Anthropogenic influences on biological uptake and transformations of nitrogen and phosphorus in southern California coastal streams

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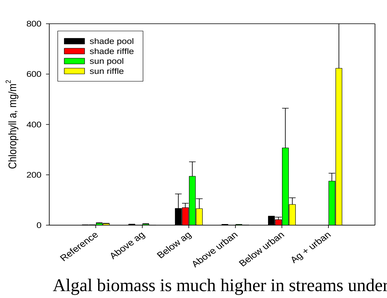
Abstract

The south coast of California has been subject to substantial development in recent decades, and the human population in this region continues to grow rapidly. Changes in both the intensity and the type of land use often result in increases in nutrient inputs (principally nitrogen and phosphorus) to nearby streams and rivers, and subsequent transport of these nutrients to the coastal ocean. Biological processing of nitrogen and phosphorus in stream water can alter both the form and the absolute amount of N and P which are delivered to coastal systems. We are conducting research to determine answers to the following questions: 1) How do changes in nutrient concentrations affect the composition of photosynthetic communities in streams and rivers, and 2) How do different components of the photosynthetic communities (algae, vascular plants, cyanobacteria) function with regard to nutrient processing, and how do those functions change across streams receiving a wide range of nutrient inputs? Through a combination of monitoring and experimental research, we ultimately hope to develop a predictive model for the community-level and functional responses of stream communities to land use changes on the south coast of California.

2002: algal community response to land use changes

Methods:

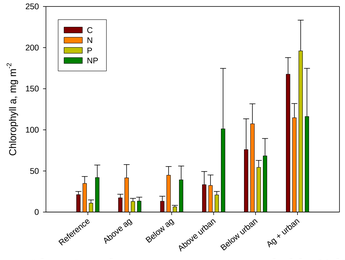
- 4 watersheds: reference, agricultural , urban, and urban + agricultural.
- Surveyed algal biomass and community composition
- Nutrient diffuser experiment to determine algal response to nutrient enrichment



Algal biomass is much higher in streams under anthropogenic influence.

Reference site: thin film of mixed community diatoms, N-fixing cyanobacteria

Ag + urban site: green macroalgae dominate



Algae in reference streams are probably N-limited; those in urbanized streams do not respond to nutrient addition.

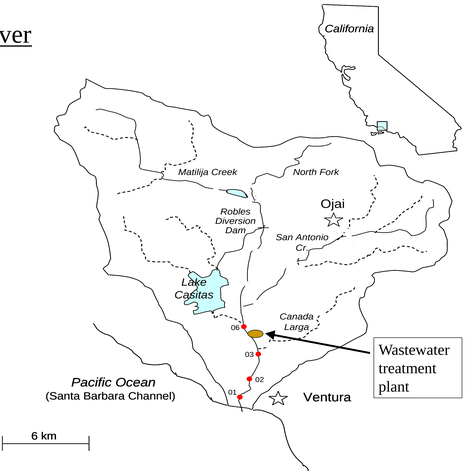
Nutrient diffuser array

Conclusions:

- algal community composition varies dramatically with land use; biomass also varies, by more than two orders of magnitude
- several streams show nitrogen limitation of benthic algal growth; urbanization may interfere with algal response to nutrient enrichment

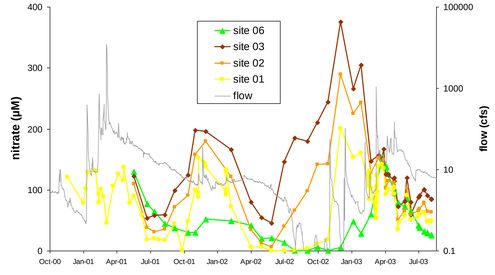
2003: nutrient processing and photosynthetic community response to a point source on the Ventura River

A wastewater treatment plant on the Ventura River discharges effluent high in nitrogen and phosphorus, resulting in locally elevated N and P concentrations in the river water. Within several kilometers of river flow, these high concentrations of nutrients decrease dramatically. Upstream of the plant, the river is dominated by filamentous macroalgae; downstream sites shift from macroalgal dominance in spring to near 100% cover by vascular plants in the summer and fall. We are investigating the relative importance of plants and algae to in-stream processing of nitrogen and phosphorus.



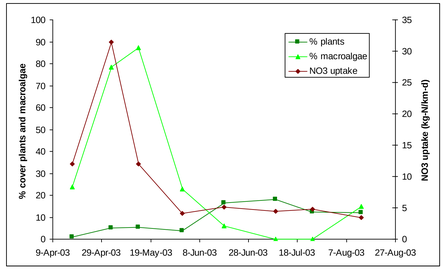
Through the spring and summer of 2003, vascular plants (*Ludwigia hexapetala*) have overgrown the river and become the dominant cover downstream of the wastewater treatment plant.

During the same period, filamentous macroalgae have remained dominant upstream (*Cladophora*, *Rhizoclonium*, and *Enteromorpha* spp.).

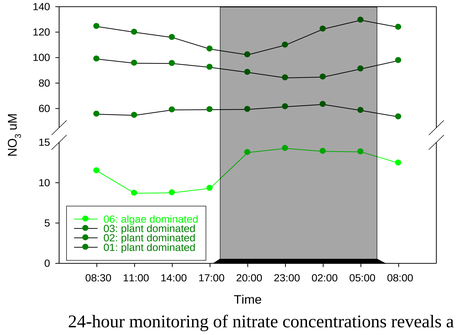


Nutrient concentrations peak in the winter, when floods have scoured most plants and algae from the riverbed. As photosynthetic organisms grow back during spring and summer, nutrient concentrations decrease. In addition, nitrate is consistently reduced with distance downstream from the wastewater treatment plant (from site 03 to site 01).

The highest rates of nitrate removal occur in the presence of filamentous macroalgae:



Below the treatment plant, the highest rates of nitrate uptake coincide with springtime macroalgal dominance.



24-hour monitoring of nitrate concentrations reveals a daytime draw-down at the upstream, algal-dominated site.

Works in progress:

- C:N:P analysis of plant and algal tissues to determine N and P storage capacity
- Greenhouse experiments to quantify N and P uptake rates
- Denitrification assays comparing algal, plant, and inorganic substrates

Future work: Field and/or greenhouse stable isotope tracer additions to further quantify N processing capacity of plant, algal and microbial communities