Science Supporting Revision of Dissolved Oxygen Objectives in California Estuaries

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Approach to Setting Nutrient Objectives Distinct From That Used For Traditional Contaminants

• Nutrients are required to support life
  – How much is too much?
• Toxicity rarely endpoint of interest
  – Effects occur at much lower levels
• Using ambient nutrients to diagnose effects can often give a false-negative or false-positive
  – Need a different approach
Tenets of California’s Approach to Nutrient Objectives

• Narrative objective, with numeric guidance
  – Guidance coined as “Nutrient Numeric Endpoint or NNE”

• Diagnosis based on response indicators = NNE assessment framework
  – Assessing eutrophication et al. adverse effects of nutrients
  – Multiple lines of evidence for more robust diagnosis

• Models to link response indicators to nutrients et al. factors (e.g. hydrology, climate, etc.)= NNE load-response models
  – Can be empirical or dynamic simulation models
  – Nutrient loads rather than ambient concentration
Why Dissolved Oxygen?

- Dissolved oxygen is a core component of NNE framework
  - Common indicator to lakes, stream, and estuarine NNE
  - Applicable to most estuarine subtidal habitats
- Most commonly used indicator among other states to diagnose eutrophication
  - Strong linkage to beneficial uses
- All coastal regional boards have DO in basin plans

Estuarine NNE Indicators

- Dissolved Oxygen
- Macroalgae
- Phytoplankton
Coastal Regional Boards Lack Consistency on DO Objectives

Lack of consistency on:

• Numeric versus narrative objectives

• Some beneficial uses not cited at all

• Approach
  – Percent saturation
  – Concentration (mg/l)
  – Averaging period- mean annual vs instantaneous
Scope of Review of Science Supporting Dissolved Oxygen Objectives

• Evaluate the scientific basis for deriving DO criteria for California bays and estuaries
• If possible, derive criteria that reflect regional differences and estuary types

Clarification of Language Used in This Discussion
Criteria: Calculated numeric values based on actual data and EPA standard procedures
Objectives: Policy decisions on final numeric thresholds
Process to Develop DO Objectives Based on USEPA Virginia Province Approach (EPA 2000)

- Identify fish and invertebrate indicator species
- Review existing data on tolerance of organisms to low DO:
  - Juvenile and adult survival (acute)
  - Growth, reproduction (chronic)
- Identify most sensitive endpoints with respect to individual species
  - In absence of data, consider “nearest relative”
- If appropriate, calculate numeric criteria for consideration/discussion
Selected 20 Fish and 34 Invertebrate Indicator Species Representative of Calif. Estuaries

• Spends majority of life history in estuaries
• Representative of beneficial uses
• Regional (north/south) representation
• Represent different estuary types:
  – e.g., “open” or “closed” to tidal surface water connections
• Priority given to native and threatened species
  – introduced species also considered potentially useful as genus or family level surrogates
Criteria Derivation: Criteria Minimum Concentration (Acute)

- Data found for 21 species (12 invert; 9 fish)
  - 3 native, 5 introduced, 13 surrogates at genus or family levels
- LC50s of 4 most sensitive species ranged from 2.8-1.6 mg L⁻¹
  - Shrimp, Sturgeon, Herring, Mysid
- Calculated CMCs
  - All Cal: 3.8 mg/L (all species, regions, estuary types)
  - So Cal regional: 2.8 mg/L
  - Salmonid: 3.94 mg/L
Criteria Derivation: Criteria Continuous Concentration (Chronic)

- Data found for 10 species (4 fish; 6 inverts)
  - 0 native species, 3 introduced species, 7 genus or family-level surrogates

- 4 most sensitive species ranged from 5.35-4.67 mg L\(^{-1}\)
  - Mud crab, Sturgeon, Grass shrimp, Spider crab

- Calculated CCCs
  - All Cal: 5.5 mg/L (all species, regions, estuary types)
  - So Cal regional: 5.6 mg/L
  - Salmonid: 6.3 mg/L
Criteria For California Within Range, Though Slightly Higher than East Coast Estuaries

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>CMC (mg/L)</th>
<th>CCC (mg/L)</th>
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<tr>
<td>Draft AllCal/NorCal</td>
<td>3.9</td>
<td>5.5</td>
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<tr>
<td>Draft SoCal</td>
<td>2.8</td>
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<tr>
<td>Draft Cal Salmonid</td>
<td>4</td>
<td>6.3</td>
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<td>Draft Southeast US</td>
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<tr>
<td>Chesapeake Bay</td>
<td>Habitat Dependent; open water &gt;3.5</td>
<td>Open water 30 day &gt;5; 7 day &gt;4</td>
</tr>
<tr>
<td>EPA Salmonid</td>
<td>4</td>
<td>6.5</td>
</tr>
</tbody>
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Considerations:
- Similarity of thresholds across species supports process; not driven by outliers
- Conservative assumptions valid, and also compensate for uncertainty
- Lack of data for native species of interest, particularly for CCC
Data to Generate Larval Recruitment Curves for Native Species Also Lacking

- Allowable time that magnitude and duration of low DO results in < 5% impact on recruitment
  - E.g. Approximately 3 mg/L for 1 day, 4.5 mg/L for 30 days

- Assumptions and Data Needs:
  - Allows for impacts to individual cohorts or broods while protecting overall year-class
  - Requires species specific data (number of broods, number per brood, etc)

- Lack of data tends drives to more conservative regulation (CCC applied as instantaneous)
Additional Technical Issues for California

• Incorporate effects of salinity and/or temperature?
  – Percent saturation versus concentration

• Utility in intertidal habitats and naturally muted areas

• Natural hypoxia
  – Bar-built estuaries can trap salt during mouth closure (stratify) - prone to natural hypoxia
  – Need data on reference

Natural Hypoxia can result from “salt trapped” from inlet closure
Recommended Next Steps

• Collect DO tolerance data and larval recruitment model input for native California fish and invertebrates species
  – Not realistic for revising DO objectives in near term
  – Resource intensive; may not change criteria much

• Collect data on “reference condition” for bar-built estuaries

• Develop assessment framework and implementation guidance
  – Decisions on thresholds and how to apply
  – Identify spatial and temporal density of data needed to make a determination of impairment
Summary

• Scientifically valid and consistent approach to developing dissolved oxygen objectives across the State
  – Large improvement over existing objectives
  – Lack of data on native species is concerning, particularly for CCC

• SWRCB must decide:
  – Whether and how to use the updated criteria as NNE guidance or...
  – Work with Regional Boards to update dissolved oxygen in basin plans