

## Science Supporting Dissolved Oxygen Objectives in California Estuaries

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### EXECUTIVE SUMMARY

California State Water Resources Control Board (SWRCB) is developing nutrient water quality objectives for the State's surface waters, using an approach known as the Nutrient Numeric Endpoint (NNE) framework. The NNE framework establishes a suite of numeric endpoints based on the ecological response of an aquatic waterbody to nutrient over-enrichment (eutrophication; e.g., dissolved oxygen, algal biomass). The SWRCB intends to use dissolved oxygen (DO) as an indicator in the NNE framework for estuaries.

All seven coastal Regional Water Quality Control Boards (RWQCB) have existing basin plan objectives for DO concentrations intended to maintain satisfactory water quality in enclosed bays and estuaries. However, these objectives are not consistent across the individual RWQCBs and reflect outdated science. Thus, recent advances in scientific understanding of DO tolerance in estuarine and marine organisms, as well as new methods for setting protective limits, may provide the technical basis for improved and more consistent objectives to protect beneficial uses.

The primary objective of this document is to evaluate the current scientific basis supporting derivation of DO objectives for estuaries and enclosed bays in California. Ideally, such objectives would be applicable to the approximately 400 estuaries found in California and address regional (i.e., north-south) differences among organisms present.

The scientific approach used in this effort is adapted from the Virginia Province Salt Water Dissolved Oxygen Criteria (USEPA 2000). Briefly, fish and invertebrate species were selected as representative of estuary class, beneficial uses, life history strategies, and regional differences in species distribution across the state. Existing literature was then reviewed for each candidate indicator species or family "surrogates" to document tolerance of the fish or invertebrate species to low DO. Two types of data were sought: 1) Acute data used to derive a maximum concentration (minimum concentration in the case of DO) to protect against short-term mortality, and 2) chronic data used to derive a value protective of lethal and sublethal effects under long-term exposure conditions. These basic data requirements were then compared against data available for species that are representative of California estuaries. The DO tolerance data were then evaluated to establish their suitability for derivation of DO criteria for protecting organisms associated with California estuaries.

### Study Findings

Our review found that there were insufficient data to derive criteria for native California species. Specifically, acute data were available for only three native species, and chronic data were not available for any native species. However, there were data available for some introduced species, and USEPA guidelines allow for the use of data from surrogate species (i.e., genus or family level) in cases where data

on native species are lacking. Ultimately, by using data from surrogate and introduced species, the minimum data requirements for calculation of acute and chronic criteria were met. In addition, there was sufficient species representation to derive separate *acute* criteria for northern and southern California estuaries that have an "open" surface-water tidal connection to the coastal ocean and those

that are intermittently closed (bar-built river mouth estuaries and lagoons). Conversely, there were insufficient data to derive separate *chronic* criteria based on region or estuary type.

Because of insufficient data issues, the SWRCB and its advisory groups had three options:

1. Collect additional DO tolerance data for native California species.
2. Apply the Virginia Province criteria on an interim basis until sufficient data are generated for native species.
3. Calculate DO objectives based on substituting genus or family surrogates for California species.

We chose to proceed with the exercise of calculating DO objectives based on substituting genus or family surrogates for California species. Dissolved oxygen objectives were calculated for the entire state (AllCal), Northern California (NorCal; north of Point Conception), and Southern California (SoCal). Dissolved oxygen objectives related to salmonids or other endangered species (sturgeon) were also calculated, because these species form a subset of the species present in California estuaries. Moreover, salmonids and sturgeon tend to be more sensitive to low DO than most other taxonomic groups, represent RARE and SPAWN beneficial uses, and have historically occupied wider distributions across the State. This substitution approach offers flexibility to establish objectives based on habitat requirements of local species assemblages and protection of applicable beneficial uses. Although the criteria were calculated using USEPA methodology (USEPA 1985), some concern regarding the reliance on introduced and surrogate species data, rather than native California species, may arise. Still, the species sensitivity distributions featured a reasonable number of data points for both acute and chronic conditions; criteria derivations were based on the four most sensitive genera. Reasonable agreement in sensitivity among the most sensitive genera suggests that results would not likely improve with additional estuarine species. Nevertheless, it may be desirable to obtain data for some California native species to increase confidence in the overall conclusions or to develop site-specific criteria.

Criteria that represent broad regions and estuary types are presented in the following table (CMC and CCC refer to acute and chronic values, respectively). The data also support some additional criteria categories that reflected species with limited distributions (e.g., sturgeon); these are described more fully in Section 6 of the report.

<b>Regions and Estuary Types</b>	<b>CMC</b>	<b>CCC</b>
All California (all systems)	4.0	5.8
Southern California (all systems)	2.9	5.8
All California (intermittently closed systems)	2.3	5.8
All California + salmonids (all systems)	4.0	6.3

In addition to acute and chronic criteria, the Virginia Province Salt Water Dissolved Oxygen Criteria (USEPA 2000) includes a criterion intended to protect cumulative annual larval recruitment. The larval recruitment criterion provides a unique set of protective targets, distinct from the acute criterion that was derived to protect the more hypoxia-tolerant juvenile and adult components of the aquatic community, and allows for varying periods of exposure depending on the concentration of DO. The default data used to derive the larval criterion do not include any California native species, but do include introduced and surrogate species. To address two basic information gaps, we recommend the following:

**1) Collect DO tolerance data for native California fish and invertebrates species.** A limitation of our study was finding sufficient data to derive criteria for different types of estuaries. This was compensated to some degree with the acute data, where broad distinctions could be made on a regional basis and between open and intermittently closed systems. However, it was not possible to draw similar distinctions with the chronic data, or to make finer distinctions within the acute data set. Regardless, we would caution against making the distinctions overly precise as setting criteria at lower values based on the apparent absence of key species may limit the ability of these species to utilize or recolonize these areas on an opportunistic basis. In any case, the potential exists to refine the criteria on a site-specific basis.

**2) Develop an assessment framework and implementation guidance.** A next step in utilizing the calculated DO objectives would be to develop an assessment protocol that specifies the temporal/spatial averaging and data density necessary to make a determination of "impairment". Implementation guidance will be needed to inform agencies and stakeholders about these DO objectives in the context of assessment, TMDLs, and NPDES permitting decisions. Guidance will also be needed to address the many estuaries that exhibit naturally occurring seasonal, diurnal, or tidally influenced periods of low DO. Consequently, consideration should be given to supporting a follow-up study to identify and formalize guidance for monitoring programs and interpretation of DO data. Part of this guidance should include methodologies to interpret temporal/spatial representation data in the context of the acute, chronic, and larval-recruitment criteria limits. Similarly, identification of appropriate averaging periods for acute and chronic criteria should help in establishing defensible objectives. Available guidance and appropriate application/implementation across Regional Boards will provide a level of assessment consistency that is currently lacking.

## **Full Text**

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