New Jersey Flows

New Jersey Water Resources Research Institute

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The Hackensack Meadowlands - An Ecological Paradox

By Mary Anne Thiesing, Ph. D., Regional Wetland Ecologist, US Environmental Protection Agency, Region II

The Hackensack Meadowlands District is a 32-square mile area covering portions of 14 municipalities in northeastern New Jersey. Of the 21,000 acres which comprise the District, approximately 17,000 were originally wetlands and waters, and comprised a diverse array of wetland cover types, including tidal marsh, hardwood forest, and Atlantic white-cedar swamp. From the beginning of European colonization up until the present, the District's wetlands have been logged, diked, drained, farmed, filled, and contaminated, with the result that half of the wetlands and waters have been lost to fill and/or degradation. Today, the District's landscape is surrounded by urban development, and its once diverse plant communities have been succeeded by what is essentially a monoculture of invasive Phragmites australis, better known as common reed.

In spite of a history of abusive land-use practices, however, there has been a remarkable renaissance of fish and wildlife use in the District. The passage of the Clean Water Act in 1972 along with aggressive local enforcement by the New Jersey Meadowlands Commission resulted in dramatic increases in water quality, air quality, and surface land quality in the last 30 years. The result: the number of species of both migratory and resident birds which use the Meadowlands has more than tripled during this time, and the numbers of fish and invertebrate species have shown similar increases. Crackdowns on illegal dumping, as well as ongoing clean closure of some of the District's landfills, are reducing the volume of leachate which enters the Hackensack River and adjacent wetlands. In addition, the Meadowlands Environmental Research Institute (MERI) has intensively begun to study the myriad environmental problems which still face this urban wetlands ecosystem.

What is it that makes the Meadowlands so significant? First, despite loss of about half of its original wetland and open water areas, the Meadowlands is still a large system, comprising about 8,500 acres of wetlands and open water. Second, it is located within the Atlantic flyway, a significant coastal pathway for migratory birds, for which the Meadowlands represents a significant resource. Finally, because it is surrounded by intense urban development, the Meadowlands is an important island of wetlands in a landscape that has lost most of its coastal wetlands. The only other large estuarine wetland in the New York metropolitan area is the Jamaica Bay National Wildlife Refuge; consequently, the Meadowlands becomes especially important for its ability to provide food and resting habitat for hundreds of migratory bird species, as well as breeding habitat for more than 60 resident bird species. Additionally, a variety of estuarine fish species such as blueback herring depend on the Meadowlands for nursery habitat as juvenile fish make their way to coastal waters.

Apart from the obvious human pressures on this ecosystem, however, there are serious ecological problems facing the Meadowlands. Aerial photographs from over a period of 30 years show that some marshes which were not filled or altered have lost half of their open water. The cause of this loss appears to be from sediment accretion and overgrowth resulting from colonization by invasive forms of *Phragmites australis*. This variant of *P. australis* is probably a recently identified non-native genotype, dubbed haplotype M, which seems to be responsible for the aggressive colonization of northeastern marshes and concomitant displacement of other plant and animal species from those systems. This variant is highly aggressive, forming dense root mats and clonal populations of stems which remain standing for several years after dying. Ecosystem fragmentation promotes the spread of *Phragmites*; the plant reproduces through rhizomes and seed germination and is able to tolerate fairly high levels of salinity (in the range of 15 ppt). While type M *Phragmites* can provide benefits to the urban environment, such as sediment stabilization and toxicant immobilization, it changes marsh dynamics dramatically. Over time this monoculture is much less likely to support larval fishes and causes loss of open water/marsh complexes, rendering less habitat available to wading birds, waterfowl, shorebirds and other species. Consequently, the choice of what to do to save the Meadowlands' remaining marshes will need to balance a variety of considerations.

The Meadowlands is likely to experience considerable change over the upcoming decades as hazardous waste sites are remedi-

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The Director's Chair

by Joan G. Ehrenfeld, Ph.D., Director, New Jersey Water Resources Research Institute
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The Hackensack Meadowlands, within a stone's throw of New York City, is one of the most high-profile complexes of wetlands and waters in the state. Over the past few years, the public perception of the Meadowlands has undergone a remarkable transformation, from being viewed as a major eyesore, to an important habitat. This change in perception has come about in part because of the wide-ranging research that has been conducted. In this issue we highlight some of this recent research. *

New Jersey Meadowlands: Current and Recent Research

By Dr. Kirk R. Barrett, MERI, with introduction by Dr. Joan G. Ehrenfeld, NJWRRI

The Meadowlands Environmental Research Institute (MERI), a joint initiative of Rutgers University - Newark and the New Jersey Meadowlands Commission (formerly the Hackensack Meadowlands Development Commission), has been a major sponsor of research in the Meadowlands. Under the direction of Dr. Kirk Barrett, Science Director of MERI, research projects have been selected and funded that address a remarkably broad range of topics. Brief summaries of this research are given below with information for obtaining further information about individual research efforts. For more information about MERI, Dr. Barrett can be contacted at ***tel.: 973-353-5026 email:*** meri@cimic.rutgers.edu

RECENTLY COMPLETED PROJECTS

An assessment of natural attenuation and the effects of contamination in Eight Day Swamp along Berry's Creek.

This swamp is known to have been heavily contaminated by mercury, chromium, and a variety of other toxic metals. The degree to which natural processes may have helped to mitigate the effects of these toxic substances is unknown. Sediment cores were collected, and 2 cm-thick slices were analyzed to measure the metal content of succeeding layers of the soil. The results showed that cleaner sediments have been deposited on top of the older, heavily contaminated materials, so that this dangerous material is now below the zone that is colonized by many sediment-dwelling invertebrates. The abundance of these invertebrates declines as metal concentrations increase, but even the most contaminated sediments support diverse populations of benthic organisms, suggesting that the metals may not be bioavailable, or that the cleaner surface sediments permit the growth and survival of many organisms

Published results: P. Weis and J. S. Weis. 2002. Eight Day Swamp: Assessment of heavy metal contamination and benthic diversity. Final Report to MERI. 42p.

For more information, contact *Dr. J. Weis*, (973) 353-5387
e-mail: jweis@andromeda.rutgers.edu

Experimental investigations of mechanisms of Phragmites invasions

The reasons for the extensive spread of common reedgrass, *Phragmites australis*, need to be understood in order to effectively manage and restore the marshes of the Meadowlands. In this research, hypotheses were tested concerning the relative importance of seeds and rhizome fragments in establishing new populations, the role of salinity and sulfide in the sediments as limiting factors for *Phragmites* growth and spread, and the importance of the connections between adult stems and newly emerging stems. It was shown that periods of low salinity and low sulfide concentrations in well-drained areas, and the presence of large rhizome fragments, combine to promote the spread of *Phragmites*. In addition, the connections between older and emerging stems promotes the spread of the plant into poorly drained areas.

Published results: D. Bart and J. M. Hartman. 2002. Environmental Constraints On Early Establishment Of Phragmites Australis In Salt Marshes Wetlands v 22 n 2 p 201-213

For more information, contact *Dr. J. M. Hartman* (732) 932-6785, *e-mail:* jhartman@rci.rutgers.edu

Uptake and excretion of metals by salt marsh cordgrass and common reed

This project studied uptake and excretion of metals (such as chromium, lead, copper and zinc) by two grasses that are commonly found in the Meadowlands, salt-marsh cordgrass and common reed. Some of the metals are stored in plant tissue, including the leaves that are shed in the fall, which can enter food web through organisms that eat dead vegetation. The plants can also excrete metals and can then dissolve in marsh water, releasing them into the ecosystem. Such a release is a concern because certain metals can be harmful at high concentrations to plant and animal life. For the samples studied, cordgrass had three times as much chromium and twice as much lead in leaf tissue than common reed. Cordgrass also excreted about twice as much chromium, copper, lead and zinc than common reed, under both lab and natural conditions. The research showed that potential release of toxic metals should be considered in planning and conducting wetland restoration in contaminated areas.

Published results: Windham, L., J.S. Weis and P. Weis.2003 Uptake and distribution of metals in plant tissue of two dominant salt marsh macrophytes, *Spartina alterniflora* (cordgrass) and *Phragmites australis* (common reed). Estuarine and Coastal Shelf Science. In press.

For more information, contact*: Dr. J. Weis*, (973) 353-5387
e-mail: jweis@andromeda.rutgers.edu

Nutritional value of different marsh plants to key estuarine invertebrates

Detritus samples (decaying leaves) were collected from the marsh surface under *Phragmites*, natural *Spartina* and restored *Spartina* in the Meadowlands and from the same three types of plants from a cleaner site in Eastern Long Island in April 1998. Ground up, it was fed to groups of two species of fiddler crabs (*Uca pugnax* and *Uca pugilator*) that were regenerating new limbs, and to grass shrimp (*Palaemonetes pugio*). The different diets produced no noticeable difference in the fiddler crabs. *Uca pugilator* regenerated limbs and molted equally well on all six diets; *Uca pugnax* failed to complete limb regeneration and molting on all six diets. Grass shrimp did not survive on any of the pure detritus diets, but when provided with mud containing detritus and very small organisms from the three Meadowlands sites, did survive. The Mill Creek (restored cordgrass) mud supported the growth of shrimp, while the other two mud diets did not. This research highlighted the relative ecological value of *Phragmites* vs. other salt marsh vegetation.

Published results: J.S. Weis, L. Windham and P. Weis. 2002. Growth, Survival and Metal Content in Marsh Invertebrates Fed Diets of Detritus from *Spartina alterniflora* Loisel and *Phragmites australis* Cav. Trin. Ex Steud. from Metal-Polluted and Clean Sites. Wetlands Ecology and Management, v10 n1 Feb 2002 pp71-84.

For more information, contact*: Dr. J. Weis*, (973) 353-5387
e-mail: jweis@andromeda.rutgers.edu

Vegetative History of the Meadowlands

A definitive history of vegetation in the Meadowlands, from the time of first European settlement until present was produced by investigators who examined historical documents including botanical texts, reports, maps and aerial photographs. A series of color-coded maps depicting change in land cover resulted. The project's findings challenged the "conventional wisdom" that the Meadowlands was encompassed by a massive cedar forest when

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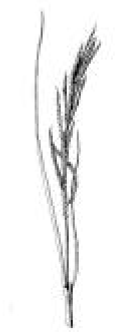
Some Recent Research in the Meadowlands

By Dr. Judith S. Weis, Department of Biological Sciences, Rutgers University, Newark

Phragmites

Long considered an urban wasteland, the Hackensack Meadowlands have proven to be a resilient estuarine ecosystem. As a result of decades of uncontrolled dumping and pollution, the sediments in the marshes and creeks remain contaminated and there is a federal "Superfund" site in Berry's Creek due to extremely high mercury that has still not been remediated after over 25 years. We (Dr. Peddrick Weis of UMDNJ and myself) found that in Eight-Day Swamp (which is along Berry's Creek) the most highly contaminated sediments are 10-20 cm below the surface (corresponding to the 1960s). This indicates that in the past few decades, cleaner sediments have been deposited on top of the more polluted ones. Presumably as this process (called "natural attenuation") continues, the most polluted sediments will be down so deep that they will no longer be available to biota. In the upper layers of sediments a benthic community exists that is not as diverse as that at Saw Mill Creek (a cleaner site, considered a reference site for the Meadowlands), but nevertheless, it is not a biological desert. A fish survey is indicating the presence of a diverse fish community in the Hackensack River, and ongoing studies on the health and reproduction of white perch (*Morone americana*) by Cathy Czerwinski, a grad student in my lab, indicate that this species is doing reasonably well in the system.



Spartina

Another stress in the Meadowlands is its domination by the common reed, *Phragmites australis*, an invasive species. Considered ecologically useless before studies on its actual effects on marsh ecology, developers argued that paving over such marshes would be no ecological loss. In recent years, scientists have been studying the actual effects of this plant on the ecosystem. We have studied its role as habitat and as food for estuarine organisms. Sites at Saw Mill Creek, where *Spartina* and *Phragmites* marshes are growing next to one another separated only by a tidal creek, have proven to be excellent field sites for such studies, since water quality, tidal cycle, etc. are identical. Cathy Yuhas, a graduate student, found that *Phragmites* provides suitable habitat for sediment-dwelling benthic organisms, comparable to *Spartina alterniflora* (the desired tidal marsh vegetation). The taxa richness tended to be somewhat greater in the *Phragmites* than the *Spartina* marsh. Behavior studies in the lab and sampling in the field indicate that fiddler crabs (*Uca pugnax*) and grass shrimp (*Palaemonetes pugio*) also "do not care" whether the marsh vegetation is *Spartina* or *Phragmites*. However, this is not the case for all estuarine organisms - *Phragmites* appears to be inferior to *Spartina* in terms of providing habitat for small stem-dwelling epifauna, as found by Tish Robertson, a graduate student working in our lab. Also, killifish, or mummichogs (*Fundulus heteroclitus*), the larvae of which require small depressions on the marsh surface that are not present in *Phragmites* marshes, were found by Craig Woolcott, another graduate student, to be more numerous in *Spartina* than *Phragmites* marshes. How killifish manage to remain so abundant in the Meadowlands (where there is a commercial bait fishery for them), long dominated by *Phragmites*, remains a mystery.

We have also done comparative studies of the food value of detritus from the two plant species. Our results indicated that detritus from decaying leaves of *Phragmites* has comparable food value to that of *Spartina* detritus in supporting growth and survival of fiddler crabs (*Uca pugnax* and *U. pugilator*) and grass shrimp (*Palaemonetes pugio*). Detritus of both species supported limb regeneration, molting, and growth of *U. pugilator*, but not of *U. pugnax*, which survived well but did not regenerate or molt. Diets of detritus from both plants were inadequate to support survival of the grass shrimp, which, as an omnivore, requires other food as well as detritus.

In another set of research projects, we investigated the effects of *Phragmites* vs *Spartina* on metal cycling in the tidal marshes of the Hackensack Meadowlands. We found that the reed deals with metal contaminants in a way that is more beneficial to the environment. In studies done with Lisamarie Windham, then a postdoctoral fellow, we found that both *Phragmites* and *Spartina* take up metals from sediments and concentrate them mostly in roots. However, we found that *Spartina* moved a greater proportion of the metals up into the leaves, from which they were excreted back to the ecosystem. *Spartina* has salt glands, and it is through them that the metals are excreted. We found that *Phragmites* leaves released much smaller amounts of metals, and we do not know the mechanisms of release, since this plant does not have salt glands. We found that in both plants the young leaves initially have lower levels of metals and that the levels accumulate over time in individual leaves. Because of this, upper leaves (younger, newer ones) tend to have lower metal concentrations than lower leaves, which are older. Thus, when the leaves are senescent they have high levels of metals. We have studied the fate of metals when leaves of both species decay on the marsh surface. While generally the metal levels in *Spartina* leaves are initially higher than *Phragmites*, the concentration of metals increases so greatly during the decay process that the initial species differences disappear. The source of the metals to the decaying litter is the surrounding sediments, but at some sites, the decaying litter acquires higher concentrations of some metals (Cu and Zn) than the surrounding sediments, indicating active uptake processes.

We are learning that *Phragmites* is not an ecologically useless or evil plant, and that it plays a role in marsh ecosystems. We suggest that the wholesale removal and replacement with *Spartina* should not be the automatic restoration goal at all sites, especially in contaminated areas. *

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Ecological Mapping in Meadowlands and the Hackensack River Watershed

By Ralph W. Tiner, Regional Wetland Coordinator, Northeast Region, U.S. Fish and Wildlife Service

The 70-odd square miles that comprise the Hackensack Meadowlands have for centuries presented a unique challenge to human habitation and use. Historically viewed as wasteland in need of drainage for agriculture and other development, the Meadowlands are now recognized as one of the Northeast's premier urban wetlands.

Since the late 1970s, the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) Program has been mapping the Nation's wetlands, and the Meadowlands was one of the NWI's first projects. The NWI relies on aerial photointerpretation techniques to produce large-scale maps that show the distribution of wetlands, using a 1:24,000 U.S. Geological Survey topographic map as a base. The original NWI maps of the Hackensack Meadowlands were produced from mid-1970s black and white aerial photographs (scale = 1:80,000) with a target mapping unit of about 5 acres. In 2001, the Service initiated its Strategic Mapping Initiative to update NWI maps in priority areas and northern New Jersey was designated as a high priority.

Work for the Hackensack watershed involved four tasks: 1) updated NWI mapping and digital data, 2) wetland trends analysis for the Meadowlands, 3) watershed-wide preliminary assessment of wetland functions, and 4) watershed-wide assessment of "natural habitat integrity." In 2002, the first two tasks were completed. The maps were updated from 1995 1:40,000 color infrared photographs; wetlands as small as one acre are mapped (access at: http://wetlands.fws.gov). The trends study[*] focused on wetland changes from the 1950s to the mid-1990s, but also reported on the general extent of wetlands at the end of the 19th Century. Approximately 20,000 acres of wetlands were present in the Meadowlands study area in 1889. By 1995, only 28 percent (5,500 acres) of these wetlands remained. The greatest wetland losses took place from 1966-1976, with annual losses averaging about 300 acres. Annual losses of more than 200 acres were detected for two other time periods: from the 1950s to the mid-1960s, and from the mid-1970s to the mid-1980s. From the late 1800s to the 1950s, annual wetland losses averaged about 100 acres. Most recently, wetland losses have amounted to 20 acres per year.

The other two parts of the Hackensack watershed initiative are underway; a report should be available by the end of this year. Both efforts involve using NWI data and other remotely sensed data for resource analysis. For the preliminary assessment of wetland functions, potential wetlands of significance will be identified for a host of functions including surface water detention, streamflow maintenance, nutrient transformation, and fish and wildlife habitat. The assessment of "natural habitat integrity" involves analysis of wetlands, deepwater habitats, and uplands and computation of metrics ("natural habitat integrity indices") that express the general condition of these resources. The indices include assessments of the remaining extent of "natural habitat", the condition of wetland, stream, lake, and pond buffers (100m), the current extent of wetlands and standing waterbodies, the amount of damming and channelization of streams, the extent of wetland disturbance, and the amount of "natural habitat" framentation by roads (see report on two Maryland watersheds [Nanticoke River and Coastal Bays] on the NWI website for sample application - http://wetlands.fws.gov). From these indices, a composite index called the "index of remotely-sensed natural habitat integrity" will be calculated.

When finished, this combined work will provide a baseline for assessing future changes in both wetlands and other natural habitats through remote sensing. It will also give resource managers more information on the extent and relative condition of natural habitat throughout the watershed. Such information is vital for developing strategies to protect, conserve, and restore fish and wildlife habitats in this highly urbanized area. *

[*]Tiner, R.W., et al. 2002. Wetland Status and Trends for the Hackensack Meadowlands. U.S. Fish & Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, MA.

For further information contact Ralph Tiner c/o National Wetlands Inventory Program, U.S. Fish & Wildlife Service, Northeast Region, 300 Westgate Center Drive, Hadley, MA 01035;e-mail: ralph_tiner@fws.gov
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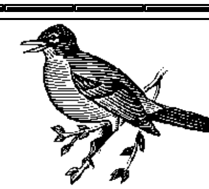
Meadowlands Symposium



A scientific symposium focusing on the Hackensack Meadowlands
New Jersey Meadowlands Commission, 1 Dekorte Park Plaza, Lyndhurst, NJ
October 9 and 10, 2003
Symposium web site: http://cimic.rutgers.edu/meri/symposium

Hudsonia, Ltd., the U.S. Fish & Wildlife Service, the U. S. Army Corps of Engineers (NY District), and the Meadowlands Environmental Research Institute (MERI) and their cosponsors [including NJWRRI] have partnered to organize a scientific symposium on the Hackensack Meadowlands. As the USFWS, the Army Corps of Engineers and the New Jersey Meadowlands Commission begin to prepare a multimillion dollar "Comprehensive Restoration Improvement Plan" for the Meadowlands, it is an excellent time to review and discuss the complex, interdisciplinary, scientific issues in this fascinating post-industrial landscape. The intent of the Symposium is to provide a forum for a diverse group of scientists to exchange information about their research in the Meadowlands and to disseminate their findings to the environmental communities at large. The organizing committee invites you to **attend the conference** and **submit an abstract** relevant to the Meadowlands for an oral presentation or a poster to be presented at the symposium. For more information including a list of topics, see the symposium website. *

New Jersey's Toxics Reduction Work Plan for the New York-New Jersey Harbor

By Joel A. Pecchioli, New Jersey Department of Environmental Protection, Division of Science, Research and Technology

The New York-New Jersey Harbor estuary is enormously important ecologically and economically to New Jersey and to the nation.

In recognition of its value, the harbor was included for study in 1988 in the federal Clean Water Act National Estuary Program as the New York-New Jersey Harbor Estuary Program. A Comprehensive Conservation and Management Plan for the harbor estuary program was finalized in March 1996, and identified the management of toxic contamination as one of the five primary reasons that the estuary's ecosystem, and people's use of the estuary, was impaired.

Fifteen toxic chemicals of concern were identified, including polychlorinated biphenyls (PCBs), dioxins/furans, chlorinated pesticides, polycyclic aromatic hydrocarbons (PAHs), and the metals cadmium, lead, and mercury.

About the same time the Comprehensive Conservation and Management Plan was being developed, a dredging crisis was brewing in the harbor. Because of changes in federal regulations and testing requirements for toxic contaminants, most of the dredged material previously deemed suitable for unrestricted ocean disposal was now found unsuitable for such disposal. As a result, alternative dredged material management and disposal facilities were required, and substantially increased the cost of dredging.

In response, the New York-New Jersey Harbor Estuary Program developed the Contaminant Assessment and Reduction Program (CARP), incorporating toxics-reduction work plans then under development by the states of New Jersey and New York.

In 1998, the Port Authority of New York-New Jersey, through the New Jersey Department of Transportation's Maritime Resources provided $9.5 million to the New Jersey Department of Environmental Protection to develop and implement the New Jersey Toxics Reduction Work Plan for New York-New Jersey Harbor. The work plan is an adaptive, four-phased approach, designed to foster a better understanding of the sources, transport, and fate of sediment and toxic chemicals in the harbor. Each of the four phases includes sampling, data analysis and program management.

Phase One of the New Jersey work plan, initiated in June 2000 and largely completed by the spring of 2002, has three main components:

- Ambient water quality sampling at the head-of-tide and in the tidal sections of the five major New Jersey tributaries to the harbor (the Passaic, Hackensack, Raritan, Rahway, and Elizabeth Rivers), and in the estuarine areas of Newark Bay, the Arthur Kill, and the Kill van Kull;
- Hydrodynamic surveys in the Passaic, Hackensack and Raritan Rivers, and in the harbor's estuarine areas, conducted synoptically with water quality sampling; and,
- Sampling the 12 New Jersey publicly owned treatment works, and selected stormwater and combined sewer outfalls that discharge into the harbor.

In the Hackensack River, the U.S. Geological Survey collected water quality samples at a head-of-tide station, just below the Oradell Dam. In addition, researchers from Stevens Institute of Technology and Rutgers University conducted water-quality sampling and hydrodynamic surveys at three downstream tidal stations. The Great Lakes Environmental Center sampled effluent discharges from the Bergen County Utilities Authority, North Bergen-Central and Secaucus publicly owned treatment works, and at selected combined sewer outfalls and stormwater outfalls.

The main problem with sampling for toxic chemicals in ambient waters is "false negatives," meaning chemicals are present, but in concentrations too low to be detected through standard sampling and analytical procedures. To solve the problem, the Trace Organics Platform Sampler, a high-volume water sampler, was combined with state-of-the-science high-resolution analytical methods, enabling acquisition of a unique and comprehensive data set for contaminants previously undetectable in ambient waters.

Phase Two and Three work plan studies were designed to track down and identify sources of the toxic chemicals. Phase One studies revealed that the highest Hg concentrations in the harbor are found in the Hackensack River. Therefore, special studies of Hg contamination in the Hackensack River were initiated in April and November 2002. These studies included hydrodynamic surveys, sampling of river bottom sediments, and additional water quality sampling over the course of two tidal cycles.

Phase Four of the work plan consists of developing a comprehensive model of sediment and contaminant fate and transport throughout the harbor. Administered by the Hudson River Foundation as a CARP project, the work has been contracted to Hydroqual.

Identifying sources of the toxic contaminants and implementing management actions to eliminate the sources are the ultimate objectives of the New Jersey Toxics Reduction Work Plan and CARP. To achieve these objectives, additional work and funding will be needed, but studies completed to date have provided a wealth of information about the transport and fate of toxic chemicals in the New York-New Jersey Harbor.

The gathering of this information represents a critical milestone in our effort to reduce toxic loadings in the harbor. *

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Ecological Paradox (Cont.)

(Continued from page 1)

ated, brownfields are redeveloped, and the estuary's watershed responds to development pressures. As resilient as the Meadowlands has shown itself to be, it is now in an urban landscape setting which places enormous stress on the ecosystem. One thing seems certain: if the Meadowlands is not managed, it is likely to experience an overall decline in wetland quality and estuarine life support. Ongoing research, such as the studies being performed by MERI, can help fill the information gap that currently exists on urban ecosystems, and hopefully, allow for better informed decisions. *

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Meadowlands Research Projects (Cont.)

(Continued from page 2)

Europeans arrived; rather, cedars covered only portions of the area. Also, the Oradell dam, constructed in the 1920s, was not responsible for conversion from cedar forest to brackish marshlands; the conversion had already taken place by that time. Sea level rise and the decline of ground elevation since the 1600s has greatly affected the trajectory of vegetation change. One important implication of the work is that, since the vegetation has changed so much within the Meadowlands, through both natural and human forces, site-specific historical conditions may have limited usefulness in guiding restoration strategy.

Published results: M. Wong. 2002. Land Use Change in the Meadowlands." Master's Research Project. Graduate School-New Brunswick, Rutgers, The State University of New Jersey. CD-ROM publication.

For more information, contact *M. Wong: MERI (973) 353-5026, e-mail: meri@cimic.rutgers.edu*

The influence of low dissolved oxygen on predatory fishes in two marsh creeks in the Hackensack Meadowlands

These investigators caught fish and measured dissolved oxygen in Mill Creek and Doctor's Creek to see if there was any influence of low dissolved oxygen on the feeding behavior of predatory fishes such as white perch, striped bass and bluefish. White perch were most tolerant to low dissolved oxygen; striped bass the least tolerant. Investigators analyzed stomach contents of these same species to determine if the composition of diet varied with dissolved oxygen and other variables and found there was no obvious relationship between dissolved oxygen and stomach fullness in either creek for any species. This research demonstrated that these sport fish are commonly found in tidal creeks in the Meadowlands and that their distribution could be influenced by low dissolved oxygen.

Published results: K. W. Able, M. J. Neuman and F. Ruess. 2002. The influence of low dissolved oxygen on predatory fishes in two marsh creeks in the Hackensack Meadowlands. Final Report to MERI. 33p.

For more information, contact: *K.W. Able* (609) 296-5260 Ext. 230, e-mail: able@imcs.rutgers.edu

Development of a field-operable bioluminescent optical fiber bio-sensor instrument for monitoring genotoxicity and other contaminants in the Meadowlands.

Investigators from the Ben-Gurion University of the Negev in Beer-Sheva Israel have developed a field operable version of their instrument, which employs genetically engineered bacteria to produce light (bioluminescence glow) when exposed to certain contaminants. The bacteria are affixed in a gel to the end of an optical fiber, which in turn is connected to a light detector. When the fiber is dipped into a water sample, the amount of light produced by the bacteria (and captured by the detector) is proportional to the concentration of the contaminant. The bacteria that are presently being used are sensitive to DNA-damaging contaminants (genotoxicants). The device was field tested during an extended visit to MERI lab; no genotoxicants were found in surface water samples collected in the Meadowlands. Further efforts are underway to apply the instrument with bacteria that are sensitive to other contaminants of importance in the Meadowlands, such as mercury.

Published results: B. Polyak and R. Marks. 2002. Fiber optic RecA lux sensor and genotoxicity biosensing of samples collected at HMDC sites. Final report to MERI. 35p.

For more information, contact*: MERI (*973) 353-5026

Automated image analysis as tool to analyze the impact of heavy metal availability on microbial communities in contaminated estuarine salt marshes

The objective of this project was to develop and evaluate an image analysis protocol for the analysis of specific populations of bacteria in contaminated environments. Processing of microscopy images allowed the researchers to specifically enumerate hybridized bacteria, measure their cell sizes, and subsequently calculate their biovolumes and estimate their biomass. This procedure was used to analyze bacterial populations in sediment samples from Kearny Marsh artificially contaminated with nickel (Ni) and incubated under sulfate-reducing conditions. Compared to non-amended samples, Ni-amended samples generally displayed lower cell numbers, but cell size distributions in a larger range. These result indicated the development of different bacterial populations, and thus demonstrated the usefulness of the developed image analysis protocol.

Published results: H. Cai and D. Hahn. 2002. Assessing Microbial Indicators for Heavy Metal Contamination using Automated Image Analysis. Final Report to MERI. 47p.

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Microbial community structure in the root zone of salt marsh plants as an indicator of contamination

Sediment samples associated with two different vegetation types (*Spartina alterniflora* and *Phragmites australis* were obtained from two brackish marshes, Saw Mill Creek in the Meadowlands and the nearly pristine Mullica River in southern NJ, and from *Phragmites* in the freshwater Kearny Marsh in the Meadowlands. Analysis showed that the microbial communities differed between sites. Sediment biogeochemical and microbial population differences between vegetation type were greater at Mullica River than at Saw Mill Creek. These findings suggest that in pristine wetlands, the vegetation type exerts a stronger influence on the microbial population than in contaminated wetlands, where the influence of the vegetation did not appear to be an important factor in determining microbial community structure or biogeochemical functional capabilities. Experiments were also conducted to see if differences in microbial communities would result in differences in the degradation rate of an organic contaminant, specifically tetrabromobisphenol A (TBBPA), a halogenated flame retardant. While samples from Kearny Marsh degraded TBBPA the fastest, there were no site differences between Saw Mill Creek and Mullica River. *Spartina* samples degraded the contaminant more quickly than *Phragmites* samples at both sites.

Published results: Ravit, B., Ehrenfeld, J.G., Haggblom, M.M. In press. A Comparison of Sediment Microbial Communities Associated with *Phragmites australis* and *Spartina alterniflora* in brackish wetlands of New Jersey. Estuaries.

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Continuous Monitoring of Air Toxics: Phase I: Alternatives Analysis

The objective of Phase I of this project was to evaluate commercially available instrumentation for continuous monitoring of VOCs in ambient air at the Meadowlands. Based on currently available technology, a GC or GC/MS system with sorbent sampling followed by thermal desorption was recommended.

Published results: Mitra. S. 2002. Evaluation and installation of instrumentation for continuous monitoring of VOCs at the Meadowlands. 9p.

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PROJECTS IN PROGRESS

Aquatic Animals Inventory

An assessment of the abundance, diversity and health of fish and other aquatic animals in the Hackensack River and its tributaries within the Hackensack Meadowlands District. River bottom sediments are being collected at each fish collection location.

Heavy Metals, Pesticides and PCBs in Fish, Crabs and Sediments of the Hackensack Meadowland

In conjunction with MERI's inventory of aquatic animals, this project is analyzing the levels of contaminants in selected fish species, blue crab tissue, and river bottom sediment for selected heavy metals, pesticides and PCBs.

Reproductive Health & Diet of White Perch in the Meadowlands

An assessment of white perch caught by MERI for reproductive health and food.

Evaluating the Effects of Contamination at Kearny Marsh

The environmental health of Kearny Marsh is measured by biomonitoring macroinvertebrates *in situ*, testing sediment and detritus toxicity and measuring heavy metal bioaccumulation.

Ecological Risk Assessment of Contamination of Wetlands in the Hackensack Meadowlands District.

A geographic database of chemical contamination and biotic inventory will be developed for previously assessed wetlands in the Hackensack Meadowlands District. Screening-level ecological risk assessments will be conducted on studied contaminants to determine wetland fauna at multiple trophic levels that are potentially at risk.

Status and Trends of Heavy Metals in the Waters of the Lower Hackensack River

By examining the status and trends of heavy metal concentrations of the lower Hackensack River and tributaries, investigators will compare concentrations with other estuaries, investigate spatial and temporal trends, and investigate correlation of metals with proceeding rainfall, salinity, drought and total suspended solids.

Factors controlling mercury contamination in Berry's Creek and downstream ecosystems

A study of the concentration and fluxes of various species of mercury in and between water, sediments and air in and along Berrys Creek and Canal will determine the biological and chemical conditions which govern transformation from less toxic forms of mercury to the more toxic form of methylmercury. Results will indicate the distribution and spread of mercury from Berrys Creek and reveal patterns of and mechanisms governing methylmercury production in the Meadowlands.

Assessing and monitoring groundwater contamination from landfill leachate in Kearny Marsh using high-resolution geophysics

Research on a high resolution baseline geophysical survey to (a) confirm the existence, and (b) map the spatial and vertical extent, of the groundwater leachate plume suspected to be invading Kearny Marsh from Keegan landfill. Geophysical measurements will be obtained on the landfill fringe, connecting wetlands and Kearny Marsh.

Effect of heavy metals on interactions between vesicular arbuscular mycorrhizal fungi (AMF) and Spartina patens in a restored urban salt marsh in the Hackensack Meadowlands

Vesicular arbuscular mycorrhizal fungi (AMF) that interact with plant roots and increase nutrient capture and thus plant productivity, affect plant biodiversity. This research will determine the principal interactions between *Spartina patens*, with associated microbial populations (AMF, Bacteria, protozoa) that may limit productivity at increasing heavy metal concentrations in soils/sediments.

Bioprospecting for interesting microbes in Meadowlands sediments

"Bioprospecting" in the Meadowlands involves looking in sediment for new microbes that have evolved unusual and useful properties resulting from long-term exposure to a contaminated environment in the Meadowlands. Once catalogued in a DNA library of samples, the microbes can be used by researchers to discover new genes similar to known genes that produce useful enzymes.

Effect of Salinity and Hydroperiod on Distribution of Spartina Alterniflora and Phragmites Australis in the Hackensack Meadowlands

The two major species of grasses found in salt-marshes the in Meadowlands are Spartina Alterniflora and Phragmites Australis. This research questions how salinity and hydroperiod (frequency and duration of flooding) influence which species will out compete the other at a given location.

Automated Validation of Environmental Monitoring Data

In a continuous, real-time data collection environment, validation of environmental monitoring data of weather, air quality, water quality and hydrology must be automated. *

The Ecology of the Meadowlands - A Recent Review

Recently, a "biological state of the swamp" report was prepared by Eric Kiviat and Kristi MacDonald, of Hudsonia, Ltd. entitled "Hackensack Meadowlands, New Jersey, Biodiversity: A Review and Synthesis." The report surveyed all the available information about the status of vegetation, birds, mammals, amphibians and reptiles, fishes, invertebrates, and rare and endangered species. The report starts with a comprehensive description of the Meadowlands environment - its geology, hydrology, and history - and includes a survey of the contamination issues facing the wetland. An analysis of conservation challenges, restoration and habitat management goals, and research needed to support these goals concludes the report. The surprise, for many readers, may be the high diversity of organisms that inhabit the marshes. The document is an impressively comprehensive view of the ecology of the marsh, and the challenges for protecting and restoring its ecological integrity. The document can be obtained as a .pdf file rom the Hackensack Meadowlands Partnership, the organization that sponsored the study, at ***http://www.meadowlandspartnership.org/bn.html#A***. This site includes the 97 page report, as well as the 21 page plant and bird inventory. *

Features

New Jersey Flows

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