Determining protective dissolved oxygen levels in SF Bay sloughs

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Lower South Bay Monitoring
Low dissolved oxygen (DO) in Slough Habitats
Low dissolved oxygen (DO) in Slough Habitats

The graph shows the dissolved oxygen (DO) levels over time in various locations, including Sloughs and channels. The data indicates persistent low DO levels, which can be detrimental to aquatic life.
Dissolved Oxygen Objectives for SF Bay

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Temporal Integration Method</th>
<th>Threshold by Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO (mg L⁻¹)</td>
<td>none</td>
<td>North of Carquinez Br.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.0</td>
</tr>
<tr>
<td>DO (%sat)</td>
<td>3-month rolling median</td>
<td>80%</td>
</tr>
</tbody>
</table>
Low DO in Slough Habitats
Low DO in Slough Habitats
Assessment Framework in LSB Sloughs and Creeks - Project Goals

- Develop thresholds/tools/models that delimit oxygen conditions that are protective of aquatic life in LSB sloughs and tidal creeks.

- Assess protective dissolved oxygen thresholds under future conditions.
Virginia Province Approach

Metabolic Index

Protective DO

Fish Community Models
Fish Community Sampling
Virginia Province Approach

Determine relevant species
Virginia Province Approach

Determine relevant species

Compile existing data on tolerance to low DO
Virginia Province

Approach

Determine relevant species

Compile existing data on tolerance to low DO

Identify and rank most sensitive species
Virginia Province Approach

- Determine relevant species
- Compile existing data on tolerance to low DO
- Identify and rank most sensitive species
- Protective DO
# Acute Thresholds

<table>
<thead>
<tr>
<th>Genera with most sensitive acute values</th>
<th>Value (DO mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>With Sturgeon</strong></td>
<td></td>
</tr>
<tr>
<td>Clupea (herring)</td>
<td></td>
</tr>
<tr>
<td>Poecilia (mosquito fish)</td>
<td></td>
</tr>
<tr>
<td>Fundulus (killifish)</td>
<td>3.7</td>
</tr>
<tr>
<td>Acipenser (sturgeon)</td>
<td></td>
</tr>
<tr>
<td><strong>Without Sturgeon</strong></td>
<td></td>
</tr>
<tr>
<td>Clupea (herring)</td>
<td></td>
</tr>
<tr>
<td>Poecilia (mosquito fish)</td>
<td></td>
</tr>
<tr>
<td>Fundulus (killifish)</td>
<td></td>
</tr>
<tr>
<td>Harengula (sardine)</td>
<td>3.8</td>
</tr>
</tbody>
</table>
# Chronic Thresholds

<table>
<thead>
<tr>
<th>Genera with most sensitive chronic values</th>
<th>Value (DO mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>With Sturgeon and Salmonids</strong></td>
<td></td>
</tr>
<tr>
<td>Oncorhynchus (salmonids)</td>
<td>5.3</td>
</tr>
<tr>
<td>Libinia (spider crab)</td>
<td></td>
</tr>
<tr>
<td>Acipenser (sturgeon)</td>
<td></td>
</tr>
<tr>
<td>Paralichthys (flounder)</td>
<td></td>
</tr>
<tr>
<td><strong>Without Sturgeon and Salmonids</strong></td>
<td></td>
</tr>
<tr>
<td>Libinia (spider crab)</td>
<td>4.5</td>
</tr>
<tr>
<td>Paralichthys (flounder)</td>
<td></td>
</tr>
<tr>
<td>Menidia (silverside)</td>
<td></td>
</tr>
<tr>
<td>Mercenaria (clams)</td>
<td></td>
</tr>
</tbody>
</table>
Frequency of Exceedances of VPA Criteria

<table>
<thead>
<tr>
<th>Condition</th>
<th>DO (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic (no salmon or sturgeon)</td>
<td>4.5 mg/L</td>
</tr>
<tr>
<td>Chronic (w/ salmon and sturgeon)</td>
<td>5.3 mg/L</td>
</tr>
<tr>
<td>Acute (w/ sturgeon)</td>
<td>3.7 mg/L</td>
</tr>
</tbody>
</table>
Metabolic Index

Compile experimental data of tolerance to low DO or field abundance & environmental data
Metabolic Index

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Determine temp dependence of species’ oxygen supply and metabolic demand
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DO required to support ecological activity at in situ temps
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Determine temp dependence of species’ oxygen supply and metabolic demand

DO required to support ecological activity at in situ temps

Protective DO
Metabolic Index Conditions in Lower South Bay
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Metabolic Index: Conditions in Lower South Bay
Metabolic Index - Oxygen and Temperature Preference

Stripped Bass
Fish distributions are consistent with oxygen sensitivity

→ Animals are disproportionately present in higher $O_2$ conditions

→ In general, a ‘preference’ for >50% $O_2$ sat (~4-5 mg $O_2$/L)

Some patterns consistent with temperature dependence of $O_2$ threshold
Metabolic Index of Oxygen and Temperature Preference

Fish distributions are consistent with oxygen sensitivity

→ Animals are disproportionately present in higher O$_2$ conditions

→ In general, a ‘preference’ for >50% O$_2$ sat (~4-5 mg O$_2$/L)

Some patterns consistent with temperature dependence of O$_2$ threshold
Metabolic Index Findings To-Date

- DO concentrations occasionally dip below published lethal thresholds in LSB sloughs and often go below ecological thresholds.
- Fish distributions in LSB are consistent with oxygen sensitivity, and oxygen thresholds appear to be temperature dependent.
- Difficult to determine species-specific temperature-dependent hypoxia traits from LSB biogeography data.
- Patterns in temperature-dependent hypoxia thresholds are relatively consistent across marine species and could be used to support the analysis.
Fish Community Models

Existing biota data and targeted surveys
Fish Community Models

Existing biota data and targeted surveys

Analysis with generalized additive models (GAMs)
Fish Community Models

- Existing biota data and targeted surveys
- Analysis with generalized additive models (GAMs)
- Model biota responses to environmental variation
Fish Community Models

- Existing biota data and targeted surveys
- Analysis with generalized additive models (GAMs)
- Model biota responses to environmental variation
- Protective DO
Fish Community Models

- Models accounted for 60-70% of deviance in abundance patterns of each species.
- Variation in fish abundance occurred in space and time (regions, seasons, and years) and with environmental conditions.
- Model performance increases with more complex models, however, simple vs. complex models exhibited different responses for some species.
Key Takeaways

- Dissolved oxygen levels in Lower South Bay sloughs frequently fall below the 5 mg/L Basin Plan objectives

- Study goal is to investigate what constitutes protective DO levels using multiple lines of evidence

- Draft chronic and acute criteria were developed using the Virginia Province Approach

- Other mechanistic and empirical analyses could be powerful for validating and informing the VPA
Collaborators/Experts

Evan Howard, NOAA
Levi Lewis, UC Davis
Martha Sutula, SCCWRP
Sujoy Roy, Tetra Tech
Jerry Diamond, Tetra Tech
Alexis Walls, Tetra Tech
Perry de Valpine, UC Berkeley
Jim Hagy, EPA
Peter Tango, USGS
Christina Frieder, SCCWRP
More Information

Contact me: ariellac@sfei.org

Explore data using Shiny app: sfeinms.shinyapps.io/LSB_AF

→ Created by Dan Killam, SFEI

View past reports at: sfbaynutrients.sfei.org
Takeaway: patterns in temperature dependent hypoxia thresholds are relatively consistent across marine species.