



Proceedings of the 2007 Delaware Estuary Science Conference & Environmental Summit

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Partnership for the Delaware Estuary - Contacts:



Jennifer Adkins
Executive Director
One Riverwalk Plaza
110 S. Poplar Street, Suite 202
Wilmington, DE 19801
302-655-4990 x102
JAdkins@DelawareEstuary.org

Danielle Kreeger, Ph.D.
Science Director
One Riverwalk Plaza
110 S. Poplar Street, Suite 202
Wilmington, DE 19801
302-655-4990 x104
DKreeger@DelawareEstuary.org

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Science Conference Overview and Goals

In early 2005 the Partnership for the Delaware Estuary: a National Estuary Program, convened the first Delaware Estuary Science Conference as a two-part meeting to bring researchers, resource managers, the public, and other interested parties together to summarize the **current state of science** in the system and to build consensus in defining and prioritizing **future science needs** for the Estuary. More than 250 experts from the diverse science and resource management community came together to hear more than 130 presentations. The fertile exchange among various sectors led to the 2006 release of the “White Paper on the Status and Needs of Science in the Delaware Estuary” (see reports page). The White Paper, which is already being used as a guidance document, captured key points from the 2005 conference, highlighted consensus on top needs, and charted a blueprint for addressing these needs in the future.

Building on the successful 2005 conference, the principal goals of the 2007 Delaware Estuary Science Conference were to:

- Continue fertile exchange among diverse sectors. The organizers hope to establish this conference as a regular, biennial forum for diverse environmental science and restoration professionals to come together to exchange findings and ideas in a regional, watershed-based context. Although national conferences and issue-specific regional meetings provide venues for scientific presentations, the Delaware Estuary Science Conference is seen as filling a void for interdisciplinary, cross-sector dialogue to address the many complex challenges in the 13,611 square mile Delaware Estuary and its watershed. By continuing to build an interactive, enthusiastic science and management community across the Delaware Estuary, we expect to continue to raise awareness for the system’s special traits and work toward resolving disparities in science funding between the Delaware and other mid-Atlantic/New England estuaries.
- Extend the theme and build on the momentum from the 2005 conference. The 2005 conference focused on assessing science needs where at this conference we plan to foster greater dialogue on future planning and environmental goal-setting, hence the theme of “Linking Science, Management and Policy to Set Achievable Environmental Goals in the Delaware Estuary”. For example, how can links be strengthened among scientists, resource managers, and policy-makers to ensure that science-based decision-making takes place? How can we address the science and management needs identified at the first conference and summarized in the White Paper? What environmental targets should be set and how do we work together to meet them?



The Partnership for the Delaware Estuary plans to reconvene the Delaware Estuary Science Conference every two years. This regularity will provide a predictable forum for the presentation of a broad array of topics related to ecology, environmental science, ecosystem health, and natural resource management, within a regional context. Each conference will consist of:

- Regular science and management sessions for the presentation of any type of scientific topic relevant to the region;
- Special sessions that address matters of contemporary importance to the region's scientific and management community; and,
- Thematic sessions that pertain to the central theme of each biennial meeting.

For the purpose of this meeting, we focused on the entire Delaware Estuary and River Basin study region, including both tidal and non-tidal portions of the ecosystem. While holding to this geographic emphasis, topics that are germane to the broader mid-Atlantic region and coastal shelf are also welcome.

Environmental Summit Overview and Goals

The first-ever Delaware Estuary Environmental Summit consisted of environmental organizations and other interested parties that are joining together, in a regional context, to discuss current and emerging issues and to showcase activities resulting in environmental improvement.

Throughout the Summit, presentations were scheduled on many topics such as successful partnerships and innovative collaborations, creative messaging, building stewardship, and various project sharing sessions. By overlapping the Summit with the Science Conference, participants were being provided with a rare opportunity to learn first hand about the latest science in the Estuary, as well as engage in dialogue regarding important and emerging issues.

Attendees of the Environmental Summit and/or Science Conference were encouraged to move among the concurrent events, which have been scheduled to allow for such movement. All Summit sessions took place on Monday and Tuesday. Joint sessions (for both Summit and Conference attendees) occurred on Monday morning and evening, Tuesday evening, and all day Wednesday.



Format

Taken together, the Science Conference and Environmental Summit consisted of more than 100 oral and poster presentations. Participants included over 300 scientists, resource managers, agency personnel, industry representatives, conservation groups, and the public from over 10 different states throughout the region.

The Science Conference consists of ten sessions (designated as Sessions 1-10) and approximately 80 presentations, approximately half of which were invited and half contributed. The Environmental Summit consisted of six sessions (designated as Sessions A –F) and 21 presentations. Contributed poster presentations represented an important component of both the science and summit programs.

Powerpoint files are available on the Partnership's website (www.DelawareEstuary.org) for those presentations that have granted us permission to do so. Finally, we issued an updated edition of the Delaware Estuary Resource Directory, listing scientists, environmental professionals, and others interested in the science of the Delaware Estuary, cross-referenced by area of expertise.



MONDAY, 22 JANUARY - Morning

Note: Only the first authors and abbreviated titles are listed here. Please refer to pages 15-23 for a full description of the Science Conference and pages 24-27 for the Environmental Summit.

Time	Science Conference Grand Ballroom	Environmental Summit Burgundy Room
7:30	Registration & Poster Set-Up begins	
8:30	Opening Remarks, Welcome Presentations, Conference Goals	
9:00 – 11:00	Session 1. Hydrology, Hydrodynamics and Sedimentation	<p style="text-align: center;">Open or Attend Session 1 of Science Conference</p>
9:00	S. J. Szalay . Protecting stream channels in the Delaware Estuary.	
9:15	B. D. Wilson . Delaware Integrated Marsh Monitor Network: sedimentation and sea-levels effects on marsh elevation and evolution.	
9:30	N. D. Ward . A hydraulic study of the Chesapeake and Delaware Canal.	
9:45	C. K. Sommerfield . Understanding turbidity in the Delaware Estuary.	
10:00	M. Piasecki . A numerical study on the impact of different turbulence closure models on salinity and sediment distribution in the Delaware Estuary.	
10:15	J. A. Madsen . Constraints on the sediments and geologic framework of Delaware Bay from sub-bottom imaging.	
10:30	Session 1 General Q&A	
11:00	BREAK	
11:30	<p>Keynote Presentation. Dr. Scott Nixon (UNESCO/Cousteau Chair in Coastal Ecology and Global Assessment, University of Rhode Island) “The National Importance of the Delaware Estuary”</p>	
12:00 – 1:00	<p style="text-align: center;">LUNCH (provided) Penthouse Ballroom (5th Floor)</p>	



MONDAY, 22 JANUARY - Afternoon

Note: Only the first authors and abbreviated titles are listed here. Please refer to pages 15-23 for a full description of the Science Conference and pages 24-27 for the Environmental Summit.

Time	Science Conference Grand Ballroom	Environmental Summit Burgundy Room
1:00 – 3:00	Session 2. Living Resources and Ecological Processes	<p>Session A</p> <p>Successful Strategies for Messaging & Communication</p> <p>Christine Heenan The Clarendon Group</p>
1:00	D. Carter . Delaware Benthic Mapping Project.	
1:15	T. E. Targett . Young-of-the-year weakfish in DE Bay and major tidal tributaries.	
1:30	H. W. Avery . Effects of wetland fragmentation on freshwater turtle populations in the DE Estuary.	
1:45	J. R. Spotila . DE Bay is an important foraging habitat for loggerhead turtles.	
2:00	R. E. Loveland . Alternative habitats to spawning horseshoe crabs in lower Delaware Bay, NJ.	
2:15	K. A. Strait . Fish production from a large scale marsh restoration program.	
2:30	Session 2 General Q&A	
3:00	BREAK	
3:30 – 5:45	Session 3. Wetlands	<p>Session B</p> <p>Messaging and Communications: Workshop</p> <p>Christine Heenan The Clarendon Group</p>
3:30	W. F. Moyer . The necessity to monitor wetlands due to changing programs and decisions.	
3:45	Ralph Spagnolo . Regionalization of the 1987 Corps Wetland Delineation Manual.	
4:00	R. Poeske . Wetland monitoring and assessment in the Mid-Atlantic states	
4:15	A. Jacobs . DE's Wetland Monitoring & Assessment Program: science-based restoration and protection.	
4:30	C. W. Bason . Sudden wetland dieback in Delaware's Inland Bays.	
4:45	T. Elsey . Nutrient and carbon in salt marsh plants in the face of eutrophication and sea-level rise.	
5:00	A. E. Banning . The effect of long piers on birds in Worcester County, MD marshes.	
5:15	Session 3 General Q&A	
5:45	BREAK	
6:45 – 8:00	RECEPTION AND DINNER (provided) Penthouse Ballroom (5 th Floor)	
8:00 – ?	Panel Discussion. Charting the Future of the Delaware Estuary.	



TUESDAY, 23 JANUARY - Morning

Note: Only the first authors and abbreviated titles are listed here. Please refer to pages 15-23 for a full description of the Science Conference and pages 24-27 for the Environmental Summit.

Science Conference Grand Ballroom		Environmental Summit Burgundy Room	
8:00	Registration Desk Opens		
8:15 – 10:00	Session 4. Special Panel: Linkages among Science, Management & Policy	8:15 – 10:15	Session C. Stormwater Issues and Pollution Prevention
	Panelist Contributions: E. Stiles . Moderator (NJ Audubon) M. Maxwell-Doyle . Moderator (PDE) ----- C. Collier . The Role of DRBC in Linking Science, Management and Policy. C. Frank . NJA's Important Bird and Birding Areas Program. R. Stahl . A company perspective on linking science, management and policy. M. K. van Rossum . The importance of independence and advocacy. L. J. Silverman . Teaching Estuaries 101 to Congress 110.	8:15	M. Allio . Seeing is believing: a showcase of best management practices in Montgomery County.
		8:35	L. Feinberg . Urban stormwater retrofit projects.
		8:55	M. E. Noonan . Rain gardens for clean streams.
		9:15	L. O'Hare . Schuylkill Action Network / agricultural best management practices.
		9:35	J. Waldowski . Philadelphia Water Department's Tookany/Tacony-Frankford Partnership: from partnership to independent nonprofit.
	Session 4 General Q&A	9:55	J.M. Eisenhardt . CAFO Designs/ Environmental Stewardship at DE Park.
10:00	BREAK		
10:15	BREAK		
10:30– 12:30	Session 5. Environmental Monitoring & Assessment I: Hydrologic & Chemical	10:30 – 12:30	Session D. Building Stewardship
10:30	A. R. MacGillivray . Monitoring the tidal Delaware River for ambient toxicity.	10:30	J. Jones . Corporate Environmental Stewardship Program, a partnership for conservation and economic growth.
10:45	T. J. Fikslin . PCB concentrations in the DE Estuary and coastal waters: TMDLs for PCBs.	10:50	D. Baumgarten . Habitat restoration at Oak Lane Day School: elementary environmental education.
11:00	E. Santoro . Towards the goal of setting nutrient criteria for the Delaware Estuary.	11:10	J. Starwood . Earth Force GREEN: young people protecting our watersheds.
11:15	D. R. Legates . A real-time and historical environmental data archive for the DE Estuary.	11:30	T. Fenchel . Exelon-Schuylkill River Restoration Fund.
11:30	H. A. M. Quinodoz . Optimizing reservoir operations for water supply and ecological objectives using flow modeling.	11:50	V. Williams . Using your website as a teaching tool.
11:45	J. Yagecic . Using real time monitoring for real time management.	12:10	L. R. Calvo . Engaging students in DE Bay oyster restoration efforts—Promoting Oyster Restoration Through Schools: Project PORTS.
12:00	Session 5 General Q&A		
12:30 – 1:30	LUNCH (provided) Penthouse Ballroom (5 th Floor)		



TUESDAY, 23 JANUARY - Afternoon

Note: Only the first authors and abbreviated titles are listed here. Please refer to pages 15-23 for a full description of the Science Conference and pages 24-27 for the Environmental Summit.

Science Conference Grand Ballroom		Environmental Summit Burgundy Room	
1:30 – 4:15	Session 6. Environmental Monitoring & Assessment II: Biota and Habitats	1:30 – 3:30	Session E Water Quality and Restoration
1:30	B. W. Muffley . Survey of New Jersey's recreational blue crab fishery in DE Bay.	1:30	K. Mantay . Wetland restoration site preparation and site management: costs and benefits to waterfowl.
1:45	B. D. Wilson . Mapping the distribution and habitat of oysters in upper DE Bay.	1:50	J. Harrod . Backyard Wildlife Habitat Program.
2:00	S. F. Michels . Bottom trawl sampling of fish and invertebrates in the DE Estuary.	2:10	H. Edwards . The Watershed Ambassador Program.
2:15	K. S. Kalasz . Monitoring shorebird populations in DE Bay during spring.	2:30	K. Laudenbach-Nelson . The Guide to the Natural Communities of the DE Estuary.
2:30	BREAK	2:50	G. North . Citizen's Science in Delaware: a success story.
3:00	R. G. Lathrop . Assessing horseshoe crab spawning habitat of DE Bay beaches.	3:10	R. Lonsdorf . Restoring shad to the Brandywine River.
3:15	J. M. Fischer . Landscape characteristics affecting streams in urbanizing subbasins.	3:30	BREAK
3:30	D. Fox . Atlantic sturgeon of the Delaware: historical perspectives and habitat needs.	4:00 – 5:00	Session F. Innovative Collaboration
3:45	Session 6 General Q&A	4:00	J. Adkins . Schuylkill Action Network Schuylkill Watershed Initiative Grant.
4:00		4:20	R. Bivens . Cape Henlopen Osprey Project.
4:15 - 6:00	Session 7. Poster Reception Penthouse Ballroom (5th Floor)	4:50	E. Grusheski . The wireless revolution in ecotourism communication.
Posters: J. Ashley . Polybrominated diphenyl ethers in Eels from the DE River. R. M. Babb . DE Bay Oyster (<i>Crassostrea virginica</i>) Restoration Program. J. Bennett . The Underground Injection Control Program. M. Colip . Igo, Porter, Warren Memorial Field Rain Garden Project. A. L. Friedman . Marine geologic and geophysical investigations off NJ. K. Goddard . Parasites on Black-nosed Dace <i>Rhinichthys atratulus</i> in PA. J. Halchak . Transition from agricultural lands to wetlands during sea level rise. A. R. MacGillivray . Salinity acclimation & tolerance of <i>Americamysis</i> . E. M. Rehm . DE's wetland monitoring, restoration, and education efforts. J.W. Starwood . Earth Force Watershed Awareness to Action. K. Strait . Status and success for a large scale marsh restoration program in the DE Estuary. J. Taylor . Constructed oyster reef habitat in lower Delaware Bay. Y. Voynova . Do low-frequency watershed inputs impact the Delaware Estuary? D. Werry . Clear into the Future, a DuPont Delaware Estuary initiative. V. Williams . Using Your Website as a Teaching Tool.			
6:00	BREAK		
6:30 – 8:00	DINNER (provided) Penthouse Ballroom (5 th Floor)		
7:30 – 11:00	Plenary Presentations <i>Followed by Roundtable Discussion: Monitoring Needs and Concepts</i>		



WEDNESDAY, 24 JANUARY - Morning

Note: Only the first authors and abbreviated titles are listed here. Please refer to pages 15-23 for a full description of the Science Conference and pages 24-27 for the Environmental Summit.

Time	Science Conference Grand Ballroom	Environmental Summit Burgundy Room
8:00	Registration Desk Opens	
8:30 – 11:45	Session 8 (Special). Bivalve Shellfish Ecology, Management and Restoration	Joint with Science Conference Program
8:30	R. M. Babb . The Delaware Bay Oyster (<i>Crassostrea virginica</i>) Restoration Program.	
8:45	E. N. Powell . How long does oyster shell last on an oyster reef?	
9:00	R. Mann . Native oyster restoration in the Chesapeake Bay: Lessons for the Delaware Estuary.	
9:15	R. B. Carnegie . Increasing tolerance for <i>Perkinsus marinus</i> among natural <i>Crassostrea virginica</i> populations from Virginia waters.	
9:30	BREAK	
10:00	J. W. Ewart . Delaware Center for the Inland Bays Oyster Gardening Program.	
10:15	D. Bushek . Some potential alternative strategies and applications for shellfish enhancement and restoration in Delaware Bay.	
10:30	C. M. Gatenby . A freshwater mussel propagation program for restoring aquatic ecosystems and endangered species.	
10:45	D. A. Kreeger . From local to regional: water processing and restoration of native bivalves throughout the DE Estuary and its watershed.	
11:00	R. D. Brumbaugh . From local to global: using site-based projects to inspire large scale conservation action for native bivalves.	
11:15	Session 8 General Q&A	
11:45–12:45	LUNCH (provided) Penthouse Ballroom (5 th Floor)	



WEDNESDAY, 24 JANUARY - Afternoon

Note: Only the first authors and abbreviated titles are listed here. Please refer to pages 15-23 for a full description of the Science Conference and pages 24-27 for the Environmental Summit.

Time	Science Conference Grand Ballroom	Environmental Summit Burgundy Room
12:45 – 2:30	Session 9. Special Panel: Restoration and Enhancement Activities, Opportunities & Needs	Joint with Science Conference Program
12:45	J. M. Eisenhardt . Ecological restoration in an urban watershed.	
1:00	R. Huddleston . Is the Estuary Enhancement Program of DE Bay working?	
1:15	G. Rowland . Opportunities and barriers to restoring wetlands in urban areas: a case study.	
1:30	<u>Panelist Contributions</u> (3-5 minutes each) R. Stahl . Restoration Up Front and the DuPont Delaware River Initiative. L. Dwyer . Delaware Estuary NFWF. C. Woolcott . Community based restoration and funding by NOAA. P. Starr . North Philadelphia Waterfront Revitalization: Restoration challenges & insights. W. Shadel . An Inventory of Restoration Opportunities in DE Bay. K. Laudenbach-Nelson . Prospects for Regional Restoration Planning for the Delaware Estuary.	
	Session 9 Discussion	
2:30	BREAK	
3:00 – 5:00	Session 10 (Special). Hot Topics in Delaware Estuary Science and Management	
3:00	A. R. MacGillivray . Emerging contaminants of concern in the Delaware Estuary and watershed.	
3:15	R. Greene . Polybrominated diphenyl ethers (PBDEs) in fish from the Delaware Estuary.	
3:30	A. J. Broccoli . Global climate change: causes and consequences.	
3:45	N. M. Targett . "Linking science and society: an overview of the developing national priorities.	
4:00	A. A. DeSantis . Assessing multi-stressor impacts on environmental conditions of the Delaware River Estuary.	
4:15	J. Firestone . Science, social science and policy regarding developing offshore wind power in the DE Estuary region.	
4:30	Session 10 General Q&A	
5:00	Announcements and Closing Remarks	



Featured Speakers

Scott Nixon, Ph.D.

UNESCO/Cousteau Chair in Coastal Ecology and Global Assessment

University of Rhode Island

Keynote Speaker, Monday 22 January, 11:00 pm

“The National Importance of the Delaware Estuary”

Scott Nixon received his BA in biology from the University of Delaware and his PhD in botany and ecology from the University of North Carolina at Chapel Hill. He has been on the faculty of the Graduate School of Oceanography at the University of Rhode Island since 1970, and served as Director of the Rhode Island Sea Grant College Program for 16 years. He also served as Co-Editor-in-Chief of Estuaries and Coasts, the journal of the Estuarine Research Federation for 13 years. He has been a member the National Research Council Ocean Studies Board and has been on many NRC committees, including reviews of science in the Everglades restoration and the restoration plan for coastal Louisiana. He has received several awards, including the Ketchum Award from the Woods Hole Oceanographic Institution for excellence in coastal research and education and the Odum Award for lifetime achievement from the Estuarine Research Federation. He has published over 100 scientific and technical papers and graduated over 30 MS and PhD students.



Abstract. Forty years in marine ecology have made me painfully aware that one of my favorite bays is underappreciated by marine ecologists who do not live and work in its watershed. I often hear disparaging remarks that Delaware Bay is too muddy, or too marshy, or too polluted. Well, it must be admitted that Delaware Bay will probably never become a favored spot for SCUBA diving, and that its shoreline will probably never be lined with sunbathers lying towel to towel, and that its sediments may always contain some nasty chemicals. But the estuary of the Delaware and its bay deserve a special place in the heart of every coastal ecologist. The Delaware is the quintessential drowned river mouth estuary with a simplicity of shape that is the dream of coastal physical oceanographers. The massive anthropogenic loadings at its head produce an ideal laboratory for studies of the fate and effects of pollutants. Its complex bathymetry and treacherous shoals provide a dynamic sedimentary environment for the geologists and a turbid water column that challenges ecologists and chemists alike.

There is a long and rich intellectual history of coastal science and management in this system that should inform us all, regardless of where we work. It was around this bay and estuary that the first multiple state management of coastal waters began with INCODEL and the DRBC. It was for the Delaware River in the early 1930s that the US Supreme Court first made a water apportionment ruling in which environmental impacts in the downstream estuary were a consideration. It was in the Delaware River and Estuary that one of the first two dimensional time varying hydrodynamic models of estuarine circulation was coupled with simple biology to link management actions with dissolved oxygen targets in the receiving waters. It was here that Ketchum worked out his fresh water fraction technique for



Featured Speakers *(continued)*

estimating residence time of estuarine waters. Much of our knowledge of the trophic and biogeochemical links between wetlands and tidal waters has been based on studies of the extensive salt and tidal fresh marshes of the Delaware River, Estuary, and Bay. Today they are the site of one of the most ambitious wetland restoration projects in the world. During the past twenty-five years Delaware Bay and Estuary rank fifth in the country in terms of peer-reviewed science articles published. A formidable accomplishment for a relatively small bay and research community.

Christine Heenan

Clarendon Group

Environmental Summit - Invited Workshop Coordinator, Monday 22 January, 1:00-5:00 pm
“Successful Strategies for Marketing and Communication”

Christine Heenan is President and founder of Clarendon Group and leads the strategic communications and strategic planning practices for the firm. Christine comes to Clarendon with a background in business strategy, national domestic policy, government relations, strategic communications, and speechwriting. In addition to leading Clarendon Group, she is an Adjunct Professor of Public Policy at Brown University.



Christine served as senior policy analyst on the White House Domestic Policy Council during the first term of the Clinton Administration, where she worked on health and women's issues. She also worked closely with the speechwriting office, writing speeches for President Clinton, First Lady Hillary Rodham Clinton, Vice President Al Gore, and Tipper Gore. Christine has also written speeches for Senator Chris Dodd, three Brown University Presidents, and other elected and appointed officials. She served in communications roles at both the 1996 and 2000 Democratic Conventions, working as liaison to the party chairman's speechwriting operation in 1996, and with online media in 2000.

Abstract. Convincing key audiences to act in support of conservation and environmental protection -- be they town zoning boards passing ordinances to protect wetlands or suburbanites forgoing lawn chemicals -- relies on reaching them with clear, persuasive communications and strategies for capturing their attention. In addition, media can be an important conduit for reaching and educating consumers, but reporters and editors often don't understand the nature of the problem, or the substance of the solutions. This two-part workshop will give participants important background on successful communications strategies, provide effective tools for reaching and persuading key audiences, and allow participants to "test drive" those tools through case study exercises drawn from their own day to day work. Participants are asked to come to the workshop with an actual communications challenge or project in mind, to build on in the afternoon session.



Featured Speakers *(continued)*

Michael T. Koterba

Northern Co-Director, Chesapeake Bay Observing System

Plenary Speaker, Tuesday 23 January, 7:30 pm

“Integrated Coastal Ocean Observing Systems: An Example from the Chesapeake Bay”

Mike currently is the Northern Co-Director of the Chesapeake Bay Observing System, on detail to NOAA from the USGS. His main interest is hydrology in any form with a bent towards contamination. His early professional career found him in Mexico, where for five years he worked for the first national ecological institute of Mexico (INREB).. He spent the next five years in the US arid southwest studying arid land hydrology, and initial recharge from ephemeral stream flows. The next five years found him in Maui, HI with US AID aiding agricultural development in the Pacific Rim. In the late 80's Mike joined the USGS, and spent the next 8 years working on the pilot development and full implementation of the USGS National Water-Quality Assessment Program (NAWQA). Soon after Y2K Mike was on detail to the Dept. of Homeland Security, and part of the team that wrote the National Infrastructure Security Plans--one for Water, and another for Dams. Recently, back at the USGS, he completed studies



of mercury contamination in ground water in southern Delaware. Since the fall of 2005, Mike, along with his southern counterpart Elizabeth Smith at ODU, have been the driving forces in the development of the Chesapeake Bay Observing System. Mike's formal education includes a BS in Analytical Chemistry and Mathematics from St. Cloud State University, a MS in Hydrology and Soils from the University of New Hampshire, and a PhD in Hydrology and Watershed Management from the University of Arizona.

Abstract. Integrated long-term observing systems in inner coastal and near-shore ocean waters are essential to improve our ability to forecast physical conditions and manage natural resources in coastal zones. Establishment, operation, and maintenance of these observing systems coupled with unfettered access to the resultant data and information can (a) enhance the safety and efficiency of marine operations, (b) improve prediction of natural hazards (including tsunamis and storm surges), (c) increase the accuracy of predictions of climate and sea-level changes, (d) enhance national security, (e) reduce public health risks, (f) help protect and restore healthy ecosystems, and (g) sustain and restore living marine resources. Immediate results can lead to improvements in (a) efficiencies in shipping, fishing, energy, tourism, and other industries, (b) search-and-rescue operations, and (c) monitoring and clean-up of discharges and spills in ocean and coastal waters. Although the benefits of developing such (observing) systems are clear, they present a challenge in a climate of limited resources.

The Chesapeake Bay Observing System (CBOS) is being developed as a sub-regional coastal ocean observing system of the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA) and the U.S. Integrated Ocean Observing System (IOOS). Its development is being accelerated through the use of three prototype demonstration projects. These prototype projects target open and deep waters in the main stem and estuaries of the Chesapeake Bay, both areas of concern with limited near-real-time



Featured Speakers (continued)

observations. Although somewhat limited in scale and effort, each of these demonstration projects was designed to (a) build partnerships among key data users and providers, (b) establish standards for the acquisition and dissemination of observational, quality-control, and meta- data, (c) help identify additional data needs, and (d) facilitate the creation of a governance and operational foundation. The focus of this presentation will demonstrate the benefits of an integrated and interoperable observing system, and show how these three projects, as proofs of concept, will help promote the expansion and development of an observing system and the associated collaboration necessary for sustainability.

Jonathan Sharp, Ph.D.

Plenary Speaker, Tuesday 23 January, 7:45 pm

“The Delaware Estuary Watershed to Ocean Observing System (DEWOOS): Current and Future Design for a Comprehensive Monitoring Infrastructure”

Jonathan Sharp received his BA and MS degrees (Biology/Biochemistry) from Lehigh University and Ph.D. (Oceanography) from Dalhousie University. After a post-doctoral research experience at Scripps Institution of Oceanography, he joined the faculty of the University of Delaware in 1973 and is now a Professor of Oceanography there in the Graduate College of Marine Studies. A major research direction throughout his career has been refinement of analytical chemical methodology and accuracy of the international marine community in routine biogeochemical measurements. Associated with this effort is his involvement with the Global Ocean Flux efforts related to climate change. He has had a 25-year research effort on the biogeochemistry of the Delaware Estuary. As an outgrowth, he has been involved with a number of activities related to the Delaware Estuary Program and other local cooperative resource management efforts for about 20 years. He is trying to return to an earlier research interest in tropical ecology with a new effort in coral reef carbon budget studies. His teaching has primarily been through courses in chemical oceanography and general oceanography. From his laboratory about 25 MS and Ph D students have been launched into a variety of academic, government, teaching, and industrial careers. The following are the title and abstract for Jonathan Sharp’s presentation at the Delaware Estuary Science Conference.



photo by Kevin Fleming

Abstract. In the past decade, increased international interest in developing a more coherent ability for long-term observations of potential anthropogenic impacts on the ocean has led to the Global Ocean Observing System (GOOS). Recent interest in including nearshore waters has led to development of regional ocean observing consortia in the US. As part of the mid-Atlantic coastal GOOS activity, a suggestion has been made for a pilot project in the Delaware Estuary that includes the watershed as well as coastal ocean (DEWOOS).

An effective DEWOOS program is critical for better management of one of the most critical estuaries and coastal regions of the US. The Delaware River watershed constitutes one of the largest drinking water systems in the country. The Greater Philadelphia ports as a unit is one of the largest in the US. A large industrial complex, including nuclear electrical generation capacity, can influence the



ecology of the estuary and also comprises a major security target. The natural resources of Delaware Bay provide valuable recreational uses and valuable past and potentially larger future commercial fisheries capacity. The DEWOOS program should be important for maintenance of quality drinking water, protection of municipal and industrial security, and protection of living resources providing recreational and commercial amenities.

There are a number of examples of significant changes in water quality that can be documented with our long-term discrete sampling monitoring programs. We can also make partial demonstrations of impacts of low-frequency (storm scale) events that have major potential impact on the ecology of the estuary; better continual measurements would make these easier to assess. Discussion of rare events in the nearby area (Chesapeake Bay, mid-Atlantic coastal waters) highlights the need for better ability to understand similar rare future events in the Delaware Estuary.

A reason for DEWOOS as a national pilot is that there are significant monitoring efforts, with long histories, that can be linked together for a comprehensive analysis of conditions along the full length of the Delaware River and Bay Estuary. In addition, the relatively simple geometric shape and physics of the Delaware Estuary makes a relatively simple characterization feasible with added continuous measurement fixed sites and use of AUV gliders for surveys of the baymouth to adjacent coastal ocean. The presentation will describe some of the extant monitoring programs, recent progress and plans for additional continuous measurement capabilities, and ideas for a comprehensive cooperative program in the near future.



Program Detail and Session Summaries Science Conference

(Each presentation was assigned a unique reference number, listed after each title)

Note Posters: A comprehensive list of posters for both the Science Conference and Environmental Summit is provided on pages 27-28. Posters are aligned with a session theme, and they are therefore listed at the end of each session summary below. Posters are being displayed throughout the meeting, and authors are asked to stand by their poster during the poster session on Tuesday afternoon.

MONDAY, 22 JANUARY – Science Conference

- 7:30 Registration & Poster Set-Up
8:30 Opening Remarks, Welcome Presentations, Conference Goals

9:00 – 11:00

Session 1. Hydrology, Hydrodynamics and Sedimentation

Moderators: **Dan Soeder** (USGS) and **Chris Sommerfield** (University of Delaware)

- 9:00 Shandor J. **Szalay**. “Protecting stream channels in the Delaware Estuary.” (#7)
- 9:15 Bartholomew D. **Wilson**, Robert Scarborough, David B. Carter and Donald R. Cahoon. “Delaware Integrated Marsh Monitor Network: evaluating sedimentation and sea-levels effects on marsh surface elevation and evolution.” (#28)
- 9:30 Nicholas Dudley **Ward**, Jeffrey A. Gebert and J. Richard Weggel. “A hydraulic study of the Chesapeake and Delaware Canal.” (#34)
- 9:45 Christopher K. **Sommerfield**. “Understanding turbidity in the Delaware Estuary.” (#38)
- 10:00 Michael **Piasecki** and Kutay Celebioglu. “A numerical study on the impact of different turbulence closure models on salinity and sediment distribution in the Delaware Estuary.” (#53)
- 10:15 John A. **Madsen**, Bartholomew D. Wilson and David B. Carter. “Constraints on the sediments and geologic framework of Delaware Bay from sub-bottom imaging.” (#54)
- (Poster) Andrea L. **Friedman**, Jeffrey S. Waldner, Jane Uptegrove and J. Bailey Smith. “Marine geologic and geophysical investigations offshore of Cape May, New Jersey: methodology, representative data, and preliminary findings.” (#51)

- 10:30 **Session 1 General Q&A**

11:00 BREAK



MONDAY, 22 JANUARY – Science Conference

- 11:30 **Keynote Presentation. Dr. Scott Nixon** (UNESCO/Cousteau Chair in Coastal Ecology and Global Assessment, University of Rhode Island)
“The National Importance of the Delaware Estuary” (#64)

12:00 – 1:00 LUNCH

1:00 – 3:00

Session 2. *Living Resources and Ecological Processes*

Moderators: **Sue Kilham** (Drexel University), **Andrew Zemba** (PADEP), and **Dewayne Fox** (Delaware State University)

- 1:00 Bartholomew D. Wilson and David B. **Carter**. “Delaware Benthic Mapping Project: addressing the forgotten resource in coastal management.” (#21)
- 1:15 Timothy E. **Targett** and Brian P. Boutin. “Spatiotemporal comparisons of density, growth and production of young-of-the-year weakfish in Delaware Bay and major tidal tributaries.” (#47)
- 1:30 Harold W. **Avery**, James R. Spotila and Walter F. Bien. “Effects of wetland fragmentation on freshwater turtle populations in the Delaware Estuary.” (#57)
- 1:45 James R. **Spotila**, Pamela Plotkin and John Keinath. “Delaware Bay is an important foraging habitat for loggerhead turtles.” (#58)
- 2:00 Robert E. **Loveland** and Mark L. Botton. “The importance of alternative habitats to spawning horseshoe crabs (*Limulus polyphemus*) in lower Delaware Bay, New Jersey.” (#14)
- 2:15 Kenneth A. **Strait**. “Fish production from a large scale marsh restoration program.” (#67)
- Poster Kathryn **Goddard**, Steven Ordog, Kelly Bemis and Julius Cook. “Parasite burden on the Black-nosed Dace *Rhinichthys atratulus* at four sites in the Darby Creek, PA watershed.” (#70)

2:30 Session 2 General Q&A

3:00 BREAK

3:30 – 5:45

Session 3. *Wetlands*

Moderators: **Amy Jacobs** (DNREC), **Ken Strait** (PSEG), and **Danielle Kreeger** (PDE)

- 3:30 William F. **Moyer**. “The increasing necessity to monitor wetlands losses due to changing regulatory programs and recent Supreme Court decisions.” (#3)
- 3:45 Ralph **Spagnolo**. “Overview of the regionalization of the 1987 Corps Delineation Wetlands Delineation Manual.” (#22)



MONDAY, 22 JANUARY – Science Conference

- 4:00 Regina **Poeske**. “Wetland monitoring and assessment in the Mid-Atlantic states.” (#37)
- 4:15 Amy **Jacobs**, Evan Rehm and Debora Fillis. “Delaware’s Wetland Monitoring and Assessment Program: a science-based approach to prioritize restoration and protection.” (#18)
- 4:30 Christopher W. **Bason** and Amy Jacobs. “Sudden wetland dieback in Delaware’s Inland Bays.” (#16)
- 4:45 Tracy **Elsey**, John L. Gallagher and Denise M. Seliskar. “Nutrient and carbon sequestration of salt marsh plants in the face of eutrophication and sea-level rise.” (#17)
- 5:00 Alison E. **Banning**, Jacob L. Bowman and Bruce L. Vasilas. “The effect of long piers on birds using marsh habitat in Worcester County, Maryland.” (#25)
- Poster Kenneth A. **Strait** and Brenda Q. Evans. “Evaluation of status and success for a large scale marsh restoration program in the Delaware Estuary.” (#71)
- 5:15 **Session 3 General Q&A**
- 5:45 BREAK**
- 6:45 – 8:00 **Reception and Buffet Dinner**
- 8:00 - ? **Panel Discussion. Charting the Future of the Delaware Estuary.**

Help steer the future of the Estuary by joining a discussion about effective environmental management, goal-setting, and the selection and use of appropriate environmental indicators to monitor whether goals are being met and resources are being managed effectively within the Delaware Estuary and its watershed. Should we move from management of specific resources to management of estuaries (i.e., ecosystems)? Is this a realistic goal and what would it entail?

Moderators/Panelists:

Kathy Klein (PDE Executive Director)

Martha Maxwell-Doyle (PDE Deputy Dir.)

Danielle Kreeger (PDE Science Director)

Jessica Rittler Sanchez (DRBC Basin Planner)

John Kraeuter (Rutgers HSRL Scientist)

Dorina Frizzera (NJDEP, Coastal Zone Manager)

Challenge Questions for Monday Evening Panel:

- What entities currently manage the key components (e.g., wetlands, fisheries) of the Estuary?
- What indicators are used now to assess ecosystem health? What indicators are needed?
- What aspects are being managed well? Not so well?
- Who manages the estuary holistically, linking key components?
- Is there a need for an ecosystem management approach? And what does that mean exactly?
- What are appropriate environmental goals linked to indicators that are useful for managers?



TUESDAY, 23 JANUARY – Science Conference

8:00 Registration Desk Open

8:15 – 9:45

Session 4. (Special Panel Discussion). *Linkages among Science, Management & Policy*
Moderators: **Eric Stiles** (New Jersey Audubon) and **Martha Maxwell-Doyle** (PDE)

Topics: Panelists will address challenge questions about how to strengthen linkages among science, management, and policy. Why is this important for our region? What can be done to foster dialogue and improve coordination to assure that decision-making is based on sound science, and the scientific community is providing useful information for decision-makers and policy-makers?

Format: Each panelist will be asked to give a five minute opening remark to include the following: From their perspective, briefly present a case history of a project integrating policy, science and management – good, bad and ugly and lessons learned. Following the remarks, the session we'll then go into a question and answer session utilizing a set of challenge questions to foster dialog.

The panel will be comprised of moderators as well as the following speakers:

Carol **Collier** (Delaware River Basin Commission). “The Role of DRBC in Linking Science, Management and Policy.” (#66)

Cristina **Frank** (New Jersey Audubon Society). “NJ’s Important Bird and Birding Areas Program: a science-based effort linking management and policy to conserve important bird habitat.” (#27)

Ralph G. **Stahl**, Jr. (DuPont). “A company perspective on linking science, management and policy for addressing issues in the Delaware Estuary.” (#102)

Maya K. **van Rossum** (Delaware Riverkeeper Network). “The importance of independence and advocacy.” (#6)

Larry J. **Silverman** (Attorney, professional lobbyist, and Adjunct Professor of Environmental Law and Policy at Johns Hopkins University). “Teaching Estuaries 101 to Congress 110: what, how, when, and why to tell the new Congress about the benefits of supporting scientific investigations in the Delaware Estuary.” (#26)

Challenge Questions for Session 4:

- How do we create a better mechanism to facilitate dialogue between the science community and policy makers?
- How can policy makers and resource managers inform science of their needs?
- What is the best mechanism for scientists to communicate their findings to policy makers and resource managers?
- What are the necessary actions needed to create a strong political will to enhance economic sustainability and support and protect the Delaware Estuary region?
- How do we overcome the challenges posed by operating within a region spanning 3 states?



TUESDAY, 23 JANUARY – Science Conference

10:00 BREAK

10:30 – 12:30

Session 5. Environmental Monitoring & Assessment I: Hydrologic & Chemical

Moderators: **Tom Fikslin** (DRBC) and **Amie Howell** (EPA Region 3)

- 10:30 A. Ronald **MacGillivray**, David E. Russell, Betty Jane Boros-Russo, Steven S. Brown, Thomas J. Fikslin, Richard Greene, Robert Hoke, Christopher Nally and Linda O'Donnell. "Monitoring the tidal Delaware River for ambient toxicity." (#9)
- 10:45 Thomas J. **Fikslin** and Gregory J. Cavallo. "PCB concentrations in the ambient waters of the Delaware Estuary and coastal waters: implications for TMDLs for PCBs." (#36)
- 11:00 Edward D. **Santoro**. "Towards the goal of setting nutrient criteria for the Delaware Estuary." (#72)
- 11:15 David R. **Legates**, Robert Scarborough, Daniel J. Leathers, Geoffrey E. Quelch and Kevin Brinson. "A real-time and historical environmental data archive for the Delaware Estuary." (#19)
- 11:30 Hernan A. M. **Quinodoz**. "Optimizing reservoir operations for water supply and ecological objectives using flow modeling." (#65)
- 11:45 John **Yagecic**. "Using real time monitoring for real time management." (#29)
- Poster Christopher J Nally, A Ronald **MacGillivray**, Tarmo Pallop, Kerri Koch, Thomas J Fikslin. "Low salinity acclimation & salinity tolerance of *Americamysis bahia* in short-term chronic toxicity tests." (#10)
- Poster Yoana **Voynova** and Jonathan H. Sharp. "Do low-frequency watershed inputs have a major impact to the Delaware Estuary?" (#33)
- Poster Jeffrey **Ashley**, David Velinsky, Danielle Libero, Evan Halscheid, Linda Zaoudeh and Heather Stapleton. "Polybrominated diphenyl ethers in American Eels from the Delaware River Estuary." (#42)
- Poster Jim **Bennett** and Roger Reinhart. "Protection of underground sources of drinking water: the Underground Injection Control Program." (#69)

12:00 Session 5 General Q&A

12:30 – 1:30 LUNCH



TUESDAY, 23 JANUARY – Science Conference

1:30 – 4:15 Session 6. Environmental Monitoring & Assessment II: Biota and Habitats

Moderators: **Lance Butler** (Philadelphia Water Department), **Roy Miller** (DNREC), and **Dave Russell** (EPA Region 3)

- 1:30 Brandon W. **Muffley** and Lynette Lurig. “Survey of New Jersey’s recreational blue crab fishery in Delaware Bay.” (#13)
- 1:45 Bartholomew D. **Wilson**, David G. Bruce, John Madsen and David B. Carter. “Mapping the distribution and habitat of oysters in the upper Delaware Bay.” (#20)
- 2:00 Stewart F. **Michels** and Michael J. Greco. “Bottom trawl sampling of fish and invertebrates in the Delaware Estuary – getting the word out.” (#39)
- 2:15 Kevin S. **Kalasz**. “Monitoring shorebird populations in Delaware Bay during spring migration using mark-recapture methods.” (#40)

2:30 BREAK

- 3:00 Richard G. **Lathrop**, Michael Allen and Aaron Love. “Assessing horseshoe crab spawning habitat suitability of Delaware Bay USA beaches.” (#44)
- 3:15 Jeffrey M. **Fischer**, Karen Riva-Murray, Rachel Riemann and Peter S. Murdoch. “Landscape characteristics affecting streams in urbanizing subbasins of the Delaware River Basin, New York, New Jersey, and Pennsylvania.” (#56)
- 3:30 Dewayne A. **Fox**, Phil Simpson, Lori Brown, Kevin J. Magowan and Joseph E. Hightower. Atlantic sturgeon of the Delaware: historical perspectives and current approaches to understanding habitat requirements. (#61)
- 3:45 **Session 6 General Q&A**

4:15 - 6:00 Session 7. Poster Reception

Moderators: **Dan Soeder** (USGS) and **Amie Howell** (EPA Region 3)
See pages 27-28 for a comprehensive listing.

6:00 BREAK

- 6:30 – 8:00 **Seated Dinner** (Grand Ballroom)
- 7:30-8:30 **Plenary Presentations** (during dessert)
- Michael Koterba** (USGS) (#1)
“Integrated Ocean Observing Systems: An Example from the Chesapeake Bay”
- Jonathan H. Sharp** (University of Delaware) (#35)
“The Delaware Estuary Watershed to Ocean Observing System (DEWOOS): Current and Future Design for a Comprehensive Monitoring Infrastructure”
- 8:30-? **Roundtable Discussion:** Monitoring Needs and Concepts



WEDNESDAY, 24 JANUARY – Science Conference

8:00 Registration Desk Open

8:30 – 11:45

Session 8 (Special). *Bivalve Shellfish Ecology, Management and Restoration*

Moderators: **John Kraeuter** (Rutgers HSRL), **Danielle Kreeger** (PDE) and **Dave Bushek** (Rutgers HSRL)

8:30 Russell M. Babb, Jason **Hearon**, David Bushek and Eric Powell. “The Delaware Bay Oyster (*Crassostrea virginica*) Restoration Program.” (#49)

8:45 Eric N. **Powell**, John N. Kraeuter and K. A. Ashton-Alcox. “How long does oyster shell last on an oyster reef?” (#2)

9:00 Roger **Mann**. “Native oyster restoration in Chesapeake Bay: Lessons for the DE Estuary.” (#32)

9:15 Ryan B. **Carnegie** and Eugene M. Bureson. “Increasing tolerance for *Perkinsus marinus* among natural *Crassostrea virginica* populations from Virginia waters.” (#55)

9:30 BREAK

10:00 John W. **Ewart**, E. J. Chalabala and Jim Alderman. “Delaware Center for the Inland Bays Oyster Gardening Program.” (#46)

10:15 David **Bushek** and Danielle A. Kreeger. “Some potential alternative strategies and applications for shellfish enhancement and restoration in Delaware Bay.” (#48)

10:30 Catherine M. **Gatenby**, Matthew A. Patterson and Danielle A. Kreeger. “A freshwater mussel propagation program for restoring aquatic ecosystems and endangered species.” (#50)

10:45 Danielle A. **Kreeger** and Catherine M. Gatenby. “From local to regional: contrasting the water processing and restoration potential of native bivalves throughout the Delaware Estuary and its watershed.” (#63)

11:00 Robert D. **Brumbaugh** and Michael W. Beck. “From local to global: using site-based projects to inspire large scale conservation action for native bivalves.” (#45)

Poster Jaclyn **Taylor** and David Bushek. “Preliminary investigations of constructed oyster reef habitat in lower Delaware Bay.” (#23)

Poster Russell M. Babb, Jason **Hearon**, David Bushek and Eric Powell. “The Delaware Bay Oyster (*Crassostrea virginica*) Restoration Program.” (#68)

11:15 Session 8 General Q&A

11:45 – 12:45 LUNCH



WEDNESDAY, 24 JANUARY – Science Conference

12:45 Session 9. (Special Panel). *Restoration & Enhancement: Activities, Opportunities & Needs*

- 2:30 Moderators: **Simeon Hahn** (NOAA), **Krista Laudенbach-Nelson** (PDE) and **Ralph Stahl** (DuPont). The panel will be comprised of moderators plus additional speakers listed below.

Topics: Consistent with the theme of the conference, this panel will begin to address goal-setting and targets as related to restoration. Most restoration practitioners in the Delaware Estuary, including federal and state agencies and non governmental organizations, are guided by goals and/or performance measures relative to their specific mission. These performance metrics are often very specific to particular resources and habitats and may not necessarily be ecosystem based. Ecosystem based management is quickly evolving as the preferred environmental approach for management though there is little current guidance and/or interpretation of what that actually means.

Challenge Questions for Session 9:

- How can we improve coordination and partnership of efforts?
- Who should be involved with regional restoration planning efforts?
- What natural resource inventories and assessments already exist?
- What critical and/or unique habitats are in the estuary, and should we focus efforts and resources on those habitats?
- What funding opportunities exist (federal, state, private), and how can they be leveraged for additional support?

12:45 Part I. Contributed Papers

12:45 James M. **Eisenhardt**. “Ecological Restoration in an Urban Watershed.” (#4)

1:00 Ralph **Huddleston**. “Mitigating for Cooling Water Intakes – Is the Estuary Enhancement Program of DE Bay Working?” (#5)

1:15 Gwyn **Rowland**. “Opportunities and Barriers to Restoring Wetlands in Urban Areas -- A Case Study from Cobbs Creek Watershed Wetlands Restoration Project.” (#30)

Poster Matthew **Colip** and Fred Suffian. “Igo, Porter, Warren Memorial Field Rain Garden Project in Warrington Township, Bucks County.” (#15)

1:30 Part 2. Panelist Contributions (3-5 minutes each) followed by General Session 9 Discussion

Ralph **Stahl**. “Restoration Up Front and DuPont Delaware River Initiative.” (#73, no abstract)

Lynn **Dwyer**. “Delaware Estuary NFWF.” (#74, no abstract)

Craig **Woolcott**. “NOAA’s community-based restoration program: resources for coastal restoration.” (#75)

Patrick **Starr**. “North Philadelphia Waterfront Revitalization - restoration challenges and insights.” (#76, no abstract)

Bill **Shadel**. “An Inventory of Restoration Opportunities in the Delaware Bay.” (#77)

Krista **Laudенbach-Nelson**. “Prospects for Regional Restoration Planning for the Delaware Estuary.” (#78)

2:30 **BREAK**



WEDNESDAY, 24 JANUARY – Science Conference

3:00 – 5:00

Session 10. (Special). *Hot Topics in Delaware Estuary Science and Management*

Moderators: **Gary Buchanan** (NJDEP), **Jonathan Sharp** (University of Delaware) and **Robert Tudor** (DRBC)

Challenge Questions:

- Why is your presentation a 'hot topic', and how does it rank as a priority for science or management attention?
- Can you briefly summarize the additional tasks or studies that need to be conducted or action that needs to be taken?

- 3:00 A. Ronald **MacGillivray**. “Emerging Contaminants of Concern in the Delaware Estuary and Watershed.” (#11)
- 3:15 Rick **Greene**, Gary Buchanan and Bruce Ruppel. “Polybrominated Diphenyl Ethers (PBDEs) in Fish from the Delaware Estuary.” (#24)
- 3:30 Anthony J. **Broccoli**. “Global climate change: causes and consequences.” (#59)
- 3:45 Nancy M. **Targett**. “Linking Science and Society: An Overview of the Developing National Priorities.” (#62)
- 4:00 Amanda A. **DeSantis**, Timothy J. Iannuzzi, Judi Durda, Damian V. Preziosi, David F. Ludwig, Ralph G. Stahl, J.B. Ruiter, Robert A. Hoke and Richard F. Schwer. “Assessing historical and current multi-stressor impacts on environmental conditions of the Delaware River Estuary.” (#8)
- 4:15 Jeremy **Firestone** and Willett Kempton. “Science, Social Science, and Policy Regarding Developing Offshore Wind Power in The Delaware Estuary Region.” (#60)
- Poster Jennifer **Halchak**, John L. Gallagher, Denise Seliskar. “The Transition from Agricultural Lands to Wetlands during Sea Level Rise: Managing the Ecology and Economics.” (#31)
- 4:30 **Session 10 General Q&A**

5:00 CLOSING REMARKS



Program Detail and Session Summaries Environmental Summit

(Each presentation was assigned a unique reference number, listed after each title)

Note Posters: A comprehensive list of posters for both the Science Conference and Environmental Summit is provided on pages 27-28. Posters are being displayed throughout the meeting, and authors are asked to stand by their poster during the poster session on Tuesday late afternoon.

MONDAY, 22 JANUARY – Environmental Summit

7:30 – 11:00 Registration for Environmental Summit Participants
8:30 Welcome and Opening Remarks

9 – 11:00 Environmental Summit Participants (early arrivals) may attend Session 1 of the Science Conference: Hydrology, Hydrodynamics, and Sedimentation (see page 14.)

11:00 BREAK

11:30 **Keynote Presentation. Dr. Scott Nixon** (UNESCO/Cousteau Chair in Coastal Ecology and Global Assessment, University of Rhode Island)
“The National Importance of the Delaware Estuary” (#64)

12:00 – 1:00 LUNCH

1:00 – 3:00

Session A. Successful Strategies for Messaging & Communication
Christine **Heenan**, The Clarendon Group

You know why your project is worth doing, or the pending zoning change is so important, but who else does? These interactive sessions will explore making the most of your message, reaching key audiences, and working with the media to build understanding and support for your initiatives. Come with specific challenges you face in your work, and be prepared to roll up your sleeves.

3:00 BREAK

3:30 – 5:30

Session B. Messaging and Communications - Workshop
Moderators Christine **Heenan**, The Clarendon Group)

5:30 BREAK



MONDAY, 22 JANUARY – Environmental Summit

6:45 – 8:00 **Reception and Buffet Dinner**

8:00-? **Panel Discussion. Charting the Future of the Delaware Estuary.**

Help steer the future of the Estuary by joining a discussion about effective environmental management, goal-setting, and the selection and use of appropriate environmental indicators to monitor whether goals are being met and resources are being managed effectively within the Delaware Estuary and its watershed. Should we move from management of specific resources to management of estuaries (i.e., ecosystems)? Is this a realistic goal and what would it entail? (see page 16 for more information)

TUESDAY, 23 JANUARY

8:00 Registration Desk Open

8:15 – 10:15

Session C. Stormwater Issues and Pollution Prevention

- 8:15 Maggie **Allio**, Montgomery County Conservation District
“Seeing is Believing: A Showcase of Best Management Practices in Montgomery County.” (#81)
- 8:35 Liz **Feinberg**, Pennsylvania Environmental Council
“Urban Stormwater Retrofit Projects.” (#82)
- 8:55 Mary Ellen **Noonan**, Bucks County Conservation District
“Rain Gardens for Clean Streams.” (#83)
- 9:15 Lyn **O’Hare**, Berks County Conservation District
“Schuylkill Action Network /Agricultural Best Management Practices.” (#84)
- 9:35 Jeanne **Waldowski**, Philadelphia Water Department
“Philadelphia Water Department’s Tookany/Tacony-Frankford Partnership: From Partnership to Independent Nonprofit.” (#85)
- 9:55 James M. **Eisenhardt**, P.W.S., Duffield Associates
“CAFO Designs/Environmental Stewardship at Delaware Park.” (#86)

10:15 BREAK



TUESDAY, 23 JANUARY – Environmental Summit

10:30 – 12:30 Session D. Building Stewardship

- 10:30 Jennifer **Jones**, Partnership for the Delaware Estuary
“Corporate Environmental Stewardship Program, a Partnership for Conservation and Economic Growth.” (#87)
- 10:50 Dottie **Baumgarten**, Oak Lane Day School
“Habitat Restoration at Oak Lane Day School: Elementary Environmental Education.” (#88)
- 11:10 Janet **Starwood**, Earth Force
“Earth Force GREEN: Young People Protecting our Watersheds.” (#89)
- 11:30 Tim **Fenchel**, Schuylkill River National & State Heritage Areas
“Exelon-Schuylkill River Restoration Fund.” (#90)
- 11:50 Vivan **Williams**, Stroud Water Research Center
“Using Your Website as a Teaching Tool.” (#91)
- 12:10 Lisa Ragone **Calvo**
“Engaging Student Communities in Delaware Bay Oyster Restoration Efforts—Promoting Oyster Restoration Through Schools: Project PORTS.” (#92)

12:30 – 1:30 LUNCH

1:30 – 12:30 Session E. Water Quality and Restoration

- 1:30 Kirk **Mantay**, Ducks Unlimited
“Wetland Restoration Site Preparation and Site Management: Balancing Project Costs and Habitat Benefits to Waterfowl.” (#93)
- 1:50 John **Harrod**, Delaware Nature Society
“Backyard Wildlife Habitat Program.” (#94)
- 2:10 Helen **Edwards**, New Jersey Watershed Ambassadors Program: WMA 16
“Working for Cleaner Water with the Watershed Ambassador Program.” (#95)
- 2:30 Krista **Laudenbach-Nelson**, Partnership for the Delaware Estuary
“The Guide to the Natural Communities of the Delaware Estuary.” (#96)
- 2:50 Ginger **North**, Delaware Nature Society
“Citizen’s Science in Delaware: A Success Story.” (#97)
- 3:10 Robert **Lonsdorf**, Brandywine Conservancy
“Restoring Shad to the Brandywine River.” (#98)



TUESDAY, 23 JANUARY – Environmental Summit

3:30 BREAK

4:00 – 5:00 Session F. Innovative Collaboration

- 4:00 Jennifer **Adkins**, Partnership for the Delaware Estuary
“Schuylkill Action Network / Schuylkill Watershed Initiative Grant.” (#99)
- 4:20 Ray **Bivens**, Delaware State Parks
“Cape Henlopen Osprey Project.” (#100)
- 4:40 Ed **Grusheski**, Philadelphia Water Department, and Craig Johnson, Talisman Interactive
“The Wireless Revolution in Ecotourism Communication.” (#101)

5:00 - 6:00 Session 7. Poster Reception

Moderators: **Dan Soeder** (USGS) and **Amie Howell** (EPA Region 3)
See pages 27-28 for a comprehensive listing.

6:00 BREAK

6:30 – 8:00 **Seated Dinner** (Grand Ballroom)

7:30-8:30 **Plenary Presentations** (during dessert, Joint Session of Summit and Conference):

Michael Koterba (USGS) (#1)

“Integrated Ocean Observing Systems: An Example from the Chesapeake Bay”

Jonathan H. Sharp (University of Delaware) (#35)

*“The Delaware Estuary Watershed to Ocean Observing System (DEWOOS):
Current and Future Design for a Comprehensive Monitoring Infrastructure”*

8:30-? **Roundtable Discussion:** Monitoring Needs and Concepts
(Joint Session of Summit and Conference participants)

WEDNESDAY, 24 JANUARY – Environmental Summit

8:00 Registration Desk Open

8:30 – 5:00 Attend Day 3 of the Science Conference (see pages 20-22)

5:00 CLOSING REMARKS



Poster Presentations

A comprehensive list of posters presented for the Science Conference and Environmental Summit follows below with information on which session they are affiliated with.

- Jeffrey **Ashley**, David Velinsky, Danielle Libero, Evan Halscheid, Linda Zaoudeh and Heather Stapleton. “Polybrominated diphenyl ethers in American Eels from the Delaware River Estuary.” (#42, affiliated with Session 5)
- Russell M. Babb, Jason **Hearon**, David Bushek and Eric Powell. “The Delaware Bay Oyster (*Crassostrea virginica*) Restoration Program.” (#68, affiliated with Session 8)
- Jim **Bennett** and Roger Reinhart. “Protection of underground sources of drinking water: the Underground Injection Control Program.” (#69, affiliated with Session 5)
- Matthew **Colip** and Fred Suffian. “Igo, Porter, Warren Memorial Field Rain Garden Project in Warrington Township, Bucks County.” (#15, affiliated with Session 9)
- Andrea L. **Friedman**, Jeffrey S. Waldner, Jane Uptegrove and J. Bailey Smith. “Marine geologic and geophysical investigations offshore of Cape May, New Jersey: methodology, representative data, and preliminary findings.” (#51, affiliated with Session 1)
- Kathryn **Goddard**, Steven Ordog, Kelly Bemis and Julius Cook. “Parasite burden on the Black-nosed Dace *Rhinichthys atratulus* at four sites in the Darby Creek, PA watershed.” (#70, affiliated with Session 2)
- Jennifer **Halchak**, John L. Gallagher, Denise Seliskar. “The transition from agricultural lands to wetlands during sea level rise: managing the ecology and economics.” (#31, affiliated with Session 10)
- Christopher J Nally, A Ronald **MacGillivray**, Tarmo Pallop, Kerri Koch, Thomas J Fikslin. “Low salinity acclimation & salinity tolerance of *Americamysis bahia* in short-term chronic toxicity tests.” (#10, affiliated with Session 5)
- Evan M. **Rehm**, Mark Biddle, Amy Jacobs, Gary Kreamer, Steve Williams. “Integrating Delaware’s wetland monitoring, restoration, and education efforts to improve the health of the Delaware Estuary.” (#12, affiliated with Environmental Summit)
- Janet W. **Starwood**. “Earth Force Watershed Awareness to Action.” (#52, affiliated with Environmental Summit)
- Kenneth A. **Strait** and Brenda Q. Evans. “Evaluation of status and success for a large scale marsh restoration program in the Delaware Estuary.” (#71, affiliated with Session 3)
- Jaclyn **Taylor** and David Bushek. “Preliminary investigations of constructed oyster reef habitat in lower Delaware Bay.” (#23, affiliated with Session 8)



Poster Presentations *continued*

Yoana **Voynova** and Jonathan H. Sharp. “Do low-frequency watershed inputs have a major impact to the Delaware Estuary?” (#33, affiliated with Session 5)

Dawn R. **Werry**. “Clear into the Future, a DuPont Delaware Estuary initiative.” (#41, affiliated with Environmental Summit)

Vivian **Williams**. “Using Your Website as a Teaching Tool.” (#43, affiliated with Environmental Summit)



Abstracts

Abstracts are listed alphabetically by last name of first author. Each presentation was assigned a unique reference number and was aligned with one of the session themes. Science Conference sessions are assigned numbers from 1 to 10. Environmental Summit sessions are assigned letters from A to F. The reference number, session affiliation, and presentation time and date are listed following the lead presenter's email address.

DEMONSTRATING A COLLABORATIVE APPROACH TO WATERSHED PROTECTION IN THE HEADWATERS OF THE ESTUARY. Jennifer Adkins, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar Street, Suite 202, Wilmington, DE 19801. Jadkins@DelawareEstuary.org. **Session F**, 4:00, 1/23/07 (presentation #99).

As the largest tributary to the Delaware Estuary and the source of drinking water for over 1.5 million people in southeastern Pennsylvania, the Schuylkill River is a resource critical to the health of our region. The Partnership for the Delaware Estuary has teamed up with the Philadelphia Water Department, the U.S. Environmental Protection Agency, and over 60 other agencies and organizations to form the Schuylkill Action Network – a unique collaboration of government agencies and private and non-profit organizations working together to protect water quality in the Schuylkill River. With funding from a 2004 Targeted Watershed Grant from USEPA, the Partnership coordinates with a variety of Schuylkill Action Network members to undertake a suite of projects designed to demonstrate how collaboration can protect water resources in a large and diverse watershed.

Using the Schuylkill Action Network's structure of workgroups for guidance and technical assistance, project partners are using grant funds to study and remediate abandoned mine drainage in the Schuylkill County region, reduce and better manage stormwater in the Montgomery County region, and implement conservation plans and agricultural best management practices in the Berks County region of the watershed. Working closely with water suppliers, local land trusts, and other partners, we are also undertaking monitoring, case studies, educational programs, and prioritization efforts that will generate information and learning to benefit future watershed protection. To match the federal grant funds, these projects also utilize funds from state, local, private, and in-kind contributions. With such a diversity of partners, projects, and funding sources, this initiative offers numerous examples for collaborating to protect watershed resources.

This session will provide a brief overview of the structure and accomplishments of the Schuylkill Action Network, with an emphasis on projects funded by the Targeted Watershed Grant awarded to the Partnership for the Delaware Estuary.



SEEING IS BELIEVING: A SHOWCASE OF STORMWATER BEST MANAGEMENT PRACTICES IN MONTGOMERY COUNTY. Maggie L. Allio, Montgomery County

Conservation District, 143 Level Road, Collegeville, PA 19426.

mallio@montgomeryconservation.org. Session C, 8:15, 1/23/07 (presentation #81).

The Montgomery County Conservation District will present *Seeing Is Believing: A Showcase of Stormwater Best Management Practices in Montgomery County*. This project highlights BMPs that effectively manage stormwater, protecting our local watersheds. In addition to educating the community, the showcase also provides an opportunity for property owners to receive public recognition for implementing innovative stormwater management.

The showcase includes a self-guided tour book, a guided bus tour, and a virtual tour. The Conservation District provided this project as part of the Montgomery County Coastal Non-point Pollution Program. The Showcase was generated because of concerns that there was a lack of local examples of BMPs from the PA Stormwater BMP Manual. Funding was provided by the Pennsylvania Association of Conservation Districts, Inc. through its education grant with PA Department of Environmental Protection and the EPA Section 319 Program; and National Oceanic and Atmospheric Administration through the Coastal Nonpoint Pollution Program administered by the PA Department of Environmental Protection.

A printed Self-Guided Tour booklet highlights BMPs at twelve demonstration sites with photographs and descriptions, allowing developers, engineers and community members interested in stormwater to visit the BMPs in person.

The Montgomery County Conservation District hosted a guided field tour for municipal officials and engineers on October 25, 2006. The bus tour visited four locations, ranging from a wetland garden and greenroof at a campus of a large University to a rain barrels and permeable pavers that homeowners can easily install. Four presentations on stormwater management were given on the bus during travel. The participants' surveys indicated that after the tour they were most likely to promote naturalized basins and porous pavement because they felt these BMPs were more cost-effective than green roofs and maintenance-intensive BMPs.

Conservation District's *Virtual Tour of Stormwater BMPs* webpage is available to any interested viewers at www.montgomeryconservation.org/bmptour.htm. This website is an on-line version of the Self-Guided tour and contains detailed information on each site and links to multiple other web-based resources on stormwater-related issues. A demonstration of the virtual tour will show how the site can be accessed and used.

POLYBROMINATED DIPHENYL ETHERS IN AMERICAN EELS FROM THE DELAWARE RIVER ESTUARY. Jeffrey Ashley, Philadelphia University, School of Science and Health, Philadelphia, PA 19144; David Velinsky, Danielle Libero, Evan Halscheid and Linda Zaoudeh, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103; and Heather Stapleton, Nicholas School of the Environment, Duke University, Durham, NC 27708. ashleyj@philau.edu. Session 5, poster, 1/23/07 (presentation #42).

Certain structures (referred to as congeners) of polybrominated diphenyl ethers (PBDEs) have been and are currently used as flame retardants in products ranging from computers to textiles. Production and use of these chemicals has been largely concentrated in industrialized countries however, due to their persistence and volatility, PBDEs are globally ubiquitous and have been



shown to bioaccumulate in aquatic organisms. In 1998, American eels were captured from various locations within the Delaware River Estuary and subsequently analyzed for PBDEs (as well as PCBs and other organohalogen compounds). Total PBDE concentrations ranged from 1 to 408 ng/g wet weight. Values for PBDEs were consistently an order of magnitude less than their counterpart PCB levels. To date, there are no published consumption guidelines for t-PBDEs. The most abundant brominated diphenyl ether congeners detected in American eels, in order of largest contributor to smallest, were $47 < 100 < 154 < 119$ and 49. The fully brominated conformation of the diphenyl ether (BDE 209) was not detected in any of the eel samples suggesting that American eels have the potential for metabolic debromination. Preliminary data on PBDE levels and patterns in Delaware River Estuary sediment confirms that 209 is the dominate congener in this matrix. Eels are likely exposed to this congener but do not accumulate it because of the debromination processes. The predominant PBDE congeners found in this study were consistently similar to those found in other U.S. and European studies, reflecting the widespread usage of the technical formulations used as flame retardants. However, with the U.S. now following western European bans on the penta and octa formulations and the fact that fishes may selectively debrominate some congeners, differences in world-wide congeneric patterns may begin to be discerned. Because of their limited home-range and ability to accumulate PBDE, we hypothesize that these organisms may be used as sentinel species for monitoring the magnitude and extend of PBDE contamination in the Estuary.

EFFECTS OF WETLAND FRAGMENTATION ON FRESHWATER TURTLE POPULATIONS IN THE DELAWARE ESTUARY.

Harold W. Avery, Department of Bioscience and Biotechnology, Drexel University, 3141 Chestnut St., Philadelphia, PA 19104; **James R. Spotila**, Department of Bioscience and Biotechnology, Drexel University, 3141 Chestnut St., Philadelphia, PA 19104; **Walter F. Bien**, Department of Bioscience and Biotechnology, Drexel University, 3141 Chestnut St., Philadelphia, PA 19104. haltort@aol.com. **Session 2**, 1:30, 1/22/07 (presentation #57).

Understanding how the arrangement of habitat patches within a landscape affects wildlife viability is essential to conservation and recovery efforts of threatened and endangered species. Freshwater wetlands associated with the Delaware Estuary are important habitats for the Pennsylvania Threatened red-bellied turtle (*Pseudemys rubriventris*) as well as several other turtle species. We estimate that there more than 6,000 turtles inhabiting 33 individual wetlands that constitute a fragmented landscape of wetlands at the Philadelphia International Airport. For painted turtles and snapping turtles the size of a wetland, rather than its degree of isolation from other wetlands, was the important determinant of how many turtles were present. In contrast, significantly more red-bellied turtles and more size classes of red-bellied turtles occurred in populations inhabiting wetlands that interconnected to the Delaware River or between other wetlands, compared to populations inhabiting isolated wetlands. Invasive, non-native red-eared slider turtles (*Trachemys scripta*) were found throughout the freshwater wetland system, but were generally more prevalent outside the protected Airport grounds where the surrounding human population had free access to wetlands, compared to wetlands inside the protected Airport grounds. One striking exception was a wetland within the Airport grounds that had interconnections to the Delaware River and had high densities of red-eared sliders. Among the greatest threats facing adult turtles of all species were risks associated with overland movements between wetlands. A total of 104 inter-wetland movements were reported among four species of turtles. Mortality of red-bellied turtles, painted turtles and snapping turtles occurred during our study, with the discovery of turtle carcasses along presumed movement corridors. Low rates of successful nesting, high adult mortality while moving on land, and possibly competition with other turtle species such as the introduced red-eared slider turtle, are major factors contributing to the decline of red-bellied turtle populations within the



Delaware Estuary. Protection and enlargement of nesting areas to ensure successful reproduction and population recruitment, reduction of mortality risks along terrestrial corridors, and protection of existing wetlands and adjacent upland areas from further destruction and degradation, are necessary measures to ensure the viability of the threatened red-bellied turtle in the Delaware Estuary.

THE DELAWARE BAY OYSTER (*CRASSOSTREA VIRGINICA*) RESTORATION PROGRAM. **Russell M. Babb, Jason Hearon**, New Jersey Department of Environmental Protection, Bureau of Shellfisheries, Port Norris, NJ 08349; **David Bushek and Eric Powell**, Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349. rbabb@gtc3.com, njfw_hearon@hotmail.com. **Session 8**, poster, 1/23/07; and 8:30, 1/24/07 (presentations #49 and 68).

Natural oyster production on Delaware Bay seed beds is close to collapse following six consecutive years of exceptionally low recruitment. Size frequencies have shifted toward larger oysters with few young oysters to replace those lost to fishing or natural mortality. Reasons for the low recruitment are unclear. While recruitment across the natural seed beds has been below the baywide average for six consecutive years, consistently high settlement continues to occur in the lower bay when suitable substrate is available, but few oysters survive in this region. In summer 2003, the NJDEP conducted a pilot-scale program where spat was captured from the lower bay on surf clam shell (*Spisula solidissima*), then transferred to a primary seed bed in fall 2003 increasing early recruitment about 75-fold. This project site remained closed as a conservation area for 2.5 years and opened to industry harvest in April 2006. This small-scale effort increased the oyster industry TAC by nearly 26 percent and had an approximate ex-vessel value of \$500,000.

Based in large part on the success of this small project, federal funding support was secured by the Oyster Industry Revitalization Working Group (OIRWG) through the Delaware Bay Congressional delegation for activities in 2005 and 2006. OIRWG partners working on the project include New Jersey's Department of Environmental Protection, the U.S. Army Corp of Engineers', Delaware's Department of Natural Resources and Environmental Control, Rutgers University's Haskin Shellfish Research Laboratory, the Delaware River and Bay Authority, the Partnership for the Delaware Estuary, the Delaware River Basin Commission and oyster industries of both New Jersey and Delaware.

Envisioned as a five-year program, Year 1 began in FY'05 with a total of 280,000 bushels of shell being planted in New Jersey and Delaware on about 150 acres. The FY'05 program succeeded in increasing recruitment by about 50 percent in the bay region receiving the shell. Year 2 resulted in greater than 500,000 bushels of shell being planted on 12 sites in NJ and DE waters. As of this writing, early monitoring of two sites in NJ's lower bay (sited similar to the 2003 NJDEP project site) indicates a significant setting event has occurred. The oyster industries will sustain the program via the collection of landings fees beginning in Year 6.



THE EFFECT OF LONG PIERS ON BIRDS USING MARSH HABITAT IN WORCESTER COUNTY, MARYLAND. Alison E. Banning, Jacob L. Bowman, Department of Entomology and Wildlife Ecology, and Bruce L. Vasilas, Department of Plant and Soil Sciences, University of Delaware, 531 South College Avenue, Newark, DE 19717. abanning@udel.edu. Session 3, 5:00, 1/22/07 (presentation #25).

Vegetated tidal wetlands are an essential part of coastal systems and breeding habitat for many marshbirds. Worcester County, Maryland is presently concerned with how increased development and human populations will affect the coastal bays watershed. Specifically, how the construction of long piers across marshes influences birds using marsh habitat. The objective of our research was to determine the environmental impact of long piers (>100 ft) on the avian community in marshes during the breeding season. We compared marsh areas with and without long piers in 2005 (n=18 and n=14, respectively) and 2006 (n=20 and n=20) for bird abundance, bird species richness, and bird occurrence. We detected 86 bird species in 2005 and 93 species in 2006. Point count survey data from 2005 showed that Herons & Egrets used pier sites more than non-pier control sites ($P=0.03$), whereas obligate marshbirds used control sites more than pier sites ($P=0.04$). Gulls & terns used pier sites slightly more than control sites ($P=0.11$), and facultative marshbirds (i.e. Boat-tailed Grackles, Fish Crows, and Red-winged Blackbirds) used control and pier sites equally ($P=0.59$). Obligate marshbirds species richness was greater at control than pier sites ($P=0.06$), whereas piers did not effect species richness for the other groups ($P\geq 0.13$). Results from 2006 data will be included in the conference presentation. In addition to the pier data, we will use spatial habitat analysis to determine if landscape features (e.g. marsh area, human development) influence the avian community in marshes.

SUDDEN WETLAND DIEBACK IN DELAWARE'S INLAND BAYS. Christopher W. Bason, Delaware Center for the Inland Bays, 39375 Inlet Road, Rehoboth Beach, Delaware 19971; and Amy Jacobs, Delaware Department of Natural Resources and Environmental Control, Watershed Assessment Section, 820 Silver Lake Blvd., Suite 220, Dover, DE 19904-2464. chrisbason@inlandbays.org. Session 3, 4:30, 1/22/07 (presentation #16).

Sudden Wetland Dieback (SWD) is the rapid death of tidal wetland vegetation due to a yet undetermined combination of environmental factors. SWD was first identified in marshes of Delaware's Inland Bays in 2006 where it was found to affect large areas of smooth cordgrass (*Spartina alterniflora*). A similar phenomenon was reported in the scientific literature as early as 1968. However, the frequency and extent of SWD in Gulf and Atlantic Coast marshes of the US since the early 1990s is alarming. SWD is a concern for scientists, managers, and the public because its occurrence can contribute directly to saltmarsh loss and may interact with other stressors to increase rates of saltmarsh loss. Saltmarshes are some of the most valuable ecosystems in the world and many are highly susceptible to loss during this period of coastal population growth and climate change.

The discovery of SWD in the Inland Bays is summarized and the initial attempts to quantify its distribution are presented. An aerial survey that sufficiently captured 22% of saltmarshes in the Bays revealed that SWD may be present in 40% of these marshes. Frequency of occurrence is presented by dieback intensity. A number of semi-permanent monitoring plots were established in the Bays at the end of the 2006 field season. Initial results from plant pathology testing and soil testing are presented.



Three major initiatives in Louisiana, Georgia, and New England have already generated data and preliminary conclusions on the causes of SWD. Similarities and differences of SWD between the regions will be discussed.

SWD has been observed in the Delaware Estuary at Prime Hook National Wildlife Refuge. Though apparently not widespread, the phenomenon strongly relates to the PDE science priorities and provides an interesting example of the interrelations between science, management, and policy. The Inland Bays region has benefited from the State of Delaware's policy to monitor tidal wetland health by having resources available to quickly research the emergence of SWD, and a partial framework within which to incorporate continuing research.

Currently, a SWD workgroup for Delaware is meeting to plan further monitoring and identify causes and remedies for this potential problem. Current research is focused on determining the causes the ultimate impact on the marshes. However, rapid management action may be required if it is determined that the marshes do not re-vegetate rapidly resulting in submergence or erosion. The discovery of SWD also provided an opportunity to observe other little understood stressors to marshes of the Inland Bays, and has raised awareness about the need to address these threats which may result in policy change. Advantages exist in the expansion of our Delaware workgroup regionally for purposes of information sharing, funding, and response to emerging situations.

HABITAT RESTORATION AT OAK LANE DAY SCHOOL: ELEMENTARY ENVIRONMENTAL EDUCATION. Dottie Baumgarten, Oak Lane Day School, 137 Stenton Avenue, Blue Bell, PA 19422. dbaumgarten@oaklanedayschool.org. **Session D**, 10:50, 1/23/07 (presentation #88).

Oak Lane Day School is an independent, nonsectarian elementary school located in Blue Bell, Montgomery County, Pennsylvania. The school's thirty-acre property that is situated in the Wissahickon Creek watershed (a tributary to the Schuylkill River) includes marsh, meadow, woods, hedgerow, a spring-fed creek and pond.

Science education is rooted in the diverse habitat found on our campus. Our land is a valuable tool that can broaden children's understanding of science including: environment, life science, earth science, and the scientific process. Our hope is that by learning to appreciate the natural world through their scientific explorations outdoors, children of Oak Lane will ultimately develop a mature foundation for scientific literacy for environmental topics.

As the science program has grown and changed over the course of seven years, connections to the community have also grown and changed. The first connections provided opportunities to educate the educators that in turn helped to clarify the direction of the science program. Three organizations most helpful in the beginning were Partnership for the Delaware Estuary, Chestnut Hill College and Consortium for the Scientific Assistance to Watersheds.

Groundwork laid through these relationships came to fruition during the Partnership's Sense of Place habitat restoration project with Oak Lane in spring of 2003. We benefited from plants and professional support from Sense of Place along with the effort from students, parents and staff, a DEP mini-grant that provided tools for water testing, and tree care, including a tree inventory, from Whippen Township Shade Tree Commission.



Two local organizations with whom we maintain on-going connections are Whitpain Township Shade Tree Commission and Wissahickon Valley Watershed Association (WVWA). The most recent community service day with WVWA became a collaborative project with both organizations when we planted disease-resistant American elm trees on Township property. Another helpful connection has been the Pennypack Ecological Restoration Trust, which offered training on plant restoration, advice on choosing native plants, and lessons on collecting, preserving and propagating native seeds.

Past and current successes include the Schuylkill Action Network Environmental Education Award in spring 2004, certification as a National Wildlife Habitat in summer 2006, the beginnings of adult education through an after-school garden club in fall 2006, and on-going teachable moments for each student. Strategies for the future include a master plan for sustainable habitat maintenance and restoration, and development of adult volunteer help and adult education events.

PROTECTION OF UNDERGROUND SOURCES OF DRINKING WATER: THE UNDERGROUND INJECTION CONTROL PROGRAM. **James C. Bennett**, Environmental Protection Agency, Region 3, 1650 Arch Street, Philadelphia, PA, 19103; and **Roger Reinhart**, Environmental Protection Agency, Region 3, 1650 Arch Street, Philadelphia, PA, 19103. bennett.james@epa.gov. **Session 7**, poster, 1/23/07 (presentation #69).

What is Underground Injection? Underground injection is the technology of placing fluids underground, in porous formations of rocks, through wells or other similar conveyance systems. Man-made or produced fluids (liquids, gases or slurries) can move into the pores of rocks by the use of pumps or by gravity. The fluids may be water, wastewater or water mixed with chemicals. The Safe Drinking Water Act established the Underground Injection Control (UIC) Program to provide safeguards so that injection wells do not endanger current and future underground sources of drinking water (USDW). The most accessible fresh water is stored in shallow geological formations called aquifers and is the most vulnerable to contamination. These aquifers feed our lakes; provide recharge to our streams and rivers, particularly during dry periods; and serve as resources for 92 percent of public water systems in the United States.

What Is an Injection Well? The UIC Program defines an injection well as any bored, drilled or a driven shaft or a dug hole, where the depth is greater than the largest surface dimension that is used to discharge fluids underground.

How Does the UIC Program Prevent Contamination of Our Water Supply? The goals of the EPA's UIC Program are to prevent contamination by keeping injected fluids within the well and the intended injection zone, or in the case of injection of fluids directly or indirectly into a USDW, to require that injected fluids not cause a public water system to violate drinking water standards or otherwise adversely affect public health. The uses for Class V wells (shallow disposal systems) vary widely. Some examples of Class V wells include:

- A gas station with a service floor drain that leads to a septic system.
- An apartment building with a septic system for sanitary waste disposal.
- A rest stop that uses a cesspool.
- A municipality where stormwater flows into drywells.
- A strip mall, with small businesses such as a photo processor and a dry cleaner, that discharge sanitary wastes mixed with process chemicals into a septic system
- An office building that injects water passed through a heat exchanger to cool the building.



All operational injection wells require authorization under general rules or specific permits. In 1999, EPA banned two types of Class V wells: [motor vehicle waste disposal wells](#) and [large capacity cesspools](#).

CAPE HENLOPEN OSPREY PROJECT. **Ray Bivens**, Delaware Division of Parks and Recreation, 152 South State Street, Dover, DE 19901. Raymond.bivens@state.de.us. **Session F**, 4:20, 1/23/07 (presentation #100).

Satellite telemetry is currently being used to monitor migratory movements of three juvenile Ospreys (*Pandion haliaetus*) from Sussex County, Delaware to points south. The movements of Lew, Erica, and Della will be tracked for the next two years until they return on their northern migration in the spring of 2008. This innovative education/research partnership between Delaware State Parks, Dr. Bierregaard from UNC-Charlotte, and The Friends of Cape Henlopen State Park helps park visitors, students and teachers better connect with one of Delaware Estuary's keystone species.

Collecting satellite telemetry data on the migration habits of juvenile Ospreys is only one aspect of this research and educational partnership. A few of the educational outcomes of this project include new interactive educational displays for nature center visitors, environmental education curricula, and e-field trips opportunities. Come learn more about this model for non-conventional innovative collaboration of educators, researchers, and parks.

GLOBAL CLIMATE CHANGE: CAUSES AND CONSEQUENCES. **Anthony J. Broccoli**, Department of Environmental Sciences, Cook College, Rutgers University, 14 College Farm Road, New Brunswick, NJ 08901-8551. broccoli@envsci.rutgers.edu. **Session 10**, 3:30, 1/24/07 (presentation #59)

Global climate change may very well be the most important environmental issue of the 21st century (and beyond). Global temperatures have risen to unusually high levels, and a variety of evidence indicates that human activities, primarily the emission of carbon dioxide from burning fossil fuels, are responsible for most of this warming. Computer models of the earth's climate system, the best tools available for projecting future changes in climate, indicate that further warming will occur. Many aspects of the physical, chemical, and biological environment will be impacted by climate change, including human health, agriculture, natural ecosystems, water resources, and coastal environment. Specific impacts on water resources and the coastal environment will have major implications for the Delaware estuary and will be discussed in more detail.

FROM LOCAL TO GLOBAL: USING SITE-BASED RESTORATION PROJECTS TO INSPIRE LARGE SCALE CONSERVATION OF NATIVE BIVALVES. **Robert D. Brumbaugh**, The Nature Conservancy Global Marine Initiative, University of Rhode Island Narragansett Bay Campus, Narragansett, RI 02882; and **Michael W. Beck**, The Nature Conservancy Global Marine Initiative, University of California Santa Cruz, Center for Ocean Health, Santa Cruz CA 95060. **Session 8**, 11:00, 1/24/07 (presentation #45).

Native bivalve shellfish have been identified as a restoration and conservation priority for many coastal bays and estuaries around the U.S. where The Nature Conservancy (TNC) and its partners work. Shellfish are the ecosystem engineers that help to regulate water quality and provide enabling conditions for the biodiversity that is central to TNC's mission. Shellfish restoration is also a priority for many agencies and coastal communities that are or have historically been supported by bivalve fisheries, including those agencies that manage submerged and intertidal



lands in and around Delaware Bay. Restoration efforts in different estuaries have mostly been conducted in relative isolation from each other, and even projects within the same system or basin are sometimes designed without regard to lessons learned relatively nearby. Exacerbating this is the fact that projects have historically had little monitoring from which to derive lessons. TNC is assembling a shellfish restoration network to address some of these challenges by fostering better communication and coordination among projects, particularly those funded through a National Partnership with NOAA's Community-based Restoration Program. Electronic newsletters and web-based tools are being developed (e.g., <http://conserveonline.org/workspaces/shellfish>) to support this exchange of information. A Practitioners Guide published jointly with NOAA's Restoration Center in 2006 provides guidance for designing projects that can be monitored effectively and compared across sites. Emerging lessons from the Network include: (1) harvest is still a primary objective of many partners, and other ecosystem services are still under-utilized as explicit and measurable objectives, (2) monitoring approaches are still rather coarse (e.g., annual landings) (3) permitting for restoration is challenging, particularly in areas with water quality issues, and (4) funding levels are not sufficient in most areas to conduct restoration at ecologically meaningful scales. The development of new in situ monitoring approaches should improve our ability to use the full array of ecosystem services provided by shellfish as an objective for restoration. Complementing this network is a global 'shellfish reefs at risk' assessment that TNC and partners are now developing.

SOME POTENTIAL ALTERNATIVE STRATEGIES AND APPLICATIONS FOR SHELLFISH ENHANCEMENT AND RESTORATION IN DELAWARE BAY. **David Bushek**, Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Ave., Port Norris, NJ 08349; and **Danielle A. Kreeger**, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar Street, Suite 202, Wilmington, DE 19801. bushkek@hsrl.rutgers.edu. **Session 8**, 10:15, 1/24/07 (presentation #48).

Suspension-feeding bivalve molluscs often comprise a dominant component of aquatic ecosystems. For most species, each adult can filter about one liter of water per hour when actively feeding. This activity benefits water quality and ecosystem functioning by removing suspended matter from the water column and re-mineralizing nutrients that are bound up in phytoplankton and other microscopic organisms. This process can increase system productivity via a positive feedback loop. Hence, dense populations of bivalves can substantially improve water quality and increase biological production. Many bivalve molluscs create reefs or beds as they attach to each other or settle in dense aggregates. This produces a unique biogenic habitat that supports other species thereby increasing local species diversity. The reefs and beds can help protect shorelines and beaches from erosion by armoring the shoreline or otherwise reducing erosional forces. These statements are equally true for marine and freshwater ecosystems, including the Delaware Estuary where historical documents describe rich populations of oysters, clams and mussels in tidal areas as well as a diverse array of freshwater mussels in non-tidal areas. Today, bivalve populations are impaired throughout much of the system though a wide diversity still exists. Oyster restoration and enhancement of the Delaware Bay seedbeds has been the primary focus of shellfish restoration in Delaware Bay. In this talk, we explore how other efforts, in other locations using oysters as well as alternative species such as the ribbed mussel *Geukensia demissa*, might benefit the Delaware Bay by provided additional shellfish habitats, increasing biological filtration, and reducing shoreline and beach erosion.



ENGAGING STUDENT COMMUNITIES IN DELAWARE BAY OYSTER RESTORATION EFFORTS—PROMOTING OYSTER RESTORATION THROUGH SCHOOLS: PROJECT PORTS. Lisa M. Ragone Calvo, Rutgers University Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ 08349. calvo@hsrl.rutgers.edu. **Session D**, 12:10 1/23/07 (presentation #92).

In the past decade scores of community-based habitat restoration programs have proven highly successful in engaging the general public in stewardship activities and increasing the awareness of communities to significant local environmental issues. *Promoting Oyster Restoration Through Schools: Project PORTS* is a new community-based restoration and educational program focusing on the importance of oysters in the Delaware Bay ecosystem. The Project targets elementary and high school students in New Jersey's Delaware Bayshore region. The goal of *Project PORTS* is to restore oyster habitat and to increase an awareness and understanding of the oyster as a keystone species and an important natural resource of the Bay, while at the same time promoting a basic understanding of scientific concepts and stewardship values.

Project PORTS offers teacher workshops, educational materials, and in Spring 2007 will launch its first oyster habitat restoration project. The restoration component is central to *Project PORTS* as it offers educators, students, and their families an opportunity to experience the Delaware Estuary, oyster ecology, and environmental stewardship first hand, while at the same time enhancing critical oyster habitat in the Delaware Bay. The restoration program will greatly enrich in-class lessons and lend a sense of ownership to the student's academic studies by bringing future citizen-scientists and their families into direct contact with the Bayshore environment. Ultimately it is hoped that this community-based restoration effort will demonstrate a way that local citizens can invest in the Delaware Bay and feel a personal commitment for its stewardship.

INCREASING TOLERANCE FOR *Perkinsus marinus* AMONG NATURAL *Crassostrea virginica* POPULATIONS FROM VIRGINIA WATERS. Ryan B. Carnegie and Eugene M. Burreson, Department of Environmental and Aquatic Animal Health, Virginia Institute of Marine Science, Gloucester Point, VA 23062. carnegie@vims.edu. **Session 8**, 9:15, 1/24/07 (presentation #55).

Intensification of dermo, the oyster disease caused by protistan parasite *Perkinsus marinus*, has contributed to the decline of natural *Crassostrea virginica* populations along the U.S. mid-Atlantic coast since the 1980s. *P. marinus* is viewed as a primary impediment to oyster population restoration, and the failure of natural oyster populations to respond to *P. marinus* parasitism by evolving dermo resistance underpins arguments favoring restoration using domesticated dermo-resistant oyster strains. Abundance of naturally recruited oysters in dermo-intense waters like the Lynnhaven River, Virginia, however, suggests that tolerance for *P. marinus* may be manifest at a population level. Mechanisms remain to be determined, but two observations may be important. First, long-term comparison of *P. marinus* levels in natural stocks with levels in naïve imports to dermo-enzootic waters reveals that dermo disease pressure during the first season of exposure has reached high levels. Dermo disease is now acute in the most susceptible oyster stocks, which may limit the pre-dermo reproductive contribution of the most susceptible animals. Second, large oysters in disease-intense waters often display surprisingly light *P. marinus* levels. In 57 samples collected over 2002-2005 from Virginia populations experiencing serious dermo disease (weighted prevalence ≥ 2.00), 216/1412 oysters were ≥ 100 mm. Of these oysters, 69.4% had infections below moderate intensity. In Lynnhaven River samples from 2005, 36/49 larger (≥ 100 mm) oysters (73.5%) had only lighter infections. Initial Lynnhaven River samples from 2006 revealed a similar trend. In the first four Lynnhaven sites to display weighted prevalences ≥ 2.00 , 31/100 oysters were ≥ 100 mm in size. Of these larger oysters, 77.4% had infections below moderate



intensity. One may hypothesize that larger, healthier, more fecund oysters that resist dermo disease over several challenges contribute disproportionately to reproduction, which may be a key to evolution of *P. marinus* tolerance among wild oyster populations.

IGO, PORTER, WARREN MEMORIAL FIELD RAIN GARDEN PROJECT IN WARRINGTON TOWNSHIP, BUCKS COUNTY. **Matthew Colip**, AmeriCorp VISTA; and **Fred Suffian**, Nonpoint Source Program Manager, U.S EPA - Region III, 1650 Arch Street, Philadelphia, PA 19103. Suffian.Fred@epa.gov. **Session 9**, poster, 1/23/07 (presentation #15).

Little Neshaminy Creek is a tributary of Neshaminy Creek, its watershed covers an area of 43.2 square miles in Bucks and Montgomery Counties. The protected uses of the stream include water supply, recreation, and aquatic life. Little Neshaminy Creek has been identified as impaired because of sediment overload from continuing land development projects as well as nutrient/DO/BOD issues from municipal point sources. The need for a restoration plan is crucial in preserving the designated aquatic uses for the Creek, its tributary Park Creek and several other unnamed tributaries. These designated aquatic uses include warm water fishes and migratory fishes. The watershed restoration plan includes: (1) retro-fitting stormwater retention basins for quantity and quality control through the installation of rain gardens and educational programs; (2) urban nutrient management (lawn care); (3) water quality data collection; and (4) watershed data management with the goal of positive environmental results. These restoration plan components aim to reduce the Creek input issues, i.e. runoff from urban development, before addressing the impacts such issues create, stream bank erosion etc.

In this plan, the establishment of rain gardens will help control stormwater runoff from localized and residential sites through bioretention and allow the water to infiltrate back into the water table. Rain gardens are crucial in reducing the negative effects of stormwater runoff created by the introduction of impervious surfaces to an area from urban development.

Last October, The Warrington Township Environmental Advisory Council in Bucks County, PA, and the Central Bucks South High School, in partnership with USEPA, Region III's Office of Watersheds Nonpoint Source Program, began to implement the restoration plan for the Little Neshaminy Watershed and Bradford Lake. This initiative started with the construction of a rain garden on the Igo, Porter, Warren Memorial Field in Warrington. All labor and materials for the project were donated by local businesses and the Township. This presentation explains the importance of using rain gardens for stormwater runoff management, the usefulness of rain gardens in the greater scope of the Little Neshaminy Watershed Restoration Plan as well as the value of the partnerships and their commitments to the Township and the community.

THE ROLE OF DRBC IN LINKING SCIENCE, MANAGEMENT AND POLICY. **Carol R. Collier**, Delaware River Basin Commission, 25 State Police Drive, West Trenton, NJ 08628. Carol.Collier@drbc.state.nj.us. **Session 4**, panel, 1/23/07 (presentation #66).

The Delaware River Basin Commission's (DRBC) mission is to manage the water resources of the Delaware River Basin without regard to political boundaries. One issue we always struggle with is the correct balance of science and policy in our management decisions.

Many water resource management decisions were made in the 1970's or earlier based on the available science at the time. For instance, the amount of water that New York City (NYC) is required to release from their reservoirs in the very headwaters of the Delaware Basin in order to protect instream flows and down basin water users was set by the Supreme Court in 1954. Our



knowledge base of instream flow needs has definitely increased since then, but there are still many unanswered questions, especially in the tidal river and bay. Do releases from these NYC reservoirs impact critical stages of the oyster life cycle? Can potential impacts of sea level rise and increased salinity in fresh water marsh systems be mitigated by additional upstream releases? More scientific study is needed on these issues, but management of the reservoirs can not wait.

We have learned that management of natural resources is best done through a flexible, adaptive approach. I will be giving examples of the use of adaptive management in the Delaware Basin.

ASSESSING HISTORICAL AND CURRENT MULTI-STRESSOR IMPACTS ON ENVIRONMENTAL CONDITIONS OF THE DELAWARE RIVER ESTUARY. **Amanda A. DeSantis**, DuPont, Wilmington, DE; **Timothy J. Iannuzzi**, BBL Sciences; **Judi Durda**, Integral Consulting; **Damian V. Preziosi**, Integral Consulting; **David F. Ludwig**, BBL Sciences; **Ralph G. Stahl**, DuPont; **J.B. Ruiter**, DuPont; **Robert A. Hoke**, DuPont; and **Robert F. Schwer**, DuPont. amanda.a.desantis@usa.dupont.com. **Session 10**, 4:00, 1/24/07 (presentation #8).

Understanding the historical impacts of human and industrial development on urban rivers and their watersheds has become an important endeavor by the public and private sectors in the U.S. and elsewhere. Such assessments typically focus on identifying and then linking the suite of physical, chemical and biological stressors to current environmental conditions, and, where feasible, placing perspective on those stressors that have had, or may currently have, impacts on the rivers and watersheds. This approach and the information it provides helps scientists and decision-makers to ascertain what might be done to mitigate, remediate, restore, or otherwise improve conditions in the future – whether those include improvements to water quality, habitats, human use of the waterway, etc. Such an approach is currently being applied to the industrialized portion of the Delaware River Estuary. As part of this work, a historical and current impact assessment has been conducted, based on the synthesis of more than 200 years worth of data and several decades of studies for the Estuary, and the first phase of a multi-stressor risk characterization. Results from these efforts will be presented.

WORKING FOR CLEANER WATER WITH THE WATERSHED AMBASSADOR PROGRAM. **Helen Edwards**, Watershed Ambassador: WMA 16. hedwards@co.cape-may.nj.us. **Session E**, 2:10, 1/23/07 (presentation #95).

Through the NJ Watershed Ambassadors Program, twenty AmeriCorps members provide interactive watershed presentations, volunteer monitoring training and assist with watershed stewardship projects. The Ambassadors focus on community outreach, stewardship and assessment work.

This 15 minute presentation will provide an overview of the AmeriCorps NJ Watershed Ambassador Program and how it fits in with other Division of Watershed Management education and outreach programs. The New Jersey Watershed Ambassadors program is a community-oriented AmeriCorps environmental program designed to raise awareness about water issues in New Jersey. Through this program, AmeriCorps members are placed across the state to serve their local communities. Watershed Ambassadors monitor the rivers of New Jersey through Visual Assessment and Biological Assessment volunteer monitoring protocols. The members train community volunteers on how to use these two volunteer monitoring techniques. Watershed Ambassadors also make presentations to community organizations and schools. These interactive presentations provide information about water and watershed issues in New Jersey. The presentations can be tailored to the interests of the audience. Members educate students and



citizens about water issues and empower them to get involved in their watershed. In addition, they can assist schools with watershed stewardship projects through the community service component of the program. In addition, past examples of watershed stewardship action projects will be discussed.

**CAFO DESIGNS/ENVIRONMENTAL STEWARDSHIP AT DELAWARE PARK
"OBTAINING MULTIPLE GOALS ON A WILD AND SCENIC WATERCOURSE."**

James M. Eisenhardt, P.W.S., Duffield Associates, Inc., 5400 Limestone Road, Wilmington, DE 19808. JEisenhardt@duffnet.com. **Session C**, 9:55, 1/23/07 (presentation #86).

Delaware Park is a multi-dimensional establishment featuring horse-racing, casino slots, and an 18-hole championship golf course. The facility is nestled between the banks of the White Clay Creek (Wild and Scenic) and Mill Creek in Stanton, Delaware, in the highly urbanized reach of the Creek. It is located just upstream of the tidal influence of the White Clay Creek/Christina River. The facility was established in the early 1930's in the floodplain of the creeks and is prone to flooding. This presentation will review the multiple environmental stewardships Delaware Park has undertaken within this watershed to improve and restore multiple watershed improvement objectives. Some of these have included unique uses of BMP practices for water quality, floodplain reforestation, wetlands restoration, stream restoration and native upland meadow management.

As the first such establishment in the state directed to adopt a Concentrated Animal Feeding Operation (CAFO) under the guidelines of the Environmental Protection Agency (EPA), Duffield Associates designed a system for Delaware Park which focuses on improving water quality in the watershed system. The primary goal of the project was to address the concentration of non-point source pollution as a means to enhance watershed quality. The design became two-fold, in that one aspect focused on directing storm water runoff away from barn and stable areas, while a second facet was to treat runoff resulting directly from daily equine operations and removing this from the storm water system. BMPs typically considered for urban uses were adapted to this "traditional" agricultural operation. This tied in well with other urban storm water quality controls contemplated on site.

BMPs used included bio filtration basins, "rain gardens" and bio swales. Another feature was the installation of carport roofing over manure bins, limiting the potential for nutrient run off. The manure is collected on a routine basis and hauled off-site for recycling.

Other components of the stewardship included stream restoration along Mill Creek and creation of wetlands in the Mill Creek floodplain, stream restoration along the White Clay Creek in multiple locations, riparian forest restoration, upland meadow and upland forest restoration and storm water quality BMPs.

Various partnerships were established to meet multiple policy and program objectives in the watershed at this location. An example of a positive public-private approach to meeting common objectives.



ECOLOGICAL RESTORATION IN AN URBAN WATERSHED“LINKING SCIENCE, MANAGEMENT, POLICY AND FUNDING TO ACHIEVE GOALS”CASE STUDY – GLENVILLE James M. Eisenhardt, Duffield Associates, Inc. with the State of Delaware Department of Transportation Stanton, Delaware. jeisenhardt@duffnet.com. **Session 9**, 12:45, 1/24/07 (presentation #4)

This presentation will explore a case study (Glenville Wetlands Mitigation Bank) for “Ecological Restoration” in an urban watershed. It will focus on how creative project funding/partnering and management made multiple watershed improvement goals achievable for this watershed.

Duffield Associates, Inc. was contracted by the State of Delaware Department of Transportation to create and restore forested wetlands (about 30 acres) and upland riparian floodplains (about 25 acres) within an active floodplain/floodway of the Red Clay Creek at the fall zone (Piedmont/Coastal Plain regions). The project is actually located in a highly urbanized landscape, within a developed area that was once a neighborhood. The Glenville development was a typical neighborhood constructed during the 1950’s which bordered the Red Clay Creek in Northern Delaware, until a series of flood events led to the destruction and eventual buyout of approximately 85 % of the homes.

The initial focus of the project was to serve as a flood mitigation/storage program, and has since evolved into a broader project meeting multiple watershed improvement objectives such as wetlands creation/restoration/preservation. The Red Clay Creek runs adjacent to the west side of the site, while a tributary to Hershey Run borders the east side of the site. The basis of the wetland design was to tie-in with the existing wetlands associated with the tributary without substantially altering the stream morphology. The tie-in to existing adjacent wetlands while still maintaining the current stream hydrology has proven to be a difficult challenge.

The preliminary stage of the project involved razing 162 homes and associated infrastructure within the neighborhood. Approximately 40,000 cubic yards of material was excavated in the creation of a pilot project of six acres of wetlands, connecting to the existing wetland ecosystem. The excavated area was stabilized with native wetland seed mixes and approximately 18,000 native trees, including: sycamore, green ash, silver and red maples, tulip poplar, pin oak, and black willow. Although the persistence of invasive species throughout the constructed wetlands is a concern, the plantings seem to have adopted well during the first growing season. The new ecosystem has even attracted various herons and egrets, as well as a few bald eagle sightings.

Future plans include increasing the initial six acres to upwards of 30+ acres of wetland creation/restoration and 20 acres of preservation, as part of a Wetlands Mitigation Bank, as well as the incorporation of parkland with a potential boardwalk/trail and an interpretive education center.

NUTRIENT AND CARBON SEQUESTRATION OF SALT MARSH PLANTS IN THE FACE OF EUTROPHICATION AND SEA-LEVEL. Tracy Elsey, John L. Gallagher and Denise M. Seliskar, Graduate College of Marine and Earth Studies, University of Delaware, 700 Pilotown Road, Lewes, Delaware 19958. telsey@udel.edu. **Session 3**, 4:45, 1/22/07 (presentation #17).

Coastal wetlands are being subjected to two distinct yet co-occurring threats, eutrophication and sea-level rise. Nutrient loading can result in algal blooms, toxic algal productivity, and fish kills. The presence of fringing marshes reduces the intensity of algal blooms by sequestering nutrients



from tidewater, upland runoff, or groundwater. These wetland filters are lost when sea-level rises faster than marsh accretion and migration inland is impeded by development. Salt marsh plants increase marsh elevation through the deposition of organic matter from both above- and belowground parts. Storage of carbon above- and belowground by salt marsh plants aids in lowering atmospheric C and increasing surface elevation. Salt marsh species are being evaluated for sequestration rates of nutrients, carbon, and other elements. *Spartina alterniflora*, *Spartina patens*, *Baccharus halimifolia*, and *Juncus roemerianus* were selected for determination of seasonal uptake, storage, and loss of biomass, nitrogen, and carbon. Species such as *S. patens*, with the lower aboveground biomass tend to have higher belowground carbon storage capacity, whereas species such as *J. roemerianus* that have greater aboveground biomass have less belowground root biomass. *Juncus roemerianus*' green leaves had more nitrogen stored per unit area than the other three species. This nitrogen storage aboveground has the potential to be rather short term whereas longer term belowground storage of nitrogen in the roots is currently being investigated. *Baccharus halimifolia* has the highest concentration of nitrogen in the green leaves, however depending on the turnover and leaching rates longer term storage may occur in the fine roots, large roots, and trunk wood. The nitrogen storage capacity also correlates with the longer term storage of carbon, most of which occurs belowground. Determining the nitrogen and carbon storage capacity of these species is essential for predicting how they can mitigate eutrophication and sea-level rise. The seasonal loss of nutrients and carbon are also being determined through decomposition and microbial respiration studies. Results will be used for future studies on determining ability of different local genotypes of each of the four species to filter nutrients and build marsh elevation. Using this information, systems models will be developed to compare relationships among storage compartments of the plant species and their genotypic variants. The applications of these studies will be models for evaluation of improved storage of nutrients and carbon and recommendations for the use of specific genotypes to restore and manage fringe coastal habitats, which are being or will be subjected to eutrophication and sea-level rise.

DELAWARE CENTER FOR THE INLAND BAYS OYSTER GARDENING PROGRAM

John W. Ewart, Aquaculture & Fisheries Specialist Delaware Sea Grant Marine Advisory Program Graduate College of Marine and Earth Studies University of Delaware, 700 Pilottown Road, Lewes, DE 19958; **E. J. Chalabala** and **Jim Alderman**, Delaware Center for the Inland Bays (CIB), 39375 Inlet Road, Rehoboth Beach, DE 19971. ewart@UDel.Edu. **Session 8**, 10:00, 1/24/07 (presentation #46).

Delaware's three coastal bays have been experiencing the impacts of chronic eutrophication and sediment erosion resultant from several decades of sustained nutrient input and development from within the surrounding watershed. Field research sponsored by the Delaware Center for the Inland Bays has demonstrated that off-bottom oyster aquaculture methods offer a distinct advantage over bottom planting to maximize growth and survival. Growing public interest and participation in oyster gardening, modeled after similar programs in the Chesapeake Bay, has rapidly expanded the Center's four-year old community-based program to 47 locations involving the volunteer efforts of 70 individuals with homes in residential lagoon communities within the estuary.

The presentation discusses how deploying off-bottom oyster gardening sites throughout the Inland Bays is an effective means for engaging local community participation and for public education. Oyster gardening provides a unique opportunity to observe first hand many of the important ecological services provided by oysters and other bivalve shellfish. Oysters grow rapidly and their shell creates excellent refuge and nursery habitat for juvenile fish and small invertebrates. The relatively closed nature of the residential lagoon systems where the floats are deployed makes them ideal locations for establishing spawning sanctuaries to promote natural recruitment. Oyster



gardening also involves the participation of numerous other private and public sector community groups including volunteer organizations like AmeriCorps and the Upward Bound program for at risk youth. The system-wide distribution of oyster gardening locations creates additional habitat and a volunteer network that can assist with additional environmental monitoring needs in the estuary.

IMPROVING URBAN STORM WATER MANAGEMENT THROUGH STORM WATER RETROFITS. **Liz Feinberg**, Pennsylvania Environmental Council, 123 Chestnut Street, Philadelphia, PA 19106. Lfeinberg@pecpa.org. **Session C**, 8:35, 1/23/07 (presentation #82).

Improving urban storm water management to better control flooding, prevent stream degradation, and restore our water and watersheds is a challenge in our built out communities of southeast Pennsylvania. Pennsylvania Environmental Council received funding from the Pennsylvania's Coastal Zone Management Program to initiate a program that provided technical assistance to property owners and municipalities to develop model retrofit concepts at developed sites and in urban areas. The program has helped develop, document and showcase storm water management retrofit concepts and opportunities at developed sites in the Neshaminy, Chester-Ridley-Crum, Darby-Cobbs watersheds. Working with municipal officials and property owners, PEC's design team, including Cahill & Associates and Borton Lawson Engineering, developed site-specific retrofit design concepts to improve storm water management at 15 sites. Retrofit design concepts developed for these sites employ storm water best management practices (BMPs), including practices advocated in the Pennsylvania BMP Manual, with a focus on retrofitting parking lots and conventional storm water basins. Retrofit concepts developed for residential, commercial and light industrial sites address volume and quality issues incorporating a variety of BMPs. BMPs to be highlighted in the review of case studies include porous pavement systems, storm water infiltration practices, bioretention practices, non-structural vegetative BMPs and pollution control practices. This presentation highlights retrofit and BMP design concepts for these 15 sites and includes a discussion of retrofit costs and benefits.

EXELON-SCHUYLKILL RIVER RESTORATION FUND. **Tim Fenchel**, Schuylkill River National & State Heritage Areas, 140 College Drive, Pottstown, PA, 19464. tfenchel@schuylkillriver.org. **Session D**, 11:30, 1/23/07 (presentation #90).

The Schuylkill River Heritage Area and Exelon Nuclear developed a partnership in 2006 to create a Schuylkill River Watershed Restoration Program. The annual fund is part of a demonstration project for the water diversion program at Exelon Nuclear's Limerick Generating Station and is under the purview of the Delaware River Basin Commission.

As a part of Limerick's water diversion program, Exelon Nuclear uses various water sources to reduce the environmental impact of their daily water consumption. Exelon's yearly contribution to the fund is based on the amount of water that is not required to be pumped from the Delaware River to support the Limerick Generating Station's cooling needs. Parameters for Exelon's water usages are regulated by the Delaware River Basin Commission.

Exelon will contribute a portion of their savings annually to the restoration fund. The program is being overseen by the Schuylkill River Heritage Area, which distributes the money each year to non-profit organizations and government agencies to qualifying projects.

Unique partnerships were created to develop program criteria, rank and assess applications, and grant the awards. This committee is made up of representatives from Exelon, the Delaware River



Basin Commission, Philadelphia Water Department, Environmental Protection Agency, Department of Environmental Protection, and the Schuylkill River Heritage Area.

This year, three projects devoted to agricultural improvements, stream bank restoration, and headwaters restoration were selected. All projects benefit the entire watershed because they reduce the amount of run-off and pollution that enters creeks, and ultimately, the river, which is a source of drinking water for over one million people.

Projects selected were:

- Berks County Conservancy for stream bank improvements to diminish manure and sediment run-off from two farms in the Maiden Creek watershed, which flows into Lake Ontelaunee, a principal source of drinking water for Reading.
- Berks County Conservation District for improvements to a tributary of Irish Creek, addressing a non-point source of pollution concerns on a farm.
- Perkiomen Watershed Conservancy for reconstruction and stabilization of 600 feet of a headwater tributary of the Unami Creek, lessening sediment build-up and run-off to improve water quality in Perkiomen Creek and the Schuylkill River.

PCB CONCENTRATIONS IN THE AMBIENT WATERS OF THE DELAWARE ESTUARY AND COASTAL WATERS: IMPLICATIONS FOR TMDLS FOR PCBs.

Thomas J. Fikslin and **Gregory J. Cavallo**, Modeling & Monitoring Branch, Delaware River Basin Commission, 25 State Police Drive, West Trenton, NJ 08628.

Thomas.Fikslin@drbc.state.nj.us. **Session 5**, 10:45, 1/23/07 (presentation #36)

The development of TMDLs for the Delaware Estuary required several data collection and modeling efforts including the collection of low level (i.e., picogram per liter) data on the concentrations of PCB congeners in ambient waters of the estuary proper, tributaries and coastal waters for specification of boundary conditions and for use in model calibration. Calibration efforts required the analysis of both particulate and dissolved PCBs. Therefore, in order to collect a substantial particulate mass approximately 18- 20 liter samples were collected using Niskin Bottles at three locations on a transect in the riverine portion of the estuary, and at three locations across the shipping channel in Delaware Bay. An additional benefit of collecting large volume sample collection is lower detection limits. Estimated detection limits on the order of < 1 pg/L were routinely achieved for many of the 209 PCB congeners.

In June 2006, sampling was also conducted concurrently in the coastal waters at six locations including three locations at which samples were collected at multiple depths out to the edge of the continental shelf. All samples were processed to obtain dissolved and particulate fractions, and analyzed using EPA Method 1668A for all 209 congeners utilizing project specific quality control requirements provided at <http://www.state.nj.us/drbc/PCB-Modifications020305.pdf>.

The resulting data were analyzed for spatial patterns between the dissolved and particulate fractions, and the PCB homolog distributions. Concentrations decreased from the lower portion of the tidal river to the mouth of the bay with a shift from a larger proportion in the particulate fraction to a greater proportion in the dissolved fraction. Ocean samples were dominated by the dissolved fraction in both the surface and samples collected at other depths. PCB homolog distributions also showed a shift from a distribution dominated by the penta homolog in the tidal river to one dominated by the hexa homolog. The significant proportion of PCBs in the deca homolog that was observed in Zone 5 was not evident in the lower bay and coastal waters.



Implications for the TMDLs currently being revised by the Commission for the tidal Delaware River and Delaware Bay are discussed.

SCIENCE, SOCIAL SCIENCE, AND POLICY REGARDING DEVELOPING OFFSHORE WIND POWER IN THE DELAWARE ESTUARY REGION. **Jeremy Firestone**, College of Earth and Marine Studies, University of Delaware, Robinson Hall, Newark, DE 19716; and **Willett Kempton**, College of Earth and Marine Studies, University of Delaware, Robinson Hall, Newark, DE 19716. jf@udel.edu. **Session 10**, 4:15, 1/24/07 (presentation #60).

The Delaware Estuary is threatened by two consequences of CO₂ emissions—climate change (with consequent sea level rise) and ocean acidification. Electrical generation accounts for almost 40 percent of all anthropogenic carbon emitted into the atmosphere. Presently, wind power is the only cost-competitive renewable energy resource that is large enough to become a significant fraction of the electric supply within the time needed to address CO₂. Because Delaware and New Jersey have few windy sites on land, most wind power development must look offshore. The N.J. Blue Ribbon Panel on Offshore Wind has recommended a test wind farm off the New Jersey coast, and a Delaware RFP for new power has generated a proposal for 600 MW (capacity) of offshore wind in either Delaware Bay or off the Delaware Atlantic coast. With the passage of the Energy Policy Act of 2005, there is significant activity at the federal level as well.

This talk summarizes our analysis of the wind resource over the estuary and near-by Atlantic waters, and reviews wind power technology, the current regulatory framework, and environmental studies of wind power off the Danish coast. We analyze a recent poll on offshore wind power of coastal county residents and tourists at New Jersey beaches and present our new scientific survey results from Delaware on perceptions and knowledge of, and opinions toward, offshore wind power development in the Delaware Estuary and in the Atlantic ocean and, the anticipated effects (both pro and con), and anticipated changes in beach-going behavior that wind power development might engender. We conclude by considering the scientific, technical and socio-economic considerations most pertinent to the challenge posed by development of offshore wind power in the Delaware Estuary and off of the Delaware and New Jersey Atlantic coasts.

LANDSCAPE CHARACTERISTICS AFFECTING STREAMS IN URBANIZING SUBBASINS OF THE DELAWARE RIVER BASIN. **Jeffrey M. Fischer, Karen Riva Murray, Rachel Riemann** and **Peter S. Murdoch**, US Geological Survey, 810 Bear Tavern Rd, W. Trenton, NJ 08618; US Geological Survey, 425 Jordan Rd, Troy, NY 12180; and USDA Forest Service, Troy, NY, 12180. Fischer@USGS.gov. **Session 6**, 3:15, 1/23/07 (presentation #56).

Many Delaware River Basin subbasins are undergoing rapid urbanization. Effective management requires knowledge of specific landscape characteristics that influence stream ecosystems. This study's objectives were to (1) describe biological, physical, and chemical responses of streams along an urban intensity gradient, and (2) identify landscape characteristics influencing stream ecosystem responses. Forty-two streams were sampled during 2000-2001. Photointerpretation of digital ortho-quads provided landscape data from fine-resolution imagery for 32 watersheds.

Responses to urbanization (as determined by correlation with road density) included reduced numbers of sensitive invertebrate taxa, reduced habitat quality, and increased concentrations of dissolved nutrients, pesticides, and chloride. Landscape variables contributing significantly to one or more multiple regression response models included percent forested or developed land in the subbasin, percent forested or developed land in the buffer zone, and indicators of forest



fragmentation.

ATLANTIC STURGEON OF THE DELAWARE: HISTORICAL PERSPECTIVES AND CURRENT APPROACHES TO UNDERSTANDING HABITAT REQUIREMENTS.

Dewayne A. Fox, Phil Simpson, Lori Brown, Delaware State University, College of Agriculture and Natural Resources, 1200 N. Dupont Highway, Dover, DE 19901-2277; **Kevin J. Magowan**, and **Joseph E. Hightower**, U.S. Geological Survey, NC Cooperative Fish and Wildlife Research Unit, NC State University, Box 7617, Raleigh, NC, 27695-7617. dfox@desu.edu. **Session 6**, 3:30, 1/23/07 (presentation #61).

Historically, the Delaware River supported the largest known population of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Record harvest levels combined with poor water quality and low reproductive rates likely caused the collapse of the Delaware River Atlantic sturgeon population during the late 1800s. Over a century later, this population has not rebounded and like many other sturgeon species, their continued existence is threatened with extinction. Large scale habitat alterations (e.g., dredging) coupled with mortality due to by-catch and boat strikes are likely factors in the delayed recovery. As a result of their current status, there have been recent calls for an increased understanding of Atlantic sturgeon habitat requirements. To address this need we initiated a program in May 2005 to characterize habitat utilization patterns of Atlantic sturgeon using both telemetry and hydroacoustic techniques. Telemetry results suggest Atlantic sturgeon principally utilize main channel habitats that are comprised of coarse sediments. Telemetered Atlantic sturgeon enter the bay in the late winter and exit in the fall. During their residency in the Delaware River, Atlantic sturgeon exhibit greater activity during the early summer and fall periods, where movements occasionally exceeded 100 km/day and >8.5 km/hr. Likely spawning areas are much further upriver than reported during the peak of the fishery in the late 1800s and occur over hard bottom habitat. Recent work with hydroacoustic equipment (i.e., DIDSON and split-beam sonar) has shown much potential as a means for the rapid non-invasive sampling of sturgeon (*Acipenser spp.*) in the Delaware River. These techniques may be applied to large scale habitat and population assessment programs for these traditionally difficult-to-sample species. Given the logistical difficulties in sampling main-channel habitat in the Delaware River, a non-invasive sampling technique would be of much value to resource managers.

NJAS'S IMPORTANT BIRD AND BIRDING AREAS PROGRAM: A SCIENCE-BASED EFFORT LINKING MANAGEMENT AND POLICY TO CONSERVE IMPORTANT BIRD HABITAT.

Christina Frank, IBBA Coordinator, New Jersey Audubon Society, 600 Route 47 North, Cape May Court House, NJ 08210. Cristina.frank@njudubon.org. **Session 4**, panel, 1/23/07 (presentation #27).

The Important Bird and Birding Areas (IBBA) Program is a science-based program founded in grass-roots, public participation. This program's mission is to identify and conserve essential bird habitat throughout NJ. Conservation plans developed and implemented for important bird areas (IBAs) describe the key species and habitats in need of protection and detail conservation actions that communities can take to be stewards of their natural resources. This site-based conservation effort brings local stakeholders together and promotes local stewardship and advocacy. Involvement of citizens in the science and advocacy of bird conservation is the key to the success of the IBBA Program. Local residents and other volunteers have engaged in the process of identifying and collecting data on potential Important Bird and Birding Areas, and have also taken part in conservation planning, implementation and monitoring at demonstration sites. By also providing decision makers, generally non-scientists, with conservation plans based on scientific principals and data, we can increase the likelihood that conservation of natural resources are



considered in future policy decisions.

Birds are widely known to be effective indicators of biodiversity in flora and fauna – especially when used to identify sites for conservation. Thus, although selected sites are defined by bird communities, conservation of sites will ensure preservation of many other animal and plant species. By encouraging monitoring and protection of sites, the program will contribute to maintaining regional biodiversity. IBA sites become part of a wider, integrated approach to conservation and sustainable development that focuses on species, habitats, and people.

IBAs are recognized world-wide and they attract interest from birdwatchers, conservationists and planners. They become travel destinations and targets for ecotourism projects and scientific study. Governments and donor agencies recognize the value of IBAs, so these sites attract financial incentives or direct funding for sympathetic development and management. IBBA has become an important reference for birders, students, scientists, conservationists, citizens groups, state and federal agencies and regulators, land-use planners and policy makers. This project supplies them with crucial information to direct acquisition, stewardship, and planning efforts for watersheds and natural habitats. In addition to providing habitat for the conservation of rare, threatened and endangered bird species, the IBBA project will result in more open space for outdoor recreation.

New Jersey Audubon Society collaborates with many organizations because of the importance of IBA site identification and prioritization for their conservation efforts. These groups include the National Audubon Society, the National Fish and Wildlife Foundation, the US Fish and Wildlife Service (USFWS), NJ Department of Environmental Protection (NJDEP), The Nature Conservancy (TNC), Pinelands Preservation Alliance (PPA), Delaware River Keeper (DRK), New Jersey Public Interest Research Group (NJPIRG), Association of NJ Environmental Commissions (ANJEC), New Jersey Conservation Foundation (NJCF), Trust for Public Land (TPL), and the American Littoral Society (ALS). NJAS consults with these organizations to help guide private land acquisitions, policy advocacy, state land acquisitions through Green Acres and regulatory protection through the Landscape Project, municipal planning and zoning and support for Smart Growth and watershed protection.

MARINE GEOLOGIC AND GEOPHYSICAL INVESTIGATIONS OFFSHORE OF CAPE MAY, NEW JERSEY: METHODOLOGY, REPRESENTATIVE DATA, AND PRELIMINARY FINDINGS. **Andrea L. Friedman, Jeffrey S. Waldner, and Jane Uptegrove**, New Jersey Geological Survey, P.O. Box 427, Trenton, NJ 08625; and **J. Bailey Smith**, U.S. Army Corps of Engineers, Philadelphia District, 100 Penn Square East Philadelphia, PA 19107. Andrea.Friedman@dep.state.nj.us. **Session 1**, poster, 1/23/07 (presentation #51).

The Inner Continental shelf offshore of Cape May, New Jersey is characterized by marked spatial variations in sediment type and seafloor morphology. Sedimentation patterns exert significant influence on estuarine benthic habitat and community composition, contaminant transport, and relevant physical and chemical gradients; therefore, a geologic framework of the Cape May region is useful to understand geologic controls on the coastal and estuarine processes in the southeastern reach of the Delaware Estuary. The New Jersey Geological Survey (NJGS) has conducted geological and geophysical investigations toward developing this regional geologic framework.

High-resolution seismic profiles, in a ½ mile reconnaissance-scale grid, cover ~ 90 square miles offshore of Cape May. Thirty 20-ft vibrocores ground-truth the seismic data and help to assess lithology and grain size distribution. Approximately one third of the coverage is in waters southwest of Cape May at the southeastern reach of the Delaware Estuary. Additional seismic



data and vibracores will be collected in the summer of 2007. Integrated geophysical and geologic technologies will facilitate development of a 3-dimensional geologic map. This poster displays representative data and preliminary findings.

The research focuses on identifying and delineating potential sources of sand for beach nourishment projects. NJGS works with the New Jersey Department of Environmental Protection, Division of Engineering and Construction and the U.S. Army Corps of Engineers (USACE) in support of the USACE/NJ cooperative shore protection and regional sediment management programs. These data help the USACE to develop a coring strategy to further characterize Cape May area sand resources in selected high-prospect areas.

High-resolution seismic data sets are extremely useful for regional-scale geologic mapping. Research that integrates geologic and geophysical data is both beneficial and cost-effective for all parties. The synergy of both the geologic and biologic data will yield a better characterization. It is essential that we facilitate the sharing of these data so we may gain the best understanding of the controls and dynamics of the estuary zone.

A FRESHWATER MUSSEL PROPAGATION PROGRAM FOR RESTORING AQUATIC ECOSYSTEMS AND ENDANGERED SPECIES. Catherine M. Gatenby, Matthew A. Patterson, White Sulphur Springs National Fish Hatchery, United States Fish and Wildlife Service (USFWS), 400 E. Main Street, White Sulphur Springs, WV 24986; and **Danielle A. Kreeger,** Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar Street, Suite 202, Wilmington, DE 19801. Catherine_Gatenby@fws.gov. **Session 8**, 10:30, 1/24/07 (presentation #50).

Freshwater mussel populations are imperiled world-wide. In the United States, approximately 70% of native species are in serious decline because of chronic habitat degradation, toxic spills, and the invasion of the exotic zebra mussel. Approximately 23% of native freshwater mussels are federally endangered and another 7% are already extinct. Freshwater mussels are suspension-feeders equipped with very large gills; thus, they can filter 1000's of gallons per day, providing clean water and suitable habitat for other species. As they decline, however, the quality of that habitat declines. Regrettably, little is known how these population declines will impact existing water quality and riverine processes.

All 70 recovery plans for endangered mussel species call for propagation and reintroduction of populations to restore endangered species. These same recovery plans also call for restoration of critical habitat prior to reintroduction of target endangered species. A nation-wide conservation effort of the USFWS, therefore, includes the culture and propagation of mussels for restoration of endangered species, augmentation of populations to prevent the listing of species, and restoration of mussel bed habitat for the ecosystem services they provide as critical habitat to federally endangered species AND as habitat for fish. The goals of this conservation efforts are to protect and restore freshwater mussels, to protect and restore water quality, and enhance overall aquatic ecosystem health. Additionally, propagation technology is viewed as a mitigation tool for mussels killed by toxic spills or for mitigating the loss of a resource due to in-stream activities such as road/bridge construction and channel maintenance for navigation.

Freshwater mussels have many unique life history traits. Unlike marine bivalves, freshwater mussels require a fish host to complete their life cycle and they brood their larvae. These characteristics of their life history must be considered when developing propagation protocols and relocation management plans for freshwater mussels. I will provide an overview of propagation



and relocation technology to restore endangered species, restore habitat, and restore our nation's fishable rivers. I will also discuss why we care about these invertebrates that are often unnoticed in our rivers and streams, what we know about their declines, what we can do to help them, and what do we still need to know. I will discuss management challenges with respect to propagation and release/reintroduction of mussel species, and opportunities for restoration and recovery of riverine habitat.

PARASITE BURDEN ON THE BLACK-NOSED DACE RHINICHTHYS ATRATULUS AT FOUR SITES IN THE DARBY CREEK, PA. WATERSHED. Kathryn Goddard and Steven Ordog, Ursinus College, Collegeville, PA; Kelly Bemis, Muhlenberg College, Allentown, PA; and Julius Cook, Philadelphia Community College, Philadelphia, PA. kgoddard@ursinus.edu. Session 2, poster, 1/23/07 (presentation #70).

We conducted a preliminary investigation of the parasite burden on a single species of fish at four sites in the Darby Creek water shed. Various methods are employed to assess water quality in aquatic environments. The number and type of parasites affecting the fish community is one of those methods. The basis for this idea is that high levels of pollution-induced stress on the organism translate into a greater vulnerability to parasites.

Conversely, it has also been found that extremely polluted habitats can adversely affect even the parasite community. Reduced numbers of fish individuals and fish host species due to poor water quality can reduce the number and variety of parasites. Further, many parasites have complex life cycles which require bird hosts, fish hosts, and snail hosts to complete their life cycle. The lack of all three hosts due to both natural and manmade factors must also be considered.

To make initial observations about the parasite load in fishes in different parts of Darby Creek system, we focused on the black-nosed dace (*Rhinichthys atratulus*) due to its presence throughout the watershed. We examined the number of three types of trematodes white grubs (*Posthodiplostomum minimum*), yellow grubs (*Clinostomum marginatum*), and a black spot or black grub (*Uvulifer ambloplitis* or *Neascus pyroformis*) in 30 individuals from each site. The stream sites were chosen because each is exposed to different levels of urbanization and the corresponding anthropogenic effects. The sites range from a first order stream at the top of the watershed to a site is located downstream of an EPA designated superfund site, close to where the Darby meets the Delaware River. It appears that two of the parasite species do not vary significantly between sites. The black grub, however, is significantly more abundant (0.05 level) at the site closest to the superfund site, despite the apparent lack of snail hosts anywhere nearby. We will increase our sample size to further test whether differences occur between sites. We plan to add water quality analysis and fish tissue contamination analysis to further examine the health of the fish in the Darby Creek system. The integration of our different types of data as they are collected, and development of collaboration with researchers using different techniques will be the most cost-effective way to increase our understanding and provide the public with information about the Darby Creek watershed.



POLYBROMINATED DIPHENYL ETHERS (PBDES) IN FISH FROM THE DELAWARE ESTUARY. Rick Greene, Delaware Department of Natural Resources and Environmental Control, Silver Lake Office Plaza, Suite 220, 820 Silver Lake Boulevard, Dover, DE 19904; Gary Buchanan and Bruce Ruppel, New Jersey Department of Environmental Protection, 401 E. State Street, P.O. Box 409, Trenton, NJ 08625. richard.greene@state.de.us. Session 10, 3:15, 1/24/07 (presentation #24).

PBDEs are a group of organohalogen chemicals that were introduced into commerce approximately 30 years ago as flame retardants. They have been used in thousands of products to prevent fires, including polyurethane foam in furniture and seating, textiles and fabrics (e.g., children's PJs), printed circuit boards, and coatings on electrical wire. Not long after their introduction into the marketplace, PBDEs began showing up in environmental samples. At present, they have been documented in human blood and milk, terrestrial and aquatic mammals, fish, birds, plants, air, soil, aquatic sediments, and water all over the globe, often showing an exponential increase over time. PBDEs, like PCBs and dioxins and furans, are complex mixtures of congeners with a wide range of physical and chemical properties. Although a substantial amount of information has been generated on PBDEs over the last decade, PBDEs are still considered an 'emerging contaminant' because they are not routinely monitored, their fate & transport is not fully understood, and consensus has not been reached concerning their toxicity.

This presentation summarizes the data that have been collected by the States of New Jersey and Delaware and by the Academy of Natural Sciences on PBDEs in fish collected from the Delaware Estuary, tributaries of the Estuary, and the coastal waters near the mouth of the Estuary. Over the period September 2003 through November 2005, a total of 110 fish samples representing 14 different species were collected and then analyzed for PBDEs. PBDEs were detected in all samples, ranging from a minimum of 0.6 ng/g ww fillet to a maximum of 290.7 ng/g ww fillet. Apparent relationships, if any, between PBDE concentrations in fish and trophic level, lipid content, fish length, and surrounding land use are discussed. In addition to the existing data, we also identify fish samples that have been recently collected in the Delaware Estuary for which PBDE results are pending within the coming months. PBDE data for Delaware Estuary fish are placed into broader perspective through comparison to data collected elsewhere in the U.S. and abroad. Finally, we discuss several data gaps that should be considered by the scientific and management community. Continued monitoring is needed for these and other emerging contaminants, as well as continued cooperation and sharing of resources between states. Additional toxicity data are needed for these and other emerging contaminants in order to determine potential risks to ecosystems and human health. Appropriate management decisions can then be made with the combined monitoring and toxicity data.

THE WIRELESS REVOLUTION IN ECOTOURISM COMMUNICATION. Ed Grusheski, Philadelphia Water Department, 1101 Market Street, Philadelphia, PA 19107; and Craig Johnson, Talisman Interactive, 4169 Main Street, Philadelphia, PA 19127. Ed.Grusheski@phila.gov. Session F, 4:50, 1/23/07 (presentation #101).

We are in the midst of a paradigm shift in wireless communication. Our cell phones are becoming our cameras, mp3 players, and PDAs. They are now becoming a new means for professional and public education, communication and wayfinding. Cell phone and wireless kiosk technologies give individuals and institutions promoting ecotourism, innovative methods to tell their stories and connection with their communities.



One of the great challenges and opportunities for “Ecotourism Communication” is to provide on-site information outdoors in natural, cultural and built environments. Traditional interpretative and wayfinding techniques and signage are static and difficult to maintain. Given the many constraints of traditional signage, several emerging wireless technologies are heralding the coming of a communication revolution for on-site interpretation, exploration and wayfinding for institutions that promote ecotourism.

The new GPS integrated, high bandwidth cell phones, wireless PDAs and sustainable outdoor kiosks are transforming how we will learn and find our way “outdoors.”

Innovative projects demonstrating these remarkable technologies have been implemented by the collaborative efforts of the Philadelphia Water Department and Talisman Interactive. Ed Grusheski, the General Manager Public Affairs for the PWD will speak about the “Ecotourism Communication” challenges and opportunities for outdoor education and interpretation. Craig Johnson, Principal at Talisman Interactive, will show examples of informational programs associated with the Fairmount Water Works Interpretative Center that use new communication and design methods such as sustainable outdoor kiosks and interactive cellphone “soundtrails.” Attendees will learn how they can use and benefit from these new techniques to tell their stories and communicate to their communities and the general public.

THE TRANSITION FROM AGRICULTURAL LANDS TO WETLANDS DURING SEA LEVEL RISE: MANAGING THE ECOLOGY AND ECONOMICS. Jennifer Halchak, John L. Gallagher and Denise Seliskar. College of Marine and Earth Studies, University of Delaware, 700 Pilottown Road, Lewes, DE 19958. jhalchak@UDel.Edu. Session 3, poster, 1/23/07 (presentation #31).

The Earth is entering a period of significant global climate change. These changes are increasing the rate of transition from terrestrial to marine ecosystems as mean sea level rises. Tidal flooding along the coast significantly impacts farm lands by salinizing and water logging the soils. As flooding becomes more frequent these fields cannot support traditional crops and the economy as well as the ecology of the area suffers. With continuing sea level rise building dikes could delay the process, however, the best management practice for these areas may be a calculated retreat, allowing the ecosystem to naturally transition. During this interim period, when the fields would otherwise be barren, they can be of economic and ecological benefit by growing Seashore Mallow (*Kosteletzkya virginica*), a halophyte which tolerates salinities of coastal ocean water.

Seashore Mallow produces numerous products of economic value. The oilseeds can be used for biodiesel production. Seashore Mallow is a perennial plant, lasting up to a decade, which reduces energy requirements for production and decreases the global carbon dioxide balance. Currently, *Kosteletzkya virginica* produces 22 bushels/acre, increasing as the plants mature. Each seed contains approximately 18-20% oil. The oil is similar in composition to cottonseed oil, which is made into biodiesel fuel. Seashore Mallow oil is extracted with hexane and the fatty acid esterified with methyl alcohol. The seed meal which remains is high in protein (approximately 32%) and fiber and can be used for animal feed. Fatty and amino acid profiles are very suitable for biodiesel and feed production. *Kosteletzkya virginica* stems are rich in lignocelluloses, used for the production of ethanol or other alcohols. After five years of cultivation the fleshy roots can be harvested and a gum extracted for industrial use. Seashore Mallow can be handled with traditional farm equipment, as demonstrated in a 2.5 acre test field, in Sussex County, DE, using a conventional row grain planter with sorghum plates in the hoppers. The Halophyte Biotechnology Center presently holds hundreds of seeds derived from callus cultures which are regenerated to be



tested for somaclonal variances. There are plans to conduct experiments involving irrigation efficiency, fertilizer use, population comparisons, and salinity effects which would further agronomy of this plant and increase marketability. Alternative methods of extraction and esterification will be tested to determine the most efficient and cost effective methods of producing Seaside Biodiesel.

USING THE BACKYARD WILDLIFE HABITAT PROGRAM TO ADDRESS NONPOINT SOURCE POLLUTION. **John Harrod**, Delaware Nature Society, P.O. Box 700, Hockessin, DE 19707. john@delawarenaturesociety.org. **Session E**, 1:50, 1/23/07 (presentation #94).

Though water quality concerns are a reality, citizens are not always interested in them. Watershed residents need to connect personally with the issues in order to desire affecting change. The Delaware Nature Society (DNS) utilizes the National Wildlife Federation's Backyard Wildlife Habitat program address water quality education through people's interest in wildlife. The program and its subsets, schoolyard habitats and community habitats, are used to teach how changes to home and garden management practices can not only enhance habitat for wildlife, but also affect non-point source pollution. The Delaware Nature Society added components to the program to make them more useful to Delaware residents, including DNS trained Habitat Steward Volunteers that consult for free on location to suggest site specific actions that may be taken.

SUCCESSFUL STRATEGIES FOR MARKETING AND COMMUNICATION. **Christine Heenan**, Clarendon Group. cheenan@clendongroup.net. **Sessions A & B**, 1:00-5:00, 1/22/07 (presentations #79 and 80).

Convincing key audiences to act in support of conservation and environmental protection -- be they town zoning boards passing ordinances to protect wetlands or suburbanites forgoing lawn chemicals -- relies on reaching them with clear, persuasive communications and strategies for capturing their attention. In addition, media can be an important conduit for reaching and educating consumers, but reporters and editors often don't understand the nature of the problem, or the substance of the solutions. This two-part workshop will give participants important background on successful communications strategies, provide effective tools for reaching and persuading key audiences, and allow participants to "test drive" those tools through case study exercises drawn from their own day to day work. Participants are asked to come to the workshop with an actual communications challenge or project in mind, to build on in the afternoon session.

MITIGATING FOR COOLING WATER INTAKES – IS THE ESTUARY ENHANCEMENT PROGRAM OF DE BAY WORKING? **Ralph Huddleston**, Carpenter Environmental Associates, for the Delaware Riverkeeper Network, 300 Pond Street, Second Floor, Bristol, PA 19007. re.huddleston@cea-enviro.com. **Session 9**, 1:00, 1/24/07 (presentation #5).

Pursuant to a permit, Public Service Electric and Gas Company (PSEG) has undertaken a series a wetland restoration program and a baywide biological monitoring program in an effort to offset the loss of over 3 billion fish killed each year at its Salem nuclear generating station. In 2003, with support from the Environmental Protection Agency, the Delaware Riverkeeper Network undertook an assessment of the success of these efforts.

PSE&G has undertaken restoration efforts at 3,723 acres of *Phragmites*-dominated wetlands in New Jersey, 4,398 acres of *Phragmites*-dominated wetlands in Delaware, and 4,398 acres of diked salt hay farms in New Jersey. The wetlands program included applying herbicides, prescribed burning, and mowing to *Phragmites*-dominated marshes and opening former salt hays farms to



tidal inundation. At the *Phragmites* dominated sites, the *Phragmites* eradication program reduced *Phragmites* coverage. However, the sustainability of the *Phragmites* reduction appears to be dependent on annual herbicide treatment.

The restoration of the *Phragmites* dominated sites has not increased fish utilization. Monitoring at Alloway Creek includes several sites (a) dominated by *Phragmites*, (b) dominated by *Spartina* or (c) under treatment for *Phragmites* removal. 2000 monitoring showed that within the Alloway Creek study area, fish abundance was similar at all three types of sites; in 2002, fish abundance at the *Phragmites* dominated site was approximately twice as great as that seen at *Spartina* dominated site and the treated site. Reproduction of mummichog and Atlantic silverside was seen in the *Phragmites* dominated sites both prior to and following the treatment of *Phragmites* and growth patterns were seen to be similar for mummichog and Atlantic silverside both pre and post treatment. Studies also indicate that mummichog use *Phragmites* as a food source.

DELAWARE'S WETLAND MONITORING AND ASSESSMENT PROGRAM: A SCIENCE-BASED APPROACH TO PRIORITIZE RESTORATION AND PROTECTION.

Amy Jacobs, Evan Rehm and Debora Fillis, Delaware Department of Natural Resources and Environmental Control, Watershed Assessment, 820 Silver Lake Blvd., Ste 220, Dover, DE 19904. amy.jacobs@state.de.us. Session 3, 4:15, 1/22/07 (presentation #18).

The state of Delaware's Wetland Monitoring and Assessment Program collects data on the ecological condition of wetlands on the watershed level and then translates this information to management responses to set achievable goals. The program uses a science-based process to evaluate the current state of wetland resources which has not previously been performed, and then uses this information to determine appropriate and achievable goals for restoration and protection.

The Appoquinimink, Murderkill, and St. Jones subwatersheds of the Delaware Estuary will be sampled in 2007 and additional subwatersheds in subsequent years. This information evaluates the condition of wetlands compared to an undisturbed or reference condition using two levels of assessment methods: the Delaware Comprehensive Assessment Method and the Delaware Rapid Assessment Method. Assessment protocols have been developed for all non-tidal wetland types in the Outer Coastal Plain physiographic region and are currently being developed for tidal wetlands.

Assessments are conducted using a probabilistic sampling design so that results can be extrapolated from a set of random sites to the watershed level. In addition to using the results to report on the condition of wetlands, we determine the dominant stressors that are impacting sites and lowering condition. For example, in the Nanticoke watershed, we categorized stressors into hydrologic alterations and vegetative alterations. By combining these 2 categories into a matrix we have identified 8 different combinations of hydrologic and vegetative alterations and subsequently 8 different management responses to improve or protect the condition of wetlands in these categories. Using landscape models that predict wetland condition based on surrounding land use features, we have extrapolated these management categories to the watershed to identify the types of management responses that are needed in different parts of the watershed. Combining the results of the Wetland Monitoring and Assessment Program with trend data on wetland loss for the various wetland types in the watershed will provide a holistic picture on the current state of wetland resources in a watershed. This information will be used in combination with other conservation strategies such as Green Infrastructure and State Resource Areas to develop a comprehensive restoration strategy for a watershed.



A similar approach will be used in subwatersheds in the Delaware Estuary. Restoration strategies will be developed for each subwatershed to improve water quality and wildlife habitat and support initiatives such as Pollution Control Strategies and the state Wildlife Action Plan. The protocols of the Delaware Wetland Monitoring Program could be adapted to other states in the watershed to produce a comprehensive assessment of the condition of wetlands, serve as baseline data to monitor changes in the condition, and set goals to assess progress towards improving wetland health and sustainability.

CORPORATE ENVIRONMENTAL STEWARDSHIP PROGRAM -A PARTNERSHIP FOR CONSERVATION AND ECONOMIC GROWTH. **Jennifer Jones**, Habitat Coordinator, Partnership for the Delaware Estuary, Inc., 110 S. Poplar Street, Suite 202, Wilmington, Delaware, 19801. jjones@DelawareEstuary.org. **Session D**, 10:30, 1/23/07 (presentation #87).

The Partnership for the Delaware Estuary is a regional, nonprofit organization based in Wilmington, Delaware. Our mission is to lead collaborative and creative efforts to protect and enhance the Delaware Estuary and its tributaries for current and future generations. The Delaware Estuary is one of 28 estuaries recognized by the United States Congress as being nationally significant.

Over the last ten years, the Partnership has focused much time and effort on reducing the levels of stormwater runoff pollution that enter the region's rivers and streams in urban and suburban areas; building awareness and stewardship of the natural, cultural, and recreational resources of the Delaware Estuary; and educating our residents about the types of activities they can become involved in to protect, enhance, and sustain our environment.

The Partnership will discuss our efforts promoting environmental stewardship to corporations in the region.

The Partnership's Corporate Environmental Stewardship Program (CESP) is designed to promote corporate, business, and industry participation in the reduction of nonpoint source pollution through habitat restoration on corporate property. It is the only program in the Delaware Estuary region that works with corporations in this capacity. More than 80 companies have attended CESP workshops and more than 20 corporations have participated in the program. Today the program has evolved into a self sustaining membership program and continues to grow each year.

MONITORING SHOREBIRD POPULATIONS IN DELAWARE BAY USING MARK-RECAPTURE METHODS. **Kevin S. Kalasz**, Delaware Natural Heritage and Endangered Species Program, Division of Fish and Wildlife, 4876 Hay Point Landing Rd, Smyrna, DE 19977; **Phillip Atkinson** and **Nigel Clark**, British Trust for Ornithology; **Amanda Dey**, New Jersey Division of Fish and Wildlife; **Simon Gillings**, British Trust for Ornithology; **Larry Niles**, Conserve Wildlife Foundation; and **Ron Porter**. kevin.kalasz@state.de.us. **Session 6**, 2:15, 1/23/07 (presentation #40).

The Delaware Estuary is an exceptional location to monitor migratory shorebirds. It is one of the most important stopover sites in North America due to the presence of large concentrations of several shorebird species during spring migration. At times, the majority of an entire species population may be in the Estuary, possibly even at a single site. This presents a unique opportunity to monitor shorebird populations since it is the only time during the year so many birds can be observed at a single location. However, the complexity of the system presents unique challenges to monitoring species populations and the resources they need.





Mark-recapture through flagging-resighting efforts is one of the many ways we are linking science to management and policy. Mark-recapture studies are central to monitoring shorebirds in Delaware Bay and methods have been greatly improved in recent years with the use of coded leg flags. Every Red Knot (*Calidris canutus*), Ruddy Turnstone (*Arenaria interpres*) and Sanderling (*Calidris alba*) caught during monitoring activities in Delaware Bay are banded and flagged with individually-coded leg flags. Therefore, each bird has a unique code that can be easily read in the field allowing us to obtain recapture information without actually capturing the birds. This has greatly increased the amount and quality of information we can obtain on each individual while reducing the number of birds captured each year limiting research impacts to shorebird populations.

Since 2003, 4632 red knots, 2850 ruddy turnstones, and 2782 sanderling have been fitted with coded flags. A total of 24,791 observations of individually marked birds since 2004 have been recorded during resighting efforts. These data have allowed us to determine arrival and departure patterns, detect movement patterns within the Bay, and derive stopover duration. Stopover duration can be further used to refine estimates of stopover population size for marked species.

Monitoring the health and condition of Delaware Bay for shorebirds is not limited to resighting flagged birds. Additional efforts to monitor weight gain, egg density, horseshoe crab spawning activity, and horseshoe crab populations are continuing to provide as complete a picture as possible. All of these datasets are needed to begin to understand the complexity of the Delaware Bay stopover. Integrating all of these datasets in a quantifiable and meaningful way will ultimately provide achievable targets for horseshoe crab and shorebird conservation.

INTEGRATED COASTAL OCEAN OBSERVING SYSTEMS: AN EXAMPLE FROM THE CHESAPEAKE BAY. Michael T. Koterba, Northern Co-Director, Chesapeake Bay Observing System, 410 Severn Avenue, Suite 107A, Annapolis, MD 21403. Michael.Koterba@noaa.gov. Plenary, 7:30 pm, 1/23/07 (presentation #1).

Integrated long-term observing systems in inner coastal and near-shore ocean waters are essential to improve our ability to forecast physical conditions and manage natural resources in coastal zones. Establishment, operation, and maintenance of these observing systems coupled with unfettered access to the resultant data and information can (a) enhance the safety and efficiency of marine operations, (b) improve prediction of natural hazards (including tsunamis and storm surges), (c) increase the accuracy of predictions of climate and sea-level changes, (d) enhance national security, (e) reduce public health risks, (f) help protect and restore healthy ecosystems, and (g) sustain and restore living marine resources. Immediate results can lead to improvements in (a) efficiencies in shipping, fishing, energy, tourism, and other industries, (b) search-and-rescue operations, and (c) monitoring and clean-up of discharges and spills in ocean and coastal waters. Although the benefits of developing such (observing) systems are clear, they present a challenge in a climate of limited resources.

The Chesapeake Bay Observing System (CBOS) is being developed as a sub-regional coastal ocean observing system of the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA) and the U.S. Integrated Ocean Observing System (IOOS). Its development is being accelerated through the use of three prototype demonstration projects. These prototype projects target open and deep waters in the main stem and estuaries of the Chesapeake Bay, both areas of concern with limited near-real-time observations. Although somewhat limited in scale and effort, each of these demonstration projects was designed to (a) build partnerships among key data users and providers, (b) establish standards for the acquisition and dissemination of observational,



quality-control, and meta- data, (c) help identify additional data needs, and (d) facilitate the creation of a governance and operational foundation. The focus of this presentation will demonstrate the benefits of an integrated and interoperable observing system, and show how these three projects, as proofs of concept, will help promote the expansion and development of an observing system and the associated collaboration necessary for sustainability.

FROM LOCAL TO REGIONAL: CONTRASTING THE WATER PROCESSING AND RESTORATION POTENTIAL OF NATIVE BIVALVES THROUGHOUT THE DELAWARE ESTUARY AND ITS WATERSHED. **Danielle A. Kreeger**, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar Street, Suite 202, Wilmington, DE 19801; and **Catherine M. Gatenby**, White Sulphur Springs National Fish Hatchery, United States Fish and Wildlife Service (USFWS), 400 E. Main Street, White Sulphur Springs, WV 24986; DKreeger@DelawareEstuary.org. **Session 8**, 10:45, 1/24/07 (presentation #63).

Bivalve shellfish feed at the base of the food chain and often achieve a population biomass exceeding that of all other aquatic animals combined. Where abundant, they can affect and even “regulate” key aspects of the structural and functional ecology of the system. This is equally true for marine and freshwater habitats, and was perhaps once true in the Delaware Estuary where rich populations of oysters, clams and mussels are believed to have lived throughout tidal and non-tidal areas. Today, bivalve populations are impaired throughout much of the system, but billions of individuals are estimated to still exist for many species. Although serious data gaps exist, the total population biomass was estimated for three prominent species: the freshwater mussel *Elliptio complanata*, the brackish/estuarine mussel *Geukensia demissa*, and the estuarine oyster *Crassostrea virginica*. For each species, physiological data on summer clearance rates were integrated with population biomass estimates to calculate the potential water processing during summer for populations of each species. Although oysters are reported to have slightly greater weight-specific clearance rates, their total water processing was estimated to be comparable to freshwater mussels (*E. complanata*) but was dwarfed by ribbed mussels (*G. demissa*) at today’s population levels.

A more rigorous analysis would be needed to determine the actual ecosystem importance of different bivalve species by considering the system’s hydrodynamics, residence time, turbidity and water quality in relation to the population biomass for these animals. Nevertheless, it appears that oyster biomass will need to be further increased to have a more substantial impact on overall water processing. Most importantly, oysters are clearly not the only native species worthy of conservation and restoration. Based on these estimates, native species of mussels, along with perhaps dozens of other species, can play prominent roles in ecosystem services. Wherever they are abundant, they likely improve water quality, enhance the transformation of suspended matter, and enrich and stabilize bottom and shoreline habitats to the benefit of other fauna and flora. Although they lack the historical or (direct) economic stature of oysters, they provide similar ecosystem services while perhaps offering advantages such as being disease-resistant and having a wider geographic range. In addition to continuing to strengthen oyster population biomass in Delaware Bay and its fringing marshes, an expansion of the focus to include the preservation, enhancement and restoration of other native bivalves would provide new opportunities to promote the integrated ecosystem health from the headwaters to the mouth of Delaware Bay.



ASSESSING HORSESHOE CRAB SPAWNING HABITAT SUITABILITY OF DELAWARE BAY USA BEACHES. Richard G. Lathrop, Michael Allen and Aaron Love, Center for Remote Sensing & Spatial Analysis, 14 College Farm Rd., Rutgers University, New Brunswick, NJ 08901-8551. lathrop@crssa.rutgers.edu. **Session 6**, 3:00, 1/23/07 (presentation #44).

The beaches of Delaware Bay, on the United States Middle Atlantic seaboard, provides essential spawning habitat for horseshoe crabs, *Limulus polyphemus*. Visual interpretation of high resolution digital color infrared aerial photography (acquired in 2002) was used to map beach habitat of the Delaware and New Jersey shorelines of Delaware Bay. Based on the remotely sensed assessment, we classified the Bayshore's beaches into five categories of horseshoe crab spawning habitat suitability: optimal, suitable, less suitable, avoided and disturbed. Approximately 45% and 21% of Delaware's and New Jersey's Delaware Bay shoreline, respectively, was classified as optimal or suitable spawning habitat. Comparison of the habitat suitability mapping results with the U.S. Geological Survey Horseshoe Crab Beach Survey Index of Spawning Activity (ISA) for the years of 1999-2004 did not show a clearcut relationship between mapped habitat type and ISA values. These results suggest that horseshoe crabs were using all sand or predominantly sand beaches without regard to the subtle composition differences that were interpreted and mapped. Modeled wave fetch length was used to investigate the potential impact of shoreline exposure to wave energy on spawning habitat suitability. During the crucial May-June spawning period, the prevailing wind direction is from the SSW, leading to higher wave energies along the New Jersey side of Delaware Bay. Conversely during this same May-June spawning period, the Delaware beaches are in the lee of the prevailing wind and generally receive lower wave energy. These results suggest that wind conditions may result in wave energies sufficiently high to inhibit the spawning activities of horseshoe crabs on some New Jersey beaches.

REGIONAL RESTORATION PLANNING FOR THE DELAWARE ESTUARY. Krista Laudembach-Nelson, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar Street, Suite 202, Wilmington, DE 19801. Knelson@DelawareEstuary.org. **Session 9**, panel, 1/24/07 (presentation #78).

The Delaware Estuary is a unique natural resource that faces the challenge of competing interests and various political boundaries. The estuary region encompasses three states, two regions of the US Environmental Protection Agency and a diverse array of other federal and local governmental entities. The Delaware Estuary Regional Restoration Plan (RRP) would be a comprehensive multi-jurisdictional effort to identify and characterize ecologically significant and/or critical species and habitats, outline federal and state decision-making processes (that govern their protection and restoration), identify partnering/collaborating opportunities for advancing and coordinating their enhancement and restoration efforts, provide prioritized projects and criteria suggestions that stakeholders can utilize to select restoration project(s) and focus efforts. This initiative will assist the implementation of short-term projects as well as, strategize long-term activities to restore natural resources and ecological functions across the region.

Typically, enhancement and restoration projects are implemented piecemeal often in response to incidents or mitigation needs, with little regional focus. Regional restoration planning provides a holistic framework for addressing safeguards and improvements in a coordinated fashion and reduces the costs while increasing the efficiency of restoration planning and implementation at the state and on-site scales.



Specifically, The RRP would ensure enhancement and restoration is:

1. **Coordinated:** Identification of agency programs and non-profit efforts promotes the pooling of individual resources and experiences to provide for implementation of larger, more ecologically significant restoration projects with increased efficiency.
2. **Comprehensive:** The RRP will cover all major ecosystem components and habitat types from the headwaters and uplands to the ocean. PDE will consider the tidal-influenced portion of the watershed as 4 regions which coincide with existing initiatives. This approach ensures that there will be no gaps in consideration at local, regional and watershed scales. The Partnership for the Delaware Estuary (PDE) would take the lead on this initiative to maximizing opportunities for partnering among stakeholders' and other public and private restoration efforts while achieving several PDE objectives and goals.
3. **Inclusive:** This Initiative will consider all projects contributed by all environmental stakeholders in the region (i.e. non-profit organizations, companies, agencies) on regional benefit merits.
4. **Credible:** The Delaware Estuary RRP workgroup, under the guidance of the STAC, would be a collaborative effort to engage the best resource management, academic, and institutional restoration expertise from throughout the region.

And ultimately, it should be prioritized based on the best science, focusing on key life-sustaining functions and signature resources with greatest natural capital value.

THE GUIDE TO THE NATURAL COMMUNITIES OF THE DELAWARE ESTUARY.
Krista Laudenbach-Nelson, Partnership for the Delaware Estuary, Inc., 110 S. Poplar Street, Suite 202, Wilmington, Delaware, 19801. knelson@DelawareEstuary.org. **Session E**, 2:30, 1/23/07 (presentation #96).

The Partnership, working with NatureServe and the Natural Heritage Programs in New Jersey, Delaware, and Pennsylvania, has completed *The Guide to the Natural Communities of the Delaware Estuary*. The *Guide* describes 35 ecological systems and 187 natural community types known to occur in the tri-state watershed. Community types were identified using the National Vegetation Classification System (NVCS), approved by the Federal Geographic Data Committee as the U.S. vegetation standard. Each of the three Estuary state's vegetation classifications was crosswalked to the NVCS, providing a common language across multiple jurisdictions.

The information contained in the *Guide* can help growth management decision-making, steering development away from ecologically sensitive resources. It can aid land acquisition prioritization, answering questions of rarity and representation in protected areas. Application of the information on-the-ground can lead to more informed natural resource management on conservation lands and more accurate selection of targets in ecological restoration. Because reference site locations are given, it can provide restoration practitioners with an actual site to use as a system of reference. Further, the conservation status rank of communities targeted for restoration can identify the role of a project in regional habitat strategies. When looking at the conservation ranks, it was found that 23% of the associations are considered at-risk globally and 32% are considered at risk at the state level. Phase II of this initiative will include the development of a GIS model and maps of the vegetative systems, relative to landscape position and local physical characteristics. Over 185 sites will be evaluated to validate the model and ensure map accuracy.



A REAL-TIME AND HISTORICAL ENVIRONMENTAL DATA ARCHIVE FOR THE DELAWARE ESTUARY. **David R. Legates**, Center for Climatic Research, 216 Pearson Hall, University of Delaware, Newark, DE 19716-2541; **Robert Scarborough**, Delaware National Estuarine Research Reserve, 818 Kitts Hummock Rd, Dover, DE 19901; and **Daniel J. Leathers, Geoffrey E. Quelch and Kevin Brinson**, Center for Climatic Research, 216 Pearson Hall, University of Delaware, Newark, DE 19716-2541. legates@udel.edu. **Session 5**, 11:15, 1/23/07 (presentation #19).

The Delaware Environmental Observing System (DEOS) – a partnership between the University of Delaware, the Delaware National Estuarine Research Reserve (DNERR), and the Delaware Geological Survey – is a real-time system dedicated to monitoring environmental conditions across the State of Delaware, the near-shore coastal waters and the Delaware Bay, along with adjacent regions of Maryland, Pennsylvania, and New Jersey. DEOS focuses on several atmospheric and hydrological monitoring areas and is designed to be a tool for decision makers involved with natural resource monitoring as well as a number of other activities.

Decision makers and researchers focusing on the Delaware Estuary must have environmental data with the highest spatial and temporal resolution possible. This includes both real-time as well as historical data to both monitor current conditions and to place these conditions in an historical context. Data requirements include weather information, observations of streamflow and groundwater conditions, bay and ocean conditions, and water and air quality. But more importantly, these data must be of the highest quality, readily available, and easily applied. To accomplish this, DEOS has integrated existing observations from federal, state, and local sources and augmented them with approximately twenty additional environmental observing sites around Delaware, Maryland, and Pennsylvania. The partnership with the DNERR has brought in several abiotic water quality monitoring sites, an offshore weather monitoring location and the real-time monitoring of wave properties in the lower Delaware Bay. The eventual goal is to have a dense network of observation stations along Delaware's ocean and bay coasts and continuing inland to upper reaches of the Delaware Bay watershed.

All data are stored in an Oracle[®] database for easy retrieval and analysis. Long-term records of historical weather data also are available through the Delaware Office of the State Climatologist and other linked sites, including the DNERR datasets that contain more than ten years of continuous water quality data. Moreover, DEOS is developing a user-friendly data analysis and display system to provide high-resolution, spatially distributed, digital data products from both surface observing systems as well as the National Weather Service's weather radars. This system will produce both graphical and digital products that can be used for monitoring and analyzing environmental conditions for a particular location or a region. It also can be specifically tailored to meet the needs of various state and federal agencies or environmental monitoring organizations. DEOS also supports a number of analysis systems that are designed to provide decision support in a variety of environmentally-sensitive areas.

In summary, DEOS provides an integration and synthesis of environmental data for the Delaware Estuary that heretofore was not readily available. Many of the observations either were not available or were spread out over a number of agencies and websites in a variety of formats. Much of it was not recorded for future use. By bringing the data into a central repository, archiving it for historical analysis, and providing real-time analysis tools to assist decision-makers, DEOS now provides a service for the Delaware Bay Estuary that simply was previously unavailable.



RESTORING SHAD TO THE BRANDYWINE RIVER. Robert Lonsdorf, Brandywine Conservancy, P.O. Box 141, Chadds Ford, PA 19317. rlonsdorf@brandywine.org. **Session E**, 3:10, 1/23/07 (presentation #98).

American shad were once an abundant migratory fish found throughout East Coast rivers and streams, including the Brandywine River. Shad were an important part of Native Americans' and early colonialists' diets, and later were the basis of important commercial fisheries in larger rivers like the Susquehanna and Delaware. Spring runs of shad comprised a unique and dramatic natural phenomenon, now a lost part of our cultural and natural heritage.

The Brandywine Conservancy is leading an effort to restore American shad along with other migratory fish to the Brandywine. In 2005 the Conservancy prepared a feasibility study centering on the dams in the Delaware portion of the watershed which currently block shad from access to upstream habitat. The project established partnerships with dam owners and key stakeholders and identified fish passage options. The report is now available on the Conservancy's website at www.brandywineconservancy.org.

Dam owner-partners include the City of Wilmington (owner of two dams); the State of Delaware (owner of two dams); the Hagley Museum and Library (owner of four dams), and the DuPont Company (owner of one dam). The report indicated that providing fish passage may include: fish ladders, rock ramps, by-pass channels, or dam removals. All of these partners are moving forward studying and implementing fish passage options.

Restoring shad to the Brandywine River could have important ecological as well as economic and cultural benefits for the Brandywine watershed. Ecologically, this would mark the restoration of a group of native species that have long been absent from the system. American shad are the largest and most popular member of a family of migratory fish (herring) that could return to the Brandywine. Other family members include blueback herring, hickory shad, and alewives. Several other fish species numbers could be enhanced as well. Collectively, the influx of possibly tens of thousands of fish "biomass" should create a positive "ripple effect" throughout the watershed and up the food chain. Other fish, including trout and small-mouthed bass, and riparian species, including herons, mink, and fox, should relish the new delicacies.

This restoration could support an increase in the use of the Brandywine for recreational fishing, especially during the three month spring migration season. Migratory fish would be safe to eat since they do not reside in the stream for a long time. In other parts of the country, shad runs have fostered annual celebratory shad festivals.

THE IMPORTANCE OF ALTERNATIVE HABITATS TO SPAWNING HORSESHOE CRABS (*LIMULUS POLYPHEMUS*) IN LOWER DELAWARE BAY, NEW JERSEY.

Robert E. Loveland, Department of Ecology, Evolution & Natural Resources, Cook College, Rutgers University, New Brunswick, NJ 08901; and **Mark L. Botton**, Department of Natural Sciences, Fordham University, 113 West 60th Street, New York, NY 10023. robert.loveland@gmail.com. **Session 2**, 2:00, 1/22/07 (presentation #14).

Previous studies of habitat suitability for spawning horseshoe crabs in lower Delaware Bay, N.J., has focused almost entirely on sandy open bay beaches. We present data indicating that "alternative" habitats, which were previously overlooked, or assumed to be of negligible importance, are indeed productive areas for the deposition and development of horseshoe crab eggs and larvae.



Delaware Bay should be characterized as heterogeneous relative to variation in beach size, sediment, erosion, and the influence of tidal creeks. Sandy open beaches are the dominant feature from Reeds Beach south to Cape May Point, N.J. Open beaches within this range have been regarded as optimal habitat for spawning horseshoe crabs. An example of an alternative habitat that attracts spawning horseshoe crabs is a mini-delta consisting of one or more intertidal sandbars that are formed by a small tidal creek draining the adjacent salt marsh system. Sandy banks often intrude upstream into tidal creeks for several hundred meters. The combination of global ocean rise, and sinking landscape, has caused some beaches to migrate inland, generally unchanged in such basic characteristics as slope, grain size, etc. In some locations, beaches literally migrate into the existing salt marsh or upland forest, forming new habitat. North of Reeds Beach, vast salt marshes dominate the bay shore. However, the presence of small tidal creeks and longshore current results in small “pocket” beaches fronting the erosional salt marsh. Yet another alternative spawning habitat is created when the bay breaches over sand dune systems and floods the once protected salt marsh directly. Several beaches have been severely disturbed by bulkheading and dumping of ‘clean fill’ consisting largely of broken concrete. Finally, other beaches have been partially restored or stabilized by beach replenishment.

We examined a number of areas from Fortescue to Villas, N.J., with the objective of determining the importance of so-called “alternative” habitats that might be suitable for egg deposition, and development, by spawning horseshoe crabs. In this presentation we report on the importance of such alternative habitats to spawning horseshoe crabs, using egg density as an index of spawning intensity. Six areas will be compared, and include examples of the habitats discussed above. Lowest egg densities were found on beaches that were strongly disturbed, including erosional beaches and areas with beach fill. Horseshoe crab egg density in areas where sand was accreting, such as mini-deltas and embankments along tidal creeks, was generally comparable to adjacent open bay beaches. Because tidal creek areas are hot spots for migratory shorebirds as well as horseshoe crabs in Delaware Bay, we suggest that these habitats are deserving of special consideration by agencies concerned with the conservation and management of these key species.

MONITORING THE TIDAL DELAWARE RIVER FOR AMBIENT TOXICITY. A.

Ronald MacGillivray, Delaware River Basin Commission, 25 State Police Drive, West Trenton, New Jersey 08628; **David E. Russell**, Environmental Science Center, U.S. Environmental Protection Agency—Region III, 701 Mapes Road, Fort Meade, MD 20755; **Betty Jane Boros-Russo**, New Jersey Department of Environmental Protection, P.O. Box 426, Trenton, NJ, 08625; **Steven S. Brown**, Rohm and Haas, 727 Norristown Road, Spring House, PA 19477; **Thomas J. Fikslin**, (DRBC, see above); **Richard Greene**, Delaware Dept. of Natural Resources and Environmental Control, 820 Silver Lake Boulevard, Dover, DE 19904; **Robert Hoke**, E.I. DuPont de Nemours, Haskell Laboratory for Health and Environmental Sciences, P.O. Box 50, 1090 Elkton Road, Newark, Delaware 19714; **Christopher Nally**, American Aquatic Testing, 890 North Graham Street, Allentown, Pennsylvania, 18109; and **Linda O'Donnell**, Philadelphia Water Department, 1500 East Hunting Park Avenue, Philadelphia, PA 19124.

Ronald.MacGillivray@drbc.state.nj.us. **Session 5**, 10:30, 1/23/07 (presentation #9).

This study assessed ambient waters in an urbanized and industrialized estuarine segment of the Delaware River. The objective was to assess if chronic or sublethal toxicity, as measured in laboratory controlled experiments, was present in the ambient river water samples collected. Sixteen fixed stations in the main-stem of the tidal Delaware River with salinities from 0 to 15 ppt were assessed using six species: the fathead minnow, *Pimephales promelas*; a mysid, *Americamysis bahia*; and the inland silverside, *Menidia beryllina* in 7-day tests; the water flea,



Ceriodaphnia dubia in a test conducted for a maximum of 8-days; a green alga, *Pseudokirchneriella subcapitata* in a 96-hour test; and an amphipod, *Hyaella azteca* in a 10-day test. Survival, growth, and when possible, reproduction were measured in the bioassays. The June and September 2005 toxicity surveys indicated overall, based on the measured toxicity endpoints, that the ambient water samples collected were not chronically toxic. Ambient concentrations of the metals, cadmium, chromium, copper, lead, nickel, and zinc did not exceed the applicable regulatory criteria. In addition, ambient concentrations of copper did not exceed a site-specific water quality criterion predicted by the Biotic Ligand Model. Future direction includes a shift from a developmental phase of identifying appropriate test species and methods to a monitoring phase with a continuing focus on ambient toxicity testing of water. The proposed monitoring will increase the spatial and temporal coverage of the estuary with a new focus on tidal tributaries as well as main-stem river samples.

EMERGING CONTAMINANTS OF CONCERN IN THE DELAWARE ESTUARY AND WATERSHED. A. Ronald MacGillivray, Delaware River Basin Commission, 25 State Police Drive, West Trenton, New Jersey 08628. Ronald.MacGillivray@drbc.state.nj.us. **Session 10**, 3:00, 1/24/07 (presentation #11).

There are more than 85,000 chemicals commercially available in the United States with new chemicals and technologies introduced each year. The number of substances released to the environment, improved detection methods and a growing body of information on adverse effects has increased interest by scientists, the public and regulators in these substances. These emerging contaminants of concern (ECOC) are substances that have been detected in humans or other living organisms, are toxic in some way to humans, aquatic life or wildlife, or are persistent in the environment. Therefore, the substance may have the potential to cause adverse effects on human health or the environment of the Delaware River Basin. Examples of ECOC include phthalates, perchlorate, brominated flame retardants, nanoparticles, pharmaceuticals and personal care products. Studies sponsored by the Delaware Estuary Program, United States Environmental Protection Agency, United States Geological Survey, and private industry have generated and continue to generate data on ECOC from locations within the estuary and watershed. The basin states also have emerging issues and unregulated contaminant initiatives. In 2006, the Delaware River Basin Commission included a select number of ECOC in ongoing fish tissue monitoring. This presentation summarizes a number of efforts underway within the tidal Delaware Estuary and the non-tidal portion of the watershed to identify, understand and prioritize ECOC in order to set achievable environmental management and policy goals.



CONSTRAINTS ON THE SEDIMENTS AND GEOLOGIC FRAMEWORK OF DELAWARE BAY FROM SUB-BOTTOM IMAGING. **John A. Madsen**, Department of Geological Sciences, University of Delaware, Newark, DE 19716; **Bartholomew D. Wilson**, Delaware Coastal Program, Delaware Department of Natural Resources and Environmental Control, Dover, Delaware 19901; and **David B. Carter**, Delaware Coastal Program, Delaware Department of Natural Resources and Environmental Control, Dover, Delaware 19901. jmadsen@udel.edu. **Session 1**, 10:15, 1/22/07 (presentation #54).

The Coastal Program of the Division of Soil and Water Conservation within Delaware's Department of Natural Resources and Environmental Control, the University of Delaware, the Partnership for the Delaware Estuary, and the New Jersey Department of Environmental Protection are partnering in an acoustic imaging project to identify and map the bottom and sub-bottom sediments of Delaware Bay. The goal of this project is to provide data that can be used in the delineation of the Bay's benthic habitats and sub-bottom features. This critical information provides decision makers with much needed scientific data that can be used to better manage and conserve the resources of Delaware Bay.

As part of the project, sub-bottom data is being collected using an Edgetech chirp sonar system. Because acoustic reflecting boundaries usually occur at interfaces between different geologic materials, spatial changes in the amplitude, continuity, and geometry of chirp reflections associated with these boundaries can be used to image sub-bottom layers. From the chirp tow-fish, a 2-12 kHz sound pulse is emitted 8 times per second. Given this sampling interval, and the 4-5 knot survey speed, the horizontal spacing between individual chirp traces is on the order of 25-30 cm. Reflections from sub-surface boundaries have been observed to depths of 20 m beneath the tow-fish. The chirp data is integrated with additional information from cores to develop three-dimensional maps of the distribution and thickness of sub-bottom sediments. These maps can be used in near shore areas to determine suitable sand deposits for potential beach replenishment and, on a more regional scale, to study the shallow geologic setting of the bay.

As an example of the utility of the sub-bottom data, in the portion of Delaware Bay near the Chesapeake and Delaware Canal and Artificial Island, chirp profiles are characterized by a series of southward dipping reflections. These reflections correlate with upper Cretaceous sediments observed in cores in this region. The chirp profiles indicate that these upper Cretaceous sediments "outcrop" along the bay bottom. Grab samples of bottom sediments collected in this area confirm the presence of these older sediments. The significance of these observations is that these sediments are associated with underground aquifers. Areas where they outcrop on the bay bottom could be sites of groundwater discharge into the bay. Freshwater discharge points are unique benthic habitats and may be the preferred sites for spawning and/or feeding for a variety of pelagic and benthic organisms.

NATIVE OYSTER RESTORATION IN THE CHESAPEAKE BAY: LESSONS FOR THE DELAWARE ESTUARY. **Roger Mann**, Virginia Institute of Marine Science, Gloucester Point VA 23062. rmann@vims.edu. **Session 8**, 9:00, 1/24/07 (presentation #32).

We seek to restore native oysters in the Chesapeake Bay for both ecological and fishery purposes. Ecological restoration is the provision of ecological services by a self-sustaining population within a defined footprint. Fishery restoration is the provision of a sustainable economic resource. These are different end points but are often presented in unison with little consideration of the fact that they may be incompatible. Restoration efforts enjoy enormous public support, and have consumed and continue to consume vast amounts of funding. Yet their stated goals remain poorly defined, as



do measures of success in terms of time, space or biomass. We lack the ability to both predict recruitment and limit the ingress and impact of disease. Thus expansion of extant populations in a self-sustaining mode beyond the current footprints has proven intractable. Improved disease tolerance and longevity are critical to rebuilding populations. Sustained expansion of the current footprint through substrate provision is prohibitively expensive, beyond the limits set by availability of substrate material, and of questionable value in the presence of disease and susceptible oysters. Thus additional ecological services will be limited. Water quality impacts have been unduly optimistic and will be limited to local improvement that is still subject to being overwhelmed by periodic storm events. These biological limitations dictate more realistic, and indeed very modest goals for ecological restoration. In the absence of improved disease tolerance and practices to sustain populations with multiple year class representation the prognosis for improvement of this situation is poor.

WETLAND RESTORATION SITE PREPARATION AND SITE MANAGEMENT: BALANCING PROJECT COSTS AND HABITAT BENEFITS TO WATERFOWL Kirk Mantay and Scott Reinhart, Ducks Unlimited, 34 Defense Street, Suite 200, Annapolis, MD, 21401. kmantay@ducks.org. Session E, 1:30, 1/23/07 (presentation #93).

In the growing field of wetland restoration, many tools & methods are available to biologists to potentially improve the habitat functionality and performance relative to wildlife needs. These tools are identified and utilized through the design, construction, and post-construction site management phases; and include active water control, planting and seeding, invasive species control, and soil augmentation, among many other measures. However, there is always a risk of providing minimal additional habitat benefits associated with these often costly site measures—resulting in an unnecessary increase in project cost.

The speakers will discuss several commonly utilized restoration site activities, and their overall cost of implementation relative to the benefits they provide to the lifecycle needs of waterfowl species in the Delaware Bay watershed.

BOTTOM TRAWL SAMPLING OF FISH AND INVERTEBRATES IN THE DELAWARE ESTUARY – GETTING THE WORD OUT. Stewart F. Michels and Michael J. Greco, Delaware Division of Fish and Wildlife, 89 Kings Highway, Dover, DE 19901. stewart.michels@state.de.us. Session 6, 2:00, 1/23/07 (presentation #39).

The Delaware Division of Fish and Wildlife monitors a wide variety of finfish and aquatic invertebrate populations in the Delaware Estuary through its bottom trawl surveys. Two gear types are used in the sampling. A 17-foot semi-balloon otter trawl is used to sample juvenile finfish and invertebrates (juvenile survey) and a 30-foot otter trawl is used to sample adult and sub-adult finfish and invertebrates (adult survey).

The Division's surveys are among the longest running and most consistent state fisheries surveys on the East Coast. Maintaining consistency to the extent possible has made these surveys extremely useful tools in monitoring some of the Estuary's key species. Species composition, abundance, length/age, and basic water quality parameters are routinely collected in the 300+ tows made annually. More than 150 species of fish and invertebrates have been documented in the surveys since their inception. Over 20 age-specific abundance indices have been generated from the surveys for use in state, regional or coastwide stock assessments and management plans. In addition to monitoring trends in relative abundance and year-class strength, data from the surveys has been used in state environmental permitting and licensing, identifying important fisheries



habitat and examining spatial and temporal trends in fish distributions. Whenever practical, the surveys have also served as a platform for a number of other research initiatives such as mark-recapture, food habit, genetic, and contaminant studies.

Similar fishery-independent surveys are being conducted in the Delaware Estuary by governmental agencies, universities, and other entities that could be used by managers to further examine trends fish abundance and distribution. Though making raw survey data available for general use is controversial and labor intensive, assembling lists of projects, contacts, and/or summary reports of available biological data would be a useful cost-effective approach to improving survey awareness and better understanding of monitoring needs in the estuary.

THE INCREASING NECESSITY TO MONITOR WETLANDS LOSSES DUE TO CHANGING REGULATORY PROGRAMS AND RECENT SUPREME COURT DECISIONS. **William F. Moyer**, Duffield Associates, Inc., 5400 Limestone Road, Wilmington, DE 19808. bmoyer@duffnet.com. **Session 3**, 3:30, 1/22/07 (presentation #3).

Considerable, warranted effort is being made to monitor wetlands functions and values and to assess wetlands within a ‘watershed’ context. In addition, non-regulatory approaches to wetlands protection are ongoing. The effectiveness of regulatory programs, it could be argued, have not been fully assessed for a number of reasons. One reason is the lack of an adequate monitoring program that accurately tracks wetlands losses over time at a meaningful mapping scale. Another is the ever-changing federal regulatory program that, since its inception, has had to weather constant Congressional oversight and a variety of federal court decisions including several landmark Supreme Court decisions. These Supreme Court cases, as well as a multitude of lower federal court decisions, have resulted in an increasingly complex program for regulating wetlands and begs the question of whether or not there is a need for change.

What is the history of the Clean Water Act and how has it changed over the past 35 years? What has been the outcome of the four most significant Supreme Court decisions with respect to wetlands protection and what risks do we face today. This presentation briefly examines the history of the Clean Water Act as it relates to the protection of wetlands. It also presents a summary of four Supreme Court decisions – *Natural Resources Defense Council v. Callaway* (1975), *United States v. Riverside Bayview Homes* (1987), *Solid Waste Authority of Northern Cook County v. U.S. Army Corps of Engineers* (2001), and *United States v. Rapanos and Carabell* (2006). The Rapanos decision and its implications for wetlands protection will be examined more closely. In addition, recent federal guidance, if issued, by the Corps of Engineers and EPA will be summarized.

Several options exist for strengthening wetlands protection. One option would be for states to enact more extensive wetland protection programs. Delaware attempted this without success in the early 1990s. Other options would include enacting a federal wetlands protection statute, revising and clarifying federal wetlands regulations and combining the various federal wetlands regulatory programs in one federal agency.



SURVEY OF NEW JERSEY'S RECREATIONAL BLUE CRAB FISHERY IN DELAWARE BAY. **Brandon W. Muffley**, New Jersey Division of Fish and Wildlife, Marine Fisheries Administration, PO Box 418, Port Republic, NJ 08241; and **Lynette Lurig**, New Jersey Division of Science, Research, and Technology, 410 E. State St, Trenton, NJ 08625. Brandon.Muffley@dep.state.nj.us. **Session 6**, 1:30, 1/23/07 (presentation #13).

Blue crabs, *Callinectes sapidus*, are one of the most important commercial and recreational species in New Jersey. Despite the fact that Delaware Bay and New Jersey's coastal bays are near the northern range of the blue crab distribution, New Jersey's commercial harvests have averaged 5.3 million pounds over the last five years with an annual dockside value of approximately \$5.7 million. Recent declines in the Delaware Bay blue crab landings and the overall lack of information on the status of blue crab populations from New Jersey waters has prompted both interest and possible concerns about the status of New Jersey's blue crab resource. Despite their importance, there is limited information collected on blue crab biology, population status, and data from the commercial fishery, while there is no information gathered on the recreational fishery. The lack of information from New Jersey's recreational fishery has been pointed out as one of the major pieces of information missing in accurately characterizing the Delaware Bay blue crab resource. Also, there is some anecdotal information from estuarine inventory surveys conducted during the 1970's, the last time data on the recreational fishery was collected, that the recreational harvest may be equal to or exceed that of the commercial fishery in New Jersey.

In an effort to begin to address these concerns and gain an understanding of the recreational blue crab fishery, the New Jersey Marine Fisheries Administration and Division of Science, Research and Technology initiated a comprehensive sampling program in 2005 to characterize the recreational fishery in New Jersey's portion of the Delaware Bay. The goals of the survey were to 1.) estimate the monthly fishing effort, catch and harvest by gear within Delaware Bay, during the 2005 fishing season, by telephone and dockside intercept surveys and 2.) characterize the stock structure of the harvest, by sex and size, based on measurements taken at dockside intercept surveys.

Over 2,270 completed telephone interviews were conducted from June – November 2005 within the tri-county area that borders New Jersey's portion of Delaware Bay (Salem, Cumberland and Cape May counties). Telephone interviews gathered information on the number of recreational crabbers, number of trips per month, gear type and access location and were used to estimate the total number of recreational crabbing trips taken by residents in the tri-county area. Biological data (sex, maturity stage and size), catch and harvest data, as well as gear type and residency information were collected during 831 dockside intercept interviews from May – October 2005. This information was used to estimate the average catch/harvest per trip by gear type. Recreational crabbers took an estimated 202,000 individual crabbing trips during the course of the 2005 season. They caught nearly 4 million crabs and harvested 1.9 million crabs which equates to about 20% of the 2005 commercial harvest in Delaware Bay and the average size of a harvested crab was 5.4 inches with males comprising 75% of the harvest.



LOW SALINITY ACCLIMATION & SALINITY TOLERANCE OF *Americamysis bahia* IN SHORT-TERM CHRONIC TOXICITY TESTS. Christopher J Nally, American Aquatic Testing, Inc. 890 North Graham Street, Allentown, Pennsylvania 18109; **A Ronald MacGillivray**, Delaware River Basin Commission, 25 State Police Drive, West Trenton, NJ 08628-0360; **Tarmo Pallop, Kerri Koch**, American Aquatic Testing (see above); and **Thomas J Fikslin**, DRBC (see above). Ronald.MacGillivray@drbc.state.nj.us. **Session 5**, poster, 1/23/07 (presentation #10).

Efforts to study and characterize the nature and extent of chronic toxicity in the Delaware estuary have been hampered by the limited number of EPA approved test species that are tolerant of the low salinity present in the estuary. The purpose of this work was to develop supporting data for the test species and test methods selected by the Delaware River Basin Commission's Chronic Toxicity Workgroup for use in monitoring ambient waters with salinities between 1 and 15 part per thousand (ppt). The mysid, *Americamysis bahia* (formerly *Mysidopsis bahia*), was selected because mysids play a significant role in the estuarine environment and have a long history of use in standardized tests. Current EPA guidance requires *A. bahia* tests be conducted at salinities of 20-30 ppt. The first part of the study, conducted by American Aquatic Testing, Inc. (AAT) of Allentown, Pennsylvania, evaluated the effects on survival and growth of five salinities between 5 and 25 ppt, using water only comparisons to determine which salinities below 20 ppt should be tested in the second round using a standard reference toxicant (SRT) test with potassium chloride. The SRTs were conducted to compare species response at the lower salinity with a concurrent test conducted at the EPA standard salinity, 25 ppt. The initial exposures identified 10 ppt as the lowest salinity at which the survival and growth were both comparable to the results at 25 ppt and consistently met the minimum requirements of 80% survival and 0.20 mg average dry weight. SRT testing included two different groups of *A. bahia* acclimated to 10 ppt and 25 ppt tested concurrently. The 10 ppt tests produced results that met all acceptability criteria and produced endpoints that were comparable to the tests run concurrently at 25 ppt, and to an established 20-point moving-average control chart of tests conducted with potassium chloride at 25 ppt. *Acknowledgement.* Financial support for this study was from the Partnership for the Delaware Estuary, Delaware River Basin Commission and United States Environmental Protection Agency.

THE NATIONAL IMPORTANCE OF THE DELAWARE ESTUARY. Scott Nixon, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882. swn@gso.uri.edu. **Keynote Speaker**, 11:30, 1/22/07 (presentation #64).

Forty years in marine ecology have made me painfully aware that one of my favorite bays is underappreciated by marine ecologists who do not live and work in its watershed. I often hear disparaging remarks that Delaware Bay is too muddy, or too marshy, or too polluted. Well, it must be admitted that Delaware Bay will probably never become a favored spot for SCUBA diving, and that its shoreline will probably never be lined with sunbathers lying towel to towel, and that its sediments may always contain some nasty chemicals. But the estuary of the Delaware and its bay deserve a special place in the heart of every coastal ecologist. The Delaware is the quintessential drowned river mouth estuary with a simplicity of shape that is the dream of coastal physical oceanographers. The massive anthropogenic loadings at its head produce an ideal laboratory for studies of the fate and effects of pollutants. Its complex bathymetry and treacherous shoals provide a dynamic sedimentary environment for the geologists and a turbid water column that challenges ecologists and chemists alike.

There is a long and rich intellectual history of coastal science and management in this system that should inform us all, regardless of where we work. It was around this bay and estuary that the first



multiple state management of coastal waters began with INCODEL and the DRBC. It was for the Delaware River in the early 1930s that the US Supreme Court first made a water apportionment ruling in which environmental impacts in the downstream estuary were a consideration. It was in the Delaware River and Estuary that one of the first two dimensional time varying hydrodynamic models of estuarine circulation was coupled with simple biology to link management actions with dissolved oxygen targets in the receiving waters. It was here that Ketchum worked out his fresh water fraction technique for estimating residence time of estuarine waters. Much of our knowledge of the trophic and biogeochemical links between wetlands and tidal waters has been based on studies of the extensive salt and tidal fresh marshes of the Delaware River, Estuary, and Bay. Today they are the site of one of the most ambitious wetland restoration projects in the world. During the past twenty-five years Delaware Bay and Estuary rank fifth in the country in terms of peer-reviewed science articles published. A formidable accomplishment for a relatively small bay and research community.

PLANTING A RAIN GARDEN TO REDUCE NONPOINT SOURCE POLLUTION. **Mary Ellen Noonan**, Bucks County Conservation District, 1456 Ferry Road, Suite 704, Doylestown, PA, 18901. maryellennoonan@bucksccd.org. **Session C**, 8:55, 1/23/07 (presentation #83).

Storm water runoff is responsible for up to 70 % of the pollution found in our streams, lakes and rivers. Impervious surfaces (ones that do not allow water to penetrate the ground) such as buildings and parking lots contribute large amounts of water to our storm drains. This water often contains many pollutants.

Rain gardens help hold this storm water and allow it to soak into the ground where many of the pollutants can be filtered out by the soil. Rain Gardens can reduce the amount of water and pollutants which enter our streams by up to 30 %.

Gardens can be positioned to catch water before it runs into storm inlets on your street, or as it runs out of downspouts. A gentle sloping area (no more than a 10% slope) at least 10 feet away from your house is best. For easiest installation choose a site that is in line with the way water naturally runs off your property.

Estimate the amount of area (roof top or paved area) which will drain into your garden. Gardens planted on sandy soils should be 20-30% the size of the drain area. Gardens planted on clay soil should be 60 % of the drain area. *The garden should be dug into a bowl-like depression* so that excess water collects and drains slowly into the soil over several days allowing the soil to filter out pollutants.

Native plants are the preferred type of plants because they tolerate a wide variety of soil and moisture condition. Remember...each garden is unique, so be creative!

CITIZEN SCIENCE IN DELAWARE: A SUCCESS STORY. **Ginger North**, Delaware Nature Society, P.O. Box 700, Hockessin, DE 19707. ginger@delawarenaturesociety.org. **Session E**, 2:50, 1/23/07 (presentation #97).

What does it take to sustain a successful monitoring program? With an increased emphasis on the importance of clean water and a growing focus on volunteer collected data, citizen science plays an expanding role in determining the health of our streams and rivers. Established in 1995, Delaware's Technical Stream Monitoring is a nationally recognized example of the acceptance and use of citizen science data by the State and the Federal Environmental Protection Agency (EPA).



Technical Stream Monitoring was developed to supplement the State's monitoring efforts in other locations by providing reliable baseline values for several different chemical and physical parameters. Technical Monitoring data has been published in the State's Watershed Assessment Report (305(b)). The data collected by our volunteers is being incorporated into water quality models used by Division of Water Resources in Delaware's Department of Natural Resources and Environmental Control (DNREC) for calculations.

Nature Society volunteers are currently collecting water samples at over 45 sites in 3 separate watersheds throughout the state. This program is an excellent example of a productive and positive partnership and citizen science at work.

COOPERATIVE CONSERVATION AND THE SCHUYLKILL ACTION NETWORK Lyn O'Hare, Berks County Conservation District, 1238 County Welfare Road, Suite 200, Leesport, PA . Cohare@countyofberks.com. **Session C**, 9:15, 1/23/07 (presentation #84).

In 2003, an assortment of people committed to the environment met to form the *Schuylkill Action Network's* Agricultural Workgroup - representatives from various agricultural and governmental organizations not normally found at the same table. Assessments of the Schuylkill River showed local degradation, with the impairments blamed on decades of conventional farming practices. Each member of the group represented different perspectives of the agriculture industry...from farming operations to regulatory agencies responsible for environmental stewardship. As members continued to meet, these different viewpoints merged into a common goal: improvement of impaired streams while enhancing the business of agriculture. Traditionally, local assistance agencies have been stand-alone organizations, each with their own programs and grants to be utilized for improvements. When the SAN was awarded a \$1.1 million EPA grant in 2005, \$300,000 was allocated to the Workgroup for reducing sediment and nutrients from impaired streams.

The group was now compelled to formulate a common goal answering these questions: What best management practices are the most cost-effective? How do we even begin to select farms that could use assistance? Who should be in charge? Each organization was accustomed to complete independence in managing their projects, and were now obligated to share resources, both funding and personnel. After many discussions, various member agencies were approved by group consensus to handle the tasks involved with establishing new environment-enhancing practices on the participant farms.

While we are still learning the art of collaboration, the Ag Workgroup has accumulated a number of accomplishments out of this cooperative experience. One important lesson learned is that while each organization may have its own focus, each brings strengths to the table that complement each other. The common struggle to achieve a shared objective helped overcome some difficulties with funding, territories, and duplication of effort.

The "Cooperative Conservation" demonstrated by the Ag Workgroup has been responsible for a measurable reduction of nutrients and sediment along tributaries of the Maiden Creek Watershed. Thousands of feet of streambank fencing have been installed along selected farms on impaired streams. Hundreds of trees have been planted, and numerous animal crossings installed. Because of this collaborative effort, member agencies have been able to leverage additional grant monies from other sources to continue agricultural improvements in the future.



A NUMERICAL STUDY ON THE IMPACT OF DIFFERENT TURBULENCE CLOSURE MODELS ON SALINITY AND SEDIMENT DISTRIBUTION IN THE DELAWARE BAY.

Michael Piasecki, Department of Civil, Architectural & Environmental Engrg., Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104; and **Kutay Celebioglu**, Department of Civil, Architectural & Environmental Engrg., Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104. Michael.Piasecki@rexel.edu. **Session 1**, 10:00, 1/22/07 (presentation #53).

Salinity intrusion into the Delaware Bay as well sediment transport characteristics has a profound impact on all habitats in the estuary. For example, oyster fisheries that are located in the brackish water zones are adversely impacted by increased salinity levels because of increased predatory activity on the young oyster population. As a result, freshwater diversion and channel deepening can impact commercial fisheries because of the reduced freshwater flux or increased conveyance in the shipping channel, i.e. issues of water quality are linked together throughout the system from the headwaters to the continental shelf. Consequently, in order to gain predictive capabilities or assess changes in the system through executing what-if-scenarios numerical modeling of the estuary is the only sensible way to approach these objectives. We have developed a numerical 3D model for the tidal portion of the Delaware Bay using the UnTRIM hydrodynamic kernel in order to capture the weakly stratified nature of the Delaware Bay flows.

In this research we seek to investigate the impact of different closure schemes on the mixing processes of the estuary flow structure, namely the impact on salinity and velocity profiles at various points in the bay as well as the identification of the location and intensity of the turbidity maximum. The grid domain extends from Trenton, NJ south past the inlet at Cape May, NJ and incorporates a large portion of the continental shelf (up to the 50 meter isobath) to capture the processes of the continental shelf and their relation and impact on the bay dynamics. To test various closure models (constant, one-equation algebraic model, two-equation model) we have included a two equation turbulence closure, generic length scale (GLS) model into the code to permit several alternatives for turbulence closure, i.e. $k-\epsilon$, $k-\omega$, Y-M2.5, and generic length scale. The objective is i) to see whether simple or more complicated turbulence closures are necessary to accurately model the mixing processes, and ii) to find out whether there is a profound difference between those 3 or 4 commonly used 2-equation models potentially suggesting that care must be taken which one to use. The simulations extend over a period of two months (July - August 2003) to capture varying flow conditions over a medium-size duration. We compare the numerical results to observations obtained from buoys (salinity and velocity) located in the bay, and sediment measurements carried out by researchers at the University of Delaware (C. Summerfield).

WETLAND MONITORING AND ASSESSMENT IN THE MID-ATLANTIC STATES.

Regina Poeske, US EPA Region III, 1650 Arch Street, Philadelphia, PA 19103. Poeske.Regina@epamail.epa.gov. **Session 3**, 4:00, 1/22/07 (presentation #37).

Under the Clean Water Act (CWA) States are required to monitor and report on the quality of waters within their states, which includes wetlands. Building state capacity in wetlands assessment is a big challenge and significant area of emphasis for EPA over the next several years.

The Environmental Protection Agency's (EPA) Office of Wetlands, Oceans and Watersheds (OWOW) released the "Application of Elements of a State Water Monitoring and Assessment Program for Wetlands" to foster the development of State wetland monitoring and assessment programs. This guidance ultimately hopes to promote interstate consistency in reporting the quantity and quality of the nation's wetlands. Understanding the condition of our wetland resources is essential to maintaining and restoring wetland health and to ensuring that states are prepared to participate in the 2011 National Wetlands Condition Assessment. The National



Waters Assessment Program establishes an EPA program to survey the biological condition of waters that will provide the nation with statistically-valid snapshots of the status and trends for streams, lakes, rivers, coastal waters, and wetlands. Wetlands, as waters of the United States, are a component of this program and field work for their assessment is slated to begin in 2011. In anticipation of the National Assessment of Wetlands, Region III will embark on a pilot Regional Wetland Assessment in the Mid-Atlantic Region. Region III's Wetland Program has been very active in promoting statewide programmatic monitoring of wetland resources in the Mid-Atlantic with successes of state programs highlighted.

HOW LONG DOES OYSTER SHELL LAST ON AN OYSTER REEF? E. N. Powell, J. N. Kraeuter and K. A. Ashton-Alcox, Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Ave., Port Norris, NJ 08349. eric@hsrl.rutgers.edu. **Session 8**, 8:45, 1/24/07 (presentation #2).

Programs designed to restore oyster (*Crassostrea virginica*) reefs typically utilize oyster shell. There is an assumption that this shell, unless it is buried, will be available for many years. A reduction in population abundance brought on by 6 years of low recruitment has reduced shell input through natural mortality on Delaware Bay oyster beds. Quantitative stock surveys provide an estimate of surficial shell over the same time period. This permitted the reconstruction of the time history of shell since 1998 and the estimation of addition and loss rates. Shell loss rates were surprisingly high. In most cases, half of the shell added to an oyster bed in Delaware Bay in a given year is lost over the subsequent 2 to 10 years. The expectation that the half-life of shell would be lowest at higher salinities where boring sponges and other epibionts are prevalent was not the case. The shortest half-lives, typically 2 to 3 years, were at intermediate salinities. Half-lives increase to about 10 years both upbay (lower salinity) and downbay (higher salinity). Minimal shell doubling times were calculated under the assumption of no shell loss, implying a maximum accretion rate. Doubling time varied from less than 10 to more than 20 years. This indicates that oyster shell has the potential to accumulate rapidly. The lack of shell accumulation in Delaware Bay can be explained if most shell produced yearly does not remain intact for long. Restoration programs need to take into account loss rate of the shell resource.

OPTIMIZING RESERVOIR OPERATIONS FOR WATER SUPPLY AND ECOLOGICAL OBJECTIVES USING FLOW MODELING. Hernán A.M. Quinodoz, Delaware River Basin Commission, P.O. Box 7360, West Trenton, NJ 08628-0360. quinodoz@drbc.state.nj.us. **Session 5**, 11:45, 1/23/07 (presentation #65)

There are more than ten major reservoirs in the Delaware Basin; some were built for a single purpose (water supply, flood control, hydropower), others to meet more than one purpose. They all play a key role in managing flows in the mainstem and major tributaries. Over the last 30 years, the Delaware River Basin Commission (DRBC) has developed and implemented various sets of reservoir operation rules to control drought impacts, instream flows, minimum flow targets, and salinity intrusion in the tidal river. These rules have been modified several times to accommodate new requirements.

In every case, decision makers have relied upon extensive modeling of alternative proposals, using a basin-wide daily flow model. The current version of the model simulates reservoir operations and flow routing with a daily time step on the mainstem and major tributaries. An optimization scheme yields a solution at every time step, based on priorities assigned to each demand in the whole system. Demands include withdrawals for water supply, reservoir diversions and releases, and target flows. If and when demands conflict, the model meets them according to the priorities



assigned in advance.

The basin-wide model extends from the headwaters in New York to the tidal river at the Delaware Memorial Bridge, calculating flows at about 70 locations in between. It can be used to estimate freshwater inflows to the Delaware Bay and examine their variability, in response to either natural conditions (hydrologic extremes, climate) or anthropogenic change (upstream water use, reservoir operations). In addition, the model can easily test the ability to meet specific ecological objectives that are directly related to flows at a particular location. However, this requires prior studies to link flows to ecological metrics of interest. By incorporating such “flow relationships” into the flow model, we can utilize the most current quantitative understanding of ecological (and other) needs, and refine them as new information becomes available.

INTEGRATING DELAWARE’S WETLAND MONITORING, RESTORATION, AND EDUCATION EFFORTS TO IMPROVE THE HEALTH OF THE DELAWARE ESTUARY. **Evan M. Rehm, Mark Biddle, Amy Jacobs, Gary Kreamer and Steve Williams,** Delaware Department of Natural Resources and Environmental Control, 820 Silver Lake Blvd, Suite 220, Dover, DE 19904. evan.rehm@state.de.us. **Environmental Summit**, poster, 1/23/07 (presentation #12).

Delaware is the only state in the Delaware Estuary that does not have regulatory authority over its nontidal wetlands. With increasing threats that are degrading and destroying wetlands and recent limitations on the Army Corps to regulate all wetlands, Delaware is developing an innovative program to protect and restore wetlands using non-regulatory efforts. The program integrates three areas: education, monitoring and assessment and restoration and protection. Collaboration among state agencies and conservation partners is increasing communication, forming new partnerships, and creating new opportunities to protect the Delaware Estuary resources.

The monitoring and assessment program which is currently, assessing the St. Jones, Murderkill, and Appoquinimink River watersheds identifies the primary stressors that are affecting wetland function and provides a holistic approach to setting wetland restoration goals, ultimately improving water quality and wildlife habitat. In addition to providing information to direct restoration and protection, the monitoring program will track wetland condition over time to assess the benefits of restoration and protection efforts. Through the Delaware Adopt-a-Wetland program, projects completed through the restoration and protection program are often linked with universities, private schools, citizens groups, and local organizations to increase community education opportunities and involvement. These organizations act as stewards of the wetlands and collect valuable data that supports the ongoing monitoring program. Through the education program, we are using information from the monitoring and assessment and restoration and protection programs to develop workshops aimed to educate local decision makers and community planners of the importance of wetlands to overall environmental health. In addition, these workshops will help produce a wetland restoration guidebook to educate landowners of the value of wetlands and opportunities to protect, restore, and enhance wetlands on their property.



OPPORTUNITIES AND BARRIERS TO RESTORING WETLANDS IN URBAN AREAS -- A CASE STUDY FROM COBBS CREEK WATERSHED WETLANDS RESTORATION PROJECT. Gwyn Rowland, Director, Water Resources, Pennsylvania Environmental Council, 123 Chestnut Street, Suite 401, Philadelphia PA 19106. growland@pecpa.org. **Session 9**, 1:15, 1/24/07 (presentation #30).

Restoring wetlands in urban areas offers an important opportunity to protect streams, restore urban watersheds, enhance habitat, and manage stormwater. Wetlands in our older urban communities have been drained, dredged, and filled over many years as the region developed. Recreating wetlands is an opportunity to reverse past trends of degradation and renew urban watersheds. This presentation outlines opportunities and barriers to wetlands restoration in an effort to isolate policies and practices that will preserve wetlands and accelerate wetland restoration to protect and restore natural resources of the estuary region.

In 2004, the Pennsylvania Environmental Council (Council) received a grant from the National Fish and Wildlife Foundation to embark on wetlands restoration program in the Cobbs watershed as part of implementing the Cobbs Creek Integrated Watershed Management Plan. In partnership with the Philadelphia Water Department (PWD), candidate sites were identified from an analysis completed by PWD entitled “Southeast PA Regional Wetland Inventory and Water Quality Improvement Initiative”. After site visits and property owner meetings were conducted, a 2-3 acre parcel was selected in Lower Merion Township. Site selection considered existing conditions and habitat improvement prospects; owner willingness; municipal support; stakeholder interest and potential as a demonstration project.

Considering the multi-faceted functions and values wetlands provide, overcoming barriers to restoring urban wetlands becomes worthwhile endeavor. The obstacles encountered have slowed pace of the project, but provide a valuable case study. The most important challenge to date has been working with the township on access to and protection of the township’s main sewer line that runs the length of the project area. Other challenges include invasive weed control and public concern about mosquito prevalence.

These challenges have yielded a programmatic response that will influence the actual design and project plan. They also elicit a broader policy response relative wetland protection and restoration. This case study highlights the need to improve the regulatory framework so we better protect the integrity of streams, riparian areas, and wetlands, which can occur through improved zoning, land use development policies, and improved utility construction practices and education.

TOWARDS THE GOAL OF SETTING NUTRIENT CRITERIA FOR THE DELAWARE ESTUARY. Edward D. Santoro, Delaware River Basin Commission 25 State Police Drive, Trenton, NJ 08628-0360. edward.santoro@drbc.state.nj.us. **Session 5**, 11:00, 1/23/07 (presentation #72).

The Current USEPA nutrient criteria guidance recommends the adoption of nutrient criteria by states and by extension the DRBC. The guidance also provides for optional criteria based upon extensive monitoring data. EPA recommends that states adopt criteria for Total N, Total P, Chlorophyll-*a* and water clarity. The USEPA criteria suggest an assignment of a level encompassed by the 25th percentile of data for ambient conditions or a 75 % in reference areas.



It has been the strong advice of both academic scientists and regional EPA and state scientists that criteria be a response – e.g., chlorophyll, dissolved oxygen, SAV cover. It is recognized such criteria may result in variable controls on the loadings of nitrogen and phosphorus.

This presentation identifies DRBC's approach towards setting nutrient criteria in the tidal areas of the river and the estuary. Our approach uses a large data set (> 15 years) from our long-term boat run program and river studies to set proposed criteria for the Delaware River Basin

Currently most of the mainstem Delaware River is meeting fishable/swimmable water quality objectives where designated based upon oxygen, pH and bacteria standards. Historically the Delaware River and Bay have not experienced the typical signs of eutrophication ie; fish kills, algal blooms, water discoloration or other. The conditions of the waters of the Delaware Estuary continue to improve. The nutrient levels, while elevated do not appear to manifest aquatic impacts and are effectively utilized by resources downstream. The DRBC is moving towards using the 95% of ambient data as a nutrient threshold limit in the Estuary.

The use of this approach for total N, Total P Chlorophyll - a and Water Clarity to evaluate nutrient effects in the estuary are discussed. These include studies to define nutrient impact thresholds and algal stimulation studies which started in 2003. In addition DRBC is utilizing tributary and mainstem data to identify major nutrient sources. We believe given the large amounts of nutrient data we have been collecting over a long period will provide for establishing criteria which is realistic based upon our understanding of the Delaware River Basin.

AN INVENTORY OF RESTORATION OPPORTUNITIES IN THE DELAWARE BAY.

William P. Shadel, American Littoral Society, Sandy Hook, Highlands, NJ 07732,
bill@littoralsociety.org. **Session 9**, panel, 1/24/07 (presentation #77).

To help facilitate habitat restoration in the Delaware Bay, the American Littoral Society is creating a comprehensive database of potential restoration projects in the estuary. Like similar efforts in other estuaries, one of the primary reasons for this database is so that those in the restoration arena can have a resource from which to draw information about specific sites and therefore be in a better position to apply for restoration funding and, hence, serve the overriding purpose of restoring the estuary's critical habitats. It also can be used in broad planning and prioritization for the estuary. This will be coordinated with other related work in the estuary to ensure effort is not duplicated and that the database is most appropriate for the estuary.

Sites are being solicited from various sources - public agencies, private organizations, and interested individuals – who can download the nomination form at <http://littoralsociety.org/userfiles/doccenter/ALSRESTORATIONINVENTORY.doc>. Envisioned as a living database that will be periodically updated, this database will result in a first-edition report as early as spring 2007. This presentation will introduce this inventory – its purpose and methods – and illustrate its utility. This first edition of the database is funded, in part, by the National Partnership between the NOAA Community-based Restoration Program and Restore America's Estuaries.



THE DELAWARE ESTUARY WATERSHED TO OCEAN OBSERVING SYSTEM (DEWOOS): CURRENT AND FUTURE DESIGN FOR A COMPREHENSIVE MONITORING INFRASTRUCTURE. Jonathan H. Sharp, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958, jsharp@udel.edu. **Plenary Speaker**, 8:00 pm, 1/23/07 (presentation #35).

In the past decade, increased international interest in developing a more coherent ability for long-term observations of potential anthropogenic impacts on the ocean has led to the Global Ocean Observing System (GOOS). Recent interest in including nearshore waters has led to development of regional ocean observing consortia in the US. As part of the mid-Atlantic coastal GOOS activity, a suggestion has been made for a pilot project in the Delaware Estuary that includes the watershed as well as coastal ocean (DEWOOS).

An effective DEWOOS program is critical for better management of one of the most critical estuaries and coastal regions of the US. The Delaware River watershed constitutes one of the largest drinking water systems in the country. The Greater Philadelphia ports as a unit is one of the largest in the US. A large industrial complex, including nuclear electrical generation capacity, can influence the ecology of the estuary and also comprises a major security target. The natural resources of Delaware Bay provide valuable recreational uses and valuable past and potentially larger future commercial fisheries capacity. The DEWOOS program should be important for maintenance of quality drinking water, protection of municipal and industrial security, and protection of living resources providing recreational and commercial amenities.

There are a number of examples of significant changes in water quality that can be documented with long-term discrete sampling monitoring programs. We can also make partial demonstrations of impacts of low-frequency (storm scale) events that have major potential impact on the ecology of the estuary; better continual measurements would make these easier to assess. Discussion of rare events in the nearby area (Chesapeake Bay, mid-Atlantic coastal waters) highlights the need for better ability to understand similar rare future events in the Delaware Estuary.

A reason for DEWOOS as a national pilot is that there are significant monitoring efforts, with long histories, that can be linked together for a comprehensive analysis of conditions along the full length of the Delaware River and Bay Estuary. In addition, the relatively simple geometric shape and physics of the Delaware Estuary makes a relatively simple characterization feasible with added continuous measurement fixed sites and use of AUV gliders for surveys of the baymouth to adjacent coastal ocean. The presentation will describe some of the extant monitoring programs, recent progress and plans for additional continuous measurement capabilities, and ideas for a comprehensive cooperative program in the near future.



TEACHING ESTUARIES 101 TO CONGRESS 110: WHAT, HOW, WHEN, AND WHY TO TELL THE NEW CONGRESS ABOUT THE BENEFITS OF SUPPORTING SCIENTIFIC INVESTIGATIONS IN THE DELAWARE ESTUARY. Larry J. Silverman, Esq., 7308 Birch Avenue, Takoma Park, MD 20912. ljoelsilverman@gmail.com. **Session 4**, panel, 1/23/07 (presentation #26).

The key to government relations success by the National Estuary Programs is to focus attention on the word “National”. The word “National” in the National Estuary Program imposes great responsibilities on individual program managers to understand how their work contributes to carrying out a national agenda. The word “National” also suggests great opportunities for winning substantial national support, financial and otherwise, in pursuit of other national objectives -- for climate change, energy, transportation, agriculture, Homeland Security, and so on. Plans for achieving these objectives will often not succeed without including a close examination of and careful planning for estuarine conditions, and compliance with estuarine laws.

Understanding of traditional watershed issues casts a brilliant and indispensable light on the great questions of energy, security, and climate change and perturbations, for example. Estuarine managers would do well to address the issue of how estuarine science and policy affect and are impacted by these other national concerns.

The identification of key national policies is done by the Congress and the President. Discerning policy trends takes attention but not extraordinary insights. The Estuary program needs to identify in turn the estuarine connection to National policy debates and decisions. One important role of the Estuary program is to provide crucial information in the sphere of its expertise to support decision making. The idea is to offer information that people are hungry for, or for which there is an underlying appetite. Decision makers, especially the Congress and the agencies, in these circumstances tend to be much more willing to pay the actual costs of information gathering. The designation of an Estuary of National Significance is of course a reflection on the importance, size and richness of the natural resource. However, the money committed to this program goes to the people who manage estuarine programs. The key to financial success is to demonstrate not just the importance of the estuary but the relevance of the scientific and management program to issues of high national priority.

All of these issues command large constituencies and some garner vast support. One approach to the new Congress is to communicate key estuarine and scientific considerations that should be supported and carried forward in connection with these policy directions. The author, who has been involved in the formation of national environmental policy since the creation of the National Estuary program, and many years before, will review how to transform these theoretical concerns into high levels of support.

The author is a member of the Washington, DC bar, a professional lobbyist, and an adjunct professor of Environmental Law and Policy at Johns Hopkins University in Baltimore and Washington, DC.



UNDERSTANDING TURBIDITY IN THE DELAWARE ESTUARY. Christopher K. Sommerfield, College of Marine and Earth Studies, University of Delaware, 700 Pilottown Rd., Lewes, DE 19958. cs@udel.edu. **Session 1**, 9:45, 1/22/07 (presentation #38)

Spatial gradients in estuarine turbidity (suspended-sediment concentration) arise from sediment fluxes generated by tidal and longer-term fluctuations in currents and sediment delivery from freshwater and marine sources. The origins of these fluxes can be deduced from time series records of sediment concentration and current flow, decomposed to rank the relative importance of specific transport mechanisms. In Delaware Estuary, knowledge of these mechanisms has been elusive despite a host of environmental and engineering concerns related to fine-grained sediment. Recent research conducted at the University of Delaware, however, has begun to shed new light on the underlying sediment dynamics toward a process-based understanding of the estuarine sedimentary system.

On average, 1.3×10^6 tonnes of suspended sediment is delivered annually to Delaware Estuary from its river tributaries, and an additional 3.4×10^6 tonnes is internally produced by erosion of the seafloor and shoreline. These sediment sources are approximately balanced by the main sinks, namely, maintenance dredging (2.8×10^6 tonnes) and estuary-marsh accumulation (2.1×10^6 tonnes). How and when land-derived sediment transits the tidal river and upper estuary to depositional sites in the lower estuary is a question of long standing, one with important morphologic and ecologic implications.

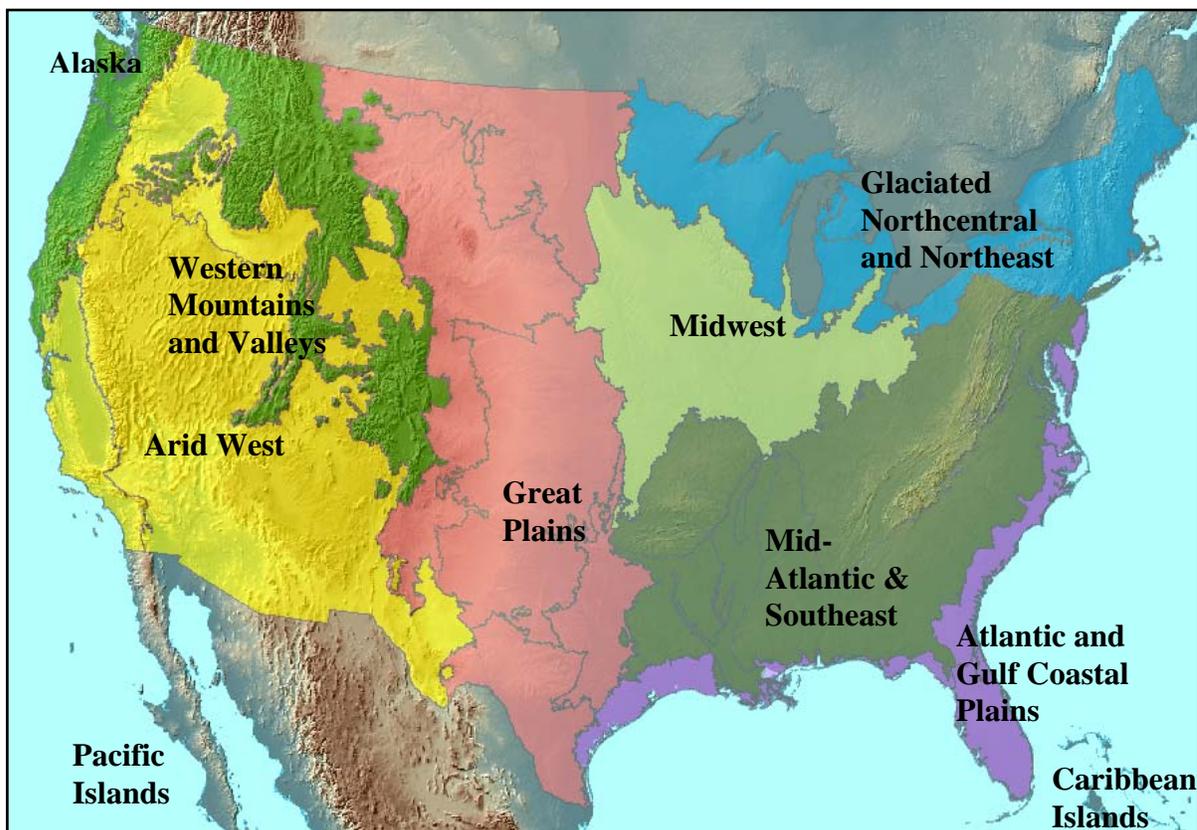
Beginning in 2003 and continuing through 2006, we performed a series of oceanographic observations to identify mechanisms of sediment mass transport among the tidal Delaware River, estuary and bay. The study involved short-term deployments of instrumented sensors, along with shipboard measurements in the estuarine turbidity maximum (ETM) zone. This quasi-stationary zone of elevated suspended-sediment concentration, typically resident in the lower estuary, moderates exchange of suspended matter between subtidal and intertidal environments. The goal of the measurement program was to quantify the magnitude and variability of tidal and residual sediment fluxes, throughout the ETM zone, and over the widest possible range of hydrological and meteorological conditions. Among other objectives, the data were analyzed to evaluate the relative importance of estuarine gravitational circulation and tidal pumping in maintaining the turbidity maximum. Significantly, the dataset includes the April 2005 flood, a 50-yr flow event, and thus provides a rare glimpse of the estuary under the influence of extreme freshwater discharge. In this presentation, highlights of these observations will be used to provide a generalized interpretation of turbidity maximum processes in Delaware Estuary.



OVERVIEW OF THE REGIONALIZATION OF THE 1987 CORPS WETLANDS

DELINEATION MANUAL. Ralph Spagnolo, U.S. Environmental Protection Agency, Region III, 1650 Arch Street, Philadelphia, PA 19103 (3WP10). spagnolo.ralph@epa.gov. **Session 3**, 3:45 1/22/07 (presentation #22).

The 1987 U.S. Army Corps of Engineers Wetland Delineation Manual has existed for approximately twenty years. The original document was written to identify wetlands that were common to the Mississippi Delta region. The indicators for hydrology, hydrophytic vegetation and hydric soils are a set of field tools used to identify jurisdictional wetlands across the country. However, wetlands vary across the continuum in each type have a unique set of characteristics that reflect the local ecology. To fine-tune and better identify federal jurisdictional wetlands based on regional variability, the U.S. Army Corp of Engineers is leading an effort to regionalize the federal manual. The regions are identified by the natural resources conservation service based on their identified Land Resource Regions. They are:



So far, the effort has been finalized with a 1-year trial period in Alaska. Additionally, the effort in the Arid West will be implemented shortly. The Mountains and Valleys along with The Great Plains regions are currently under review by the National Advisory Team which consists of different representatives from the federal agencies. The Midwest working group held its first meeting in November, 2006. The Atlantic and Gulf Coastal Plain effort began on December 5, 2006 in Atlanta, GA. This talk will explain the details about the federal process mentioned above and how it will affect the Delaware estuary.



DELAWARE BAY IS AN IMPORTANT FORAGING HABITAT FOR LOGGERHEAD TURTLES. **James R. Spotila**, Department of Bioscience and Biotechnology, Drexel University, 3141 Chestnut St., Philadelphia, PA 19104; **Pamela Plotkin**, Office of Research, East Tennessee State University, Johnson City TN 37614; and **John Keinath**, Department of Bioscience and Biotechnology, Drexel University, 3141 Chestnut St., Philadelphia, PA 19104. spotiljr@drexel.edu. **Session 2**, 1:45, 1/22/07 (presentation #58).

In 1996 and 1997 we carried out an in-water and aerial assessment of the presence of sea turtles in Delaware Bay. This involved netting surveys as well as angler surveys. At that time Delaware Bay was not considered to have any significant numbers of sea turtles inhabiting it. However, the Salem Nuclear Power plant had reported some strandings of Kemp's ridley turtles in previous years. We captured loggerhead turtles in trammel nets, received reports of loggerheads from fishermen and identified large numbers of loggerheads in our aerial surveys.

The density of loggerhead turtles in Delaware Bay is similar to the density of loggerheads in the Chesapeake Bay! Reports from satellite telemetry studies indicate that loggerheads migrate from their nesting beaches in the Carolinas and Georgia into and near the Delaware Bay during the summer months. This confirms the importance of the Bay as a foraging habitat for this species. Several turtles were located in and near the main shipping channel. We did not observe any Kemp's ridley turtles in the Bay during this survey and angler responses were not conclusive as to their presence. This is not surprising given the small size of this turtle. Thus, Delaware Bay is an important foraging habitat for loggerhead turtles during the summer months. We do not know if sea turtles over winter in the Bay. If they did so we would expect that they would hibernate in the deepest areas with soft mud. This would probably be in the shipping channel. The occurrence of loggerhead turtles and probably Kemp's ridley turtles in the Bay and the importance of the Bay to these species should be considered in any management activities taken in the Bay.

A COMPANY PERSPECTIVE ON LINKING SCIENCE, MANAGEMENT AND POLICY FOR ADDRESSING ISSUES ON THE DELAWARE ESTUARY. **Ralph G. Stahl, Jr.**, DuPont, Wilmington, DE 19805. ralph.g.stahl-jr@usa.dupont.com. **Session 4**, panel, 1/23/07 (presentation #102).

In this and other venues, we have described the importance of understanding the historical impacts of human and industrial development on urban rivers and their watersheds (see DeSantis et al., this conference). Without this historical perspective it is difficult to determine the source, magnitude and significance of stressors – physical, chemical or biological, on the watershed or estuary. This information and the understanding it brings are also crucial to developing effective management actions and policies that seek to address problem areas. Today there is no lack of agencies, academic institutions and non-governmental groups that have an interest in or which have worked on the Delaware River and Estuary. Each agency, academic institution and non-governmental group bring to the table specific strengths and areas of interest, some of which overlap and some that do not. One way that managers and policy makers can help to link the science and management of the Delaware River and Estuary is to foster greater communication and interaction among these diverse groups, and include those companies, municipalities and other stakeholders that share their goals and objectives for improving conditions in the area.



EARTH FORCE GREEN: YOUNG PEOPLE PROTECTING OUR WATERSHEDS. Janet Starwood and Colleen Contrisciane, Delaware Valley Earth Force, 100 Greenwood Ave. Wyncote, PA 19095. c.contri@verizon.net. **Session D**, 11:10, 1/23/07 (presentation #89).

Young people can be effective agents of environmental change. Earth Force GREEN (Global Rivers Environmental Education Network) is an experiential framework that takes young people beyond water quality monitoring to taking civic action to improve water quality and protecting their watersheds. GREEN helps students select a problem to address, devise a solution and implement an action project. Students practice watershed assessment protocols, analyze the results, identify environmental problems or threats, and develop plans for action based on their examination of their findings. The GREEN framework encourages student outreach to peers, parents, neighbors, business and community leaders, political representatives, and media in the investigation of watershed issues and implementation of watershed projects.

The Earth Force Watershed Awareness to Action poster and activity guide promote awareness and stewardship of waterways in the Delaware River Basin. Exploring issues on the poster prepares students to explore the real world of their urban watershed. The poster and the Earth Force GREEN framework are designed to generate youth action and stewardship around watershed quality and management issues, particularly with respect to non-point source pollution and the impacts of stormwater runoff.

EARTH FORCE WATERSHED AWARENESS TO ACTION. Janet Starwood, Delaware Valley Earth Force, 100 Greenwood Ave. Wyncote, PA 19095. c.contri@verizon.net. **Environmental Summit**, poster, 1/23/07 (presentation #52).

The Watershed Awareness to Action poster and activity guide is designed to promote awareness and stewardship of waterways in the Delaware River watershed. The poster serves as a tool for watershed education for adults and children, and the accompanying activity guide is designed for educators to use with their students. The goal of using the poster is to encourage both children and adults to work together on watershed quality issues in their communities—a vital component of successful efforts to protect and restore waterways in the Delaware River watershed. The depiction, which is large enough for group use, portrays activities that occur in our communities and watersheds on a daily basis and is designed to spark group discussion about how these activities impact water quality and the health of the environment. The poster shows people applying fertilizers or pesticides to lawns, children walking dogs without picking up pet waste, a motorist pouring motor oil in a storm drain, a park attendant mowing next to a stream bank, and other examples of the impacts of unsustainable human activities in the watershed. The poster provides an engaging visual introduction to key watershed concepts, such as point source and nonpoint source pollution. In addition, the depiction is generic enough for use by educators in other watersheds.

EVALUATION OF STATUS AND SUCCESS FOR A LARGE SCALE MARSH RESTORATION PROGRAM IN THE DELAWARE ESTUARY. Kenneth A. Strait and Brenda Q. Evans, PSEG Services Corporation, Estuary Enhancement Program, 130 Money Island Road, Salem, NJ 08079, kenneth.strait@pseg.com **Session 3**, poster, 1/23/07 (presentation #71).

Public Service Enterprise Group (“PSEG”), in response to the New Jersey Pollutant Discharge Elimination System permit for its Salem Generating Station, established the Estuary Enhancement Program (“EEP”) in 1994. The EEP is restoring over 4,550 ha of degraded salt marsh along the



Delaware Estuary. Designed to expand and protect the habitat for fish and other aquatic species, the EEP has implemented the restoration of diked salt hay farms and degraded *Phragmites*-dominated marshes. Data from a comprehensive monitoring program is used to evaluate the status and success of these marsh restoration efforts.

EEP restored normal daily tidal inundation and drainage to three formerly diked salt hay farm sites totaling 1780 ha during the period 1996–1998. Restoration of tidal exchange through removal of perimeter dikes, and excavation and construction of tidal channels and inlets, was completed by March 1998. Restoration of the four *Phragmites*-dominated sites totaling 2068 ha is a multi-phased program that includes *Phragmites* control through herbicide application and targeted marsh plain modifications. The initial restoration efforts on the *Phragmites*-dominated sites were completed in 1999 and supplemental *Phragmites* control continues on three of the four primary sites.

Monitoring of the restoration sites focuses on the structural and functional characteristics that promote production of finfishes: 1) re-establishment of desirable vegetation on the marsh plain; 2) restoration of a natural hydroperiod; and 3) re-establishment of natural geomorphology of marsh plain habitats. Interim and Final Success Criteria were established to define restoration trajectory and success based on conditions observed at reference marshes.

Examination of the data for the three restored salt hay farms indicates that two of the three sites are fully restored in advance of the expected restoration trajectory. The third salt hay farm site has met its Interim Success Criteria and is on the expected trajectory. Data for the four *Phragmites*-dominated sites indicates that *Phragmites* coverage has substantially declined, that the natural tidal creek drainage network has been restored, and that *Spartina*/other desirable species coverage has expanded into areas formerly dominated by *Phragmites*. One of the formerly *Phragmites*-dominated sites has met the Final Success Criteria. The other three sites have met the Interim Success Criteria and are approaching the Final Criteria.

Although not discussed here, additional monitoring of the structural and functional attributes of the fish assemblage (i.e., species composition and abundance, feeding, growth, survival and production) demonstrates that the restored marshes are also functioning like the reference marshes. PSEG's program has successfully restored natural and productive structure and function to the degraded wetlands.

FISH PRODUCTION FROM A LARGE SCALE MARSH RESTORATION PROGRAM.

Kenneth A. Strait, PSEG Services Corporation, Estuary Enhancement Program, 130 Money Island Road, Salem, NJ 08079, kenneth.strait@pseg.com. **Session 2**, 2:15, 1/22/07 (presentation #67).

PSEG is restoring over 4,550 ha of degraded salt marsh along the Delaware Estuary. PSEG used data collected within three formerly-diked salt hay farms (~1800 ha), and within the Delaware River, to estimate fish production using three independent methods: 1) a vegetation-based estimate (Aggregated Food Chain Model), 2) an ecosystem-based estimate (Ecopath with Ecosim), and 3) a fish abundance-based estimate.

Monitoring of vegetative cover and geomorphology on the restored marshes indicates that the restored marshes are structurally similar to adjacent reference marshes. Fish species composition, abundance, feeding, growth, survival and production within the restored marshes are also comparable to reference marshes.



Production of secondary consumer biomass was estimated using an Aggregated Food Chain Model (“AFCM”). The AFCM simplifies complex food web interactions by aggregating species and lifestages across similar trophic levels to reflect basic ecosystem function. The AFCM uses data on the biomass of aboveground vegetation within the restored marshes and applies three trophic transfer coefficients to estimate secondary consumer production. The aboveground net primary production on the restored marshes results in approximately 8.4 million kg/yr of secondary consumer production.

Ecopath with Ecosim (“EwE”) is a software package that is widely used for addressing ecological questions. EwE contains two main components: 1) a mass-balance snapshot of the ecosystem (Ecopath), and 2) a dynamic simulation model for predicting changes in biomass over time in response to changes in fishing policies, productivity and trophic interactions (Ecosim). The EwE model indicates that approximately 11 million kg/yr of secondary consumer biomass is attributable to PSEG’s salt hay farm restoration (approx. 1.9 million kg/yr for dominant fish species).

The fish abundance based method estimates production of age-0 fish biomass that occurs within the restored marshes and the annual production of age-0 fish biomass attributable to the restored marshes within the open Delaware Estuary. The average annual age-0 fish production attributable to the restored marshes for 10 species of fish was estimated to be 2.4 million kg/yr.

Estimates of production from the independent methods are not directly comparable to the AFCM, but provide corroboration. The EwE estimate for secondary consumer biomass is likely an underestimate of production because the P:B ratios for the dominant taxa are greater than 1. The fish abundance-based estimate for production of 10 species of age- 0 fish provides corroboration for the EwE method for biomass of the dominant fish species, and thereby for the AFCM estimate of production for all secondary consumers.

PROTECTING STREAM CHANNELS IN THE DELAWARE ESTUARY. Shandor J.

Szalay, F. X. Browne, Inc., 1101 South Broad Street, Lansdale, PA 10446.

sszalay@fxbrowne.com. **Session 1**, 9:00, 1/22/07 (presentation #7).

Post European settlement, stream channels in the Delaware Estuary watershed have been destabilized and/or altered from their natural form by a range of human activities. Historically, dam construction; channel straightening and piping, levee and bridge construction; and agricultural deposition have significantly destabilized stream channels. Today, the effects of urbanization on stream channels continue, primarily in the context of modifications to runoff patterns and wash loads. Unstable stream channels, particularly incising channels, continue to have significant but poorly quantified impacts including increased sediment loading to downstream waterbodies, habitat simplification and disruption, and damage to urban infrastructure. Restoration of highly unstable urban channels is often costly (with costs up to \$1,000 per linear foot) and failure rates are often high due in part to the complexity of urban stream channel dynamics and to the site specific (as opposed to basin wide) nature of many restoration efforts. While restoring destabilized stream channels will continue to be an important undertaking, strategies to prevent streams from becoming geomorphically unstable in newly developing areas are clearly badly needed.

Protecting naturally stable stream channels from becoming destabilized requires new approaches to land planning and conservation that are based on regionalized understanding of how streams respond to various levels of direct and indirect human disturbances. Research that enhances our



understanding of the causes and implications of destabilized stream channels will provide an important basis for future land planning in the region.

Topics for further research include: (1) To what extent do current channel forms reflect the legacy of past disturbances; (2) To what extent have stormwater management practices lessened the effects of urban land conversion on stream channel geomorphology; (3) To what extent do stream channels naturally restabilize without intervention following urbanization; (4) How long does this process take and what factors influence response time; (5) To what extent does disturbance history (e.g., the presence of legacy sediments) and intrinsic stream and valley characteristics such as slope, geology, and soil types influence the type and extent of stream channel responses to certain types of disturbance; (6) What are the cumulative economic consequences of destabilized stream channels; (7) How should land conservation planning and municipal land planning policies be changed to avoid destabilizing stream channels.

SPATIOTEMPORAL COMPARISONS OF DENSITY, GROWTH AND PRODUCTION OF YOUNG-OF-THE-YEAR WEAKFISH IN DELAWARE BAY AND MAJOR TIDAL TRIBUTARIES. Timothy E. Targett and Brian P. Boutin University of Delaware, College of Marine & Earth Studies, Lewes, DE 19958. ttargett@udel.edu boutin@udel.edu Session 2, 1:15, 1/22/07 (presentation #47).

We compared spatial and temporal dynamics in juvenile weakfish (*Cynoscion regalis*) density, growth and production in Delaware Bay vs. selected tidal tributaries to better define the most productive nursery habitats for this species in the Delaware Estuary. Weakfish were collected biweekly from July through October, 2005, using standardized otter trawl tows at three stations (3 km apart) in the lower portion of six tributaries (Broadkill River near the estuary mouth, Mispillion River, Murderkill River, St. Jones River, Simons River and Blackbird Creek in the upper estuary). Four adjacent bay sites (~1 km off the Broadkill, Mispillion, St. Jones/Murderkill and Simons Rivers) were sampled with the same frequency and techniques. Fish were frozen in the field and nucleic acids of individual fish were assayed in the laboratory. RNA:DNA was used to calculate short-term growth rates from established growth rate/RNA:DNA relationships. This paper reports results from the first year of a 3-year investigation. Numerical and biomass densities declined during the sampling period at all locations. Specific growth rate and production also showed an overall seasonal decline. Both growth and production rates plummeted in August (during a period of high temperatures) and rebounded somewhat in early September. Generally, numerical and biomass densities were higher in the bay sampling locations compared to the tributaries. Growth rates were consistently highest in the bay site off the Mispillion River. Highest production values, however, were found in the lower Murderkill and Mispillion Rivers where occasional very high biomass was coincident with high growth rates. This result suggests the absence of density-dependent growth for young weakfish in these tributary systems. Production was also consistently high in bay sites off the Mispillion and Simons Rivers, due to high biomass at both locations and high growth rates particularly at the Mispillion bay site. These results suggest the most productive nursery areas for young weakfish in the Delaware Estuary are found in the lower portions of mid-bay tidal tributaries and the adjacent open bay. Results will be discussed in terms of potential approaches to a) assessing patterns and processes of fish productivity in the Delaware Estuary and b) examining limitations imposed by abiotic and biotic environmental conditions.



LINKING SCIENCE AND SOCIETY: AN OVERVIEW OF THE DEVELOPING NATIONAL PRIORITIES FOR OCEAN RESEARCH. Nancy M. Targett, College of Marine and Earth Studies, University of Delaware, Newark, DE 19716, ntargett@udel.edu. **Session 10**, 3:45, 1/24/07 (presentation #62).

The Oceans Act passed by Congress in 2000 set in motion a comprehensive review of U.S. Ocean Policy. To date, significant outcomes of this Act include: the report of the U.S. Commission on Ocean Policy, *An Ocean Blueprint for the 21st Century*; the President's response, *An Ocean Action Plan*; the creation of a cabinet-level Committee on Ocean Policy; and the development of a draft Ocean Research Priorities Plan (ORPP). The draft ORPP, *Charting the Course for Ocean Science in the United States: Research Priorities for the Next Decade*, was developed by the U.S. Joint Subcommittee on Ocean Science and Technology; a group composed of representatives from the 25 federal agencies that support ocean science research. It represents the first coordinated national planning exercise undertaken by these agencies. Input into the draft document was solicited from academia, industry, and NGO's to complement the information provided by the federal agencies. The draft plan, delivered in August 2006, identifies six themes that are thought to represent the key areas of human interaction with the ocean: 1. Stewardship of Our Natural and Cultural Resources, 2. Increasing Resilience to Natural Hazards, 3. Enabling Marine Operations, 4. The Ocean's Role in Climate, 5. Improving Ecosystem Health, 6. Enhancing Human Health. Included within the framework of the six themes are a total of 25 priorities; 4 are near term and 21 are longer term.

The ORPP represents a collaborative effort to develop a strategy for U.S. ocean research in the next decade. There are obvious benefits to be gained from elevating the ocean science agenda in a cohesive way at the national level (e.g., visibility, funding). However, to fully realize these benefits it is critical that there be a clear connection between the research priorities and the underlying societal needs. The Delaware Estuary is an ideal microcosm within which to discuss the implications for, and implementation of, the ORPP.

PRELIMINARY INVESTIGATIONS OF CONSTRUCTED OYSTER REEF HABITAT IN LOWER DELAWARE BAY. Jaclyn Taylor and David Bushek, Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349. jaclynt@eden.rutgers.edu. **Session 8**, poster, 1/23/07 (presentation #23).

In June 2006, a preliminary small-scale oyster restoration project began at Rutgers University's Cape Shore Hatchery Facility near Green Creek, NJ. The Cape Shore is an extensive high energy intertidal zone with consistently high oyster recruitment, but high predation, disease and other factors apparently limits the formation of oyster reefs. This region of the Bay is an important spawning habitat for Horseshoe Crabs *Limulus polyphemus* and foraging zone for shore birds which is being threatened by shoreline erosion. The establishment of oyster reefs could protect the shoreline and enhance beach habitats.

To evaluate variations of one reef construction method, experimental reefs of varying height were constructed in the intertidal zone of the lower Delaware Bay where there is the possibility for high oyster (*Crassostrea virginica*) recruitment rates but oyster populations are restricted by high predation rates and sparse hard substrates. About 200 shell bags were constructed and deployed to form three 1.5m x 3m reefs varying height from one to three layers of shell bags. The constructed reefs are being monitored for stability, oyster recruitment and growth, sedimentation rates and colonization by benthic and motile species. Preliminary data will be presented on the sediment stabilization around the three experimental reefs, the fauna associated with the reef habitat and oyster recruitment. Initial data indicates the potential habitat value of constructed reefs in the



lower Delaware Bay. These and other benefits have not been documented nor demonstrated in Delaware Bay and there are no efforts underway to compare secondary impacts of different kinds of oyster enhancement and restoration methods.

THE IMPORTANCE OF INDEPENDENCE AND ADVOCACY. **Maya K. van Rossum**, The Delaware Riverkeeper Network, 300 Pond Street, Second Floor, Bristol, PA 19007. keepermaya@delawareriverkeeper.org. **Session 4**, panel, 1/23/07 (presentation #6).

It is not uncommon for the science and studies used to support permit decisions to be conducted by the permittee, by the discharger, by the developer and to only receive after the fact review from agency resources. But the outcome of the science is very much dictated by the underlying assumptions made, the models chosen, the guiding studies and principles relied upon. The debate over the impacts of the proposed Delaware River deepening, the impacts of dumping VX nerve agent waste into the Delaware River, the impacts of PSE&G's Salem Nuclear Generating station and the use of herbicides on thousands of acres of sensitive wetlands are all based upon and around the science submitted by the Army and Dupont, the Army Corps and PSE&G (respectively). Rarely is there independent scientific study or review conducted prior to, or in an effort to inform, the decisions that have to be made. In order to lift the cloud of suspicion, in order to ensure full and independent scientific study and review, the science used to inform decisions such as these needs to be conducted by agency scientists or third party consultants with no ties to the industry being reviewed.

In addition, the value of ecological advocacy based on sound science needs to be nurtured and respected. In order to ensure the best decisions possible for protection and restoration of the Delaware Estuary, it is important that voices dedicated to the River are nurtured and heard. Without advocacy spreading the word, science is easily ignored in the decisionmaking process. In addition, regarding advocacy, when everyone is expected to compromise, intends to join the table in order to negotiate a reduced level of protection or restoration, then the outcome for the River is genuinely greatly reduced. Strong, river oriented advocacy based on sound science and the needs of our many communities raises the bar in terms of ultimate decisionmaking and is an asset to the region, not a hurdle to be overcome.

DO LOW-FREQUENCY WATERSHED INPUTS HAVE A MAJOR IMPACT TO THE DELAWARE ESTUARY? **Yoana Voynova** and **Jonathan H. Sharp**, College of Marine and Earth Studies, University of Delaware, Lewes DE 19958. yvoynova@udel.edu. **Session 5**, 1/23/07 (presentation #33).

From our long time research effort, we have characterized five segments within the Delaware Estuary: 1) the upper tidal river, which extends from the Delaware River watershed fall line, 2) the urban river, with major nutrient inputs from Philadelphia municipal area, 3) the turbidity maximum, with high suspended particle concentrations from re-suspension of in-situ sediments, 4) the mid-bay, with highest primary production, and 5) the lower bay, characterized by low nutrient concentrations.

Typically, we observe that the nutrient and dissolved organic matter (DOM) concentrations are moderate in the upper tidal river, peak in the urban river region, and are diluted to low concentrations in the lower bay

(down the estuary's salinity gradient). Suspended sediment concentrations are comparatively low in the upper river, peak in the turbidity maximum region and decrease in the mid- to lower bay.



We have documented occasional large watershed inputs of nutrients, DOM, and total suspended sediments from storm events, which seem to significantly alter the typical conditions in the Delaware estuary mentioned above. We attempt to better evaluate the impact of these low-frequency watershed inputs, through examining long-term records: in addition to our 27 year database, we examine the DRBC boat-run database (38 years long), as well as the USGS daily stream discharge (over 95 years), and the USGS daily suspended sediments (over 33 years) databases at Trenton, NJ. Preliminary analysis demonstrates a strong correlation ($R^2 = 0.76$) between high discharge events and elevated suspended sediment concentrations, and supports our observations of large sediment inputs during storm events.

We hypothesize that climate change may affect the occurrence of low-frequency events, as it has been previously suggested to influence the mean annual river discharge.

PHILADELPHIA WATER DEPARTMENT'S TOOKANY/TACONY-FRANKFORD PARTNERSHIP: FROM PARTNERSHIP TO INDEPENDENT NONPROFIT. **Jeanne Waldowski**, Philadelphia Water Department, Office of Watersheds, 1101 Market Street, Philadelphia, PA, 19107. jeanne.waldowski@phila.gov. **Session C**, 9:35, 1/23/07 (presentation #85).

The highly urbanized Tookany/Tacony-Frankford (TTF) watershed experiences all of the urban ills – including litter and illegal dumping, “channelization” of portions of the stream, steeply eroded streambanks, degraded aquatic and riparian habitat, and impaired water quality. In 2000, the Philadelphia Water Department (PWD) launched the TTF Watershed Partnership, a groundbreaking effort to connect diverse stakeholders as neighbors and stewards of the watershed.

The group’s mission to improve and enhance the parks, streams, and surrounding communities in the TTF Watershed was accomplished through biological assessments; volunteer visual assessments; rain barrel workshops; and the development, completion, and implementation of a River Conservation Plan (RCP).

Over the three year study period, PWD collected water quality samples from many locations throughout the watershed and analyzed them for numerous water quality parameters. PWD biologists also performed physical habitat, fish and benthic macroinvertebrate assessments to complement the water chemistry data. Our challenge was involving the public in a very real way to encourage their unique connections to the stream.

The Volunteer Visual Assessments were a great way to get the community out to their local streams and teach them the benefits of a healthy waterway. Visual assessments aide in determining the condition of a stream as well as the surrounding riparian area.

The Rain Barrel project encompassed distributing rain barrels to residents in the TTF Watershed and the surrounding areas. Seven formal rain barrel workshops were held in all as well as various informal neighborhood workshops that were held.

The River Conservation Plan (RCP) addresses the natural and neighborhood amenities in the entire watershed and creates a prioritization strategy for obtaining state funding for community-based improvements.

The volunteer stream assessments, rain barrel project, and RCP have been integrated into every Partnership plan since the success of the TTF plan.



In 2005, the TTF Partnership formally incorporated as an independent nonprofit, composed of environmental organizations, community groups, municipal governments, and other watershed stakeholders. Now, the Partnership has embarked on implementing the one million dollar integrated watershed management plan, which is the overarching plan that includes the RCP and all other “environmental” plans in the watershed.

The accomplishment of the TTF Partnership to the formation of this 501C3 nonprofit partnership is the only project of its kind for the PWD and the City of Philadelphia. The TTF Partnership model will be utilized in the conception and development of our future partnerships.

A HYDRAULIC STUDY OF THE CHESAPEAKE AND DELAWARE CANAL. **Nicholas Dudley Ward**, Department of Civil, Environmental and Architectural Engineering, Drexel University, 3141 Walnut Street, Philadelphia, PA 19104; **Jeffrey A. Gebert**, US Army Corps of Engineers, Philadelphia District, 100 Penn Square East, Philadelphia, PA 19107; and **J. Richard Weggel**, Department of Civil, Environmental and Architectural Engineering, Drexel University, 3141 Walnut Street, Philadelphia, PA 19104. nicholas.f.dudleyward@drexel.edu. **Session 1**, 9:30, 1/22/07 (presentation #34).

We document the development and application of a 1-D flow model of the C&D Canal based on the dynamic form of the St. Venant equations. Model geometry is based on hydrographic surveys obtained by the US Army Corps of Engineers (USACE) in 2006. The model is forced with time-varying tidal boundary conditions at the east and west ends of the Canal, and predicts velocity and discharge at selected locations within the Canal. The model was calibrated using current meter data obtained between October 1992 and October 1993, when USACE operated recording current meters in and adjacent to the Canal. Calibration established the appropriate values for Manning’s n and the channel bottom slope. Following selection of these parameters, the model was run to simulate other periods between October 1992 and October 1993. Comparison of model and prototype current speeds for these simulations demonstrates the ability of the model to reproduce observed flows accurately under a wide range of tidal and hydrological conditions. Notable events that were modeled include the mid-Atlantic northeaster of December 1992, when high water in the Delaware estuary drove a continuous westward flow through the Canal for about 60 hours. Also, the large spring freshet of the Susquehanna during March and April 1993 was successfully simulated.

The principal finding of this analysis is that there is a long-term net eastward flow in the C&D Canal that is likely driven by the higher mean sea level at the west end (Town Point, MD) compared to MSL at Reedy Point, DE, at the east end. Analysis of the 1992-93 current meter data indicates a long-term net non-tidal flow of about 4,000 CFS to the east. This value can be compared to the long-term mean discharge of the Susquehanna River at Conowingo, MD - 40,000 cfs - and to the same parameter on the Delaware River at Trenton, NJ - 12,000 cfs. The C&D Canal thus has a measurable impact on water quality and salinity of the two estuaries it connects. The model should be considered a useful screening tool to estimate long-term flow impacts of potential changes to geometry of the Canal, or to simulate the shorter-term impacts of transient hydrological or tidal events that perturb ordinary astronomic tidal boundary conditions of the system.



CLEAR INTO THE FUTURE, A DUPONT DELAWARE ESTUARY INITIATIVE. Dawn R. Werry, DuPont, Wilmington, DE 19805. dawn.r.werry@usa.dupont.com. **Environmental Summit**, poster, 1/23/07 (presentation #41).

Clear into the Future is a community initiative with a common goal—preserving the beauty and integrity of the Delaware River for generations to come. DuPont recognizes that the Delaware River is a beautiful resource to our community, in addition to being a multi-use waterway. Because we strongly believe this natural treasure should be respected and appreciated, we have joined with the community to protect it. Clear into the Future, a DuPont Delaware Estuary Initiative, is an ongoing commitment to maintain and improve the Delaware Estuary for the future.

One of the pillars of Clear into the Future is its education component. To that end, the program sends a robot named Professor Green to engage elementary school students at assemblies in the region. The professor captures the children's attention, showing them why the Delaware River Estuary is important and explaining how they can help preserve it.

Another pillar of the project pertains to science-related projects and research to help drive improvements in the Estuary. By teaming the historical excellence of DuPont science and environmental stewardship with the enthusiasm of the community, Clear into the Future is poised to make a positive impact on the Estuary. The scientists at DuPont are already contributing technical assistance to other organizations in the area. For example, volunteers from DuPont periodically test different brands of dish soap to verify which is most effective in cleaning oiled birds for Tri-State Bird Rescue.

Clear into the Future has also jumped on board with a number of other special projects in the watershed, lending its science expertise where applicable. Spring of 2007 will mark the opening of the DuPont Nature Center at Mispillion Harbor Reserve, a family nature center constructed in cooperation with DNREC. Additionally, the horseshoe crab bait substitution project being undertaken by the University of Delaware and a shad restoration project being funded by the Brandywine Conservancy are two projects on the horizon that Clear into the Future is excited to get involved with.

USING YOUR WEBSITE AS A TEACHING TOOL. Vivian Williams, Education Department, Stroud Water Research Center, 970 Spencer Rd., Avondale, PA 19311. vwilliams@stroudcenter.org. **Session D**, 11:50, 1/23/07; and poster, 1/23/07 (presentation #43 and 91).

The Stroud Water Research Center, www.stroudcenter.org, is a research and education institution dedicated to the study of streams and rivers. The mission of our education department is to make the research of the Center's scientists and others more accessible to the public, and we are increasingly using our website as an instructional tool in professional development workshops, as a reference for student projects, and as an effective way to reach a large audience. My presentation at the Environmental Summit will include information about one of our established educational programs, the Leaf Pack Network[®] as well as recent activities and programs that we have developed based on the data generated by our scientists and displayed on our website.

The Leaf Pack Network[®] has been one of our most successful projects. It involves placing artificial leaf packs in a stream, thus replicating the natural process of autumn leaves forming packs as they get caught on fallen branches and exposed rocks in the water. Participants learn scientific



principles and gain an understanding of how streams function as ecosystems. They can then communicate their data to the global community through the Leaf Pack Network[®]. Here is an opportunity for students to connect the food web to the World Wide Web whether they are a registered participant or a website visitor.

In addition, the Stroud Center's scientific research projects are described on our website and offer opportunities for case studies, data analysis and learning activities using downloadable photographs, maps and diagrams. Current projects include: The Schuylkill River Project, Stroud Center Research Project in Madre de Dios, Peru, Water Quality Monitoring in the Source Water Areas for New York City, and local monitoring data from long term study sites. Finally, our website has chemical and physical measurements and baseline data on aquatic macroinvertebrates collected from numerous locations, all of which can be used to describe and evaluate both current and long-term water and habitat quality.

Water quality assessments derived from the data are available for educational outreach and will hopefully encourage students and community groups to assess, monitor, improve, and/or protect their streams and rivers.

DELAWARE BAY BENTHIC MAPPING PROJECT: ADDRESSING THE FORGOTTEN RESOURCE IN COASTAL MANAGEMENT. Bartholomew D. Wilson and David B. Carter*, Delaware Coastal Program, Division of Soil and Water Conservation, DNREC, Dover, Delaware 19901. David.Carter@state.de.us. **Session 2**, 1:00, 1/23/07 (presentation #21).

The Coastal Program of Delaware's Division of Soil and Water Conservation (DNREC), the University of Delaware, Partnership for the Delaware Estuary, and the New Jersey Department of Environmental Protection have partnered is carrying out a bottom and sub-bottom imaging project to identify and map the benthic habitat and sub-bottom sediments of Delaware Bay and River. This project was initiated to better understand the distribution of bottom sediment types, habitat, biodiversity, and most importantly humans impact on the bay bottom and its living resources.

This project integrates the use of three types of acoustical systems: Roxann seabed classification system, chirp sub-bottom profiling, and multi-beam bathymetric mapping. Verification of the acoustic data with bottom and sub-bottom sediments is performed through the collection of grab and core samples and underwater video images.

Having now completed its third year of an expected seven year timeline, 245 square miles of bay bottom has been mapped, approximately 35% of the total area. This has already resulted in a greater understanding of the local and region sediment distribution patterns and transport pathways, in addition to an enhanced awareness of the local and regional habitat patterns for several species of interest within the Delaware Estuary.

With an integrated scientific approach, the project hopes to fill many of the existing data gaps that exist in the background information necessary to successfully manage this important resource. Many of the existing needs for benthic data are directly related to the lack of information on the potential impact to the benthic habitat due to human interaction with the bay bottom (i.e. beach replenishment, benthic habitat damage due to fisheries dredging and anchor scars, and chemical spills). By utilizing the benthic mapping project's collected data, resource management may now: identify sand resources for beach replenishment that satisfy grain size requirements while minimize the impact upon ecologically rich areas of biodiversity, identify locations for marine protection, monitor dredge sites recovery, and enhance emergency response monitoring.



Through this project, Delaware continues to develop and provide biodiversity information on this relatively unknown resource, which includes mapping oyster beds and worm “reefs” (*Sabellaria vulgaris*), artificial reef monitoring, monitoring critical habitat areas for a variety of organisms including horseshoe crabs, key fish species, and macro-invertebrates. Through identifying and mapping the benthic habitat and sub-bottom sediments of the Delaware Bay, and supplying this information in GIS format, decision makers and stakeholders will have access to critical data that will allow them to successfully manage and conserve Delaware’s coastal zone.

MAPPING THE DISTRIBUTION AND HABITAT OF OYSTERS IN THE UPPER DELAWARE BAY. **Bartholomew D. Wilson**, Delaware Coastal Program, Division of Soil and Water Conservation, DNREC, Dover, Delaware 19901; **David G. Bruce**, NOAA Chesapeake Bay Office, Cooperative Oxford Laboratory, Maryland 21654; **John Madsen**, University of Delaware, Department of Geology, Newark, Delaware 19711; and **David B. Carter**, DNREC (see above). Bartholomew.Wilson@state.de.us. **Session 6**, 1:45, 1/23/07 (presentation #20).

The decline of the oyster industry along the mid-Atlantic region has initiated Delaware Department of Natural Resources, Partnership for the Delaware Estuary, and the New Jersey Department of Coastal Management to partner in an attempt to assess the status of the oyster habitat in the Delaware Bay. As part of the Coastal Program of the Delaware Department of Natural Resources and Environmental Control project to identify and map the benthic habitat and sub-bottom sediments of the Delaware Bay, remote acoustics (Roxann Seabed Classification and Chirp Sub-bottom profiler) along with field verification, were utilized to map 150 square miles of prime oyster habitat.

This project has identified the spatial extent and relative density of oyster shell on the bay bottom, while also determining the composition of the regional surrounding sediments. As a whole, 245 square miles of bay bottom has been mapped, which has resulted in a greater understanding of the local and region sediment distribution patterns and transport pathways.

Bottom and sub-bottom sediment maps were compiled into an ArcMap database, which included all historical oyster bed outlines and oyster dredge abundance data. The full integration of this data allowed, for the first time, a comprehensive spatial assessment of current oyster bottom conditions, in addition to overall bottom sediment conditions. Integration of the acoustic mapping and database development by the Delaware Coastal Program was conducted with the intent of greatly improving the management of the Delaware Bay resources, such as the role of oyster trawl data in distribution and habitat studies.

DELAWARE INTEGRATED MARSH MONITOR NETWORK: EVALUATING SEDIMENTATION AND SEA-LEVELS EFFECTS ON MARSH SURFACE ELEVATION AND EVOLUTION. **Bartholomew D. Wilson**, Delaware Coastal Program, Division of Soil and Water Conservation, DNREC, Dover, Delaware 19901; **Robert Scarborough**, Delaware National Estuarine Research Reserve, Division of Soil and Water Conservation, DNREC, Dover, Delaware 19901; **David B. Carter**¹, DNREC DCP (see above); and **Donald R Cahoon**, Patuxent Wildlife Research Center, United States Geological Survey, Beltsville, MD 20705. Bartholomew.Wilson@state.de.us. **Session 1**, 9:15, 1/22/07 (presentation #28).

As suburban sprawl encroaches into New Castle and Kent Counties and global sea-level rise irreversibly impacts the entire coastal zone, the holistic effects of human alteration and development upon estuarine system’s evolution become a major area of concern of study.

Utilizing a comparison of two valley fill estuaries along the Delaware Bay coast, one greatly



influenced by anthropogenic alteration (St. Jones River Estuary; i.e. ditching, channel straightening, and increased surface run-off) and a relatively pristine estuary (Blackbird Creek Estuary), the Delaware Natural Estuarine Research Reserve (DNERR) is attempting to develop a marsh evolution and surface elevation monitoring network. An integrated approach to marsh monitoring through the use of Sediment-Elevation Tables (SET's), radiometric analysis (PB^{210} and Cs^{137}), palynology, and stratigraphic analysis will enable the DNERR to evaluate these two marshes response to global sea-level rise and the effect of anthropogenic encroachment. Stratigraphic analysis will enable the response of a marsh to rising sea level to be modeled from past transgressive sequences preserved in the subsurface sediments. While radiometric and palynology analysis are being used to compare rates of sedimentation over the past two hundred years to current sedimentation rates. Comparing an altered estuary to a pristine estuary will allow the full effects of human impact on natural marsh evolution to be full assessed.

The rates of anthropogenic and natural sedimentation can be measured through the use of a Sediment-Elevation Table (SET), which can be used to determine both the influence of a single meteorological event on sediment surface elevation and a long-term trend (i.e. decades) in elevation change. The SET measurements allow the magnitude of increased runoff of particulate matter from the areas of development and disturbance, as well as the natural subsurface and surface processes, to be full assessed and quantified. After understanding the dominant factors that influence sediment elevation changes in the estuary can we then understand the impact that increased anthropogenic sedimentation is having upon the system and how the system will respond through time to increase global sea-level.

The estuaries ability to pace sea-level rise is directly correlated with the rate of elevation change along the marsh surface. The equilibrium between natural sedimentation and sea-level relay how well the marsh will react to long-term and rapid shifts in the rate of sea-level change. Therefore, anthropogenic alterations to the system can cause lasting shifts in the equilibrium and may accelerate marsh loss, as a result of sea-level rise.

NOAA'S COMMUNITY-BASED RESTORATION PROGRAM: RESOURCES FOR COASTAL HABITAT RESTORATION Craig A. Woolcott, NOAA Fisheries Restoration Center, NMFS, Sandy Hook Field Office, 74 Magruder Road, Highlands, NJ 07732. Craig.Woolcott@noaa.gov. Session 9, panel, 1/24/07 (presentation #75).

The NOAA Restoration Center (RC) enhances living marine resources to benefit the nation's fisheries by restoring their habitats. The NOAA Restoration Center plans, implements, and funds coastal restoration projects throughout the United States and is the focal point for marine and estuarine habitat restoration within NOAA. The Restoration Center (housed in the National Marine Fisheries Service, Office of Habitat Conservation) performs restoration pursuant to federal legislation and improves the state of restoration ecology and habitat management. Working with others, the Restoration Center achieves its mission by:

- Restoring degraded habitats
- Advancing the science of coastal habitat restoration
- Transferring restoration technology to the private sector, the public and other government agencies
- Fostering habitat stewardship and a conservation ethic

The RC is home to the NOAA Community-based Restoration Program, a highly successful program that involves communities in the restoration of local marine and estuarine habitat. Partnerships with Federal agencies, states, local governments, non-governmental and non-profit organizations, businesses, industry and schools have helped over 1500 local organizations restore



marine and coastal habitats through over 900 projects around the United States. NOAA Fisheries and its partners provide funding and expertise to numerous coastal community projects that promote coastal stewardship and a conservation ethic. Through partnerships, the Community-based Restoration Program has been able to leverage \$3-\$5 for every Federal dollar invested. The CRP works through direct grants and subawards granted by our Habitat Restoration Partners.

USING REAL TIME MONITORING FOR REAL TIME MANAGEMENT. John Yagecic, Delaware River Basin Commission, 25 State Police Dr., West Trenton, NJ 08628. John.Yagecic@drbc.state.nj.us. **Session 5**, 11:45, 1/23/07 (presentation #29).

The increasing availability of real-time monitoring data via the internet improves resource managers' abilities to make real time decisions affecting their biological and aquatic resources. Raw measurements alone, however, are typically not sufficient to support complex decision making processes. Information must be processed and combined in the context of tools and points of comparison to be meaningful. Similarly, data reporting systems gain usefulness when coupled with automated retrieval systems and alerts, to capture and process measurements and to ensure that managers and decision makers are informed in a timely manner. The Delaware River Basin Commission and its partners are developing new tools to harvest and utilize real time data for more effective management of basin aquatic resources. This presentation will briefly discuss the development status of new products including: (1) a real-time flow and transport model for the Delaware Estuary; (2) an e-mail alert system for water quality featuring several stations in the Delaware Estuary; and (3) an e-mail flood warning system. We will also describe the Delaware Valley Early Warning System, developed by the Philadelphia Water Department.

The real time flow and transport model retrieves data from USGS and NOAA web sites, populates a model input file, runs a hydrodynamic model, and processes output. All of these activities are automated and occur overnight without user input. The water quality e-mail notification system compares real time water quality measurements at USGS and NOAA stations, compares values to applicable criteria, and generates and sends an e-mail warning to a list server when observations are outside criteria. Similarly, the e-mail flood warning system retrieves forecasted river stages at various stations in the non-tidal river, and generates and sends an e-mail to a list server when forecasted stages exceed flood action levels. NOAA has adopted the original algorithm from the flood warning product and developed a national flood warning product. Finally the Delaware Valley Early Warning System provides a secure web-based clearinghouse for spill notifications and real-time monitoring at water intakes. This presentation will also include a very brief case study surrounding an actual release in spring 2006, which highlights how the components are used together to protect water resources.

While the existing products are useful individually, they offer the prospect of combining and processing various data sets to generate higher value real time information. As DRBC and its partners strive to link science and management, we seek to enhance our dialogue with resource managers to determine what real-time derived information would prove most beneficial to the management of estuary aquatic resources.



Pre-Registered Participants 2007

Note: Contact information was obtained from registration forms and correspondence, and so it may be incomplete or inaccurate. Some participants declined to be listed.

Bob Adams
Wissahickon Valley Watershed
12 Morris Rd
Amber, PA 19002
Phone: 215-646-8866
Email: bob@wvwa.org

Jeff Ashley
Philadelphia University
8 Brynwood Manor
Narberth, PA 19072
Phone: 215-951-2779
Email: ashleyj@philau.edu

Jenn Adkins
Partnership for the Delaware Estuary
One Riverwalk Plaza,
110 S. Poplar St., Suite 202
Wilmington, DE 19801
Phone: 302-655-4990 x112
Email: JAdkins@delawareestuary.org

Harold W. Avery
Department of Bioscience and
Biotechnology, Drexel University
3141 Chestnut St.
Philadelphia, PA 19104
Phone: 856-630-1708
Email: haltort@aol.com

Bob Allen
The Nature Conservancy
2350 Route 47
Delmont, NJ 08314
Phone: 609-861-0600
Email: rallen@tnc.org

Russell M. Babb
NJDEP Bivalve Field Station at the
Haskin Shellfish Research Laboratory
6959 Miller Ave., Suite A
Port Norris, NJ 08349
Phone: 856.785.0730
Email: rbabb@gtc3.com

Maggie Allio
Montgomery County Conservation District
43 Level Rd
Collegeville, PA 19426
Phone: 610-489-4506
Email:
mallio@montgomeryconservation.org

Shaun Bailey
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar St., Suite 202
Wilmington, DE 19801
Phone: 302-655-4990 x113
Email: SBailey@delawareestuary.org

Tricia Arndt
Delaware Coastal Management Program89
Kings Highways
Dover, DE 19901
Phone: 302-739-9283
Email: tricia.arndt@state.de.us

Karen Barker
Tatnall School
1501 Barley Mill Rd
Wilmington, DE 19807
Phone: 302-892-4298
Email: barker@tatnall.org



Chris Bason
DE Center for Inland Bays
39375 Inlet Rd
Rehoboth Beach, DE 19971
Phone: 302-226-8105
Email: chrisbason@inlandbays.org

Nature Conservancy
URI Narragansett Bay Campus
South Ferry Rd
Narragansett RI 02882
Phone: 401-874-6870
Email: rbrumbaugh@tnc.org

Dottie Baumgarten
Oak Lane Day School
37 Stenton Ave
Blue Bell, PA 19422
Phone: 610-825-1055
Email: dbaumgarten@oaklanedayschool.org

Katherine Bunting-Howarth
DNREC
89 Kings Highway
Dover, DE 19901
Phone: 302-739-5726
Email: Katherine.howarth@state.de.us

James Bennett
US EPA, Region 3
1650 Arch St
Philadelphia PA 19103
Phone: 215-814-5469
Email: Bennett.james@epa.com

William Burton
VERSAR, INC
9200 Rumsey Rd
Columbia, MD 21045
Phone: 410-740-6086
Email: burtonwill@verdar.com

Ray Bivens
DE State Parks
152 South State St
Dover, DE 19901
Phone: 302-739-9189
Email: raymond.bivens@state.de.us

David Bushek
Rutgers Haskin Shellfish Research Lab
6959 Miller Avenue
Port Norris, NJ 08349
Phone: 856-785-0074
Email: bushek@hsrl.rutgers.edu

Matt Blake
American Littoral Society
Sandy Hook
Hightlands, NJ 07732
Phone: 732-291-0055
Email: matt@littoralsociety.org

Lance Butler
Philadelphia Water Department
1500 E. Hunting Park Avenue
Bureau Laboratory Sciences
Philadelphia, PA 19124
Phone: 215-685-4947
Email: lance.butler@phila.gov

Mark L. Botton
Fordham University
Dept. of Natural Sciences
113 West 60th St.
New York, NY 10023
Phone: 212-636-6327
Email: botton@fordham.edu

Lisa Calvo
RUTGERS, HSRL
6959 Miller Ave
Port Norris, NJ 08349
Phone: 856-785-0074, ex-4315
Email: calvo@hsrl.rutgers.edu

Rob Brumbaugh



Ryan B. Carnegie
Department of Environmental and Aquatic
Animal Health
Virginia Institute of Marine Science
Gloucester Point, VA 23062
Phone: 804.684.7713
Email: carnegie@vims.edu

Dave Carter
DNREC Division of Soil & Water
Delaware Coastal Program
89 Kings Highway
Dover, DE 19901
Phone: 302-739-3451
Email: david.carter@state.de.us

Beth Ciuzio
NJ Audubon Society
Rancocas Nature Center
600 Rte 47 North
Cape May Court House, NJ 08210
Phone: 609-861-0700
Email: beth.ciuzio@njudubon.org

Kathleen Clark
NJ DFW
2201 RT 631
Woodbine, NJ 08270
Phone: 609-628-2108
Email: kclark@gte3.com

Kimberly Cole
Delaware Coastal Management Program
89 Kings Highways
Dover, DE 19901
Phone: 302-739-9283
Email: kimberly.cole@state.de.us

Matthew Colip

EPA, Region III
1650 Arch St
Philadelphia, PA 19103
Phone: 215-814-5417
Email: colip.matthew@epa.gov

Carol R. Collier
Delaware River Basin Commission
25 State Police Drive
West Trenton, NJ 08628
Phone: 609-883-9500, Ext. 200
Email: carol.collier@drbc.state.nj.us

Colleen Contrisciane
Earth Force
100 Greenwood Ave
Wyncote, PA 19095
Phone: 215-884-9888
Email: c.contri@verizon.net

Amanda DeSantis
DuPont
4417 Lancaster Pike,
Barley Mill Plaza, Bldg 19-1124
Wilmington, DE 19805
Phone: 302-992-2692
Email: amanda.a.desantis@usa.dupont.com

Tim Dillingham
American Littoral Society
Bldg. 18
Sandy Hook Highlands, NJ 07732
Phone: 732-291-0055
Email: tun@littoralsociety.org

Kevin C. Donnelly
DNREC, Division of Water Resources
89 Kings Highways
Dover DE 19901
Phone: 302-739-9949
Email: kevin.donnelly@state.de.us



Karen Dorris
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar St., Suite 202
Wilmington, DE 19801
Phone: 302-655-4990 x101
Email: KDorris@delawareestuary.org

Delaware Aquaculture Resource Center
College of Marine Studies
University of Delaware
700 Pilottown Road
Lewes, DE 19958
Phone: 302-645-4060
Email: ewart@udel.edu

Lynn Dwyer
Assistant Director
Eastern Partnership Office
National Fish and Wildlife Foundation
40 West 4th Street, #102
Patchogue, NY 11772
Phone: 631-289-0250
Email: Lynn.Dwyer@nfwf.org

Jim Falk
University of Delaware
Sea Grant Program
700 Pilottown Rd.
Lewes, DE 19958
Phone: 302-645-4235
Email: jfalk@udel.edu

Tracy Elsey
UD, College of Marine and Earth Studies
700 Pilottown Rd
Lewes, DE 19958
Phone: 302-645-4376
Email: telsey@udel.edu

Ann Faulds
PSU Pennsylvania Sea Grant
1450 Edgmont Avenue
Suite 150
Chester, PA 19013
Phone: 215-806-0894
Email: afaulds@psu.edu

Charles Epifanio
University of Delaware
Graduate College of Marine Studies
700 Pilottown Road
Lewes, DE 19958
Phone: 302-645-4272
Email: epi@udel.edu

Liz Feinberg
Pennsylvania Environmental Council
123 Chestnut Street
Philadelphia, PA 19106.
Email: Lfeinberg@pecpa.org

William S. Ettinger
Normandeau Associates, Inc.
23723 Woods Drive
Lewes, DE 19958-3314
Phone: 302-945-3567
Email: wettinger@normadeau.com

Thomas Fikslin
Delaware River Basin Commission
25 State Police Drive
West Trenton NJ 08628
Phone: 609-883-9500, Ext. 253
Email: Thomas.Fikslin@drbc.state.nj.us

John Ewart



Jeff Fischer
USGS
810 Bear Tavern Road
West Trenton, NJ 08628
Phone: 607-771-3953
Email: fischer@usgs.gov

Jeremy Firestone
University of Delaware
College of Marine and Earth Studies
212 Robinson Hall
Newark, DE 19716
Phone: 302-831-0228
Email: jf@udel.edu

Cristina Frank
NJ Audubon Society
Rancocas Nature Center
600 Rte 47 North
Cape May Court House, NJ 08210
Phone: 609-861-0700, ex-23
Email: cristina.frank@njudubon.org

Andrea Friedman
NJ Geological Survey
P.O. Box 427
Trenton, NJ 08625
Phone: 609-292-2576
Email: andrea.friedman@dep.state.nj.us

Todd Fritchman
Envirotech Environmental Consulting, Inc
34634 Bay Crossing Blvd.
Suite C
Lewes, DE 19958
Phone: 302-645-6491
Email: Phragmites1201@aol.com

NJ DEP
Coastal Management Office
PO Box 418
Trenton, NJ 08625
Phone: 609-777-3251
Email: dorina.frizzera@dep.state.nj.us

Jack Gallagher
University of Delaware
College of Marine Studies
700 Pilottown Road
Lewes, DE 19958
Phone: 302-645-4262
Email: Jacky@udel.edu

Catherine M. Gatenby
White Sulphur Springs
National Fish Hatchery
USFWS
400 E. Main Street,
White Sulphur Springs, WV 24986
Phone: 304-536-1361
Email: Catherine.Gatenby@fws.gov

Rick Greene
Delaware DNREC
820 Silver Lake Blvd.
Suite 220
Dover, DE 19904
Phone: 302-739-4590
Email: richard.greene@state.de.us

Ed Grusheski
Philadelphia Water Department
1101 Market Street
Philadelphia, PA 19107
Phone: 215-685-6110
Email: Ed.Grusheski@phila.gov



Kate Goddard
Ursinus College
Darby Creek Valley Assoc.
Dept Of Biology, Ursinus College
Collegeville, PA 19426
Phone: 610-489-4111,ex-3790
Email: kgoddard-doms@ursinus.edu

Jennifer Halchak
University of Delaware
College of Marine and Earth Studies
16044 Bowman Drive, Unit 2
Lewes, DE 19958
Phone: 302-645-4376
Email: jhalchak@udel.edu

Maribeth Hampel
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar St., Suite 202
Wilmington, DE 19801
Phone: 302-655-4990 x114
Email: MHampel@delawareestuary.org

Simeon Hahn
NOAA
Office of Response and Restoration
1650 Arch St
Philadelphia, PA 19103
Phone: 215-814-5419
Email: simeon.hahn@noaa.gov

Jason Hearon
NJ DEP
Bureau of Shellfisheries
Port Norris, NJ 08349
Phone: 856-785-0730
Email: hearon@hotmail.com

Clarendon Group
12 Bassett St, 1st Fl
Providence, RI 02903
Phone: 401-831-5898
Email: cheenan@clendongroup.net

Kevin Hess
DEP Water Planning Office
400 Market St., 15th Floor
Harrisburg, PA 17105
Phone: 717-783-9491
Email: rhess@state.pa.us

Christopher Heyer
YSI
8830 Rymer Way
Owings, MD 20736
Phone: 410-257-0335
Email: cheyer@ysi.com

Ray Hinkle
URS
201 Willowbrook Blvd.
Wayne, NJ 07470
Phone: 973-812-6886
Email: ray_hinkle@urscorp.com

Amie Howell
US EPA Region 3
1650 Arch Street, 3WP10
Philadelphia, PA 19103
Phone: 215-814-5722
Email: Howell.Amie@epa.gov

Ralph Huddleston
Carpenter Environmental Associates
Delaware Riverkeeper Network
300 Pond Street, Second Floor
Bristol, PA 19007.
Phone: 845- 781-4844
Email: re.huddleston@cea-enviro.com

Christine Heenan



Edythe Humphries
DNREC, DWR
89 Kings Highways
Dover, DE 19901
Phone: 302-739-9275
Email: edythe_humphries@state.de.us

Natalie Ignacio
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar St., Suite 202
Wilmington, DE 19801
Phone: 302-655-4990, ext-115
Email: NIgnacio@delawareestuary.org

Sean Jacobs
Clean Air Council
135 S 19th Street, Suite 300
Philadelphia, PA 19103
Phone: 215-567-4004
Email: sjacobs@cleaniar.org

Craig Johnson
Talisman Interactive
4169 Main St
Philadelphia, PA 19127
Phone: 215-482-6600, ext-222
Email:
craig.Johnson@talismaninteractive.com

Bonni Jones
Delaware Museum of Natural History
4840 Kennett Pike
P.O. Box 3937
Wilmington, DE 19807
Phone: 302-658-9111, ext-328
Email: bjones@delmnh.org

Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar St., Suite 202
Wilmington, DE 19801
Phone: 302-655-4990 x107
Email: JJones@delawareestuary.org

John Kennel
DNREC
89 Kings Highway
Dover, DE 19901
Phone: 302-739-5726
Email: john.kennel@state.de.us

Kathy Klein
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar Street, Suite 202
Wilmington, DE 19801
Phone: 302-655-4990
Email: kklein@delawareestuary.org

Michael T. Koterba
Northern Co-Director
Chesapeake Bay Observing System
410 Severn Avenue, Suite 107A
Annapolis, MD 21403
Phone: 410 295 3146
Email: Michael.Koterba@noaa.gov

John Kraeuter
Haskin Shellfish Lab
Rutgers University
6959 Miller Avenue
Port Norris, NJ 08349
Phone: 856-785-0074, x4331
Email: kraeuter@hsrl.rutgers.edu



Danielle Kreeger
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar St., Suite 202
Wilmington, DE 19801
Phone: 302-655-4990 x104
Email: DKreeger@DelawareEstuary.org

Rick Lathrop
RUTGERS
Dept of Ecology
14 College Farm Rd
New Brunswick, NJ 08901
Phone: 732-932-1580
Email: lathrop@crssa.rutgers.edu

Krista Laudendach-Nelson
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar St., Suite 202
Wilmington, DE 19801
Phone: 302-655-4990 x111
Email: KNelson@delawareestuary.org

David R. Legates
Center for Climatic Research
216 Pearson Hall
University of Delaware
Newark, DE 19716-2541
Phone: 302-831-4920
Email: legates@udel.edu

Eric Lienhard
Greeley and Hansen
110 South Poplar St, Ste 301
Wilmington, DE 19801
Phone: 302-428-9530
Email: elienhard@greeley-hansen.com

RUTGERS
29 Lakeside Drive
Pisataway, NJ08854
Phone: 732-463-9108
Email: robert.loveland@gmail.com

Robert Lonsdorf
Brandywine Conservancy
PO Box 141, Rte 1
Chadds Ford, PA 19317
Phone: 610-388-8314
Email: rlonsdorf@brandywine.org

Ron MacGillivray
Delaware River Basin Commission
25 State Police Drive
West Trenton, NJ 08628
Phone: 609-883-9500, Ext. 252
Email:
Ronald.MacGillivray@drbc.state.nj.us

John Madsen
University of Delaware
Department of Geological Studies
Newark, DE 19348
Phone: 302-831-1608
Email: jmadsen@udel.edu

Kirk Mantay
Ducks Unlimited
34 Defense Street, Suite 200
Annapolis, MD, 21401
Phone: 410-224-6620
Email: kmantay@ducks.org

Andrew Manus
Nature Conservancy
703 Chesnut St
Milton, DE 19968
Phone: 302-684-5351
Email: amanus@tnc.org

Bob Loveland



Martha Maxwell-Doyle
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar Street, Suite 202
Wilmington, DE 19801
Phone: 302-655-4990 x-103
Email: mdoyle@DelawareEstuary.org

Christopher J. Nally
American Aquatic Testing, Inc.
890 North Graham Street
Allentown, PA 18109
Phone: 609-883-9500, ext-252
Email:

Scott Nixon
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882
Phone: 401-874-6803
Email: swn@gso.uri.edu

Lyn O'Hare
Berks County Conservation District
1238 County Welfare Rd, STE 200
Leesport, PA 19533
Phone: 610-372-4657, ex-222
Email: cohare@countyofberks.com

Ron Ohrel
University of Delaware
Sea Grant Program
Marine Public Education Office
103 General Services
222 South Chapel St
Newark, DE 19716
Phone: 302-831-8083
Email: rohrel@hotmail.com

Albright College, Dept Biology
Albright College Box 15234
13th & Bern St
Reading, PA 19612
Phone: 610-921-7726
Email: dosgood@alb.edu

Gulnihal Ozbay, Ph.D.
Delaware State University
1200 North DuPont Highway
DSU Dept. of Agriculture & Natural
Resources
Dover, DE 19901
Phone: 302-857-6476
Email: gozbay@desu.edu

Kelly Peeler
University of Delaware
700 Pilotown Rd
105 Canon Laboratory
Lewes, DE 19958
Phone: 302-645-4285
Email: kapeeler@udel.edu

Kurt Phillip
Wetlands Research Services
P.O. Box 156
Newark, DE 19715
Phone: 302-738-7535
Email: krphilipp@aol.com

Michael Piasecki
Department of Civil Architectural &
Environmental Engineering
Drexel University
3141 Chestnut Street
Philadelphia, PA 19104
Phone : 610 564 8184
Email : Michael.Piasecki@drexel.edu



Eric Powell
Haskin Shellfish Research Laboratory
Rutgers University
6959 Miller Avenue
Port Norris, NJ 08349
Phone: 856 785 0074
Email eric@hsrl.rutgers.edu

Hernan Quinodoz
Delaware River Basin Commission
25 State Police Drive
West Trenton, NJ 08628
Phone: 609-883-9500, ex-225
Email: Hernan.Quinodoz@drbc.state.nj.us

Roger Reinhart
US EPA, Region 3
1650 Arch St
Philadelphia, PA 19103
Phone: 215-814-5462
Email: Reinhart.roger@epa.gov

Jessica Rittler-Sanchez
Delaware River Basin Commission
25 State Police Drive
West Trenton, NJ 08628
Phone: 609-883-9500
Email: Jessica.Sanchez@drbc.state.nj.us

Marlene Robinson
The Peopling of Philadelphia, Inc.
1416 Second Street
Delanco, NJ 8075
E-mail: mrpopci@comcast.net

Gwyn Rowland
Director of Watersheds
Pennsylvania Environmental Council, SE
Office
123 Chestnut Street, Suite 401 Philadelphia
PA 19106
Phone: 215-592-7020 Ext 109
Email: growland@pecpa.org
Dee Ross

Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar Street, Suite 202
Wilmington, DE 19801
Phone: 302-655-4990
Email: dross@DelawareEstuary.org

Ed Santoro
Delaware River Basin Commission
25 State Police Drive
West Trenton, NJ 08628
Phone: 609-883-9500, Ext. 268
Email: Edward.Santoro@drbc.state.nj.us

Bob Scarborough
DNREC
DNREC Division of Soil & Water
Dover, DE 19901
Phone: 302-739-3436
Email: bob.scarborough@state.de.us

Denise Seliskar
University of Delaware
College of Marine Studies
700 Pilottown Rd
Lewes, DE 19958
Phone: 302-645-4366
Email: seliskar@udel.edu

Bill Shadel
American Littoral Society
Sandy Hook
Higlands, NJ 07732
Phone: 732-291-0055
Email: bill@littoralsociety.org



Liz Shea
DE Museum of Natural History
4840 Kennett Pike
Wilmington, DE 19801
Phone: 302-658-9111
Email: eshea@delmnh.org

Larry J. Silverman
Attorney, Washington D.C.
7308 Birch Ave
Takoma Park, MD 20912
Phone: 301-346-6757
Email: ljoelsilverman@gmail.com

Dan Soeder
USGS
8987 Yellow Brick Road
Baltimore, MD 21237
Phone: 410-238-4213
Email: dsoeder@usgs

Christopher K. Sommerfield
College of Marine and Earth Studies
University of Delaware
700 Pilottown Rd.
Lewes, DE 19958
Phone: 302-645-4255
Email: cs@udel.edu

Ralph Spagnolo
U.S. Environmental Protection Agency
Region III, 1650 Arch Street Philadelphia,
PA 19103 (3WP10)
Phone: 215-814-2718
Email: spagnolo.ralph@epa.gov

Department of Bioscience and
Biotechnology
Drexel University
3141 Chestnut St.
Philadelphia, PA 19104
Phone: 215-895-2627
Email: spotiljr@drexel.edu

Ralph Stahl
DuPont Company
Barley Mill Plaza
Bldg. 27 Lancaster Pike
Wilmington, DE 19805
Phone: 302-892-1369
Email: ralph.g.stahl-jr@usa.dupont.com

Josey Stamm
Network Arts
209 Gribbel Rd
Wyncote, PA 19095
Phone: 215-887-2612
Email: jstamm@verizon.net

Patrick Starr
Vice President, Southeast Region
Pennsylvania Environmental Council
123 Chestnut Street, Suite 401
Philadelphia, PA 19106
Phone: 215-592-7020
Email: pstarr@pecpa.org

Janet Starwood
Earth Force
100 Greenwood Ave
Wyncote, PA 19095
Phone: 215-884-9888
Email: janet.starwood@verizon.net



Shandor J. Szalay
F. X. Browne, Inc.
1101 South Broad Street
Lansdale, PA 10446
Phone: 215-362-3878
Email: sszalay@fxbrowne.com

Timothy E. Targett
University of Delaware
Graduate College of Marine Studies
700 Pilottown Road
Lewes, DE 19958
Phone: 302-645-4396
Email: ttargett@udel.edu

Jackie Taylor
RUTGERS
6959 Miller Ave
Port Norris, NJ 08349
Phone: 856-785-0074, ex 4332
Email: jaclynt@eden.rutgers.edu

Andy Thurman
HydroQual, INC
33 Wood Ave South, Suite 660
Iselin, NJ 08830
Phone: 732-603-5260
Email: athuman@hydroqual.com

Kayti Tigani
University of Delaware
700 Pilottown Rd
Lewes DE 19958
Phone: 302-528-0432
Email: ktigani@udel.edu

Jane Uptegrove
NJ Geological survey (NJDEP)
P.O. Box 427
Trenton, NJ 08625
Phone: 609-292-2576
Email: Jane.uptegrove@dep.state.nj.us

Maya K. Van Rossum

Delaware Riverkeeper Network
300 Pond St, 2nd Floor
Bristol PA 19007
Phone: 215-369-1188
Email: keepermaya@delawareriverkeeper.org

David Velinsky
Academy of Natural Sciences
1900 Ben Franklin Parkway
Philadelphia, PA 19004
Phone: 215-299-1147
Email: velinsky@acnatsci.org

Holly S. Weyers
USGS, 1289 McD Drive
Dover, DE 19901
Phone: 302-734-2506, x224
Email: hsweyers@usgs.gov

Yoana Voynova
University of Delaware
700 Pilottown Rd
Lewes, DE 19958
Phone: 302-645-4279
Email: yvoynova@udel.edu

Kim Walsh
Sanford School
2200 W. 11th Street
Wilmington, DE 19805
Phone: 302-239-5263
Email: walshkim@sanfordschool.org

Kathleen Walz
NJ DEP
Natural Heritage Program
Office of Natural Lands Management
PO Box 404
Trenton, NJ 08625
Phone: 609-984-1339
Email: Kathleen.walz@dep.state.nj.us



Bill Ward
Independence Seaport Museum
1906 Hillcrest Ave
Pennsauken, NJ 08110
Phone: 215-413-8649
Email: bward@phillyseaport.org

Dawn Werry
Barley Mill Plaza 23-2320
Routes 48 & 141
Wilmington, DE 19805
Phone: 302- 992-3765
Email: dawn.r.werry@usa.dupont.com

Vivian Williams
Stroud Water Research Center
970 Spencer Rd
Avondale, PA 19311
Phone: 610-268-2153, ex 249
Email: vwilliams@stroudcenter.org

Bart Wilson
Delaware Coastal Management Program
89 Kings Highways
Dover, DE 19901
Phone: 302-739-9283

Email: bartholomew.wilson@state.de.us
Lisa Wool
Partnership for the Delaware Estuary
One Riverwalk Plaza
110 S. Poplar Street, Suite 202
Wilmington, DE 19801
Phone: 302-655-4990
Email: lwool@DelawareEstuary.org

Craig A. Woolcott
Coastal Restoration Specialist
NOAA Fisheries Restoration Center
NMFS, Sandy Hook Field Office
74 Magruder Road
Highlands, NJ 07732
Phone: 732- 872-3069
Email: Craig.Woolcott@noaa.gov

John Yagecic
Delaware River Basin Commission
25 State Police Drive
West Trenton, NJ 08628
Phone: 609-883-9500, ex-271
Email: John.Yagecic@drbc.state.nj.us



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