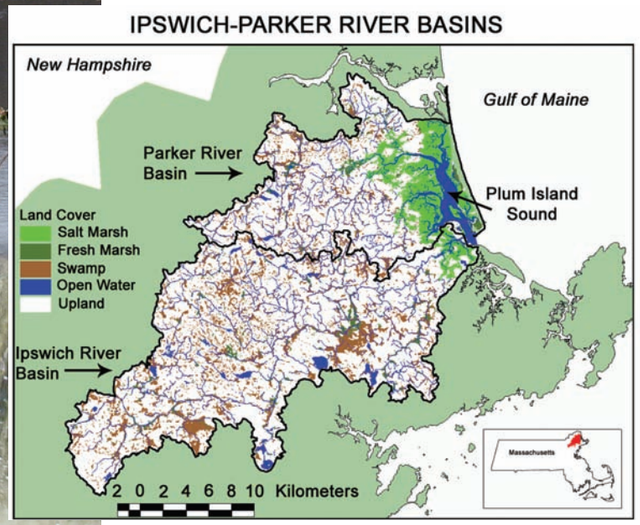
Greg Peterson collects water from the Parker River as it enters Plum Island estuary. (Photo: Chuck Hopkinson)



The Plum Island Ecosystems (PIE) research site consists of a coupled watershed and estuary in northeastern Massachusetts. The Ipswich River (400 km^2) and Parker River (200 km^2) basins make up the watershed of the estuary. The watersheds lie within the Boston Metropolitan region and include suburban (38%), agricultural (7%), marsh and water (10%) and forest (45%) land uses. Population density is about 250 people per km^2.

The 25-km long macrotidal Plum Island Sound estuary contains salt marsh, dominated by smooth cordgrass (*Spartina alterniflora*) and marsh hay (*Spartina patens*), fresh marsh, dominated by cattail (*Typha*), intertidal flats and open water tidal creeks and bays. This is the largest wetland-dominated estuary in New England and it supports extremely productive commercial and recreational soft-shell clam and striped bass fisheries. We have been investigating the ecology of Plum Island Sound estuary since the late 1980s with support primarily from the National Science Foundation (NSF).

We were part of the NSF Land Margin Ecosystems Research program in the early 1990s. The site became part of the NSF Long Term Ecological Research (LTER) network in 1998. The Plum Island project is one of only four LTERs that studies the effects of human activities in watersheds on estuaries. The PIE LTER has developed an extensive database open to the public via the Internet that includes our results from long-term field observations and experiments in the Ipswich and Parker River watersheds and the Plum Island Sound estuary. The LTER maintains two research facilities adjacent to the estuary. Marshview Farm consists of a house and field lab for 12 people; the Rowley River field house provides housing for 8, minimal lab space, dock facilities and access to field sites.

Primary institutions participating in the PIE LTER include the Marine Biological Laboratory (MBL), Clark University, Massachusetts Audubon Society, University of Massachusetts, University of New Hampshire, and University of South Carolina.

LTER

Plum Island Ecosystems

Long Term Ecological Research

Supported by the National Science Foundation

For further information about LTER research activities, data, facilities, and facility use, contact:

Charles Hopkinson (Principal Investigator) or Robert Garritt (Information Manager) at the MBL's Ecosystems Center, 7 MBL Street, Woods Hole, MA 02543; chopkins@mbl.edu and hgarritt@mbl.edu; 508-289-7688 and 508-289-7485; <http://ecosystems.mbl.edu/pie>.

Tidal creek at low tide. (Photo: Christian Picard)

Plum Island Ecosystems

Long Term Ecological Research

Josh Goldstein conducts a high-precision kinematic survey of marsh elevation. (Photo: Chuck Hopkinson)

Estuaries are among the most productive ecosystems on Earth. Their location at the land-sea interface, where growth-stimulating inputs from river runoff mix with ocean tides, contributes to a broad diversity of primary producers and some of the most productive fisheries in the world. But estuaries are also increasingly threatened by a variety of natural phenomena (climate variability, sea level rise) and human actions (nitrogen pollution, freshwater withdrawal, sediment erosion, overfishing).

The Plum Island Ecosystems (PIE) LTER is an integrated research, education and outreach program. Its goal is to be able to predict the long-term effects of human activities on land, climate change, and sea level rise on the health of estuaries. While our studies are focused on a single system, this system can be considered a model for what is happening in estuaries worldwide. We seek to apply our ecological knowledge of how this system works to help in the management and development of policy that protects the natural resources of this and other estuaries in the U.S coastal zone.

What We Study

Plum Island LTER studies are focused in three regions: the watersheds that drain into Plum Island Sound, the intertidal marshes that fringe the estuary, and the tidal creeks and bays of Plum Island Sound.

Watersheds

Our research on watersheds focuses on the water and nitrogen cycles. Because the water cycle has been so altered, the Ipswich River has been designated one of the 10 most threatened rivers in America. Our watershed investigations document the extent to which the water cycle has been altered and the factors contributing to that change including climate variability, municipal water needs and water diversions, and land use change. Our nitrogen cycle studies have focused on quantifying sources and fates of nitrogen in the Parker and Ipswich River basins and in predicting how they will change in the future. We are investigating the major factors affecting nitrogen dynamics, including population growth, land cover change, and watershed hydrology.

Intertidal Marshes

An increase in sea level is likely to promote the transgression of estuaries inland and could lead to the loss of intertidal wetlands if they are unable to build in elevation. We have observed substantial marsh disintegration over the past 50 years in the lower estuary, due to a combination of lateral erosion, decreased sedimentation and marsh ponding. We attribute this to the long-term increase in sea level and reduced sediment loads resulting from reforestation of the watershed after agriculture was abandoned across New England. Climate warming may further limit marsh accretion by decreasing peat accumulation. We are maintaining long-term observations and experiments to better understand how marshes respond to sea level rise, sediment supply and climate change. We are further investigating the effects of potential marsh loss on overall estuarine productivity.

Tidal Creeks and Bays

The primary question we are investigating in the Plum Island estuarine waters is how changes in river runoff, climate change and sea level rise will affect food-web structure, primary production and production of higher trophic levels. The diversity and abundance of estuarine organisms and their food-web structure are related to the distribution of estuarine habitats, water residence time and nitrogen loading from land. We study how river runoff affects the distribution of salinity and water residence time. We also study how variations in salinity affect nitrogen release from sediments to the overlying water. We have found that when residence time is long, phytoplankton blooms dominate nitrogen uptake. In this situation, the food-web has well-developed benthic and pelagic communities with strong benthic-pelagic coupling controlled by the animal community. When water residence time is short, benthic microalgae are the dominant primary producers and the principal food chain is benthic.

Finally, we are investigating the coupling between intertidal marshes and adjacent tidal creeks and bays. We study both biogeochemical linkages between marshes and tidal waters and the role marshes play in providing food, habitat and refuge for a variety of larval, juvenile and small adult fish and shellfish.

Education and Outreach

Educating the next generation of citizens and scientists and providing public outreach are integral components of the PIE LTER. Plum Island estuary is an active training ground for undergraduate and graduate students as well as post-doctoral fellows. They participate in all facets of our research. In connection with the Mass Audubon's Salt Marsh Science Project and the PIE LTER Schoolyard Project, we offer K-12 students and their teachers opportunities to better understand the ecology of estuaries, the value of long-term ecological research and the threats posed by human activities and global change. We also work with numerous non-governmental organizations and local, state and federal agencies to address issues related to population growth, land use change, sea level rise, climate change, water diversions, and river dams.

Students install a mummichog barrier at an estuarine tidal creek. (Photo: Christian Picard)