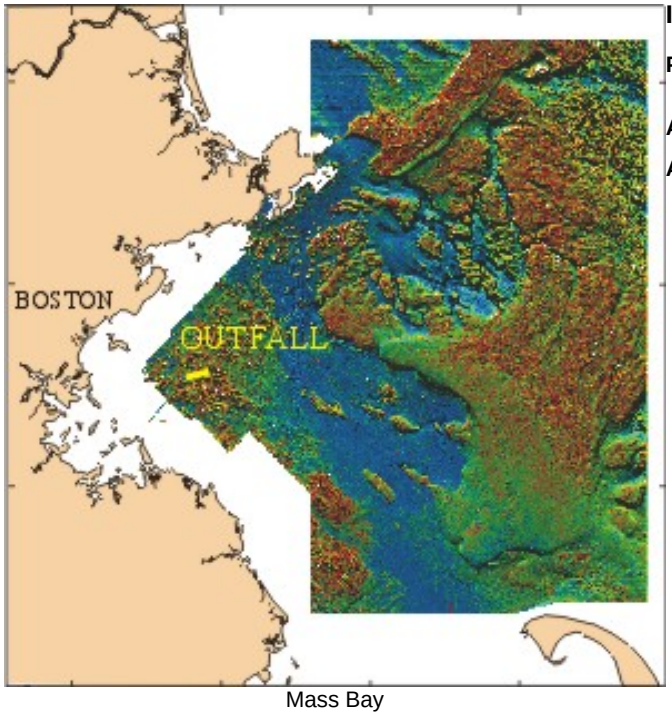
Coastal Geologic Processes and Long-term Environmental Change in the Northeast U.S.

SUMMARY:

The discharge of wastes from coastal metropolitan centers around the US and the resulting accumulations of contaminated coastal sediments have, in some areas, compromised human health, degraded habitat for living resources, hindered economic development, and restricted recreational activities. The potentially wide-ranging impact of wastes in the coastal ocean can be minimized if the behavior and fate of contaminants are well understood. In Boston Harbor and Massachusetts Bay a 1985 court ordered plan costing $4 billion has been implemented to minimize the consequences of discharged wastes. Throughout a continuing clean-up effort, the USGS has worked cooperatively with the Massachusetts Water Resources Authority (MWRA) to provide scientific information to assist management decisions concerning environmental and engineering issues. One remaining challenge is to understand the fate of contaminated sediments that are a legacy from past discharge practices. The procedures we are developing and the information that is being provided for Massachusetts coastal waters will address fundamental questions related to contaminant fate and transport and will be applicable to other coastal areas in the nation and world.



Mass Bay

INVESTIGATORS:

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DESCRIPTION:

The overarching objective for this project is to refine and verify a predictive capability for the transport, fate, and environmental effects of wastes discharged to the coastal oceans and to make this information readily available to environmental managers and the public. Specific objectives include implementation and testing of a coupled hydrodynamic-sediment transport model, documentation of long-term changes in contaminants in sediments, quantification of geochemical processes influencing the mobility of contaminants in sediments, and development of biological recorders of long-term contaminant concentrations. This study will be primarily focused in Massachusetts coastal waters, an ideal location for study because of the recent major changes in the discharge point and treatment of Boston#s sewage. In September 2000, the nation's second largest sewage treatment plant stopped all discharges into Boston Harbor and began discharging secondary treated sewage effluent at a new location in Massachusetts Bay, 9 miles seaward of the harbor mouth. A final objective is to verify our predictions that the diversion of wastes to the new ocean outfall will improve conditions in Boston Harbor, while not significantly changing conditions in Massachusetts Bay. #Statement of plans for the next 2-3 years# The emphasis for FY2007 and 2008 will be on experiments designed to quantify the processes of metal cycling within sediments and the rates of release of metals from contaminated sediments to overlying water by diffusion, advection, and erosion. We intend to investigate the influence of seasons, redox conditions, and levels of contaminants on these processes over the next 2 years. The research will be part of a collaborative with W. Martin (WHOI Marine Chemistry and Geochemistry Department), with partial funding from SEA GRANT. Assuming a successful pilot study this FY to evaluate the use of mollusk shells as monitors of contaminants in coastal seawater over the past few decades, we would

expand this effort to other coastal areas of New England and the nation.

START DATE OF PROJECT:

September 30, 2004

END DATE OF PROJECT:

September 30, 2008

TOPIC:

Aquatic and Marine Processes Related to Human Health

APPROACH:

The technical goals and approaches for this project are to: A. Characterize sediment transport processes during catastrophic events and determine seasonal and annual variability in currents and water properties at the USGS long-term station 1.3 km from the new outfall in western Massachusetts Bay. B. Understand processes influencing long-term change in contaminant concentrations in surface sediments in Massachusetts Bay and Boston Harbor. Explore the use of mollusk shells as recorders of contaminant concentrations over the life of the organism. C. Determine the diagenetic mechanisms and rates by which heavy metals, initially bound and buried with sediments, can dissolve and cycle within the sediment column or migrate out of the sediment by diffusion and advection. Loss of metals by resuspension of surface sediment will also be examined. D. Implement a coupled hydrodynamic sediment transport model to investigate the fate of sediments resuspended by oceanographic processes in Massachusetts Bay. E. Synthesize geochemical and oceanographic observations from Boston Harbor, Massachusetts Bay, and Cape Cod Bay to understand the sources, distribution, and transport of contaminants. Make these data and interpretations available to managers, scientists, and the public rapidly and in an effective format. Our strategy for meeting program objectives is to: (1) provide easily accessible information to managers, scientists and the public by establishing and maintaining a web home page and by meeting regularly with MWRA and federal managers; (2) document pre- and post-discharge changes in contaminant levels in sediments of Boston Harbor, the outfall site, and in Massachusetts and Cape Cod Bays by continuing established time-series sediment sampling at selected sites; (3) Develop a predictive model for the transport of sediment and associated contaminants; and (4) publish results in scientific journals.

IMPACT/RESULTS:

This research project provides a regional perspective to both scientific and management issues of wastes in the coastal ocean of Massachusetts and develops techniques and information that can be applied to other US (and foreign) urban coastal areas. We are using a multi-disciplinary approach to address questions about the transport and fate of contaminants. Specific to the Boston area, our research is also a critical component of the EPA mandated monitoring plan to evaluate the potential environmental impact of the Massachusetts Bay sewage outfall. This work is carried out cooperatively with MWRA, the agency responsible for implementing a $4 billion waste management program. MWRA has signed a 3-year Joint Funding Agreement with USGS and will contribute $1.03 million in operating expenses to this project for the period February 2004 - January 2007. #Outcome statement# USGS science products in Boston Harbor and Massachusetts Bay often have been used in management decisions during the $4 billion Boston Harbor cleanup. Examples include: (1) The siting decision for the offshore outfall was influenced by USGS maps of the seafloor that were available in time to avoid expensive surveys of alternative sites; (2) The court-ordered outfall monitoring program was designed on the basis of sediment texture and morphology maps by USGS, which greatly increased sampling efficiency; (3) Results of the USGS numerical models of circulation and sewage effluent dilution were used by the US Attorneys Office (Department of Justice) in defending the government in the endangered species case concerning right whales in the Stellwagen Bank National Marine Sanctuary; and (4) The model results also helped the Massachusetts Water Resources Authority evaluate and gain approval for downsizing of the planned secondary sewage treatment plant. It is estimated that the downsizing saved Boston area ratepayers about $160 million. Another #outcome# of USGS research has been development of new collaborative work with geochemists at the Woods Hole Oceanographic Institution (WHOI) focussed on specific processes controlling the cycling and release of metals from contaminated sediments to the overlying water. The collaborative effort has broadened the scope of our studies by increasing the scientific expertise, by applying unique instrumentation, and by attracting co-funding from new sources. A Ph.D thesis (Kalnejais, L., 2005. Mechanisms of metal release from contaminated coastal sediments. Ph.D. Dissertation, MIT/WHOI Joint Program in Oceanography. Woods Hole, MA: 214 p.) and chapters by W. Martin and by F. Sayles in Bothner and Butman, 2005 (Open File Report 2005-1250) describe early results from cooperative geochemical work with WHOI. Many other collaborations between project scientists from USGS and from other institutions demonstrate #outcomes# that have advanced scientific understanding. Among the wide variety of collaborative research topics listed in the project bibliography are: (1) generation and transport of harmful algal blooms (red tide); (2) sediment transport by internal waves; and (3) marine instrument development. The project bibliography includes 117 papers and maps, 71 abstracts, and 5 web sites and is available on the project web site at http://woodshole.er.usgs.gov/project-pages/bostonharbor.

PUBLICATIONS:

- Crusius, J., Bothner, M.H., and Sommerfield, C.K., 2004, Bioturbation depths, rates and processes in Massachusetts

Bay sediments inferred from modeling of 210Pb and 239+240Pu profiles. Estuarine Coastal and Shelf Science 61, 643-655.

- Kalnejais, L., 2005. Mechanisms of metal release from contaminated coastal sediments. MIT/WHOI Joint Program in Oceanorgaphy. Woods Hole, MA: 214 pp.

RELATED:

- The fate of sediments and contaminants in Massachusetts Bay