Insights from Sensors

Understanding the Complex Dynamics of Dissolved Oxygen in Lower South Bay

Phil Bresnahan, Rusty Holleman, Zephyr Sylvester, Ila Shimabuku, Emily Novick, and David Senn

San Francisco Estuary Institute
OUTLINE

Why does dissolved oxygen matter?

What are the principle drivers?

How can we untangle them?
CONCLUSION

Dissolved oxygen varies in every dimension
CONCLUSION

Dissolved oxygen varies in every dimension, but how much? And why should we care?
WHY SHOULD WE CARE?
Why should we care?

\[ \text{CH}_2\text{O} + \text{O}_2 \rightleftharpoons \text{CO}_2 + \text{H}_2\text{O} \]
Why should we care?

\[
\text{CH}_2\text{O} + \text{O}_2 \rightleftharpoons \text{CO}_2 + \text{H}_2\text{O}
\]

← Photosynthesis dominates
Why should we care?

Respiration → dominates

\[ \text{CH}_2\text{O} + \text{o}_2 \xrightarrow{\text{CO}_2 + \text{H}_2\text{O}} \]
Why should we care?

The SF Bay food web depends on DO
We can directly influence DO
We need to know how much is natural vs…?
Why should we care?

The SF Bay food web depends on DO
We can directly influence DO
We need to know how much is natural vs…?

\[
\text{CH}_2\text{O} + \text{O}_2 \leftrightarrow \text{CO}_2 + \text{H}_2\text{O}
\]

Wray Gabel, SF Bay Bird Observatory
Constraining variability allows us to estimate rates, slough-to-basin scale budgets, and habitat quality and the effects of nutrient loads.
THE DRIVERS OF CHANGE
Drivers of variability in DO

Interfaces:
- air–water
- sediment–water

Production vs. Respiration:
- Phytoplankton/zooplankton/nekton/detritus/bacteria

Connections:
- ponds
- marshes
- bay
- ocean
- land
Drivers of variability in DO
Drivers of variability in DO

- Air–water exchange
- Water column metabolism
- Sediment oxygen demand

Higher DO

Lower DO
Drivers of variability in DO

- Air-water exchange
- Water column metabolism
- Sediment oxygen demand
- Tides facilitate stratification and mixing
Dimensions

Drivers of variability in DO

Interfaces:
- air-water
- sediment-water

Production vs. Respiration:
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Connections:
- ponds
- marshes
- bay
- ocean
- land

Vertical
Lateral (cross-channel)
Longitudinal (along channel)
Temporal
Inter-site
Drivers of variability in DO

Interfaces:
- air–water
- sediment–water

Production vs. Respiration:
- Phytoplankton/zooplankton/detritus/bacteria

Connections:
- ponds
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Dimensions
- Vertical
- Lateral (cross-channel)
- Longitudinal (along channel)
- Temporal
- Inter-site

IT’S COMPLICATED
DISENTANGLING VARIABILITY
DISENTANGLING VARIABILITY

Vertical ?
Cross-channel ?
Along-channel ?
Inter-site ?
Temporal ?
The LSB Network
The LSB Network

Deep Subtidal Biweekly-Monthly sampling

High-frequency measurements – Dumbarton

Vertical
Cross-channel
Along-channel
Inter-site
Temporal

Deep Subtidal Biweekly-Monthly sampling

High-frequency measurements – Dumbarton

DO (mg/L)

1995 2000 2005 2010

USGS

DO (mg/L)

Aug 17 Aug 19 Aug 21 Aug 23

Low tide
The LSB Network
The LSB Network
The LSB Network

Vertical
Cross-channel
Along-channel
Inter-site ✓
Temporal ✓
Measurements in all dimensions

- Vertical: ?
- Cross-channel: ?
- Along-channel: ?
- Inter-site: ✓
- Temporal: ✓
transect location:

mooring location:
Transects (cross/along-slough variability)

Dissolved oxygen
Multi-probe: T, sal, DO, chl turb, depth
Velocity
Moorings
(variability over time and depth at one location)

Transects
(cross/along-slough variability)

Dissolved oxygen
Multi-probe: T, sal, DO, chl turb, depth
Velocity
Moorings (variability over time and depth at one location)

Transects (cross/along-slough variability)
Along-Slough: Alviso

Start (Mouth)

Pond A8

End (Alviso)
Vertical/Along-Slough Variability
Vertical/Along-Slough Variability

Vertical ✔️
Cross-channel ?
Along-channel ✔️
Inter-site ✔️
Temporal ✔️
Moorings (variability over time and depth at one location)

Transects (cross/along-slough variability)

- Dissolved oxygen
- Multi-probe: T, sal, DO, chl turb, depth
- Velocity
Temporal Vertical Variability
Temporal Vertical Variability

- Depth vs. time for different layers:
  - Bottom
  - Middle
  - EXO2
  - Top

- Dissolved Oxygen Saturation over time from August 6, 2016 to October 3, 2016.

- Color scale indicates saturation levels from 15 to 105.
Next Steps

Combine with velocity data to calculate fluxes
Preliminary Conclusions

DO varies in all dimensions

**Inter-site** variability is enormous

**Temporal** variability is strong

**Vertical** variability is ephemeral

Gross-slough variability is weak to non-existent

Along-slough variability is apparent but constrained

To determine LSB biogeochemical variability, we need inter-site, vertically resolved time-series

The variability we’ve constrained allows us to estimate rates and slough-to-basin scale budgets and 4-D habitat quality
Thanks!

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RMP
REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY
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