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Woods Hole Sea Grant: 2000-2002 Projects

Controls on Nitrogen Fluxes from Estuarine Sediments: The Importance of Salinity

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Nitrogen is the key element limiting primary production in estuaries. While a great deal of research has been done to examine the relationship between nitrogen loading from a watershed and primary productivity, very little work has been done to consider the quantity and timing of freshwater runoff to an estuary. The overall goal of this project is to study how nitrogen release from estuarine sediments changes in response to changes in overlying water salinity. To achieve that goal, investigators will determine the effect of salinity on nitrogen storage and release from sediments, determine the effect of porewater salinity on rates of sediment nitrification and denitrification, and model the implications of salinity control of benthic nutrient dynamics on temporal and spatial patterns of estuarine metabolism. With the project's second year now underway, investigators are monitoring salinity, temperature, and benthic nitrogen fluxes and denitrification rates in the upper portion of the Parker River, located on the north shore of Massachusetts. Inventories of dissolved and exchangeable ammonium in the sediments are also being measured over the course of the season. Investigators found that denitrification rates decreased, following an increase in salinity. This study complements the investigators' work on the nitrogen cycle and denitrification in estuaries. The release of adsorbed ammonium during low river discharge in summer can be quite important ecologically: it occurs when watershed inputs of nitrogen are at their lowest. This ammonium pulse, coupled with the longer residence time that accompanies the decrease in water flow, may be important in beginning and maintaining summer phytoplankton blooms in the upper estuary. Also, year to year differences in salinity, and potentially nitrogen loss due to denitrification, may be one factor determining the year to year variation in primary productivity in estuaries. (R/M-141)

Demographic Analysis of the North Atlantic Right Whale

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The North Atlantic right whale (Eubalaena glacialis) is one of the world's most endangered whales. Its management raises more political, economic, and policy issues than perhaps any other marine mammal. Within the last few years, the right whale's status has led to the closing of fishing areas, lawsuits against the Commonwealth of Massachusetts, and changes in shipping regulations by the World Trade Organization. This project will provide a detailed population analysis to provide an accurate picture of the recent trends, current status, and projected fate of the right whale population, which is essential for determining whether current efforts are appropriate, evaluating the effects of such efforts, and considering new or different management tactics. A previous finding by the investigator -- that crude survival probability has declined to the point that the population is incapable of persisting -- underscores the urgency of the situation facing this species. A more detailed analysis of the population, applying rigorous statistical methods to a more detailed model of the life cycle, is critical to determining which parts of the life cycle are responsible for the trends in survival, projecting the consequences of those trends, and exploring strategies to improve population performance. (R/M-45)

Post-Outfall Studies of Toxic Alexandrium Populations in Massachusetts Bay

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Past Sea Grant investigations have confirmed the importance of a coastal current as a southward transport mechanism for toxic cells. At the downstream end of this transport pathway, efforts are needed to understand the dynamics of Alexandrium blooms in Massachusetts Bay and to assist in management decisions relating to a controversial sewage outfall. Opponents of the outfall have argued that one result of the new discharge patterns will be an enhancement of toxic or harmful blooms, leading to more paralytic shellfish poisoning (PSP) and, potentially, to mortality of endangered species such as the North Atlantic right whale. By collecting data on Alexandrium population dynamics, nutrient concentrations, and distributions in the area surrounding the sewage outfall, the investigator hopes to develop a sufficient understanding of the bloom dynamics of Alexandrium so that an informed evaluation of the actual impact of the outfall, once operational, will be possible. Specifically, this project will characterize the meteorological and hydrographic factors which regulate the introduction of Alexandrium into Massachusetts Bay, examine the vertical migration behavior of Alexandrium cells within the bay, and assess the extent to which Alexandrium populations in the bay might be affected by outfall nutrients. (R/B-158)

The Recycling of Anthropogenic Metals in Massachusetts Bay Sediments: Assessing the Impact of the New Outfall

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Boston's new sewage outfall in Massachusetts Bay will become operational in the near future. It is expected that, once on-line, the outfall will lead to an increased supply of organic detritus and anthropogenic metals to the sediments in the area. The resulting changes in the sedimentary environment will affect the rates at which metals are recycled by sedimentary processes, which in turn may alter the balance between burial and return to the water column of anthropogenic metals. The goal of this project is to document the changes in metal cycling resulting from the operation of the new sewage outfall. Initially, these investigators will make measurements before the outfall is on-line to record any changes that may occur once it is operational. The measurements that are central to this project are based on two new methods, both using instruments which are designed for in situ deployment in order to avoid sample recovery artifacts. The researchers will use benthic flux chambers, in which the dissolved oxygen level is maintained near that of bottom water for several days, to make direct determinations of metal fluxes across the sediment-water interface. They will obtain profiles of metal concentrations vs. depth in sediment pore waters using gel probes, which have the potential of avoiding artifacts resulting from the more widely used core recovery/core sectioning/centrifugation/filtering methods. These measurements, coupled with flux and profile measurements of other chemical components of pore waters, will provide the investigators with direct information on metal cycling rates and the mechanisms of metal recycling. (R/B-160)

Development of a Carbon Isotopic Method for Quantifying Groundwater Inputs to Estuaries

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Many important interactions between groundwater, surface water, and seawater take place in coastal regions. Examples include salt intrusion, which occurs in many coastal areas as a result of increasing demands on aquifers, and nutrient and pollutant release to the coastal ocean by both groundwater and surface water flow. This project, set to begin in 2001, seeks to develop a new geochemical tool for estimating groundwater discharge into estuaries and the coastal ocean. The approach will use the chemical and carbon isotopic signature of groundwater to distinguish groundwater discharge from surface (river) flow. As part of this project, a field study will be conducted at North Inlet, South Carolina. This carbon isotope-based approach will complement another Sea Grant project, (see "Groundwater Discharge of Nutrients into Coastal Ponds as Traced by Radium Isotopes," below). If successful, these two projects will provide tools with which to estimate groundwater fluxes -- and the associated fluxes of nutrients and contaminants -- in a variety of settings. (R/M-47)

Groundwater Discharge of Nutrients into Coastal Ponds as Traced by Radium Isotopes

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This project will look at the importance of sub-surface (groundwater) pathways in delivering dissolved nutrients, such as nitrate and phosphate, to coastal waters. Such pathways are often overlooked, in part because they are difficult to measure. Traditional methods, such as seepage meters or diffusion models, merely prove the existence of submarine groundwater discharge (SGWD), but are not a good means for estimating groundwater flow on regional scales since discharge can be patchy. In this project, set to begin in 2001, investigators will use radium isotopes as tracers of SGWD. Key questions to be considered include: Is submarine groundwater a significant source of nitrogen to coastal ponds on Cape Cod? What role does SGWD play in nutrient budgets for these coastal ponds? What are the sources of nutrients transported by submarine groundwater? By investigating these questions, this project provides a unique opportunity to better understand the importance of groundwater processes in the supply and cycling of nutrients in nearshore regions. In addition, the project provides an excellent opportunity to develop a SGWD budget for the Cape Cod region. The radium budgets will provide estimates of SGWD, which, in turn, will provide information on fluxes of nutrients, contaminants, or elements associated with the groundwater. In the end, these results could help environmental managers identify problem areas and any resulting impact on local ecosystems. (R/M-46)

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