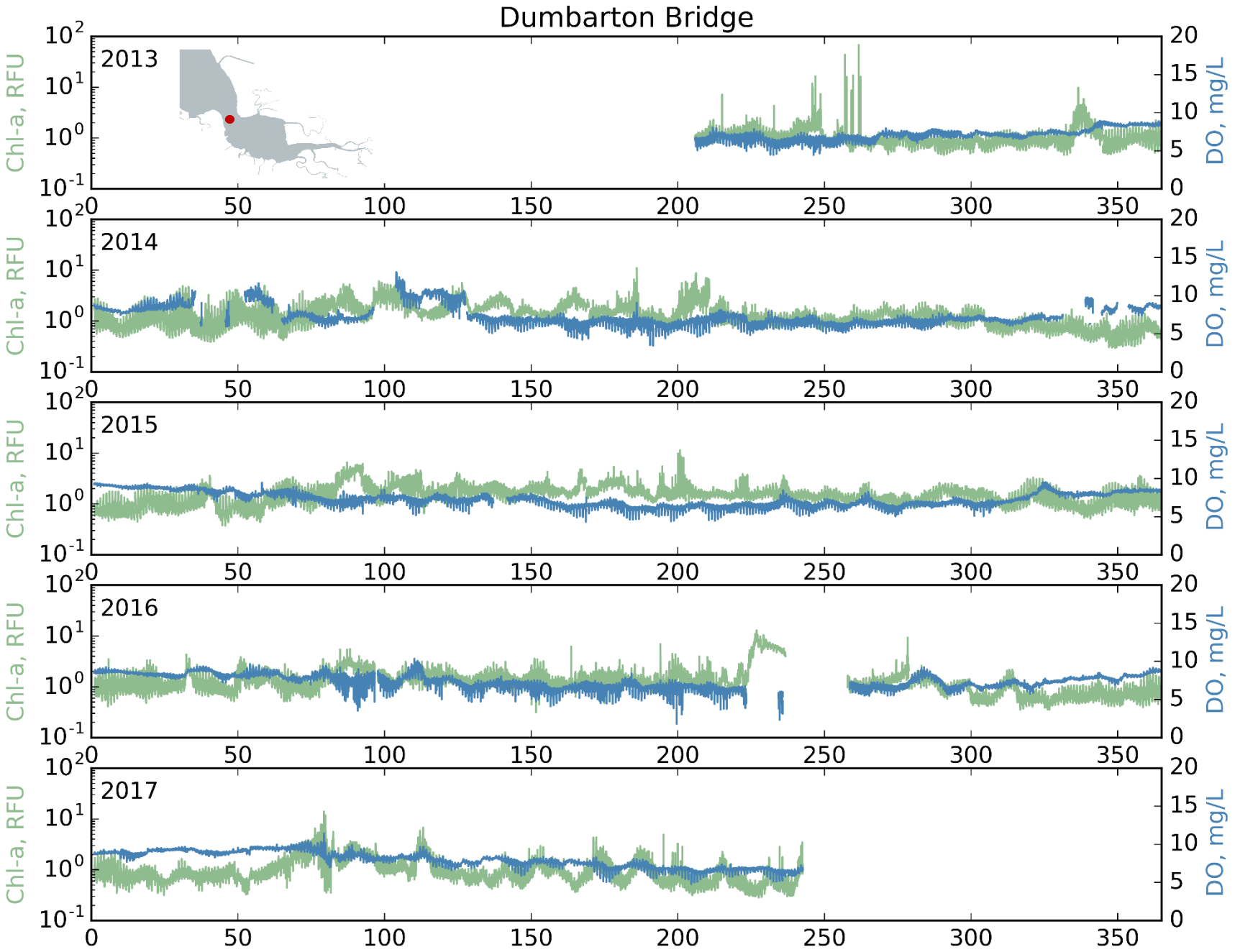


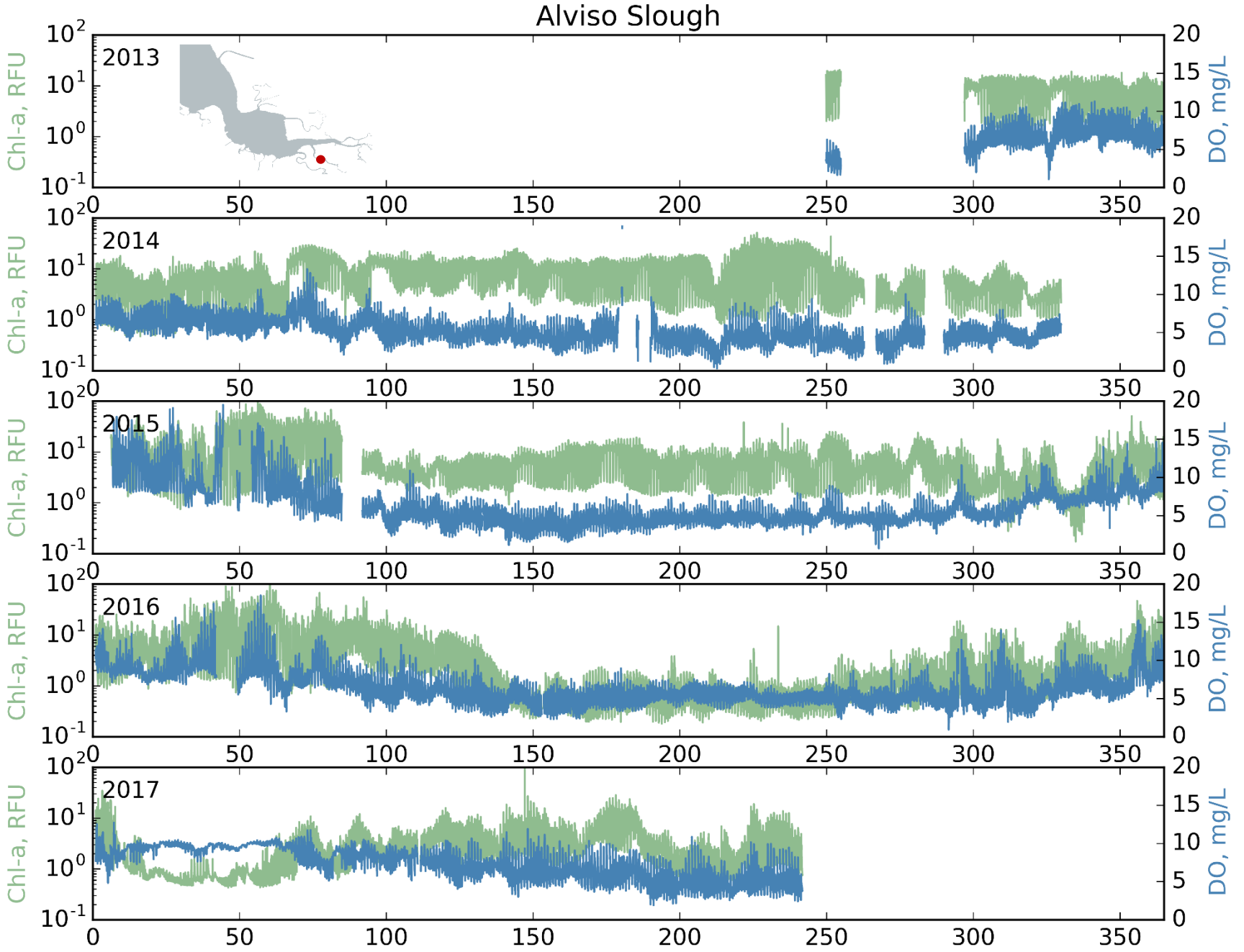
Observing: not as passive as it sounds!

Photo: Shira Bezalel

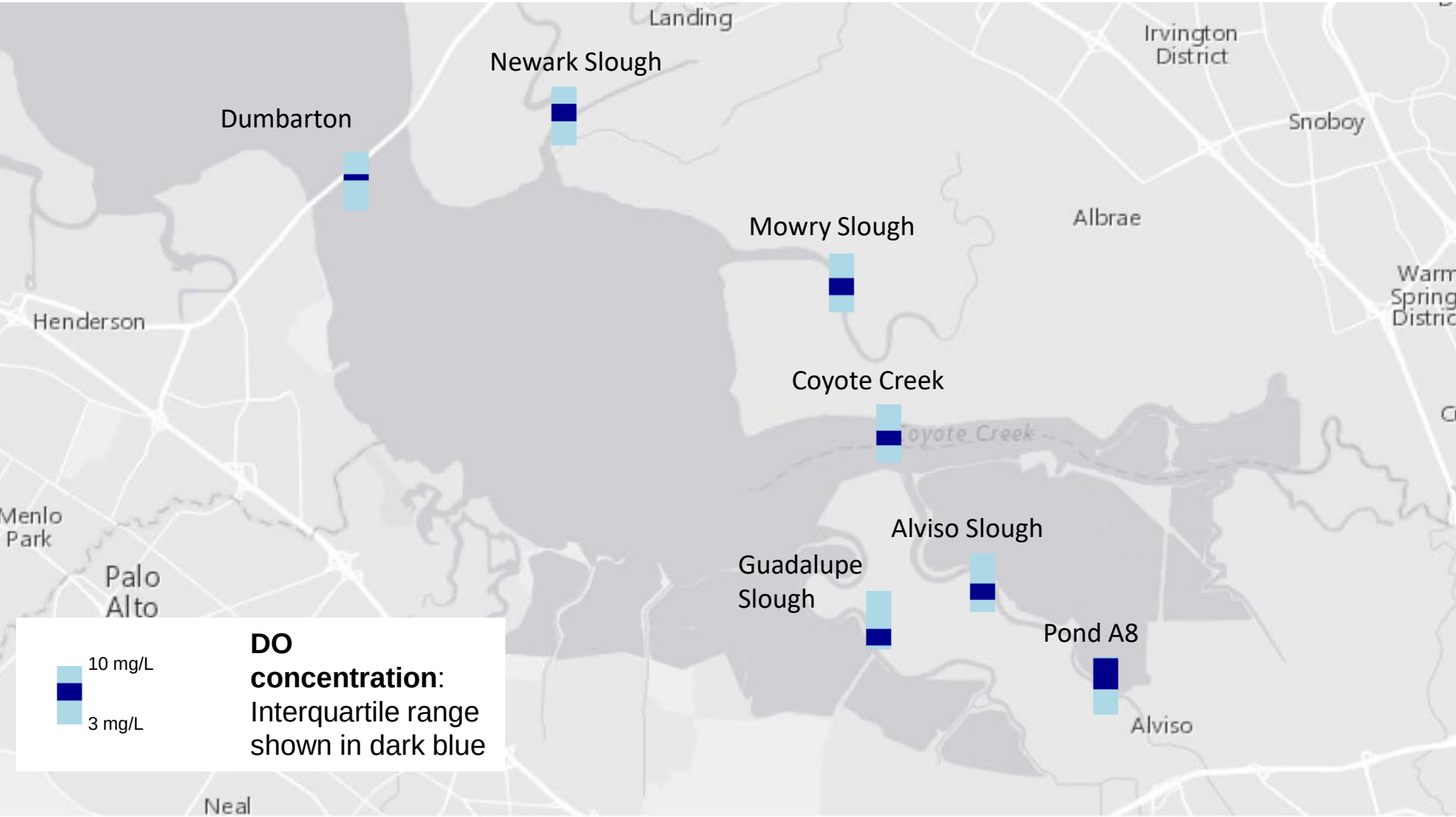
Very interdisciplinary…

Requires a unique skillset


Dumbarton Bridge
2013
2014
2015
2016
2017
Chl-a, RFU
DO, mg/L
10^{2}
10^{1}
10^{0}
10^{-1}
0
50
100
150
200
250
300
350
20
15
10
5
0


Alviso Slough
2013
2014
2015
2016
2017
Chl-a, RFU
DO, mg/L

DO variability in space: Bay vs Sloughs

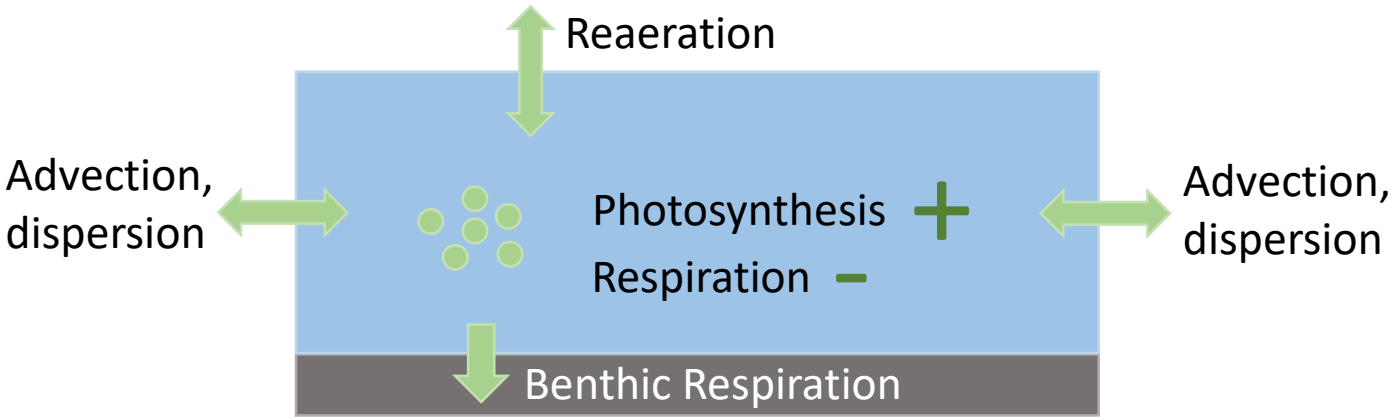


Can we go beyond condition to underlying mechanisms?

Framework: a 1-D transport and reaction equation

$$\underbrace{\frac{\partial C}{\partial t}}_{\text{Unsteadiness}} + \underbrace{u\frac{\partial C}{\partial x}}_{\text{Advection}} = \underbrace{D\frac{\partial^2 C}{\partial x^2}}_{\text{Dispersion}} + \underbrace{\frac{B}{H}}_{\text{Everything else!}}$$

C = DO concentration [mg/L]
u = velocity [m/s]
D = dispersion coefficient [m^2/s]
H = water depth [m]
B = DO consumption rate [$g\ O_2\ m^{-2}\ day^{-1}$]



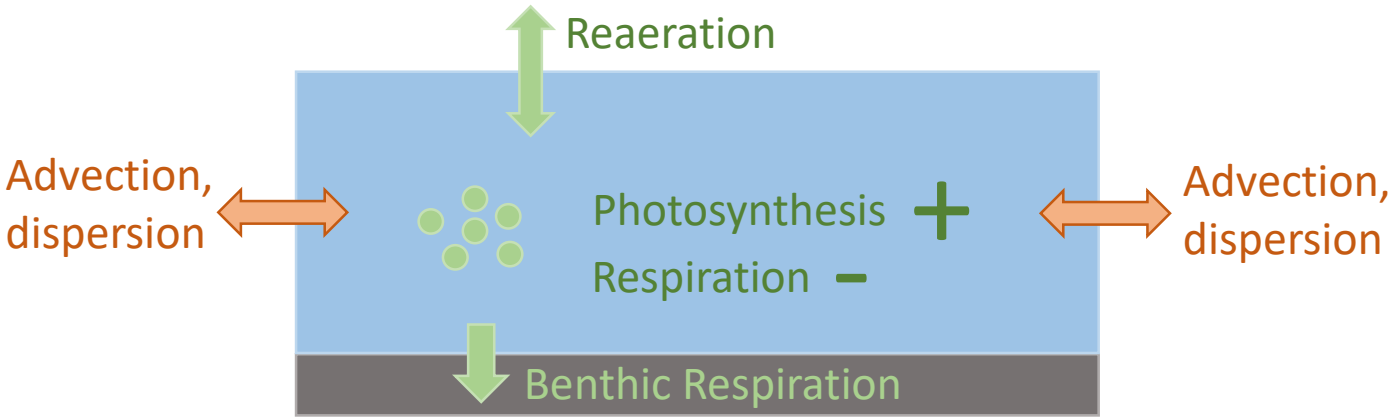
Framework: a 1-D transport and reaction equation

$$\frac{\partial C}{\partial t} + u\frac{\partial C}{\partial x} = D\frac{\partial^2 C}{\partial x^2} + \frac{B}{H}$$

Condition

Physical processes

Everything else!



Parsing physical from biogeochemical: notoriously difficult

Estuaries and Coasts (2014) 37 (Suppl 1):S91–S110
DOI 10.1007/s12237-013-9765-2

Fortnightly Tidal Modulations Affect Net Community Production in a Mesotidal Estuary

Nicholas J. Nidzieko · Joseph A. Needoba · Stephen G. Monismith · Kenneth S. Johnson

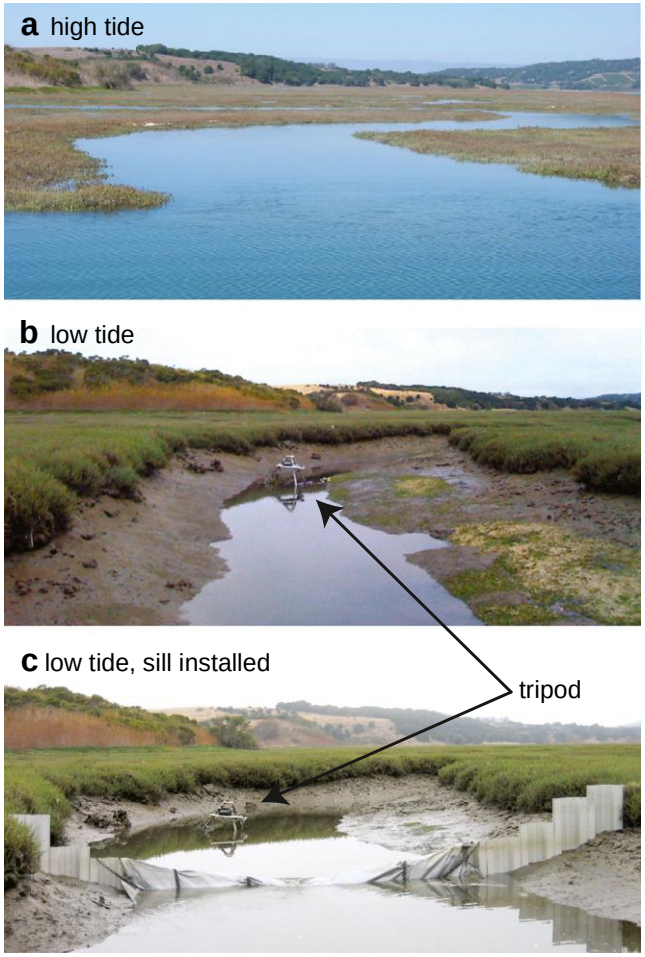


Fig. 2 Tidal creek study site at **a** High tide and **b** Low tide. **c** Following the installation of sharp crested sill

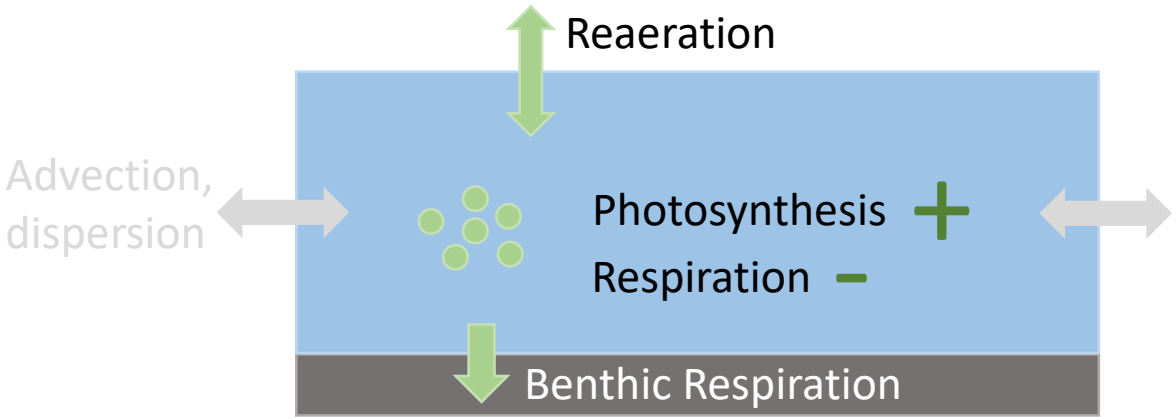
We developed a method to remove transport from the data

$$\frac{\partial C}{\partial t} + u\frac{\partial C}{\partial x} = D\frac{\partial^2 C}{\partial x^2} + \frac{B}{H}$$

Physical processes

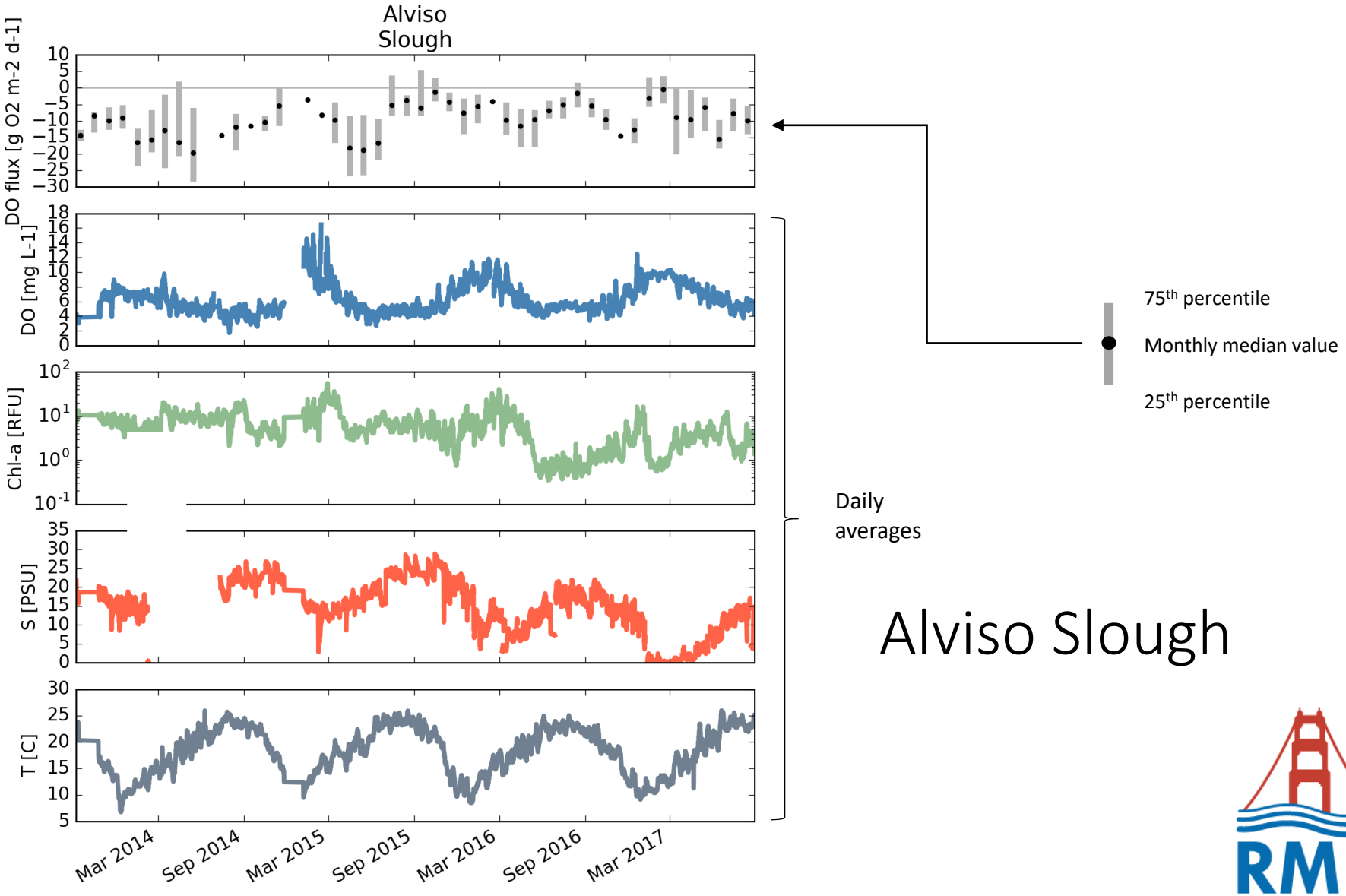
Everything else!

"Net DO flux"



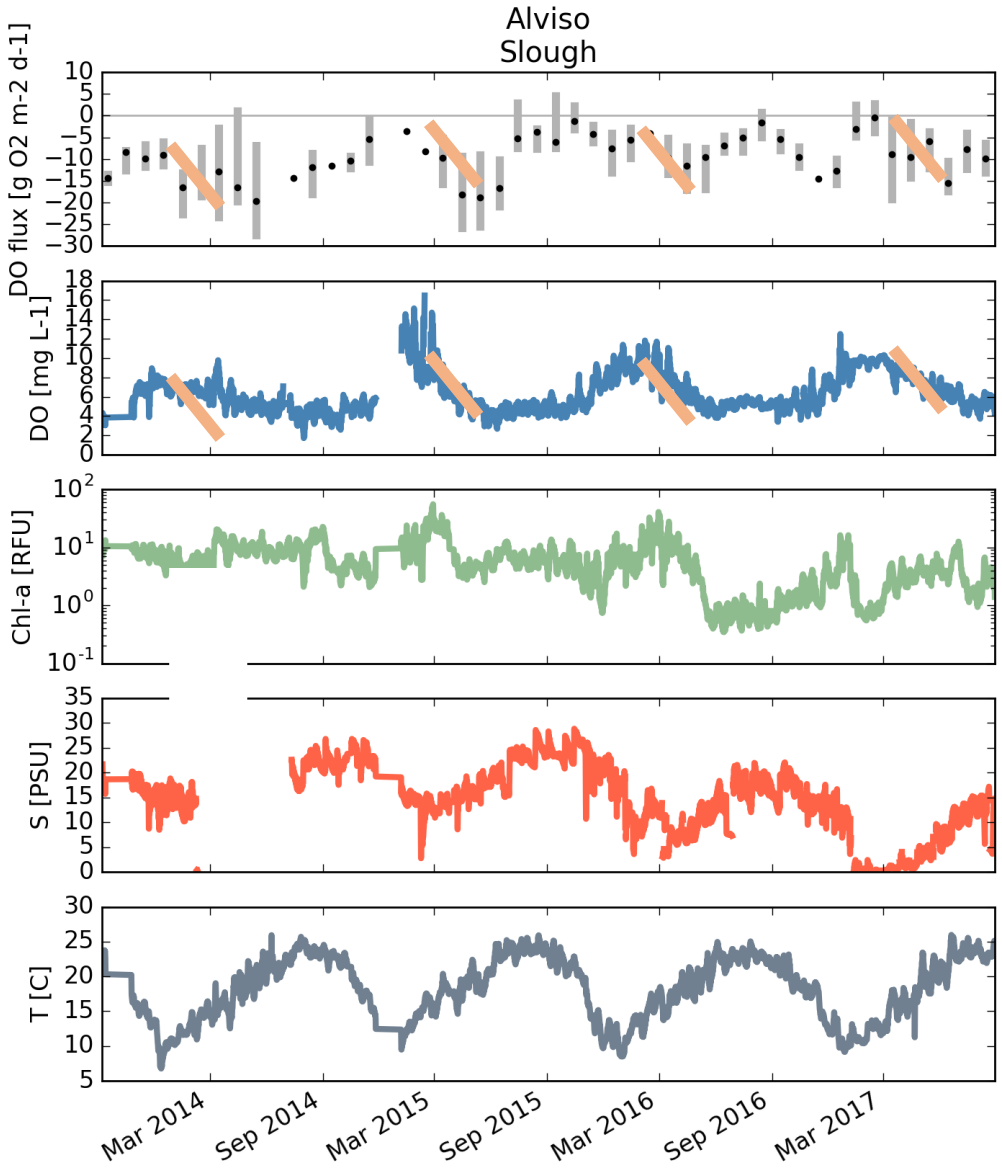
>0: net production
<0: net respiration

DO flux time-series



Alviso Slough

DO flux time-series



- Decline in daily-averaged DO concentration reflects increased consumption rates
- DO consumption is calculated using measurements 10 to 60 minutes apart
- *The DO consumption flux is associated with large drops in DO*

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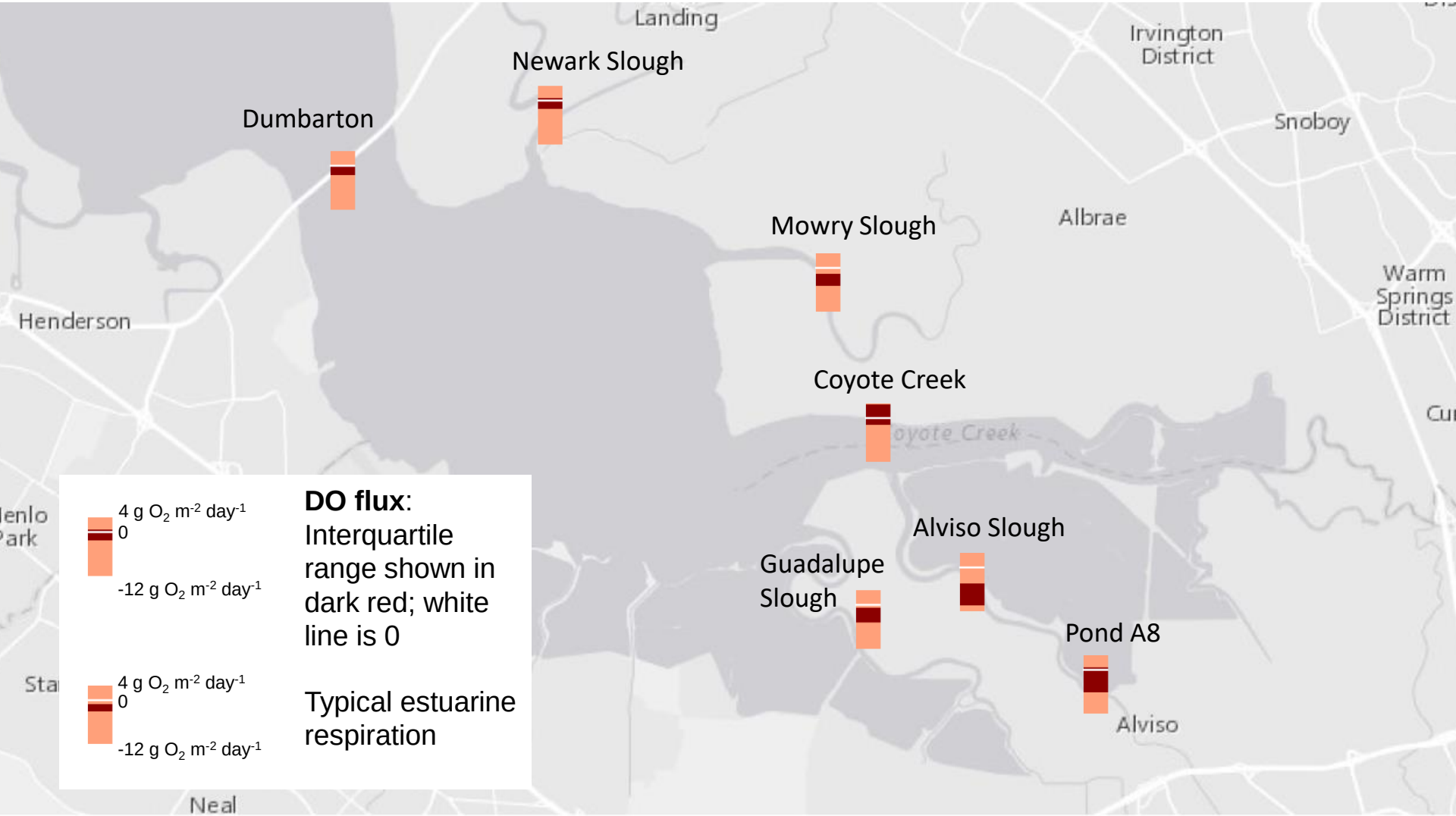
Spatial variations in net DO flux



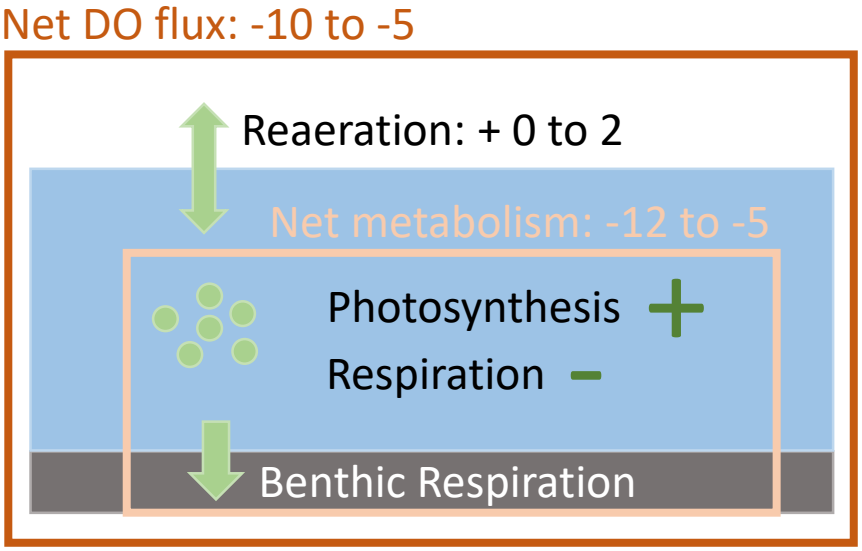
DO flux: Interquartile range shown in dark red; white line is 0

Typical estuarine respiration

What does this mean for net metabolism?

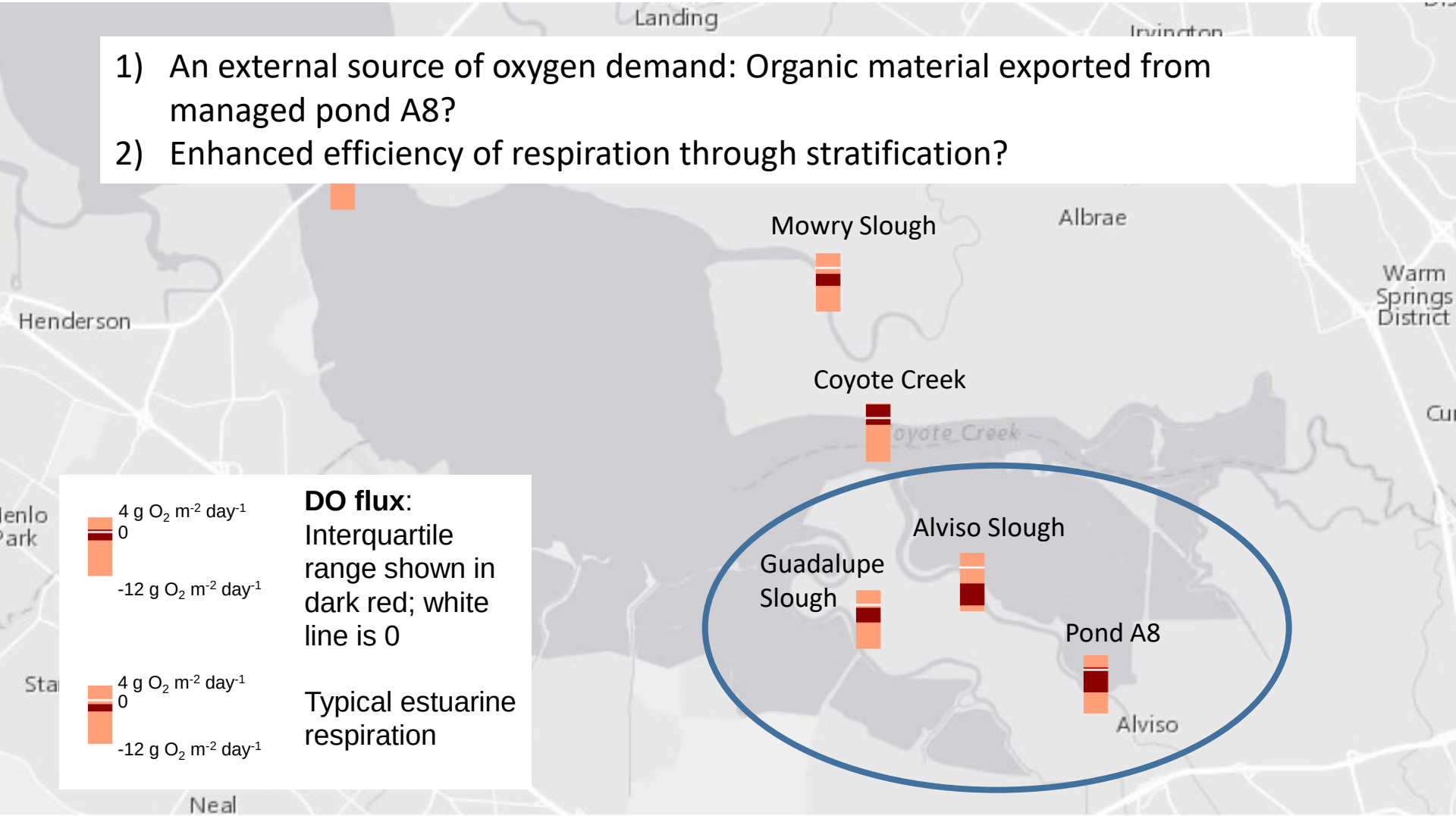
- Net metabolism = net DO flux – reaeration
- Reaeration estimated at the **Alviso Slough station**, where we have water properties, wind, and flow velocity
- Net DO flux:
  ~ -10 to -5 g O_2 m^{-2} day^{-1}
- Reaeration:
  ~ +0 to 2 g O_2 m^{-2} day^{-1}
- Net metabolism:
  ~ -12 to -5 g O_2 m^{-2} day^{-1}

Respiration dominates at this location, implying external O_2 drawdown.



Alviso complex: respiration dominated

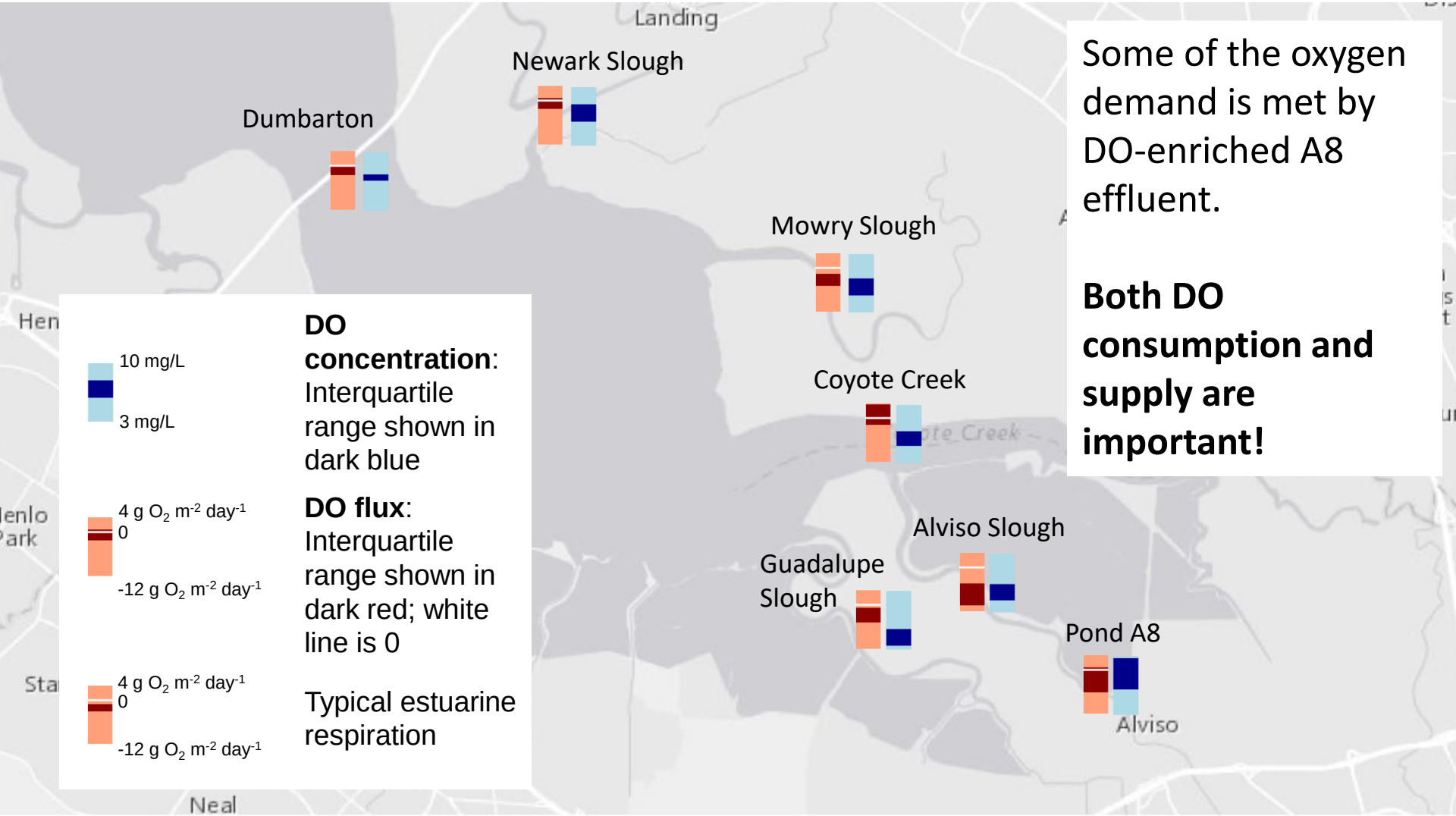
1) An external source of oxygen demand: Organic material exported from managed pond A8?
2) Enhanced efficiency of respiration through stratification?



DO flux: Interquartile range shown in dark red; white line is 0

Typical estuarine respiration

Alviso complex: not chronically low in DO



DO concentration: Interquartile range shown in dark blue

DO flux: Interquartile range shown in dark red; white line is 0

Typical estuarine respiration

Some of the oxygen demand is met by DO-enriched A8 effluent.

Both DO consumption and supply are important!

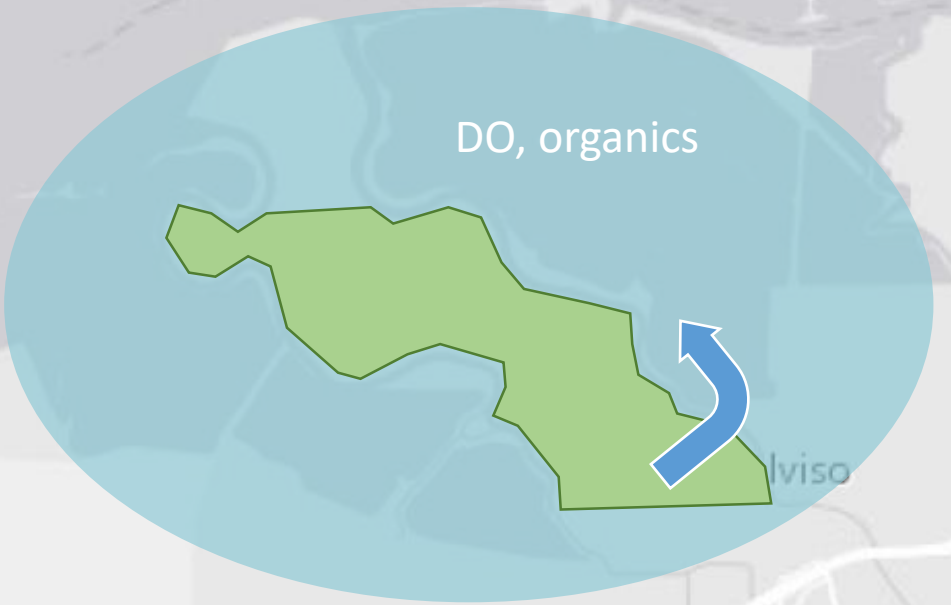
The influence of managed ponds

Ponds are incubators of phytoplankton

DO-enriched water and *organic material* are discharged to slough network

High supply of DO, high demand for DO

What are implications for management?



Mooring network helps us understand DO condition and driving mechanisms (physical, biogeochemical)

We've developed an efficient way of estimating net metabolism

The margins consume DO, but also supply it

Where does that leave managers?

Next steps: explore effects of A8 management in the data; physical-biogeochemical interactions in sloughs

Image Landsat / Copernicus
Image © 2016 DigitalGlobe

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