State of the Bay:
Past, Present and Future – Revisited

Jamaica Bay Research Symposium
October 20-21, 2011

Welcome

Today's symposium is part of a continuing effort on the part of many public agencies, educational institutions, environmental organizations and other stakeholders to exchange information on scientific investigation and management activities within Jamaica Bay.

Jamaica Bay has a history of being extremely rich in estuarine resources. In the late 1800's the bay supplied much of the oyster market in New York. At the time of its final closure to oyster harvest in 1921the bay been producing 80 million oysters for harvest every year.

The current environmental health of the bay now reflects the impact of urbanization during the early part of the 20th century. These impacts include: channelization and dredging of the bay bottom; the filling of much of its wetlands for airports, highways and residential communities; and the creation of a number of garbage dumps. Additionally, Jamaica Bay has become the endpoint for most of the wastewater and storm water that is generated in much of southern Brooklyn and Queens.

Today, millions of people live within the bay's watershed and recreate within its waters. In 1951 New York City established the Jamaica Bay Wildlife Refuge. This was followed by the creation of Gateway National Recreation Area in 1972 which provided national park status to much of Jamaica Bay.

Much has been done to try to reverse the past degradation of the ecological health of Jamaica Bay. Much more remains to be done. It is the hope of the sponsors of this symposium that the information presented will help fuel the future discussions, scientific investigation and needed actions to keep moving forward in improving the environmental health of Jamaica Bay.

Cover illustration by Anne Yen

BOAT AGENDA for Friday, October 21st

The American Princess departs Riis Landing Warf in Fort Tilden at 10am. Please arrive early to allow for boarding. Boat will return to dock at 1 pm.

Welcome by Suzanne McCarthy, NPS Deptuy Superintendent, Gateway National Recreation Area

Discussion to be lead by Jamaica Bay Unit Coordinator, Dave Taft (NPS)

- General Discussion about Jamaica Bay in historical terms and its connection to NYC
- Watershed description, dredging, filling, development, marsh loss, JFK airport,wastewater/storm water
- Jamaica Bay Wildlife Refuge designation and management implications
- Jamaica Bay as important regional ecological resource, biodiversity, importance to migratory bird species, endangered/threatened species.
- Jamaica Bay as a recreational resource for NYC

Loop 1:
along Rockaways to Joco
- First marsh restoration in Big Egg
- Oyster Reef Experiment

Loop 2:
Broad Channel Restoration sites:
- Yellow Bar
- Black Wall
- Rulers Bar

Loop 3:
Elders Point
- Floyd Bennett Field
- DEP storm water capture
- improvements
- DEP tributary improvements
- Closure and capping of PA/FA landfills
- Elders Pt E/W Restoration

Notes:

SYMPOSIUM AGENDA for Thursday, October 20th

	Meet and greet- Light breakfast
	Welcome Karen Gould- President, Brooklyn College Angela Licata- DEP Deputy Commissioner Linda Canzanelli- NPS Superintendent, Gateway National Recreation Area Lane Smith- New York Sea Grant Research Program Coordinator Steve Zahn- DEC Natural Resources Supervisor
Keynote	Denise Reed- Seeking Sustainability for Estuarine Habitats in the 21st Century: Challenges and Opportunities
Environmental History	Eric Sanderson- Welikia: The past, present and future ecology of New York City
	BREAK- 10 minutes
Bathymetry	Roger Flood- bathymetry
Water Quality	Raymond Sambrotto- Seasonal change in nutrient limitation of biological production in Jamaica Bay and its potential use for improved management
	DEP Pilots in Jamaica Bay: Chris Pickerell – Eelgrass pilot update Gregg Rivara – Jamaica Bay Oyster Pilot Update Peter May – The use of algae to clean wastewater and create a biofuel in New York City
	LUNCH- 50 minutes
Water Quality (cont.')	Josh Cheng- Green Infrastructure Pilot Studies in the Jamaica Bay Watershed
	Chester Zarnoch- Oyster restoration and sediment nitrogen cycling in Jamaica Bay
	Jim Fitzpatrick- Factors Affecting Sustainable Oyster Reefs in Jamaica Bay
	Brett Branco- Working Together to Increase the Scientific Value of Monitoring Programs in Jamaica Bay
	BREAK- 10 minutes
Marsh Restoration	Peter Weppler- USACE Restoration Planning Activities in Jamaica Bay – An Example of Collaboration
	Patti Rafferty and Don Cahoon- marsh monitoring results and SETs
	Chris Small- Decades of Change in Jamaica Bay: Mapping Vegetation Phenology and Interannual Variability from Space
Hydrodynamics	Larry Swanson- Increased tidal ranges coinciding with Jamaica Bay development contribute to marsh flooding
Summary	Wrap-up and summary by Mary Foley

Seeking Sustainability for Estuarine Habitats in the 21st Century: Challenges and Opportunities

Denise J. Reed

Pontchartrain Institute for Environmental Sciences, University of New Orleans
Maass-White Visiting Scholar, US Army Institute for Water Resources

The 21st century promises to be a time of change in water resources, both floods and droughts may be more common and sea-levels will certainly be higher. In estuaries where influence from both rivers and the ocean converge, change in natural forcing will likely be substantial. In addition, expanding coastal populations and the importance of global trade place additional stress on estuarine habitats. Fixing the damages done to valuable estuarine systems during previous centuries must be seen in the context of future change. In many systems 'restoration' is impossible – rather our focus needs to be on ensuring a sustainable future for the aspects of estuaries that are important to us. Wetlands and other aspects of estuaries are highly valued for the services they provide, often associated with direct economic benefits. When resources are limited the best opportunities to ensure sustainability of the natural system may be to leverage what the environment provides to society and the economy. Scientific studies and monitoring underpin such efforts by increasing understanding of ecosystem benefits and improving our ability to predict how estuaries will change in the future – without and without intervention. This presentation will use examples from across the country to illustrate how actions can be taken to ensure estuarine wetlands and other habitats can adjust and survive, both with and without intervention, into the 21st century.

<u>Denise Reed, Univ. New Orleans</u>

Dr. Denise Reed is a University Research Professor at the University of New Orleans and is currently the Maass-White Visiting Scholar at the U.S. Army Institute for Water Resources . Her research interests include coastal marsh response to sea-level rise and how this is affected by human activities. She has worked on coastal issues on the Atlantic, Pacific and Gulf coasts of the US, as well as other parts of the world, and has published the results in numerous papers and reports. She is involved in ecosystem restoration planning both in Louisiana and in California. Dr. Reed has served on numerous boards and panels concerning the effects of human alterations on coastal environments and the role of science in guiding ecosystem restoration, including a number of National Research Council Committees, and the Ecosystems Sciences and Management Working Group of the NOAA Science Advisory Board. She received her BA and PhD from the University of Cambridge in England and has worked in coastal Louisiana for over 20 years.

Jamaica Bay Research and Management Information Network (JBRMIN)

John Scialdone

Lamont-Doherty Earth Observatory, Columbia University

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Since 2004, the Columbia University Center for International Earth Science Information Network (CIESIN) has operated the Jamaica Bay Research and Management Information Network (JBRMIN), a community-driven knowledge base of past, present, and future activities in Jamaica Bay, drawing on information from partners that include federal, state and local government agencies, academic institutions, and non-governmental organizations. Collaborating with the National Park Service (NPS), JBRMIN contains data and information resources from the bay's most vital stakeholders on air and water quality, wetlands management/restoration, coastal zone management, land use, fish and wildlife, natural resources, and preservation. JBRMIN's electronic bibliography holds more than 1,200 citations dating back to 1850, primarily based on the Jamaica Bay Ecological Research and Restoration Team (JABERRT) report, the most comprehensive study ever performed in the bay. A map catalog depicts land use/land cover, watershed extent, geology, impervious surfaces, along with historical maps from several sources. Guided by the National Resources Defense Council (NRDC), along with New York City Department of Environmental Protection (DEP) and its Advisory Committee, JBRMIN is tracking the progress of the Jamaica Bay Watershed Protection Plan, and has contributed to the plan's public education and outreach objective as a member of its Education Committee. JBRMIN has supported 24-hour species surveys (BioBlitz') of Jamaica Bay and recently Sandy Hook by providing information dissemination, online registration, and data collection facilitation. Lastly, JBRMIN's dynamically changing home page keeps its community current on recreation, education, research, and management activities.

On the Shores of Jamaica Bay: What Have Three Years of Monitoring Shown Us About Shorebirds and Horseshoe Crabs?

John Rowden[1]* and Susan Elbin[1]
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The relationship between horseshoe crabs and migratory shorebirds has been well-studied, particularly in the Delaware Bay and estuary. Observers are well aware that Jamaica Bay is also an important spawning site for horseshoe crabs and stopover site for migrating shorebirds. In 2009 and with the support of the National Park Service, New York City Audubon initiated a three-year Citizen Science project to systematically monitor horseshoe crabs and migratory shorebirds at several sites in Jamaica Bay during the spring spawning and migratory season to 1) identify important sites and 2) to track local population trends. Monitors used the International Shorebird Survey protocol to record shorebirds at Plumb Beach, the Jamaica Bay Wildlife Refuge West Pond, Big Egg Marsh and Bay Dunes. Horseshoe crab monitors used a standard New York State DEC/Cornell Cooperative Extension protocol to survey horseshoe crabs at Plumb Beach for three years and added surveys at Dead Horse Bay and Big Egg in 2011. Our data indicate that horseshoe crabs spawn at high density (up to 4 crabs per square meter) on Plumb Beach, and their numbers have been stable during the three years of monitoring (n = 149, 136 and 135 crabs per sample night, respectively). Shorebirds were present in varying densities at the monitored sites and numbers have declined from 1,196 per sample visit to 128 per sample visit during the three years of monitoring.

Evaluating the Role of Nitrogen as a Cause of Marsh Loss in Jamaica Bay

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Nitrogen loading may cause or contribute to marsh loss in Jamaica Bay. On average, 15,785 kg N d^{-1} enter the bay via wastewater discharge, subway dewatering, landfill leachate, submarine groundwater discharge and atmospheric deposition. High nitrogen levels may result in the reallocation of energy from roots to shoots in *Spartina alterniflora.* Diminished root production can lead to a loss in marsh elevation relative to sea level rise. In addition, roots bind sediments and slow sediment compaction and erosion. In 2009, research was initiated to evaluate the role of N on plant function at three marshes in Jamaica Bay. High N loading may alter plant function by decreased nitrogen resorption efficiency, lowered nitrogen resorption proficiency, decreased belowground biomass productivity, and decreased marsh elevation. Mechanisms of marsh loss due to changes in plant function, research methodology and preliminary results will be presented.

Welikia: The past, present and future ecology of New York City

Eric Sanderson
Wildlife Conservation Society

Nature never gives up on a place. Although the ecology of New York City has changed dramatically over the last 400 years, ecological cycles of water, carbon and habitat continue to endure, albeit in modified form. Understanding those cycles, their changes, and their distribution across the landscape provides the foundation for urban sustainability and ecosystem restoration at Jamaica Bay and across the five boroughs of New York City. Welikia means "my good home" and the Wildlife Conservation Society's Welikia Project is providing a part of the foundation for nature for the next 400 years of the city.

Eric Sanderson, Wildlife Conservation Society

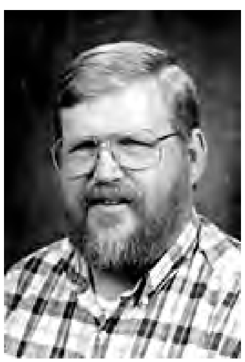
Eric W. Sanderson is a Senior Conservation Ecologist at the Wildlife Conservation Society (WCS). Sanderson received his Ph.D. in ecology (emphasis in ecosystem and landscape ecology) from the University of California, Davis, in 1998. He is an expert in geographic analysis for large wildlife conservation efforts and species conservation planning. Sanderson founded the "Landscape Ecology and Geographic Analysis." Dr. Sanderson and colleagues created the Human Footprint map, the first look at human influence globally at less than 1 square mile resolution, and generated a map of the "Last of the Wild" areas representing the largest remaining wildernesses on Earth. He is also an expert on species conservation planning and has contributed to efforts to save lions, tigers, Asian bears, jaguars, tapirs, peccaries, American crocodiles, North American bison and Mongolian gazelle; and landscape planning conservation efforts in Argentina, Tanzania, Mongolia, and elsewhere, including the Greater Yellowstone Ecosystem and the Adirondack Park, in the USA. He co-authored guidelines on species conservation planning for the IUCN Species Survival Commission in 2008. In addition he has edited two scientific volumes and written numerous scientific papers. His work has been featured in the New York Times, National Geographic Magazine, CNN, NPR, and The New Yorker. Recently he directed the Mannahatta Project, an effort to reconstruct the original ecology of Manhattan Island at the time of European discovery in the early seventeenth century. In 2009 Abrams published his book, "Mannahatta: A Natural History of New York City," illustrated by Markley Boyer.

A Detailed Bathymetric Study of Jamaica Bay

Roger Flood
Stony Brook University

The management of underwater lands requires a detailed knowledge of the morphology of those lands, including the locations and shapes of the shallow and deep areas, the nature and distribution of various sediment types and associated benthic fauna and the processes that have been important in creating the underwater morphology, or seascape, observed today. Nautical charts of Jamaica Bay east of the Gil Hodges Memorial Lift Bridge are based primarily on bathymetric surveys done primarily from the 1934 through the 1950 although some areas were surveyed in the 1960s. We conducted detailed bathymetric studies of the deeper waters of Jamaica Bay, water deeper than about 4 feet, using multibeam bathymetric mapping and side-scan sonar techniques in 2008 and we continued our study to the shallow regions of Jamaica Bay west of Cross Bay Boulevard using standard single-beam bathymetry and side-scan sonar techniques in 2009. Water depths are reported referenced to NAVD88 to allow comparison of depths collected in different years. Follow-on studies have involved sediment sampling and bottom photography in deeper water to better understand sediment distribution patterns and benthic habitats. Initial results of the mapping project demonstrate that dredging is the main process that has shaped the morphology of deep-water areas in Jamaica Bay and show that the area of water deepened by dredging is somewhat larger than suggested on the current NOAA chart, especially at the intersection of Runway Channel and Reynolds Channel. Indeed, sediment transported along marsh channels appears to get trapped in nearby dredged areas effectively removing that sediment from the marsh system. Much of the bottom is marked by dredging scars, and some scars appear fresher than other scars although the relative ages of dredging in the different areas are not known. While much of the seabed consists of fine-grained sediments, other seabed features include scoured areas, sand waves of a range of sizes and occasional shipwrecks.

Roger Flood, SUNY Stony Brook



Roger Flood is has been a Professor in the School of Marine and Atmospheric Sciences at Stony Brook University where since 1988. Prior to his current position he worked at Lamont-Doherty Geological Observatory after a Postdoctoral Fellowship in a UK IOS Laboratory and after obtaining a Ph.D. in Oceanography from the Woods Hole Oceanographic Institution / MIT Joint Program in Oceanography.

Investigating Changes in Diamondback Terrapin Nesting Behavior in Jamaica Bay, New York

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Little is known about the process by which turtles abandon old nesting areas and colonize new nesting areas, but this process must occur with some frequency as habitats undergo succession and erosion. This must be especially rapid in areas that are highly impacted by urban development. Jamaica Bay (JB) is a large estuary in New York City whose shore lines, islands, and marshes were heavily modified in the 20th century. Many nesting and feeding sites were destroyed and some new nesting sites were created. This process is ongoing, as salt marshes in the area are currently eroding at a rapid rate. A mark-recapture study of diamondback terrapins (*Malaclemys terrapin*) has been conducted in JB since 1998 to determine whether this population is sustained by recruitment. Nearly all nesting now occurs on an island known as Ruler's Bar Hassock that was created in the 1920s. The number of nesting females in the population has remained fairly constant at just under 1000 adults but the number of nests on Ruler's Bar has been dropping steadily and is now 37% lower than in 1999. The decrease may be the result of females moving to other sites to oviposit, perhaps sites closer to remaining marshes. A genetic analysis of the terrapins in Gateway National Recreation area is currently being conducted to better understand the history of terrapin colonization and abandonment of nesting sites in Jamaica Bay and elsewhere in the region.

The Effects of Nutrients on Algae in Jamaica Bay: Quantifying the Interactions Among Nutrient Loads, Primary Producers and Dissolved Oxygen

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Jamaica Bay is a hyper-eutrophic urban estuary and receives a daily discharge of almost 300 million gallons of treated effluent from four sewage treatment plants that can promote algal blooms and hypoxia. Starting in April 2010, we sampled eight stations across Jamaica Bay to determine the spatial and temporal dynamics of both micro- and macro-algae within this system. We conducted both in situ, as well as bottle incubation experiments to determine the effects of altered nutrient loads on phytoplankton communities, the macroalga *Ulva lactuca*, and dissolved oxygen concentrations across Jamaica Bay. We found that phytoplankton communities within the North Channel and Grassy Bay reached very high densities (chlorophyll *a* > 135 µg L^{-1}) during the spring and summer with blooms often dominan ted by the small centric diatom *Thalassiosira pseudonana*. The phytoplankton community within Grassy Bay was limited by the supply of silicon during the late spring and early summer, although there was a strong spatial gradient across the bay as regions closer to Rockaway Inlet were concurrently limited by nitrogen. Experiments conducted in situ with the fresh thalli of the macroalga *U. lactuca* displayed rapid growth rates in the Grassy Bay region, but significantly slower growth to the west. Plankton communities within the Grassy Bay region also displayed rapid respiration rates that are likely to cause the chronic bottom hypoxia there during the summer months. Finally, we will present the results of experiments documenting improvements in water quality with the reduction of nutrients in the Grassy Bay region.

Seasonal change in nutrient limitation of biological production in Jamaica Bay and its potential use for improved management

Raymond Sambrotto
Lamont-Doherty Earth Observatory of Columbia University

Although shallow estuaries and lagoons like Jamaica Bay likely have always been highly productive, the levels of phytoplankton growth have increased still more as wastewater from growing cities has caused eutrophication in the these waters. Identifying the specific nutrient element such as nitrogen or phosphorus that limits phytoplankton growth and reducing its concentration in wastewater therefore, is a key goal for the management of eutrophication in coastal waters. The nutrient and chlorophyll *a* time series from the NYCDEP Harbor survey suggest that the limiting nutrient for phytoplankton growth changes seasonally in Jamaica Bay. The late winter/ early spring bloom strips most of the phosphate from the water, while the impact of summer production is relatively greater on the dissolved nitrogen pools. Additional sampling indicates that the biological nature of the phytoplankton community also changes seasonally, as does the amount of organic carbon it produces. The presentation will develop a more detailed biogeochmical analysis of seasonal nutrient limitation as well as consider the prospects for integrating recent information into more effective strategies to control eutrophication.

Raymond Sambrotto, Lamont-Doherty Earth Observatory of Columbia University

Raymond Sambrotto is a marine plankton ecologist and biogeochemist. His work focuses mainly on the interaction between the ocean's microbial life and its chemical makeup. In recent years, there has been significant progress in understanding the global role of the ocean ecosystem that covers 70% of the Earth. However, critical questions remain such as how this system interacts with climate variation and with the addition of pollutants from human activities.

Sambrotto has worked in most of the major regions of the ocean and the BEST-BSIERP work is a return to research on the Bering Sea where he began his oceanographic studies. He is currently a Doherty Research Scientist at the Lamont-Doherty Earth Observatory of Columbia University.

Abstract for Chris Pickerell's presentation will be included in final symposium materials

Chris Pickerell, Cornell Cooperative Extension

Chris Pickerell is a Habitat Restoration Specialist with Cornell Cooperative Extension of Suffolk County. He has 18 years experience in coastal habitat assessment and restoration in southeastern New York. His primary area of interest has been in the ecology, health and restoration of all types of coastal plant communities. Pickerell has consulted on or been directly involved with seagrass assessment and restoration projects on both coasts of the United States and in Europe. Early work focused on the design and implementation of salt marsh and coastal plant community restoration while work during the last 12 years has focused on Eelgrass (*Zostera marina* L.) restoration and monitoring. Mr. Pickerell has recently developed innovative methods for restoration of SAV at sites with extreme physical disturbance and a new system that involves the use of land-based volunteers to enhance these restoration efforts.

Estuarine Shoreline Changes in Jamaica Bay, New York City: Implications for Management of an Urban National Park

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Remote sensing and GIS are becoming increasingly important tools used for resource monitoring and ecosystem modeling within national parks. The Jamaica Bay portion of Gateway National Recreation Area, located next to highly urbanized New York City, faces many challenges to preserve and protect its natural, cultural, and recreational resources. To aid in the management of the park resources, detailed estuarine shoreline analyses of Jamaica Bay have been undertaken using air photos taken in 1924, 1951, 1974, and 2006. A 16 class land use/land cover scheme was created after doing an initial examination of the types of land cover in the 2006 air photos and then consistently applied in the analyses of the other years. By quantifying how and where the shoreline has changed over the past 85 years, park managers will have a better understanding of shoreline changes within and outside of the park boundaries as well as before and after the park was created in 1972. A comparison of each quarter-century period shows the effects of heavily increased urbanization, while indicating the effectiveness of the park's management and providing insights on ways to better restore and protect its natural resources. Despite the heavy development of New York City, the shoreline of Jamaica Bay within and outside the park has maintained large percentages of vegetation and sandy beaches.

POSTERS

Understanding Horseshoe Crab Population Dynamics in New York and New Jersey National Parks

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The American horseshoe crab (*Limulus polyphemus*) is an important component of the marine ecosystem and a valuable socio-economic species. Crabs are harvested commercially for bait and by the biomedical industry that produces a critical pharmaceutical product from their blood. Coastal National Parks Service (NPS) units in New York and NewJersey have actively spawning horseshoe crabs; however, little is known about population dynamics in terms of spawning densities, spawning sex ratios, or egg densities. Horseshoe crab monitoring will be conducted at the Jamaica Bay and Sandy Hook Units of Gateway National Recreation Area (GATE), Fire Island National Seashore (FIIS) and Sagamore Hill National Historic Site. Crabs will also be tagged as part of the US Fish and Wildlife Service (USFWS) Cooperative tagging program. This national database will provide information on recaptured crabs to the NPS long after this project has ended. Acoustic transmitters will be used to track subtidal movement in Jamaica Bay (GATE) and Great South Bay (FIIS)). Crabs tagged with acoustic transmitters can be tracked over short time intervals (e.g., days to months) and provide information on subtidal movement within park boundaries and adjoining waters. Limited tagging with USFWS tags done in conjunction with NPS interpretative programs in 2011 indicates promising tag-recapture results. This project will provide information on regional horseshoe crab populations that is essential for the conservation and management of this species. An additional goal of this project is the development of park-specific, long-term citizen-based monitoring programs to sustain future data collection.

Jamaica Bay Oyster Pilot Update

Gregg J. Rivara[1],
R. Michael Patricio[1], Terry Doss[2] and Michael Spina[2]
[1]*Cornell University Cooperative Extension of Suffolk County*

Remote setting of eastern oyster (*Crassostrea virginica*) larvae onto whole shell and concrete reef balls was used to create pilot-scale oyster reefs in the eutrophic waters of Jamaica Bay, New York. Oysters once thrived in the bay, with a peak annual commercial harvest of 700,000 bushels 100 years ago and provided important habitat for many species while filtering bay water. The bay was closed to shellfish harvesting in 1921 due to human disease outbreaks linked to oysters from the bay. Today naturally occurring live oysters are absent from the bay although relic shell is abundant in some areas.

In the spring of 2010, Oyster broodstock from F.M. Flower and Sons in Oyster Bay were conditioned, spawned and their larvae cultured at the Suffolk County Marine Environmental Learning Center in Southold, NY using standard techniques. Larvae were set onto shell and reef balls then hardened intertidally for four months before transported to Jamaica Bay, approximately 150 km from the hatchery. To create the Dubos Point, Queens reef, aged surf clam shell were used to build a subtidal base 14 m^{-2} by 0.5 m high with a veneer of oyster spat on aged oyster and surf clam shell. In Gerritsen Creek, Brooklyn, 12 concrete reef balls, each measuring 0.5 m wide by 0.3 m high were anchored to the bottom.

As of the end of September 2011, population estimates are on the order of 650 oysters for the 12 Gerritsen reef balls and 3,800 for the Dubos reef. Keep in mind that the shell surface area available to oyster larvae is orders of magnitude greater than that of the reef balls. At the same time shell height averaged 60 mm; upon deployment in early October 2010 oysters averaged 7.5 mm. Survival at both sites during the spring and summer of 2011 averaged 83% with most of the mortality due to predation by crabs and oyster drills.

Monitoring includes measuring oyster size and mortality, photo/video documentation and water quality parameters once per week during spring/summer, twice per month during fall and once per month during winter. Also, water quality and current data were collected using continuous data sondes for multi-day periods. Future monitoring will include testing for disease and gonadal development.

Funded by the New York City Department of Environmental Protection as a pilot to look into the possibility of using oysters to improve water quality and provide habitat, the project includes evaluating oyster growth, survival, reproduction, possible water quality improvements and ecological benefits over a two year period. The results will guide future attempts to restore oyster habitat in Jamaica Bay.
The authors wish to thank John McLaughlin and Robert Will of the NYC DEP and Steve Zahn and Susan Maresca from the NYS DEC for their support in carrying out this project.

Gregg Rivara, Cornell Cooperative Extension

Gregg has been the aquaculture specialist at Cornell University Cooperative Extension of Suffolk County since 1986. He received a Bachelor of Science degree in marine science from Southampton College of Long Island University and a Master of Science from the Marine Environmental Sciences Program at the Marine Sciences Research Center, State University of New York at Stony Brook (now the School of Marine and Atmospheric Sciences at Stony Brook University).

Gregg works primarily with shellfish growers on Long Island in both the public and private sectors, assisting in problem solving and carrying out applied research projects. He is currently co-chair of a Cornell University statewide program work team whose charge is to identify and make recommendations to mitigate constraints to aquaculture development in New York. Gregg also manages the Suffolk County Marine Environmental Learning Center, a marine laboratory at Cedar Beach County Park in Southold, New York.

Increased tidal ranges coinciding with Jamaica Bay development contribute to marsh flooding

Larry Swanson and R.E. Wilson
SUNY Stony Brook

Sea level rise has been identified as a possible factor contributing to marsh loss in Jamaica Bay, New York. However, Jamaica Bay has also experienced increases in tidal ranges throughout as a consequence of natural and engineering modifications that occurred in the bay during the first half of the twentieth century. The increases in the elevations of high tides are of the same order as the increase in regional sea level that occurred since the early 1900s. Marsh inundation in the bay is thus greater than noted to date and greater than that in adjacent bays where tidal ranges have been more stable. Changes in tidal hydrodynamics may be one more factor to consider in the list of potential of marsh loss in Jamaica Bay.

Larry Swanson, SUNY Stony Brook

Dr. R. Lawrence Swanson received his Ph.D. in Physical Oceanography from Oregon State University in 1971. Since 1987, he has been the director of the Waste Reduction and Management Institute (WRMI) of the Marine Sciences Research Center (MSRC), Stony Brook University, and since 2003 has been the Associate Dean of MSRC. Dr. Swanson was a Senior Executive Fellow at the Kennedy School of Government, Harvard University. Prior to his appointment at SBU, he was with the National Oceanic and Atmospheric Administration and served in a variety of capacities including Project Manager of the Marine Ecosystems Analysis Program for the New York Bight; Director of the Office of Marine Pollution Assessment; and the Executive Director of the Office of Oceanic and Atmospheric Research. He was a member of the Jamaica Bay Watershed Protection Plan Advisory Committee.

Decades of Change in Jamaica Bay: Mapping Vegetation Phenology and Interannual Variability from Space

Christopher Small

Lamont-Doherty Earth Observatory of Columbia University

Optical sensors on the Landsat 4, 5 and 7 satellites have imaged NYC hundreds of times in the past three decades, measuring the brightness of reflected sunlight at both visible and infrared wavelengths. In this imagery, vegetation is distinguished from other materials by its extreme brightness at near-infrared wavelengths and by its deep absorption of visible red and blue light by chlorophyll. Because the spatial resolution of Landsat pixels is 30x30 meters, the aggregate reflectance of each pixel is generally a spatial mixture of the reflectances of the individual land cover components within the area imaged by the sensor. Vegetation abundance is estimated by unmixing the spectrally mixed pixels; accomplished mathematically by inverting a linear mixture model. A similar unmixing approach can be applied to the resulting time series of vegetation abundance maps to map temporal patterns of vegetation phenology. Vegetation abundance maps derived from over one hundred cloud-free LANDSAT images of NYC are used to produce a vegetation phenology map of NYC, including Jamaica Bay. Landsat imagery clearly distinguishes deciduous trees, lawn grass and late-greening wetland vegetation on the basis of their annual green-up and senescence cycles. Spatial heterogeneity and gradients in vegetation type and abundance are accommodated by representing the presence and amount of different phenology types using continuous fields of phenological endmember abundance. Because the imagery has been collected over a 27 year time interval, it is also possible to identify interannual changes in vegetation abundance and phenology. When combined with LiDAR-derived elevation models and field observations, these data provide a basis for mapping wetland extent in a repeatable, objective manner that is easily updated when new data become available. Phenology and change maps will be presented for Jamaica Bay and a prototype wetland mapping tool will be demonstrated.

<u>Chris Small, Lamont-Doherty Earth Observatory</u>

Christopher Small is a geophysicist at the Lamont-Doherty Earth Observatory of Columbia University. Prior to receiving a Ph.D. from the Scripps Institution of Oceanography in 1993, his formative experiences ranged from shipboard studies of the circulation of the Chesapeake Bay with the University of Maryland to satellite mapping of subseafloor structure for frontier petroleum exploration with the Exxon Production Research Company. Current research interests focus on quantifying the spatiotemporal changes of Earth's surface and understanding the causes and consequences of these changes. Specific projects involve spectroscopic measurement of mass and energy flux, satellite mapping of spatio-temporal land cover dynamics and impacts of vegetation and building morphology on urban microclimate. Details available online at http://www.LDEO.columbia.edu/~small.

The use of algae to clean wastewater and create a biofuel in New York City

Peter I. May[1] and John McLaughlin[2]

[1] *Biohabitats, Inc., Baltimore, MD, USA*

[2] *Department of Environmental Protection, New York City, NY, USA*

The City of New York has, as a pilot model, employed a novel approach to partially addressing its nutrient reduction goals for the restoration of Jamaica Bay, a mesohaline estuary of significant ecological and cultural importance. The approach uses the unique Algal Turf Scrubber® (ATS) system, a simple and elegant method for removing nutrient pollution from water sources and converting it at low cost into algae biomass. Algae injects large quantities of oxygen into treated waters as well as removes CO_2 from the water and atmosphere. Deployed at the City's Rockaway wastewater treatment plant on the southern edge of Jamaica Bay, the pilot employs two, 107m x 0.3m floways receiving pulsed, secondarily treated sewage effluent.

The ATS supports a natural, mixed assemblage of attached microalgae, periphyton and bacteria which colonize the floway media. Measurements of nutrients and other physical/chemical water quality parameters, algal community composition, biomass and nutrient and carbon content were conducted upstream and downstream, and at intervals along each floway weekly, and periodically on a diurnal basis. The results of these measurements are presented, as are estimates for a potential scale-up of the ATS system in terms of nutrient removal and biomass production. Algal biomass production is important as it is also usable as a low-impact feedstock for bio-fuels as a natural byproduct of the water treatment process. This effort produced a volume of butanol from the Rockaway WWTP ATS algae and information is presented on the potential for scale-up and implications of the ATS algae/energy relationship in New York City.

<u>Peter May, Biohabitats</u>

Peter I. May, Ph.D., is a Senior Environmental Scientist with Biohabitats, Inc., an ecological engineering, environmental planning and restoration design firm. He has been involved in a range of innovative projects involving urban coastal environments in Baltimore, Washington, DC, New York City, San Francisco and Philadelphia.

Peter's work as an aquatic ecologist and fisheries biologist for over 20 years includes extensive experience working with urban stream and tidal marsh restoration. Peter received his Ph.D. in the Marine Estuarine Environmental Science (MEES) program at the University of Maryland. Heavily exposed to the theory and practice of Ecological Engineering, he has worked in developing prototypes for a "bathroom buoy" and "marina heavy metal removal" living machines. Working with the Smithsonian Institution's Marine System Lab exposed him early on to the algal turf scrubber (ATS) eco-technology, a unique method of ecologically based water treatment.

Green Infrastructure Pilot Studies in the Jamaica Bay Watershed

Zhongqui (Joshua) Cheng

Brooklyn College of the City University of New York

The New York City Department of Environmental Protection (DEP) installed various green infrastructure demonstration pilots as part of its 2007 Jamaica Bay Watershed Protection Plan, Nitrogen Consent Order and Combined Sewer Overflow (CSO) Consent Order Environmental Benefit Projects with the New York State Department of Environmental Conservation (NYSDEC), the City's 2008 Sustainable Stormwater Management Plan and the September 2010 Green Infrastructure Plan. These pilots include four Streetside Infiltration Swales (SSIS), ten Enhanced Tree Pits (ETP), one Wet Meadow, one Green Roof, and one Blue Roof. For Enhanced Tree Pits, stormchamber, crushed stone and recycled glass were employed and compared. The 17 pilots were built at 11 locations in Brooklyn, Queens and Far Rockaway, and on three different landforms. Five of the systems are in parking lots, whereas ten are on street sidewalk. These demonstration studies are used to help identify effective measures to reduce stormwater flows to the City's sewer system during storm events. The soils at each site also function to retain part of the stormwater to sustain healthier plant growth, thereby establish a dynamic mico ecosystem to better the local urban environment and for carbon storage. Tree and plant roots and microbial activities in turn promote a functioning rhizosphere that helps to improve and maintain good infiltration rates. The soils also serve as natural filters to remove and breakdown contaminants and excess nutrients from runoff. Stormwater capture volume and efficiency, storage, as well as the quality of runoff water and sediments/soils, have been monitored to evaluate the pros and cons of each design, implementation cost, benefits and identify specific maintenance requirements.

<u>Zhongqi (Joshua) Cheng, Brooklyn College, CUNY</u>

Dr. Zhongqi (Joshua) Cheng is a tenured faculty and an environmental geochemist at Brooklyn College of The City University of New York. His current research focus is on urban environmental issues. Trained as a "traditional geologist" with a PhD in isotope geology from The Ohio State University, Cheng spent five years at the Lamont-Doherty Earth Observatory researching arsenic with an inter-disciplinary team. At Brooklyn College, he has developed an urban garden soil testing program and research projects on the soil and water quality in New York City. He is also the Director of the Environmental Sciences Analytical Center at Brooklyn College.

Marsh Restoration Presentation Title

Don Cahoon[1] and Patricia Rafferty[2]

[1]USGS, [2]National Park Service

Abstract

<u>Don Cahoon, USGS</u>

Don Cahoon, a senior research ecologist with the U. S. Geological Survey, has more than 25 years experience investigating wetland plant ecology, wetland accretionary processes, and wetland restoration and management; and has published his findings in more than 100 research papers and reports. With his colleagues, he has developed a research approach for measuring wetland elevation dynamics (surface elevation tables (SET) used in conjunction with artificial soil marker horizons), which is being used in 18 countries by 65 coastal scientists. He and his colleagues have developed : 1) a global network of elevation monitoring sites using standard measurement protocols (SET and marker horizons) on coastal wetlands to give an advance warning of change, 2) new predictive models to determine the long-term potential for submergence of coastal wetlands, and 3) new elevation monitoring technology to improve our understanding of subsurface process influences on elevation. These developments are being used to determine: 1) the vulnerability of coastal wetlands to global change (e.g., sea-level rise and storms), 2) the critical driving forces and subsurface processes controlling elevation for a wide range of wetland types, and 3) the impact of current wetland management and restoration practices on elevation dynamics and wetland stability. The SET-marker horizon methodology is described in the website www.pwrc.usgs.gov/set.

<u>Patricia Rafferty, National Park Service</u>

USACE Restoration Planning Activities in Jamaica Bay – An Example of Collaboration

Peter Weppler

US Army Corps of Engineers

The salt marsh islands of Jamaica Bay have been disappearing rapidly. Left alone, the marshes could vanish by 2025, destroying wildlife habitat and threatening the bay's shorelines. To date, there is no consensus among ecological experts on the cause of the loss of the marsh islands, which range from rising sea levels and warmer temperatures to nitrogen input from stormwater run-off. Federal, State and local agencies representatives have helped to "jumpstart" the ecological process by joining forces and acknowledging the daunting challenges quickly. The USACE with NYCDEP and NYSDEC and with the concurrence of the stakeholders, decided on two parallel tracks of action: 1) Jamaica Bay Ecosystem Restoration Project (JBERP) being conducted under the USACE's General Investigations Program and 2) a restoration effort on the central marsh islands (under the USACE's Continuing Authorities Program (CAP)). Also as part of the USACE's Beneficial Use Program, additional sand from the HDP will be placed at Black Wall and Rulers Bar Marsh Islands. NYCDEP, NYSDEC, NPS, USACE and the Port Authority of New York and New Jersey are significant partners/contributors to the cost sharing of these islands. The marsh island restoration efforts is providing valuable data on the cause of the problems and helping identify the most effective future restoration options. While the rebuilding of marsh islands does not increase the net acreage of salt marsh in Jamaica Bay Wildlife Refuge, it does replace what is lost on a yearly basis.

Also under the CAP Authority, USACE, in cooperation with NYCDPR, recently restored Gerritsen Creek to ameliorate the adverse impacts of past filling activities related to the construction and maintenance of the large network of navigation channels created in Jamaica Bay. The project restored approximately 40 acres of habitat, including approximately 20 acres of inter-tidal salt marsh and approximately 20 acres of coastal/maritime grassland.

<u>Peter Weppler, U.S. Army Corps of Engineers</u>

Peter Weppler is an Environmental Section Chief with the US Army Corps of Engineers-NY District, Planning Division. Among his many projects, Peter is the Environmental Team Lead for multiple ecosystem restoration projects including the Jamaica Bay Marsh Islands Restoration and Hudson-Raritan Estuary Ecosystem Restoration Study which developed the Comprehensive Restoration Plan (CRP) for the NY/NJ Harbor. He has 20 years of experience which includes ecosystem restoration initiatives and flood and coastal storm damage reduction. Peter has an extensive background in ecological investigations in coastal and riverine systems throughout the New York/New Jersey Bight. In his early years at the Corps, Peter gained his experience in biological monitoring and NEPA Compliance. Later, Peter briefly stepped away from the Corps to work at a water supply commission in NJ before returning as a Section Chief.

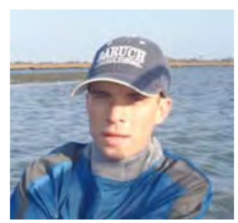
Oyster restoration and sediment nitrogen cycling in Jamaica Bay

Chester B. Zarnoch[1] and Timothy J. Hoellein[2]

[1]*Department of Natural Science, Baruch College, City University of New York, New York, NY*

[2]*Department of Biology, Loyola University Chicago, Chicago, IL*

Excess nitrogen (N) loading generates multiple, negative ecosystem effects and currently is one of the most significant management challenges in Jamaica Bay. Oyster feeding results in the removal of water column particulates and promotes the transfer of nutrients to the benthos. This may enhance sediment N cycling including N removal via denitrification. Management actions in the Hudson-Raritan estuary (NY/NJ) include the restoration of oyster reefs to improve ecosystem functioning but the environmental conditions under which oysters could enhance the N cycling have not been previously examined in urban environments. Oysters (3 densities) were deployed in May 2010 at four sites in Jamaica Bay, NY along a nutrient gradient. We measured oyster feeding and excretion rates in summer and fall, water quality monthly, and sediment denitrification potential, nitrification, and organic matter bimonthly. Oysters increased sediment organic matter, nitrification, and denitrification only initially, but had no effect or inhibited denitrification as the experiment progressed. Denitrification was linked with nitrate concentration and sediment organic matter across sites and dates. Oyster clearance rates were negatively correlated with the high total particulate loads typical of high nutrient sites. In addition, feeding rates and efficiencies were low when food quality was poor and during hypoxic events. Our initial results show that the desirable impacts of oyster restoration may not be attained under eutrophic conditions occurring seasonally in Jamaica Bay. Continued analysis will help elucidate the environmental drivers of these ecological processes and guide future management actions.



<u>Chester B. Zarnoch, Baruch College</u>

Chester Zarnoch is an Assistant Professor of Environmental Science at Baruch College and is a graduate faculty member in Biology at CUNY's Graduate Center. Dr. Zarnoch's research focuses on shellfish ecology, particularly in relation to restoration and aquaculture.

<u>Timothy J. Hoellein, Loyola University</u>

Timothy Hoellein is an Assistant Professor of Biology at Loyola University Chicago. Dr. Hoellein's research focuses on the influence of restoration efforts on ecosystem function across both rural and urban environments.

Factors Affecting Sustainable Oyster Reefs in Jamaica Bay

Jim Fitzpatrick
Hydroqual

Jamaica Bay, New York is a highly eutrophic tidal embayment that receives wastewater from four municipal wastewater treatment facilities. The Bay has also been highly altered by man's activities, including dredging for navigation and airport construction and hardening of shoreline. In order to improve water quality within the bay, resource managers are considering implementation of top-down controls, i.e., establishment of oyster reefs, as well as traditional bottom-up controls, i.e., nutrient reduction. Residence time within the Bay is fairly short, so placement of the oyster reefs within the bay to maximize residence time for larval settlement and recruitment to provide a sustainable oyster community is an important consideration. However, in general, potential areas with the longest residence time also have degraded water quality (low dissolved oxygen), which can be a stressor on larval survival. This paper will discuss a framework, using a linked hydrodynamic - particle tracking model, the latter of which includes the biological behavior of oyster larvae, to evaluate larval survival and recruitment within the bay. The paper will also describe potential water quality benefits that may be achieved with the implementation of oyster reefs using a linked hydrodynamic - water quality - suspension feeder model of the Bay.

<u>James J. Fitzpatrick, HydroQual</u>

Jim received a Masters degree in Environmental Engineering from Manhattan College. While at HydroQual and its predecessor firm, Hydroscience, he has gained over 40 years experience in the development and application of mathematical models to solve environmental problems. His modeling experience has included lake, river, and estuarine systems and has considered relatively simple applications, such as coliform bacteria and BOD/DO, as well as more complicated problem settings involving eutrophication and chemical fate and transport. Recently, he has worked on building biology into particle tracking models to evaluate larval transport and larval survival when larvae are exposed to sub-optimal dissolved oxygen.

Working Together to Increase the Scientific Value of Monitoring Programs in Jamaica Bay

Brett F. Branco
Brooklyn College of the City University of New York

It is commonly recognized both locally and nationally that water quality monitoring activities conducted by multiple entities are more efficient and effective when coordinated by a central organization. The Interagency Ecological Program (IEP) in San Francisco Bay provides one example of a complex integrated program that coordinates the monitoring and research of many stakeholders. The Jamaica Bay Watershed Protection Plan calls for similar structure for monitoring and research in Jamaica Bay, though significant progress towards this goal has not been attained. As an example, the National Park Service and New York City Department of Environmental Protection conduct independent but similar water quality sampling programs in Jamaica Bay, often sampling on the same or consecutive dates in the summer. The National Park Service water quality datasets provide important information about trends in Jamaica Bay. However, comparisons between NPS and NYC DEP datasets from 2008 and 2009 illustrate the need to begin coordination sooner rather than later. In particular, Jamaica Bay monitoring programs need to establish universal protocols and quality control standards to increase the scientific value of data and ensure maximum benefit to managers and stakeholders.

<u>Brett Branco, Brooklyn College</u>

Dr. Branco is a Marine Scientist, and Associate Director, Aquatic Research and Environmental Assessment Center (AREAC) and Assistant Professor, Earth and Environmental Sciences at Brooklyn College. He is interested in the impacts of eutrophication on shallow aquatic ecosystems, both marine and fresh water. His particular expertise is in measuring and modeling physical and biogeochemical interactions and feedbacks. Dr. Branco earned his PhD in Oceanography at the University of Connecticut and recently completed a two year post doc at the University of Western Australia in Perth. He arrived at Brooklyn College in 2009 to build a field program investigating the dynamics of eutrophication in New York City’s urban waterways.