DELTA SCIENCE FELLOW 2020

Delta Stewardship Council
Delta Science Program

Sea Grant California

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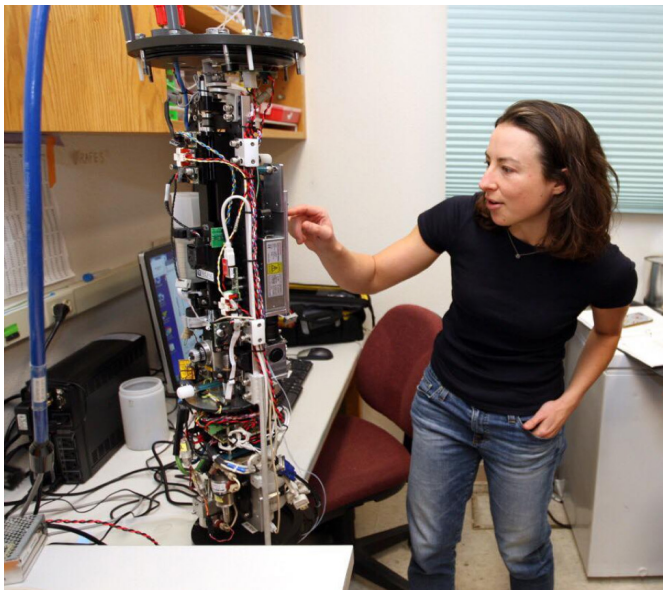
WHY THIS RESEARCH MATTERS

The San Francisco Bay-Delta ecosystem has experienced a dramatic decline in pelagic fish since 2001, particularly in Suisun Bay (a phenomenon known as "Bad Suisun"). Research suggests that this decline is caused by reduced phytoplankton biomass, which was initially attributed to high ammonia concentrations in wastewater effluent, and invasive clams that consume the phytoplankton. However, this study indicates that salinity tolerances of different phytoplankton plays an important role in determining regions of high and low biomass. As work is underway to reduce wastewater nitrogen pollution, understanding the complex mechanisms underlying "Bad Suisun" is important to restoring ecosystem health.

Do light, nutrient, and salinity interactions drive the "Bad Suisun" phenomenon? A physiological assessment of biological hotspots in the San Francisco Bay-Delta



Alexis Fischer prepares an Imaging FlowCytobot (IFCB) for deployment on the R/V Peterson for the monthly USGS cruise in the San Francisco Bay-Delta. The IFCB is a submersible imaging-in-flow cytometer, which when coupled with tools for automatic classification of images, can produce abundance estimates of phytoplankton taxa to the species- and genus-level in near real-time. Photo: Dan Coyro.

PROJECT

This project assessed the physiological basis for reduced phytoplankton growth in Suisun Bay, prior to the major upgrade at the Sacramento Regional Wastewater Treatment Plant (SRWTP), which is responsible for 90% of the nitrogen released into the bay. The work involved analyzing almost three decades of historical field data from the bay-delta and using it to build a model to evaluate environmental drivers of phytoplankton biomass. Discoveries from the field data were then tested through laboratory culturing experiments. By illuminating the interacting effects of bottom-up drivers (light, nutrients, salinity) on phytoplankton, this research helps provide a fundamental understanding of this complex ecosystem.

RESULTS

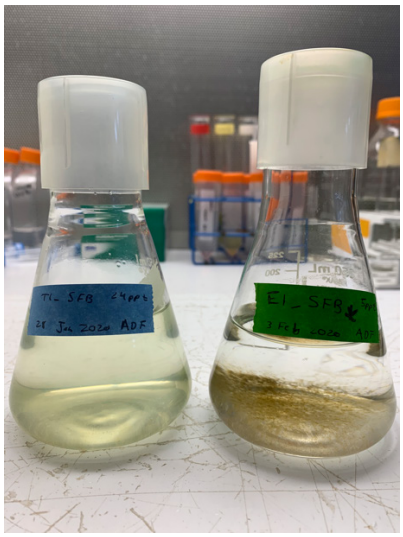
The analyses revealed that lower phytoplankton biomass in Suisun Bay is partly due to its intermediate salinity, which phases out the dominant freshwater and marine diatoms, leaving a "dead zone". Fischer then examined the spatial range of this intermediate salinity zone (ISZ) over time and found that it varies seasonally and annually, due to outflow from the delta. During drought years, the ISZ extends further upstream, while in wet years, it moves further downstream.

MANAGEMENT APPLICATIONS

Suisun Bay is a critical nursery for many fish species, and a plan for its restoration and management was completed in 2014. This plan included upgrading SRWTP to reduce nutrients, especially ammonium, in wastewater effluent. Given that ammonium was not found to be a significant driver of diatom biomass in this study, the planned ammonium reductions from the SRWTP upgrade may not have the desired effect of reversing "Bad Suisun". Instead, changes in how freshwater outflow from the delta is released might have more of an effect because salinity was found to be a major driver of diatom biomass.

For example, if delta outflow were increased throughout the year, such that the ISZ moved further downstream, this would be expected to increase freshwater diatom blooms in Suisun Bay. In comparison to other phytoplankton, diatoms are among the highest quality food for zooplankton and fish. This research will help inform resource managers by improving the understanding of phytoplankton dynamics.

Laboratory culture experiment set-up. (top) Fischer uses a microscope and mouth pipet to isolate cells of the dominant marine and freshwater diatom genera, Thalassiosira and Entomoneis, from upper San Francisco Estuary water. (bottom) Many weeks later, these isolated cells have grown into robust cultures. Photos: Alexis Fischer.



SELECT PUBLICATIONS AND PRESENTATIONS

Fischer AD, Berg GM, Hayashi K, Kudela RM (in prep). Spatial and seasonal patterns of environmental variables and phytoplankton photosynthetic efficiency from the Sacramento River to Suisun Bay, California.

Fischer AD, Kudela RM. 2020. Is Intermediate salinity partly responsible for low primary productivity in the upper San Francisco Estuary, California? Ocean Sciences Meeting, San Diego, CA, February 2020.

Fischer AD, Kudela RM. 2018. Bottom-up drivers of phytoplankton biomass in the upper San Francisco Estuary. Nutrient Management Strategy Program Meeting, Menlo Park, CA, August 2018.

Fischer AD. 2018. Facial Recognition for San Francisco Bay Plankton. Public Seminar at the Exploratorium Museum, San Francisco, CA, August 2018.

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