EXPLORE THE ISSUE BEING INVESTIGATED

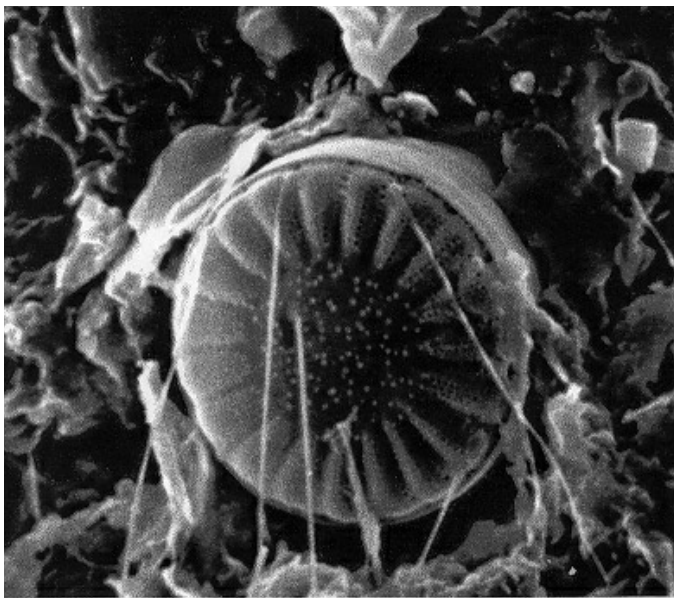
Why does contamination of a coastal salt marsh with diesel fuel lead to increased microalgal biomass?

When we hear about the contamination of water by oil spills, such as that which occurred by the grounding of the Exxon Valdez, we recall dire images of oil soaked sea birds unable to fly, sea otters covered with sludge, and slick, blackened shorelines. We can't image any wildlife surviving such devastating pollution. However, ecologists know well that pollution events such as an oil spill can influence a food web in unexpected ways. So while our images of such tragedies focus on the adverse impact suffered by animals at the top of the food web, we have to keep in mind that other quite different changes may be occurring down farther in the food web. To really understand the effects of contamination of an ecosystem, we must examine the effects on the entire community living in the ecosystem.

Ecosystems are largely structured by who eats whom. The different levels of consumers in an ecosystem are referred to as "trophic levels." Trophic levels are organized into a series called a "food chain." The base of any food chain is made up of autotrophs, organisms that are able to capture light energy from the sun in order to manufacture their own food. Plants, algae, and some bacteria fall into this category. Heterotrophs are organisms that cannot manufacture their own food, and instead consume other organisms to obtain energy. Heterotrophs include animals, fungi, and most protists and bacteria. Food chains offer a simplified view of an ecosystem, as more often than not any given consumer feeds on more than one kind of other organism, leading to a more complex "food web."

Food webs exist in all ecosystems. The benthic food web -- the food web of the sediment in an aquatic ecosystem -- is particularly interesting to study because the relationships in a benthic food web significantly influence the impact of any pollution-induced changes. The introduction of pollutants will sometimes influence a food web in a manner similar to that of a predator, reducing numbers of an intermediate level; other times the introduction of pollutants will influence a food web at its base, affecting autotrophs. If contamination by a pollutant reduces the population of benthic intermediate-level grazers, the result might well be an increase in the biomass of the base-level autotrophs, simply because there are fewer grazers feeding on the autotrophs.

Conversely, if pollution contamination reduces the amount of autotroph biomass, a ripple effect up the food web could result in the reduction in grazers and higher-level predators. Therefore, a complete examination of the effects of contamination requires analysis of not just the highest trophic levels, but also a careful look at interactions at lower trophic levels.



Microalgal cell in the sediment. This photosynthetic diatom is a member of the benthic community. It lives within the sediment of aquatic systems and serves as food for meiofauna grazers. (SEM photo courtesy of Kevin Carman)

Diesel fuel is a highly toxic pollutant, and contamination by it can reduce marine biodiversity, community density, and reproductive success of meiofauna (the grazer heterotrophs in a benthic food web). In some cases, however, diesel fuel contamination actually seems to result in increased microalgal biomass!

A possible explanation for the increases seen in microalgal biomass is that contaminates may reduce the abundance of sensitive meiofaunal species that consume microalgae. When populations of intermediate-level consumers are reduced by the contamination, the direct result is to reduce their grazing on microalgae, and as a consequence of this reduced grazing the organisms underneath the intermediate-level consumer on the food web increase in density.

This "reduced grazing hypothesis" was the focus of a study conducted by researchers from Louisiana State University at Baton Rouge. Kevin Carman, John Fleeger, and Steven Pomarico examined the effects of diesel-contaminated sediments on the microalgal-meiofaunal levels (corresponding to autotroph-grazer relationship) in the food web of a coastal salt marsh. By introducing the contaminant and then monitoring effects on the number and type of organisms that make up the microalgae population, they were able to determine how the pollution was affecting the microalgae. They also determined the amount of grazing on these organisms following the contamination, to see if grazing by meiofauna was influencing changes in the microalgae community.