Interbay comparisons of drivers of primary production using generalized additive models

Dr. Marcus W. Beck

February 12, 2018

#### Overview

Managing primary production is a critical concern for coastal regions around the country. The need to understand drivers of primary production is particularly important near estuaries or open embayments that act as mixing areas of pollutants from the watershed and nearshore runoff. A standard conceptual model of nutrient response dynamics in coastal areas does not exist because drivers of change act at different spatial and temporal scales that are site-specific. Similarly, interpreting the efficacy of management actions to mitigate or prevent environmental degradation is difficult because actions can occur at time scales that may or may not have ecological relevance.

Analysis tools are needed that can describe long-term trends in primary production relative to drivers acting at different scales. These tools are necessary to describe natural changes over time to inform our understanding of water quality dynamics and can also be used to evaluate or anticipate outcomes of management actions. Recent applications of Generalized Additive Models (GAMs) to describe water quality changes in coastal environments have shown promise. GAMs are appealing because they are less computationally intensive than alternative methods, support a hypothesis-testing framework, and provide estimates of model uncertainty. The Chesapeake Bay Program has begun development of an open-source software program to identify water quality trends using GAMs. However, this program is limited in scope and has not been applied to other datasets outside of Chesapeake Bay.

This project will develop new tools for time series analysis that will allow a hypothesis-driven approach to identify multiple drivers of primary production in space and time. We will quantify the variance in production across different regions that is explained by climate, chemical, and physical drivers to develop conclusions on the importance of each controlling factor. This will enable a more targeted approach for managing water quality issues in coastal regions by reducing the uncertainty of conclusions from monitoring data.

#### Approach

We will focus on routine monitoring data of chlorophyll from San Pedro Bay at the outflow of the Los Angeles River. These data will also be compared with long-term time series from San Francisco Bay, Chesapeake Bay, and Tampa Bay. Specific questions include:

* Can a unified GAMs method be used to distinguish the relative impacts of climate, physical, and chemical drivers in estuarine and coastal primary production?
* What do these relative differences tell us regarding which factors are important for managing coastal water quality issues in southern California?
* How do differences in drivers of primary production compare between systems at a national-scale and in response to past management actions?
* Can this information be used to improve how management decisions are made to mitigate or prevent issues with cultural eutrophication?

#### Proposed budget and collaborators

A total of $45000 is requested for Marcus Beck to cover approximately thirty days of work to occur over the next year. Matching funds of approximately $10000 will also be provided by the San Francisco Estuary Institute (SFEI) for the analysis of monitoring data in the San Francisco Bay area. These combined funds will be used to coordinate efforts between collaborators to synthesize, analyze, and interpret monitoring data in each of the study regions. Funds will specifically be used to support meetings between collaborators (remote and in-person), software development, and writing after completion of the analysis tools.

Collaborators within SCCWRP will include Eric Stein (Biology), Raphael Mazor (Biology), Martha Sutula (Biogeochemistry), and Nikoly Nezlin (Information Management and Analysis). External partners from SCCWRP member agencies will include individuals from the Los Angeles County Sanitation District, Los Angeles County, and Los Angeles Regional Water Quality Control Board for synthesis and assessment of the San Pedro water quality data. External partners will also include David Senn and Ian Wren from SFEI for the San Francisco Bay data, Rebecca Murphy of the University of Maryland Center for Environmental Sciences for the Chesapeake Bay data, and Yongshan Wan and James Hagy of the Office of Research and Development (USEPA) for the Tampa Bay data.

#### Benefits to SCCWRP and its member agencies

Key products of this research will include a software package that can be used to identify drivers of water quality change in nearshore coastal environments. This software will be designed for use by practictioners that are concerned with the management of primary production in aquatic environments where nutrient pollution is a critical concern. This includes several areas in southern California where long-term data are available, ranging from tributaries (e.g, Tijuana River estuary) to large areas with coordinated monitoring efforts across agencies (e.g., Bight Regional Monitoring Program). Literature products will also include a detailed vignette on application of the analysis software and a research paper to describe results of inter-bay comparisons on the national scale. All data products used for analysis, including the software, will be made available in an open source environment to ensure transparancy and accessibility within the broader management community.