

Proceedings



DELAWARE ESTUARY SCIENCE & ENVIRONMENTAL SUMMIT 2011

**“Connections — Land to Sea,
Shore to Shore & Science to Outreach”**

January 30 – February 2, 2011
Cape May, New Jersey

For more information visit www.DelawareEstuary.org

Partnership for the Delaware Estuary

PDE Report No. 11-01

April 2011

For more information, please see the conference website at:

http://www.delawareestuary.org/news_pde_science_conference.asp

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2011 Delaware Estuary Science and Environmental Summit

The fourth biennial Delaware Estuary Science & Environmental Summit was held by the Partnership for the Delaware Estuary in Cape May, New Jersey. The theme for this meeting was “Connections – Land to Sea, Shore to Shore & Science to Outreach.” The program aimed to entice and challenge participants to look beyond their own fields and jurisdictions to address the challenges facing the Delaware Estuary.

This 3-day meeting built upon the momentum created at the previous conferences, held every two years since 2005: the 2005 Science Conference, “Linking Science and Management”; the 2007 Science Conference and Environmental Summit, “Setting Achievable Environmental Goals”; and the 2009 Science and Environmental Summit, “Planning for Tomorrow’s Delaware Estuary.” 2011 once again brought together scientists, educators, resources managers, environmental organizations and others to discuss current and emerging issues and showcase exemplary research and activities in the Estuary. The program included a full range of subject material related to estuarine science, management, and outreach, including special sessions on benthic systems, multiple stressors, combat communications, and social media.

The 2011 Summit consisted of 137 oral and poster presentations, up from 120 in 2009. The presentations were diverse, spanning the environmental spectrum, giving participants the rare opportunity to learn not only about science in the Estuary, but also how this information can be better used to manage resources and engage the public. Joint sessions were scheduled for when science and communications overlap, and attendees were encouraged to move between these sessions to expand their knowledge.

Climate change, sea level rise, loss of natural lands, freshwater availability, and contaminants are examples of challenges the Delaware Estuary faces that require smart solutions implemented by diverse sectors working together. This watershed-based meeting provides an important retreat-like forum for the exchange of information and ideas among sectors and individuals with diverse expertise and perspectives.

An updated edition of the “Science Directory: A listing of scientists and others interested in the science of the Delaware Estuary” is being completed, along with a list of available presentations from the conference online at www.DelawareEstuary.org/news_pde_science_conference.asp. Similar products from our previous conferences can also be found at this website.

Contingent upon continued support, the 5th Delaware Estuary Science and Environmental Summit should be held on January 2013.

2011

4th Delaware Estuary Science & Environmental Summit

Connections—Land to Sea, Shore to Shore & Science to Outreach

The Grand Hotel
Cape May, New Jersey
January 30 – February 2, 2011

Sponsors

- Benefactor**
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 - PSEG Nuclear, LLC
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Delaware Estuary Lifetime Achievement Award

The first ever Delaware Estuary Lifetime Achievement Award, for advancing science & management of the Delaware Estuary and river basin was given February 1st, 2011 to Jonathan H. Sharp of the University of Delaware. Dr. Sharp was acknowledged for his commitment to bringing the Delaware Estuary into the national spot light. He has published over 60 papers and various pivotal peer-reviewed papers that have helped to increase the understanding of the Delaware Estuary. Dr. Sharp has also developed international standards to better understand global changes to the oceans. During his thirty eight year teaching career, Dr. Sharp has advised over 20 students and continues to teach at the University of Delaware's College of Earth, Ocean and Environment.



Jonathan H. Sharp received the first ever Delaware Estuary Lifetime Achievement Award. Pictured left to right: Danielle Kreeger, Jen Adkins, Jonathan Sharp, Sue Kilham (STAC Chair)

Student Presentation Awards

The Partnership for the Delaware Estuary (PDE) thanks all the undergraduate and graduate students who journeyed to Cape May to present their original research findings at the Fourth Delaware Estuary Science & Environmental Summit. Working with our Science and Technical Advisory Committee and the many others who helped to judge student presentations, PDE was pleased to announce the recipients of the student presentation awards. This competition was added to the 3rd biennial conference in recognition of the important contributions that students make to the environmental sector in our watershed.

Eighteen students presented (11 oral, 7 posters) at the 2011 Summit. Three students were given certificates acknowledging their awards and were invited to contribute articles on their research to [Estuary News](#). In addition to the “Best Talk” winners, two oral presentations and two poster presentations were honorably mentioned as Outstanding Student Presentations. All students should be commended for their outstanding contributions and presentations!

Best Student Talk Award

Joshua Moody, Rutgers University

*Exploring the role of ribbed mussels (*Guekensia demissa*) in salt marsh stabilization*

Co-authors: David Bushek and Danielle Kreeger

Outstanding Student Talk Award (honorable mention)

Anna L. Hermes, Rutgers University

Assessing sources and sinks of carbon in Delaware Bay: A biogeochemical approach

Co-author: Elisabeth L. Sikes

Yoana Voynova, University of Delaware

Sea surface temperature and biogeochemical anomalies due to coastal upwelling in the Delaware Estuary

Co-author: Jonathan H. Sharp and Matthew J. Oliver

Best Student Poster Award (a tie)

Steven H. Pearson, Drexel University

Resource overlap and potential completion between invasive red-eared slider turtles and native red-bellied turtles in Pennsylvania

Co-authors: Harold W. Avery

Ramona Stammermann, Drexel University

A numerical approach to study sediment transport processes in marshes of the Delaware Bay

Co-author: Michael Piasecki



Winners of the Best Student Poster Award with PDE staff. Left to Right: Jen Adkins (PDE), Ramona Stammermann, Steven Pearson, Danielle Kreeger (PDE)

Outstanding Student Poster Award (a tie for honorable mention)

Emily S. Maung, University of Delaware

Predicting the effects of methoprene application on horseshoe crab populations in the Delaware

Co-authors: Douglas C. Miller

Kelly Somers, Drexel University

The contribution of land use practices to changes in tidal wetland condition and configuration in representative Delaware Estuary marshes

Co-author: Danielle Kreeger

The Best Oral and Poster winners are receiving:

- A Certificate of Excellence from the Estuary Program (nice for resumes),
- An invitation to contribute a feature article on their research to a future issue of *Estuary News*, which has a circulation in the thousands and can be referenced as a non-peer reviewed publication (great exposure), and
- Acknowledgement in these proceedings and on the website.

Thank you to everyone for your support of students!

Agenda at a Glance

Sunday, January 30

- 5:00 – 8:00pm Registration - *Penthouse Ballroom 5th Floor*
- 6:00 – 9:00pm Evening Reception - *Penthouse Ballroom 5th Floor*

Monday, January 31

- 8:00 a.m. Registration -*5th Floor* & Continental Breakfast – *Atrium 1st Floor*
- 9:00 a.m. Welcome & Keynote: EPA Region 3 Administrator Shawn M. Garvin, U.S. Representative; Frank A. LoBiondo, New Jersey's 2nd District; Commissioner Bob Martin, New Jersey Department of Environmental Protection – *Grand Ballroom 1st Floor*
- 10:30 a.m. Break
- 10:45 a.m. Session 1 - Green City, Clean Waters – *Grand Ballroom 1st Floor*
- 11:45 a.m. Lunch & Presentation: Promise & Pitfalls of Integrating Ecosystem Concepts into the Public Policy Making Process - *Penthouse Ballroom 5th Floor*
- 1:15 p.m. Concurrent Sessions
 - Session 2 - Water Quality & Quantity -*Grand Ballroom A 1st Floor*
 - Session 3 - Social Media 101 for Scientists & Organizations -*Grand Ballroom B 1st Floor*
- 2:45 p.m. Break
- 3:00 p.m. Concurrent Sessions
 - Session 4 - Climate Change -*Grand Ballroom A 1st Floor*
 - Session 5 - Easy Web-based Tools for Projects -*Grand Ballroom B 1st Floor*
- 5:00 p.m. Session 6 - Posters & Networking (drinks & hors d'oeuvres) - *Penthouse Ballroom 5th Floor*
- 7:00 p.m. Dinner (on your own)

Tuesday, February 1

- 8:00 a.m. Registration -*5th Floor* & Continental Breakfast – *Atrium 1st Floor*
- 9:00 a.m. Session 7 - Joint Panel Discussion: Energy in the Delaware Estuary – *Grand Ballroom 1st Floor*
- 10:00 a.m. Plenary: Dramatic Long Term Changes in Delaware Estuary Environmental Conditions Explained Using Consistent Water Quality Monitoring – *Grand Ballroom 1st Floor*
- 10:45 a.m. Break
- 11:00 a.m. Concurrent Sessions
 - Session 8 - *Special Session: The Delaware Estuary Benthos -*Grand Ballroom A 1st Floor*
 - Session 9 - *Special Session: Multiple Stressors in Rivers and Estuaries -*Grand Ballroom B 1st Floor*
- 12:15 p.m. Lunch & Presentation: The World Outside: What They Say About Why Your Work Matters - *Penthouse Ballroom 5th Floor*
- 1:30 p.m. Concurrent Sessions
 - Session 10 - Living Resources -*Grand Ballroom A 1st Floor*
 - Session 11 - Combat Communications for Conservationists -*Grand Ballroom B 1st Floor*
- 3:15 p.m. Break
- 3:30 p.m. Concurrent Sessions
 - Session 12 - Restoration & Enhancement/Conservation -*Grand Ballroom A 1st Floor*
 - Session 13 - More than a Message: Communications Efforts for Results You Can Measure -*Grand Ballroom B 1st Floor*
- 5:00 p.m. Session 14 - Posters & Networking - *Penthouse Ballroom 5th Floor*
- 7:00 p.m. Dinner - *Penthouse Ballroom 5th Floor*
- 7:30 - 9:00 p.m. Interactive Polling Activity - *Penthouse Ballroom 5th Floor*

Wednesday, February 2

8:00 a.m. Registration -5th Floor & Continental Breakfast – Atrium 1st Floor

9:00 a.m. Concurrent Sessions

Session 15 - Ecological Linkages and Functions -Grand Ballroom A 1st Floor

Session 16 - Design Principles for Scientific Products -Grand Ballroom B 1st Floor

10:30 a.m. Break

10:45 a.m. Concurrent Sessions

Session 17 - Wetlands & Other Habitats -Grand Ballroom A 1st Floor

Session 18 - Using Conceptual Diagrams to Communicate Science -Grand Ballroom B 1st Floor

12:30 p.m. Lunch - Penthouse Ballroom 5th Floor

1:45 p.m. Concurrent Sessions

Session 19 - Wetlands (Part 2) -Grand Ballroom A 1st Floor

Session 20 – Oysters -Grand Ballroom B 1st Floor

2:45 p.m. Break

3:00 p.m. Session 21 - Hot Topics -Grand Ballroom 1st Floor

4:45 p.m. Announcements, Awards, and Closing Remarks – Grand Ballroom 1st Floor



Detailed Agenda

Sunday, January 30

5:00 - 8:00	P.M. Registration - <i>Penthouse Ballroom 5th Floor</i>
6:00 - 9:00	Evening Reception - <i>Penthouse Ballroom 5th Floor</i> (Heavy appetizers & beverages)

Monday, January 31

8:00 a.m.	Registration - 5th Floor & Continental Breakfast – <i>Atrium 1st Floor</i>		
9:00 a.m.	Welcome & Keynote Address <i>Grand Ballroom 1st Floor</i> (Jennifer Adkins , Partnership for the DE Estuary) Regional Administrator Shawn M. Garvin , U.S. EPA Region 3 U.S. Representative Frank A. LoBiondo , New Jersey's 2 nd District Commissioner Bob Martin , New Jersey Department of Environmental Protection		
10:30 a.m.	Break		
10:45 a.m.	Opening Session 1 - Green City, Clean Waters – <i>Grand Ballroom 1st Floor</i>		
	Speaker: Christopher S. Crockett , Director of Planning & Research, Philadelphia Water Dept. Green City, Clean Waters is Philadelphia's vision for meeting regulatory obligations while helping to revitalize the City.		
10:45 a.m.	Associated Posters:		
	Glen Abrams, Michael Leff. Green infrastructure comes of age (29) Michael Leff, Laura Whalen, Robert Lonsdorf, Shandor Szalay, Jim Thorne, Diane Rosencrance, Mike McGeehin, Flavia Rutkosky, Donna Suevo, Joe Berg, Jamie Blaine, Marisa Ranieri, Gerald Bright, Richard McCorkle. Regional Restoration Initiative: Case study on headwater streams (89)		
11:45 a.m.	Lunch - Penthouse Ballroom 5th Floor Speaker: John Duff , Associate Professor of Environment, Earth & Ocean Science Dept., Uni. Massachusetts Promise & Pitfalls of Integrating Ecosystem Concepts into the Public Policy Making Process		
1:15 p.m.	Session 2 - Water Quality & Quantity – <i>Grand Ballroom A 1st Floor</i>		
	Moderators: Thomas Belton (NJDEP) and Gerald Kauffman (UDEL)		
	1:15	Lyn O'Hare, Matt Bixler	Achieving watershed improvements through source water protection (7)
	1:30	Eric Vowinkel	The Delaware Basin demonstration project of the National Monitoring Network for coastal waters and their tributaries-relations among dissolved oxygen, biochemical oxygen demand, nutrients, and shad populations (32)
	1:45	Andrew J. Thuman, Biswarup Guha, Ruta Rugabandana	Murderkill River nutrient & dissolved oxygen study: The role of tidal water quality modeling (77)
	2:00	Yoana Voynova, Jonathan H. Sharp, Matthew J. Oliver	Sea surface temperature and biogeochemical anomalies due to coastal upwelling in the Delaware Estuary (99)
	2:15	A. Ronald MacGillivray	Emerging contaminants in the Delaware Estuary (95)
	2:30	John Callahan, A. Scott Andres	A web-based mapping system for the delivery of hydrogeologic data for Delaware (44)

Monday 1:15 p.m.	Water Quality & Quantity Posters:		
	<p>Patricia Wnek. Application of NOAA, National Weather Service precipitation estimates in support of ecosystems (2)</p> <p>Daniel Duval, Christopher K. Sommerfield. Comparison of historical and recent sediment loads of the Delaware River (31)</p> <p>Julie Becker. Identifying stakeholders' practices and concerns about pharmaceuticals: A qualitative study (34)</p> <p>Lisa Wool, Arthur Holst. Green infrastructure and nonpoint source pollution reduction education at the Philadelphia International Flower Show (54)</p> <p>Sandeep Mehrotra, James Garin, Nick Barbaro, Dana Gumb, Tiffany Witwer. Hydrologic and hydraulic modeling for green stormwater practices (113)</p> <p>Tiffany Witwer, James Garin, Dana Gumb, James Rossi, Sandeep Mehrotra. Successful maintenance of green infrastructure for stormwater management: New York City's Staten Island Bluebelt (114)</p>		
Concurrent Sessions 2 & 3	Session 3 - Social Media 101 for Scientists & Organizations –Grand Ballroom B 1st Floor		
	<p>Speaker: Whitney Hoffman, Hoffman Digital Media, LLC Why social media is important to your work, and how to use it to help build awareness for your projects.</p>		
2:45 p.m.	Break		
3:00 p.m.	Session 4 - Climate Change –Grand Ballroom A 1st Floor		
	Moderators: Danielle Kreeger (PDE) and Ray Najjar (PSU)		
	3:00	Simon Engelhart, Benjamin P. Horton, W. Richard Peltier, Kelvin Ramsey	Holocene relative sea levels and paleogeographies of the Delaware River Estuary: Implications for current rates of sea-level change (56)
	3:15	Steve Gill, Allison Allen, Carolyn Lindley, William Sweet, Chris Zervas	Long-term variations in tidal characteristics and sea-level in the Delaware Estuary (38)
	3:30	Ray Najjar	Climate projections for the watershed of the Delaware Estuary (57)
	3:45	Danielle Kreeger, Jennifer Adkins, Priscilla Cole	Climate adaptation in the Delaware Estuary: Results from the climate Ready Estuaries Pilot (16)
	4:00	Nathaniel B. Weston	Response of salt-marsh and tidal freshwater marshes in the Delaware River Estuary to sea-level rise and salt-water intrusion (73)
	4:15	Dorina Frizzera	A coastal vulnerability index for the Delaware Bay: A pilot study for New Jersey coastal communities (68)
	4:30	John Callahan, Daniel J. Leathers, David R. Legates, John H. Talley, Kevin R. Brinson, Linden S. Wolf	A prototype coastal flood monitoring system for Delaware (52)
	4:45	Kelly Valencik, Jennifer Holmes	Survey says: Sea-level rise needs attention & action in Delaware (70)
Concurrent Sessions 4 & 5			

Monday 3:00 p.m.	Climate Change Posters: Daniel J. Leathers, David Legates, John Talley, John Callahan, Kevin Brinson, Linden Wolf. A data gap analysis and inland inundation survey for the Delaware coastline (51)	
	Chris Miller. The Cape May Plant Materials Center-developing plant technologies for a changing climate (71)	
Concurrent Sessions 4 & 5	Session 5 - Easy Web-based Tools for Projects –Grand Ballroom B 1st Floor	
	Speaker: Whitney Hoffman , Hoffman Digital Media, LLC Producing audio or video podcasts, as part of a larger education or marketing strategy, that are designed to gain more attention and support for projects.	
	4:30	Lisa Tossey Getting Social – Creating and building a social media presence on the web
	4:45	Lisa Wool, Tom Davidock Improving Watershed Communication: Using a website for public and partner outreach
5:00 p.m.	Session 6 - Posters & Networking - Penthouse Ballroom 5th Floor	
7:00 p.m.	Dinner (on your own)	

Tuesday, February 1		
8:00 a.m.	Registration - 5th Floor & Continental Breakfast – Atrium 1st Floor	
9:00 a.m.	Session 7 - Joint Panel Discussion: Energy in the Delaware Estuary –Grand Ballroom 1st Floor	
	Panel Moderator: Jennifer Adkins , Executive Director, Partnership for the Delaware Estuary A joint panel of some of the Delaware Estuary’s leading environmental officials will present and discuss policies and programs being undertaken by agencies in our region to address today’s energy challenges. <ul style="list-style-type: none"> • Kathy Bunting-Howarth, Delaware Department of Natural Resources and Environmental Control • Wayne Staub, New Jersey Department of Environmental Protection • Carol R. Collier, Delaware River Basin Commission 	
10:00 a.m.	Special Plenary Session: Dr. Jonathan H. Sharp –Grand Ballroom 1st Floor	
	Speaker: Jonathan H. Sharp , School of Marine Science and Policy, University of Delaware, Lewes Dramatic Long Term Changes in Delaware Estuary Environmental Conditions Explained Using Consistent Water Quality Monitoring	
10:45 a.m.	Break	

Session 8 - *Special Session: The Delaware Estuary Benthos –Grand Ballroom A 1st Floor		
Moderators: Doug Miller (UDEL) and Renee Searfoss (EPA)		
11:00	William Burton	Identifying the habitat and distribution of juvenile horseshoe crabs in Delaware Bay (6)
11:15	Nicole A. Raineault, Art Trembanis, Doug C. Miller	Small-scale hard-bottom benthic diversity in Delaware Bay (12)
11:30	Richard W. Greene	An assessment of sediment metals data from the Delaware Estuary Benthic Inventory (60)
11:45	John A. Madsen	Relevance of the geologic setting of the Delaware Estuary to offshore wind sites (64)
11:00 a.m.	Benthos Posters:	
	Douglas C. Miller, Angela Padeletti. Benthic indicators derived from the 2008 Delaware Estuary Benthic Inventory (DEBI) sampling (74)	
Session 9 - *Special Session: Multiple Stressors in Rivers and Estuaries –Grand Ballroom B 1st Fl		
Moderators: Robert Hoke (DuPont) and David Velinsky (ANSP)		
11:00	Julie Becker, Teresa Mendez-Quigley, Kelly Anderson, Paula Conolly	Safer pharmaceutical disposal practices through a pilot program for consumers (35)
11:15	Gregory J. Cavallo, Thomas J. Fikslin	Evaluation of PCB and dioxin/furan (dxf) concentrations in sediment samples from the Delaware Estuary (46)
11:30	David Velinsky, Don Charles, Christopher Sommerfield, Richard Greene, Thomas Fikslin	Tidal marshes in the Delaware Estuary: Historical reconstruction of chemical loadings (69)
11:45	Robert W. Scarborough, Bartholomew Wilson, David Carter	Supporting science-based management at the USFWS coastal Delaware refuge complex and surrounding Delaware Bay marshes (72)
12:00	Greg Murphy, Todd Morrison, Barry Baker, Vincent Pellerito, Ralph Stahl, Jr., Robert Hoke	Application of a relative risk model for natural resource assessment in the Delaware Estuary (19)
Lunch - Penthouse Ballroom 5th Floor		
Speaker: Eric Eckl - Environmental Communications Consultant, Water Words That Work, LLC		
Tuesday 12:15 p.m.	The World Outside: What They Say About Why Your Work Matters - Join us for a fascinating journey through the insights that social scientists and market researchers can provide about how your work plays on the big stage of public opinion. Sometimes frustrating, sometimes encouraging, always fascinating -- we'll explore citizens' attitudes and actions when presented with information about nature protection and pollution control.	



Session 10 - Living Resources –Grand Ballroom A 1 st Floor		
Moderators: Desmond Kahn (DNREC) and Dorina Frizzera (NJDEP)		
1:30	Mary Alessio Leck, Charles Leck	Biodiversity overview - Hamilton - Trenton - Bordentown marsh (62)
1:45	Emma Melvin	Addressing aquatic invasive species in upland waterways: The challenges and opportunities for success (9)
2:00	Martha Corrozi Narvaez, Gerald J. Kauffman, Robert Lonsdorf	Restoration of shad and anadromous fish to the White Clay Creek National Wild and Scenic River (30)
2:15	Harold M. Brundage, John C. O’Herron , Lisa Calvo	Acoustic telemetry studies of the distribution and movement of juvenile sturgeons in the Delaware River and Estuary (112)
2:30	Joshua Moody, David Bushek, Danielle Kreeger	Exploring the role of ribbed mussels (<i>Geukensia demissa</i>) in salt marsh stabilization (40)
2:45	David R. Smith, Nancy L. Jackson, Karl F. Nordstrom, Penelope S. Pooler	Hierarchical selection of horseshoe crab spawning habitat: A sandy beach is the last thing on their ganglia (76)
3:00	Mark L. Botton, Robert E. Loveland	Reflections on five decades of horseshoe crab science in Delaware Bay: What we have learned, and suggestions for further research (13)
1:30 p.m.	Living Resources Posters:	
Concurrent Sessions 10 & 11	Emily Suzanne Maung, Douglas C. Miller. Predicting the effects of methoprene application on horseshoe crab populations in Delaware (33)	
	Steven H. Pearson, Harold W. Avery. Resource overlap and potential competition between invasive red-eared slider turtles and native red-bellied turtles in Pennsylvania (48)	
	J.E. Stone, W.F. Bien, J.R. Spotila, H.W. Avery. Distribution and abundance of non-native red-eared slider turtles (<i>Trachemys scripta elegans</i>) and native red-bellied turtles (<i>Pseudemys rubriventris</i>) (49)	
	Heidi Wood-Tucker, Angela Padeletti, Michael DeHaven, Charles Owens, Catherine M. Gatenby, Danielle Kreeger, William Lellis, Steven G. Hughes. Laboratory culture of the lightfoot mussel, <i>Elliptio complanata</i> (116)	
	Thomas M. Grothues, Joseph Dobarro, Rose Petrecca, Hal Brundage, John C. O’Herron, Lisa Calvo. Acoustic mapping of sturgeon and their critical habitats in the Delaware River and Estuary from a multi-sensored autonomous underwater vehicle (117)	
	Danielle Kreeger, Roger Thomas, Eric Powell. Spatial and temporal variability in oyster food quality in the Delaware Estuary (91)	
	Roger Thomas, Danielle Kreeger, Sylvan Klein, Angela Padeletti, Zoe Ruge, Matthew Gray, Catherine Gatenby. Occurrence of freshwater mussels (Unionidae) in surveyed streams of southeastern Pennsylvania, 2000-2010 (92)	
	Danielle Kreeger, Roger Thomas, Sylvan Klein, Angela Padeletti, William Lellis. Recent discoveries of rare freshwater mussels (Unionidae) in the urban corridor of the Delaware Estuary (78)	
	Paula Zelanko, Nathan H. Rice, David Velinsky. Using carbon and nitrogen stable isotopes of osprey (<i>Pandion haliaetus</i>) to infer historic ecosystem characteristics within the Delaware Bay (131)	

Tuesday 1:30 p.m.	Session 11 - Combat Communications for Conservationists –Grand Ballroom B 1 st Floor		
	Speaker: Eric Eckl , Environmental Communications Consultant, Water Words That Work, LLC Conservation and controversy go hand in hand. Sooner or later, the mud will fly and your work and your reputation will be on the line. In this hands-on workshop, you'll learn the dos and don'ts of managing controversial situations: deflecting their accusations, making yours stick. You'll develop confidence and skills to set the record straight and come out on top.		
Concurrent Sessions 10 & 11			
3:15 p.m.	Break		
3:30 p.m.	Session 12 - Restoration & Enhancement/Conservation –Grand Ballroom A 1 st Floor		
	Moderators: Laura Whalen (PDE) and Paul Racette (PEC)		
	3:30	Laura Whalen, Danielle Kreeger, Simeon Hahn, Paul Racette	A science-based regional restoration approach in the Delaware Estuary: Overview (85)
	3:40	Paul Racette, Laura Whalen, Danielle Kreeger, Simeon Hahn	A science-based regional restoration approach in the Delaware Estuary: Urban Waterfront Case study (10)
	3:50	Scott E. Bush, Christine J. Potts	Conceptual ecological restoration of two urban waterfront parcels in the Bridesburg section of Philadelphia, Pennsylvania (93)
	4:05	Joe Berg	Watershed restoration, trade-offs between headwater restoration projects and downstream confluence projects, and the concept of regenerative design (80)
	4:20	Jane Fava, Kathy Bergmann, Aaron Clauser	Brandywine Valley Association's Red Stream Blue Program: A working model for stream restoration (11)
	4:35	Will Hohman	Wetland green infrastructure design along the Delaware River: A project harmonizing stormwater management, pollutant removal, and native species habitat enhancements with the ebb & flow of human impacts on our environment (104)
	4:50	Jessica Anderson, Linda Rink	If we build it, they will boat: How raising awareness of river recreation and providing boating opportunities will increase recreational use and stewardship of the tidal Delaware River (83)
	Concurrent Sessions 12 & 13	<p>Restoration & Enhancement/Conservation Posters:</p> <p>Kathy Bergmann, Jane Fava, Aaron Clauser. Monitoring streambank restoration through a bank erosion and deposition protocol (43)</p> <p>Sherestha Saini, Nancy L. Jackson, Karl F. Nordstrom. Bulkhead configurations and horseshoe crab spawning on sandy shorelines in Delaware Bay, New Jersey (55)</p> <p>Mike Haberland, Craig McGee, Pat Rector, Sandra Goodrow. Retrofitting detention basins in Cherry Hill, NJ (61)</p> <p>Angela Padeletti, Danielle Kreeger, Steven G. Hughes, Heidi Tucker-Wood. Freshwater mussel recovery: A core component of watershed-wide bivalve restoration (81)</p> <p>Ron Smith, Karen Sprinsky, and the students from the Environmental Science Program at Haddonfield Memorial High School. Ecological restoration: Practice, science and education, using restoration projects in the Cooper River Park to improve (127)</p> <p>Laura Whalen, Karen Johnson. Corporate & Community Environmental Stewardship Program (CESP) (86)</p> <p>Laura Whalen. Rain gardens for the bays – St. Jones Watershed case study (90)</p>	

<p>Tuesday 3:30 p.m.</p> <p>Concurrent Sessions 12 & 13</p>	<p>Session 13 – More than a Message: Planning a Communications Effort for Results You Can Measure –<i>Grand Ballroom B 1st Floor</i></p> <p>Speaker: Eric Eckl, Environmental Communications Consultant, Water Words That Work, LLC How many citizens heard your message? Responded? Took action to save their hometown river? Increasingly, funders demand that grantees document accomplishments and learnings. In this session, participants will learn a simple system for planning outreach campaigns that include the data collection you need to prove what you accomplished—and accomplish even more next time.</p> <p>Associated Poster with Session 13: Ronald L. Ohrel, Jr, Elizabeth Boyle, Tamara Beeson, Lisa Tossey. What’s that big pinwheel all about? Communicating to the public about alternative energy research (21)</p>
<p>5:00 p.m.</p>	<p>Session 14 - Penthouse Ballroom 5th Floor Posters & Networking</p>
<p>7:00 p.m.</p>	<p>Dinner - Penthouse Ballroom 5th Floor</p>
<p>7:30 - 9:00 p.m.</p>	<p>Interactive Polling Activity - Penthouse Ballroom 5th Floor</p>



Wednesday, February 2

8:00 a.m.	Registration -5th Floor & Continental Breakfast – Atrium 1st Floor		
9:00 a.m.	Session 15 –Grand Ballroom A 1st Floor Ecological Linkages and Functions		
	Moderators: Susan Kilham (Drexel) and Jessica Sanchez (DRBC)		
	9:00	Chris Sommerfield, David J. Velinsky	Understanding tidal marsh accretion in Delaware Estuary (45)
	9:15	Robert Chant, Maria Aristizabal, Chris Sommerfield	The role of stratification in controlling salt flux, sediment transport and primary production in Delaware Bay (42)
	9:30	Anna L. Hermes, Elisabeth L. Sikes	Assessing sources and sinks of carbon in Delaware Bay: A biogeochemical approach (98)
	9:45	Justin Meschter, Nathaniel B. Weston	Sediment and heavy-metal deposition in tidal freshwater and saltwater marshes in the Delaware River Estuary: temporal and spatial patterns of deposition and possible impact of sea-level rise on rates of deposition (115)
	10:00	David Walsh, Christopher Sommerfield, J. Bailey Smith, Jeffrey Gebert	Historical bathymetric morphology of the Delaware Estuary, a component in developing a comprehensive sediment budget (110)
	10:15	J. Bailey Smith	Delaware Estuary Regional Sediment Management Planning effort: A 16-month status report of opportunities and challenges (3)
	Ecological Linkages and Functions Posters:		
	Mara Aristizabal, Robert Chant. A numerical study of the circulation, stratification and salt fluxes in Delaware Bay Estuary (5)		
Ramona Stammermann, Michael Piasecki. A numerical approach to study sediment transport processes in marshes of the Delaware Bay (22)			
9:00 a.m.	Session 16 –Grand Ballroom B 1st Floor Design Principles for Scientific Products		
	Speakers: Caroline Wicks , EcoCheck (NOAA-UMCES Partnership) & Joanna Woerner , Integration & Application Network, Science Communicators How to effectively communicate your science in printed (brochures, posters, articles), web, and presentation media. Topics covered include overall design principles, formatting graphs and maps for effective communication, and tips for PowerPoint presentations.		
10:30 a.m.	Break		

Session 17: Wetlands & Other Habitats –Grand Ballroom A 1st Floor		
Moderators: Kenneth Strait (PSEG) and Angela Padeletti (PDE)		
10:45	Robert B. Coxe	State of Delaware vegetation community and land cover map (8)
11:00	Dave Bushek, Danielle Kreeger, Laura Whalen, Josh Moody, Angela Padeletti	Mussel powered living shorelines for salt marsh erosion control (25)
11:15	Joseph Smith, Robert Allen	A retrospective look at sea-level rise induced habitat changes at the forest-wetland fringe along the Delaware Bay, New Jersey (27)
11:30	Jeffrey C. Cornwell, Michael S. Owen	Denitrification in Delaware Bay tidal marshes and creeks (123)
11:45	Tracy Elsey-Quirk, A. Smyth, M. Piehler, B. P. Horton, J. Mead, D. J. Velinsky	Denitrification in an urban tidal fresh-water wetland of the Delaware (53)
12:00	Tiffany Witwer, Michael Usai, Laurie Machung, Sandeep Mehrotra, Kevin Ward	Water quality enhancement and flood attenuation through wetland restoration and creation in a New York City watershed (75)
12:15	Thomas McKenna	A simple model for evaluating tidal inundation of wetlands in the Murderkill Estuary (Kent county, Delaware) (111)
Wednesday 10:45 a.m. Concurrent Sessions 17 & 18	Wetlands Posters: Alison B. Rogerson, Amy D. Jacobs, Andrew M. Howard. The use of two wetland rapid assessment methods in Delaware (39) Ramona Stammermann, Michael Piasecki. Generating numerical model grids of marshes with the use of LIDAR data (23) Ellen Creveling, Su Fanok, Mari-Beth DeLucia. Condition of freshwater systems of the Delaware River Basin: A GIS assessment (108) Tracy Elsey-Quirk, R. Thomas, D.J. Velinsky, Danielle Kreeger, Angela Padeletti, Martha Maxwell-Doyle. Initiation of long-term monitoring in wetlands along Delaware and Barnegat Bays (65) Kathleen Strakosch Walz, Stephen Domber. Developing a wetland condition monitoring network for New Jersey: Application of new assessment methods (101) Kelly Somers, Danielle Kreeger. The contribution of land use practices to changes in tidal wetland condition and configuration in representative Delaware Estuary marshes (129)	
Session 18: Using Conceptual Diagrams to Communicate Science –Grand Ballroom B 1st Floor		
Speakers: Caroline Wicks , EcoCheck (NOAA-UMCES Partnership) & Joanna Woerner , Integration & Application Network, Science Communicators Conceptual diagrams are visual displays of attributes and processes of an ecosystem. They can be used in 1-way (e.g., in a presentation) and 2-way (e.g., workshop setting) communication. This session includes a short lecture, a hands-on activity, and group discussion about effective science communication.		
Wednesday 12:30 p.m.	Lunch- Penthouse Ballroom 5th Floor	

Session 19 - Wetlands (Part 2) –Grand Ballroom A 1st Floor		
Moderators: Kenneth Strait (PSEG) and Angela Padeletti (PDE)		
1:45	Andrew Homsey, Richard T. Field, Jo Young-Heon, Geri Pepe, Kurt Philipp	Methods For quantifying tidal wetland changes in Delaware’s Inland Bays (1937 To 2007) (47)
2:00	Alison Rogerson, Amy D. Jacobs, Andrew M. Howard	Delaware’s wetland trends and condition assessment (28)
2:15	Drexel Siok, Bartholomew Wilson, Robert W. Scarborough, David Carter	Marsh vulnerability index: Assessing health of Delaware’s marshes. (102)
2:30	Danielle Kreeger, Martha Maxwell-Doyle, Amy Deller Jacobs, Angela Padeletti, Tracy Quirk, Thomas Belton, Dorina Frizzera	The Mid-Atlantic Coastal Wetland Assessment: Integrated monitoring of tidal wetlands for water quality and habitat management and restoration planning (119)
Session 20 – Oysters –Grand Ballroom B 1st Floor		
Moderators: Desmond Kahn (DNREC) and Dorina Frizzera (NJDEP)		
1:45	Eileen Hofmann, David Bushek, Susan Ford, Ximing Guo, Eric Powell, Dale Haidvogel, John Wilkin, John Klinck	Understanding how disease and environment combine to structure resistance in estuarine populations (36)
2:00	Eric N. Powell, John Klinck, Ximing Guo, Eileen Hofmann, Susan Ford, David Bushek	Can oysters develop resistance to dermo disease in the field: Evaluation using a gene-based population dynamics model (1)
2:15	Diego Narváez, John Klinck, Eric Powell, Eileen Hofmann, John Wilkin, Dale Haidvogel	How does environmental variability affect the dispersion of oyster larvae?: A numerical study for Delaware Bay (15)
2:30	Zhiren Wang, David Bushek, Susan Ford, Eric Powell, Dale Haidvogel, John Wilkin	Inter-annual variability in circulation and water properties in Delaware Bay and its relationship to disease prevalence (59)
Oyster Posters:		
Elizabeth Diamond, David Bushek. Do scavengers influence dermo disease transmission among Delaware Bay oysters? (20)		
David Bushek, Susan Ford, Iris Burt, Emily Scarpa, Brenda Landau. MSX and dermo disease in Delaware Bay oysters: The role of disease refugia (37)		
Kurt M. Cheng, David Bushek. Using ribbed mussels as sentinels for dermo disease in Delaware Bay (105)		
Ximing Guo, Coren Milbury, Liusuo Zhang, Yongping Wang, David Bushek, Susan Ford. Genetic structure of Eastern Oyster populations in Delaware Bay (118)		
2:45 p.m.	Break	

Session 21 - Hot Topics –Grand Ballroom 1st Floor

Moderators: Carol Collier (DRBC) and Allison Allen (NOAA)

3:00	Maya K. van Rossum	River values: The values of a clean and healthy Delaware River (18)
3:15	Gerald J. Kauffman	Socioeconomic value of the Delaware Estuary: A hard-working river and bay (41)
3:30	John Callahan	Development of a GIS database in a marine spatial planning context for offshore wind power for Delaware (106)
3:45	Desmond M. Kahn	Cumulative impact of industrial water intakes in the Delaware River on the Delaware River spawning stock of striped bass (125)
4:00	Rachel Muir	USGS update on Marcellus shale drilling
4:15	Ashlie Strackbein, Rachel Dawson	Federal opportunities to maximize watershed conservation: Delaware River Basin Task Force and Delaware River Basin Conservation Act (66)

Wednesday
3:00 p.m.

Hot Topics Posters:

S. Stephen Platt. The new dreaded “F” word ... Fracking. Is the hydraulic fracturing process the real cause for concern in unconventional shale gas development? (67)

V. Lyle Trumbull, Will Meeks, Mark Ray, Steven Alexander, Ronald Chiarello, Al Pfister, Larry Malizzi, Jason Ayers, Grant Matthews, Robert Tawes, Jason Kase, Calvin Douglas, Don Wendt. The natural resource advisor program: An innovative approach to protect natural and cultural resources during the Deepwater Horizon oil spill response (79)

Donna W. Pitz, Patty Elkins. Economic value of protected open space in southeastern Pennsylvania (107)

Dave Jungblut. "Keeping it real -High school science curriculum"- Hurricane Katrina and BP oil spill inspire creative curriculum (128)

Priscilla Cole, Danielle Kreeger. Natural capital at the Partnership for the Delaware Estuary (88)

Jennifer A. Adkins. PDE Alliance promotes top priorities for the Estuary (124)

4:45 p.m.

Announcements, Outstanding Student Presenter Awards, and Closing Remarks - Grand Ballroom 1st Floor



Special Poster Session – 2011 Technical Report for the Estuary and Basin (TREB)

Danielle Kreeger, Sue Kilham. Overview of the 2011 State of the Delaware Estuary and Basin Technical Report (121)

Jessica Rittler Sanchez, Jerry Kauffman, Andrew Homsey, Karen Reavy. Land use changes in the Delaware River Basin (130)

John Yagecic. Assessment of water quality indicators for the State of the Estuary / State of the Basin reports (94)

Jeffrey A. Gebert. Integration of sediment budget and dynamics research with an RSM (regional sediment management) initiative for the Delaware Estuary (103)

Douglas C. Miller, Angela Padeletti. Benthic indicators derived from the 2008 Delaware Estuary Benthic Inventory (DEBI) sampling (74)

Danielle Kreeger, Ken Strait, Andrew Homsey, Angela Padeletti. Tidal wetland indicators for the 2011 state of the Delaware Estuary and Basin technical report (122)

Gerald Bright, Dave Burke, Robert Limbeck, Jerry Mohler. Delaware Estuary non-tidal living resources: status and trends (50)

Laura S. Whalen, Simeon Hahn, Renee Searfoss, Paul Racette, Anthony Dvarkus, Danielle Kreeger, Kenneth Strait, Joe Berg, Dorina Frizzera. Restoration section of the State of the Estuary Report (87)



Poster Presentations

Glen Abrams, Michael Leff. Green infrastructure comes of age (29)

Jennifer A. Adkins. PDE Alliance promotes top priorities for the Estuary (124)

Mara Aristizabal, Robert Chant. A numerical study of the circulation, stratification and salt fluxes in Delaware Bay Estuary (5)

Julie Becker. Identifying stakeholders' practices and concerns about pharmaceuticals: A qualitative study (34)

Kathy Bergmann, Jane Fava, Aaron Clauser. Monitoring streambank restoration through a bank erosion and deposition protocol (43)

Gerald Bright, Dave Burke, Robert Limbeck, Jerry Mohler. Delaware Estuary non-tidal living resources: status and trends (50)

David Bushek, Susan Ford, Iris Burt, Emily Scarpa, Brenda Landau. MSX and dermo disease in Delaware Bay oysters: The role of disease refugia (37)

Kurt M. Cheng, David Bushek. Using ribbed mussels as sentinels for dermo disease in Delaware Bay (105)

Priscilla Cole, Danielle Kreeger. Natural capital at the partnership for the Delaware Estuary (88)

Ellen Creveling, Su Fanok, Mari-Beth DeLucia. Condition of freshwater systems of the Delaware River Basin: A GIS assessment (108)

Elizabeth Diamond, David Bushek. Do scavengers influence dermo disease transmission among Delaware Bay oysters? (20)

Daniel Duval, Christopher K. Sommerfield. Comparison of historical and recent sediment loads of the Delaware River (31)

Jeffrey A. Gebert. Integration of sediment budget and dynamics research with an RSM (regional sediment management) initiative for the Delaware Estuary (103)

Thomas M. Grothues, Joseph Dobarro, Rose Petrecca, Hal Brundage, John C. O'Herron, Lisa Calvo. Acoustic mapping of sturgeon and their critical habitats in the Delaware River and Estuary from a multi-sensored autonomous underwater vehicle (117)

Ximing Guo, Coren Milbury, Liusuo Zhang, Yongping Wang, David Bushek, Susan Ford. Genetic structure of eastern oyster populations in Delaware Bay (118)

Mike Haberland, Craig McGee, Pat Rector, Sandra Goodrow. Retrofitting detention basins in Cherry Hill, NJ (61)

Dave Jungblut. "Keeping it Real -High School Science Curriculum"- Hurricane Katrina and BP Oil Spill inspire creative curriculum (128)

Danielle Kreeger, Roger Thomas, Sylvan Klein, Angela Padeletti, William Lellis. Recent discoveries of rare freshwater mussels (Unionidae) in the urban corridor of the Delaware Estuary (78)

Danielle Kreeger, Roger Thomas, Eric Powell. Spatial and temporal variability in oyster food quality in the Delaware Estuary (91)

Danielle Kreeger, Sue Kilham. Overview of the 2011 state of the Delaware Estuary and Basin Technical Report (121)

Danielle Kreeger, Kenneth Strait, Andrew Homsey, Angela Padeletti. Tidal wetland indicators for the 2011 state of the Delaware Estuary and Basin Technical Report (122)

Daniel J. Leathers, David Legates, John Talley, John Callahan, Kevin Brinson, Linden Wolf. A data gap analysis and inland inundation survey for the Delaware coastline (51)

Michael Leff, Laura Whalen, Robert Lonsdorf, Shandor Szalay, Jim Thorne, Diane Rosencrance, Mike McGeehin, Flavia Rutkosky, Donna Suevo, Joe Berg, Jamie Blaine, Marisa Ranieri, Gerald Bright, Richard McCorkle. Regional Restoration Initiative: Case study on headwater streams (89)

Emily Suzanne Maung, Douglas C. Miller. Predicting the effects of methoprene application on horseshoe crab populations in Delaware (33)

Sandeep Mehrotra, James Garin, Nick Barbaro, Dana Gumb, Tiffany Witwer. Hydrologic and hydraulic modeling for green stormwater practices (113)

Chris Miller. The Cape May Plant Materials Center-developing plant technologies for a changing climate (71)

Douglas C. Miller, Angela Padeletti. Benthic indicators derived from the 2008 Delaware Estuary Benthic Inventory (DEBI) sampling (74)

Ronald L. Ohrel, Jr, Elizabeth Boyle, Tamara Beeson, Lisa Tossey. What's that big pinwheel all about? Communicating to the public about alternative energy research (21)

Angela Padeletti, Danielle Kreeger, Steven G. Hughes, Heidi Tucker-Wood. Freshwater mussel recovery: A core component of watershed-wide bivalve restoration (81)

Steven H. Pearson, Harold W. Avery. Resource overlap and potential competition between invasive red-eared slider turtles and native red-bellied turtles in Pennsylvania (48)

Donna W. Pitz, Patty Elkins. Economic value of protected open space in southeastern Pennsylvania (107)

S. Stephen Platt. The new dreaded "F" Word ... Fracking. Is the hydraulic fracturing process the real cause for concern in unconventional shale gas development? (67)

Tracy Elsey-Quirk, R. Thomas, D.J. Velinsky, Danielle Kreeger, Angela Padeletti, Martha Maxwell-Doyle. Initiation of long-term monitoring in wetlands along Delaware and Barnegat Bays (65)

Alison B. Rogerson, Amy D. Jacobs, Andrew M. Howard. The use of two wetland rapid assessment methods in Delaware (39)

Sherestha Saini, Nancy L. Jackson, Karl F. Nordstrom. Bulkhead configurations and horseshoe crab spawning on sandy shorelines in Delaware Bay, New Jersey (55)

Jessica Rittler Sanchez, Jerry Kauffman, Andrew Homsey, Karen Reavy. Land use changes in the Delaware River Basin. (130)

Ron Smith, Karen Sprinsky, and the students from the Environmental Science Program at Haddonfield Memorial High School. Ecological restoration: practice, science and education, using restoration projects in the Cooper River Park to improve (127)

Kelly Somers. The contribution of land use practices to changes in tidal wetland condition and configuration in representative Delaware Estuary marshes (129)

Ramona Stammermann, Michael Piasecki. A numerical approach to study sediment transport processes in marshes of the Delaware Bay (22)

Ramona Stammermann, Michael Piasecki. Generating numerical model grids of marshes with the use of LIDAR data (23)

Julia Stone. Distribution and abundance of non-native red-eared slider turtles (*Trachemys scripta elegans*) and native red-bellied turtles (*Pseudemys rubriventris*) (49)

Kathleen Strakosch Walz, Stephen Domber. Developing a wetland condition monitoring network for New Jersey: Application of new assessment methods (101)

Roger Thomas, Danielle Kreeger, Sylvan Klein, Angela Padeletti, Zoe Ruge, Matthew Gray, Catherine Gatenby. Occurrence of freshwater mussels (Unionidae) in surveyed streams of southeastern Pennsylvania, 2000-2010. (92)

V. Lyle Trumbull, Will Meeks, Mark Ray, Steven Alexander, Ronald Chiarello, Al Pfister, Larry Malizzi, Jason Ayers, Grant Matthews, Robert Tawes, Jason Kase, Calvin Douglas, Don Wendt. The Natural Resource Advisor Program: An innovative approach to protect natural and cultural resources during the Deepwater Horizon oil spill response (79)

Heidi Wood-Tucker, Angela Padeletti, Michael DeHaven, Charles Owens, Catherine M. Gatenby, Danielle Kreeger, William Lellis, Steven G. Hughes. Laboratory culture of the lightfoot mussel, *Elliptio complanata* (116)

Laura S. Whalen, Karen Johnson. Corporate & Community Environmental Stewardship Program (CESP) (86)

Laura S. Whalen, Simeon Hahn, Renee Searfoss, Paul Racette, Anthony Dvarkus, Danielle Kreeger, Kenneth Strait, Joe Berg, Dorina Frizzer. Restoration section of the State of the Estuary report (87)

Laura Whalen. Rain gardens for the Bays – St. Jones Watershed case study (90)

Tiffany Witwer, James Garin, Dana Gumb, James Rossi, Sandeep Mehrotra. Successful maintenance of green infrastructure for stormwater management: New York City's Staten Island Bluebelt (114)

Patricia Wnek. Application of NOAA, National Weather Service precipitation estimates in support of ecosystems (2)

Lisa Wool, Arthur Holst. Green infrastructure and nonpoint source pollution reduction education at the Philadelphia International Flower Show (54)

John Yagecic. Assessment of water quality indicators for the State of the Estuary / State of the Basin Reports (94)

Paula Zelanko, Nathan H. Rice, David Velinsky. Using carbon and nitrogen stable isotopes of osprey (*Pandion haliaetus*) to infer historic ecosystem characteristics within the Delaware Bay (131)

Featured Speakers

Carol R. Collier

Executive Director

Delaware River Basin Commission



Ms. Collier was appointed Executive Director of the Delaware River Basin Commission (DRBC) on August 31, 1998. The DRBC is an interstate/federal commission that provides a unified approach to water resource management without regard to political boundaries. Before joining DRBC, Ms. Collier was Executive Director of Pennsylvania's 21st Century Environment Commission. Governor Tom Ridge formed the Environment Commission in 1997 to establish the Commonwealth's environmental priorities and to recommend a course of action for the next century.

At the time Governor Ridge asked Ms. Collier to serve as executive director for the 21st Century Environment Commission, she was Regional Director of the Pennsylvania Department of Environmental Protection (PADEP) Southeast Region. Prior to PADEP, Ms. Collier served 19 years with BCM Environmental Engineers, Inc., Plymouth Meeting, PA., beginning as a student intern and ultimately becoming Vice President of Environmental Planning, Science and Risk.

Ms. Collier has a B.A. in Biology from Smith College and a Masters in Regional Planning from the University of Pennsylvania. She is a Professional Planner licensed in the State of New Jersey, a member of the American Institute of Certified Planners (AICP) and a Certified Senior Ecologist. In 1997 she was presented the Touchstone Award from the Society of Women Environmental Professionals and in 1998 the Woman of Distinction Award from the Philadelphia Business Journal. In 2007 the American Water Resources Association (AWRA) presented her with the Mary H. Marsh Medal for exemplary contributions to the protection and wise use of the nation's water resources.

She is a member of her township's environmental protection advisory board, on the Boards of the American Water Resources Association (AWRA) and the newly formed Clean Water America Alliance (CWAA), teaches environmental management courses at the University of Pennsylvania and has published on environmental and water-related topics. She has testified before the U.S. House of Representatives and the Pennsylvania Legislature. In 2004 she was a member of a nine person U.S./China/Japan team to assist the People's Republic of China with river basin management. Ms. Collier has also participated in water management and sustainable forest practice events along the Yangtze River in China and in the rain forests of Ecuador. She thinks proper management of water resources is the key to our economic and environmental future.



Christopher S. Crockett, Ph.D., P.E.,
Director of Planning & Research
Philadelphia Water Department

Christopher oversees a staff of 30 that conducts infrastructure planning, asset management, water and wastewater applied treatment research, energy management, renewable energy projects, stormwater management plan reviews, stormwater rate credits, water quality studies, air emissions and land management, and regulatory compliance support for the Philadelphia Water Department. Chris has over 15 years of experience in the water, stormwater, and wastewater industry participating and leading innovative projects to improve customer service, performance, revenue, and regulatory compliance. He has been responsible for stormwater and CSO compliance and managed teams to accomplish green infrastructure and watershed management approaches. Some accomplishments include leading the source water protection programs, development and implementation of new stormwater management requirements for development and studies of impervious cover based stormwater billing for non-residential customers. Under Chris' leadership, his teams have won numerous local, state, and federal awards. He has also been involved in several national and worldwide groundbreaking environmental projects using information technology for early warning systems for drinking water supplies and public notification for recreation. His current focus is on energy management including biomethane and renewable resources and asset management.



John Duff
Associate Professor and Graduate Program Director
Environmental, Earth & Ocean Sciences Department
University of Massachusetts / Boston

John Duff received his J.D. from Suffolk University Law School in Boston and his LL.M. from the Law and Marine Affairs Program at the University of Washington. He also holds degrees in business (B.S.B.A.) from the University of Lowell and Journalism (M.A.) from the University of Mississippi. Over the course of the last twenty years he has worked as a newspaper reporter; an attorney in private practice; served as general counsel to a nonprofit organization focusing on marine habitat protection issues; and, has directed the marine law research programs at the law schools of the universities of Mississippi and Maine. His work earned him a Fulbright Senior Fellowship in 1998. Since 2004, Prof. Duff has served as a faculty member in the Environmental, Earth and Ocean Sciences Department at the University of Massachusetts/Boston where he teaches courses on climate change and clean energy law, environmental policy, ocean and coastal law and land use. Prof. Duff is currently working on research related to ecosystem-informed management, ocean planning and the increasing privatization of offshore public resources. Virtually all of the work that he has been engaged in deals with the interface of natural resource assemblages, technology and public policy. Prof. Duff's research has been published in a variety of journals and professional reports. He is a co-editor of the book *INTERNATIONAL OCEAN LAW*; he serves on the editorial board of *OCEAN DEVELOPMENT AND INTERNATIONAL LAW*; and, he is a past president of The Coastal Society. He is a Faculty Advisor in the United Nations-Nippon Foundation Law of the Sea Fellowship Programme and a consultant to municipal, state, federal and intergovernmental agencies.

Eric Eckl

**Environmental Communications Consultant
Water Words That Work, LLC**

Eric is fascinated by the intersection between language, technology, and the environment. He blogs on the topic at <http://waterwordsthatwork.com>. Eric's company, Water Words That Work LLC, helps nature protection and pollution control organizations professionalize and modernize their communications efforts. The company helps its clients plan and deliver pollution prevention, fundraising, and issue advocacy campaigns.



From its early days as hobby blog, Eric has grown the company to a team of four market research and campaign experts and a stable network of graphic designers and other contractors. The company produces websites, videos, advertising campaigns, email blasts, and other marketing materials.

Since opening its doors, Water Words That Work has assisted more than 50 conservation organizations. Clients include the National Park Service, the Alliance for the Chesapeake Bay, the Southwest Florida Water Management District, the Minnesota Association of Watershed Districts, the Ogeechee Riverkeeper, and the New Jersey Department of Environmental Protection. Before launching Water Words That Work, Eric led advocacy and fundraising campaigns, managed media relations, and oversaw web and print publishing activities for a variety of conservation organizations. He has appeared on CNN and in the pages of the New York Times. He is a frequent speaker at environmental, marketing, and technology conferences.

Shawn M. Garvin

**Regional Administrator
U.S. Environmental Protection Agency, Region 3**

Shawn M. Garvin was named Regional Administrator on November 5, 2009. Shawn's career in intergovernmental affairs spans more than 20 years at the federal and local levels. In his most recent position as Senior State and Congressional Liaison for EPA Region 3, he provided counsel to agency leadership, environmental program managers, press officers and others involved in complex and controversial public health and environmental matters. Shawn's contributions to high-profile environmental litigation cases, emergency response clean-ups, contaminant investigations, and public health crises have earned him numerous EPA gold, silver and bronze medals. He's worked closely with Congressional Delegations, Governors, state and local elected leaders, environmental agencies and citizen advocacy groups. Early in his career at EPA, he served as special assistant to the Regional Administrator. Prior experience includes working as an aide to then-Senator Joe Biden, D-Del., and working on the staff of former New Castle County (Del.) Executive Dennis Greenhouse. Shawn is a native Delawarean and graduate of the University of Delaware. He lives in Wilmington with his wife and their son.





Whitney Hoffman
Hoffman Digital Media

Whitney Hoffman has been involved in New Media and Social Media for the past five years, both as a content producer and as the organizer of Digital Media conferences. She has organized Podcamp conferences in Philadelphia, New York and Boston, and as Director of Operations for the Podcamp Foundation, consults with organizers of similar conferences in other cities around the Country and overseas. Most recently, she helped organize the

Web2Open sessions at O'Reilly's Web 2.0 Expo in New York City in November, 2009.

She is CEO of Hoffman Digital Media, producing the LD Podcast, an internet radio show about learning and learning disabilities featuring interviews with well-known experts including Dr. Robert Brooks, Anne Ford, and Marcus Buckingham. She also produces OB-GYN To Go, a podcast focusing on resident and physician education. She has spoken at many blogging and podcasting conferences including BlogPhiladelphia, Podcamp conferences, and at Podcasters Across Borders in Ontario Canada in 2008 and 2010. She presents regularly to business and non-profit groups and conferences on a variety of topics including using social media tools for marketing and PR, and Business Strategy Using the Social Web.

She has an undergraduate degree in developmental biology from the University of Pennsylvania, and a JD from the Dickinson School of Law of Penn State. Whitney co-authored Public Assembly Facility Law with Turner D. Madden for the International Association of Assembly Managers and presented at their annual conference. While working with Mr. Madden, Whitney helped design the Americans with Disabilities Act access program for the National Football League and the SuperBowl, as well as providing on-site services for the event for eight years.

Whitney has blogged for the Philadelphia Inquirer and Philly.com as part of Philadelphia's Great Expectations Project. Her personal blog, discussing finance, business, social media and more can be found at www.whitneyhoffman.com. She is a regular contributor at GNM Parents www.gnmparents.com, and The LD Podcast, www.ldpodcast.com.



Dr. Katherine E. Bunting-Howarth
Division of Water Resources
Delaware Department of Natural Resources & Environmental Control

Katherine E. Bunting-Howarth was appointed Director of the Division of Water Resources, Delaware Department of Natural Resources and Environmental Control, in January 2008. As Director, she oversees multiple federal Clean Water Act programs; such as, the National Pollutant Discharge Elimination System Permitting, Clean Water State Revolving Fund, water quality monitoring and assessment, and State water quality programs, including water supply, State wetlands and subaqueous lands permitting, and onsite wastewater treatment and disposal.

Kathy also serves as a Commissioner for the Delaware River Basin Commission, a member of the Executive Implementation Council of the Partnership for the Delaware Estuary, a Board alternate for the Center for the Inland Bays, a member of the Principal Staff Committee of the Chesapeake Bay Program, and Chair of the Water Supply Coordinating Council. In addition, she serves as the Region 3 representative on the Board of the Association of State and Interstate Water Pollution Control Administrators.

Before becoming Director, Kathy spent 3 months as the Acting Administrator for the Division's Financial Assistance Branch where she administered the Clean Water State Revolving Fund programs for municipal wastewater treatment and nonpoint source loan programs and staffed the Clean Water Advisory Council. As Principal Planner, she worked on a variety of issues related to water quality, including Total Maximum Daily Loads, watershed-based planning efforts through Tributary Action Teams, and the resulting Pollution Control Strategies. In addition, Kathy represented the Department on regional water resource management efforts.

Kathy's Ph.D. is in Marine Policy from the University of Delaware's Graduate College of Marine Studies; she holds a Juris Doctorate with a Certificate in Environmental and Natural Resource Law from the University of Oregon School of Law; and has a Bachelor of Arts Degree in Biology and International Relations from the University of Delaware. Kathy and her husband, David, have two sons, Davin and Aidan, and reside in Magnolia.



U.S. Representative Frank A. LoBiondo

A boy named Frank LoBiondo grew up in constant admiration of his father; a man who knew the balance between the demands of operating a successful business, serving as an elected public servant, being active in his community, and providing for his family. As a young man Frank loved the time he spent on his grandparents farm helping where needed. Frank became a successful small businessman, working at the family trucking company for 26 years. Frank also became an active participant in numerous civic and charitable pursuits, including the SPCA, the Cumberland County Guidance Center, and the local YMCA. Frank's achievements in the community eventually led to his nomination by local leaders and private citizens to further serve the community through public office.

Frank has served South Jersey on the county, state, and federal levels since his first successful election to the Cumberland County Board of Chosen Freeholders in 1984. Following his three-year service as a Freeholder, he was elected to the New Jersey General Assembly where he represented the First Legislative District from 1988-1994. In November 1994, Frank became the representative of the Second Congressional District in the House of Representatives where he serves South Jersey to this day.

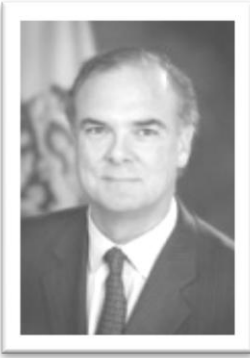
On Capitol Hill, Congressman LoBiondo is a member of the House Transportation and Infrastructure Committee. Frank also serves as the Top Ranking Republican on the Subcommittee for Coast Guard and Maritime Transportation. He is also on the Water Resources and Environment and Aviation, which have jurisdiction over critical issues that affect New Jersey's growing transportation needs.

Congressman LoBiondo is a staunch advocate for strengthening our nation's security while ensuring a future for New Jersey's military bases and service personnel with noted attention to issues of military pay and benefits. Frank has championed this cause with his service on the House Armed Services Committee. Frank also serves on the Air & Land Forces Subcommittee, Readiness Subcommittee, and Terrorism, Unconventional Threats & Capabilities Subcommittee.

In Washington, Frank LoBiondo is known as a fierce supporter of veterans, and he continues to work hard to expand access to community-based health care providers which minimizes the need for South Jersey veterans to commute outside the state for VA-approved services. Frank has always maintained a strong commitment to protecting the environment, a result of a childhood devotion to the outdoors. During his time in public office, he has striven to protect fragile wildlife and wetlands, and has stood up for projects that endeavor to preserve and restore the New Jersey coastline. Congressman LoBiondo has won recognition for his environmental work from the Audubon Society, the League of Conservation Voters, and the Sierra Club.

Frank has been a strong voice for the private business sector having once owned and operated his own small business. He believes government intervention is not responsible for the creation of jobs and economic growth, but the hard work and success of private businesses.

Frank was born on May 12, 1946 in Rosenhayn, Cumberland County. He went on to receive his B.A. in Business Administration from St. Joseph's University in Philadelphia before returning to his home in Cumberland County. Frank currently resides in Atlantic County with his wife Tina and their two rescued Weimaraners, Lola and Luca.



Bob Martin
Commissioner
New Jersey Department of Environmental Protection

Demonstrating his commitment to building a strong, experienced team, Governor Chris Christie nominated Bob Martin to serve as Commissioner of the Department of Environmental Protection.

An accomplished business and industry leader with recognized expertise in energy and utilities, he served as a key policy adviser throughout Governor Christie's gubernatorial campaign. He assisted in shaping and drafting then-candidate Christie's Energy Policy and Environmental Policy, and provided policy guidance on other major issues. In recent years, he also has served as a respected and trusted adviser, primarily in energy policy, to several other candidates for U.S. Senate, congressional and gubernatorial seats.

In 2008, he retired as a partner with Accenture LLP after more than 25 years. Accenture is the world's largest business and technology consulting firm with more than 140,000 employees around the globe.

Highly experienced in consulting, he has achieved impressive results working with a variety of businesses and industries – particularly energy and utility companies – to improve efficiency and enhance performance in an increasingly competitive marketplace. He has expertise in all aspects of business and management consulting, including business strategy and planning, business transformation and re-engineering, IT strategy, systems implementation, and change management. He also has considerable experience in project management of large systems integration and in business re-engineering projects.

Commissioner Martin also has extensive international experience. While living in England from 1991 to 1995, he worked with several large U.K. water and electric utilities as the companies privatized and the markets deregulated. He also spent significant time working with utility and energy companies throughout Europe and Canada.

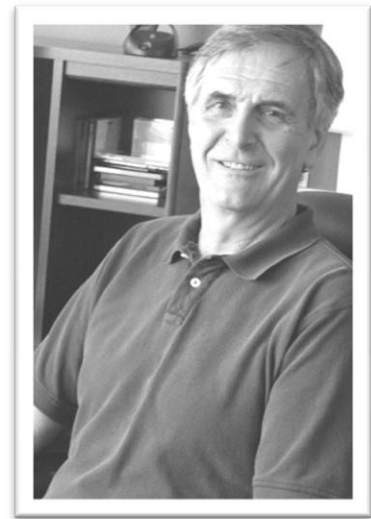
Actively involved in the community, he was a candidate for State Senate in New Jersey's 15th District in 2007. He formerly served as the Chairman of the Finance Committee for the Mercer County Republican Committee. He served on the Salvation Army Advisory Board of Greater New York from 2001 until January 2010, and as its Chairman from 2007 until January 2010. He served on the Princeton Healthcare System Foundation Board in 2008 and 2009. He also served on the Board of Trustees at the Chapin School in Princeton from 1996 to 2008, and on the Finance Advisory Committee for Hopewell Township from 2005 to 2007. He has been active in coaching youth soccer and lacrosse in Hopewell Valley for more than 13 years.

Born and raised in Massachusetts, Commissioner Martin earned a bachelor of arts in Economics and Sociology from Boston College in 1979 and an MBA from The George Washington University in 1982.

He and his wife, Brenda, have lived in Hopewell Township for more than 14 years. They have three children: Andrew, 24; Sara, 21; and Caroline, 12. Mrs. Martin is a teacher at the Cambridge School in Pennington.

Jonathan H. Sharp
Professor of Oceanography
College of Marine and Earth Studies
University of Delaware

Jonathan H. Sharp received BA (Biology) and MS (Biochemistry) from Lehigh University; PhD (Oceanography) from Dalhousie University; post-doctoral research experience at Scripps Institution of Oceanography. He has lived in Lewes for past 37 years with wife, Gwyneth. He raised his son and daughter here and both are now successful PhD environmental scientists.



Jonathan's research interests include: microbial biogeochemistry (estuarine, coastal, and oceanic), Analytical methodology for routine aquatic analyses, Translation of estuarine research results to resource management. He has published over 100 papers (in refereed literature) and reports including 30 papers in the refereed literature from his research group specifically about the Delaware Estuary. He has also published a number of newsletter articles and guest newspaper editorials on estuarine science and policy.

Dr. Sharp has been heavily involved with research, resource management, and outreach on the Delaware Estuary for over 30 years, including being primary advisor for 16 MS and PhD projects about the Delaware Estuary from 1981-present. He served as the chairman of the Scientific and Technical Advisory Committee for the Delaware Estuary Program (DELEP) planning stage from 1989-1996; then became the chairman of its Monitoring Implementation Team and first Chairman of the Board of the non-profit Partnership for the Delaware Estuary (PDE). He continues to serve on Monitoring Advisory Committee of DELEP and Advisory Board of PDE. He has served formally on a number of advisory committees and given informal advice to Delaware River Basin Commission for over 25 years. He has provided informal advice and assistance to Delaware Department of Natural Resources and Environmental Control and the similar agencies in New Jersey and Pennsylvania regarding measurements and interpretation of data on estuarine resources. He has provided various consulting activities on about Delaware Estuary science for Delaware River Basin Commission, Public Service Electric and Gas Company, Duffield Associates, DuPont Company. He has had some similar advisory and technical committee involvement with Maryland and California on Chesapeake and San Francisco bays, respectively. Recently, he has served on two national advisory committees (for NOAA and EPA) assisting management of estuarine nutrient problems.

Wayne M. Staub

**Director for Economic Growth & Sustainability
Office of Economic Growth and Green Energy
New Jersey Department of Environmental Protection (NJDEP)**

Wayne Staub joined the New Jersey Department of Environmental Protection as its first Director for Economic Growth and Sustainability in the recently established Office of Economic Growth and Green Energy. Staub brings more than 16 years of government experience from the Mercer County Office of Economic Development and Sustainability. as the County's Business Representative, he helped create and administer the Mercer County Loan Fund lead the expansion of the Mercer County Foreign Trade Zone # 200, was an original committee member for the Annual Mercer County Economic Summit, and worked closely with the Small Business Development Center at the College of New Jersey. His accomplishments caught the attention of the Mercer Business Magazine, in which he was featured as the August 2009 "Ask a Busy Person".



Working closely with Assistant Commissioner Michele Siekerka, Staub leads the Sustainability and Resource Team. The group engages stakeholders to recognize and create opportunities for sustainable economic growth in New Jersey, identifying and working to resolve any impediments to new and emerging technologies. Staub also works with local, state and federal agencies to promote New Jersey's green economy, and is developing incentives and programs in all areas related to sustainability, green energy and economic growth.

A Ewing Township resident, Staub is active in nonprofit organizations, currently serving a fifth year as President of the Ewing Public Education Foundation. In addition, he serves as a volunteer on the Trenton YMCA Golf Committee, Ewing Little League and Ewing Girls Softball, and is the Cub Master for Pack 15 Mercer County. Staub earned a BS in Marketing and Management from Seton Hall University and a MS in Management and Leadership from Thomas Edison State College.



Caroline Wicks

Science Communicator, EcoCheck

Caroline Wicks is a science communicator with EcoCheck, a partnership between the National Oceanic and Atmospheric Administration (NOAA) and the University of Maryland Center for Environmental Science (UMCES). Caroline received a Bachelor of Science in Biology from the University of North Carolina at Wilmington and a Master of Science in Biological Oceanography from the University of Maryland.

While Caroline's education is in research science, she has attended and taught numerous science communication workshops. Her current job focuses on product development for EcoCheck, including newsletters, reports, and books, which requires collaboration with many federal and state agencies.



Joanna L. Woerner

Science Communicator

Integrated and Application Network

Joanna L. Woerner is a Science Communicator with the Integration and Application Network, www.ian.umces.edu, a collection of scientists interested in solving, not just studying, environmental problems. As a Science Communicator, she has taught numerous courses on how to communicate science more effectively and has collaborated with various partners to create documents which convey complex scientific concepts to broad audiences. Joanna has received a B.S. in Marine Science from The Richard Stockton College and a M.A. in Technical and Scientific

Communication from Miami University.

We thank everyone who attended the 2011 Delaware Estuary Science and Environmental Summit. Please feel free to contact our staff with questions.

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The mission of the Partnership for the Delaware Estuary is to lead collaborative and creative efforts to protect and enhance the Delaware Estuary and its tributaries for current and future generations. www.DelawareEstuary.org

Abstracts

GREEN INFRASTRUCTURE COMES OF AGE

Glen Abrams, Watersheds Planning Manager, Philadelphia Water Department, 1101 Market Street, 4th Floor, Philadelphia, PA 19107, Glen.Abrams@phila.gov; and **Michael Leff**, Urban Forestry Program Manager, Pennsylvania Horticultural Society, 100 N. 20th Street, Philadelphia, PA 19103, mleff@pennhort.org.

Poster – *Aligned with Session 1: Green City, Clean Waters (29)*

Every tree helps manage stormwater to some degree. But when combined with innovative design and engineering practices, that stormwater benefit can be multiplied many times over. Moreover, these “green infrastructure” projects provide many other benefits not offered by the traditional grey infrastructure of pipes, holding tanks, and detention basins.

Cities across the country are beginning to realize a full range of “triple bottom line” benefits – environmental, economic, and quality of life – by exploring the possibilities of best management practices (BMPs) designed to maximize the natural capacity of trees, shrubs, and other plants to manage stormwater, promote groundwater infiltration, and create community amenities. At the same time, these green stormwater infrastructure features provide other environmental benefits – such as improving air quality and reducing the heat island effect produced by urban areas – as well as beautify neighborhoods, increase residential property values, and boost the economic vitality of commercial districts.

This session will showcase the innovative green stormwater infrastructure initiatives being developed by the Philadelphia Water Department’s Office of Watersheds, the Pennsylvania Horticultural Society, and other partners in the Greater Philadelphia region. Featured projects will range from the most basic street tree pits to more elaborate and highly engineered BMPs that utilize street runoff to sustain vegetation and replenish groundwater.

PDE ALLIANCE PROMOTES TOP PRIORITIES FOR THE ESTUARY

Jennifer Adkins, Executive Director, Partnership for the Delaware Estuary,
JAdkins@DelawareEstuary.org

Poster – *Aligned with Session 21: Hot Topics (124)*

In 2010 the Partnership for the Delaware Estuary (PDE) initiated the PDE Alliance for Comprehensive Ecosystem Solutions, a public/private collaboration of diverse interests with one important one in common: protecting and enhancing the Delaware Estuary. It includes public-sector leaders from PDE's Steering Committee, as well as leaders from companies, foundations, and organizations in the private sector with a long history of supporting restoration in the Delaware Estuary.

Each year, the PDE Alliance identifies a select list of projects to support and promote using tools developed under PDE's Regional Restoration Initiative, including the Project Registry. 2010 was a pilot year for the PDE Alliance, but that didn't stop the group from selecting an ambitious set of projects in need of over \$2 million and addressing priorities that include tidal wetlands, urban waterfronts, forested streamside areas, and shellfish or other signature species of the Delaware Estuary.

Bridesburg Urban Waterfront Restoration Project seeks to restore 15 acres and 2,000 linear feet of shoreline along the Delaware River in Philadelphia.

Delaware Bay Oyster Restoration Project is a cooperative effort to revitalize eastern oysters, a signature species of the Delaware Estuary.

Mannington Mills Scrub-Shrub Riparian Restoration Project seeks to restore 15 acres of land along the stream by planting it with native grasses, shrubs, and trees.

Mill Creek Stream Restoration Project seeks to restore approximately 2,175 linear feet of Mill Creek and create approximately 2.5 acres of wetlands.

Strategic Reforestation of Riparian Zones project is refining a new user-friendly planning tool to help reforest areas along streams throughout the Delaware River Basin.

Selection as a priority project by the PDE Alliance does not guarantee funding. But it does guarantee that PDE and other Alliance members will use all tools at their disposal to promote and support these projects throughout the year, and beyond.

IF WE BUILD IT, THEY WILL BOAT: HOW RAISING AWARENESS OF RIVER RECREATION AND PROVIDING BOATING OPPORTUNITIES WILL INCREASE RECREATIONAL USE AND STEWARDSHIP OF THE TIDAL DELAWARE RIVER

Jessica Anderson, Communications Manager, Pennsylvania Environmental Council, 123 Chestnut Street, Suite 401, Philadelphia, PA 19106, and **Linda Rink**, Rink Consulting, Philadelphia, PA.

Talk – Tuesday 5:00, *Session 12: Restoration & Enhancement/Conservation (83)*

Water trails are paths along rivers that have been mapped to provide recreational users (such as kayakers, sailors, boaters, and anglers) with information on access points, safety considerations, activities, and points of interest. Pennsylvania has more than 20 water trails designated by the Pennsylvania Fish and Boat Commission, and the Pennsylvania Environmental Council (PEC) has been involved in the development of many of these trails.

PEC created the Tidal Delaware Water Trail map and web site (www.tidaltrail.org). The trail encompasses the 56-mile stretch of the Tidal Delaware River from Trenton/Morrisville to Marcus Hook, including both Pennsylvania and New Jersey, and the cities of Philadelphia and Camden. The goal is to increase safe, enjoyable recreation on the River, and foster environmental stewardship.

To better understand the needs and wants of recreational users, PEC conducted a ***user-demand analysis***, examining what existing users love about recreation on the Tidal Delaware River, and determining the physical and attitudinal barriers that prevent more recreational use of the river. PEC hired professional marketing consultant Rink Consulting to conduct this research. The research consisted of four focus groups with both current and prospective users, and online surveys to validate findings.

Key findings included:

1. The most important reason boaters choose to use the Tidal Delaware is its location and convenience.
2. Low top-of-mind awareness of the Tidal Delaware is the number one reason non-users have not boated on it.
3. Having more information about where and how to access the Tidal Delaware would give non-users the biggest impetus to use this section of the river.

The advisory committee included representatives from PA Department of Conservation and Natural Resources, PA Fish and Boat Commission, National Park Service, Delaware River Yachtsmen's League, Philadelphia Canoe Club, and the Delaware River Traditional Small Craft Association among others.

A NUMERICAL STUDY OF THE CIRCULATION, STRATIFICATION AND SALT FLUXES IN DELAWARE BAY ESTUARY

Mara Aristizabal aristizabal@imcs.rutgers.edu and Robert Chant, Institute of Marine and Coastal Sciences, Rutgers University, 71 Dudley Road, New Brunswick, NJ 08901

Poster – Aligned with Session 15: Ecological Linkages and Functions (5)

We present results of a numerical study of Delaware Bay using ROMS (Regional Ocean Modeling System). Despite the prominence of this estuary it has received remarkably little attention among physical oceanographers. One of our main motivations to study Delaware Bay is to build a more complete picture of the physical aspects of this system. Here we provide a general description of the circulation, the salinity structure and the salt fluxes in the bay. These modeling reports are being augmented by ongoing shipboard surveys and moored observations. Preliminary results emphasize strong spring-neap variability in stratification that has not been previously documented in this system.

The physical characteristics of an estuary such as the salt field, the circulation and their time variability play a very important role in the geological, chemical and biological productivity of the system. A clear example of this is stratification which is controlled by the vertical salinity structure. When the water column is well mixed during spring tides, sediments occupy the whole water column and as a consequence phytoplankton becomes light limited. When the water column is stratified during neap tides, sediments are capped in the lower layer and phytoplankton at the surface layer has enough light to bloom. A critical factor that strongly influenced estuarine stratification is the along channel salinity gradient which is directly related with the salt intrusion length.

The salt intrusion length in an estuary is regulated by the competition between two processes: seaward salt flux due to the river output and landward salt flux due to tides and the estuarine circulation. The salt intrusion length is an important parameter because it determines the place where water becomes available for human consumption. A recent 2-D theoretical model of salinity structure in an estuary over predicts the salt intrusion in Delaware Bay whereas it has been relatively successful in other systems. Our 3-D simulation reveals that across-channel variations in bathymetry in Delaware Bay are a controlling factor of the salt fluxes in this system.

IDENTIFYING STAKEHOLDERS' PRACTICES AND CONCERNS ABOUT PHARMACEUTICALS: A QUALITATIVE STUDY

Julie Becker, Ph.D., MPH; Women's Health & Environmental Network, 704 N. 23rd Street, Philadelphia, PA 19130; becker.julie@gmail.com

Poster – *Aligned with Session 2: Water Quality & Quantity (34)*

Medications provide life-saving interventions and improve quality of life for millions. Yet, evidence increasingly suggests that large amounts of prescription medications remain unused, unwanted or expired. In 2008-2009, the Associated Press reported that a number of metropolitan water supplies have at least one or more medications present in the drinking water, including Philadelphia. Their presence in the water is causing harm to aquatic life and while not therapeutic, may influence efficacy of medications when we need them most. Almost all of the interventions have focused on a downstream approach, with mail-in or community collections, that are infrequent, require significant interagency coordination, and do not address decreasing the amount of medications by prescribing or dispensing less.

Before designing an intervention to address this issue, a qualitative research project was conducted with stakeholders to identify ways to reduce the amount of unused, unwanted or expired medications that may be misused or end up in the disposal process by understanding how key personnel prescribe, dispense, pay for, and request medications. The stakeholders included medical care providers, pharmacists, insurers, and advocacy organizations, which contract for consumers. It has been postulated that the education of stakeholders will be key to prescribing and dispensing less medications.

Data was analyzed using content and theme analyses. Results included: 1) a certain number of key drugs are prescribed and dispensed most frequently; 2) most recognized there is "significant" waste of medications but don't know what to do about it or how to dispose of them; 3) almost all wanted to address this issue; 4) many liked the alternatives posed in the interviews. The interview results were used to develop on-line web modules to educate stakeholders, how to shift prescribing and dispensing practices, and how to dispose of medication safely, with less environmental impact.

SAFER PHARMACEUTICAL DISPOSAL PRACTICES THROUGH A PILOT PROGRAM FOR CONSUMERS

Julie Becker, Ph.D., MPH; Women's Health & Environmental Network, 704 N. 23rd Street, Philadelphia, PA 19130; becker.julie@gmail.com; **Teresa Mendez-Quigley, MSW, LSW**; Women's Health & Environmental Network, 704 N. 23rd Street, Philadelphia, PA 19130; Teresa.when@gmail.com; **Kelly Anderson**, Philadelphia Water Department, 1101 Market Street, Philadelphia, PA 19107; Kelly.anderson@phila.gov; **Paula Conolly**, Philadelphia Water Department, 1101 Market Street, Philadelphia, PA 19107; paula.conolly@phila.gov

Talk – Tuesday 11:00, *Session 9: Multiple Stressors in Rivers and Estuaries (35)*

When it comes to safer disposal practices of unused, unwanted or expired medications, most people are confused about what to do. Previous qualitative research has suggested that people often flush medications because they do not have information that describes safer disposal methods. To reduce the propensity for flushing these medications directly into the water, a low-cost, intervention was implemented at one pharmacy that provided prescription assistance in Pennsylvania, using an icon-based sticker and low-literacy (3rd-5th grade) disposal directions using pictures. Research has shown that people are more likely to remember pictures and associate them with actions. The Women's Health & Environmental Network and the Philadelphia Water Department partnered to develop the icon and flyer. At three times during the intervention, recognition was tested to assess association and potential desirable actions such as taking unused medications to a take-back/mail-back program or properly disposing of the pharmaceuticals as detailed in the White House Office of National Drug Control Policy recommendations (pre, six weeks post start, one-month post intervention). Assessment of the process within the pharmacy was conducted with staff as well to identify facilitators and barriers for implementation. If this intervention proves successful, it can easily be replicated and may serve as a national model on reducing pharmaceuticals from ending up in the water through flushing.

WATERSHED RESTROATION, TRADE-OFFS BETWEEN HEADWATER RESTORATION PROJECTS AND DEOWNSTREAM CONFLUENCE PROJECTS, AND THE CONCEPT OF REGENERATIVE DESIGN

Berg, Joe, Biohabitats, Inc., 2081 Clipper Park Roag, Baltimore, MD 21211,
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Talk – Tuesday 4:15, *Session 12: Restoration & Enhancement/Conservation* (80)

Watershed management plans are developed which often identify restoration opportunities and may include estimates of the costs and benefits of the identified restoration actions. Headwater restoration projects may include storm water source control through a storm water BMP, improvements in land cover (e.g., cessation of mowing, tree planting), and restoration of an eroding flowpath. Together these actions reduce erosion and transport of sediment to downstream resources. Projects of this type may have low to moderate costs, involve hundreds to thousands of square foot of site work, and yield a variety of benefits. However, as headwater streams represent the majority of stream length in a watershed, many such projects need to be undertaken to cumulatively address the factors leading to watershed degradation, perhaps resulting in large costs and a relatively low benefit to cost ratio. On the other hand, the use of a more regional restoration project (e.g., a large wetland basin at the confluence of multiple tributaries), which receives and treats large volumes of runoff before discharging to the receiving stream, also provides a range of benefits and may have a better cost to benefit ratio. Unfortunately, in many of our feasibility studies, we don't have tools that integrate enough decision elements into the cost-benefit analysis. Generally, this lack of integrating or internalizing all costs and benefits is biased towards larger projects. The benefit of a restoration project may consist of predicted water quality benefit based on simple water quality model, and the project cost is based largely on the cost of construction. In reality, the conversion of an existing resource into a resource that is better suited to provide water quality benefits prior to discharge has a cost which is usually ignored. In addition, the neglected headwater areas continue to degrade, and transport their nutrients and sediments to the confluence wetland, resulting in its sedimentation. The continued loss of the headwater resource isn't factored into the cost of the regional restoration feature, nor is its degradation to the treatment wetland with a limited trapping efficiency. This presentation will focus on several existing and proposed projects in the same watershed, their service areas (drainage areas), pollutant removal effectiveness, implementation costs, and other costs and benefits, including ancillary ecosystem services, creation of natural capital, and other miscellaneous costs and benefits. The presentation will conclude with a discussion of the compromises resulting from 'end-of-pipe treatment' restoration efforts versus 'fixing' the many small headwater projects and a discussion of regenerative design.

MONITORING STREAMBANK RESTORATION THROUGH A BANK EROSION AND DEPOSITION PROTOCOL

Kathy Bergmann Brandywine Valley Association, 1760 Unionville-Wawaset Rd., West Chester, PA 19382, katberg17@verizon.net. **Jane Fava**, Brandywine Valley Association, 1760 Unionville-Wawaset Rd., West Chester, PA 19382, **Aaron Clauser**, PhD, Clauser Environmental, 312 Deer Trail Drive, Schuylkill Haven, PA 17972.

Poster – *Aligned with Session 12: Restoration & Enhancement/Conservation (43)*

Sediment is a major impairment in many of the watersheds that drain to the Delaware Estuary. Having an effective protocol to estimate the potential and achieved sediment reductions for stream restoration projects is essential for making the case for restoration and monitoring project effectiveness. Brandywine Valley Association has developed and utilized volunteers to implement a bank erosion and deposition protocol at several restoration sites. Sets of bank pins are installed along a 100 meter stream segment and the locations of the pins are selected so that a representative sampling of bank stability is covered including sample points inside meander bends, outside meander bends, and between meander bends in both riffle and pool locations. Bank pins were installed in stream segments above, within and below our stream restoration sites. Over a three year period, a strong correlation between the amount of erosion and deposition and the size of rainfall events has been observed. Using the erosion and deposition rates for given stream segments the amount of sediment reduction that could be attained by streambank stabilization was estimated. Implications for use of the protocol in measuring sediment reductions for TMDL watersheds are discussed.

REFLECTIONS ON FIVE DECADES OF HORSESHOE CRAB SCIENCE IN DELAWARE BAY: WHAT WE HAVE LEARNED, AND SUGGESTIONS FOR FURTHER RESEARCH

Mark L. Botton, Department of Natural Sciences, Fordham University, 113 West 60th Street, New York, NY 10023, botton@fordham.edu; and **Robert E. Loveland**, Department of Ecology, Evolution & Natural Resources, Rutgers University, New Brunswick, NJ 08901.

Talk – Tuesday 3:00, *Session 10: Living Resources* (13)

Research on horseshoe crabs in the Delaware Bay intensified in the '70's and '80's with the expansion of the commercial bait fishery, which coincided with an increasing awareness of the importance of crab eggs to migratory shorebirds. During the five decades from the '70's to the present, studies by ourselves and many others have helped to answer important questions about horseshoe crabs. We believe that major success stories include: (1) the implementation of the ASMFC management plan and the initiation of more rigorous population estimates in Delaware Bay and adjacent coastal waters through the use of improved beach spawning surveys and offshore trawls, respectively; (2) verification of the importance of horseshoe crab eggs to migrant shorebirds and the development of models that link shorebird populations to egg abundance; (3) an understanding of the reproductive biology of the species, particularly the roles of body size and condition in mating success; (4) the influences of habitat quality on the density of spawning horseshoe crabs; and (5) the effects of pollutants and other environmental factors (e.g. temperature, salinity, DO) on the survival of the embryos and larvae. As we move into the decade of the '10's, several key areas remain ripe for discovery: (1) basic information on the distribution, abundance, and feeding ecology of juvenile horseshoe crabs in Delaware Bay is almost completely lacking; (2) within the mosaic of benthic habitats in the estuary, which (if any) are critical for juvenile horseshoe crabs; (3) what are the ecological factors that could impact the survivorship of particular year-classes. Finally, given the ongoing erosion of the Delaware Bay shoreline (linked in part to global sea level rise), we see further studies of the ecological importance of eroding and artificially stabilized beaches on the NJ and DE side of the bay as an essential research priority.

DELAWARE ESTUARY NON-TIDAL LIVING RESOURCES: STATUS AND TRENDS

Gerald Bright, Philadelphia Water Department; **Dave Burke**, Pennsylvania Department of Environmental Protection; **Robert Limbeck**, Delaware River Basin Commission; **Jerry Mohler**, United States Fish and Wildlife Service

Poster – Aligned with Special Poster Session: 2011 Technical Report for the Estuary and Basin (50)

Non-tidal living resources are defined as the indicator species that inhabit the mainstem of the Delaware upstream of rivermile 133.4 (near Trenton) as well as species found in the Delaware River tributaries. "Benthic macroinvertebrates" is a term that refers to a broad and diverse category of fauna, which collectively represent a group that is a useful indicator of water quality and ecological integrity throughout the non-tidal portions of the Delaware Basin. The life history requirements of a diverse assemblage of macroinvertebrates are primarily habitat complexity and unimpaired water quality, thus trends in macroinvertebrate abundance and diversity allude to trends in many important environmental factors. State environmental agencies (and others) spend considerable effort to assess the condition of benthic macroinvertebrates throughout the watershed. As such, benthic macroinvertebrates will serve as one of the key primary indicators of the status of non-tidal living resources. In addition, anadromous fish are also valuable indicators because they give insight into the ecological conditions affecting trophic levels above that of macroinvertebrates. Therefore, American shad (*Alosa sapidissima*) and American eel (*Anguilla rostrata*) will be used as primary and secondary indicators respectively, with recent population trends determined from available data on migration and various fishery surveys.

ACOUSTIC TELEMTRY STUDIES OF THE DISTRIBUTION AND MOVEMENT OF JUVENILE STURGEONS IN THE DELAWARE RIVER AND ESTUARY

Harold M. Brundage III, Environmental Research and Consulting, Inc., 126 Bancroft Rd., Kennett Square, PA 19348, HBrund1124@aol.com; **John C. O'Herron**, II²²Amitrone O'Herron, Inc., P.O. 173, Cornwall, PA 17016-0173; and **Lisa Calvo**, Seaboard Fisheries Institute, 31 W. Commerce Street, Bridgeton, NJ 08302.

Talk – Tuesday 2:15, *Session 10: Living Resources (112)*

In 2008, a collaborative research group initiated an ongoing multi-year study of the effects of flow dynamics, salinity, and water quality on the eastern oyster, the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and the shortnose sturgeon (*Acipenser brevirostrum*) in the Delaware Estuary. A key objective of the program is to study the distribution and movements of juvenile sturgeons, as determined by acoustic telemetry, in relation to water temperature, salinity, dissolved oxygen concentration, and river flow. The ultimate goal of the project is to integrate juvenile sturgeon distribution/movement data into a water quality model (ROMS v.3), and use this model to explore the effects of natural and anthropogenic changes in river flow and water quality on the availability and suitability of sturgeon habitat in the Delaware River Estuary. Gill net sampling for sturgeon, conducted during October-November 2008, May-November 2009, and May-June 2010, yielded 76 juvenile Atlantic sturgeon and 18 shortnose sturgeon. Thirty-two young-of-the-year (YOY) Atlantic sturgeon were captured suggesting a successful and, perhaps, significant spawn of Atlantic sturgeon in the Delaware River in 2009. Acoustic transmitters were implanted in 37 juvenile Atlantic sturgeon, 15 of which were from the 2009 year class and 6 shortnose sturgeon. Acoustically-tagged subadult Atlantic sturgeon relocations ranged from the nearshore ocean off of Cape Hatteras, NC to Philadelphia, PA (rkm 148), with most detections occurring in the lower tidal Delaware River from the middle Liston Range (rkm 70) to Tinicum Island (rkm 141). The movements of subadult Atlantic sturgeon were generally localized during the summer and early fall, with areas of particular concentration noted in the Marcus Hook (rkm 123-129) and Cherry Island Flats (rkm 112-118) regions of the river. Late fall occurrences were more broadly disbursed. Distribution and movement patterns will be discussed in relation to water quality parameters and the modeling effort.

IDENTIFYING THE HABITAT AND DISTRIBUTION OF JUVENILE HORSESHOE CRABS IN DELAWARE BAY

William Burton, Versar, Inc. 9200 Rumsey Road, Columbia, MD 21045, wburton@versar.com

Talk – Tuesday 11:00, *Session 8: Delaware Estuary Benthos (6)*

Surveying the abundance of newly hatched horseshoe crabs in shallow estuaries presents a unique challenge because small trawls are not very effective at collecting 5 to 40 mm wide juvenile horseshoe crabs. A suction-dredge was developed consisting of a “T” shaped sampling head, an 8-hp trash pump, a 152-m long noncollapsible hosepipe, and a gunwale-mounted catch basin. The suction dredge was tested and compared to 5.2-m small trawl sampling at a series of 84 shallow water stations in 4 separate sampling events. Suction dredge sampling produced orders of magnitude higher catches compared to trawl sampling. The dredge was capable of sampling many stations in a single day and did not damage juveniles excessively. The device was used to assess the abundance and dispersal patterns of newly hatched horseshoe crabs in shallow water habitats in lower Delaware Bay from July through October 2004. Four stations along three inshore to offshore transects were sampled at seven horseshoe crab spawning beaches. Dramatically fewer juveniles were collected in the nearshore waters of eroded beaches in Delaware compared to undamaged beaches. Juvenile abundances were generally low at all the New Jersey beaches. The monthly transect data showed a clear pattern of offshore migration, and most juveniles moved to deeper water by September. This study demonstrated that suction dredge sampling could provide a valuable tool to annually monitor horseshoe crab spawning success. Spawning success currently is evaluated based on egg densities and adult counts at major spawning beaches.

CONCEPTUAL ECOLOGICAL RESTORATION OF TWO URBAN WATERFRONT PARCELS IN THE BRIDESBURG SECTION OF PHILADELPHIA, PENNSYLVANIA

Scott E. Bush Conestoga-Rovers & Associates, Inc., 410 Eagleview Blvd., Suite 100, Exton, PA 19341 sbush@croworld.com; and **Christine J. Potts**, Conestoga-Rovers & Associates, Inc., Exton, PA.

Talk – Tuesday 4:00, *Session 12: Restoration & Enhancement/Conservation* (93)

The Bridesburg Ecological Restoration Site, characterized as a former mixed use industrial parcel (Parcel 1) and a former coke manufacturing parcel (Parcel 2), was selected for detailed analysis and evaluation for ecological restoration due to its proximity to the Delaware River, the possibility of creating tidal wetlands, and the potential to enhance existing intertidal areas and provide significant ecological services to the community and surrounding environments. A detailed Ecological Restoration Feasibility Analysis was conducted to determine the physical limitations and economic feasibility of enhancing, restoring, or creating tidal wetlands on the Site. A preliminary cost and mitigation credit analysis was conducted for various restoration scenarios on the Site. The feasibility analysis found that the upland portions of the Site were severely constrained for tidal wetland creation due to the character of the soil, presence of fill materials, and the high cost of off-site disposal of these materials. Based on these constraints, upland restoration was recommended, which included restoring the existing weedy herbaceous uplands to riparian meadows and woodlands typical of Pennsylvania's coastal plain. Riparian upland restoration will provide habitat for a variety of wildlife including pollinating insects, small mammals, and passerine species. The feasibility analysis determined that the existing intertidal areas on Parcel 2 offered excellent opportunities for tidal wetland enhancement. Recommendations included restoring the existing unvegetated intertidal zone on Parcel 2 to create vegetated tidal wetlands. Tidal wetlands on Parcel 2 will provide habitat for fish, reptiles, amphibians, and waterfowl. Several lessons were learned from this project that can be applied to future sites. In addition to location and proximity to other resources, future sites should be selected based on availability of environmental data and the willingness of landowners to release environmental data or permit additional sampling and analysis in order to fully characterize the site.

MSX AND DERMO DISEASE IN DELAWARE BAY OYSTERS: THE ROLE OF DISEASE REFUGIA

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Poster – Aligned with Session 20: Oysters (37)

The Eastern Oyster *Crassostrea virginica* is an important species in the Delaware Bay that supports a commercial fishery and impacts the Bay ecosystem. Two oyster diseases, MSX and Dermo, have wreaked havoc on oyster populations in the Bay and elsewhere along the mid-Atlantic region of the US coast. The main Delaware Bay population has evolved a high level of resistance to MSX since it was discovered in the Bay in 1957, but not to Dermo, which has been persistently prevalent since 1989. We examined the role of low-salinity refugia in affecting host genetics by monitoring the environmental distribution of these pathogens, their ability to cause infections, and the resistance of oysters from putative refugia and non-refugia regions of the Bay. Results indicate that oysters from the rivers and upper reaches of the Bay are only marginally less resistant to MSX than are oysters from the lower Bay, and that most remain highly susceptible to Dermo. Populations living at the extremes in low salinity reaches of the Bay exist in refugia that are less likely to be exposed to either pathogen. With less disease exposure in refugia, resistance to MSX occurred either from natural selection during a rare incursion of the parasite into refugia from a prolonged drought, or through a 'reproductive sweepstakes event' that resulted in the colonization of refugia by resistant larvae and effectively eliminated susceptible individuals. These findings are being coupled with a population dynamic model, a genetic selection model, and a hydrodynamic circulation model of the Bay to generate a better understanding of how the Delaware Bay oyster population has responded to disease epizootics so that we may be able to predict further responses in the face of environmental changes expected from sea level rise and climate change. Financial support provided by NSF EID Award 0622672.

MUSSEL POWERED LIVING SHORELINES FOR SALT MARSH EROSION CONTROL

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Talk – Wednesday 11:00, *Session 17: Wetlands & Other Habitats (25)*

Tidal marshes are a hallmark feature of the Delaware Estuary that suffer from erosion due to sea level rise and other factors. In contrast to bulkheads, rip-rap and other “hard armoring” to protect shorelines, the Delaware Estuary Living Shoreline Initiative (DELSI) is designed to enhance and protect tidal marshes by establishing naturally dissipative aggregations of intertidal shellfish and marsh cord grass to “soft armor” shorelines. In these tidal marshes erosion appears most severe in areas having few ribbed mussels (*Geukensia demissa*), which can form dense aggregations at the seaward fringe of marsh grass. Natural substrates such as coconut fiber (coir) logs and mats, as well as shell bags have been deployed to trap sediments and support the development of marsh-mussel assemblages by providing structure that stabilizes the shoreline to allow the seeding and development of a natural community. Initial efforts explored a variety of methods to install coir products and shell bags in various combinations along an energy gradient near the mouth of the Maurice River, NJ. Installations trapped sediments quickly at all sites, but failed at high energy sites that were either exposed to a large fetch or excessive boat wakes. Treatments in lower energy areas survived well and tolerated relatively heavy ice flows during winter. We are now (1) quantifying physical and biological responses to the installations relative to controls, (2) testing whether seeding mussels into treatments enhances recruitment and accelerates establishment of mussel-based communities, (3) testing performance at a marina, and (4) calculating costs relative to more traditional hard armoring methods. Ultimately, DELSI should provide a new tactic to help control shoreline erosion, protect vital marsh habitats and provide important ecosystem services with natural assemblages of mussels and *Spartina*.

A PROTOTYPE COASTAL FLOOD MONITORING SYSTEM FOR DELAWARE

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Talk – Monday 4:30, *Session 4: Climate Change (52)*

In the last two decades storms such as Hurricanes Katrina and Ike along the Gulf of Mexico and Floyd and Hugo along the Atlantic Coast of the United States have resulted in significant loss of life, injuries and property damages reaching well over 100 billion dollars. Much of the damage from these and other tropical and extra-tropical weather systems is associated with severe coastal flooding. The Delaware coastline is extremely vulnerable to such events, examples being the great March, 1962 storm and the recent coastal flooding incident of May 12, 2008 which left at least one person dead and many homeless after ocean flood waters destroyed homes, especially along the Delaware Bay Coast of Kent County. The added concern of sea-level rise and its effect on the frequency and intensity of coastal flooding events, have further emphasized the need for a modern, dependable coastal flood monitoring system for Delaware's coastal communities. A prototype coastal flood monitoring system has been developed for the coastal communities of Kent County, Delaware. The overriding objective of the prototype was to develop a "proof of concept" system which allows State constituencies to be informed as to tidal conditions and possible flooding situations in advance of their occurrence. Simply put, the prototype system uses tidal surge prediction data from the National Weather Service's Extratropical Water Level Forecast System along with the Delaware Environmental Observing System (DEOS) Alerts System to notify users of a potential flooding situation up to 5-days in advance of the event. The predicted tide heights at a number of coastal observing sites are input into a statistical model that outputs potential inundation levels for a given community in a web-based mapping and data visualization system.

A WEB-BASED MAPPING SYSTEM FOR THE DELIVERY OF HYDROGEOLOGIC DATA FOR DELAWARE

John A. Callahan, Delaware Geological Survey, University of Delaware, 257 Academy St, Newark, DE 19716, john.callahan@udel.edu; and **A. Scott Andres**, Delaware Geological Survey, University of Delaware, Newark, DE 19716.

Talk – Monday 2:30, *Session 2: Water Quality & Quantity (44)*

Data, reports, and map products from the Delaware Geological Survey (DGS) are increasingly being used by State agencies (DNREC, DelDOT, DDA) and local governments to support land-use planning and resource management decisions. Several existing and proposed regulations and ordinances cite these DGS resources and encourage and require the use of these resources for preparation of development plans and permit applications. Some agencies and consulting firms have already incorporated these resources into their normal business practices, while others are still relying on less reliable proxy data and small amounts of self-generated, site-specific information. Provision of DGS resources through a common, openly accessible data delivery mechanism would standardize the reporting and access to these resources and enhance efficiency for governmental agencies, the development community, consultants, and the public.

This project is designed to deliver, by web-based mapping technology, the most commonly available and requested geologic and hydrologic information appropriate for use in hydrologic studies required by regulation and ordinance, and for use by state agencies to support resource management decisions. Information to be delivered consists of several GIS-based layers, such as surficial and subsurface geologic maps, depth to water table, recharge potential, etc., as well as data from numerous wells across the State, such as ground-water levels, geophysical logs, and descriptive logs. Additional information will be added as they are prioritized and become available. DGS is working closely with DNREC and other stakeholders to prioritize the information and functionality of the display and retrieval interfaces to clearly and effectively serve the needs of the intended community. The application will be built in modular components using client-side, server-side and database packages and will make significant use of open source technologies.

DEVELOPMENT OF A GIS DATABASE IN A MARINE SPATIAL PLANNING CONTEXT FOR OFFSHORE WIND POWER FOR DELAWARE

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Talk – Wednesday 3:30, *Session 21: Hot Topics* (106)

As defined by the National Oceanic and Atmospheric Administration (NOAA), marine spatial planning (MSP) is a “comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas.” (<http://www.msp.noaa.gov/>) MSP has gained momentum in recent years with President Obama’s creation of the Interagency Ocean Policy Task Force, Council on Environmental Quality in June 2009 and, among other things, is typically used to reduce environmental impacts and facilitate compatible uses. Concurrently, the development of offshore wind energy is progressing throughout the US, particularly within Delaware. This research project will lay the initial groundwork, through MSP, for the discussion on how best to weigh competing social, economic, and environmental effects in regard to offshore wind power for Delaware. A significant component of this process is the development of a geospatial database as well as the tools to visualize the numerous datasets in a common environment. Some of the digital datasets being gathered include established shipping lanes and other ship vessel traffic; marine wildlife; wind resources and other meteorological information; bathymetry and marine geology; artificial reefs; sand borrow sites; land-based energy infrastructure; and local and federal boundaries. Many of these data are being gathered from disparate sources. These datasets must be checked for quality, synthesized into a common platform, and presented in a usable manner consistent with the current MSP process, such as digital and hard-copy maps and GIS data formats.

EVALUATION OF PCB AND DIOXIN/FURAN (DXF) CONCENTRATIONS IN SEDIMENT SAMPLES FROM THE DELAWARE ESTUARY

Gregory J. Cavallo and Thomas J. Fikslin, Delaware River Basin Commission, PO Box 7360, West Trenton, New Jersey, USA, Gregory.Cavallo@drbc.state.nj.us

Talk – Tuesday 11:15, *Session 9: Multiple Stressors in Rivers and Estuaries (46)*

Surface sediment samples were collected as part of the Delaware Estuary Benthic Inventory (DEBI) Program in 2008. Fifty-two of these samples were analyzed for PCBs for all 209 congeners utilizing EPA Method 1668A. Twenty-four of the samples analyzed for PCBs were also analyzed for Dioxin/Furans utilizing EPA Method 1613B. Elevated concentrations of both PCBs and DxfS were observed near Wilmington, De, as were unique homolog distributions. Toxic Equivalent (TEQ) were calculated for PCB and DxfS and compared to benchmarks developed for environmental health and safety.

THE ROLE OF STRATIFICATION IN CONTROLLING SALT FLUX, SEDIMENT TRANSPORT AND PRIMARY PRODUCTION IN DELAWARE BAY

Robert J Chant, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ; **Maria Aristizabal** and **Chris Sommerfield**, College of Earth, Ocean and the Environment, University of Delaware. Lewes Delaware

Talk – Wednesday 9:15, *Session 15: Ecological Linkages and Functions (42)*

Data from moored observations and shipboard surveys of Delaware Bay are presented to highlight the importance of vertical salinity stratification to numerous physical and biogeochemical processes in the Bay. In particular, while the Delaware Bay is often classified as a well mixed estuary our results point to the critical role played by salinity stratification on driving salt flux, sediment transport and the spatial structure of primary productivity in the Bay. Data sets we will discuss include axial surveys of the Bay from its mouth to Trenton that includes vertical profiles of salinity, turbidity, dissolved oxygen, Chlorophyll-a and a high resolution cross-channel tidal cycle survey in the vicinity of Bombay Hook. Data will also include moored observations of currents and salinity from an 8-element array scheduled to be deployed from July-December 2010. The talk will emphasize the temporal and spatial structure of stratification in the Bay, discuss mechanisms that control stratification and characterize the spatial and temporal structure of turbidity, dissolved oxygen, nutrients and Chlorophyll-a and the role played by stratification in defining this structure. Understanding of the mechanism that define this structure is essential to develop meaningful models of the bay's ecosystem.

USING RIBBED MUSSELS AS SENTINELS FOR DERMO DISEASE IN DELAWARE BAY

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Poster – Aligned with Session 20: Oysters (105)

Dermo disease in oysters is caused by the protozoan pathogen *Perkinsus marinus* and has been a significant source of oyster mortality in Delaware Bay since 1990. Standard methods to monitor the pathogen involve sampling oysters and assaying them for the presence and intensity of infections. Oysters often harbor the pathogen throughout the year and during the warmer months virtually every oyster is infected. This level of prevalence makes studying transmission difficult. Molecular methods and other assays have been developed to assay water samples directly, but only limited quantities of water can be measured and pathogen densities are likely to vary dramatically with river inputs, tides and other factors. Instead, we adapted methods of Ford et al. (2009, Dis. Aquat. Org., 83(2):159-168) to use the ribbed mussel *Geukensia demissa* to collect free-living stages over a tidal cycle. Thirty mussels were collected from three sites along the Delaware Bay salinity gradient: Money Island, Maurice River and Cape Shore. Gills were dissected and assayed using a standard RFTM body burden analysis for *Perkinsus* pathogens. Results showed significant differences among sites with highest levels in the Maurice River (2528 cells g⁻¹). Levels at Cape Shore and Money Island (45 and 32 cells g⁻¹, respectively) were considerably lower indicating much lower concentrations of the pathogen were present in the water column. Highest levels were expected at the Cape Shore site because infection levels generally increase with salinity. Data from the initial outbreaks in Delaware Bay indicate that the pathogen spread outward from the Maurice River Cove. Our data coincide with that initial pattern and may indicate that factors other than salinity are responsible for concentrating the pathogen distribution, at least initially, in the Maurice River Cove. Support for this work was provided by an NSF EID REU Supplement to Award 0622672.

NATURAL CAPITAL AT THE PARTNERSHIP FOR THE DELAWARE ESTUARY

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Poster – *Aligned with Session 21: Hot Topics (88)*

The Natural Capital Team at the Partnership for the Delaware Estuary has developed tools over the past two years to assist in various projects in the Delaware Estuary, including freshwater mussel restoration, climate change planning, and regional restoration planning. One case study focused on the ecosystem benefits provided by the freshwater mussel, *Elipito complanata*. Specific ecosystem services furnished by *E. complanata* were identified and estimated based on literature values for key physiological rate functions and ecosystem process functions. These included production, clearance rate, total suspended solids removal, chlorophyll-a removal, sediment organic enrichment, sediment stabilization, macroinvertebrate habitat improvement, nutrient processing flux, and the sequestration of nitrogen and phosphorus. These metrics were related to the estimated population biomass of *Elliptio* in the Delaware Estuary and conditions such as loadings of pollutants. Mass balance estimates suggest that even the diminished current population of mussels represents ecologically important natural capital because of the ecosystem services that are furnished, including stormwater pollutant reduction and nutrient control. Estimating the services provided by *Elliptio* and other bivalve mollusks has implications for water quality standards and TMDL attainment strategies. Restoration of freshwater mussels such as *Elliptio* provides opportunities to enhance these services, improve water quality and habitat conditions, and build system resilience as an offset for the effects of climate change and continued watershed development.

DENITRIFICATION IN DELAWARE BAY TIDAL MARSHES AND CREEKS

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and **Michael S. Owens**, UMCES Horn Point Laboratory, Cambridge MD owens@umces.edu

Talk – Wednesday 11:30, *Session 17: Wetlands & Other Habitats* (123)

Nitrogen entering the coastal zone from terrestrial ecosystems can be removed from the ecosystem by loss to the coastal ocean, burial as organic nitrogen, or denitrified. The latter process, denitrification, is an anaerobic process that converts fixed nitrogen such as nitrate into N₂ gas, removing it from the nitrogen biogeochemical cycle. In estuaries, denitrification is generally limited to reducing environments found in subtidal sediments and wetlands. We examined rates of denitrification using the N₂:Ar approach in a number of Delaware River tidal creeks and one wetland ecosystem. Rates of sediment denitrification in subtidal sediments of the Indian, St. Jones, Broadkill and Murderkill Rivers ranged from zero to > 600 μmol m⁻² h⁻¹. In the Murderkill River and associated wetlands, spring and summer rates of denitrification were similar despite large changes in riverine nitrate concentrations; nitrification supplied nitrate for denitrification in the summer. Despite high rates of wetland sediment denitrification, the process of nitrogen burial appeared to be a larger nitrogen sink term. Denitrification in shallow water Delaware Bay environments are comparable to observations in shallow Chesapeake Bay and Long Island estuarine systems. We will describe the environmental controls of denitrification evident from our Delaware Bay sediment biogeochemical studies.

STATE OF DELAWARE VEGETATION COMMUNITY AND LAND COVER MAP

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Talk – Wednesday 10:45, *Session 17: Wetlands & Other Habitats* (8)

In the spring of 2006, the Delaware Natural Heritage and Endangered Species Program of the Delaware Division of Fish and Wildlife began a project to map the vegetation communities and land covers in the watersheds of Delaware starting with the Brandywine Creek watershed. Qualitative and quantitative field observations and interpretation of 2002 and 2007 aerial imagery using ArcView 3.2a and ArcGIS 9.3 are being used to determine vegetation communities and land covers to the National Vegetation Classification System (NVCS) association level using the *Guide to Delaware Vegetation Communities*. All vegetation communities and land covers are hand-digitized to achieve the highest accuracy possible. Completed maps can be used as a baseline for watershed planning by determining the amount of acreage for each community and land cover, and determining change over time (climate change and sea-level rise) using historical imagery and future imagery. Currently the Brandywine Creek and Red Clay Creek watersheds are complete, with other watersheds in varying stages of completion. Slightly more than 100,000 acres (40,469 ha) are left to be determined in the state out of 1,536,469 total acres in Delaware. Using the Brandywine Creek watershed as an example of the data that can be obtained, thirty-three vegetation communities and nine land covers were mapped and documented. Cultivated Lawn, which covers 4,206 acres (1,702 ha), is the largest vegetation community overall and Northern Piedmont Mesic Oak-Beech Forest is the largest forest community covering 2,130 acres (862 ha) or 29% and 15% of the Brandywine Creek watershed, respectively. Impervious surfaces (buildings, parking lots, railroads, and roads) cover 2,295 acres (929 ha) or about 16% of the Brandywine Creek watershed and are the largest land cover.

CONDITION OF FRESHWATER SYSTEMS OF THE DELAWARE RIVER BASIN: A GIS ASSESSMENT

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Poster – *Aligned with Session 17: Wetlands & Other Habitats (108)*

Prioritizing places for protection and restoration of tidal and non-tidal freshwater systems requires consideration of numerous factors to identify places that will contribute to river function at a basin-wide scale. River health is influenced by surrounding watershed conditions as well as by lands closer to the river corridor, with which the river directly interacts. In order to assess the condition of various rivers and small streams in the Delaware River Basin, we used a GIS to analyze factors that affect freshwater system health at a number of scales. Protecting and restoring the key ecological and physical processes that sustain dynamic riverine and riparian systems is critical to maintaining functioning ecosystems. Applying a new model and framework, called the Active River Area, we mapped the riparian areas most likely to affect river function--areas of land and water interaction that can sustain key riverine processes. We then examined indicators of key parameters, such as hydrologic regime, sediment and nutrient regime, and biotic composition to compare the condition of the Active River Area associated with different tributaries and sections of large rivers across the Delaware River Basin. Combining these results with additional assessments of factors ranging from watershed condition to water quality and the upstream/downstream connectivity of different river systems, we sought to address and incorporate many of the key aspects of freshwater system health in order to prioritize opportunities to protect and restore these ecosystems.

DO SCAVENGERS INFLUENCE DERMAL DISEASE TRANSMISSION AMONG DELAWARE BAY OYSTERS?

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Poster – Aligned with Session 20: Oysters (20)

Parasite interactions within an ecosystem may be considered in terms of an energy or nutrient flow, with sources, sinks, and reservoirs that affect the parasite's spread over time. The role of secondary interactions that may affect parasite flow, such as predation or scavenging, are often overlooked when investigating parasite transmission and disease dynamics. This study investigates how predators and scavengers influence transmission of the oyster parasite *Perkinsus marinus* in Delaware Bay.

Perkinsus marinus is a protozoan endoparasite of the Eastern oyster (*Crassostrea virginica*), and is responsible for Dermo disease, which is prevalent in oyster populations from Maine to Florida and into the Gulf of Mexico (Ford 1996). The disease is known to be waterborne, spreading through the passive shedding of parasites from infected and moribund hosts. Hoese (1962) demonstrated that scavengers which had fed upon Dermo-infected oysters could also spread the disease to uninfected oysters. Since then, few studies have investigated how such trophic interactions may affect the release and subsequent uptake of the parasites by new hosts.

This project will focus on the actions of common oyster-associated species of Delaware Bay that are known to scavenge dead or moribund oysters, specifically, the blue crab (*Callinectes sapidus*), small xanthid crabs, mud snails, and small fish (naked gobies, blennies, and mummichogs). These species can vary in abundance on natural beds, oyster leases and around oyster aquaculture. In our laboratory experiments, specific pathogen free (spf) oysters will be exposed to infected oyster tissue in tanks with scavengers (experimental) or without (control). After 2-3 months, spf oysters will be assayed for differences in parasite burden. Understanding how each species affects transmission will lead to a better understanding of disease dynamics which should ultimately lead to better management strategies.

THE NATIONAL WETLANDS CONDITION ASSESSMENT: ESTABLISHING A BASELINE CONDITION FOR THE NATION'S WETLANDS

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Poster – *Aligned with Session 17: Wetlands & Other Habitats (100)*

The National Wetlands Condition Assessment will be conducted by EPA, other federal agencies, States and Tribes in 2011. The wetland survey joins rivers and streams, wadeable streams, lakes and coastal waters in EPA's National Aquatic Resource Surveys. These are probability-based surveys, reporting on core indicators of condition using standardized field and lab methods. The surveys are implemented to provide a nationally consistent, unbiased, statistically representative estimate of condition and include a national quality assurance program. The wetland survey uses a two stage design: 1) an area frame stratified by state and physiographic region using 2 square mile plots identified in the USFWS National Wetland Survey, 2) a random stratified (by state) design for an area resource - defined by seven Cowardin wetland categories - applied to the stage one wetland polygons. Close to 1,000 sample points will be visited by field crews using standardized protocols developed, field tested and refined into the final draft Field Operating Manual. These protocols will measure vegetation, soil, algae and water quality parameters in a 40-meter assessment area incorporating the sample point and evaluate conditions in a 100-meter buffer to the assessment area. Crews will also conduct the USA RAM rapid assessment procedures at each sample location. EPA's Office of Water, in collaboration with EPA Office of Research and Development, states, tribes, and other federal agencies, will complete the survey's analyses and reporting which will conclude in a 2013 report on national wetland baseline condition.

COMPARISON OF HISTORICAL AND RECENT SEDIMENT LOADS OF THE DELAWARE RIVER

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Poster – *Aligned with Session 2: Water Quality & Quantity (31)*

In order to understand the sediment dynamics of an estuary, it is important to quantify the input of sediment from river sources. The Delaware River at Trenton has been estimated to discharge annually about 717,600 tons of suspended sediment to the Delaware Estuary, about half of the total load supplied by rivers. This estimate is based on archived suspended-sediment concentration data collected by the USGS between 1949 and 1982 and a flow-duration, sediment rating curve. Implicit in this method is the assumption that the regression equation relating the suspended-concentration and river discharge is invariant. However, sediment production and transport through river drainage basins is known to vary with factors such climate and land-use practices, and by consequence concentration-discharge rating relationships can change. In an effort to improve our ability to predict sediment delivery to Delaware Estuary, we are investigating whether the archived data for the Delaware at Trenton are representative for the present system through a comparative analysis of old and new sediment concentration data. In March 2010 an automated water sampler (ISCO) was installed at the USGS Morrisville (PA) station on the Delaware River to obtain daily suspended-sediment samples for a period of one year. These samples are returned to the lab and filtered following standard methods. Upon analysis the data will provide insight regarding the response of suspended-sediment concentration in the river to a wide range of seasonal discharge conditions. Calibration curves relating sediment concentration and water discharge for 2010-2011 are being compared to similar curves developed from the historical data to ascertain whether the sediment load characteristics of the river have changed through time. Additionally, the new sediment concentration data will be used to explore whether USGS nephelometric turbidity measured at this station can be used to predict sediment delivery to the estuary.

HOLOCENE RELATIVE SEA LEVELS AND PALEOGEOGRAPHIES OF THE DELAWARE RIVER ESTUARY: IMPLICATIONS FOR CURRENT RATES OF SEA-LEVEL CHANGE

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Talk – Monday 3:00, *Session 4: Climate Change (56)*

We have constructed a validated database of Holocene relative sea-level (RSL) data from both published and unpublished records for the Delaware Estuary. The database contains 62 index points that constrain the position of RSL with associated error terms and 20 limiting dates that identify the minima and maxima of former sea levels. The database has good temporal coverage from 8 ka to present but the early Holocene record is absent. Spatially, the majority of the samples are located in Delaware, with a limited number of index points in southern New Jersey. We consider the potential errors introduced by sediment compaction and changes in tidal range.

The data indicate that sea levels in the Delaware have not risen above its present level during the Holocene. Rates of RSL change were highest during the early Holocene ($3 - 5.5 \text{ mm a}^{-1}$) and have been decreasing over time, due to the continued relaxation response of the Earth's mantle to glacial isostatic adjustment and the reduction of ice equivalent meltwater input in the early Holocene. Late Holocene (4 ka to present) rates of rise are $> 1.2 \text{ mm a}^{-1}$. Comparison of this background rate to the tide gauge measurements at Lewes (3.3 mm a^{-1}) documents a 20th century increase in the rate of RSL rise of 2.1 mm a^{-1} , higher than the global average of $1.7 - 1.8 \text{ mm a}^{-1}$. We compare the observations to the predictions from a GIA model. Using the validated model we have produced paleogeographic maps highlighting the evolution of the Delaware Estuary during the Holocene at 1 ka timesteps. Such maps demonstrate how the shape and spatial extent of the estuary has responded to sea-level rise.

BRANDYWINE VALLEY ASSOCIATION'S RED STREAM BLUE PROGRAM: A WORKING MODEL FOR STREAM RESTORATION

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Talk – Tuesday 4:30, *Session 12: Restoration & Enhancement/Conservation (11)*

The Brandywine Valley Association (BVA) initiated their Red Streams Blue Program in 2006 to address the problem of impaired streams in the Brandywine Watershed. The BVA began this initiative by creating watershed maps showing impaired streams in red and streams attaining their designated use in blue. The approach was to complete a comprehensive assessment of smaller subwatersheds. From the assessment, restoration plans were developed that identifies projects, their priority and their costs. By concentrating restoration efforts in smaller subwatersheds more high priority projects can be completed leading to measurable improvements in water quality. So far the BVA with funding from private and government sources has finished six watershed assessments and from these assessments developed six restoration plans. The BVA partnered with the Chester County Conservation District and secured funding through DEP's Watershed Renaissance Initiative to complete five high priority restoration projects in the Plum Run Watershed. Recently completed projects include a riparian buffer planting within a local park, a floodplain restoration on private property, and a streambank stabilization project within homeowners' association managed open space. The Red Streams Blue Program also includes resident education and outreach on good watershed practices. Environmental stream teams have been started in each watershed to monitor improvements in water quality as restoration projects are completed. The Red Streams Blue Program has evolved from the initial pilot projects to an effective stream restoration model that has leveraged funding, established partners, educated diverse groups of residents and completed multiple on the ground projects. Here we focus on the successes, problems and future of the Red Streams Blue Program.

A COASTAL VULNERABILITY INDEX FOR THE DELAWARE BAY: A PILOT STUDY FOR NEW JERSEY COASTAL COMMUNITIES

Dorina Frizzera, Coastal Management Office, New Jersey Department of Environmental Protection.

Talk – Monday 4:15, *Session 4: Climate Change (68)*

Nearly 9 million people live within the coastal counties of New Jersey, making up approximately 99 percent of the most densely populated state in the nation. The shore promotes tourism, which accounts for over 16 billion dollars of yearly revenue, in addition to revenues derived from the maritime and commercial fishing industries. Global climate change threatens to negatively impact the vitality of coastal communities, industry, and the natural environment with the onset of increased rates of coastal erosion, sea level rise, and frequency of severe coastal storms. Unfortunately, few coastal communities are aware of the potential impacts of existing coastal hazards on their economy, infrastructure, and natural environment, let alone, the projected impacts of accelerated sea level rise. Defining risk and vulnerability serve as the initial steps to improve the resilience of coastal communities.

In an effort to promote resiliency and engage coastal communities to develop and plan for coastal hazards and accelerated sea level rise, the New Jersey Coastal Management Office (NJ-CMO) has developed an assessment protocol to define current and projected geographic areas at risk. This protocol is being tested on the tidal portion of the Delaware Bay, utilizing a raster overlay analysis and the Sea Level Affecting Marshes Model (SLAMM). By defining areas of geographic risk, the NJ-CMO will have the ability to identify vulnerable populations, infrastructure, and natural resources. Such information will provide the NJ-CMO the knowledge to develop local decision-support tools that will promote sustainable coastal development practices. Ultimately, it will have the ability to shape future planning on the federal, state, and local level and serve as a guide for the location of future infrastructure, conservation, and hazard mitigation efforts.

The presentation proposed for the 2011 Partnership for the Delaware Estuary Science Conference will present the results of the work completed by the New Jersey Department of Environmental Protection, Coastal Management Office (CMO) in partnership with the New Jersey Marine Sciences Consortium and Monmouth University who piloted this assessment tool in several communities in order to help characterize their social, geographic and environmental vulnerability. This assessment was conducted through an initial mapping visualization and evaluation followed by a presentation of the results to the community planners. This vulnerability mapping is intended to support community efforts to make the connection between the potential consequences of inundation and sea level rise to their vulnerability and to a realization that the community will need to adapt and plan for resilience. The vulnerability mapping was then combined with a guided survey/questionnaire “Getting to Resilience” to help the communities assess any potential planning gaps and/or opportunities. The approach was meant to validate the hazard planning that the communities have begun to implement and to identify opportunities to incorporate adaptation strategies in other community land use plans.

INTEGRATION OF SEDIMENT BUDGET AND DYNAMICS RESEARCH WITH AN RSM (REGIONAL SEDIMENT MANAGEMENT) INITIATIVE FOR THE DELAWARE ESTUARY

Jeffrey A. Gebert, US Army Corps of Engineers, Philadelphia District, 100 Penn Square East, Philadelphia, PA, 19107. jeffrey.a.gebert@usace.army.mil; J. B. Smith, US Army Corps of Engineers, Philadelphia District, 100 Penn Square East, Philadelphia, PA, 19107. j.b.smith@usace.army.mil

Poster – *Aligned with Special Poster Session: 2011 Technical Report for the Estuary and Basin (103)*

The sediment budget of the Delaware estuary, along with the dynamical processes that affect critical aspects of the budget, have been the subject of much discussion and new research within the Estuary science community over the past decade. At the same time, the US Army Corps of Engineers has adopted RSM (Regional Sediment Management) as an overall planning and project management objective for its water resources management program. Within the Philadelphia District, this has led to several initiatives that address both the specific issue of sediment budget/dynamics, as well as the broader notion of RSM within the Delaware Estuary.

This poster will present an overview of the present state-of-knowledge of the Estuary sediment budget, including those components of the budget that are relatively well understood quantitatively, and those aspects of the budget that are not as well understood. An ongoing research project funded by the Philadelphia District - “Sediment Sources and Sinks in the Delaware Estuary: A Synthesis for Regional Sediment Management Planning” – will be summarized in the poster.

The poster will also present the goals and status of the “Delaware Estuary RSM Workgroup”, initiated in 2009 with representation from government agencies as well as academic and non-profit organizations involved with various aspects of RSM. The broad goal of this workgroup is to “optimize opportunities to effectively manage sediments in a manner to achieve a sustainable balance between ecological and economic activities”. The ultimate goal of the group is to develop an RSM Plan (“RSMP”) that addresses the economic benefits and long-term needs of sediment quality, sediment quantity, dredged material management, and beneficial use in the Delaware Estuary, and provides recommendations for the development of new policies, procedures, and management practices in RSM.

LONG-TERM VARIATIONS IN TIDAL CHARACTERISTICS AND SEA LEVEL IN THE DELAWARE ESTUARY

Stephen K. Gill NOAA Center for Operational Oceanographic Products and Services, 1305 East-West Highway, Silver Spring, MD 20910 stephen.gill@noaa.gov; **Allison Allen, Carolyn Lindley, William Sweet, and Chris Zervas**, NOAA Center for Operational Oceanographic Products and Services, Silver Spring, MD

Talk – Monday 3:15, *Session 4: Climate Change* (38)

Using long-term time series from NOAA tide stations at Lewes, DE; Reedy Point, DE; Cape May, NJ and Philadelphia, PA, long-term variations in tidal characteristics and sea level are investigated for the Delaware Estuary. The latest estimates of local relative sea level trends are compared to nearby regional estimates compiled from the satellite altimeter missions and are used as baselines for projecting impacts of future sea level rise using several IPCC (2007) scenarios. Anomalies in monthly mean sea level variations are described and attributed to decadal oscillations and other oceanographic and meteorological forcing. Frequency and duration of inundation analyses of the long-term data introduce a duration (time) dimension that is important to understanding consequences of inundation on low-lying coastal areas. Variations in sea level and tidal characteristics at Philadelphia are also forced by seasonal changes in river flow. The impact of channel dredging on the range and time of tide at Philadelphia is observed in the record.

AN ASSESSMENT OF SEDIMENT METALS DATA FROM THE DELAWARE ESTUARY BENTHIC INVENTORY

Richard W. Greene, Delaware Department of Natural Resources and Environmental Control, 820 Silver Lake Blvd., Suite 220, Dover, DE 19904-2464, richard.greene@state.de.us

Talk – Tuesday 11:30, *Session 8: Delaware Estuary Benthos* (60)

Between July and September of 2008, the Partnership for the Delaware Estuary (PDE) collected surface sediment samples from over 200 locations within the Delaware Estuary, spanning the area between south Philadelphia, PA to the mouth of the Delaware Bay. This sampling campaign was part of the Delaware Estuary Benthic Inventory (DEBI). The samples were analyzed for 12 metals by the EPA Region 3 laboratory in Fort Meade, MD using a combination of methods. The PDE provided the draft metals data and locational information to the author for independent scientific evaluation. The potential for metals in the sediments to cause toxic impacts to benthic aquatic life was evaluated by comparing predicted pore water concentrations to acute and chronic aquatic life criteria. The data were also used within a simplified mass balance modeling framework to evaluate the potential toxic effects associated with deepening (dredging) the Delaware River main navigational channel in the area between the Delaware Memorial Bridge and Reedy Island, DE. This presentation summarizes the results of the analyses performed and offers recommendations going forward.

ACOUSTIC MAPPING OF STURGEON AND THEIR CRITICAL HABITATS IN THE DELAWARE RIVER AND ESTUARY FROM A MULTI-SENSORED AUTONOMOUS UNDERWATER VEHICLE

Thomas M. Grothues, **Joseph Dobarro**, and **Rose Petrecca**, Institute of Marine and Coastal Sciences, Rutgers University Marine Field Station, 800 c/o 132 Great Bay Blvd., Tuckerton, NJ 08087; **Hal Brundage**, Environmental Research and Consulting, Inc., 126 Bancroft Rd., Kennett Square, PA 19348; **John C. O'Herron, II**²²Amitrone O'Herron, Inc., P.O. 173, Cornwall, Pennsylvania 17016-0173; and **Lisa Calvo**, Seaboard Fisheries Institute, 31 W. Commerce Street, Bridgeton, NJ 08302.

Poster – *Aligned with Session 10: Living Resources (117)*

Though many studies have focused on Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus* and shortnose sturgeon, *Acipenser brevirostrum*, information on critical habitats is lacking for many populations. Acoustic telemetry studies in the Delaware River estuary have elucidated residence and return rates, spawning site fidelity, and juvenile habitat definition, but cannot be used for robust population size estimates. A complementary approach to acoustic tracking is active acoustic sonification to produce echograms capable of detecting multiple fish in their habitat. This approximates catch-per-unit-effort fishing surveys, but is non-invasive. Sidescan sonar enables search coverage of wide areas rapidly and the resolution is sufficient to visualize individual sturgeon. We used an autonomous underwater vehicle, Remote Environmental Measuring Units (REMUS-100 (Hydroid Inc) equipped with 600 kHz sidescan sonar to elucidate the distribution of adult sturgeon in the Delaware River Estuary. The propeller-driven AUV also supported a conductivity/temperature/depth sensor, an oxygen optode, upward and downward-looking 1200 kHz acoustic current Doppler profilers, chlorophyll a and CDOM optodes. The AUV also carried a hydrophone (VEMCO Inc.) for identifying acoustic tags for ground thruthing. Five missions were performed in two study regions, New Castle, DE, to Gibbstown, NJ; and Bordentown to Trenton, NJ. More than 100 targets were potentially identified as sturgeon in echograms. Positions of the putative sturgeon were mapped to benthic and hydrographic habitat features by matching the fish's location with the vehicle's time and spaced-referenced sensor data. The rapid survey provided focus and scaling to further efforts at understanding essential habitat for this species.

GENETIC STRUCTURE OF EASTERN OYSTER POPULATIONS IN DELAWARE BAY

Ximing Guo, Coren Milbury, Liusuo Zhang, Yongping Wang, David Bushek and Susan Ford. Haskin Shellfish Research Laboratory, Institute of Marine and Coastal Sciences, Rutgers University, 6959 Miller Avenue, Port Norris, NJ 08349, xguo@hsrl.rutgers.edu

Poster – *Aligned with Session 20: Oysters (118)*

Delaware Bay is a well flushed estuary system, and the eastern oyster is found in most parts of the bay. Oysters, because of their pelagic larval stage, can disperse over vast distances. It is questionable whether genetic structure can develop and be maintained in a well mixed and flushed estuary system such as Delaware Bay. However, oyster populations in the bay have been under strong selection pressure from diseases for the past several decades. The selection pressure is uneven because diseases cause less mortality in low salinity areas of the bay, so it is conceivable that differential selection by diseases may cause genetic differentiation of oyster populations. We tested this hypothesis by analyzing genetic differentiation of oyster populations with microsatellite markers, some of which are closely linked to disease-resistance genes and some are apparently neutral. The resistance markers were identified by family-based association studies. We sampled oyster populations throughout the bay including lower salinity areas and tributaries. Our analysis shows that the main part of the bay is genetically homogenous while tributaries and the upper most part of the bay are genetically distinct. This structure is strong in disease-resistance markers but weak or absent in neutral markers. Our results indicate that diseases may have caused some genetic differentiation in eastern oyster populations in Delaware Bay.

RETROFITTING DETENTION BASINS IN CHERRY HILL, NJ

Mike Haberland, Rutgers University Cooperative Extension, 152 Ohio Avenue, Clementon, NJ 08021, Haberland@njaes.rutgers.edu; **Craig McGee**, Camden County Soil Conservation District, Berlin, NJ; **Pat Rector**, Rutgers University Cooperative Extension, Morristown, NJ; **Sandra Goodrow**, Rutgers University Water Resource Program, New Brunswick, NJ

Poster – *Aligned with Session 12: Restoration & Enhancement/Conservation (61)*

Modern stormwater basins are frequently designed to meet several goals such as: providing flood control for the receiving stream, reducing the impacts of development from high frequency storms, providing water quality treatment, and meeting stormwater recharge requirements. However, many of the existing stormwater basins in New Jersey were built prior to the mid 1980's and provide only flood control. As a result, older stormwater basins are largely ineffective at providing water quality treatment, promoting infiltration and mitigating runoff from the more frequent storms. In addition to the ineffectiveness of the older basins in meeting the current goals of an integrated stormwater management program, they are often a biologic monoculture providing little if any wildlife habitat and an ongoing maintenance problem for the basin owner.

In this project we renovated and retrofitted several existing flood control detention basins in Cherry Hill, NJ in attempt to improve their stormwater treatment effectiveness and habitat value. A variety of techniques, including outlet modification, flow path extension and vegetative enhancement were employed to more effectively filter pollutants and sediment from the runoff, promote infiltration, reduce discharges from high frequency storms. The vegetative enhancements have created habitat for pollinators, birds and other beneficial wildlife. In addition the renovations have reduce municipal maintenance requirements of these facilities.

ASSESSING SOURCES AND SINKS OF CARBON IN DELAWARE BAY: A BIOGEOCHEMICAL APPROACH

Anna L. Hermes and **Elisabeth L. Sikes**, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ 08901, alhermes@marine.rutgers.edu

Talk – Wednesday 9:30, *Session 15: Ecological Linkages and Functions* (98)

Estuaries challenge the understanding of terrestrial organic matter inputs to oceanic organic matter cycling, acting as biogeochemical filters from land to sea. Considerable loads of terrestrial organic matter from multiple sources and histories mix with local organic matter production, confounding the ultimate fate of organic matter and its identity reaching the ocean. Particularly in highly urbanized estuaries such as the Delaware Estuary, anthropogenic influences such as sewage and oil spills, and physical modifications (i.e. dredging), further complicate the identity of the organic matter cycling through the estuary. What are the sources of organic matter to the Delaware Estuary and what are their fates? We seek to understand which sources of organic matter are preferentially trapped or released from the Delaware Estuary to better understand how the estuary processes organic matter both within and outside an urbanized setting.

From three seasonal shipboard cruises aboard the R/V Hugh Sharp during 2010, we collected surface and bottom water particulate organic matter along an axial transect of the Delaware Estuary. Using a biomarker and compound-specific stable isotope approach, we characterized the sources of organic matter to the estuary using *n*-alkanes and their compound-specific stable carbon isotopes. Potential sinks for organic matter within the estuary are heterotrophic bacterial uptake and respiration (releasing CO₂), and sedimentary burial. We assessed bacterial fatty acid biomarkers and their compound-specific stable carbon isotopes to determine what portion and sources of carbon bacteria consumed, and sediments from cores to assess carbon burial. Our seasonal and water column depth analysis is significant for understanding seasonal changes in inputs and the system's response to seasonal physical dynamics.

The results of this study will provide insight into the types of organic matter preferentially respired or buried, and will emphasize seasonal changes in these processes to better manage the coastal system on short time scales.

UNDERSTANDING HOW DISEASE AND ENVIRONMENT COMBINE TO STRUCTURE RESISTANCE IN ESTUARINE POPULATIONS

Eileen E. Hofmann, Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA, hofmann@ccpo.odu.edu; **David Bushek**, **Susan Ford**, **Ximing Guo**, **Eric Powell**, all at Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ; **Dale Haidvogel**, **John Wilkin**, both at Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ; **John Klinck**, Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA

Talk – Wednesday 1:45, *Session 20: Oysters (36)*

Delaware Bay oyster (*Crassostrea virginica*) populations are influenced by two lethal parasites that cause Dermo and MSX diseases. As part of the US National Science Foundation Ecology of Infectious Diseases (EID) initiative, a program developed for Delaware Bay focuses on understanding how oyster population genetics and population dynamics interact with the environment and these parasites to structure the host populations, and how these interactions might be modified by climate change. Laboratory and field studies undertaken during this program include identifying genes related to MSX and Dermo disease resistance, potential regions for refugia and the mechanisms that allow them to exist, phenotypic and genotypic differences in oysters from putative refugia and high-disease areas, and spatial and temporal variability in the effective size of the spawning populations. Resulting data provide inputs to oyster genetics, population dynamics, and larval growth models that interface with a three-dimensional circulation model developed for Delaware Bay. Reconstruction of Lagrangian particle tracks is used to infer transport pathways of oyster larvae and MSX and Dermo disease pathogens. This presentation will provide an overview of results emerging from laboratory, field, and modeling studies undertaken as part of the Delaware Bay EID program. The understanding gained from this study is providing insights into long-term changes in Delaware Bay oyster populations that occur as the oyster population responds to climate, environmental, and biological variability.

WETLAND GREEN INFRASTRUCTURE DESIGN ALONG THE DELAWARE RIVER: A PROJECT HARMONIZING STORMWATER MANAGEMENT, POLLUTANT REMOVAL, AND NATIVE SPECIES HABITAT ENHANCEMENTS WITH THE EBB & FLOW OF HUMAN IMPACTS ON OUR ENVIRONMENT

William Karl Hohman, Green Stone Engineering LLC, 5600 Kirkwood Highway, Wilmington, DE 19808, whohman@greenstone-eng.com

Talk – Tuesday 4:45, Session 12: Restoration & Enhancement/Conservation (104)

Along the Delaware River behind a small sluice gated dike dating back to the 1600's, known as Buttonwood Dike, in New Castle, Delaware, invasive monoculture stands of the common reed (*Phragmites australis*), cattails, Japanese knotweed and other invasive species have taken over a locale saturated by industrial, commercial, and high-density residential areas which predate any current stormwater and tidal water management regulations/methodologies. Fundamental ecosystem processes and economic benefits for creating and/or restoring wetlands through innovative design methods are discussed herein to help improve the water quality within our Delaware Bay & Estuary Basin Watersheds. Green Stone Engineering LLC facilitated funding, obtained environmental permits, performed preliminary planning, coordination with local residents, and initiated environmental green infrastructure design using best management practices to improve water quality, habitat, and better manage storm and tidal water fluxes. The heart of this design uses plants, micropools, and microtopographic gradients to balance the already present and inescapable human impacts with the cycles of our everyday environment to establish a more natural, biodiverse, and sustainable system. Maintaining essential ecological processes that depend on natural ecosystems provide real economic services. Wetland enhancements which encourage biodiversity restore systems choked out with invasive species limited to only particular nutrient uptake. By installing, managing, and monitoring native plant species geared toward specific nutrient uptake by way of screening, space definition, characteristic pairing, and increased plant species biodiversity a social resilience can become established to areas in need of environmental justice that are vulnerable to pollutants which harm the health of not only the habitat existing in an area but also the daily lives of those in the immediate surrounding.

METHODS FOR QUANTIFYING TIDAL WETLAND CHANGES IN DELAWARE'S INLAND BAYS (1937 to 2007)

Andrew R. Homsey, Water Resources Agency, University of Delaware, DGS Annex, Academy St., Newark, DE 19716, ahomsey@udel.edu; **Richard T. Field, Jo Young-Heon, Geri Pepe**, College of Earth Ocean & Environment, University of Delaware, Newark, DE 19716; **Kurt Philipp**, Wetlands Research Services, Inc., Newark, DE 19715.

Talk – Wednesday 1:45, *Session 19: Wetlands (Part 2)* (47)

The University of Delaware, in cooperation with the Delaware's Center for the Inland Bays, has undertaken a time series analysis of the wetlands of the Inland Bays, including Rehoboth, Indian River, and Little Assawoman Bays, to assess the nature and magnitude of changes over time. Using aerial photography from 1937, 1968, 1992, and 2007, the tidal marsh extent and land cover characteristics within a 300 meter buffer will be interpreted for each year, and the changes quantified.

To address the hypothesis that tidal wetlands are undergoing systematic change over the period, it is necessary to develop a set of objective metrics which may be applied to each photo epoch. An overview of the approaches used to capture appropriate metrics to quantify changes over time will be presented. The metrics fall into one of three categories: a set of transects off a baseline, intersecting prominent linear marsh features such as shoreline, high/low marsh boundary, tree line, and upland boundary; a 60 meter grid matrix in which percent of land cover types such as marsh, ditches, ponds, high and low marsh, forest, fresh water wetlands, agriculture, and wetlands may be calculated; and a flag applied to each 60 meter grid cell, categorizing the amount of ditching, shore hardening, and areas of sparse vegetation/open water matrix. Approaches to comparing these values across time periods, and to determining whether changes or trends are significant will be discussed.

Causal factors such as increases in the tidal prism due to altered hydrology at the Indian River Inlet, rise in relative sea levels, and sediment starvation will be discussed in relation to the various changes in tidal wetland characteristics. This is the first of a three-year study, so results are preliminary.

"KEEPING IT REAL -HIGH SCHOOL SCIENCE CURRICULUM"- HURRICANE KATRINA AND BP OIL SPILL INSPIRE CREATIVE CURRICULUM

Dave Jungblut, Oakcrest High School Science Teacher, Mays Landing, NJ

Poster – Aligned with Session 21: Hot Topics (128)

After Hurricane Katrina devastated Gulf Coast homes in 2005, Oakcrest High School science teacher and geologist, Dave Jungblut, traveled from Gulfport to Ocean Springs, Mississippi and conducted research to determine whether property damage was caused by wind or water. Jungblut wrote several studies, “Katrina Straight- Line Wind Field Study”, “Applying Research to Practical Use for Hurricane Katrina Homeowners”, and “Hurricane Katrina Wind Study” proving wind damage. Jungblut’s research, done pro bono, helped thousands of homeowner’s in the Mississippi area be reimbursed by insurance companies for wind damage caused by Hurricane Katrina <http://www.hurricanekatrinastudy.com/>

Jungblut incorporated his extensive data, in a high school curriculum that is now part of the science program he teaches each year. In January 2010, Jungblut presented “Hurricane Forensics” curriculum at the Rutgers Center for Mathematics, Science and Computer January 2009 Workshop <http://www.dimacs.rutgers.edu/wst/>.

Through labs and creative hands-on activities, Jungblut challenged his students to analyze the photographic evidence, and data he collected, for themselves. Jungblut taught his students how to use geologic and forensic inquiry techniques to discover the difference between straight-line winds from microburst activity. The students applied the concept of the Geological Principle of Relative Dating, to determine the sequence of events that happened during Hurricane Katrina. They built model structures, which were subjected to wind and water forces to better understand the effects of these phenomena, Finally, the students evaluated local and worldwide environmental issues, such as land use risks and benefits, in the face of global warming,

In the spring of 2010 when the BP Oil Spill occurred, Jungblut realized, another opportunity to bring real world issues into the classroom. After exploring scientific concepts relating to this environmental crisis, Jungblut challenged his students to devise creative solutions to stop the leak. This project was profiled on June 4th, 2010 on the CBS National News with Katie Couric, “Kids Solution to the BP Oil Spill” <http://www.cbsnews.com/video/watch/?id=6549408n&tag=contentMain;contentBody>

Jungblut continues seeking creative ways to inspire real solutions to real world problems in his classroom.

CUMULATIVE IMPACT OF INDUSTRIAL WATER INTAKES IN THE DELAWARE RIVER ON THE DELAWARE RIVER SPAWNING STOCK OF STRIPED BASS

Desmond M. Kahn, Delaware Division of Fish and Wildlife, P. O. Box 330, Little Creek DE 19961, Desmond.kahn@state.de.us

Talk – Wednesday 3:45, *Session 21: Hot Topics (125)*

Populations of fish that are important to humans are those that are sought after for recreational, cultural and for food. A population of major importance for these reasons is the striped bass stock of the Delaware River. In this talk, I will present evidence that industrial water intakes have a major impact on the productivity of this population of wild animals. While there are a score or more of the water intakes in the Delaware River, four industrial plants constitute the bulk of the withdrawals: The Salem Nuclear generating Station, (which may be the largest intake by volume in the world), the Delaware City Refinery, the Edgemoor Power Plant and the Eddystone Power Plant. The latter three installations withdraw three to four hundred million gallons per day, while Salem withdraws 2.2 million gallons per minute, or 3.2 billion gallons per day. Field studies have provided estimates of the numbers of fish killed, by species and lifestage. For individual plants, these numbers can run into the hundreds of millions of striped bass killed per year. While water withdrawal permits are usually written for one plant in isolation, regulators and permit writers have not considered the fact that all of these plants are killing members of the same population. Consequently, the mortalities produced by all the plants should be considered together, rather than as separate impacts. I will present estimates of the total numbers killed of the Delaware River spawning stock of striped bass by pooling the estimated impacts of these four plants. Probable effects include a major reduction in the productivity of this stock, that is, in the ability of this stock to produce numbers of striped bass.

SOCIOECONOMIC VALUE OF THE DELAWARE ESTUARY: A HARD-WORKING RIVER AND BAY

Gerald Kauffman, University of Delaware Water Resources Agency, DGS Annex Academy St., Newark, DE 19716 jerryk@udel.edu; and Sarah Chatterson, Stacey Mack, and Erin McVey, University of Delaware Water Resources Agency, DGS Annex Academy St., Newark, DE 19716.

Talk – Wednesday 3:15, *Session 21: Hot Topics (41)*

The University of Delaware Water Resources Agency collaborated with the Partnership for the Delaware Estuary to quantify the 2010 socioeconomic value and assets of this hard-working river and bay. Previous studies from the early 1990s indicate the estuary complex contributed over \$19 billion in annual economic activity and was directly/indirectly responsible for over 250,000 jobs in the Delaware Valley. Using 2010 demographic and economic data from the U. S. Census Bureau, NOAA, and Federal/state labor departments, the Delaware Estuary now contributes \$40 billion to the regional economy and is responsible for over a half million jobs as measured by Standard Industrial Classification (SIC) codes. The estimated ecosystem services value of water-related good and services in the 6,800 sq mi Delaware Estuary watershed in Delaware, New Jersey, and Pennsylvania ranges from \$10 to \$20 billion annually. The Delaware Estuary has significant economic value worthy of continued and expanded investment as a jobs engine in the Delaware Valley.

CLIMATE ADAPTATION IN THE DELAWARE ESTUARY: RESULTS FROM THE CLIMATE READY ESTUARIES PILOT

Danielle Kreeger, Jennifer Adkins and Priscilla Cole. Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, dkreeger@delawareestuary.org

Talk – Monday 3:45, *Session 4: Climate Change* (16)

By 2100, median temperatures will rise 1.9-3.7 degrees (more in summer,) resulting in more extreme heat days. Precipitation will increase by 7-9% (more in winter.) The growing season will increase by 15-30 days while frost days will decrease by 20-40 days. Sea levels will rise by 0.5-1.5 meters, or more, with corresponding increases in salinity. Many species, habitats and water resources will be affected by shifts in the system's salinity gradient. Due to unstoppable climate momentum over the next 30+ years, people and natural resources will need to adapt to these changing conditions. Tidal wetlands are threatened by increased sea level, salinity, precipitation and storms, which can interact with other stressors such as sediment deficits, nutrient loadings, and local subsidence. At least 26% of our >150,000 hectares will be lost by 2100. Nationally rare freshwater tidal wetlands are highly vulnerable to salinity rise. Adaptation tactics include strategic retreat, living shorelines, setbacks, and sediment supply tactics. Drinking water is most threatened by flooding, sea level rise and storm surge. Salinity intrusion as a result of sea level rise and storm surge, and degraded source water supply due to flooding and forest fragmentation are also major concerns. Adaptation tactics include upgrades and elevation of drinking water infrastructure, stormwater management, and other measures. Bivalve shellfish such as oysters and freshwater mussels supply food and habitat for people and other wildlife and they help maintain water quality. Freshwater mussels are most threatened by increases in storms, temperature and precipitation. Rising sea level, salinity and temperature will increase the virulence and prevalence of oyster diseases, leading to diminishing habitat for oyster reefs. Adaptation tactics include shellfish restoration throughout streams, rivers and the estuary, as well as water quality and flow management. More rigorous scientific information is needed, including models and an ecosystem-based, climate monitoring network.

OVERVIEW OF THE 2011 STATE OF THE DELAWARE ESTUARY AND BASIN TECHNICAL REPORT

Danielle Kreeger, Partnership for the Delaware Estuary, One Riverwalk Plaza, Suite 202, Wilmington, DE 19801, dkreeger@delawareestuary.org; and **Susan Kilham**, Drexel University, Department of Biosciences, 32nd and Chestnut Streets, Philadelphia, PA 19104.

Poster – *Aligned with Special Poster Session: 2011 Technical Report for the Estuary and Basin (121)*

The Science and Technical Advisory Committee (STAC) of the Partnership for the Delaware Estuary (PDE) is coordinating preparation of a State of the Delaware Estuary and Basin Technical Report (DEBTR), expected to be completed by December, 2011. This report will build on the 2008 PDE State of the Estuary Report and the 2008 State of the Basin Report prepared by the Delaware River Basin Commission (DRBC). The 2008 reports, which were prepared for a general audience, contained information on the status and trends for dozens of environmental indicators that when taken together provided a summary of the health of the watershed. The 2011 technical report builds on these efforts by including new indicators, new metrics, updated data, and more scientific analyses for a diverse array of indicator types. Sections of the DEBTR are devoted to sets of similar indicators, which are grouped as: 1) watersheds and landscapes, 2) water quantity and hydrology, 3) water quality, 4) sediments, 5) subtidal, intertidal, and non-tidal aquatic habitats, 6) tidal and non-tidal living resources, 7) climate, 8) system functioning, and 9) restoration activity. Status and trends for selected indicators are examined by contrasting present conditions to those from the recent and distant past. Where appropriate, forecasts for future conditions will be provided as well. Actions and needs will also be discussed to help strengthen future watershed assessments. The 2011 DEBTR will provide the scientific foundation for a public-friendly 2012 State of the Estuary Report and a 2013 State of the Delaware River Basin Report.

RECENT DISCOVERIES OF RARE FRESHWATER MUSSELS (UNIONIDAE) IN THE URBAN CORRIDOR OF THE DELAWARE ESTUARY

Danielle Kreeger, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, Dkreeger@DelawareEstuary.org.; **Roger Thomas** and **Sylvan Klein**, Patrick Center for Environmental Research, The Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103; **Angela Padeletti**, Partnership for the Delaware Estuary; and **William Lellis**, USGS - Leetown Science Center, 176 Straight Run Road, Wellsboro, PA 16901.

Poster – Aligned with Session 10: Living Resources (78)

Freshwater mussels are the most imperiled of all fauna and flora in the Delaware River watershed and across North America. These filter-feeders form dense beds in streams and rivers, and their decline contributes to degraded water quality, habitat complexity, and aquatic ecosystem resilience. The Freshwater Mussel Recovery Program (FMRP) was launched in 2007 to begin to restore freshwater mussel populations as a means to advance ecosystem-based restoration (along with restoration of marine species such as oysters.) The FMRP depends on finding genetic broodstock from the same basin for propagation and/or relocation. To date, the FMRP has been constrained to one species (*Elliptio complanata*) because the other 12 native species are no longer found in southeastern Pennsylvania streams (see poster by Thomas, et. al,) which is where the FMRP first focused its efforts. However, in 2009 and 2010 seven species of native freshwater mussels were discovered by snorkeling or dredging in the tidal freshwater portion of the Delaware Estuary between Trenton, NJ, and Chester, PA: Pond Mussel, *Ligumia nasuta*; Tidewater Mucket, *Leptodea ochracea*; Alewife Floater, *Anodonta implicata*; Creeper, *Strophitus undulatus*; Eastern Floater, *Pyganodon cataracta*; Yellow Lampmussel, *Lampsilis cariosa*, and the Elliptio, *Elliptio complanata*. At least four of these species are critically imperiled in New Jersey and Pennsylvania and two had been believed extirpated. The mussels formed robust, mixed-species beds in shallow subtidal areas having fine grain bottom sediments with cobble. Their presence in the tidal freshwater portion of the watershed, but not in smaller tributaries, likely results from dams in those streams interfering with passage of fish hosts that are essential for mussel reproduction. Since the remaining broodstock of these rare, and once ecologically important, unionids exists in the urban corridor, their protection is paramount for future mussel restoration efforts in support of broad water quality, habitat and living resource goals.

SPATIAL AND TEMPORAL VARIABILITY IN OYSTER FOOD QUALITY IN THE DELAWARE ESTUARY

Danielle Kreeger and **Roger Thomas**, Patrick Center for Environmental Research , The Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103, Dkreeger@DelawareEstuary.org.; and **Eric Powell**, Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Ave, Port Norris, NJ 08349.

Poster – *Aligned with Session 10: Living Resources (91)*

Like other suspension-feeding bivalves, oysters are “ecosystem engineers” that can regulate water quality and plankton dynamics and furnish habitat for fish and other fauna. Factors that in turn regulate oyster populations include recruitment, mortality, harvest pressure, disease, and the population productivity (growth). Of these, we know little about “bottom-up” food limitation of oysters in nature. Oysters need to filter vast quantities of microparticulate suspended matter (seston) to balance their nutritional demands. Population production can be limited quantitatively or qualitatively because the demands of oysters vary with age and season, and the amount and type of seston in the water column also varies widely in time and space, rarely being in balance with the animal’s demands. To examine how oyster food availability and quality varies in the Delaware Estuary, water samples were collected at eighteen sites in Delaware Bay and the upper Estuary during 10 months in 2009. Seston was collected on filters from water samples, and replicates were examined for total particulate matter (PM, a.k.a. TSS), particulate organic matter (POM), organic content, and the proximate biochemical composition of protein, lipid and carbohydrate. Seston quantity and quality varied widely throughout the year and among locations. In general, seston quantity was greater in spring and fall, and also was more abundant in the upper Estuary than in Delaware Bay. The concentration of POM followed a similar pattern, but the seston organic content was inversely related to PM and POM, being greater downbay than upbay. Particulate protein, lipid and carbohydrate concentrations declined as the year progressed. Oyster condition (sampled in the fall) appeared related to seston composition, especially late summer seston quantity and quality. If confirmed with additional years of surveys, these findings will yield new insights into factors governing the effect of bottom-up resource dynamics on oyster productivity in Delaware Bay.

THE MID-ATLANTIC COASTAL WETLAND ASSESSMENT: INTEGRATED MONITORING OF TIDAL WETLANDS FOR WATER QUALITY AND HABITAT MANAGEMENT AND RESTORATION PLANNING

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Talk – Wednesday 2:30, *Session 19: Wetlands (Part 2)* (119)

Coastal wetlands are a hallmark feature of the mid-Atlantic region and are critically important for both ecosystem and human health. This is particularly true in the Delaware Estuary and coastal watersheds of New Jersey and Delaware where fringing tidal marshes provide critical ecosystem services such as flood protection, carbon sequestration, food and habitat for fish and wildlife, and water quality enhancement. A scarcity of monitoring and assessment data, however, hampers efforts to regulate and preserve these wetlands even as they appear to be undergoing rapid loss and degradation. National Estuary Programs in the region are working with federal, state and academic partners to fill vital data gaps and build a multi-tier, sustained monitoring and assessment program for coastal wetlands. A network of fixed stations is being established to intensively monitor physical, chemical and biological metrics at sites stratified by salinity, watershed, and state to ensure that diverse wetland types (freshwater tidal, brackish, salt marshes) and stressor gradients (nutrients, sediments, contaminants) are represented. Sediment elevation tables were installed in 2010 in both the Delaware Estuary and Barnegat Bay to launch this site-specific intensive monitoring (SSIM). The SSIM serves to ground truth rapid assessment monitoring (RAM) that is performed in a stratified random, probabilistic approach across the region, following the Mid-Atlantic Rapid Assessment Method (MidTRAM). Initial results from pilot RAM and SSIM efforts during summer 2010 will be discussed. When fully funded and implemented, the Mid-Atlantic Coastal Wetland Assessment (MACWA) initiative will assess tidal wetlands extending from NJ to DE coastal marshes, thereby helping us to; 1) better understand causes of coastal wetland loss and degradation, 2) aid regulatory decision-making, 3) enhance regional restoration planning, 4) manage for ecosystem services, 5) strengthen climate adaptation planning, and 6) understand how coastal wetlands affect and are affected by water quality.

TIDAL WETLAND INDICATORS FOR THE 2011 STATE OF THE DELAWARE ESTUARY AND BASIN TECHNICAL REPORT

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Poster – *Aligned with Special Poster Session: 2011 Technical Report for the Estuary and Basin (122)*

Tidal wetlands will be one of the focal natural resources in the planned 2011 State of the Delaware Estuary and Basin Technical Report (DEBTR). Status and trends in the extent and health of tidal wetlands will be interpreted as environmental indicators of the health of the watershed. In past watershed assessments, wetland indicators have been difficult to develop because of insufficient and inconsistent data for the entire Delaware Estuary. Updated acreage assessments based on the National Wetlands Inventory are being examined. Several new state and academic programs are underway to examine the condition of tidal wetlands in the Delaware Estuary. In addition, land use patterns in the buffer zone around tidal wetlands and shoreline condition are being quantified as a potential indicator of future wetland resilience. Preliminary analyses of the status and trends for tidal wetland condition and extent will be presented and discussed in the context of the DEBTR, which will provide a scientific basis for the planned State of the Estuary report in 2012.

A DATA GAP ANALYSIS AND INLAND INUNDATION SURVEY FOR THE DELAWARE COASTLINE

Daniel J. Leathers, Department of Geography, University of Delaware, Newark De 19716, leathers@udel.edu. **David Legates**, University of Delaware, Newark, DE. **John Talley**, Delaware Geological Survey, Newark, DE. **John Callahan**, Delaware Geological Survey, Newark, DE. **Kevin Brinson**, Delaware Environmental Observing System, Newark, DE. **Linden Wolf**, Delaware Environmental Observing System, Newark, DE.

Poster – *Aligned with Session 4: Climate Change (51)*

The State of Delaware is progressing toward the development of a statewide coastal flood monitoring and warning system. A coastal data GAP Analysis was a necessary first step in moving toward a comprehensive coastal monitoring system for the State. This project included an exhaustive inventory of real-time and archived data suitable for coastal flood monitoring and research. The inventory included meteorological, tidal, stream flow and buoy data sources, along with ancillary sources of coastal information (i.e. research publications, non-digital records, modeling, etc.). The project led to a series of recommendations as to the data needed to reach a more comprehensive coastal monitoring network, and the spatial placement and temporal resolution of additional sensors that may need to be deployed to reach the most favorable configuration. Data from this project and interactive mapping tools are available online at <http://www.deos.udel.edu/delawaregap/>. Thus, the GAP Analysis defines the present state of coastal data collection efforts across the region, suggests a more comprehensive data collection network for coastal flood monitoring and research, identifies “gaps” in the present network of stations and recommends data that need to be added to the current network configuration. An inventory of available high water marks from previous coastal flooding events was also created to aid in understanding the relationships between water levels at tidal monitoring points and inland locations. The GAP analysis will also serve as a data resource for other environmental problems associated with sea-level rise and coastal development issues.

BIODIVERSITY OVERVIEW -- HAMILTON - TRENTON - BORDENTOWN MARSH

Mary Alessio Leck, Biology Department, Rider University, 2084 Lawrenceville Road, Lawrenceville, NJ 08648, leck@rider.edu. **Charles Leck**, Department of Ecology and Evolutionary Biology, Rutgers University.

Talk – Tuesday 1:30, *Session 10: Living Resources* (62)

The wetland along Crosswicks Creek, locally known as the Hamilton – Trenton – Bordentown Marsh, is the northernmost tidal freshwater wetland along the Delaware River. Ecological studies began in the 1970s. Plant and animal inventories include wetlands and adjacent uplands in public ownership. To date the best known are plants (> 900 vascular species) and birds (237), but inventories are also available for mammals (22), reptiles and amphibians (23), fish (62), and butterflies (32+). Focus will be on the vegetation. Main study areas have been a reference marsh (RM) and a created wetland (CW). The CW was initially (1995-1999) more diverse (177 seed bank / 72 vegetation species) than the RM (1976-1999)(96 / 66 species). The CW also had more rare / threatened species (CW – 6 seed bank / 17 vegetation species; RM - 2 / 5 species). However, now more than ~75% of the CW site is covered by *Phragmites australis*. *Lythrum salicaria*, once having high frequency, did not appear to reduce species richness and has been largely replaced by *P. australis*. Neither of these species occurred in large numbers in RM soil or vegetation samples. Significance of the wetland, changes in vegetation, and impact of invasive species will be considered.

REGIONAL RESTORATION INITIATIVE: CASE STUDY ON HEADWATER STREAMS

Michael Leff, Pennsylvania Horticultural Society, Philadelphia, PA mleff@Pennhort.org, ***Laura Whalen***, Partnership for the Delaware Estuary, Wilmington, DE, **Robert Lonsdorf**, Brandywine Conservancy, PA, **Shandor Szalay**, AKRF, PA, **Jim Thorne**, Natural Lands Trust, PA, **Diane Rosencrance**, Natural Lands Trust, PA, **Mike McGeehin**, Natural Lands Trust, PA, **Flavia Rutkosky**, Fish and Wildlife Service, **Donna Suevo**, PA DEP, **Joe Berg**, Biohabitats, NJ, **Jamie Blaine**, Stroud Water Research Center, Chester, PA, **Marisa Ranieri**, Philadelphia Water Department, PA, **Gerald Bright**, **Richard McCorkle**, Fish and Wildlife Service

Poster – *Aligned with Session 1: Green City, Clean Waters (89)*

The purpose of the Regional Restoration Initiative is to achieve a more holistic and strategic methodology for investments in restoration without duplicating the existing and ongoing efforts of other groups. Healthy estuaries depend on a complex mix of habitats, each providing unique biological, chemical and physical functions and processes important for maintaining the watershed's ecosystem. As these habitats are lost or degraded, biodiversity and functional services are lost at a great cost to our region.

Four Regional Priorities were selected to focus the initial stages of the Regional Restoration Initiative (RRI). Sub-workgroups of the STAC Regional Restoration Workgroup have been formed to address each of these Regional Priorities. Each of the four provides multiple services for people and the environment, as indicated by the lists of "Stacked Services" in the sections below. The four Regional Priorities represent some of the most critical living resources, habitats, and geographic areas for restoration, protection, and enhancement in the Delaware Estuary. One of the four priorities is "forested headwaters and riparian corridors."

All the streams feeding the Estuary begin in the headwaters, setting the stage for water quality downstream. Headwaters and riparian corridors exist in the upper reaches and tributaries of Delaware Estuary watershed, providing opportunities for protecting water quality. These source waters are key habitat areas for the upland zones of the Estuary. The introduction of development, pavement and other impervious surfaces rapidly degrade water quality. Unfortunately, many headwaters and stream corridors are degraded, making them prime candidates for restoration. Protecting and restoring the headwaters and stream buffers are crucial for improving the overall health of the Delaware Estuary, and maintaining the quality of life in our region. The ecosystem services of headwater streams will be presented as well as the progress of the workgroup to date.

RELEVANCE OF THE GEOLOGIC SETTING OF THE DELAWARE ESTUARY TO OFFSHORE WIND SITES

John A. Madsen, Department of Geological Sciences, College of Earth, Ocean and Environment, University of Delaware, Newark, DE, 19716, jmadsen@udel.edu.

Talk – Tuesday 11:45, *Session 8: The Delaware Estuary Benthos (64)*

In addition to first-order considerations such as wind conditions, water depths, proximity to onshore grid infrastructure, and ecological and human impacts, the geologic setting must be considered in the location, and construction, of offshore wind sites. The geologic setting is relevant because coastal marine areas have evolved under conditions of global sea level rise and fall during the past several hundred thousand years. These conditions have determined the present and past sedimentary environments where offshore wind sites are/will be located. As an example of the importance of geologic setting to offshore wind sites, the recent evolution of the Delaware Estuary can be considered. The region over the past ~18,000 years has experienced a major rise in sea-level. Prior to this rise, sea-level in the area fluctuated with major falls occurring between ~120,000-110,000, 80,000-70,000 and 30,000-20,000 years ago. During times of lower sea-level, significant portions of the inner continental shelf associated with the Delaware Estuary were exposed. These areas likely had geomorphologies (or land surface expressions) similar to that seen in present day Delaware and New Jersey. Across these paleo-land surfaces, channels of tidal creeks and larger fluvial (river) systems meandered with associated sediment erosion and deposition. With subsequent rises in sea-level, these paleo-channels were in-filled with coarser- to finer-grained sediments and then preserved in the sub-surface. Thus, the estuary's modern inner continental shelf, beneath a veneer of predominantly sands to silts, is characterized by sub-bottom sediments that are quite variable both in terms of their grain size and their spatial (both horizontal and vertical) distribution. Due to their different geotechnical properties, this variable distribution of sub-bottom sediments has significant implications for wind farm sites, especially in the selection (e.g., monopile, tripod pile structure, or gravity base), location, and installation of wind turbine foundations.

EMERGING CONTAMINANTS IN THE DELAWARE ESTUARY

A. Ronald MacGillivray, Delaware River Basin Commission, PO Box 7360, West Trenton, New Jersey, USA, Ronald.MacGillivray@drbc.state.nj.us:

Talk – Monday 2:15, *Session 2: Water Quality & Quantity (95)*

Emerging contaminants are unregulated substances that have entered the environment through human activities. Current regulatory approaches are inadequate to address these contaminants and the increasing public concern over their environmental and human health implications. Six sites in the tidal Delaware River were sampled in 2007, 2008 and 2009 for emerging contaminants. Water samples collected during these surveys were analyzed for 119 pharmaceuticals and personal care products, 13 perfluorinated compounds, 17 hormones, 3 nonylphenols and bis-phenol A. Concentrations of emerging contaminants in the Delaware Estuary were compared to concentrations found in surface water at other locations and to benchmarks developed for environmental health and safety by regulatory agencies. Assessment priorities in the estuary are identified including further characterization of persistent and bioaccumulative perfluorinated compounds and a more comprehensive evaluation of potential ecological effects from pharmaceuticals.

PREDICTING THE EFFECTS OF METHOPRENE APPLICATION ON HORSESHOE CRAB POPULATIONS IN DELAWARE.

Emily S. Maung, **Douglas C. Miller**, School of Marine Science and Policy, College of Earth, Ocean and Environment, University of Delaware, Lewes, DE, emaung@udel.edu

Poster – *Aligned with Session 10: Living Resources (33)*

The American horseshoe crab, *Limulus polyphemus*, is one of several horseshoe crab species, and the only one found along the coast in North America. This species has its highest spawning densities in Delaware, is of great importance to the fishing, biomedical and ecotourism industries and is critical to the diet of migratory shorebirds. Experimental results indicate that chronic exposure to the pesticide methoprene may put horseshoe crab populations at risk as the pesticide causes significant delays in larval development when applied at high concentrations. To determine how the impacts of methoprene exposure might affect future populations of *L. polyphemus* in Delaware (i.e. Delaware Bay and Inland Bays), these experimental results as well as population data from the estuaries were applied to a Lefkovitch matrix model. This mathematical model employs population counts, duration of development and stage specific survival rates to project the success of future populations. The outcome of the 50-year simulation indicated that delays in development, such as those caused by methoprene, could lead to declines in the spawning populations of these estuaries. Research is currently underway to determine if exposure to methoprene under stress may impact *Limulus polyphemus* development at environmentally relevant concentrations.

A SIMPLE MODEL FOR EVALUATING TIDAL INUNDATION OF WETLANDS IN THE MURDERKILL ESTUARY (KENT COUNTY, DELAWARE)

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Talk – Wednesday 12:15, *Session 17: Wetlands & Other Habitats* (111)

The inundation of a salt marsh with tidal water is a simple concept, but quantifying this process in time and space is difficult due to the difficulty of adequately sampling a dynamic and spatially heterogeneous flow system on a vegetated surface having microtopography. This analysis bridges the gap between the simple “bathtub model” of instantaneous inundation using water elevations from Delaware Bay and the complexity of hydrodynamic modeling. The analysis directly supports a model being developed to investigate low dissolved oxygen in the Murderkill River, but the technique can also be used to evaluate the effects of sea-level rise on tidal wetlands. A simple model of inundation is developed for the 1,200 hectares of tidal marsh along the 12-kilometer reach between Frederica and Bowers Beach. The marsh is divided into “marsh zones” based on hydrologic character. Each zone is related to a river coordinate with a dynamic tidal stage (measured or modeled). Zone areas having surface elevations lower than the related river stage are instantaneously inundated or drained. At the scale of a marsh zone, this is a “bathtub model” but on the river-reach scale it incorporates tidal propagation in the river. A temporal visualization of inundated areas and water volumes is shown for each zone and in grouped combinations. Statistics for marsh-platform elevations in zones and groups are calculated using specific LiDAR data and are compared with tidal datums for Bowers Beach and Frederica. There is a distinct pattern of decreasing marsh elevation from Bowers Beach (median=0.83 m NAVD88) upstream to Frederica (median=0.56 m). About 90% and 75% of the marshes near Bowers Beach are above Mean High Water (MHW) and Mean Higher High Water (MHHW), respectively, but in marshes near Frederica, only 75% and 25% of the marsh are above MHW and MHHW, respectively.

HYDROLOGIC AND HYDRAULIC MODELING FOR GREEN STORMWATER PRACTICES

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Poster – *Aligned with Session 2: Water Quality & Quantity* (113)

Effective stormwater management design requires consideration of not just the traditional piped drainage network but also of the receiving waters and the interface that joins the two. This paper demonstrates that the U.S. Army Corps of Engineers Hydrologic Engineering Center's widely used hydrologic (HEC-HMS) and hydraulic (HEC-RAS) models can provide a flexible and robust method of conceptualizing an urbanized, tidally-influenced watershed. Additionally, the models can simulate the impact of Best Management Practices (BMPs) on the watershed flood response and guide the design of BMPs. The modeling effort is part of the New York City Department of Environmental Protection's (NYCDEP) Staten Island Bluebelt Program, the largest urban BMP network in the northeastern U.S. HEC-RAS provides solutions to the unsteady backwater conditions in the watershed and the flexibility to incorporate different hydraulic structure and BMP designs. Along with its relatively simple data requirements, it provides a powerful tool to aid in stormwater management and flood control modeling.

ADDRESSING AQUATIC INVASIVE SPECIES IN UPLAND WATERWAYS: THE CHALLENGES AND OPPORTUNITIES FOR SUCCESS

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Talk – Tuesday 1:45, *Session 10: Living Resources (9)*

From headwaters to estuary, invasive aquatic species are invading local waterways. Impacts range from barely noticeable to major losses of exceptional native aquatic habitats.

The Perkiomen Creek is representative of the freshwater systems that supply and nourish the Delaware Estuary, and it has long experienced increases in the number and intensity of aquatic and riparian invasive species. However, no currently established invasive species presents the impacts or challenges of the European water chestnut, *Trapa natans*. Water chestnut has the potential to spread beyond the Perkiomen watershed to the Schuylkill and Delaware Estuary, significantly impacting a vast network of aquatic systems due to its prolific reproduction rates, easy transport to new locations, and lack of public understanding of invasive species, their removal and prevention.

A major water chestnut infestation has developed on the Unami Creek, a tributary to the Perkiomen and one of the region's most pristine and unique landscapes. The infestation was first noted during the Montgomery County Natural Areas Inventory (NAI) in 2007. Large areas of the Unami Creek watershed have been identified as significant natural areas in Montgomery and Bucks Counties. Water chestnut threatens many of the species noted in the NAI.

The Conservancy has been working since 2008 to address the infestation and has learned a great deal about coordinating and managing an invasives eradication project. The PWC's efforts include hands-on removal techniques, outreach to local and regional stakeholders, regional coordination, and herbicide applications.

Conservancy staff will share our experience controlling the water chestnut infestation. Discussion will include background on the water chestnut, practical information about initiating an invasives control project, outreach efforts, and the many challenges associated with the project. Participants will leave with a better understanding of the efforts needed to initiate such projects within their own watersheds.

SEDIMENT AND HEAVY-METAL DEPOSITION IN TIDAL FRESHWATER AND SALTWATER MARSHES IN THE DELAWARE RIVER ESTUARY: TEMPORAL AND SPATIAL PATTERNS OF DEPOSITION AND POSSIBLE IMPACT OF SEA-LEVEL RISE ON RATES OF DEPOSITION

Justin Meschter and Nathaniel B. Weston, Department of Geography and the Environment, Villanova University, Villanova, PA 19085, Justin.meschter@villanova.edu

Talk – Wednesday 9:45, *Session 15: Ecological Linkages and Functions (115)*

Tidal marshes are one of the most productive ecosystems in the world and provide many benefits to both humans and the environment. Saltwater and freshwater marshes have a high capacity for filtering and storing pollutants. These pollutants can range from excess nutrients to heavy metals. This study was conducted to examine the delivery and storage of several metals as well as rates of sediment deposition in both freshwater and saltwater tidal marshes of the Delaware River Estuary. Sediment deposition was measured at four sites in the estuary, at six elevations within the tidal frame to determine how deposition is related to flooding frequency and duration. The mass of sediment deposited was measured on various dates in 2009 and 2010 to investigate trends and patterns of sediment deposition along the Delaware River Estuary, and the sediments from one collection (August 2009) were digested (nitric acid) and analyzed on an inductively coupled plasma atomic emissions spectrophotometer (ICP-AES) to determine concentrations of zinc, copper, cadmium and lead. We found that metal concentrations decreased in concentration from the tidal freshwater to the salt-marsh sites. Overall sediment delivery was highest in the mid-estuary oligohaline and brackish sites, and lower at the tidal freshwater and salt-marsh sites. Metal delivery is strongly tied to rates of sedimentation. The rates of sedimentation differed between sites and also fluctuated over time. We hypothesize that sediment deposition is influenced by the estuarine turbidity maximum as well as changes in freshwater inflow from the watershed, and heavy-metal delivery to marshes is determined by the relative location to heavily populated and urban areas. The higher deposition of sediments at more frequently flooded marsh elevations may yield higher rates of sedimentation following sea-level rise and help tidal marshes accrete material and keep pace with sea-level rise.

THE CAPE MAY PLANT MATERIALS CENTER-DEVELOPING PLANTTECHNOLOGIES FOR A CHANGING CLIMATE

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Poster – Aligned with Session 4: Climate Change (71)

The USDA-NRCS recognizes that climate change and climate variability will impact all of the Agency's mission goals either directly or indirectly by such things as higher erosion rates, more invasive species, and changes in soil and vegetation relationships. As a result, the Cape May Plant Materials Center (PMC) is taking a multipronged approach in relation to developing new plant technologies. The Center is screening existing PMC releases to determine tolerance to projected climate changes (e.g., increased drought, prolonged flooding, increased salt, etc.) and is developing new plant materials as needed to ensure sustained ecosystem diversity. Some of these priorities include:

1. Selecting more southern germplasm for adaptability to the northern Mid-Atlantic/Southern New England area. An example of this is the selection of a cold tolerant sea oats (*Uniola paniculata*) which will survive north of where it presently is indigenous.
2. Quantifying the rate of carbon sequestration, in cooperation with the USDA-ARS Pasture Lab, from a range of native warm season grass species. These plots have been in place and monitored for over 10 years and soil sampling results provide some clue as to the rate of assimilation of soil carbon at depths over time.
3. Screening a wide range of coastal species for increased salinity tolerance.

Due to the network of Centers nationwide, the Plant Materials Program is particularly well positioned to design and conduct regionally and nationally coordinated studies needed to support the Agency's goals.

**TREB – SUB-TIDAL AQUATIC HABITATS:
BENTHIC INDICATORS DERIVED FROM THE 2008 DELAWARE ESTUARY BENTHIC INVENTORY
(DEBI) SAMPLING**

***Douglas C. Miller**, University of Delaware, College of Earth, Ocean and Environment, 700 Pilottown Road, Lewes, DE 19958 dmiller@udel.edu and **Angela Padeletti**, Partnership for the Delaware Estuary, Wilmington, DE.

Poster – *Aligned with Session 8: The Delaware Estuary Benthos (74)*

An EPA RARE grant to the PDE, along with other governmental and academic partners, sponsored Delaware Estuary Benthic Inventory (DEBI) project. In the summer of 2008, extensive benthic community, sediment and water-column sampling was conducted at 230 stations throughout the Delaware Bay and River chosen through a probabilistic design with both salinity and bottom type strata throughout the Delaware Bay and River. Now that these extensive data have become available in the months leading up to the next State of the Estuary Report, they can be used to inform the first-ever use of benthic indicators in the SOTER report for the Delaware Estuary. A review of similar publications from other NEP's revealed that when benthic indicators are used, there is a wide diversity of approaches, ranging from simple species diversity and richness comparisons, supplemented with distribution maps of notable species, to sophisticated indices of biotic integrity (benthic IBI) where they have been developed. Since the validation of biotic indices for the mid Atlantic estuaries is ongoing, we propose to use straightforward benthic metrics derived from DEBI community data for the report, and to display and present via GIS and the web. In addition, it should also prove possible to compare indicators derived from the 2008 data with similarly formatted and electronically available data from federally funded studies from the 1990's to assess for the first time trends in benthic communities in the Delaware Estuary.

APPLICATION OF A RELATIVE RISK MODEL FOR NATURAL RESOURCE ASSESSMENT IN THE DELAWARE ESTUARY

Greg Murphy, URS Corporation, 335 Commerce Drive, Fort Washington, PA 19034
gregory_murphy@urscorp.com; **Todd Morrison, Barry Baker,** and **Vincent Pellerito** URS Corporation, Fort Washington, PA; **Ralph Stahl, Jr.,** DuPont Corporate Remediation Group, Wilmington, DE; **Robert Hoke,** DuPont Company, Newark, DE

Talk – Tuesday 12:00, *Session 9: Multiple Stressors in Rivers and Estuaries (19)*

We developed a risk-based modeling tool to evaluate the relative importance of different stressors on selected natural resources in the Delaware Estuary. The model integrates the query and analysis capabilities of an environmental database with the Relative Risk Model (RRM) methodology using a Geographic Information Systems (GIS)-based modeling application. The RRM methodology is an adaptation of the traditional ecological risk assessment paradigm that was developed to evaluate ecological risk in regional settings where a variety of stressors exists and potentially interact with a variety of habitats leading to a range of possible ecological impacts. The risk-based modeling tool was used to conduct a preliminary assessment on striped bass in the Delaware Estuary. This presentation will discuss the inputs, assumptions, decision criteria, results and associated uncertainty of the striped bass assessment. We believe that the risk-based model developed in this study can be used, and expanded upon, by management agencies and other interested stakeholders to make more informed and risk-based management decisions in the Delaware Estuary.

EXPLORING THE ROLE OF RIBBED MUSSELS (*GEUKENSIA DEMISSA*) IN SALT MARSH STABILIZATION

Joshua Moody, Haskin Shellfish Research Laboratory, Rutgers, the State University of New Jersey, 6959 Miller Ave, Port Norris, New Jersey 08349, jmoody18@eden.rutgers.edu; **David Bushek**, Haskin Shellfish Research Laboratory, Rutgers, Port Norris, NJ; **Danielle Kreeger**, Partnership for the Delaware Estuary, Wilmington, DE

Talk – Tuesday 2:30, *Session 10: Living Resources* (40)

Marsh erosion is a major concern for estuaries as increasing storm severity, boat wakes, and sea-level rise threaten shorelines. The ribbed mussel *Geukensia demissa* is a prominent component of the Delaware Bay estuarine ecosystem, where it is typically associated with the lower edge of marshlands in close association with the marsh grass *Spartina alterniflora*. The deposition of nutrient rich feces from these mussels enhances production of *S. alterniflora* creating levees along the marsh edge which trap sediments enhancing vertical accretion. Lateral inland marsh movement threatens the ability of the marsh to create these natural levees. The physical structure formed by aggregations of ribbed mussels may provide stability to the marsh edge, but there is a dearth of information concerning the relationship between *G. demissa* and coastal erosion.

To test the hypothesis that *salt marsh shoreline erosion decreases as mussel density increases within an energy regime*, mussel demographics, mass transport potential and annual lateral shoreline movement will be quantified along shorelines of the Delaware Estuary (n = 12 sites) and potential relationships between these factors will be evaluated within and among study sites. The aim is to characterize demographics of ribbed mussels that stabilize shorelines under different erosive conditions. Results will help determine the potential role of using marsh mussels as a living shoreline fortification to reduce coastal erosion and permit natural accretion of the marsh surface.

CLIMATE PROJECTIONS FOR THE WATERSHED OF THE DELAWARE ESTUARY

Raymond G. Najjar, The Pennsylvania State University, Department of Meteorology, University Park, PA 16802, najjar@meteo.psu.edu

Talk – Monday 3:30, *Session 4: Climate Change (57)*

Global Climate Model (GCM) output was analyzed to support a climate adaptation plan developed by The Partnership for the Delaware Estuary (PDE). The goals of the GCM analysis were to evaluate the skill of the models at simulating the climate of the Delaware Estuary Watershed and to present projections of the watershed's climate throughout the 21st Century. GCM output was taken from the World Climate Research Programme's Coupled Model Intercomparison Project phase 3 multi-model dataset. Daily and monthly averages of 2-m temperature and precipitation output of 14 GCMs were used for the 20th and 21st centuries and for two greenhouse gas emissions scenarios (low and medium-high).

The analysis shows that GCMs plausibly simulate the historical climate of the Delaware Estuary Watershed. The GCMs also capture a number of hydrological extremes but do poorly for extreme high temperatures. The multi-model average is seen to be more skillful than any individual model. For the greenhouse gas scenarios considered, the projected climate by the end of the 21st century is warmer by about 2-4^o C and wetter by 7-9%. Summer warming and winter precipitation increases are substantially larger than the annual-mean changes. Also projected are substantially longer growing seasons, fewer frost days, and more intense precipitation.

HOW DOES ENVIRONMENTAL VARIABILITY AFFECT THE DISPERSION OF OYSTER LARVAE?: A NUMERICAL STUDY FOR DELAWARE BAY

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Talk – Wednesday 2:15, *Session 20: Oysters* (15)

The multidisciplinary nature of larval dispersion constitutes a challenge for management and restoration efforts of many commercially important estuarine species. In this study we address these challenges using a combination of numerical models that allows us to study the relative importance of environmental variability in the dispersion of eastern oyster larvae. A numerical model (ROMS) was configured for Delaware Bay to determine the estuarine circulation in response to winds and river discharge. Water-following Lagrangian floats in the model were modified to include larval growth and vertical migration in response to temperature, salinity and food availability. Model simulations follow larvae from a number of release points (reefs) and release times over a span of 2 to 4 weeks which is sufficient for them to mature (attain a length of 330 micron) at which point they sink and attach to the bottom. The results show that variations in temperature, salinity and food have a large impact in the larval survival, dispersal and settlement. With a homogeneous food field, an along estuary survival gradient is related to the salinity gradient observed for the Bay. This survival gradient is modified when a food gradient (low to high concentrations from the Lower to the Upper Bay) is superimposed in Delaware Bay. Long development times are associated with areas having low salinity or low temperature or low food concentrations. Simulations show that behavior is important and favors the exchange of larvae within the Bay; particles without behavior are mostly exported to the shelf. A recirculation in the lower Bay is important for the retention of larvae, increasing the settlement in this area. River discharge also affects the settlement pattern, causing a shift between middle and lower Bay settlement. These results present new evidence of how climate variability might affect the genetic dispersal through the exchange of individuals among oyster populations in Delaware Bay. These simulations have implications for the introduction of disease-resistance oysters to populations that are significantly impacted by disease.

RESTORATION OF SHAD AND ANANDROMOUS FISH TO THE WHITE CLAY CREEK NATIONAL WILD AND SCENIC RIVER

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Talk – Tuesday 2:00, *Session 10: Living Resources* (30)

The Water Resources Agency (UDWRA), a unit of the University of Delaware's Institute for Public Administration assessed the feasibility of restoring fish passage and habitat to the White Clay Creek National Wild and Scenic River watershed. This project was funded by the National Fish and Wildlife Foundation (NFWF) and is one of 17 projects undertaken by a number of regional organizations striving to improve the environment of the Delaware Estuary—the tidal portion of the Delaware River.

The long-term goal of the White Clay Creek watershed project is to restore shad and migratory fish passage and habitat, increase spawning areas, and benefit the resident fish in the 107 mi² watershed. To achieve this, UDWRA conducted a feasibility study for restoring fish passage to the federally designated Wild and Scenic White Clay Creek. In order to identify and achieve the most effective options for restoring fish passage and habitat, UDWRA collaborated with numerous public, nonprofit, and private agencies, as well as citizens and interested stakeholders.

Project tasks included the following:

- Conduct a literature review of successful fish restoration projects on the East Coast.
- Research to determine abundance and extent of the historic and current fish population.
- Conduct fish abundance surveys.
- Research and develop a fish stocking plan.
- Carry out a field survey and inventory of dams.
- Explore the feasibility of restoring fish passage utilizing a variety of techniques.
- Recommend the most feasible fish passage alternative for each dam.
- Create a shad restoration committee and implement public education and outreach programs.

This project serves as an expansion of the Brandywine Creek Shad Restoration effort. UDWRA has a long-term commitment to implementing the recommendations set forth in this study. This study and activities related to this study will be discussed in detail.

ACHIEVING WATERSHED IMPROVEMENTS THROUGH SOURCE WATER PROTECTION

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Talk – Monday 1:15, *Session 2: Water Quality & Quantity (7)*

Source water protection and watershed management create unique challenges for water systems. Source water protection technical assistance offered by the Pennsylvania Department of Environmental Protection (DEP) provides community water systems with a computerized surface water model analysis of their watersheds and options for managing potential contamination issues that serve as valuable tools for increasing understanding about the respective watersheds.

The Reading Area Water Authority and the Western Berks Water Authority are two systems actively involved in source water protection in Pennsylvania that struggle with a variety of issues in water quality improvement and watershed restoration. Since the combined protection zones for these systems cover 295 square miles of Berks County, in the heart of the Schuylkill River Watershed, their issues impact 34 percent of the county and approximately 150,000 customers.

The Reading Area Water Authority (RAWA) intake is located on Lake Ontelaunee and they wrestle with sediment and nutrient problems that have been identified through both a total maximum daily load (TMDL) and RAWA's source water protection plan.

The Western Berks Water Authority intake is located just south of Blue Marsh Lake, which is controlled by another agency - the U.S. Army Corps of Engineers. The different groups have multiple management goals - water supply, water quality, flood control, and recreation - which have the potential to inhibit the ability to effectively manage the watershed.

The issues facing these water systems are very similar to ones experienced by a large number of other communities located throughout the Delaware River Basin. This presentation will focus on the challenges, solutions, and leadership opportunities currently proposed and implemented by the two systems, including ongoing water quality data collection and the multiple partnerships that form the foundation of a sustainable source water protection plan.

WHAT'S THAT BIG PINWHEEL ALL ABOUT? COMMUNICATING TO THE PUBLIC ABOUT ALTERNATIVE ENERGY RESEARCH.

***Ronald L. Ohrel, Jr.*, Elizabeth Boyle, Tamara Beeson, and Lisa Tossey**, University of Delaware College of Earth, Ocean, and Environment and Delaware Sea Grant College Program, 222 S. Chapel Street, Room 103, Newark, DE 19716, rohrel@udel.edu.

Poster – *Aligned with Session 13: More than a Message: Planning a Communications Effort for Results You Can Measure (21)*

The University of Delaware and its partners commissioned a 2-megawatt wind turbine on the university's Lewes, Del. campus in June 2010.

A typical 2-megawatt turbine provides enough emissions-free electricity to power about 500 average homes, so the single turbine is providing clean, carbon-free electricity for the entire campus, which is part of UD's College of Earth, Ocean, and Environment (CEOE). At times, the turbine generates more than enough power for the campus; the excess is fed to the electric grid.

Carbon-free electricity is not the only benefit of the turbine, however. The project is enhancing research in areas such as turbine corrosion, avian impacts, and policy issues related to renewable energy.

Throughout 2010, UD's Marine Public Education Office (MPEO) took on the job of educating the public about the science behind the 400-foot-tall machine. MPEO wanted members of the public to know how wind energy works, its benefits, and the research possibilities presented by the Lewes turbine. To do this, office members developed a suite of communication publications, including a web site, time lapse videos showing the turbine's construction, signage for UD's Lewes campus, and a special exhibit at UD's annual marine studies open house, Coast Day.

FRESHWATER MUSSEL RECOVERY: A CORE COMPONENT OF WATERSHED-WIDE BIVALVE RESTORATION

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Poster – *Aligned with Session 12: Restoration & Enhancement/Conservation (81)*

Southeastern Pennsylvania has benefited from an increase in healthy riparian buffers, improved water quality, and the removal of dams. These environmental improvements help to set the stage for the reintroduction of freshwater mussels into habitats from which they have been extirpated. Historically over twelve species of native mussels were found in the area, often in great abundance, while today only vestigial populations of one of these species can be found. The Freshwater Mussel Recovery Program (FMRP) was created to increase resilience, biomass and restore diversity to the native freshwater mussel assemblage throughout the estuary. The program works to reintroduce species by adult translocation and propagation of hatchery raised juveniles to streams that are pre-tested to ensure they have suitable water and habitat quality. Mussel surveys are also underway to locate suitable native broodstock to support these efforts and to provide a monitoring framework to track future outcomes of the FMRP. The FMRP is one of several programs by the Partnership for the Delaware Estuary to advance a watershed-wide bivalve shellfish restoration strategy. Bivalve restoration is often focused on economically important bivalves, such as oysters; however, the ecosystem service benefits provided by bivalves can be best realized by taking advantage of the full diversity of native species living in various niches from the headwaters to the ocean. This holistic shellfish recovery strategy promotes estuarine benefits by intercepting pollutants by freshwater mussels before they reach the estuary, for instance. This strategy promotes broad-based benefits to society, whereby healthy bivalves leads to not only jobs but improved human health, flood protection and water quality. PDE is working towards this goal with not only their FMRP but with their Oyster Shell Planting Program and Shellfish-Based Living Shoreline Initiative.

RESOURCE OVERLAP AND POTENTIAL COMPETITION BETWEEN INVASIVE RED-EARED SLIDER TURTLES AND NATIVE RED-BELLIED TURTLES IN PENNSYLVANIA

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Poster – *Aligned with Session 10: Living Resources (48)*

Invasive species have affected populations and communities worldwide through predation and competition for limited resources. Globally, the invasive red-eared slider turtle (*Trachemys scripta elegans*) is hypothesized to compete with native turtles for limited food and spatial resources. In the Mid-Atlantic region of the United States, including within the Delaware River Watershed, the red-bellied turtle (*Pseudemys rubriventris*) has undergone population declines where red-eared slider turtles have been introduced. Using bio-telemetry and dietary analysis our research quantifies the extent of overlap for spatial and nutritional resources between sympatric red-eared slider turtles and red-bellied turtles in Pennsylvania. Radio tracking and trapping data suggest extensive overlap of habitat use by both species. Stomach flushing and stable isotope data show that diets of red-eared slider turtles overlap extensively with those of red-bellied turtles in smaller, anthropogenically altered wetlands. In larger, less altered wetlands, turtle species exhibit partitioning of food resources. Our research shows that wetland characteristics may play a key role in determining the extent of competition between invasive red-eared slider turtles and declining native turtle species. These findings have fundamentally important implications to conservation and management of declining turtles world-wide.

ECONOMIC VALUE OF PROTECTED OPEN SPACE IN SOUTHEASTERN PENNSYLVANIA

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Poster – *Aligned with Session 21: Hot Topics (107)*

Protected open spaces – public parks, preserved farmland, and private conserved lands – provide substantial economic, environmental, and public health benefits to surrounding communities. These benefits, however, are generally not well understood and are often undervalued in policy debates and investment decisions. Approximately 14% of the land area in Bucks, Chester, Delaware, Montgomery, and Philadelphia counties is protected open space, including Valley Forge National Park and the Schuylkill River Trail, Chester County’s White Clay Preserve, and working farms across southeastern Pennsylvania. This study estimates the economic value of protected open space in southeastern Pennsylvania by measuring impact in four areas: 1) the effect that protected open space has on residential property values, 2) the value of the environmental impacts associated with southeastern Pennsylvania’s protected open spaces, 3) the value of recreational activity taking place on these spaces and associated avoided health care costs, and 4) jobs and revenue created as a result of activity on and connected to protected open space. Major economic benefits were found, including increased value of properties within walking distance of protected open space; cost savings on flood/environmental damages and pollution remediation; decreased healthcare costs through physical activity; and direct economic activities related to maintenance, agriculture, and tourism. These estimates are derived using standard economic methodologies, including regression analysis, input-output modeling, and value transfer techniques, and indicate that protected open space adds significant value to the regional economy.

THE NEW DREADED “F” WORD ... FRACKING. IS THE HYDRAULIC FRACTURING PROCESS THE REAL CAUSE FOR CONCERN IN UNCONVENTIONAL SHALE GAS DEVELOPMENT?

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Poster – *Aligned with Session 21: Hot Topics (67)*

There has been a great deal of concern expressed about natural gas development within the Marcellus Shale formation. This geologic formation underlies approximately 35 percent of the uppermost reaches of the Delaware River Basin. In order to produce gas from this unconventional, deep, shale, a process known as hydraulic fracturing must be used to release the gas from the tight pores within the shale. Many have expressed concern that this process will create numerous environmental impacts, including the contamination of drinking water supplies. But, is the hydraulic fracturing process, itself, the real cause for concern? This presentation will explore the science behind the hydraulic fracturing process, including how wells are constructed to enable hydraulic fracturing to take place and the way these wells are fractured to release the gas trapped in the shale. In addition, this presentation will explore the geologic relationship between where hydraulic fracturing occurs versus the location of ground water formations that supply drinking water. Additional resource extraction issues will also be reviewed to determine if their impact could pose a greater concern than the hydraulic fracturing process.

CAN OYSTERS DEVELOP RESISTANCE TO DERMO DISEASE IN THE FIELD: EVALUATION USING A GENE-BASED POPULATION DYNAMICS MODEL

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Talk – Wednesday 2:00, *Session 20: Oysters (1)*

Abstract: Eastern oysters, *Crassostrea virginica*, are commonly limited by disease mortality. The development of resistance to Dermo disease has been slow, despite the high mortality rates and frequency of epizootics. Can aspects of the host's genetics or population dynamics limit the response to the disease despite the apparent opportunity afforded it by alleles conferring disease resistance? To answer this question, we utilize a gene-based population dynamics model, configured for the population dynamics of *Crassostrea virginica*, to simulate the development of disease resistance. Simulated populations were exposed to four levels of mortality covering the range in mortality observed in Delaware Bay in the 1990s. The rate of development of disease resistance increased in proportion to the increase in mortality rate imposed by the disease. The simulations, as a whole, show that a significant population response occurs even at its most rapid rate on decadal time scales, with a half-century being the more likely time scale. As the mortality rate declines with increased disease resistance, the rate of improvement in disease resistance likewise declines. Thus, disease resistance develops over decadal time scales at a 40% per year mortality rate, but each increment results in a lower mortality rate and a declining rate of development of disease resistance. At 25% mortality per year the rate of development of disease resistance falls to half-century time-scales. Unfortunately, a mortality rate of 25% per year, yielding a rate of selection profoundly slow, is still very high. In northern climes, significant decrements in abundance will occur. Evidence from fisheries retrospectives suggests that oysters cannot withstand a constant removal at this scale without compromising population integrity noticeably. So, a mortality rate that sorely limits the development of disease resistance still sorely strains the species' ability to maintain a vibrant population dynamics necessary to its long-term survival.

DENITRIFICATION IN AN URBAN TIDAL FRESH WATER WETLAND OF THE DELAWARE

Tracy Elsey-Quirk, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103, quirk@ansp.org; **A. Smyth, M. Piehler**, Institute of Marine Sciences, University of North Carolina, Morehead City, NC, **B. P. Horton**, Department of Earth and Environmental Science, University of Pennsylvania, Philadelphia, PA, **J. Mead**, and **D. J. Velinsky**, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA

Talk – Wednesday 11:45, *Session 17: Wetlands & Other Habitats (53)*

Human activities have increased the availability and mobility of N in most areas of the Earth. In temperate estuaries, N is the main limiting nutrient for primary production, which is associated with eutrophication, a process that can result in anoxic or hypoxic waters. N is removed via physical transport, burial in the sediment or denitrification. Denitrification is carried out by heterotrophic, generally facultative anaerobic bacteria, which utilize inorganic N (NO_2^- or NO_3^-) as the terminal electron acceptor during the oxidation of organic matter and produce N gas (N_2 or N_2O). In waters that receive substantial amounts of anthropogenic nutrients, denitrification may help remove excessive inorganic nitrogen inputs. The goal of this study is to evaluate N ecosystem services in an urban tidal fresh water wetland relative to sea-level rise. We examined seasonal rates of denitrification (Membrane Inlet Mass Spectrometry) in relation to hydrology, aboveground biomass, and percent soil organic matter, organic carbon, and total nitrogen. In April, aboveground biomass averaged 114 g m^{-2} and was dominated by *Nuphar lutea* in the lower elevation areas and *Typha* in the higher elevation areas. Biomass values were substantially higher in the summer and fall. In April, denitrification rates were spatially variable and ranged from 0 to $580 \text{ } \mu\text{mol N m}^{-2} \text{ hr}^{-1}$. Eleven out of the twenty total samples had undetectable rates and the remaining nine had denitrification rates that averaged $123 \pm 58 \text{ } \mu\text{mol N m}^{-2} \text{ hr}^{-1}$. Our measured denitrification rates were well within the range found in other coastal marine and freshwater sediments. In the spring, denitrification rate was not related to elevation, aboveground biomass, or soil organic matter however, this relationship may differ in the summer and fall. Additional sampling will occur in the summer and fall of 2010.

INITIATION OF LONG-TERM MONITORING IN WETLANDS ALONG DELAWARE AND BARNEGAT BAYS

Tracy Elsey-Quirk, **R. Thomas**, and **D.J. Velinsky**, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103, quirk@ansp.org, **Danielle Kreeger** and **Angela Padeletti**, Partnership for the Delaware Estuary, and **Martha Maxwell-Doyle**, Barnegat Bay Partnership

Poster – *Aligned with Session 17: Wetlands & Other Habitats (65)*

Wetlands provide important ecosystem services such as nutrient cycling, habitat for wildlife and fish, and protection from storm surge and a rising sea level. However, there is a lack of long-term datasets on the health and sustainability of wetlands along the mid-Atlantic coast. As part of a large EPA funded monitoring program wetlands along both the Delaware Estuary and Barnegat Bay (NJ) are the focus of a new Mid-Atlantic Coastal Wetland Assessment (MACWA) program. Intensive fixed-station monitoring is ongoing in several wetlands along both estuaries. One of the primary goals of MACWA is to assess the vulnerability of wetlands to sea level rise. Surface elevation tables paired with feldspar marker horizons (SET-MH) are being established in each wetland (n = 3). SET-MH data will allow us to determine whether wetlands are accreting at a rate similar to that of sea level rise. Above- and belowground biomass, soil, and tidal creek water is being sampled to assess various aspects of ecosystem health. Initial (year 1) data will be presented. In addition to assessing wetland function at each location, syntheses of long-term data may include why and how some wetlands have greater accretion rates than others and how do wetlands along these two different estuary types (Delaware Bay and Barnegat Bay) differ in both health and sustainability.

SMALL-SCALE HARD-BOTTOM BENTHIC DIVERSITY IN DELAWARE BAY

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Talk – Tuesday 11:15, *Session 8: Delaware Estuary Benthos (12)*

Although estuaries act as sediment traps, the Delaware Bay bottom is not uniformly comprised of mud, but contains hard-bottom areas that are hotspots of biodiversity. A study of spatial diversity using acoustic surveys from an autonomous underwater vehicle (AUV), remotely operated vehicle (ROV), and grab samples, reveals the heterogeneity of both sediments and biology within the Broadkill Slough. The area studied was 3 km long, 1 km wide, trending NW-SE located about 11 km north of Broadkill Beach, Delaware. The slough is a dead-end channel with depths ranging from about 6-12 m. The side-scan data provided complete coverage of areas and textural substrate information. The ROV footage provided important ground-truthing for the acoustic imagery, allowing more detailed analysis of the biology. The northern slough area was the shallowest survey location and had fine sediment with trace amounts of shell hash and was the most biologically diverse. The western and central slough contain fine sand with mud and shell hash and have worm nodule and abundant sponge communities. The eastern slough is primarily fine sand with trace shell hash. Future work will test the utility of high-resolution phase-measuring bathymetric sonar data and automated backscatter analysis programs in identifying and characterizing benthic habitats.

A SCIENCE-BASED REGIONAL RESTORATION APPROACH IN THE DELAWARE ESTUARY: URBAN WATERFRONT CASE STUDY

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Talk – Tuesday 3:45, *Session 12: Restoration & Enhancement/Conservation (10)*

Regional restoration planning is emerging nationally as a means to promote better coordination among restoration practitioners, planners and project decision-makers on a watershed basis to ensure that the most meaningful ecological outcomes are realized. Restoration, enhancement and conservation projects are often in reaction to particular program interests, issues or incidents, without scientific consideration for how they fit within the broader landscape of ecological needs. The goal of the new Regional Restoration Initiative (RRI) is to provide a science-based decision-support system that proactively guides restoration activities to ensure that outcomes: 1) are tailored to maximize ecological needs for specific sub-watershed regions and 2) minimize short-term loss of opportunity and maximize long-term “bang-for-the-buck” by considering ecological compounding relative to economic investments (a.k.a. “Restoration Up-front”.) The RRI consists of three components: 1) a “science track” that will develop ecological matrices and decision support tools to help elevate needs and opportunities that are expected to yield the greatest ecological goods and services; 2) a “policy track” that will synthesize and coordinate regional program priorities and activities among restoration decision makers, and 3) a “project registry” that will serve as a clearinghouse for restoration projects across the watershed. Four case studies are being conducted for the ‘science track’ of the RRI to develop the ecological matrices for specific habitat types in the estuary.

Urban Waterfronts is one case study which the Pennsylvania Environmental Council has taken the lead on to evaluate restoration opportunities along the Philadelphia waterfront. Following an overview of the Regional Restoration Initiative, the results to date from this case study will be presented. This will include a summary of basic restoration matrix factors used to assess and prioritize ecological restoration opportunities along an urban waterfront. A preview of value added “ecosystem services” associated with the urban waterfront will also be presented.

DELAWARE'S WETLAND TRENDS AND CONDITION ASSESSMENT

Alison B. Rogerson, Amy D. Jacobs, Andrew M. Howard

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Talk – Wednesday 2:00, *Session 19: Wetlands (Part 2)* (28)

Delaware's wetland maps were last updated in 1992. Using 2007 aerial photography, DNREC recently updated state wetland maps and received the 2009 status and trends report. Results show that Delaware has lost over three thousand acres of tidal and nontidal wetlands over the past 15 years. The majority of wetland loss during this period was to nontidal wetlands. Patterns of wetland loss have varied by county and wetland type. In particular, isolated and headwater wetlands have been the most vulnerable to alteration or destruction. The conversion of wetland acreage to other land uses was especially evident in several areas of increased development across the state. Condition assessments in tidal and nontidal wetlands identified the most common and severe impacts affecting wetland condition in the Inland Bays, St. Jones River, Murderkill River, and Broadkill River watersheds. Combining wetland trends with condition assessments enhances our understanding of how wetlands are being affected on a watershed basis. Management action items based on trends and condition results will target specific needs to improve wetland protection and condition and guide communication and outreach efforts to decision makers and citizens.

THE USE OF TWO WETLAND RAPID ASSESSMENT METHODS IN DELAWARE

Alison B. Rogerson, Amy D. Jacobs, Andrew M. Howard

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Poster – *Aligned with Session 17: Wetlands & Other Habitats (39)*

The State of Delaware's Wetland Assessment and Monitoring Program is dedicated to improving the condition of Delaware's wetlands by assessing the condition, function and ecosystem services of wetlands and then applying that information to guide protection and restoration activities. Two rapid assessment methods are used to evaluate the condition of nontidal and tidal wetlands. The Delaware Rapid Assessment Procedure (DERAP) was created for nontidal wetlands to evaluate the condition of wetlands based on the presence of stressors related to wetland habitat, hydrology, and buffer. The DERAP is calibrated to the Delaware Comprehensive Assessment Procedure (DECAP) that used more detailed information to assess condition. The Mid-Atlantic Tidal Wetland Rapid Assessment Method (MidTRAM) was created in cooperation with Maryland Department of Natural Resources and the Virginia Institute of Marine Sciences. The MidTRAM assesses the condition of tidal marshes using 14 metrics related to wetland habitat, hydrology and landscape attributes. The MidTRAM is validated with intensive biological data using below and above ground biomass and a marsh bird community index. A trained field crew can complete either the DERAP or MidTRAM in about 1-2 hours. Rapid assessment methods are used to assess the condition of wetlands on the watershed scale using a probabilistic design to report on all wetlands in the watershed. Results of the watershed assessments are used to determine condition of wetlands by different wetland types and the major stressors that are affecting wetland condition and function. The wetland assessment results are then used in combination with other conservation data to create watershed restoration plans that effectively guide restoration activities and allow conservation partners to better allocate their resources and prioritize goals.

BULKHEAD CONFIGURATIONS and HORSESHOE CRAB SPAWNING ON SANDY SHORELINES IN DELAWARE BAY, NEW JERSEY

***Sherestha Saini ***, Department of Chemistry and Environmental Science, New Jersey Institute of Technology, Newark, New Jersey. ss537@njit.edu; **Nancy L. Jackson**, Department of Chemistry and Environmental Science, New Jersey Institute of Technology, Newark, New Jersey; **Karl F. Nordstrom**, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, New Jersey

Poster – *Aligned with Session 12: Restoration & Enhancement/Conservation (55)*

This study evaluates the influence of bulkhead configurations on abundance of spawning horseshoe crabs within armored and unarmored segments of sandy shorelines in Delaware Bay. Bulkhead construction has occurred incrementally along the New Jersey shoreline resulting in structures intersecting the beach foreshore at different elevations. The irregular configurations create sandy beach enclaves between bulkhead segments that can result in the development of shadow zones to wave exposure and areas of potential horseshoe crab spawning during high waves.

A ground assessment of bulkheaded and adjacent unbulkheaded beach segments was conducted on the New Jersey shoreline of Delaware Bay. Data were gathered on alongshore length of bulkheaded and unbulkheaded shoreline and cross shore location on the intertidal profile to document the physical configuration of bulkheads. Assessment of spawning patterns was determined from counts of horseshoe crabs on two developed sandy barriers during the spring tide in May and June 2007. Counts were conducted at three enclaves and an unarmored segment of the shoreline one hour before high tide, at high tide and one hour after high tide on four separate events during spring tide.

Counts of female horseshoe crabs spawning during offshore wave heights of 0.40 – 0.60 m revealed greater densities in the enclaves, with more horseshoe crabs clustered in the shadow zones relative to the wave approach. Counts an hour after high tide were greater than at high tide. Results reveal that depending on the direction of wave approach, bulkheads located 6 - 75 % below the spring tidal elevation on the active foreshore can create shadow zones in the sandy enclaves where wave and current velocities are lower and provide spawning areas during storm events.

SUPPORTING SCIENCE-BASED MANAGEMENT AT THE USFWS COASTAL DELAWARE REFUGE COMPLEX AND SURROUNDING DELAWARE BAY MARSHES

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Talk – Tuesday 11:45, *Session 9: Multiple Stressors in Rivers and Estuaries (72)*

The USFWS Delaware Refuge complex includes Prime Hook and Bombay Hook National Wildlife Refuges along the eastern shore of the Delaware Bay. Prime Hook National Wildlife Refuge was created in 1963 in Sussex County, DE. The Refuge originally managed 3 freshwater impoundments for migratory waterfowl use. In 1986 the northern impoundment was breached along the Bay by storms and the impoundment has subsequently converted to a healthy salt marsh. Recently, the Unit II impoundment was breached requiring the consideration of temporary remediation actions. Because of recent natural occurrences, the viability of the freshwater impoundments and even the survivability of the marsh ecosystem is in question. Bombay Hook National Wildlife Refuge, established in 1937, in Kent County DE. The Refuge has moderately well protected freshwater impoundments for waterfowl use, but is experiencing significant loss of its interior salt marsh habitat.

In order to provide the information to properly manage Delaware's coastal resources with the added consideration of the impacts of climate change and sea level rise, site specific science-based research is needed. The Delaware Coastal Programs with support from the Refuge Complex have entered into a multiyear agreement to examine the marsh habitats to assist the Refuge in their management efforts. This research involves examining the historic and current accretion rates in the impoundments and surrounding areas, elevation surveys, real-time monitoring of salinity and water levels, tracking nutrient and sediment loads entering the system, hydrodynamic analysis and biological productivity of the marshes. All this data will be analyzed and used to assess the current condition and predict future conditions of the marsh under differing management scenarios. The information and experiences gained through this project will provide a framework for coastal resource management throughout the state.

DRAMATIC LONG TERM CHANGES IN DELAWARE ESTUARY ENVIRONMENTAL CONDITIONS EXPLAINED USING CONSISTENT WATER QUALITY MONITORING

Jonathan H. Sharp, School of Marine Science and Policy, University of Delaware, Lewes

Talk – Tuesday 10:00, *Special Plenary Session: Dr. Jonathon H. Sharp (120)*

The “Boat Run” monitoring program, established by the Delaware River Basin Commission (DRBC) in 1967 is, in some ways, a visionary plan. It has been maintained with relative consistency since that time, and as a result, now covers a period of over four decades. Parameters measured included those needed for regulatory compliance at compliance sensitivity levels. However, other parameters and higher sensitivity have been used also, which allows long time period trends to be tracked. It has been and continues to be difficult to maintain this program and there have been some partial gaps and slippage. The Department of Natural Resources and Environmental Control (DNREC) of the State of Delaware (and its predecessor agency) has conducted the sampling and analyses for the entire period of the Boat Run monitoring. In spite of efforts by DRBC and DNREC, the data management in the US EPA STORET program had been problematic for data input and retrieval. I have analyzed the Boat Run data for many years and have worked with DNREC and DRBC to encourage continuation and improvement of sampling and analyses, and to develop a better data management approach.

In the past several decades, there has been vast improvement in the water quality along the urban stretch of the tidal Delaware River. A dissolved oxygen (DO) problem, including severe summer hypoxia, existed in the urban river by at least the 1930s. The Boat Run database allows for a detailed analysis of the increase in DO, essentially ending the DO problem. Other very large changes have been part of the water quality improvement, including a large drop in concentrations of total phosphorus and a shift in nitrogen speciation (large decrease in ammonium and partial increase in nitrate). Analysis of the Boat Run database, plus my own 30-year research database allows interpretation of the water chemistry of the urban region as well as the environmental conditions of the entire Delaware Estuary. Analysis of long temporal trends, as well as of spatial and seasonal trends provides a distinctly local evaluation of environmental conditions of the entire Delaware Estuary. This local orientation is critical for wise management of the Delaware Estuary as a Twenty-first Century approach as opposed to the “command and control” approach mandated in an earlier time when less information on conditions was available.

MARSH VULNERABILITY INDEX: ASSESSING HEALTH OF DELAWARE'S MARSHES

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Talk – Wednesday 2:15, *Session 19: Wetlands (Part 2)* (102)

A vulnerability index is being developed to allow assessment of the long-term viability of Delaware's marshes under differing sea level rise scenarios and to target areas for conservation, restoration and monitoring. The Marsh Vulnerability Index (MVI) is developed upon the positive correlation between mean tidal range, productivity and elevational growth range of *Spartina alterniflora*. Vegetative biomass sampling serves as a proxy to quantify productivity in assessing marsh health.

The MVI classifies marshes as healthy, degrading or severely degrading. Degraded and severely threatened marshes are more prone to catastrophic losses due to sea-level rise and storm events. These classifications will be utilized to select areas to conduct detailed sediment accretion rate and other monitoring. Understanding the current and historic sedimentation accretion rates of these marshes can help to better predict the longevity and the sediment deficits of these areas and possible management practices that might be implemented to prevent marsh elevation losses.

The MVI will be essential for evaluating wetland vulnerability on a watershed and/or statewide basis, while enabling the strategic placement of monitoring resources to enhance efforts to understand the future evolution potential of Delaware's tidal wetlands. Results from work on the Delaware National Estuary Research Reserve's St Jones River and Blackbird Creek will be presented. All field based monitoring and sampling efforts can be initiated and implemented to evaluate the most severely threatened marsh areas first; the monitoring can then be expanded to encompass other marsh regions. Marsh Vulnerability Index classification optimizes the monitoring efforts and resources to the highest levels possible, so the broadest extent of Delaware's tidal wetlands may be evaluated and managed.

HIERARCHICAL SELECTION OF HORSESHOE CRAB SPAWNING HABITAT: A SANDY BEACH IS THE LAST THING ON THEIR GANGLIA

David R. Smith, USGS – Leetown Science Center, 11649 Leetown Road, Kearneysville, WV 25430, drsmith@usgs.gov, **Nancy L. Jackson**, New Jersey Institute of Technology, Newark, NJ 07102, **Karl F. Nordstrom**, Rutgers University, New Brunswick, NJ 08901, **Penelope S. Pooler**, National Park Service, Kingston, RI 02881

Talk – Tuesday 2:45, *Session 10: Living Resources (76)*

The quantity and quality of spawning habitat might limit horseshoe crab population growth. Thus, understanding selection of spawning habitat is necessary to develop an effective conservation strategy for the ecologically and economically important horseshoe crab population in Delaware Bay. However, several important recent observations have not fit current concepts of horseshoe crab habitat selection. For example, some of the most heavily used areas in NJ have marginal beach habitat, while long stretches of sandy beach are relatively unused. Also, horseshoe crabs tend to shift use to beaches with characteristic morphology in response to weather events. We propose a conceptual model of habitat selection that accounts for these discrepancies and allows the influence of factors driving selection (e.g., wave energy, beach morphology, and substrate) to change with spatial scale in a hierarchical fashion. We base the model on a synthesis of a series of field experiments examining the relationship between beach characteristics and spawning, a large-scale telemetry study of spawning behavior, and hierarchical Bayesian modeling of the spawning survey results. The conceptual model needs to be developed further quantitatively, so that it can be tested and contribute to adaptive management of shoreline habitat in Delaware Bay.

DELAWARE ESTUARY REGIONAL SEDIMENT MANAGEMENT PLANNING EFFORT: A 16-MONTH STATUS REPORT OF OPPORTUNITIES AND CHALLENGES

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Talk – Wednesday 10:15, *Session 15: Ecological Linkages and Functions (3)*

This presentation will explore the opportunities and challenges associated with Regional Sediment Management (RSM) planning for the Delaware Estuary. The US Army Corps of Engineers has received Federal appropriations to develop a RSM Plan for the Delaware Estuary. RSM is a federal initiative that is gaining momentum nationally. RSM approaches/plans have been initiated across the country, in particular in the coastal areas. Examples include Coastal California, the Columbia River, and more locally the New York/New Jersey Harbor. RSM is a tool being applied in a variety of manners.

RSM is an initiative that considers sediment as a resource along our coastlines and in our watersheds, rivers, and wetlands. A Plan to manage sediment in the Delaware Estuary is in the process of being prepared so that policy makers and funding agents can collaborate to meet multiple objectives within the Estuary. Recommendations from the Plan will then be implemented to achieve broader goals. RSM inherently requires multi-discipline technical input, programmatic input, regulatory input, and creative/collaborative partnerships to achieve goals.

The US Army Corps of Engineers has established a Delaware Estuary RSM Workgroup comprised of several federal agencies, each of the states within the basin (DE, PA, NJ), non-profit organizations and major municipalities. The RSM Workgroup has conducted a number of technical sessions to understand the dynamics, needs, and opportunities of the estuary and has developed an outline for the Plan. The RSM Workgroup has been charged with preparing the Plan with recommendations for implementation by Fall 2011.

The purpose of this presentation is to identify opportunities and challenges in preparing and ultimately implementing this Plan for the Delaware Estuary. An overview of the RSM process with specific consideration of the Delaware Estuary will be presented.

A RETROSPECTIVE LOOK AT SEA-LEVEL RISE INDUCED HABITAT CHANGES AT THE FOREST-WETLAND FRINGE ALONG THE DELAWARE BAY, NEW JERSEY

Joseph Smith, joseph_smith@tnc.org, The Nature Conservancy, 2350 Route 47, Delmont, NJ 08314; and Robert Allen, The Nature Conservancy, Delmont, NJ.

Talk – Wednesday 11:15, *Session 17: Wetlands & Other Habitats (27)*

Sea-level rise projections for the Delaware Bay indicate that we must plan for inland marsh migration in order to maintain coastal wetland habitats. Knowing how the composition of habitats change and the pace of this change are important for a realistic understanding of the effects of sea-level rise. While the effect of sea-level rise on salt marsh habitats is well studied, little is known about the process of habitat transition from forested upland to saline wetland as inland marsh migration occurs. We examined the effect of past sea-level rise in the region to determine the rate at which habitats change due to sea level rise and document the composition of the transitional plant communities that develop at the salt marsh-forest boundary. Using aerial photos and satellite imagery we (1) mapped forested areas in this region in the 1930's, 1980's, and the current decade in order to quantify changes in these areas and the rate at which these changes have occurred and (2) mapped the primary transitional habitat (dominated by *Phragmites australis*) in order to determine the relative persistence of this habitat type compared with the forest it replaces as sea level rise-induced change proceeds. Our results indicate that over time, the rate of forest transition to brackish wetland is increasing and that the *Phragmites*-dominated habitat that replaces forest may be more resistant to change than forest. These findings suggest that over time, the net area of *Phragmites* could continue to increase as the net area of forest and native marsh habitats decrease. Understanding such habitat dynamics is critical for the informed conservation of biodiversity as sea-level rise continues to affect coastal areas.

**ECOLOGICAL RESTORATION: PRACTICE, SCIENCE AND EDUCATION
USING RESTORATION PROJECTS IN THE COOPER RIVER PARK TO IMPROVE HABITAT, FOSTER
COMMUNITY INVOLVEMENT AND TEACH SCIENCE**

Ron Smith, Karen Sprinsky and Students from the Environmental Science Program at Haddonfield Memorial High School

Poster – *Aligned with Session 12: Restoration & Enhancement/Conservation (127)*

Scientists and land stewards practice ecological restoration in order to improve habitat structure and ecological function. Projects focus on returning native species and bolstering populations as well as improving physical features of terrestrial and aquatic ecosystems.

Regions with dense human populations, public access and ostensible impact on habitats may pose unique challenges to the success of restoration efforts – maintaining restoration infrastructure, communication with various interests groups to ensure restoration methods and goals are understood and the sheer strain of invasive species, urban flooding potential and habitat changes due to a variety of other anthropogenic activities. Restoring habitat in these areas, however, may serve some unique purposes including education of the general public and school children from regional districts and providing opportunities for anyone to contribute to the improvement of their environment and local community.

For the past eight years students from the environmental science program at Haddonfield Memorial High School have initiated, organized and carried out restoration projects within the Cooper River Park. In the spring riparian corridors along the Cooper River are assessed and site selection is made. Correspondence with the Camden County Park service takes place and material acquisition ensues. Restoration projects involve removal of invasive species, grading and stabilizing the river bank and sowing native seeds. Each fall, students assess the efficacy of the previous year's project. As a result of participation, students engage in the political process of land management, apply math, science and writing skills and initiate independent projects focused on restoration.

Students have the opportunity to educate on restoration methods at our Earth Day Program in April and during a two week nature education program with the elementary students from the district in May.

Ecological Restoration has become a core teaching tool, an annual service project for students and an activity that is applied to interdisciplinary endeavors within the community.

THE CONTRIBUTION OF LAND USE PRACTICES TO TIDAL WETLAND HEALTH IN REPRESENTATIVE DELAWARE ESTUARY MARSHES

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Poster – *Aligned with Session 17: Wetlands and Other Habitats (129)*

Coastal wetlands are a hallmark feature of the Delaware Estuary where they furnish a variety of important ecosystem and human services. They can be more productive than tropical rainforests, provide rare and abundant animals with breeding and nesting grounds, enhance water quality, and protect our coasts from flooding and storm surges. These coastal wetlands have long been maligned in the Delaware Estuary where nearly half have been lost, degraded or otherwise altered. According to the USFWS and NOAA, the loss of these important habitats continues despite increased attention. The Delaware Estuary lost more than 3,000 hectares of coastal wetlands between 1996 and 2006. Remote sensing data also suggests that the majority of our remaining 150,000 hectares of tidal wetlands are degraded in condition, representing an environmental indicator for the overall health of the Delaware Estuary ecosystem.

Various past and present stressors and land uses appear to be contributing to the decline of coastal wetlands in the Delaware Estuary. A new study is underway to attempt to discern the most important causes of degraded salt marsh conditions in three representative watersheds of the Delaware Estuary: The St. Jones River Watershed, The Broadkill Watershed and the Maurice River Watershed. Each has unique and rich histories of marsh use and management, and these practices will be contrasted with known stressors in the watersheds as well as current wetland configuration and condition, which is being assessed by the Partnership for the Delaware Estuary and collaborators using rapid methods. Historic and recent aerial photographs will also be examined to determine the extent of direct human alteration of the studies salt marshes. Taken together, findings from these comparative analyses should help guide future best management of our remaining coastal wetlands. Comments, suggestions, and available data are sought to support this graduate research study.

UNDERSTANDING TIDAL MARSH ACCRETION IN DELAWARE ESTUARY

Christopher K. Sommerfield, School of Marine Science and Policy, University of Delaware, Lewes, DE 19958, cs@udel.edu; **David J. Velinsky**, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103

Talk – Wednesday 9:00, *Session 15: Ecological Linkages and Functions (45)*

Tidal marsh accretion is a vital mechanism of ecosystem stability in the Delaware Estuary. Although prior work has established that tidal marshlands of the estuary sequester a large amount of fine-grained sediment, the extent to which mineral versus organic matter accumulation drive marsh accretion on the long term has been an elusive question. As part of retrospective study of Delaware Estuary water quality, we collected sediment cores at 36 marsh sites along the full length of the estuary, from tidal freshwater marsh at the head to salt marsh at the mouth, and measured rates of sediment accumulation and accretion using Pb-210 and Cs-137 dating methods. Downcore loss-on-ignition and bulk density data were used to isolate the specific influences of mineral and organic matter accumulation on marsh accretion rates. Bulk mass accumulation rates (mineral plus organic fractions) range from 0.1 to 0.3 g/cm²/yr overall and are generally higher than rates reported for coastal marshes lacking a large influx of allochthonous sediment. Corresponding accretion rates range from 3 to 13 mm/yr, exceeding rates of relative sea-level rise in the estuary. Marsh accretion rates are highest at >6 mm/yr in the tidal freshwater segment of the estuary as is the amount of mineral matter buried in the sediment column. Accretion rates decrease to 4–6 mm/yr down-estuary as *Spartina* vegetation increases in abundance and buried mineral mass decreases. Salt marshes of the lower estuary and bay exhibit the lowest accretion rates (<4 mm/yr) and quantity of buried mineral matter. Regression analysis suggests that mineral accumulation and organic accumulation are nearly equal in importance in controlling accretion rates at most of the marsh sites sampled. This finding implies that marsh accretion rates in the system are sensitive to both the allochthonous influx of mineral sediment and production of organic matter through vegetative growth.

A NUMERICAL APPROACH TO STUDY SEDIMENT TRANSPORT PROCESSES IN MARSHES OF THE DELAWARE BAY

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Poster – *Aligned with Session 15: Ecological Linkages and Functions (22)*

Wetlands and marshes belong to the most productive ecosystems in the world and play a major role in maintaining the health and function of their adjacent water bodies, e.g., estuaries, bays and rivers. They keep the water body clean, provide a significant ecological resource for terrestrial and aquatic animals and plants, and are a major coastal defense against flooding by sea.

Type and composition of tidal marshes are mainly determined by the hydro-period, the time and depth of inundation. The hydro-period depends on two factors, the water level and marsh ground elevation. Sediments have a major influence on the marsh ground elevation due to erosion and deposition processes. Hence our numerical approach concentrates on studying sediment transport processes in marshes, utilizing the two-dimensional hydrodynamic numerical model system MARINA2D.

Its modular structure includes models for currents, sediment transport, salt and heat transport, and waves, hence covers the needs for simulating the processes of interest. To achieve this, a two-step approach is chosen: 1) set up of a global model of the Delaware Estuary to produce boundary conditions for sub-models of marshes; 2) set up of localized sub-models, each covering a single tidal marsh in the Delaware Bay to study sediment transport processes in marshes. Based on the need for respective steering data, two marshes were chosen, which are already involved in long term monitoring programs: the St. Jones and Blackbird Creek Reserves on the Delaware side of the Bay, monitored by the Delaware Department of Natural Resources and Environmental Control (DNREC). The model can be used to study general transport patterns in terms of suspended sediment concentration, erosion and deposition, and to locate areas specifically prone to erosion in case of storm events. Sensitivity studies with high and low sediment concentrations can provide insights into the effect of sediment availability on marsh development.

GENERATING NUMERICAL MODEL GRIDS OF MARSHES WITH THE USE OF LIDAR DATA

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Poster – *Aligned with Session 17: Wetlands & Other Habitats (23)*

Our main research will focus on the development of a numerical approach to study sediment transport processes in marshes. Marshes are highly variable with very small spatial scales. Integration of tidal channels with widths of only a few meters is required to provide enough volume for the tidal prism of the respective marsh. Therefore a high resolution numerical grid will be necessary to resolve the modeled marsh area.

Marshes have a large geospatial extent, no exact boundaries, and are often difficult to access. Thus, remote sensing technologies like LiDAR (Light Detection And Ranging) can be a helpful tool to provide data for topography and the location of tidal channels and other structures. For our study areas we utilized high resolution LiDAR data (2x2m) which is available for the Blackbird Creek and St. Jones reserves in Delaware.

LiDAR measures the highest elevation of existing elements, including ground, structures, and vegetation. The tidal flats are mostly covered by dense vegetation, but the ground elevation is needed for the model set up. Our goal is to develop an approach that adjusts the existing LiDAR data by subtracting the height of the respective vegetation cover using a season adjusted correction, thus generate a Digital Terrain Model (DTM) that represents only the ground elevation. The DTM will be used to map the respective topography on the model grid.

It is favorable for the model that grid elements in areas with strong currents are aligned with the flow. Therefore the location of the main tidal channels is required. Analysis of LiDAR data in the marsh resulted in heights between -0.5 and 0.5m for water surface elevations. This information can be used to extract the outline of the first, second and third order channels as polygons, which are used to triangulate the model grid appropriately.

FEDERAL OPPORTUNITIES TO MAXIMIZE WATERSHED CONSERVATION: DELAWARE RIVER BASIN TASK FORCE AND DELAWARE RIVER BASIN CONSERVATION ACT

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Talk – Wednesday 4:15, *Session 21: Hot Topics* (66)

An impaired Delaware watershed negatively impacts public health and living resources and threatens commercial and recreational fisheries, tourism, and the overall quality of life for the region's residents. For decades, the Chesapeake Bay, Great Lakes, and other "Great Waters" with very active constituencies have received significant dedicated federal funding and attention to address these restoration and conservation issues, while the Delaware watershed has lagged behind in conservation dollars and federal profile.

It is important for conference attendees to be cognizant of opportunities to improve the standing of the Delaware watershed on Capitol Hill and in the Great Waters fray. The Basin is fortunate to have a group of Members of Congress dedicated to the watershed, its residents, and its natural resources—and who are eager to hear from constituents about their conservation work. Established in 1999, the Delaware River Basin Task Force is a bipartisan group of Representatives from all four Basin states that coordinate Congressional efforts to promote the restoration and vitality of the Delaware River Basin and its communities. The task force identifies and coordinates efforts on issues of importance to the nearly 15 million people who rely on the Delaware River's waters.

Through the work of the DRBTF, it was determined that unlike other Great Waters programs, the Delaware watershed currently lacks a much-needed Basin-wide coordinated conservation strategy and dedicated federal support, and thus, the Delaware River Basin Conservation Act (H.R. 4698) was drafted. The bill employs a voluntary, non-regulatory dual approach focused on both optimizing collaboration in conservation work throughout the entire basin and increasing resources and local capacity for on-the-ground and community-based projects. The Program will bolster federal resources to implement a Basin-wide coordinated approach to sustaining and enhancing habitat, water quality and flood damage reduction improvements for fish, wildlife and people; a grants program and technical assistance will provide opportunities for more on-the-ground conservation.

DISTRIBUTION AND ABUNDANCE OF NON-NATIVE RED-EARED SLIDER TURTLES (*TRACHEMYS SCRIPTA ELEGANS*) AND NATIVE RED-BELLIED TURTLES (*PSEUDEMYSS RUBRIVENTRIS*)

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Poster – *Aligned with Session 10: Living Resources (49)*

Habitat destruction and introduction of non-native species are among the greatest threats to the Earth's biodiversity. The threatened red-bellied turtle, *Pseudemys rubriventris*, historically prevalent throughout the Mid-Atlantic region, is now restricted to a few fragmented wetlands. In addition to destruction of wetland habitat, introduction of the non-native red-eared slider turtle, *Trachemys scripta*, may play an important role in the decline of red-bellied turtle populations. Because the niches occupied by these two turtle species overlap, the invasion of red-eared slider turtles represent a threat to the red-bellied turtle as a competitor for limited wetland resources. In 2005 and 2006 we assessed 52 wetlands throughout Southeastern Pennsylvania for the occurrence of red-eared slider turtles in historic red-bellied turtle habitat. *Trachemys scripta* occurred at 25 of the 52 wetlands. Thus, *T. scripta* are pervasive within the geographic range of *P. rubriventris* in Southeastern Pennsylvania. From 2007 to 2009, we used mark-recapture to determine relative abundances of the two species in different wetlands. GIS-based landscape data was used to determine relationships between habitat degradation and relative abundances of both turtle species. We found a negative relationship between our human impact rank and the relative abundance of *P. rubriventris*. We found a lower relative abundance of red-bellied turtles in wetlands in public parks. There was no significant difference in relative abundance between the two methods, trapping and observation of basking turtles. Four observation visits were sufficient to detect turtles. The data provide wildlife and habitat management agencies important information on the relationship between invasive *T. scripta*, the state threatened *P. rubriventris* and wetland characteristics.

OCCURRENCE OF FRESHWATER MUSSELS (UNIONIDAE) IN SURVEYED STREAMS OF SOUTHEASTERN PENNSYLVANIA, 2000-2010

Roger Thomas, Patrick Center for Environmental Research, The Academy of Natural Sciences, Philadelphia, PA 19103 (Thomas@ansp.org); **Danielle Kreeger**, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar St., Suite 202, Wilmington, DE 19801; **Sylvan Klein**, Patrick Center for Environmental Research, The Academy of Natural Sciences, Philadelphia, PA 19103; **Angela Padeletti**, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar St., Suite 202, Wilmington, DE 19801; **Zoe Ruge**, Patrick Center for Environmental Research, The Academy of Natural Sciences, Philadelphia, PA 19103; **Matthew Gray**, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar St., Suite 202, Wilmington, DE 19801; and **Catherine Gatenby**, USFWS, White Sulphur Springs National Fish Hatchery, 400 East Main Street, White Sulphur Springs, WV.

Poster – Aligned with Session 10: Living Resources (92)

Since the end of the 19th century, freshwater mussels (unionids) throughout the United States have experienced a rapid decline in community diversity and population density, with approximately 75 per cent of the current fauna considered at risk. Many of the potential causes are well documented including habitat disturbance and degradation, declining water quality, run-of-river obstructions preventing upstream movement of fish hosts, competition with invasive bivalves, and siltation. Historically, water bodies throughout Pennsylvania have included ~66 species in over 25 genera, with ~13 species being native to the Delaware River watershed. In the early 20th century, when the last comprehensive mussel surveys were completed, at least 8 native species were found in southeast Pennsylvania. Between 2000 and 2009, surveys were conducted above the head of tide in numerous streams in southeast PA. Only one species, the Eastern Elliptio (*Elliptio complanata*) was found to be abundant enough to support natural reproduction in Brandywine and Ridley Creeks, and only Ridley Creek contained juveniles. In 2000, a few live Creeper, (*Strophitus undulatus*) and Eastern Elliptio were found in White Clay Creek, but exhaustive surveys since 2007 failed to find them again, suggesting they recently became extirpated from that waterbody. In 2010, 34 sites in 15 waterbodies were surveyed. Live Elliptio were found in only two of the waterbodies surveyed (Brandywine and Perkiomen Creeks), while relic shells were found in two additional waterbodies (Crum and Skippack Creeks). We conclude that 12 of our 13 native mussel species appear to be extirpated from non-tidal waters of southeastern PA, and the range and abundance of the one surviving species is greatly diminished compared to historical conditions. Ecosystem-based management, along with directed freshwater mussel protection and recovery efforts, is critically needed to re-establish viable mussel populations and restore the many vital ecosystem services that they provide.

MURDERKILL RIVER NUTRIENT & DISSOLVED OXYGEN STUDY: THE ROLE OF TIDAL WATER QUALITY MODELING

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Talk – Monday 1:45, *Session 2: Water Quality & Quantity (77)*

At the 2009 Science and Environmental Summit, we presented the preliminary status of the Murderkill River Nutrient and Dissolved Oxygen (DO) Study and the plan for using watershed and tidal water quality models to support the effort. Since 2009, considerable progress has been made by the various researchers: University of Delaware (UD) and Stroud Water Research Center (tidal marsh); UD (algal production); University of Maryland (sediment flux); Academy of Natural Sciences and UD (historical sediment cores); Delaware Geological Survey/UD (marsh inundation); USGS (stream and tidal monitoring); DNREC (sampling and coordination); and HydroQual (modeling).

As part of the overall study, environmental models were used to represent the various processes occurring in the Murderkill River watershed. These models include: a watershed model to represent rainfall driven runoff and nonpoint sources; a hydrodynamic model to represent tidal circulation in the river; and a water quality model to represent the nutrient and DO dynamics in the river including the effects of the tidal marshes, sediments and Delaware Bay. These models were developed using data collected during the 2007-2008 period and focused on properly representing the role that the tidal marshes play in river tidal circulation (marsh storage) and water quality.

The focus of this presentation will describe the models used, use of the data collected and calibration to the observed data. The role of the models developed are to determine the relative importance of the various sources (watershed, tidal marshes, point sources, sediment, Delaware Bay) on river nutrient, algal and DO levels. DNREC 303(d) listings indicate that DO levels in the Murderkill River are below State standards and that a TMDL was needed. This effort is supporting that need but will also be used to assess whether low DO levels are naturally occurring and whether site-specific nutrient and DO criteria are needed.

LABORATORY CULTURE OF THE LIGHTFOOT MUSSEL, *Elliptio complanata*

Heidi Wood-Tucker, Angela Padeletti, Michael DeHaven, Charles Owens, Catherine M. Gatenby, Danielle Kreeger, William Lellis, Steven G. Hughes. Aquaculture Research and Education Center, Cheyney University, 1837 University Circle, Cheyney, PA 19319, hwood@cheyney.edu

Poster – Aligned with Session 10: Living Resources (116)

Freshwater mussels are the most imperiled animal group in the Delaware Estuary's watershed, with all but a few of our native species in danger of being extirpated. Starting in 2007, the Freshwater Mussel Recovery Program began to establish and refine captive breeding and culture protocols to facilitate the restoration and range expansion of mussel populations in Southeastern Pennsylvania. Broodstock of the lightfoot mussel (*Elliptio complanata*), along with prospective fish hosts for their larvae, were collected from two study sites and taken to Cheyney University. In the lab, work by collaborating groups was confirmed indicating that lake trout (*Salvelinus namaycush*) and American eels (*Anguilla rostrata*) proved to be the best hosts for the mussel glochidia. Details on the methods used to promote successful glochidia metamorphosis and discussions of areas requiring further research will be discussed.

GETTING SOCIAL – CREATING AND BUILDING A SOCIAL MEDIA PRESENCE ON THE WEB

***Lisa Tossey *, Elizabeth Boyle.** University of Delaware College of Earth, Ocean, and Environment and Delaware Sea Grant College Program, 222 S. Chapel Street, Room 103, Newark, DE 19716, tossey@udel.edu.

Talk – Monday 4:30, Session 5: Easy Web-based Tools for Projects (24)

Blogs, Facebook, Twitter, YouTube, Flickr, LinkedIn – the Internet has become an extremely social place. Fueled by the growth of high-speed Internet connections and Web-friendly “smart phones,” social media sites are providing new opportunities for organizations and non-profits to share information and connect with policymakers and the public.

Delaware Sea Grant has been utilizing social media since 2008, building a growing presence on YouTube, Twitter, and Facebook by sharing educational videos, news, event information, and links to publications related to current events. Due to the steady growth of subscribers, followers, and friends on these sites, all three were integrated into a new Delaware Sea Grant website, which was launched in the fall of 2009.

Many lessons have been learned along the way, from which platforms work best to disseminate certain types of information, to how to engage followers, to the most effective ways to track usage. To date, Delaware Sea Grant has shared over 60 videos on its YouTube channel, which has received over 10,000 views, and has steadily built a following on Twitter and Facebook, allowing for exciting new avenues of engagement with the public.

In an effort to expand their reach and take advantage of the growth of online video, the College of Earth, Ocean, and Environment and Delaware Sea Grant are increasing video offerings by developing multimedia news stories and video profiles of researchers and staff. The stories will enrich current social media offerings, while the profiles will augment the current YouTube presence with a companion YouTube channel that will serve to connect the public with those behind the work of both organizations.

THE NATURAL RESOURCE ADVISOR PROGRAM: AN INNOVATIVE APPROACH TO PROTECT NATURAL AND CULTURAL RESOURCES DURING THE DEEPWATER HORIZON OIL SPILL RESPONSE

***V. Lyle Trumbull^{1*}, Will Meeks², Mark Ray¹, Steven Alexander², Ronald Chiarello¹, Al Pfister², Larry Malizzi³, Jason Ayers², Grant Matthews¹, Robert Tawes², Jason Kase⁴, Calvin Douglas⁴, and Don Wendt³**
¹ O'Brien & Gere Engineers, ² U.S. Fish and Wildlife Service, ³ Matrix New World Engineers, Inc., ⁴ Anchor QEA LLC

Poster – *Aligned with Session 21: Hot Topics (79)*

The Deepwater Horizon (MC252) oil spill response required the removal of oil from the affected shorelines of Louisiana, Mississippi, Alabama, and Florida. Many of the shoreline cleanup activities had the potential to cause inadvertent but significant impacts to natural and cultural resources. As part of an emergency section 7 consultation, the USFWS developed a list of Best Management Practices (BMPs) to be implemented to minimize the impacts to federally listed species, designated critical habitat, and candidate species. Additional BMPs were developed to aid compliance with U.S. Army Corps of Engineers permits and conditions required by state natural and cultural resource agencies. Due to the size of the response area (~350 miles the Mobile Sector), it was difficult to implement agency BMPs from the Mobile Incident Command Center (MICC). The MICC (responsible for Mississippi, Alabama, and Florida Panhandle), in close coordination with the USFWS and the NPS, developed an innovative approach, the **Natural Resource Advisor (NRA)** program, to oversee compliance with agency BMPs and assist operations crews in minimizing potential injury to natural and cultural resources. The NRA program was comprised of 40 professional biologists distributed throughout the response area and imbedded within the field operations crews. NRA Team Leaders attended daily operations planning meetings and offered suggestions to maximize cleanup efficiency while minimizing resource impacts. NRAs delineated sensitive natural and cultural resources, directed cleanup crews and mechanized equipment away from these areas, and advised field operations on the least intrusive locations for staging and ingress/egress to the beach. Cleanup activities in sensitive habitats (wetlands, dunes, bird and turtle nesting areas, etc.) were continuously monitored. Where state or federal authorization was required, the NRAs took the lead in gathering the required permitting information. The NRA program was extremely successful and achieved the primary program goal of assisting field operations personnel with BMP compliance. It provided state and federal agency personnel with a single point of accountability for natural and cultural resource issues, collected data for the section 7 administrative record, reduced Natural Resource Damage liability, and, most importantly, minimized impacts to the Gulf of Mexico shoreline during this historic response.

SURVEY SAYS: SEA LEVEL RISE NEEDS ATTENTION & ACTION IN DELAWARE

Kelly Valencik and Jennifer Holmes, Delaware National Estuarine Research Reserve. 818 Kitts Hummock Road, Dover, Delaware 19901. kelly.wolfe@state.de.us jennifer.holmes@state.de.us

Talk – Monday 4:45, *Session 4: Climate Change (70)*

Have you ever wondered how many of your fellow Delawareans think climate change and sea level rise are happening? And, what, if anything, do they want us to do about it? Delaware's Department of Natural Resources (DNREC) wanted to know the answers to these questions too. Understanding public knowledge about the impacts of these issues is critical to driving innovative policy making. This, coupled with the need for a coordinated response to climate change and sea level rise, led DNREC to commission a study in December 2009 to determine what Delaware residents are thinking about these important matters. The study, conducted by Responsive Management, examined residents' basic knowledge and awareness of climate change and sea level rise; opinions on whether climate change and sea level rise are happening; perceptions of taking action to mitigate climate change and sea level rise; and opinions on management strategies and actions pertaining to climate change. The responses to the survey were then analyzed to determine differences between groups (e.g. coastal versus non-coastal residents, males versus females) and demographics.

In order to produce and implement a coordinated sea level rise outreach strategy for the state of Delaware, DNREC's Delaware Coastal Programs office has initiated a workgroup made up of members from academia, nonprofit groups, and state agency representatives to review the results and insights of the survey. The mission of the strategy is to engage Delawareans in proactive efforts to adapt to and reduce the impacts of sea level rise and climate change through implementing effective communications strategies. Messages specifically aimed at engaging priority target audiences will be garnered from the public opinion survey and distributed through the most effective media possible.

RIVER VALUES: THE VALUES OF A CLEAN AND HEALTHY DELAWARE RIVER

Maya K. van Rossum, the Delaware Riverkeeper, Delaware Riverkeeper Network
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Talk – Wednesday 3:00, *Session 21: Hot Topics* (18)

Throughout history and today, communities have recognized the Delaware River as a living resource that supports their lives.

Recreationally, there is no off-season for the Delaware. In warmer months you can find folks enjoying the River at all hours of the day or night -- fishing, boating, swimming, birding or just idly sitting on its banks. In the coldest winter months kayakers and die-hard anglers are out there enjoying the River and Bay. Preserving and enhancing the health of the River is critical for sustaining these recreational uses and protecting the local economies that rely on them.

The rich ecological history of the river region, still evidenced today, has not only been critical to the success of the recreational uses and associated ecotourism, but has been the foundation upon which the region's culture and sense of identity have evolved.

River Values-The Value of a Clean and Healthy Delaware River begins to document the economic value of a healthy and clean Delaware River, in terms of jobs, property values, tourism, commercial fisheries, and it paints a clear picture that tax rateables and the economies of a healthy River are far too significant to be forgotten during economic down-turns.

When local, state and federal governments are being pressured to create jobs, jobs, jobs, the River and environment are often undervalued and their value as a job creator and economic engine vital for the region gets downplayed and forgotten as the special interests fight for their pet projects. This report and associated presentation demonstrate that protecting and restoring the Delaware River is fundamental to healthy jobs, economies and communities in our region and if sacrificed to achieve short term political or industrial ends will result in the undermining of the health, enjoyment and economic vitality of our region's children, families and communities.

TIDAL MARSHES IN THE DELAWARE ESTUARY: HISTORICAL RECONSTRUCTION OF CHEMICAL LOADINGS.

David Velinsky, Don Charles, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103 (velinsky@ansp.org), **Christopher Sommerfield**, College of Marine and Earth Studies, University of Delaware, Lewes, DE, **Richard Greene**, Delaware Department of Natural Resources and Environmental Control, Dover, DE, and **Thomas Fikslin**, Delaware River Basin Commission, West Trenton, NJ.

Talk – Tuesday 11:30, *Session 9: Multiple Stressors in Rivers and Estuaries (69)*

Tidal marshes are among the most productive ecosystems in the world. They serve as regional sinks for fine-grained sediments and organic carbon, and contribute to the seasonal patterns of turbidity in riverine and coastal waters. Because of their ability to adsorb trace metals and organics, fine-grained sediments represent a major repository for contaminants. They are a record of the temporal changes in water quality throughout the watershed and can be used in historic ecological reconstructions. During the early 20th century, there was a substantial loading of chemical contaminants, such as PCBs, PAHs and DDT throughout the Delaware estuary. Since the mid-to-late 1980s, inputs of various “emerging” chemicals, e.g., PBDEs, have also increased. However, since the early 1960’s, there have been efforts to reduce chemical loadings, improve ecological conditions within the estuary and reduce the concentration of contaminants in finfish. Sediment cores were taken from ~30 tidal freshwater and estuarine marshes in the Delaware Estuary to estimate historic loadings of chemical contaminants, nutrients and their potential ecosystem impacts. Chronologies were determined with ^{210}Pb and ^{137}Cs isotopes. A preliminary analysis suggests an average sediment accumulation rate (^{210}Pb) of 0.62 ± 0.24 cm/yr (12% RSD; n =22) with a range of 0.22 to 1.3 cm/yr. Sediment-bound PCBs and other organic contaminants increased in concentration starting in the late 1930s to mid-1950s. Many organic contaminants showed peak concentrations in the 1960s to 1970s. There were also river basin specific differences in contaminant concentrations presumably related to changes in watershed land use. PCB and other sediment contaminant inventories were highest in more urban watersheds. The benefits of coring and developing accurate sediment contaminant chronologies are key to reconstructing historic anthropogenic impacts on the environment. This information will be used to evaluate current environmental conditions and guide future restoration efforts.

THE DELAWARE BASIN DEMONSTRATION PROJECT OF THE NATIONAL MONITORING NETWORK FOR COASTAL WATERS AND THEIR TRIBUTARIES-RELATIONS AMONG DISSOLVED OXYGEN, BIOCHEMICAL OXYGEN DEMAND, NUTRIENTS, AND SHAD POPULATIONS

E.F. Vowinkel, U.S. Geological Survey New Jersey Water Science Center, 810 Bear Tavern Road Suite 206, West Trenton, NJ 08628, vowinkel@usgs.gov

Talk – Monday 1:30, *Session 2: Water Quality & Quantity (32)*

The Delaware River Basin and Estuary was selected as a Demonstration Project Area for the National Monitoring Network for Coastal Waters and their Tributaries. An objective of the Network is to connect physical, chemical, and biological water-quality monitoring along the coast, estuary, and above the head of tide for the major drainage areas of the United States. Historical and recent water-quality data from various Federal, interstate, state, and local agencies, universities, and the private sector were used to show the relation of shad populations to dissolved oxygen, biochemical oxygen demand (BOD), and nutrients in the Delaware River Basin. Shad, an anadromous species, were abundant in the 1700 and 1800's but declined considerably in the 1900's as the Delaware Basin became heavily populated and industrialized. Continuous-real-time and discrete data for dissolved oxygen from the early 1960's to present indicate that water in the estuary was hypoxic and even anoxic during summer months in the 1960's through the mid-1980's. As secondary treatment of wastewater became prevalent as a result of the Clean Water Act of 1977, concentrations of BOD and ammonia in the estuary decreased. As a result, concentrations of dissolved oxygen increased in the estuary and tidal portions of the river. This led to an increase in the shad populations in the late 1980's through the mid 2000's. Shad populations recently decreased but the causes are unclear. Visit: <http://acwi.gov/monitoring/network/index.html>

SEA SURFACE TEMPERATURE AND BIOGEOCHEMICAL ANOMALIES DUE TO COASTAL UPWELLING IN THE DELAWARE ESTUARY

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Talk – Monday 2:00, *Session 2: Water Quality & Quantity (99)*

The Delaware Estuary is a coastal plain basin in the Mid Atlantic Bight. It is deepest at the bay mouth, where most of the tidal volume flux occurs. Despite large nutrient inputs from the urban region, the bay's biogeochemistry is controlled by river discharge, tidal flux and coastal upwelling.

Attempting to quantify the extent of summer upwelling and its influence on the lower bay, we analyzed 8-day averaged sea surface temperatures (AVHRR), for 2002-2010 for a transect along the main shipping channel and extending across the continental shelf. Temperature in a narrow region (75 km around the bay mouth) was on average 2-3 degrees colder than the adjacent up-bay and offshore waters. Examining wind records for the same period, we found that summer offshore winds are predominantly upwelling favorable and persistently trigger upwelling in the inner shelf from May through September. The source of unusually cold water is the isolated cold midshelf bottom water which forms every spring-summer (known as "the cold pool").

Due to seasonal stratification of the shelf waters, nutrient buildup occurs in the cold pool. In the summer of 2010, we measured nutrient levels at the bay mouth along the Cape May – Lewes ferry transect. We found that nitrate levels in July were close to zero ($0.19 \pm 0.21 \mu\text{M}$), while phosphates were always higher ($0.36 \pm 0.10 \mu\text{M}$). Considering the resulting low dissolved inorganic nitrogen to phosphorus ratios (~ 5.5), we conclude that this system is nitrogen limited, and nitrogen is probably consumed as soon as it is upwelled into the photic zone. Chlorophyll levels varied spatially and temporally across the bay mouth. While typical chlorophyll concentrations were below $10 \mu\text{g/L}$, the shallower region near Cape May experienced phytoplankton blooms with chlorophyll levels above $45 \mu\text{g/L}$. Overall we found that chlorophyll was higher during ebbing tide and slack ebb water, probably due to water column stratification during ebb tide.

Tides induce strong currents near the mouth of the bay, and probably affect the extent of upwelling in an estuarine system like the Delaware Bay. We hypothesize that during flood tide, upwelling becomes more prominent as water from the bay is pushed inside the bay and allows for upwelling to develop in the region of low pressure caused by upwelling winds pushing surface water offshore. During ebb tide, fresher and less dense water comes from the bay to replace the surface waters driven offshore by wind, and upwelling is temporarily weakened.

HISTORICAL BATHYMETRIC MORPHOLOGY OF THE DELAWARE ESTUARY, A COMPONENT IN DEVELOPING A COMPREHENSIVE SEDIMENT BUDGET

David Walsh, Woods Hole Group, Inc., dwalsh@whgrp.com; **Christopher Sommerfield**, University of Delaware, Lewes, DE; **J. Bailey Smith**, U.S. Army Corps of Engineers, Philadelphia, PA; **Jeffrey Gebert**, U.S. Army Corps of Engineers, Philadelphia, PA

Talk – Wednesday 10:00, *Session 15: Ecological Linkages and Functions* (110)

Since settlement of the region by colonists, the Delaware Estuary has transformed from a system dominated by natural processes to that of a system that has been influenced by anthropogenic activity. Changes in the tidal regime of the Delaware Estuary over the past century have been attributed to engineering practices such as dredging and training works; however the impact of these practices on the sediment regime and sediment budget has yet to be fully investigated. Building upon previous sediment and morphological studies, this detailed investigation has quantified historic morphologic changes in the estuary between Philadelphia, PA and Bombay Hook, DE. Subaqueous morphologic changes to the Estuary have been quantified using digital terrain models (DTMs) created from seven historical bathymetric datasets (1877-78, 1909, 1932, 1946-60, 1980-87, 1992, 2001) that represent important periods in the engineered development of the estuary. Respectively, these datasets represent the native estuary bathymetry, post-dredging of the Philadelphia to Sea federal channel to 30 feet MLW, post-dredge to 35 feet MLW, post-dredge to 40 feet MLW, and three periods of maintaining the 40 foot federal channel. The results of this investigation will be presented in the context of a comprehensive sediment budget that is being developed for the Estuary as part of the Regional Sediment Management program initiated by the U.S. Army Corps of Engineers Philadelphia District. Previously, bottom scour was identified as a significant source in the Delaware's sediment budget. Therefore, detailed quantification of natural versus anthropogenic changes to estuarine bathymetry is important in defining this component of the present sediment budget.

DEVELOPING A WETLAND CONDITION MONITORING NETWORK FOR NEW JERSEY: APPLICATION OF NEW ASSESSMENT METHODS

Kathleen Strakosch Walz Mail Code 501-04, NJ Department of Environmental Protection, DEP - Office of Natural Lands Management, PO Box 420, Trenton, NJ 08625-0420; and **Stephen Domber**, NJ Department of Environmental Protection, DEP - New Jersey Geological Survey, PO Box 427, Trenton, NJ 08625-0427.

Poster – *Aligned with Session 17: Wetlands & Other Habitats (101)*

The New Jersey Department of Environmental Protection has initiated an EPA-funded 4-year research project to develop a statewide wetland condition assessment and establish a monitoring network for both freshwater and estuarine wetlands. A new assessment method developed by NatureServe called the Ecological Integrity Assessment (EIA) will be used in conjunction with protocols of the National Wetland Condition Assessment (NWCA). Ecological attributes of wetland landscape context, size, and condition (vegetation, soils, hydrology), as well as stressors will be sampled. Sampling sites are being established in all HUC8 watersheds and will include replicates of six Cowardin wetland types - PAB/UB, PEM, PSS, PFO, E2EM, and E2SS/FO. The EIA Level 2 Rapid Assessment Method data collected from 300-400 sites will be used in the 2013 National Aquatic Resource Survey (NARS) report for New Jersey. Of these, 66 EIA Level 3 Intensive long-term monitoring sites will be established and sampled including 6 water allocation test sites to determine the impacts of water withdrawal on wetland condition. A second part of the study involves mapping and classifying the springs of New Jersey and establishing long-term monitoring at characteristic springs and associated headwater wetlands in an array of geomorphic settings. This new wetland condition study is being conducted in collaboration with other wetland studies, particularly on tidal wetlands in the Barnegat Bay and Delaware Estuary, to ensure data compatibility and analysis. Outreach to federal, state, local and private and citizen conservation groups, in particular watershed groups, is planned to provide information on the locations of vulnerable wetlands and springs in need of greater protection, restoration and adaptive management.

INTER-ANNUAL VARIABILITY IN CIRCULATION AND WATER PROPERTIES IN DELAWARE BAY AND ITS RELATIONSHIP TO DISEASE PREVALENCE

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Talk – Wednesday 2:30, *Session 20: Oysters (59)*

As part of the U.S. National Science Foundation Ecology of Infectious Diseases (EID) program, we have developed a high-resolution hydrodynamical model for the Delaware Bay. Validation studies conducted with the model confirm its ability to reproduce observed fields of water level, circulation and tracer (temperature and salinity) properties.

Here, we apply the model to ask: can inter-annual variability in these fields account for the observed variations in disease prevalence in Delaware Bay? To address this question, model simulations (presently underway) are performed for several three-year periods which collectively span a variety of physical conditions (e.g., freshwater inputs) and disease occurrence. The three periods include 1974-76, 1979-81 and 1984-86. The first two intervals correspond to periods of low observed prevalence of (e.g.) MSX in the upper Bay, whereas the latter period was observed to have elevated disease levels.

The presentation will summarize the results from the three, multi-year simulations and assess the ability of the present-generation circulation model to “explain” observed patterns of disease prevalence.

RESPONSE OF SALT-MARSH AND TIDAL FRESHWATER MARSHES IN THE DELAWARE RIVER ESTUARY TO SEA-LEVEL RISE AND SALT-WATER INTRUSION

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Talk – Monday 4:00, *Session 4: Climate Change (73)*

Accelerating sea-level rise is putting tidal marshes at increasing risk of permanent submergence. Tidal freshwater marshes (TFMs) face the additional challenge of salt-water intrusion as sea-levels rise and freshwater inputs from watersheds decline. The overall response of marshes to these changing environmental drivers will be a complex interaction between plant production, microbial organic matter decomposition, and sediment deposition, which together determine rates of marsh vertical accretion. Of particular interest is the question of whether salt-water intrusion will result in an ecosystem shift from TFM to salt-marsh, or if salt-water intrusion coupled with sea-level rise will impede the colonization of TFMs by salt-tolerant plants. In this study, sea-level rise and, for TFMs, salt-water intrusion were simulated in the field by constructing ‘organs’ at four sites along the estuarine salinity gradient. Marsh mesocosms were placed at six different elevations on each organ to simulate various rates of sea-level rise. Marsh mesocosms from the local marsh at each site (to evaluate sea-level rise) and from the upper-estuary TFM site (to evaluate salt-water intrusion coupled to sea-level rise) were placed on each of the organs in April 2010. Plant biomass and trace-gas (methane and nitrous oxide) emission rates were monitored throughout the growing season, and soil biogeochemistry and microbial sulfate reduction and methanogenesis were measured once in mid-summer. Preliminary results indicate that salt-water intrusion together with even modest sea-level rise (10-20 cm which is well within the depth tolerance of the salt-marsh plants) acts as a major disturbance that not only leads to mortality of TFM plants, but also prevents the colonization of previously TFM by salt-tolerant plant species. The results from this research will allow for better prediction of the response of salt-marshes and TFMs in the Delaware River to various scenarios of climate change, sea-level rise and salt-water intrusion.

A SCIENCE-BASED REGIONAL RESTORATION APPROACH IN THE DELAWARE ESTUARY: Overview

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Simeon Hahn, NOAA, Philadelphia, PA, **Paul Racette**, Pennsylvania Environmental Council, Philadelphia,
PA

Talk – Tuesday 3:30, *Session 12: Restoration & Enhancement/Conservation (85)*

Regional restoration planning is emerging nationally as a means to promote better coordination among restoration practitioners, planners and project decision-makers on a watershed basis to ensure that the most meaningful ecological outcomes are realized. Restoration, enhancement and conservation projects are often in reaction to particular program interests, issues or incidents, without scientific consideration for how they fit within the broader landscape of ecological needs. The goal of the new Regional Restoration Initiative (RRI) is to provide a science-based decision-support system that proactively guides restoration activities to ensure that outcomes: 1) are tailored to maximize ecological needs for specific sub-watershed regions and 2) minimize short-term loss of opportunity and maximize long-term “bang-for-the-buck” by considering ecological compounding relative to economic investments (a.k.a. “Restoration Up-front”.) The RRI consists of three components: 1) a “science track” that will develop ecological matrices and decision support tools to help elevate needs and opportunities that are expected to yield the greatest ecological goods and services; 2) a “policy track” that will synthesize and coordinate regional program priorities and activities among restoration decision makers, and 3) a “project registry” that will serve as a clearinghouse for restoration projects across the watershed. The registry will be used for ongoing access by annual funding programs, irregular funding opportunities like mitigation projects, for the Alliance for Comprehensive Ecosystem Solutions call for projects, and to boost awareness of National Estuary Program funding needs on regional or national scale. In 2010, a website was designed to house the registry and allow project managers to submit and search for projects online. The project registry website will be presented to show its functions as a resource for different users.

CORPORATE & COMMUNITY ENVIRONMENTAL STEWARDSHIP PROGRAM (CESP)

Laura S. Whalen, Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, lwhalen@delawareestuary.org, **Karen Johnson**, Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, lwhalen@delawareestuary.org.

Poster – *Aligned with Session 12: Restoration & Enhancement/Conservation (86)*

Several corporations in the Delaware Estuary are doing more than giving out cash for environmental causes and programs by becoming active partners of the groups they support and getting them involved in projects to improve the estuary and inspire their community. CESP has been facilitating this partnership between corporations and conservation groups in order to save land and wildlife while benefiting the community. Through this program, the Partnership for the Delaware Estuary (PDE) has had the opportunity to aid corporations in setting up projects that restore native habitat, while also educating students and the community. In 2010, PDE added community organizations to the program in addition to corporations.

Examples of CESP projects that will be presented could include corporate employees working with local school students to turn expensive, high-maintenance lawns into low-maintenance natural meadows that provide food and shelter

Along with project coordination, CESP members also participate in an annual “eco-excursion” at an ecologically significant location in the estuary, and this event also provides a networking opportunity for members. PDE would like to thank the CESP members for their continued commitment to improve the Delaware Estuary.

RAIN GARDENS FOR THE BAYS – ST. JONES WATERSHED CASE STUDY

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Poster – *Aligned with Session 12: Restoration & Enhancement/Conservation (90)*

The Partnership for the Delaware Estuary (PDE) completed the two rain gardens in the St. Jones Watershed in June 2010. For the first rain garden, PDE partnered with Environmental Concern, USDA Natural Resources Conservation Service (NRCS), Kent County Conservation District, and the North Dover Elementary School to complete a rain garden project at the NRCS office in Dover, DE. PDE and Environmental Concern designed the rain garden and purchased necessary materials in May and June 2010 for the 960 square foot site. Kent Conservation District donated the use of their bulldozer operator, and they excavated the site and amended the soil with bioretention mix to ensure proper drainage of the rain garden. Approximately 20 students from the North Dover Elementary second grade class spent the morning of June 10, 2010 planting more than 600 native plants in the rain garden. Environmental Concern did a short lesson and activity with the students about the importance of wetlands and storm water management. A maintenance agreement for the rain garden was given to NRCS so they know how to care for the garden properly. Currently, PDE is working with Environmental Concern to plan the next rain garden in the St. Jones Watershed. The rain garden design, photos, and lessons learned will be presented.

RESTORATION SECTION OF THE STATE OF THE ESTUARY REPORT

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Poster – *Aligned with Special Poster Session: 2011 Technical Report for the Estuary and Basin (87)*

The Partnership for the Delaware Estuary's Science and Technical Advisory Committee (STAC) is currently working to develop *The Technical Report for the State of the Delaware Estuary and River Basin* to be published in 2012. The report will have some new sections, including a section on restoration occurring in the Delaware Estuary. This poster presentation will show the indicators used to report about restoration in the estuary as well as progress to date on data collected for each indicator. One primary indicator that will be reported is habitat creation in the estuary and use by receptors (habitat diversity/landscape connectivity). The data that will be used to calculate this indicator include the number of acres restored annually compared to acres lost, mitigated (SEPs and NRDAs), or protected. Mitigation acreage may be reported in a feature box explaining how that acreage does not provide the same function as restored acreage. A second feature box will highlight the Delaware Estuary Project Registry and the proportion of projects in the registry not funded compared to those that are funded. The feature box will also examine projects funded in the Delaware Estuary compared to other estuaries such as the Chesapeake Bay, Puget Sound, or Tampa Bay. The estuaries will be compared by calculating the dollars invested per impaired river mile, for example.

SUCCESSFUL MAINTENANCE OF GREEN INFRASTRUCTURE FOR STORMWATER MANAGEMENT: NEW YORK CITY'S STATEN ISLAND BLUEBELT

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Poster – *Aligned with Session 2: Water Quality & Quantity (114)*

The Bluebelt originated as a solution to a problem facing New York City Department of Environmental Protection (NYCDEP) Staten Island. The implementation of the all-pipe network called for in the previous drainage plans would have obliterated the last stands of contiguous freshwater wetlands in New York City. To address this, an innovative use of BMPs was developed to connect the storm sewers beneath residential streets with the existing natural waterways, including streams, wetlands and ponds. The successful implementation of the stormwater component of the drainage plan relies on the effective use of drainage corridors in conjunction with the application of the BMPs. NYCDEP has acquired more than 300 acres of natural drainage corridors to protect these waterways and provide the framework for this system.

Optimally designed BMPs are cost-effective and easy to implement, providing flood control, improved water quality and aesthetic benefits. However, compared to the conventional pipe-based stormwater facilities, BMPs are much more maintenance-intensive and their performance is dependent on the level of maintenance. The Bluebelt provides evidence that successful design and maintenance of stormwater BMPs ensures flood protection and improves water quality. Successful maintenance can be achieved by considering maintenance issues when designing the BMP, creating maintenance cards, involving and educating the community and evaluating all available tools to successfully handle the maintenance needs. Properly maintaining all the Bluebelt's BMPs allows for the continued success of Staten Island's large-scale green stormwater management system.

WATER QUALITY ENHANCEMENT AND FLOOD ATTENUATION THROUGH WETLAND RESTORATION AND CREATION IN A NEW YORK CITY WATERSHED

Tiffany Witwer, P.E., Hazen and Sawyer, 498 Seventh Ave, Fl 11, New York, NY 10028, twitwer@hazenandsawyer.com, **Michael Usai¹**, **Laurie Machung¹**, **Sandeep Mehrotra, P.E.²**, and **Kevin Ward²**

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Talk – Wednesday 12:00, *Session 17: Wetlands & Other Habitats (75)*

The New York City Department of Environmental Protection (NYCDEP) is constructing an Ultraviolet Light Disinfection Facility (UV Facility) in Westchester County, New York. The UV Facility was designed to minimize disturbances to on-site wetland and stream features, however, wetland mitigation was still deemed necessary. As part of this mitigation, the NYCDEP identified a 4.5 acre area in the Town of North Castle comprised of fill and invasive weed/shrub cover portions of which were also prone to localized flooding. In addition, a first order stream, Bear Gutter Creek, flows within the site and eventually discharges to the Kensico Reservoir. A comprehensive restoration of the site would improve local water quality by reducing sediment loads and nutrients in stormwater flows and alleviating localized flooding of the surrounding businesses.

The design of the North Castle Wetland was based on a water balance between existing site hydrology and proposed wetland hydrologic requirements. The grading of the wetland was designed to ensure that the wetland area captured and retained the correct volume of water while still being interconnected with the existing surrounding hydrology. The design of the wetland included excavating an area of approximately 2.5 acres within the designated 100 year floodplain of Bear Gutter Creek. As a result, the flood storage capacity of the project area would increase by approximately 15 acre feet, with a greater conveyance capacity than the original stream segment.

The wetland landscaping plans were designed to replace invasive species with wetland trees, shrubs, and herbaceous plants. The choice of plants was carefully selected to meet two objectives: establishment of a self-sustaining ecosystem, and maximum pollution removal efficiency.

The construction of the North Castle Mitigation began in February 2010 and was completed by the end of July 2010. The site will be monitored over the next two years for further evaluation.

GREEN INFRASTRUCTURE AND NONPOINT SOURCE POLLUTION REDUCTION EDUCATION AT THE PHILADELPHIA INTERNATIONAL FLOWER SHOW

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Poster – *Aligned with Session 2: Water Quality & Quantity* (54)

For over a decade, the Philadelphia Water Department (PWD) has worked in conjunction with the Partnership for the Delaware Estuary to present an educational exhibit that focuses on a general mission to educate the public on easy, personal method to help improve water supply and quality at home.

Since Philadelphia is the largest city in the Delaware Basin, the relationship between PWD and the Partnership for the Delaware Estuary is an important one. The combined exhibit at the annual Flower Show is symbolic of our ongoing relationship and its value to the department.

The Flower Show consists of 60 professional landscapers, florists, and educational organizations that create full-scale gardens. In addition over 5,000 plants and floral displays are brought by individuals and garden clubs from around the world.

The exhibit in the 2010 show, “Passport to the World,” centered on urban stream restoration, a problem faced by many communities around the world. The health of these streams directly affects the quality of water running into the Delaware which is one of our major sources of drinking water for Philadelphians. The exhibit impressed upon visitors the importance of stream quality and informed them on how to personally do their part to improve creek quality.

Past exhibits (including accompanying signage and brochures) have covered a wide spectrum of water quality issues and solutions. Some of the issues included nonpoint source pollution, stream bank erosion, invasive species, and water conservation. Some of the solutions included green roofs, rain barrels, stormwater wetlands, infiltration trenches, rain gardens, and porous paving.

Even though the show lasts but a week, the work put into a quality exhibit lasts all year; nearly 250,000 people view this display. The PWD and the Partnership for the Delaware Estuary must meet, plan, design, and build a project which consistently brings home the importance of clean water.

IMPROVING WATERSHED COMMUNICATION: USING A WEBSITE FOR PUBLIC AND PARTNER OUTREACH.

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Talk – Monday 4:45, *Session 5: Easy Web-Based Tools for Projects (126)*

Over the past 7 years, the Partnership for the Delaware Estuary has taken a leadership role in overseeing the Schuylkill Action Network (SAN), a watershed-wide initiative aimed at advancing the shared mission of the restoration and protection of the Schuylkill River Watershed. The SAN functions through a system of project partners organized by issue-specific workgroups, including Agriculture, Abandoned Mine drainage, Education and Outreach, Land Protection, Pathogens, and Stormwater. The SAN has utilized this approach to prioritize projects and leverage funding to strategically implement a source water protection plan for the entire Schuylkill River Watershed.

The Schuylkill Watershed, which encompasses over 2,000 square miles, 1,700 miles of rivers and streams, 11 counties, and 235 municipalities, creates a unique challenge for coordinating restoration and protection efforts. The SAN was formed to address this challenge and bring the various watershed stakeholders together to strategically target water quality threats and maximize the resources of its partners. In 2007, the SAN launched its member driven website to help facilitate this process.

This proposed presentation will describe the process by which the SAN website has enabled better communication among its members and how the SAN communication strategy, enhanced by the website, has helped to prioritize watershed restoration and protection efforts and maintain a coordinated and cooperative effort throughout the watershed. Specifically, it will provide an overview of the website structure, including the internal and external components, communication features, document hosting/distribution, and social networking features. In addition to describing the benefits offered by the website, the presentation will also discuss some of the challenges that still exist in using the website and how the SAN plans to address them. The hope is that this presentation will provide useful insight into web-based communication and help participants plan for developing and/or enhancing their website projects. SAN Website: www.schuylkillwaters.org

APPLICATION OF NOAA, NATIONAL WEATHER SERVICE PRECIPITATION ESTIMATES IN SUPPORT OF ECOSYSTEMS

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Poster – *Aligned with Session 2: Water Quality & Quantity (2)*

The National Weather Service’s Middle Atlantic River Forecast Center (MARFC) has actively sought to support the NOAA goals:

- Protect, Restore and Manage the Use of Coastal and Ocean Resources through an Ecosystem Approach to Management.
- Serve Society’s needs for Weather and Water Information.

Success has come through MARFC partnerships with state and county governments through the use of high resolution, high quality, National Weather Service multi-sensor precipitation estimates (MPE). Precipitation information is particularly critical to decision makers during, and following, heavy rainfall events, when excessive runoff can degrade water quality and affect ecosystems.

This poster presentation will provide several examples of the use of National Weather Service precipitation data in support of ecosystems and public health.

ASSESSMENT OF WATER QUALITY INDICATORS FOR THE STATE OF THE ESTUARY / STATE OF THE BASIN REPORTS

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Poster – *Aligned with Special Poster Session: 2011 Technical Report for the Estuary and Basin (94)*

The Delaware River Basin Commission (DRBC) is compiling and assessing water quality data from throughout the basin in preparation for the State of the Delaware Estuary Technical Report, to be completed in 2011. In coordination with the Science & Technical Advisory Committee, DRBC has compiled data for primary indicators, including dissolved oxygen, nutrients, priority pollutants, fish contaminant levels, salinity, pH, and temperature, and secondary indicators including chlorophyll-a, organic pollutants, bacteria, emerging contaminants, chloride, total dissolved solids (TDS), and shellfish bed management and health. This poster summarizes the data compiled through 2010, identifying the available data stations and demonstrating temporal and spatial assessments of the data. The poster will highlight preliminary findings, identify data and assessment gaps, and provide recommendations to better align data collection and assessment requirements.

USING CARBON AND NITROGEN STABLE ISOTOPES OF OSPREY (PANDION HALIAETUS) TO INFER HISTORIC ECOSYSTEM CHARACTERISTICS WITHIN THE DELAWARE BAY

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Poster – Aligned with Session 10: Living Resources (131)

Stable isotopes have long been used to reconstruct trophic levels within recent and historic ecosystems. Most of these studies consider one time period, where trophic positions, niches, and diets are the main focus. We hypothesize that long term changes in the ecology and land use patterns of Delaware Bay watershed are reflected in the higher aquatic trophic groups, and that these changes would be reflected by food resources available to avian predators. In this study, we attempt to reconstruct the overall changes in Delaware Bay ecology during the last 150 years using carbon and nitrogen stable isotope analyses of Osprey feathers from the historic collections at the Academy of Natural Sciences.

Due to the complexity of osprey molt cycles, carbon and nitrogen stable isotope analyses were first used to identify the variations within and among feathers associated with molt and migration. We sampled barbs from three points along the length of each remigial feather. When compared with carbon and nitrogen results from over 100 juvenile ospreys from summer 2010 (sampled from the Delaware Bay Watershed) and 5 historic osprey (sampled from the Caribbean) we were able to determine values for breeding grounds (Delaware Bay watershed) and wintering grounds (Caribbean)

Results suggest that the methodology is sound for identifying broad regional patterns of feather growth. Remigial feathers grown in the Delaware River basin ($\delta^{13}\text{C} = -19.6\text{‰} \pm 2.9$, $\delta^{15}\text{N} = 14.5\text{‰} \pm 3.2$) have statistically significant differences in isotope signatures from feathers grown elsewhere ($\delta^{13}\text{C} = -12.1\text{‰} \pm 2.4$, $\delta^{15}\text{N} = 10.5\text{‰} \pm 1.5$). Feathers from the Delaware Bay watershed show there was an approximate 5‰ decrease in both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values from the late 1800s to 2008. However, we need to sample additional birds from the 1940s to 1990s in order to track changes over the entire time period.

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The Partnership for the Delaware Estuary leads collaborative and creative efforts to protect and enhance the Delaware Estuary and its tributaries for current and future generations.



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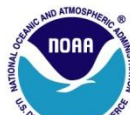
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