

COASTAL HABITAT RESTORATION

A Summary of Three Workshops:

Ecological Indicators For Salt marsh Restoration In The Mid-Atlantic Bight

Microbial Communities And Salt Marsh Health

Bioremediation Of Petroleum Contaminated Salt Marshes



CONTENTS

COASTAL RESTORATION OVERVIEW 2

RESTORATION WORKSHOP #1: *ECOLOGICAL INDICATORS FOR SALT MARSH RESTORATION IN THE MID-ATLANTIC BIGHT*

WORKSHOP SUMMARY	6
WORKSHOP AGENDA	7
RESOURCES	8

RESTORATION WORKSHOP #2: *MICROBIAL COMMUNITIES AND SALT MARSH HEALTH*

WORKSHOP SUMMARY	9
WORKSHOP AGENDA	11
RESOURCES	12

RESTORATION WORKSHOP #3: *BIOREMEDIATION OF PETROLEUM CONTAMINATED SALT MARSHES*

WORKSHOP SUMMARY	13
WORKSHOP AGENDA	15
RESOURCES	16

COASTAL HABITAT RESTORATION OVERVIEW

Between December 1999 and June 2001, the Jacques Cousteau National Estuarine Research Reserve hosted a series of three workshops on topics related to salt marsh restoration. The goal of these workshops were to synthesize the findings and experience gained from salt marsh restoration projects within the region, access research and information gaps in salt marsh restoration science, and discuss the utility of developing regional indicators for coastal wetlands.

Tidal salt and brackish marshes serve as a transition zone between terrestrial and marine environments. They are found at the mouths of rivers and streams, in bays and in other protected coastal areas. Tidal salt and brackish marshes are flooded regularly by tides and are very harsh environments due to their frequent inundation and high salinity. Plants and animals must adapt to these conditions to survive in this environment. Salt and brackish marshes are vast, flat meadows reaching from the bay side of the coastal barrier islands to the mainland. They extend up rivers and tributaries of the coast, changing gradually to freshwater marshes as the salinity of the adjacent water and tidal effects of the sea diminish. They are usually connected to an arm of the sea that reaches inland and meets the lower course of a river, called an estuary but are often found in other low energy coastal environments such as bays, and lagoons. Because of the tremendous amount of biomass in the form of vascular and subsurface plant matter, salt marshes are regarded among the world's most productive ecosystems (Teal 1962, Keefe 1972, Tiner 1984).

Salt marshes – and the wetland habitats of which they are a part – have disappeared at an alarming rate. Luckily these losses have declined in recent years, due to increased public awareness of their value and the establishment of more stringent regulations. According to a U.S. Fish and Wildlife Service Status and Trends Report, since the mid-1800's more than half the nation's original wetlands have been destroyed (Dahl and Johnson 1991). Along with these wetlands losses are the reduction in wetlands functions and their societal values. We are now experiencing catastrophic flood damage, poor water quality, and loss of critical fish and wildlife habitat. Now more than ever it is important to understand and protect our remaining wetlands.

The paramount importance of restoring these valuable coastal habitats is evidenced by the increasing emphasis on restoration through federal resource management agencies. A number of federal grant programs have been developed to promote restoration activities in freshwater and coastal wetlands. For example, Environmental Protection Agency's Clean Water Action Plan has a goal of achieving a net increase of 100,000 acres of wetlands each year by the year 2025. The United States Department of Agriculture Wetland Reserve Program will reach its goal of restoring 1 million acres of wetlands in the year 2001. The United States Fish and Wildlife Service 1999-2000 Director's priorities are to promote restoration for improving migratory bird habitat and controlling invasive species. The Service's Partners for Wildlife and Bring Back the Natives Program provide cost-share funding to landowners for habitat restoration. National

Marine Fisheries Service Community-Based Restoration Program will be providing \$3 million in FY 2001 for coastal restoration projects.

Researchers have successfully applied new technologies to restore and create salt marshes (Kusler and Kentula 1990, Thayer 1992, Matthews and Minello 1994, Dreyer and Niering 1995, Zedler 1996, Broome and Craft 1998). Through restoration activities a large body of research is emerging that can be used to provide guidance for future restoration efforts. Comparisons between natural and restored marshes can reveal patterns that may be used to assess the process of coastal marsh rehabilitation or predict the anthropogenic alteration of coastal wetlands. As we begin to develop an understanding of the ecological function of coastal marshes we can then begin to identify sensitive biological indicators of salt marsh health to improve restoration efforts.

Broome, S.W., C.B. Craft and W.A. Toomey, Jr. 1999. Soil organic effects on infaunal community structure in restored and created tidal marshes. In M.P. Weinstein and D.A. Kreeger (eds) *Concepts and Controversies in Tidal Marsh Ecology*. Kluwer Academic Publishers. Dordrecht, The Netherlands.

Dahl, T.E. and C. Johnson, "Wetlands: Status and Trends in the Conterminous United States, 1985-1995," 1997, U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Dryer, G.D. and W.A. Niering (eds). 1995. *Tidal Marshes of Long Island Sound: Ecology, History, and Restoration*. The Connecticut College Arboretum, New London, CT. Bulletin 34. 72 pp.

Keefe, C.W. 1972. Marsh production: A summary of the literature. *Contributions in Marine Science*. 16:163-181.

Kusler, J.A. and M.E. Kentula. 1990. *Wetland Creation and Restoration: The Status of the Science*. Island Press, Washington, DC.

Matthews, G.A. and T.J. Minello. 1994. Technology and success in restoration, creation and enhancement of *Spartina alterniflora* marshes in the United States. NOAA Coastal Ocean Program Decision Analysis Series No. 2, Washington, DC. 2 volumes.

Teal, J.M. 1962. Energy flow in the salt marsh ecosystem of Georgia. *Ecology*, 42:614-624.

Tiner, R.W. Jr. 1984. *Wetlands of the United States: Current status and recent trends*. U.S. Fish and Wildlife Service Publication, Washington, DC. 59 pp.

Zedler, J.B. 1996. Tidal wetland restoration: A scientific perspective and southern California focus. California Sea Grant College Publication T-038, La Jolla, CA. 129 pp.

**RESTORATION WORKSHOP #1
ECOLOGICAL INDICATORS FOR SALT MARSH RESTORATION
IN THE MID-ATLANTIC BIGHT**

WORKSHOP SUMMARY

Are restored marshes equivalent to natural marshes? The answer remains elusive because research has not yet provided functional models of natural salt marsh ecology (Copeland 1997). Due to the geographic variability of salt marshes, regional indicators and success criteria for functional trends need to be established. The purpose of this workshop was to transfer current research efforts in salt marsh restoration to the coastal management community. Researchers involved in monitoring a range of attributes (including plants, benthic infauna, and faunal communities) in several large-scale restoration projects were asked report on the presence and prominence of surrogate that can be used to determine the relative success of salt marsh structure and function. As a result of this workshop, it was hoped that coastal interest groups, management entities, and technical practitioners would be better equipped to set goals for the restoration of salt marsh habitats within the region.

The workshop was held on December 8, 1999 at Richard Stockton College in Pomona, New Jersey. This workshop was sponsored by the Jacques Cousteau National Estuarine Research Reserve, a state-federal program administered by the Institute of Marine and Coastal Sciences at Rutgers University and National Oceanic and Atmospheric Administration's (NOAA) Estuarine Reserve Division. Workshop funding is provided by the New Jersey Department of Environmental Protection's Office of Coastal Planning and NOAA's Coastal Management Program.

Copeland, B.J. 1998. Salt Marsh Restoration: Coastal habitat Enhancement. North Carolina Sea Grant College Program UNC-SG-98-08. Raleigh, North Carolina. 31 pp.

**ECOLOGICAL INDICATORS FOR SALT MARSH RESTORATION
IN THE MID-ATLANTIC BIGHT
AGENDA**

- 9:00 Welcome & Opening Remarks
- 9:10 Mitigation and Restoration in New Jersey: A Regulatory Perspective
Audrey Wendolowski, Lee Widjeskog, NJDEP Land Use Regulatory Program
- 9:30 Plan development, design feasibility and monitoring integration
Carl Alderson, NYC Dept. of Parks and Recreation, Natural Resources Group
- 10:15 Faunal response to natural and restored marshes in Delaware Bay
Ken Able, Institute of Marine and Coastal Sciences, Rutgers University
- 11:00 Benthic infaunal community structure and sediment chemical properties in
restored and reference marshes
Gary Taghon, Institute of Marine and Coastal Sciences, Rutgers University
- 11:45 Lunch
- 1:00 Monitoring plant community success in the Hackensack Meadowlands
Jean Marie Hartman, Landscape Architecture, Rutgers University
- 1:45 Oil spill remediation efforts, restoration and monitoring of urban intertidal salt
marshes
Marc Matsil, NYC Dept. of Parks and Recreation, Natural Resources Group
- 2:30 Estuarine Research Federation – Restore Americas Estuaries Habitat Restoration
Initiative
Principals for Ecological Restoration
Mike Weinstein, NJ Sea Grant
Mark Wolf-Armstrong, Restore America’s Estuaries
- 3:15 Discussion
- 4:00 Adjourn

**ECOLOGICAL INDICATORS FOR SALT MARSH RESTORATION
IN THE MID-ATLANTIC BIGHT**

RESOURCES

NOAA National Marine Fisheries Office of Habitat Restoration
<http://www.nmfs.noaa.gov/habitat/restoration/>

NOAA Office of Habitat Restoration
<http://noaa.response.restoration.noaa.gov>

Restore America's Estuaries
<http://www.estuary.org>

RESTORATION WORKSHOP #2 MICROBIAL COMMUNITIES AND SALT MARSH HEALTH

WORKSHOP SUMMARY

Decisions made by coastal managers can have profound, long-term consequences for estuarine and coastal environments. Unfortunately, key decision makers often do not have timely access to new research and technology. That is why the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) has funded five National Estuarine Research Reserves to examine the use of interactive Internet broadcasts as a tool for linking researchers to managers across a geographical separation. The Coastal Management Seminars combine on-site presentations and broadcasts of researchers filmed at their field locations.

This workshop, held at the Institute of Marine and Coastal Sciences at Rutgers University, was designed for federal, state and local government managers; researchers, environmental consultants and planners. This workshop was held on December 8, 2000 and again, in a video format, on June 21, 2001. Sponsors included the Jacques Cousteau National Estuarine Research Reserve (JC NERR), New Jersey Department of Environmental Protection Coastal Management Program, and the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET).

Using live streaming video technology researchers from the University of Maryland's Horn Point Laboratory presented their research regarding Bacterial Growth Efficiency (BGE) as an indicator of ecosystem health. Drs. del Giorgio and Newell's research focuses on investigating microbial activity to define which microbial parameters are useful, and to determine the baseline of these parameters in a range of natural tidal marshes. One key functional attribute of ecosystems is the pattern of organic carbon flow, which is largely mediated by microbial assemblages. These microbial communities – including heterotrophic bacteria and a host of other small organisms – react faster than any other biotic component to changes and perturbations of the ecosystem and thus may provide the most sensitive index of ecosystem change and recovery. These researchers are developing an index that uses microbial activity as a measure of ecosystem health.

At the bottom of a marsh food chain, microbial organisms transfer energy up the food web when they are consumed by small crabs, worms, fish and snails. Therefore, the amount of secondary production in the aquatic environment depends heavily upon the efficiency in which bacteria convert dissolved organic matter into biomass, or bacterial growth efficiency (BGE). Bacterial growth efficiency is regulated by the supply and quality of the organic substrates available to bacteria, as well as by the availability of nutrients, particularly nitrogen and phosphorus. BGE is thus a measure that integrates fundamental properties of aquatic ecosystems, such as organic matter and nutrient availability.

Drs. Del Giorgio and Newell took advantage of the National Estuarine Research Reserves as an opportunity to make baseline measurements in pristine estuarine environments. The North Carolina NERR, the Chesapeake Bay NERR in Maryland and in Virginia, the

Delaware Bay NERR, and the Sapelo Island NERR in Georgia all served as field sites for this research. They also sampled one non-NERR site in New Jersey. By using five different NERR sites, the researchers were able to assess variation in BGE across a range of human-impacted estuaries. Preliminary results suggest that high overall secondary production in salt marshes may be linked to amore efficient transfer of organic matter from detritus through high bacterial activity – high BGE. From a management viewpoint, these results further suggest that environmental managers could use BGE as a sensitive indicator of ecosystem function in natural tidal marshes and as a tool to assess either degradation of marshes or their recovery during restoration processes.

Adapted from “Use of microbial community metabolism to assess salt marsh ecological function” by Jude Apple, Paul del Giorgio, and Roger Newell, University of Maryland Horn Point Lab.

**MICROBIAL COMMUNITIES AND SALT MARSH HEALTH
AGENDA**

- 12:00 pm Welcome, Introductions and Lunch
- Discussion: Use of Microbial Activity as a Biological Indicator in Coastal
 Marshes: Examples of Local Research, Applicability as a Management
 Tool
- 1:00 pm Live Internet Broadcast featuring Dr. Pul del Giorgio and Dr. Roger
 Newell (video segments from Maryland salt marsh and laboratory in
 Cambridge, MD)
- 2:00 pm Live Question and Answers from the featured researchers via the Internet
- 3:00 pm Discussion and Wrap Up

MICROBIAL COMMUNITIES AND SALT MARSH HEALTH RESOURCES

Center for Microbial Ecology at Michigan State University
(<http://www.cme.msu.edu>)

International Society for Microbial Ecology
(<http://www.cme.msu.edu>)

Information on workshops and featured research
www.coastlive.org

Cooperative Institute for Estuarine Environmental Technology
www.ciceet.unh.edu

RESTORATION WORKSHOP #3
BIOREMEDIATION OF PETROLEUM CONTAMINATED SALT MARSHES

WORKSHOP SUMMARY

Of all estuarine and coastal Environments, salt marshes are often the most ecologically sensitive areas impacted by oil spills and leaks (Gundlach and Hayes 1978). Oil is swept into salt marsh environments by tidal currents and wind and is trapped by marsh grass and organic rich sediment. In salt marshes the impact of oil contamination is great because: (1) marshes are areas of high productivity; (2) heavy petroleum products such as polycyclic aromatic hydrocarbons or PAHs and low volatility compounds such as fuel oil and diesel fuel tend to be persistent in salt marsh sediments; and (3) natural degradation of contaminants is slower in salt marshes because anaerobic conditions predominate (Mille et al 1998). Remediation of salt marshes is difficult and can be more detrimental to biota than no action depending on the methods used, however, sometimes it is necessary to consider engineered techniques to clean up contamination, as natural processes tend to be very slow.

The workshop was held at the Institute of Marine and Coastal Sciences at Rutgers University on May 16, 2001. Sponsors included the Jacques Cousteau National Estuarine Research Reserve (JC NERR), New Jersey Department of Environmental Protection Coastal Management Program, and the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET). This workshop was part of a collaborative project where five NERR sites, led by the North Carolina NERR, were funded to examine tools that can be used to transfer scientific research to those that can use the information to make more informed decisions regarding the management of our coastal resources.

A goal of this workshop was to provide coastal managers and environmental professionals with practical ways to implement and evaluate bioremediation techniques. Presenters discussed microbial processes in natural and enhanced bioremediation. The morning portion of the program featured a live panel discussion. Panelists included Rutgers' faculty from the Institute of Marine and Coastal Sciences, Biotechnology Center of Agriculture and the Environment, and the Departments of Biology and Microbiology and Environmental Science and faculty from Pace University. Workshop panelists presented an overview of the status of research in the field as well as resources that will soon be available within the region.

After lunch, workshop participants were able to participate in a live Internet presentation. Using live-streaming video technology, researchers from the University of New Hampshire presented their research from Portland Harbor, Maine. Workshop participants were provided the opportunity to ask questions of the researchers using Internet chat technologies. The Internet portion of the workshop was broadcast simultaneously at four other National Estuarine Research Reserve's in North Carolina, South Carolina, Virginia and Washington. Some of the bioremediation techniques that were discussed included natural attenuation, nutrient-enhancement, bioventing, and nitrate addition.

Adapted from "Natural and Enhanced In Situ Bioremediation of Petroleum Contaminated Salt Marshes" by Nancy Kinner, Thomas Ballesterro, Stephen Jones, University of New Hampshire.

Gundlach, E., and M. Hayes. 1978. Vulnerability of coastal environments to oil spill impacts. *Marine Technological Society Journal*. 12:18.

Mille, G., d. Munoz, F. Jacquot, L. Rivet, and J.C. Bertrand. 1998. The AMOCO Cadiz oil spill: evolution of petroleum hydrocarbons in the Iles Grande salt marshes (Brittany) after a 13-year period. *Estuarine and Coastal Shelf Science*. 47:547.

**BIOREMEDIATION OF PETROLEUM CONTAMINATED SALT MARSHES
AGENDA**

- 10:00 – Welcome And Introductions
- 10:15 Panel Presentations and Discussion: *Advances In Microbial Bioremediation Research*
- 12:00 Lunch
- 1:00 Internet Broadcast: *Effectiveness of Bioremediation in a Petroleum Contaminated Salt marsh*
- 2:30 Future Directions
- 2:45 Evaluation
- 3:00 Adjourn

BIOREMEDIATION OF PETROLEUM CONTAMINATED SALT MARSHES RESOURCES

www.coastlive.org

Information on workshops and featured research

www.ciceet.unh.edu

Cooperative Institute for Estuarine Environmental Technology, description of funded projects. View for more information on Natural and Enhanced In Situ Bioremediation of Petroleum Contaminated Salt Marshes by Kinner, Ballesteros and Jones of UNH.

<http://cimec.rutgers.edu/~meri>

Meadowlands Environmental Research Institute at Rutgers University.

<http://noaa.response.restoration.noaa.gov>

NOAA's Office of Response and Restoration. Many publications, software downloads and procedural publications in dealing with coastal spills.

www.lbl.gov/NABIR

Natural and Accelerated Bioremediation Research Program, Department of Energy

www.bioremediationgroup.org

Compilation of a wide range of resources and on-line discussion group

<http://www.frtr.gov>

Federal Remediation Technology Roundtable. Remediation Technologies Screening Matrix and Reference Guide Version 3.0 (1997).

www.clu-in/remed1.htm

EPA Technology Information Office. Good information, mostly dealing with hazardous wastes in terrestrial and freshwater systems.

www.nalusda.gov/bic/bioremed/bioremed.htm

Comprehensive listing of other Internet resources by the U.S. National Agricultural Library.