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 and 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

<u>Clarification of Language Used in This Discussion</u>

Criteria: Calculated numeric values based on actual data and EPA standard procedures

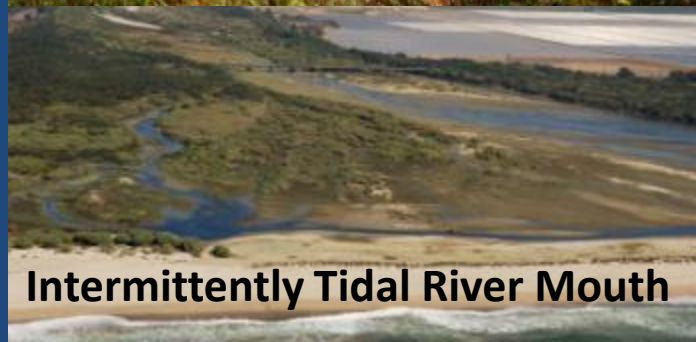
Objectives: Policy decisions on final numeric thresholds

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

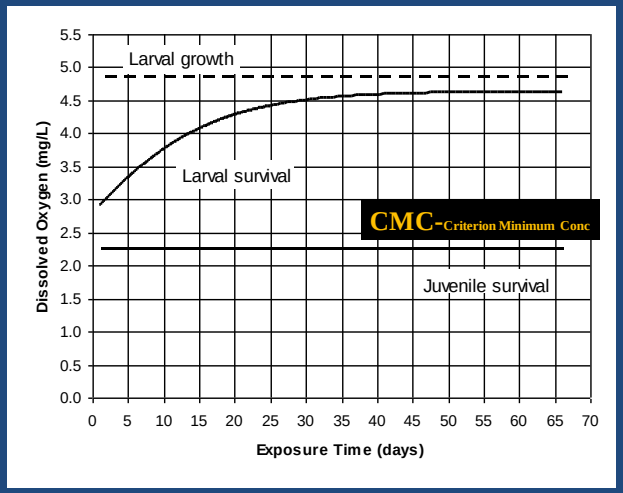
Selected 20 Fish and 34 Invertebrate Indicator Species Representative of Calif. Estuaries

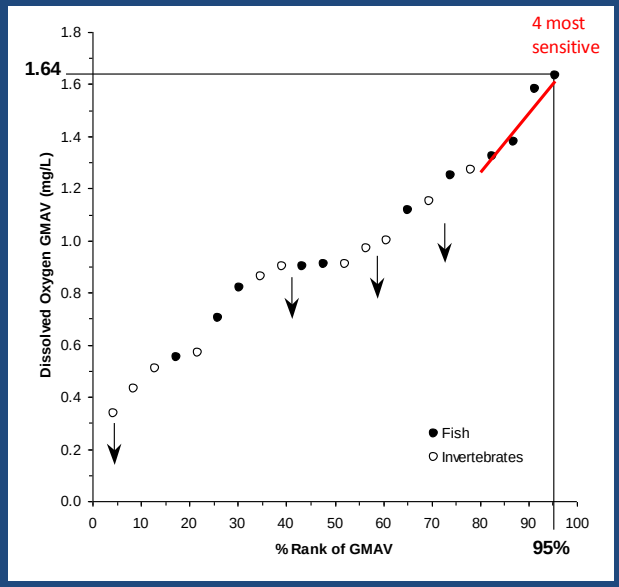
- Spends majority of life history in estuaries
- Representative of beneficial uses
- Regional (north/south) representation
- Represent different estuary types:
  - e.g., “open” or “closed” to tidal surface water connections
- Priority given to native and threatened species
  - introduced species also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



Criteria Derivation: Criteria Minimum Concentration (Acute)

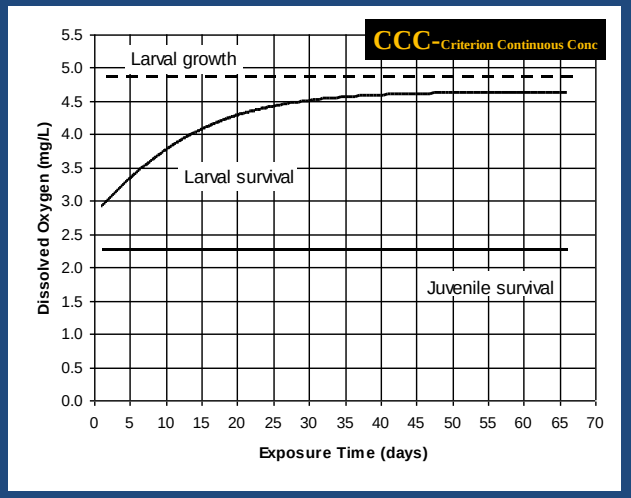
- Data found for 21 species (12 invert; 9 fish)
  - 3 native, 5 introduced, 13 surrogates at genus or family levels
- LC50s of 4 most sensitive species ranged from 2.8-1.6 mg L^{-1}
  - Shrimp, Sturgeon, Herring, Mysid
- Calculated CMCs
  - All Cal: 3.8 mg/L (all species, regions, estuary types)
  -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

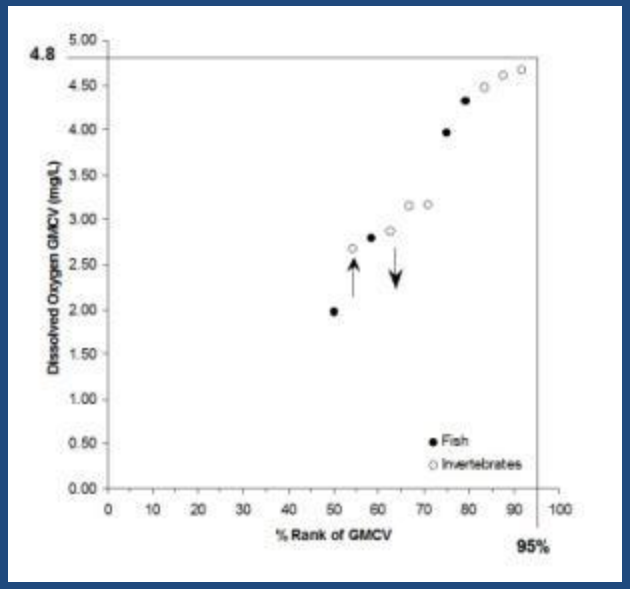




Criteria Derivation: Criteria Continuous Concentration (Chronic)

- 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

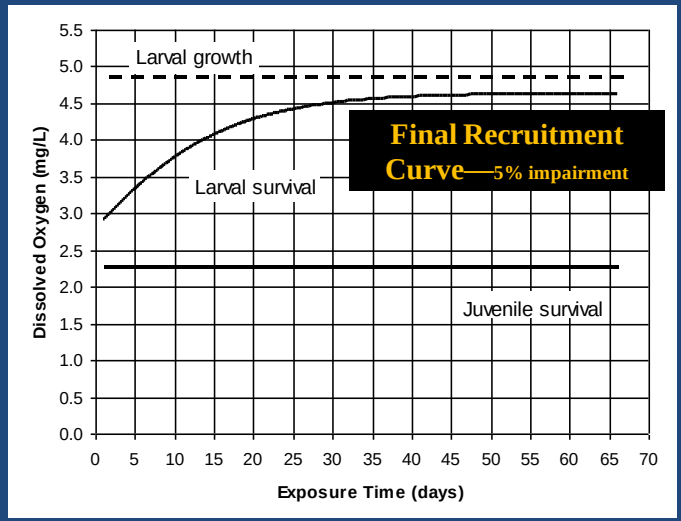
Jurisdiction	CMC (mg/L)	CCC (mg/L)
Draft AllCal/NorCal	3.9	5.5
Draft SoCal	2.8	5.6
Draft Cal Salmonid	4	6.3
Virginia Province	2.2	4.8
Draft Southeast US	3.0	4.8
Chesapeake Bay	Habitat Dependent; open water >3.5	Open water 30 day >5; 7 day >4
EPA Salmonid	4	6.5

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

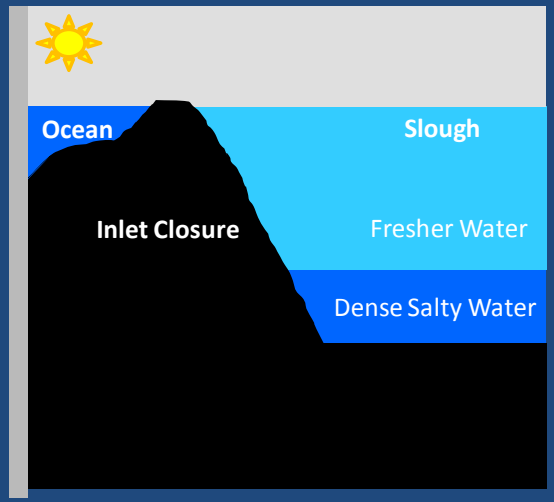
Data to Generate Larval Recruitment Curves for Native Species Also Lacking

- 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 to updated criteria as NNE guidance or…
  - Work with Regional Boards to update dissolved oxygen in basin plans