Technical Report 540
Prepared for USEPA Region IX

Developing nutrient numeric endpoints and TMDL tools for California estuaries: An implementation plan

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EXECUTIVE SUMMARY

Eutrophication is one of the top three leading causes of impairments of the nation's waters, with demonstrated links between anthropogenic changes in watersheds, increased nutrient loading to coastal waters, harmful algal blooms, hypoxia, and impacts on aquatic food webs. These ecological impacts of eutrophication of coastal areas can have far-reaching consequences, including lowered fishery production, loss or degradation of seagrass/submerged aquatic vegetation (SAV), smothering of benthic organisms, nuisance odors, and impacts on human and marine mammal health. These modifications have significant economic and social costs. In California, the impacts of nutrient loading on estuaries and coastal waters have not been well monitored and no statewide criteria or guidance exist to manage these impacts. Without management actions to reduce anthropogenic nutrient loads and other factors contributing to eutrophication, symptoms are expected to develop or worsen in the majority of systems, due to projected population increases in coastal areas.

United States Environmental Protection Agency (USEPA) Region IX and the California State Water Resources Control Board (SWRCB) have previously developed a technical approach and framework for developing numeric nutrient endpoints (NNEs) for California estuaries (USEPA 2007). The stated goal of this effort is to develop a set of numeric endpoints and Total Maximum Daily Load (TMDL) tools that can be used to address impacts from eutrophication through the water quality programs of the SWRCB, Regional Water Quality Control Boards and the regulated community. The USEPA (2007) presented a scientific framework to support the development of numeric endpoints for a suite of biological response indicators (e.g., algal biomass, dissolved oxygen, water clarity, etc.) that are directly linked with estuarine beneficial uses. The framework also highlighted data gaps and research recommendations critical for the development of numeric endpoints and TMDL tools (i.e., watershed loading and estuarine load-response models). These tools are critical because they provide the linkage between the numeric endpoints, which are based on biological response indicators, and watershed nutrient loads and other factors controlling eutrophication in estuaries.

The purpose of this document is to outline an implementation plan to address these critical data gaps in California estuaries and move forward with NNE and TMDL tool development. The implementation plan proposes a statewide approach to NNE development, with regionalization of numeric endpoints possible if warranted by differences in ecology.

Tables ES-1 and ES-2 summarize available science to support development of nutrient numeric endpoints and TMDL tools. These tables show that:

- Sufficient science exists on the physiological impacts of dissolved oxygen to proceed with interim guidance for this biological response variable
- Further research and monitoring are required to provide suggested numeric endpoints for the additional biological response variables
- Critical data gaps to support the development of watershedloading models include wet-weather loading data from a variety of urban, agricultural and undeveloped land uses
- The development of statistical estuarine load-response models by estuarine classes requires a regional dataset of watershed nutrient loading and biological response variables in a representative sample of estuaries
- Cost-effective development of dynamic-simulation models of load-response (i.e., estuarine water quality models) requires data on the major processes responsible for transformation, uptake and release of nutrients in estuaries.
- A summary of data relevant to California estuaries is needed to further prioritize funding for research

Table ES-1. Summary of existing science that would support NNE development in California estuaries.

Variable	Status of Science	Recommended Action
Surface Water Dissolved Oxygen	Physiological impacts of low DO on pelagic and benthic species is well documented, though not necessarily for resident species of California estuaries. Need to interpret existing data for relevance to resident species and identify data gaps.	Assemble expert panel to recommend key indicator species and review literature to assess applicability of existing effects data on indicator species. Set preliminary thresholds and define critical data gaps for refinement of thresholds.
Macroalgal Biomass	Current science does not provide clear linkage to impairments of beneficial uses. Need to investigate impacts of macroalgal biomass on benthic infaunal communities and SAV, with ultimate linkage to food and habitat for estuarine birds and fish.	Create research plans to study macroalgal impacts on benthic infauna and SAV. Initiate research after approval of study plans by stakeholder group.
Harmful Algal Blooms	Environmental conditions for toxin production are poorly understood. Impacts of toxins are not adequately documented, such as adverse effects on viability, growth, fecundity, etc. Need better understanding of linkage with nutrient loading. No clear linkage has been established with management controls.	Assemble a statewide group of experts to identify major data gaps and identify implementation plan needed to address them.
Aesthetics	No documentation of linkage of macroalgal biomass, surface water hypoxia, or sediment sulfide production with foul odor, bad taste, or unsightliness.	Develop study plan to establish, via focus group, levels of odor or extent of macroalgal blooms associated with poor aesthetics.
Water Clarity	Thresholds exist for east coast estuaries. Need to determine thresholds that are appropriate for SAV communities in California estuaries.	Develop a study plan to address identified data gaps with respect to light requirements of West Coast SAV species.
Surface Water Chl a	No consensus on appropriate thresholds in literature. This indicator is particularly relevant for San Francisco Bay.	Assemble panel of experts to review literature and existing monitoring data to recommend course of action.
Nuisance SAV Biomass[1]	Studies of coastal lagoons have noted overproduction SAV in oligohaline areas.	Review existing monitoring data to understand prevalence of nuisance SAV in lagoons. If prevalence is great, prioritize indicator as high course of action.

[1]This indicator applies specifically to overproduction of SAV (e.g. *Ruppia* sp.) in oligohaline lagoons. Impacts to seagrass (e.g. *Zostera* spp.) are assessed through macroalgal biomass and water clarity.

Table ES-2. Summary of status of science and recommended actions for TMDL tool development.

Tool/Data	Status of Science	Recommended Action
Watershed Loading Models (applies to both dynamic simulation and simple spreadsheet model)	Development of watershed-loading models hampered by lack of wet-weather loading data from a variety of land uses.	Two actions are recommended: 1) acquire data characterizing wet-weather loads of nitrogen and phosphorus from a variety of urban, agricultural and undeveloped land uses. This dataset will be used to create watershed-loading models and statistical load-response models for TMDL development; and 2) develop regionally calibrated dynamic-simulation models of nutrient wet-weather loading.
Simple Spreadsheet Model (to predict annual watershed nutrient loads)	Simple spreadsheet tool to predict annual nutrient loads can provide cost-effective means to improve understanding of harmful algal blooms and estuarine eutrophication. Accuracy and precision in predicting annual loads needs to be better understood.	Compare precision of simple spreadsheet model and dynamic-simulation model for predicting annual loads to estuaries.
Statistical Load – Response Models	Statistical load-response models exist for some east coast estuaries; these models are not relevant for California because of major differences in dominant primary producer communities and hydrology. Need to better investigate major variables controlling biological response to loads in California estuaries. Monitoring data that relates total nutrient loads to estuarine biological response are only known to be currently available for two estuaries (SF Bay and Upper Newport Bay). Data are currently being generated for 5 more lagoons. A more comprehensive data set is required to develop load-response models.	Acquire a datasets that relates nutrient loads to estuarine biological response. Two approaches are suggested: 1) develop a statistical load-response model for an existing long-term data set and 2) collect data on an estuarine biological response through a probability-based sample of estuaries. Both approaches will be used to understand the spatial and temporal variability in estuarine load-response.
Dynamic-Simulation Models (of estuarine water quality)	Data are generally lacking on the major processes responsible for uptake, transformation, and release of nutrients in California estuaries.	Conduct a comprehensive literature review and survey of existing research in California to identify key processes that need to be modeled, locate existing and relevant data, and identify major data gaps. This report can be used to identify priorities for future funding by entities such as Sea Grant, USEPA, etc.

The implementation plan for NNE development proposes a four-phased approach that would allow for: 1) an initial statewide outreach and preparation of supporting technical documents, 2) the development of NNEs for dissolved oxygen, 3) Research to address data gaps for development of NNEs for the additional biological response variables, and 4) TMDL tool development. The conceptual framework, decisions regarding technical approaches, prioritization of studies supporting numeric endpoint and tool development, and selection of numeric endpoints would be done through a stakeholder-driven process representing the regulators, the regulated community, environmental NGOs, scientific experts, and the general public.

Full Text

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/540_CA_NNE_PhaseII.pdf