What controls dissolved oxygen in Lower South Bay?

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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…

Minerals, organics

Biology
Requires a unique skillset
DO variability in space: Bay vs Sloughs

DO concentration: Interquartile range shown in dark blue

- 10 mg/L
- 3 mg/L
Can we go beyond condition to underlying mechanisms?
Framework: a 1-D transport and reaction equation

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

Unsteadiness  Advection  Dispersion  Everything else!

C = DO concentration  \([\text{mg/L}]\)
u = velocity  \([\text{m/s}]\)
D = dispersion coefficient  \([\text{m}^2/\text{s}]\)
H = water depth  \([\text{m}]\)
B = DO consumption rate  \([\text{g O}_2 \text{ m}^{-2} \text{ day}^{-1}]\)

Photosynthesis  Respiration

Reaeration

Advection, dispersion  Advection, dispersion

Benthic Respiration
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!**

\[ \text{Reaeration} \]
\[ \text{Advection, dispersion} \]
\[ \text{Photosynthesis} \]
\[ \text{Respiration} \]
\[ \text{Benthic Respiration} \]
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

Monthly median value
25th percentile
75th percentile

Daily averages

Alviso Slough

RMP
• 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

DO flux time-series
Spatial variations in net DO flux

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

4 g O$_2$ m$^{-2}$ day$^{-1}$
0
-12 g O$_2$ m$^{-2}$ day$^{-1}$
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: 
  \[ \sim -10 \text{ to } -5 \text{ g } \text{O}_2 \text{ m}^{-2} \text{ day}^{-1} \]
- Reaeration: 
  \[ \sim +0 \text{ to } 2 \text{ g } \text{O}_2 \text{ m}^{-2} \text{ day}^{-1} \]
- Net metabolism: 
  \[ \sim -12 \text{ to } -5 \text{ g } \text{O}_2 \text{ m}^{-2} \text{ day}^{-1} \]

*Respiration dominates at this location, implying external \text{O}_2\text{ 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

Typical estuarine respiration DO flux:
- Interquartile range shown in dark red; white line is 0
- $4 \text{ g } \text{O}_2 \text{ m}^{-2} \text{ day}^{-1}$
- $-12 \text{ g } \text{O}_2 \text{ m}^{-2} \text{ day}^{-1}$

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
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