Four decades of water quality changes in the upper San Francisco Estuary

Marcus W. Beck[1], David Senn[2], Phil Bresnahan[2], Emily Novick[2], James D. Hagy III[1], Thomas Jabusch[2]

[1]*USEPA National Health and Environmental Effects Research Laboratory*
Gulf Ecology Division, 1 Sabine Island Drive, Gulf Breeze, FL 32561
Phone: 850-934-2480, Fax: 850-934-2401
Emails: beck.marcus@epa.gov, hagy.jim@epa.gov

[2]*San Francisco Estuary Institute*
4911 Central Avenue, Richmond, CA 94804
Phone: 510-746-7334, Fax: 510-746-7300
Emails: davids@sfei.org, philb@sfei.org, emilyn@sfei.org, thomasj@sfei.org

Version Date: Wed May 25 08:44:44 2016 -0500

Abstract

Recent methods for trend analysis have been developed that leverage the descriptive potential of long-term time series. Combined with these methods, multi-decadal datasets of water quality in coastal systems can provide valuable opportunities to gain insight into ecosystem properties and drivers of change. This study describes the application of an estuarine adaptation of the Weighted Regressions on Time, Discharge, and Season (WRTDS) approach to describe water quality trends in the upper region of the San Francisco Estuary (SFE), a primary source of nutrients into the system. This statistical technique is data-driven where the parameterization of the functional model changes smoothly over time following dynamic patterns of season and flow. By doing so, changes over time that have not been previously quantified can be described, including variation in flow-normalized concentrations, frequency occurrence of extreme events, and response to historical changes in the watershed, all of which are important needs for understanding trends in the SFE. The goal of the analysis is to apply the WRTDS model at multiple stations in the Delta and Suisun Bay regions of SFE to provide novel descriptions of water quality changes over time and relationships between key species of dissolved inorganic nitrogen (ammonium, nitrate/nitrite, total). This variation is considered in the context of varying contributions of input flows from the Sacramento and San Joaquin rivers, as well as tidal exchange with the central SFE. The results are described in the context of conceptual relationships between water quality and drivers of change to generate hypotheses of mechanistic relationships using selected examples from the trend descriptions. Overall, this analysis provides an ecological and management-based understanding of historical trends in the SFE as a means to interpret potential impacts of recent changes and expected trends in this dynamic system. An argument is also made for more comprehensive evaluations of long-term monitoring datasets to understand relationships between response endpoints and causal mechanisms in coastal waters.

1 Introduction

- Paragraph 1 - how and why are trends interpreted - raw data, surrogates, various methods, what have been implications of using different approaches

- Paragraph 2 - WRTDS for estuaries, application to Tampa Bay as test set, further validation in Patuxent

- Paragraph 3 - SF estuary, unique and prominent location, full story is not known (historical context and recent changes), no one has empirically described the data, how is this related to the delta (a vigorous biogeochemical reactor)
- Paragraph 4 - Study goal and objectives
  - Provide a description of trends - annual, seasonal, spatial, response to flow, change by analytes
  - Detailed description of selected sites in the context of conceptual relationships - 1) nonlinear or extreme quantile changes site TBD, 2) P8 and WWTP improvements, 3) Suisun DIN, SiO2, Chla, and clams
  - What this means for understanding other systems

2 Methods

- Study location and data - describe conceptual relationships
- WRTDS method - estuarine adaptation, how was it applied to San Francisco Estuary (SFE)

3 Results

4 Discussuion

What additional information is needed?

method leads to hypothesis generation or mechanistic explanations of change, verification of conceptual links

$$\ln(DIN) = \beta_0 + \beta_1 t + \beta_2 \ln(Q) + \beta_3 \sin(2\pi t) + \beta_4 \cos(2\pi t) + \varepsilon$$

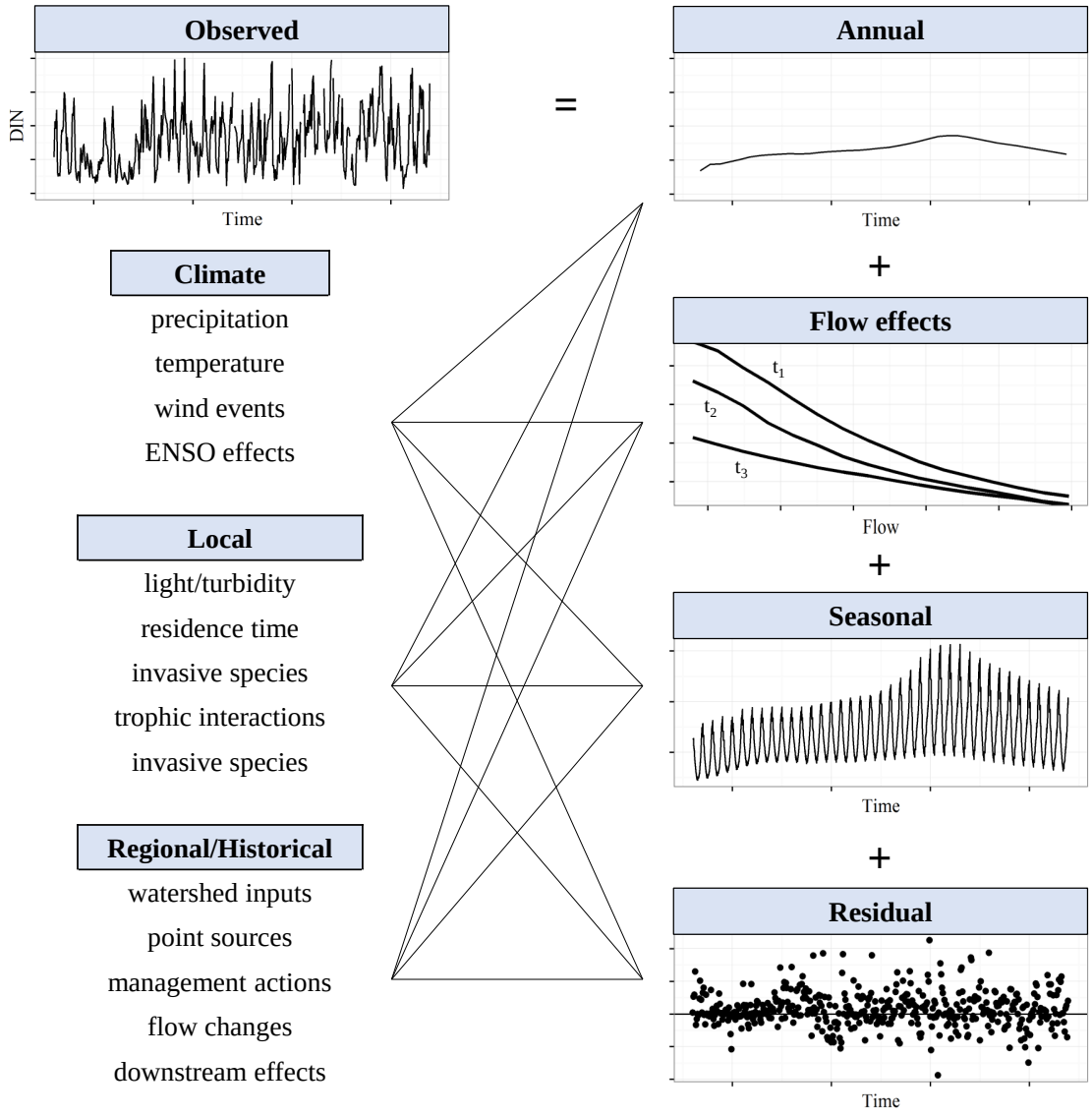

Fig. 1: schematic