N.H. Sea Grant Research Project Progress Report

Today's date: 30 March 2011

Project number: R/CE-141

Project title: Nutrient, trace metal and particle release from sediments in the Great Bay Estuary and Riverine System

Project initiation date: 2/1/10

Principal investigator: Linda Kalnejais

Affiliation: UNH

Associate investigator(s) and affiliation(s):
Professor Diane Foster, UNH

Brief project overview/Abstract:
The quantity of nutrients and trace metals that are released from the sediments of the Great Bay is unknown. This project aims to quantify if the sediments are an important source for these species with a combination of geochemical measurements, novel erosion chamber experiments and physical observations of fluid stresses at the sediment-water interface. The release due to both chemical reactions in the sediment and sediment resuspension will be determined to provide information on the release from sediments under both quiescent and stormy conditions.

Objectives:
The goal of this project is to determine the chemical and physical mechanisms that release nutrients and trace-metals from the fine-grained sediments of the rivers and estuary of the Great Bay, and to assess if the sediments are a significant source of these contaminants to the Great Bay aquatic ecosystem.

Research findings/accomplishments/progress to date:
Field work started on this project in the Fall of 2010. The sites sampled were offshore Wagon Hill Farm (site WH) and Thomas Point (site TP). The WH site was selected to investigate the tidal riverine input into the Bay, and the TP site is considered representative of the muddy sands within the Great Bay estuary. At each site, Kalnejais and graduate student Vincent Percuoco collected sediment cores and sectioned them to provide high resolution porewater and solid phase records. Erosion chamber experiments were performed at the same time as the sediment sampling. The sediment sampling coincided with the work of Foster and graduate student Meagan Wengrove who deployed ADV and sonar instruments for at least 24 hours at each site. Data processing of the physical measurements is currently underway.

The porewater nutrient profiles collected at Thomas Point are shown in Figure 1. The data reveals a strong flux of ammonium and silicate from the sediments into the water column. There is no flux of phosphate, most likely due to trapping of phosphate by the

surface iron oxyhydroxide layer. The flux of ammonium can be estimated to be 50 □mol/m^2/hr.

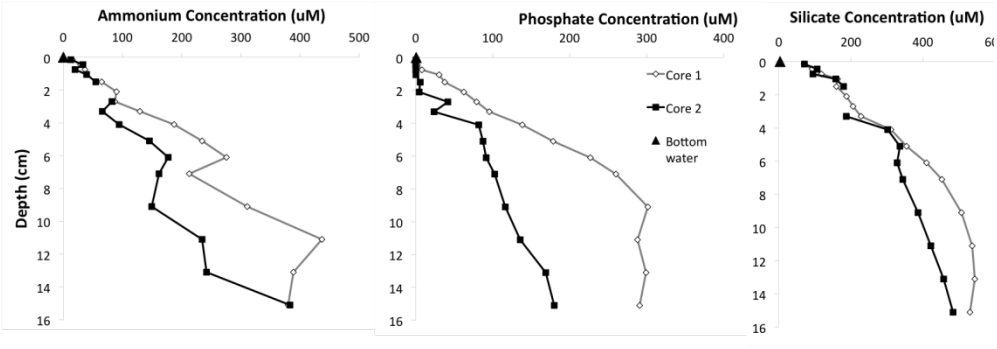

Figure 1. Porewater concentrations measured by Kalnejais and graduate student Vincent Percuoco at Thomas Point in September 2010. Cores 1 and 2 are replicate cores.

This ammonium flux was measured at a water temperature of 10^{o}C, considerably lower than the maximum temperatures that occur in the Great Bay (up to 20^{o}C is recorded by the Great Bay buoy). Reactions rates increase with increasing temperature so it is likely that remineralization in the sediments was more intensive earlier in the summer, and that the diffusive flux of ammonium was greater. As a back of the envelope calculation, the diffusive flux measured at this site can be conservatively scaled up to represent 50% of the estuary area upstream of Durham Point for 50% of the year. This is clearly a very rough estimate, however the analysis suggests that 70 tons of nitrogen per year are released from sediments. While this value is small compared to the loads to the whole estuary from rivers and runoff (1000 tons/year, PREP (2009)) it is comparable to the quantity of nitrogen released from waste water treatment plants into Great Bay and Little Bay, which was estimated from data in Trowbridge (2008) to be about 200 tons of nitrogen per year. The magnitude of this release and the uncertainty in the estimate make it important to continue this project and improve our understanding of the geochemical processes driving this release.

The erosion chamber results for the TP site are shown in Figure 2. The erosion threshold for TP is 0.18 N/m^2 and beyond this value the quantity of particles released into the water column increases steadily. There is a coincident release of silica and ammonium with resuspended particles, suggesting resuspension is an important mechanism contributing inorganic nitrogen and silica to the waters of the Great Bay.

Analysis of the metals in the porewaters and solid phase is currently being undertaken by Kalnejais and Percuoco and sampling at both sites in spring and summer of 2011 is planned to provide information on temporal variation in sediment geochemistry and resuspension fluxes.

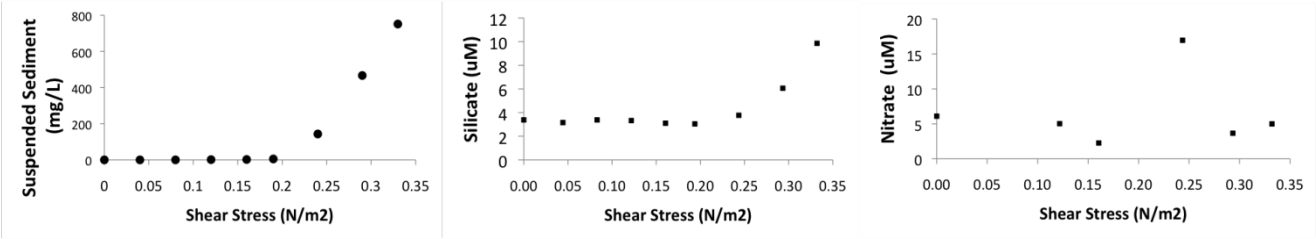

Figure 2. Erosion chamber experiment conducted at Thomas Point in Sept. 2010. The ammonium data has the same form as the silicate data but will not be available until an external calibration is complete. There was no phosphate release detected.

Impacts to date:
The porewater data collected to-date suggests that the sediments are an important source of nitrogen to the Great Bay. This is a significant finding that has the potential to impact management of the nutrient input from wastewater treatment plants and diffuse sources in the future. Our continuing work under this project will provide more data and a mechanistic understanding of these preliminary results to ensure we can provide the most accurate assessment of the role of sediments to policy makers.

Problems encountered:
This project was started 3 months later than intended due to the difficulties in finding suitably skilled graduate students to work on this project. The students best suited for this project were unable to start early in the summer, so our first field campaign was in September after both students had arrived at UNH for the start of the fall semester. Over the summer Kalnejais employed an undergraduate student on an hourly rate to prepare for the September sampling, so that once both graduate students were available, the field work was able to get underway quickly.

The ADV instrument deployed at both sites was suffering from a sporadic electrical fault and some data was lost during each deployment. Foster and graduate student Wengrove have resolved this issue and are continuing testing to ensure this will not happen again.

Publications to date (please attach PDF if applicable):
none

Presentations to date, with published abstract citation if applicable:
Kalnejais, Linda. “The Calm and the Storm: Mechanisms of Metal Release from Coastal Sediments” Invited talk at University of Massachusetts, Dartmouth.

Kalnejais, Linda. “Human Impacts in Estuaries”. Centers for Ocean Sciences Education Excellence (COSEE) Webinar presentation. Available at: http://cosee.umaine.edu/coseeos/webinars/111710webinar.htm

Kalnejais, Linda. “The Oceans - chemistry, climate and the future”. Presentation to the Durham Active Retirees Association.

Students Supported

Student name: Vincent Percuoco

Institution/Department: UNH Department of Earth Science

Duration of support: 2 years at 50% support

Type of support (stipend, travel, supplies, etc.): stipend

Type of degree (undergrad, masters, PhD): Masters

Year degree awarded: planned for 2012

Title of thesis (if supported by N.H. Sea Grant): The mechanisms of metal and nutrient release from the sediments of the Great Bay

Student name: Meagan Wengrove

Institution/Department: UNH Department of Mechanical Engineering

Duration of support: 2 years at 50% support

Type of support (stipend, travel, supplies, etc.): stipend

Type of degree (undergrad, masters, PhD): Masters

Year degree awarded: planned for 2012

Title of thesis (if supported by N.H. Sea Grant): Erosion in the Great Bay, New Hampshire.

Student name: Sophia Burke

Institution/Department: UNH Department of Natural resources

Duration of support: summer 2010

Type of support (stipend, travel, supplies, etc.): hourly

Type of degree (undergrad, masters, PhD): undergrad