Concentrations, loads, and associated trends in nutrients entering the Sacramento-San Joaquin Delta, Priority Ecosystems Project

I**ntroduction**

Discuss here the purpose of the paper. The purpose is to demonstrate what the concentrations, loads, nutrient ratios, and associated trends in concentrations, loads, and ratios are at both the Freeport site and the Vernalis sites. A secondary purpose is to show what the sources of total nitrogen and total phosphorus are above the Freeport and Vernalis sites, and how they vary from the headwaters to the downstream locations. The impetus for this study is the upcoming change in the treatment process at the Sacramento Regional Wastewater Treatment plant. When fully operational in a few years, the discharge of nitrogen to the Sacramento River will be mostly eliminated. Most of the nitrogen currently being discharged to the Sacramento River is in the form of ammonium. Previous investigations have shown that the load of nitrogen substantially increases below the treatment plant discharge. Both nitrate and ammonium are bioavailable for primary productivity but the amounts of ammonium and/or the ratios of nitrate to ammonium are thought to have an effect on primary productivity. Ammonium concentrations are not implicated as causing acute or chronic toxicity in the levels currently being measured. Although the amount of ammonium-nitrogen plus nitrate-nitrogen (Dissolved Inorganic Nitrogen) is not enough to result in eutrophication of the estuary, the amounts discharged have been implicated as affecting primary productivity (driving it down) and changing the species composition of the phytoplankton community from diatom dominated to green algal dominated (See papers by Parker and Glibert).

Removing the nitrogen from the treatment plant will likely drive down the ratio of nitrogen to phosphorus in the Sacramento River and Delta which may result in nitrogen becoming a limiting nutrient, and may result in further changes in the phytoplankton species composition. The Sacramento River at Freeport site is ideally suited to understand what the concentrations and nutrient ratios entering the Delta will be as there has been a long-term monitoring program(s) at that location for the common forms of nitrogen and phosphorus. The current concentrations and loads are indicative of what is to be expected entering the Delta ecosystem once the treatment plant upgrades are finished. In addition, to the Sacramento River, we will also model the same constituents at the other major river entering the Delta, the San Joaquin River.

**Approach and Methods**

We will use three methods to consider either concentrations, loads, trends, and sources. These include EGRET modeling for nitrate, ammonium, Kjeldahl Nitrogen, ortho-phosphorus, and total phosphorus, one continuous nitrate sensor at the Freeport site, and SPARROW modeling.

Concentrations and Loads and their Trends: The following nutrients will be modeled: nitrate, ammonium, Kjeldahl Nitrogen, orthophosphorus, and total phosphorus. Total nitrogen is the sum of nitrate and Kjeldahl Nitrogen. EGRET will be used to model concentrations, flow normalized concentrations, loads, and flow normalized loads. EGRET model output can be used to report on daily, seasonal, or yearly concentrations and loads. EGRETci will provide statistics on trends in concentration and load and can be used to plot confidence limits around the flow normalized concentrations and fluxes. In addition to EGRET, we will use the nitrate sensor data at the Freeport station to compare the concentration and load estimates using EGRET (which relies on discrete samples).

SPARROW (2012) modeling will be used to show sources of total nitrogen and total phosphorus to the Sacramento and San Joaquin Rivers.

**Data Sources:** NWIS and Kratzer report, Wise paper on SPARROW

**Results and Graphics**

Discharges for the period of record, and quantile Kendall analysis of the discharge records. Brief discussion of wet and drought years.

Plots of flow normalized concentrations and flow normalized fluxes of nitrate, ammonium, Kjeldahl N, orthophosphate, and total phosphorus for Freeport and Vernalis site. Use the EGRETci plots for this.

Accompany the plots with a:

Table of statistical significance from EGRETci for each of these constituents for concentration and flux (use statistical method from Hirsch paper to show if a trend is likely, unlikely, highly likely, etc. The EGRETci output will provide this).

**Table of annual loads** and average concentration for period of record at Freeport and Vernalis sites.

Plot of nitrate sensor data with 15 minute discharge values from the Sacramento River at Freeport site.

Plots of nitrate to orthophosphate **ratios,** total nitrogen (total Kjeldahl plus nitrate) to total phosphorus **ratio**, dissolved inorganic nitrogen (nitrate plus ammonia) to orthophosphate ratio, nitrate to ammonia ratio. These ratio plots will use **molar quantities of each constituent**, not concentration. Each individual plot should contain the ratio, and also the molar concentrations of the individual constituents. For example, DIN (dissolved inorganic nitrogen) vs ortho-phosphorus will show the ratio (nitrate plus ammonium) to ortho-phosphorus and the molar concentrations of nitrate, ammonium, and ortho-phosphorus.

From the SPARROW model, river mile plots of total nitrogen and total phosphorus. Maps of total annual load and yields of total Nitrogen and total phosphorus for the Central Valley.

**Discussion**

Discussion will focus on the concentrations and loads and trends of nutrients and most importantly on bioavailable constituents using the ratio plots as a starting point for the discussion. Discuss which trends are significant in either direction and which have no trends. The discussion will primarily be on how the riverine inputs may change the Delta to a predominantly nitrogen limited system.

Summary