Proceedings of the 2009 Delaware Estuary Science & Environmental Summit

Planning for Tomorrow's Delaware Estuary

The Grand Hotel
Cape May, New Jersey
January 11 – 14, 2009

Sponsored by:

The Academy of Natural Sciences
ConocoPhillips
DNREC, Delaware Coastal Management Program
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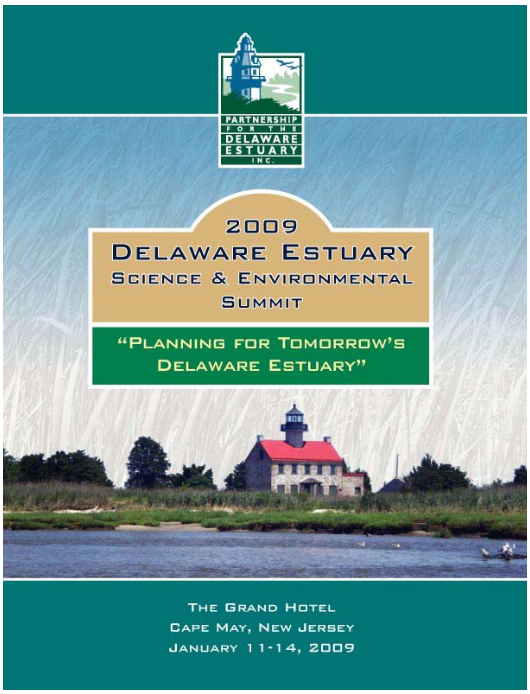
2009 Proceedings



The 2009 Delaware Estuary Science and Environmental Summit was the 3rd in the series of biennial conferences put on by The Partnership for the Delaware Estuary. The 2 year interval and regularity provides a predictable forum for regional environmental scientists, managers and practitioners to present on their work and to learn what else is going on in a watershed-based context. The timing and location of the meeting is also chosen to facilitate exchanges and cross-learning among professionals from different environmental sectors in a retreat like atmosphere.

Sessions in each conference cover a broad array of topics related to ecology, environmental science, ecosystem health, and natural resource management. The conferences consist of science and management sessions, outreach and messaging sessions, and special sessions that address matters of contemporary importance to the region's scientific and management community.

Over 250 scientists, resource managers, policy makers, educators and restoration practitioners participated in the 2009 Delaware Estuary Science and Environmental Summit. The theme was "Planning for Tomorrow's Delaware Estuary." Attendees came from various sectors including academia, government, non-profits, and industry. More than 90 oral presentations were given and over 40 posters were presented.

In a new twist, participants were questioned about some of the issues facing our area during a live polling session. Highest rated issues facing the estuary today were: habitat loss, non-point source pollution and water quality. Some top stressors were; climate change, sea level rise and habitat loss. Attendees suggested policy makers should focus on were protection and development, in particular. When asked what topics were likely to be of high importance in the future, climate change and energy ranked very high.

The next conference in this series is expected to occur in January 2011. Stay tuned to the PDE website for more information: http://www.delawareestuary.org/news_pde_science_conference.asp

Student Presentation Awards

The Partnership for the Delaware Estuary, working with the Science and Technical Advisory Committee, announced the launch of a new student award competition. There were more students participating than ever before, at least 14 oral presentations and 10 poster presentations. This competition was added to the biennial conference program in recognition of the important contributions that students make to the environmental sector in our watershed.

Our intent was to select a **Best Talk Award** and also a **Best Poster Award**. Winners received:

- 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 the conference proceedings report and website.

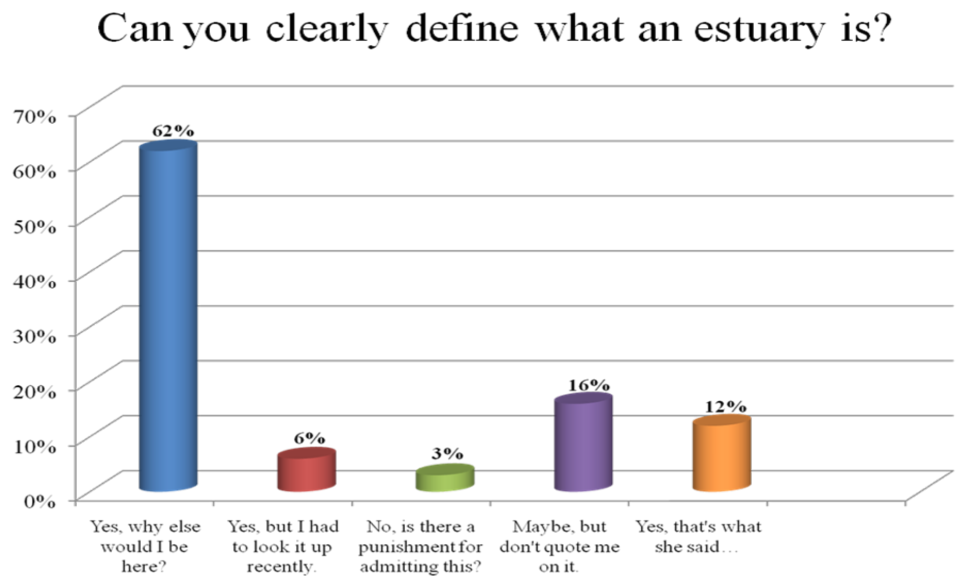
Eligible students were graduate, undergraduate, or recently graduated students (within the past 12 months) who are presenting their own original research results at the conference.

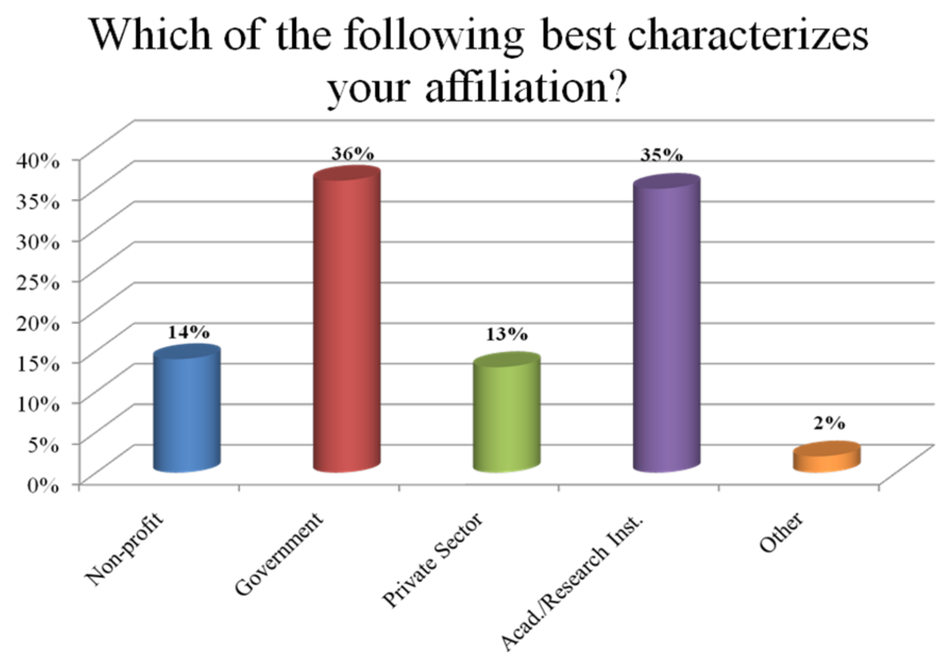
There were so many great posters and talks the PDE presented a total of 4 awards;

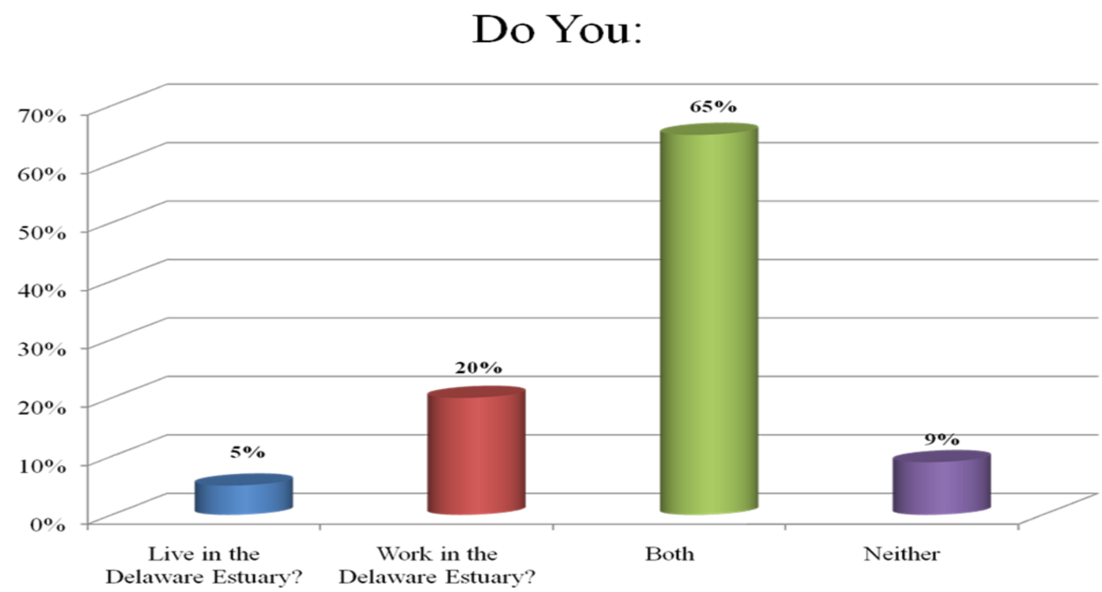
- Jennifer Halchak- University of Delaware: Best Student Talk Award
- Kelley Appleman- University of Delaware: Outstanding Student Talk Award
- Tatjana Prsa- Villanova University: Best Student Poster Award
- Rebecca Hays- University of Delaware: Best Student Poster Award

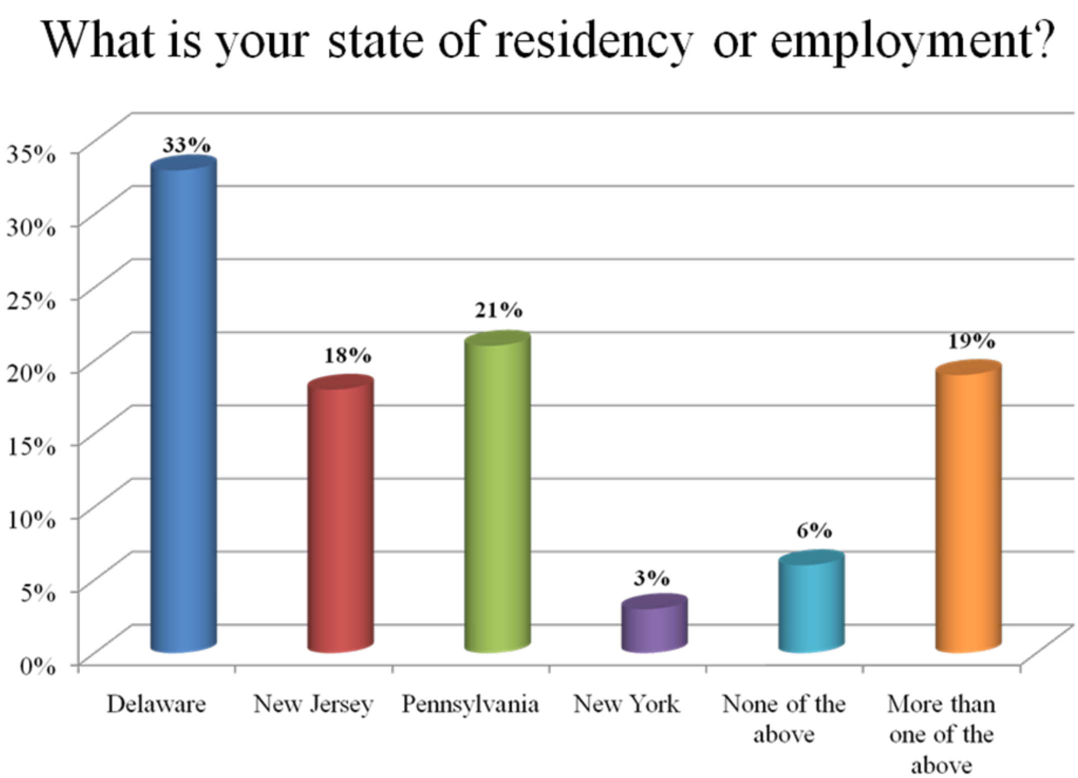
Priorities in the Delaware Estuary
Live Polling of Audience

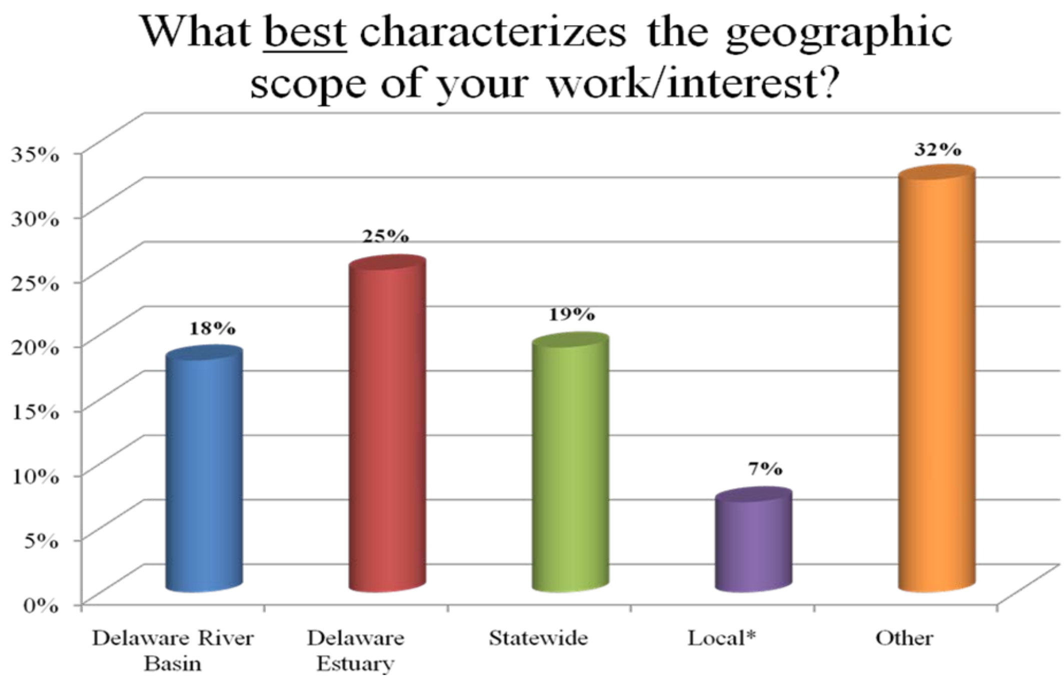
Live polling of the audience was preformed after dinner on the 12th of January. One hundred and thirty people participated in the polling. Polling equipment was donated by the University of Delaware's Sea Grant. The following are some of the results of the polling;

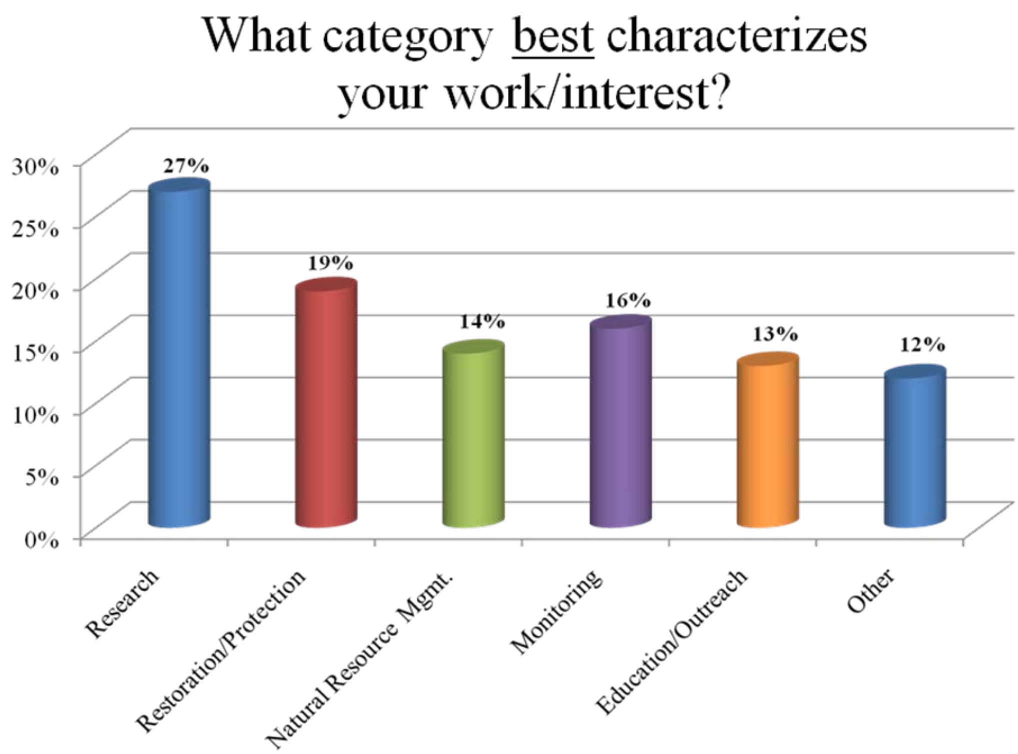


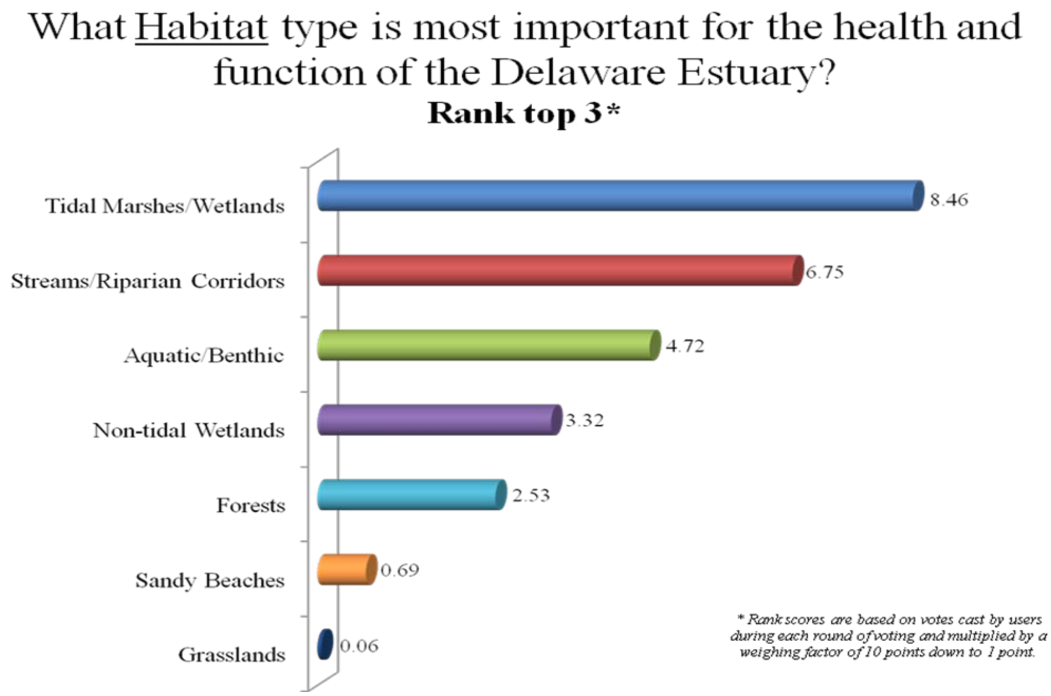


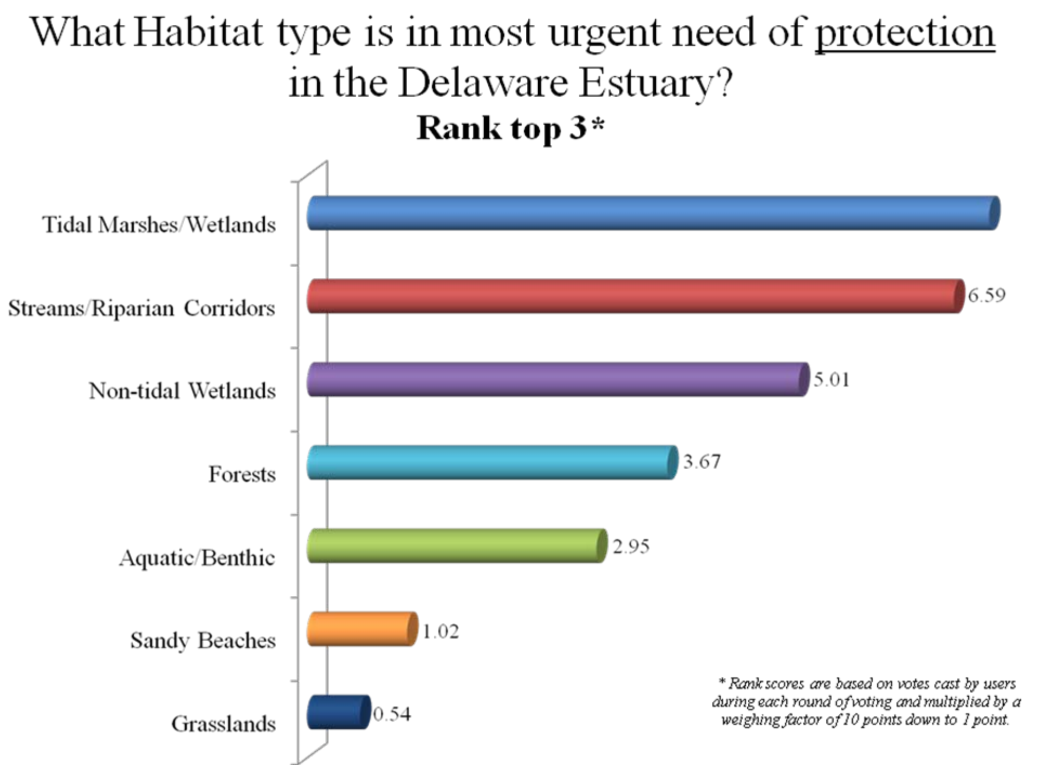

Do You:
70%
60%
50%
40%
30%
20%
10%
0%
5%
20%
65%
9%
Live in the Delaware Estuary?
Work in the Delaware Estuary?
Both
Neither

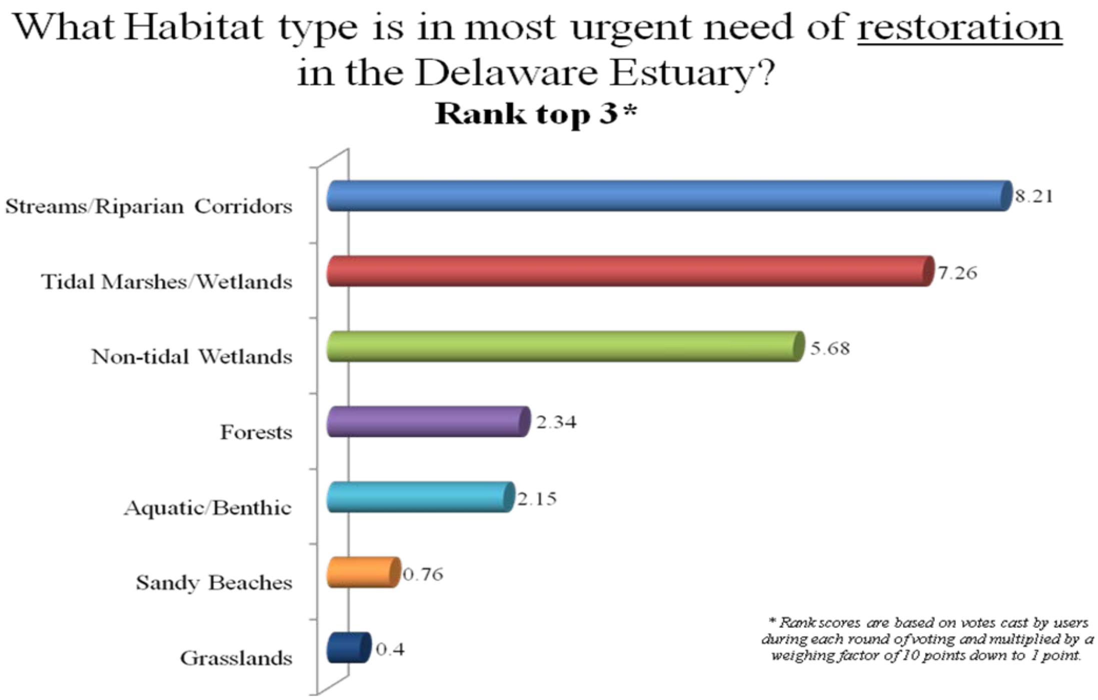

What is your state of residency or employment?
35%
30%
25%
20%
15%
10%
5%
0%
33%
18%
21%
3%
6%
19%
Delaware
New Jersey
Pennsylvania
New York
None of the above
More than one of the above

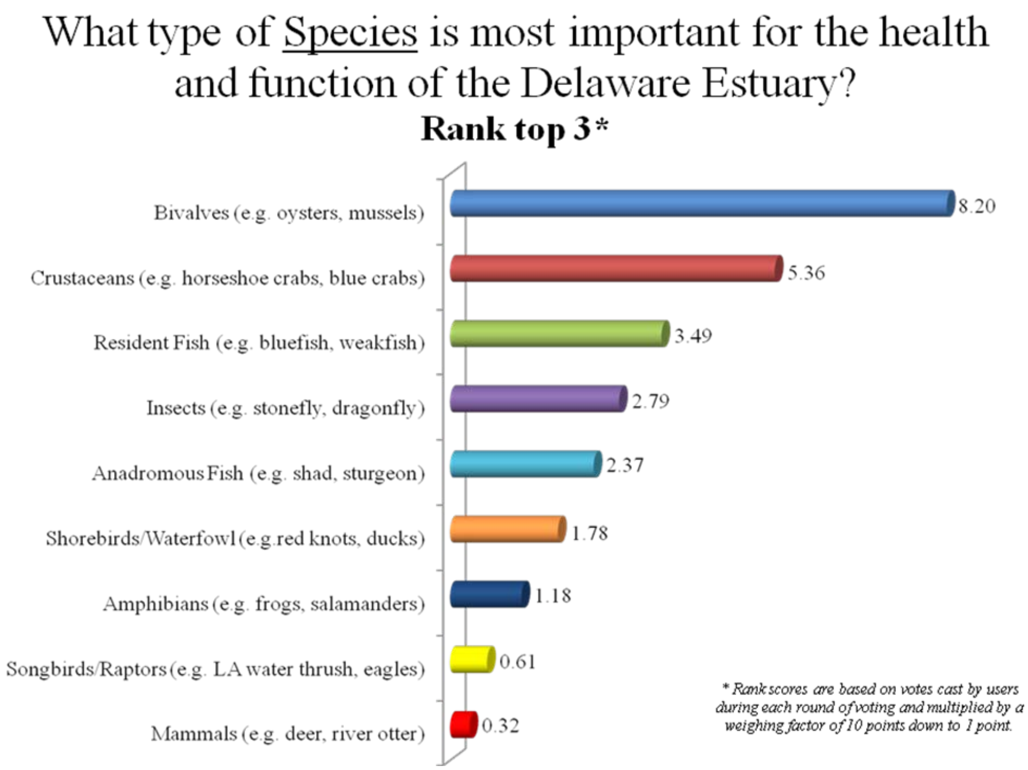

What best characterizes the geographic scope of your work/interest?
35%
30%
25%
20%
15%
10%
5%
0%
18%
25%
19%
7%
32%
Delaware River Basin
Delaware Estuary
Statewide
Local*
Other

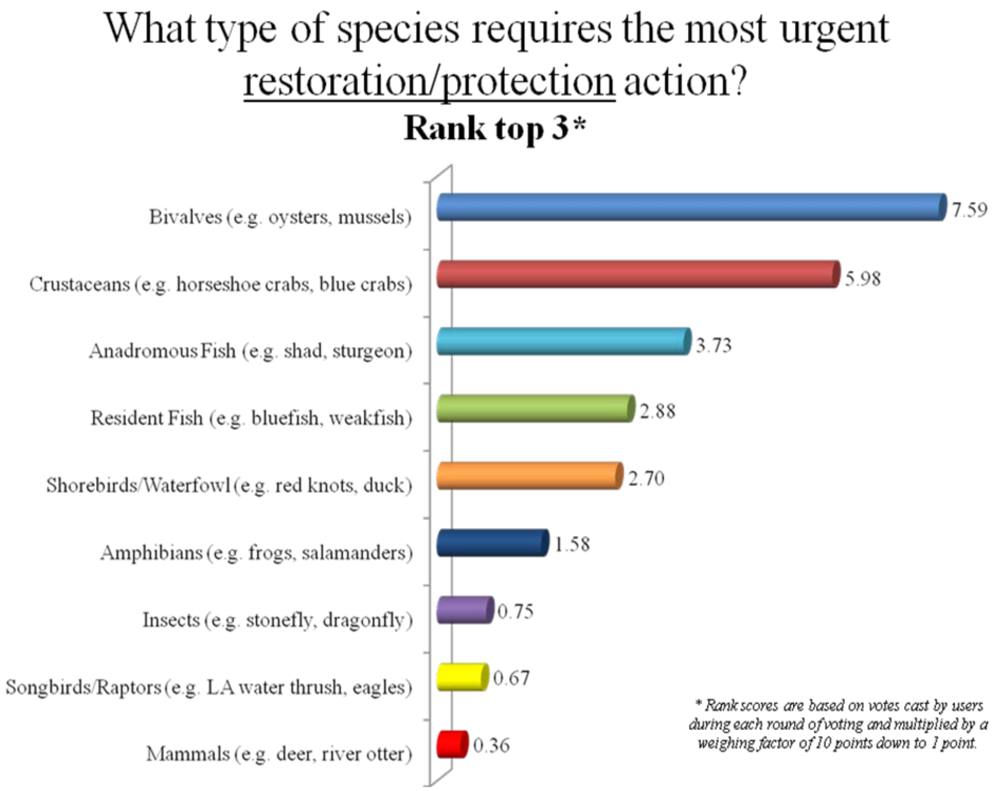

What category best characterizes your work/interest?
30%
25%
20%
15%
10%
5%
0%
27%
19%
14%
16%
13%
12%
Research
Restoration/Protection
Natural Resource Mgmt.
Monitoring
Education/Outreach
Other

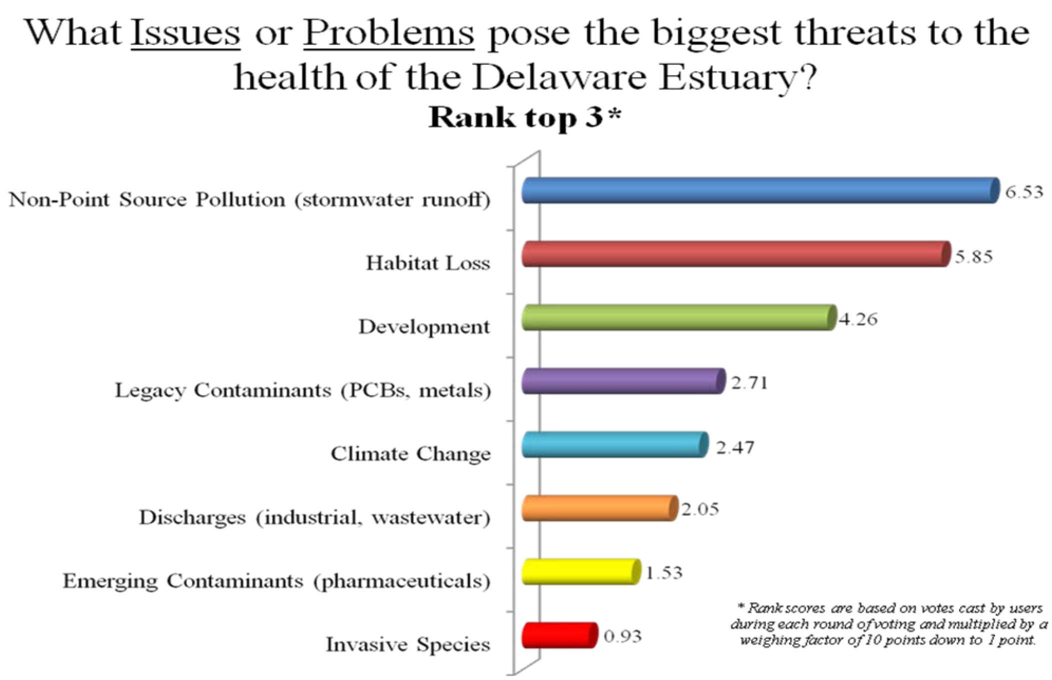

What Habitat type is most important for the health and function of the Delaware Estuary?
Rank top 3*
Tidal Marshes/Wetlands
8.46
Streams/Riparian Corridors
6.75
Aquatic/Benthic
4.72
Non-tidal Wetlands
3.32
Forests
2.53
Sandy Beaches
0.69
Grasslands
0.06
* Rank scores are based on votes cast by users during each round of voting and multiplied by a weighing factor of 10 points down to 1 point.


What Habitat type is in most urgent need of protection in the Delaware Estuary?
Rank top 3*
Tidal Marshes/Wetlands
Streams/Riparian Corridors
6.59
Non-tidal Wetlands
5.01
Forests
3.67
Aquatic/Benthic
2.95
Sandy Beaches
1.02
Grasslands
0.54
* Rank scores are based on votes cast by users during each round of voting and multiplied by a weighing factor of 10 points down to 1 point.


What Habitat type is in most urgent need of restoration in the Delaware Estuary?
Rank top 3*
Streams/Riparian Corridors
8.21
Tidal Marshes/Wetlands
7.26
Non-tidal Wetlands
5.68
Forests
2.34
Aquatic/Benthic
2.15
Sandy Beaches
0.76
Grasslands
0.4
* Rank scores are based on votes cast by users during each round of voting and multiplied by a weighing factor of 10 points down to 1 point.

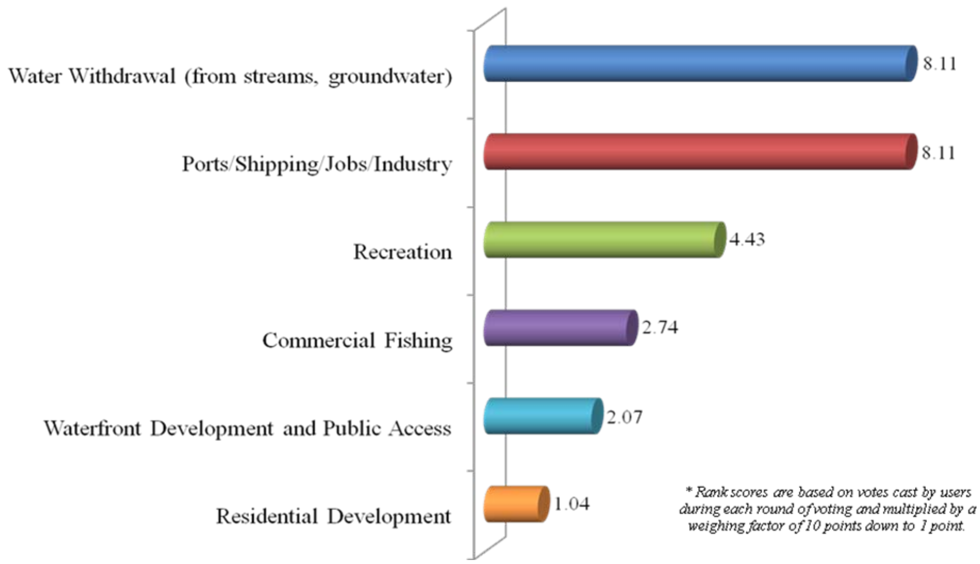

What type of Species is most important for the health and function of the Delaware Estuary?
Rank top 3*
Bivalves (e.g. oysters, mussels)
8.20
Crustaceans (e.g. horseshoe crabs, blue crabs)
5.36
Resident Fish (e.g. bluefish, weakfish)
3.49
Insects (e.g. stonefly, dragonfly)
2.79
Anadromous Fish (e.g. shad, sturgeon)
2.37
Shorebirds/Waterfowl (e.g red knots, ducks)
1.78
Amphibians (e.g. frogs, salamanders)
1.18
Songbirds/Raptors (e.g. LA water thrush, eagles)
0.61
Mammals (e.g. deer, river otter)
0.32
* Rank scores are based on votes cast by users during each round of voting and multiplied by a weighing factor of 10 points down to 1 point.


What type of species requires the most urgent restoration/protection action?
Rank top 3*
Bivalves (e.g. oysters, mussels)
7.59
Crustaceans (e.g. horseshoe crabs, blue crabs)
5.98
Anadromous Fish (e.g. shad, sturgeon)
3.73
Resident Fish (e.g. bluefish, weakfish)
2.88
Shorebirds/Waterfowl (e.g. red knots, duck)
2.70
Amphibians (e.g. frogs, salamanders)
1.58
Insects (e.g. stonefly, dragonfly)
0.75
Songbirds/Raptors (e.g. LA water thrush, eagles)
0.67
Mammals (e.g. deer, river otter)
0.36
* Rank scores are based on votes cast by users during each round of voting and multiplied by a weighing factor of 10 points down to 1 point.


What Issues or Problems pose the biggest threats to the health of the Delaware Estuary?
Rank top 3*
Non-Point Source Pollution (stormwater runoff)
6.53
Habitat Loss
5.85
Development
4.26
Legacy Contaminants (PCBs, metals)
2.71
Climate Change
2.47
Discharges (industrial, wastewater)
2.05
Emerging Contaminants (pharmaceuticals)
1.53
Invasive Species
0.93
* Rank scores are based on votes cast by users during each round of voting and multiplied by a weighing factor of 10 points down to 1 point.

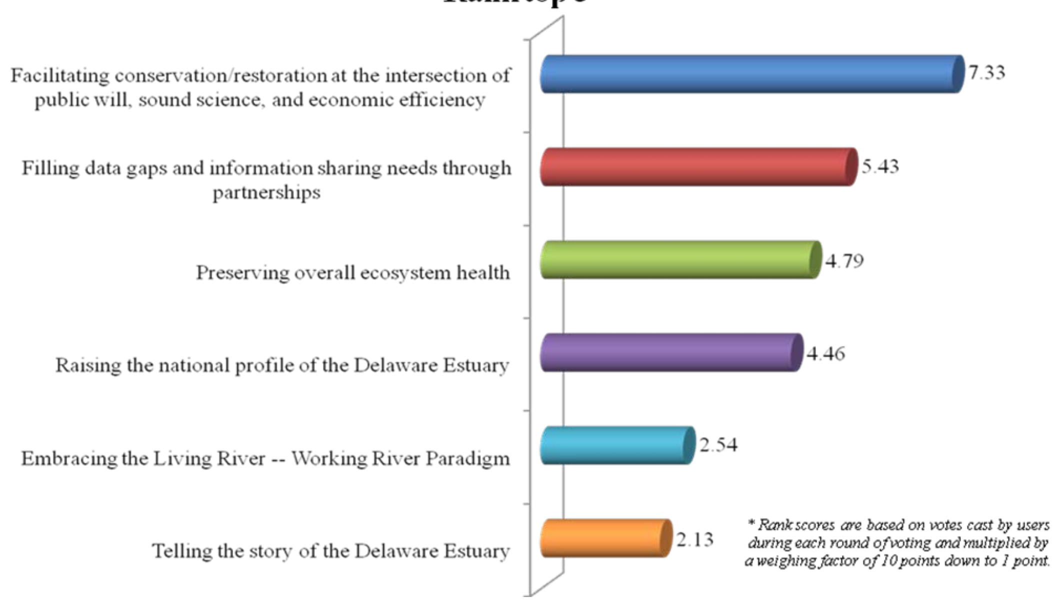
Which of the following do you think is the most important Human Use of the Delaware Estuary?

Rank top 3*



Which of the following resonates most with you as a role played by the Partnership for the Delaware Estuary, the National Estuary Program for the tidal Delaware River and Bay?

Rank top 3*



Welcome to the Delaware Estuary Science and Environmental Summit!

It is with great excitement that the Partnership for the Delaware Estuary welcomes you to Cape May, New Jersey for our third biennial Science & Environmental Summit. This meeting of the minds comes at a critical time as we enter our twelfth year as a National Estuary Program, with new leadership in the Partnership, in the region, and in our country. In the midst of unprecedented challenges and opportunities ahead, it's the perfect time to look toward the future.

This 3 day meeting will build upon the momentum created at the last Science Conference and Environmental Summit held in 2007. The theme of the 2009 meeting is "Planning for Tomorrow's Delaware Estuary," building on the themes of the 2005 Science Conference ("Linking Science and Management") and the 2007 Science Conference and Environmental Summit ("Setting Achievable Environmental Goals").

This year once again we have the goal of bringing together scientists, educators, resource managers, environmental organizations and others to discuss current and emerging issues within the Estuary and to showcase exemplary research and activities. The program includes a full range of subject material related to estuarine science, management, and outreach, including special sessions on horseshoe crabs and climate change.

We are delighted that this Summit consists of more than 130 oral and poster presentations, up from 104 in 2007. The presentation topics are diverse, spanning the environmental spectrum. Participants are therefore being provided with a rare opportunity to not only learn first hand about the latest science in the Estuary, but how this information can better be used to manage resources, and inform the public. Joint sessions where science and education overlap are scheduled, and attendees are encouraged to move between concurrent sessions to broaden 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.

Following the conference, the PDE will prepare a "proceedings" document summarizing the overall program and providing information on presentors as well as participants. Presentations (with permission) will also be available online. An edition of the Environmental Who's Who in the Delaware Estuary, listing scientists, educators, environmental professionals, and others interested in the Delaware Estuary, cross-referenced by area of expertise will be published after the Summit. Previous documents pertaining to the 2005 and 2007 meeting as well as those mentioned above can be found at: www.DelawareEstuary.org.

On behalf of the Partnership Board and Staff, we hope you will be both informed and inspired by the three days ahead in Cape May with your colleagues from throughout the region. Enjoy!

Jennifer Adkins
Executive Director
Partnership for the Delaware Estuary

Contents

Agenda-at-a-Glance

Sunday, January 11		
5:00 - 8:00pm	**Registration** - 5th Floor	
6:00 – 9:00pm	**Evening Reception** - Penthouse 5th Floor *(heavy appetizers and beverages)*	
Monday, January 12		
7:30 – 9:00am	**Continental Breakfast** - Atrium 1st Floor *(provided)*	
8:00 am	**Registration** - 5th Floor	
9:00 am	**Welcome:** Jennifer Adkins, Executive Director, Partnership for the Delaware Estuary **Keynote Presentation**: **Jerry Schubel**, President and CEO of Aquarium of the Pacific Grand Ballroom 1st Floor	
10:15 am	**Session 1 (Joint)** **Climate Change** (Special Session) Grand Ballroom 1st Floor	
Noon	**Lunch -** Penthouse 5th Floor *(provided)* **Presenter: Peter Mitchell**, Chairman and Chief Creative Officer Salter Mitchell Inc. Marketing for Change	
1:00 pm	**Session 2 (Concurrent) - Living Resources & Ecological Processes** Grand Ballroom A 1st Floor	**Session 3 (Concurrent)** **Marketing Your Message** Grand Ballroom B 1st Floor
2:45 pm	**Break -** Atrium 1st Floor	
3:00 pm	**Session 4 (Concurrent)** **Horseshoe Crabs** (Special Session) Grand Ballroom A 1st Floor	**Session 5 (Concurrent)** **Setting Conservation Priorities** Grand Ballroom B 1st Floor
4:30 pm	**Session 6 (Joint)** **Posters & Networking** *(will continue on Tuesday at 5:00)* Penthouse 5th Floor	
6:30 pm	**Dinner** - Penthouse 5th Floor *(provided)*	
7:15 – 7:45pm	**Live Polling on Estuary Priorities** Penthouse 5th Floor	

7:45-9:00 pm	**Ad Hoc Panel: State of the Delaware Estuary & River Basin** Penthouse 5th Floor

Agenda-at-a-Glance
(cont.)

Tuesday, January 13		
7:30 am	**Continental Breakfast** - Atrium 1st Floor *(provided)*	
8:00 am	**Registration** - 5th Floor	
9:00–10:45am	**Session 7 (Concurrent)** **Restoration, Enhancement & Conservation** Grand Ballroom A 1st Floor	**Session 8 (Concurrent)** **Pollutants & Contaminants** Grand Ballroom B 1st Floor
10:45	**Break** - Atrium 1st Floor	
11:00 am	**Session 9** **Panel Discussion (Joint):** ***"Meeting the Challenges of Tomorrow's Estuary"*** ***PDE Steering Committee representatives*** Grand Ballroom 1st Floor	
Noon	**Lunch-** Penthouse 5th Floor *(provided)* **Christopher J. Christie -** Former United States Attorney for the District of New Jersey **NFWF Delaware Estuary Watershed Grants Program Awards Ceremony**	
1:30-3:15 pm	**Session 10 (Concurrent)** **Wetlands & Other Habitats** Grand Ballroom A 1st Floor	**Session 11 (Concurrent)** **Outrageous Outreach** Grand Ballroom B 1st Floor
3:15 pm	**Break** – Atrium 1st Floor	
3:30 pm	**Session 12 (Concurrent)** **Indicators & Monitoring** Grand Ballroom A 1st Floor	**Session 13 (Concurrent)** **"Fun"-damental Fundraising** Grand Ballroom B 1st Floor
5:00-6:30 pm	**Session 6 Joint** **Posters & Networking** *(continued from Monday)* Penthouse 5th Floor	
6:30 pm	**Dinner** on your own in Cape May	

Agenda-at-a-Glance

(cont.)

Wednesday, January 14		
7:30 am	**Continental Breakfast** Atrium 1st Floor *(provided)*	
8:00 am	**Registration** - 5th Floor	
9:00–10:30am	**Session 14 (Concurrent)** **Water Quality & Quantity I** Grand Ballroom A 1st Floor	**Session 15 (Concurrent) - Partnership Approaches: Working with Schools, Local Government, and Communities** Grand Ballroom B 1st Floor
10:30	**Break** - Atrium 1st Floor	
10:30-12:15	**Session 16 (Concurrent)** **Physical Processes** Grand Ballroom A 1st Floor	**Session 17 (Concurrent)** **Water Quality & Quantity II** Grand Ballroom B 1st Floor
12:15 pm	**Lunch -** Penthouse 5th Floor *(provided)* **Presenter: Larry J. Silverman**, Member, Washington, DC Bar	
1:30-3:30 pm	**Session 18 (Joint)** **Hot Topics** Grand Ballroom 1st Floor	
3:30 pm	**Announcements and Closing Remarks** Grand Ballroom 1st Floor	

Detailed Agenda

Time	Sunday, January 11
5:00-8:00 pm	**Registration** - 5th Floor
6:00-9:00 pm	**Evening Reception** - Penthouse 5th Floor *(heavy appetizers and beverages)*

Time	Monday, January 12th
8:00am	**Registration** - 5th Floor
7:30– 9:00am	**Continental Breakfast** - Atrium 1st Floor *(provided)*
9:00 am	**Welcome:** Jennifer Adkins, Executive Director, Partnership for the Delaware Estuary **Keynote Presentation**: **Jerry Schubel**, President and CEO of Aquarium of the Pacific *"You talkin' to me"* Grand Ballroom 1st Floor

10:15- Noon	**Session 1 (Joint)** **Climate Change** (Special Session) Grand Ballroom Moderators: **Dorina Frizzera** (NJDEP) & **Nathaniel B. Weston** (Villanova)	
10:15	**S. Jeffress Williams**, USGS, Coastal Marine Geologist, Woods Hole Science Center (invited)	*Sea-level rise and storm effects on coastal systems under changing global climate*
10:30	**Mike Szabados**, NOAA Center for Operational Oceanographic Products and Services, National Ocean Service (invited)	*Understanding sea level*
10:45	**Jim Titus**, U.S. EPA, Climate Change Division (invited)	*Will people allow ecosystems to migrate inland?*
11:00	**David Carter**, Delaware Division of Natural Resources and Environmental Control (invited)	*Local planning for climate change adaptation in a social environment of scientific uncertainty*
11:15	**Ray G. Najjar, S. Graham, and L. Patterson**, Pennsylvania State University (invited)	*Climate projections for Delaware Bay and its watershed*
11:30	**Danielle Kreeger**, Partnership for the Delaware Estuary	*Adapting to changing climate, watersheds and ecological interactions in the Delaware Estuary*

Posters Aligned with Climate Change Session

- **David Bushek**, Susan Ford, Ximing Guo, Iris Burt, Brenda Landau, Coren Milbury, Emily Scarpa and Liusuo Zhang. Field and laboratory studies to understand disease resistance in the Delaware Bay oysters and response to climate.
- **Priscilla Cole** and Danielle Kreeger. The Delaware Estuary Climate Ready Pilot: Vulnerability Assessment and adaptation Planning.
- **R. G. Najjar** and M. E. Mann. Potential impact of changing sea level and streamflow on salinity of the upper Delaware Bay.
- **Jerry Mead,** Fredrick Scatena, Richard Horwitz, Yude Pan and Richard Birdsey. The growth potential of stream fishes as affected by changes in water temperature driven by climate and land-use in the Delaware River basin.
- **S. Stephen Platt.** Geologic sequestration: a proposed alternative to combat climate change.
- **Tatjana Prša**, Nathaniel B. Weston and Melanie A. Vile. Changes in metabolic activity and community composition of sulfate reducing bacteria in tidal freshwater marsh soils in response to climate change and saltwater intrusion.

Noon	**Lunch -** Penthouse 5th Floor *(provided)* **Presenter: Peter Mitchell** "*"Homeland insecurity, pink flamingos and making your goal into a product that sells itself. What's new in social marketing and behavior change"*

Time	Monday, January 12th	
1:00- 2:45 pm	**Session 2 (Concurrent with Session 3)** **Living Resources & Ecological Processes** Grand Ballroom A Moderators: **Susan Kilham** (Drexel) & **Roger Thomas** (ANSP)	
1:00	**Eric N. Powell,** John M. Klinck, Kathryn A. Ashton-Alcox, and John N. Kraeuter	*Multiple stable points in oyster populations*
1:15	**Kathryn Ashton-Alcox**, Eric Powell, Jason Hearon, Russell Babb, Gulnihal Ozbay, Richard Cole	*The Delaware Bay shell planting program after 3 years: oyster recruitment enhancement and carbonate budget*
1:30	**Eileen E. Hofmann**, John Klinck, David Bushek, Susan Ford, Ximing Guo, Eric Powell, Dale Haidvogel, John Wilkin	*Understanding disease resistance in estuarine populations and response to climate change*
1:45	**Shawn Shotzberger**	*Reframing introduced species policy in the Delaware Estuary Watershed*
2:00	**Gurdeep Bains,** Thimmaraju Rudrappa, Thomas E. Hanson and Harsh P. Bais	*Can plant & microbial biochemistry contribute to understanding of invasion ecology?*
2:15	**Steven Pearson** and Harold W. Avery	*Resource overlap and potential competition between invasive red-eared slider turtles and threatened native red-bellied turtles in the upper Delaware Estuary.*

Posters Aligned with Living Resources & Ecological Processes

- **Dale B. Haidvogel,** John Wilkin and Joseph Wang. Modeling circulation and transport pathways for oyster larvae in Delaware Bay.
- Richard J. Horwitz, Paul F. Overbeck**, David H. Keller,** and Shane M. Moser. American eel abundance: recent trends in southeastern Pennsylvania**.**
- **Douglas C. Miller** and Stephen L. Gardiner. Acquisition, curation and digitization of a collection of Delaware Estuary benthic invertebrates from over fifty years ago.
- **Douglas C. Miller** and Danielle Kreeger. Hard-bottom sampling methodology and characterization of a “sponge garden” in the Broadkill Slough as part of the Delaware Estuary Benthic Inventory.
- **Diego A. Narváez**, John M. Klinck, Eileen E. Hofmann, Eric N. Powell, Dennis Hedgecock. The effect of immigration on disease resistance in an oyster population: a numerical model study.
- **Angela T. Padeletti**, Danielle A. Kreeger, Catherine M. Gatenby, Steven G. Hughes, Roger L. Thomas, Rosemary Malfi and Heidi Tucker-Wood. Musseling our way to restoration of the Delaware Estuary with the lightfoot mussel (*Elliptio complanata*).
- **David E. Russell,** Danielle Kreeger, Angela Padeletti, Laura Whalen, Rene Searfoss, Jim Gouvas, Steven Donohue, Amie Howell, Charles Strobel, Henry A. Walker, Bartholomew Wilson, Douglas C. Miller and Irene Purdy. Survey of Delaware Estuary soft-bottom benthic communities: sampling design and 2008 field work.
- **Oluchi Ukaegbu** and Gulnihal Ozbay**.** Investigating growth and cellular response of *Prorocentrum minimum* and *Karlodinium veneficum* across salinity gradient: application of molecular methods for species-specific quantification.

2:45 pm	**Break -** Atrium 1st Floor

Time	Monday, January 12th
1:00- 2:45 pm	**Session 3 (Concurrent with Session 2)** **Marketing Your Message** Grand Ballroom B Moderator: **Deanne Ross** (PDE)

Peter Mitchell
Chairman and Chief Creative Officer
Salter Mitchell Inc. Marketing for Change
http://www.saltermitchell.com/

This session will explore in more depth and with more interactions the concepts presented in Mr. Mitchell's lunch address.

After 10 years as a reporter, Peter left The Wall Street Journal to work in Florida politics but quickly found himself serving as the founding marketing director of what became the "truth" anti-smoking campaign. Since then, Peter has designed behavior-changing campaigns for the Centers for Disease Control and Prevention, the Chesapeake Bay Program, the Environmental Protection Agency, and many more.

2:45 pm	**Break -** Atrium 1st Floor

Time	Monday, January 12th	
3:00- 4:30 pm	**Session 4 (Concurrent with Session 5)** **Horseshoe Crabs (Special Session)** Grand Ballroom A Moderators: **Greg Breese** (USFW) & **Mark Botton** (Fordham)	
3:00	**Roy W. Miller**	*Complexities and challenges of managing horseshoe crabs in an ecosystem context*
3:15	**Robert E. Loveland**, and Mark L. Botton	*Sands of time: survival of the grittest*
3:30	**Mark L. Botton** and Robert E. Loveland	*The importance of horseshoe crabs in the ecology of Delaware Bay: more than just bird food?*
3:45	**James F. Cooper,** Frances D. Cooper and Benjie Swan	*The expanding role of* Limulus *amebocyte lysate (LAL) reagent in the global pharmaceutical industry*
4:00	**David R. Smith,** James D. Nichols, Conor P. McGowan	*Adaptive management of horseshoe crabs and red knots in Delaware Bay: could it be home at last?*
4:15	**Glenn A. Gauvry**	*Survival of the worlds four horseshoe crab species requires a global perspective*
Poster Aligned with Horseshoe Crabs • **David Bushek,** Brian Marsh and Peter Van Veld. An assessment of a methoprene-containing insecticide on horseshoe crab (*Limulus polyphemus*) using proteomics and observations of embryonic development and survival.		
4:30-6:30 pm	**Session 6 (Joint)** **Posters** Penthouse 5th Floor	

Time	Monday, January 12th	
3:00- 4:30 pm	**Session 5 (Concurrent with Session 4)** **Setting Conservation Priorities** Grand Ballroom B Moderator: **Cheryl Jackson** (PDE)	
3:00	**Martha Corrozi Narvaez,** Maureen HS Nelson, Martha Corrozi, Andrew Homsey, Gerald Kauffman, Erika Farris, and Maureen Seymour.	*White Clay Creek state of the watershed report*
3:15	**Robert Lonsdorf** and Jessie Benjamin	*Landscape-scale forest restoration in the White Clay Creek watershed, Pennsylvania*
3:30	**Jennifer Adkins**	*Prioritizing land protection to protect source water in Schuylkill River*
3:45	**Priscilla Cole** and Jennifer Adkins	Building Consensus on Priorities for the Delaware Estuary: The PDE Alliance for Comprehensive Ecosystem Solutions.
Posters Aligned with Setting Conservation Priorities • **Rebecca Rothweiler,** Amy Jacobs, Mark Biddle, Gary Kreamer, and Stephen Williams Delaware wetlands conservation strategy**.**		
4:30–6:30 pm	**Session 6 (Joint)** **Posters** Penthouse 5th Floor	

Time	Monday, January 12th
6:30 pm	**Dinner** - Penthouse 5th Floor *(provided)*
7:15 – 7:45pm	**Live Polling on Estuary Priorities** Penthouse 5th Floor
7:45- 9:00 pm	**Ad Hoc Panel** **State of the Delaware Estuary & River Basin** Penthouse 5th Floor Moderators: **Jim Eisenhardt** (Duffield Assoc.) & **Martha Maxwell-Doyle** (BBNEP)
Panelists	**Bob Tudor**, Delaware River Basin Commission **Jennifer Adkins,** Partnership for the Delaware Estuary **Dan Soeder**, United States Geological Survey **Gerry Kaufman,** University of Delaware **Danielle Kreeger**, Partnership for the Delaware Estuary
Description	• Findings from the 2008 State of the Estuary Report (PDE) and 2008 State of the Basin Report (DRBC) will be briefly presented and discussed. • Potential "next generation" environmental indicators and an idea for an ecosystem model for the Delaware Estuary will be presented and discussed. • The audience will be asked to provide input on how to strengthen environmental indicators and associated monitoring for the future to aid future reporting.

Time	Tuesday, January 13th
7:30 am	**Continental Breakfast** - Atrium 1st Floor *(provided)*
8:00 am	**Registration** - 5th Floor

Time	Tuesday, January 13th

9:00- 10:45 am

Session 7 (Concurrent with Session 8)
Restoration, Enhancement & Conservation

Grand Ballroom A

Moderators: **Simeon Hahn** (NOAA), **Joe Berg** (Biohabitats) & **Ken Strait** (PSEG)

9:00	**Elizabeth Ciuzio,** C. Frank, and T. Ettel	*Using the important bird areas program as a model for conservation planning in the Delaware Estuary*
9:15	**Cristina Frank,** B. Ciuzio and T. Ettel	*Mapping priority areas for conservation in the Delaware Estuary: applying a GIS model to delineate important bird areas*
9:30	**Shandor J. Szalay,** Jason Cruz and Mike Wilson	*Project headwaters: a new framework for watershed restoration in the Delaware Estuary*
9:45	**Lance H. Butler** and Joseph A. Perillo	*Evaluating the use of Fairmount Dam fish passage facility with application to anadromous fish restoration in the Schuylkill River, Pennsylvania*
10:00	**Kathy Bergmann**, Jane Fava and Aaron S. Clauser	*Red streams blue: a subwatershed approach to restoring the estuary*
10:15	**Christopher F. Miller**	*The USDA-NRCS, Cape May Plant Materials Center-a case study in developing a revegetation plan for a brownfield site in Cape May County, NJ*
10:30	**Joe Berg**	*Improvements to natural channel design in urban estuarine watersheds*

Posters Aligned with Restoration, Enhancement & Conservation

- **Aaron Gibson,** Frank Marenghi, and Gulnihal Ozbay. Assessment of artificial oyster habitat for blue crab (*Callinectes sapidus*) population in Delaware's Inland Bays.
- **Simeon Hahn**, Anthony Dvarskas, Jill Bodnar, Danielle Kreeger, Laura Whalen, Paul Racette, and Lance Butler. Regional restoration planning case study in the Delaware Estuary: Ecosystem valuation along an urban waterfront.
- **Joshua Moody** and David Bushek, Danielle Kreeger, Angela Padeletti and Laura Whalen**.** The Delaware Estuary Living Shoreline Initiative (DELSI).
- **Danielle Kreeger,** Jennifer Adkins
- , Laura Whalen and Priscilla Cole**.** A science-based regional restoration initiative in the Delaware Estuary.

10:45	**Break** - Atrium 1st Floor

Time	Tuesday, January 13th	
9:00- 10:45	**Session 8 (Concurrent with Session 7)** **Pollutants & Contaminants** Grand Ballroom B Moderators: **Jeff Ashley** (Philadelphia Univ) & **Gary Buchanan** (NJDEP)	
9:00	**Jeffrey M. Fischer,** Andrew G. Reif, Kristin Romanok, Paul E. Stackelberg and R. Lee Lippincott	*Occurrence of organic wastewater-related compounds in streams entering the Delaware Estuary*
9:15	**A. Ronald MacGillivray**	*Contaminants of emerging concern in the tidal Delaware River*
9:30	**Jeffrey T.F. Ashley,** Marcel Vasquez, Heather Stapleton, Mike Schafer, Richard Horwitz and David Velinsky	*Bioaccumulation of PCBs and PBDEs within a tidal freshwater marsh*
9:45	**Robert Hindt** and John Botts	*Development and implementation of a pollutant minimization plan for polychlorinated biphenyls (PCB's) in the Delaware Estuary*
10:00	**Paula Conolly**	*Unused pharmaceuticals education and disposal program in Philadelphia*
10:15	**Jeffrey M. Fischer**, Mary M. Chepiga and Susan J. Colarullo.	*A spatially detailed assessment of nutrient loading in the Delaware River basin*
Poster Aligned with Restoration, Enhancement & Conservation • **Paula Zelanko,** Erin McKinley, Jeffrey T.F. Ashley, Marcel Vasquez, Richard Horwitz and David Velinsky**.** Trophic relationships within Tinicum Marsh, Philadelphia, PA: Insights from the stable isotopes of carbon and nitrogen.		
10:45	**Break** - Atrium 1st Floor	

Time	Tuesday, January 13th

Panel Session 9 (Joint)

11:00- Noon **Meeting the Challenges of Tomorrow's Estuary**

Grand Ballroom

Moderator: **Jennifer Adkins** (PDE)

Meeting the Needs and Challenges of Tomorrow's Delaware Estuary
Moderator: Jennifer Adkins, Executive Director of the Partnership for the Delaware Estuary

As a National Estuary Program, the Partnership for the Delaware Estuary has a unique management structure designed to promote collaboration across jurisdictions. This structure includes a Steering Committee that consists of leaders from each of the major public agencies involved in managing the water resources of the Estuary. The role of the Steering Committee includes guiding the identification of resources, facilitating or resolving issues, and setting policy for the implementation of the Comprehensive Conservation Management Plan for the Delaware Estuary (CCMP).

With the recent release of the *2008 State of the Estuary* report and major leadership transitions in our country, the region, and the Estuary, this is a great opportunity to prepare for the needs and challenges of the future. The purpose of this panel discussion is to hear the perspectives of our Steering Committee representatives on those needs and challenges, as an element of the ongoing dialogue at the Summit. Each panelist will be asked to give a 5-10 minute opening remark on what he or she sees as the most critical needs or challenges for the future, after which there will be a question and answer period.

The panel will be comprised of the following speakers:

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

Jon M. Capacasa, P.E. Director of the Water Protection Division, U.S. Environmental Protection Agency Region III

Carol R. Collier, P.P., AICP, Executive Director of the Delaware River Basin Commission

Barbara A. Finazzo, Director of the Division of Environmental Planning & Protection, U.S. Environmental Protection Agency Region II

Commissioner Mark Mauriello, New Jersey Department of Environmental Protection (Invited)

Noon	**Lunch-** Penthouse 5th Floor *(provided)* **NFWF Delaware Estuary Watershed Grants Program Awards Ceremony** **Christopher J. Christie -** Former United States Attorney for the District of New Jersey

Time	Tuesday, January 13th	
1:30- 3:15 pm	**Session 10 (Concurrent with Session 11)** **Wetlands & Other Habitats** Grand Ballroom A Moderators: **Amy Jacobs** (DNREC) & **Danielle Kreeger** (PDE)	
1:30	**Nathaniel B. Weston,** Melanie A. Vile, Scott C. Neubauer, David J. Velinsky	*The impact of climate change and sea-level rise on tidal freshwater marshes of the Delaware River Estuary*
1:45	**Jim D'Agostino, Jr.**	*Mingo Creek freshwater tidal wetland restoration: wetland creation in an urban reach of the Schuylkill River, Philadelphia, Pennsylvania*
2:00	**Amy Alsfeld-Nazdrowicz**, Jacob J. Bowman and Amy Jacobs	*Effects of woody debris, microtopography, and organic matter amendments on the biotic community of constructed wetlands and their applications for wetland mitigation*
2:15	**Alison B. Rogerson**, Amy D. Jacobs and Andrew M. Howard	*The condition of wetlands in the St. Jones Watershed, Delaware and application to restoration and protection targeting*
2:30	**Tracy Elsey,** Denise M. Seliskar and John L. Gallagher	*Consequences of interspecific variation in nitrogen and carbon pools of salt marsh plants*
2:45	**Bartholomew Wilson** and Michael Rhode, John Madsen, Dewayne Fox and Phillip Simpson	*Utilizing benthic mapping, biotelemetry, and 3-D GIS to assess sturgeon habitat in the Delaware River and Bay*

Posters Aligned with Wetlands & Other Habitat

- **Stephen K. Davis,** Lawrence D. Malizzi, Dennis Petrocelli and Doug Lashley. How prospective restoration or restoration up front could be used in the Delaware River watershed.
- **Andrew Homsey.** Development of hydro-geomorphic modifiers for Delaware's wetlands in the Delaware Estuary.
- **Alex Riter,** Michael S. Kearney and Amy Jacobs. Assessment of Delaware Bay tidal wetland condition and change from 1993 to 2008.
- **Alison B. Rogerson**, Amy D. Jacobs and Andrew M. Howard. The use of two wetland rapid assessment methods in Delaware.
- **Laura Whalen** and Danielle Kreeger. Native Vegetation Classification System (NVCS): On-the-ground application of NVCS and future plans.

3:15	**Break** - Atrium 1st Floor

Time	Tuesday, January 13th	
1:30- 3:15 pm	**Session 11 (Concurrent with Session 10)** **Outrageous Outreach** Grand Ballroom B Moderators: **Cheryl Jackson** (PDE) & **Deanne Ross** (PDE)	
1:30	**Deanne C.T. Ross**	*Shhh – don't tell them your teaching – PA Coast Day*
1:45	Shaun Bailey**, Kimberly B. Cole,** Sarah W. Cooksey, Kate Hackett, Debbie Heaton, Jennifer Holmes, Melanie Rapp and Lisa Wool	*Thank You Delaware Bay – Developing an estuary awareness campaign*
2:00	**Crystal G. Gilchrist**	*Perkiomen Watershed Conservancy: The challenges of reaching and inspiring*
2:15	**Lisa D. Tossey** and Elizabeth Boyle	*A PSA facelift – bringing traditional media up to the multimedia age*
2:30	**Barry Lewis**	*Getting the word out: Stormwaterpa, a multi-media blueprint for success*
2:45	**Chris Strohmaier** and Charlotte Sprenkle	*Case Study- Best management practices and conservation education in the Amish community, Chester County, Pennyslvania*
Posters Aligned with Outrageous Outreach • **Shaun Bailey.** ecodelaware.com. • **Ronald L. Ohrel, Jr**, Lisa Tossey, Tamara Beeson, Elizabeth Boyle and Kimberly Doucette. Passport to personal action in Delaware Bay. • **Deanne C.T. Ross.** Telling the story…Sharing the successes of the Schuylkill Watershed initiative grant and the Schuylkill Action Network. • **Kelly Wolfe,** Erika Farris and Maureen Nelson. It's easy being blue.		
3:15	**Break** - Atrium 1st Floor	

Time	Tuesday, January 13th	
3:30- 5:00 pm	**Session 12 (Concurrent with Session 13)** **Indicators & Monitoring** Grand Ballroom A Moderators: **Alan Everett** (PADEP) & **Renee Searfoss** (EPA R3)	
3:30	**E.F. Vowinkel** and Robert Tudor	*National monitoring network for coastal waters and their tributaries: the Delaware River basin demonstration project*
3:45	**Y. Voynova** and J.H. Sharp	*Long-term water quality trends in the Delaware Estuary from the boat run database*
4:00	**Greg Murphy**, Todd Morrison, Barry Baker, and Vincent Pellerito, Ralph Stahl, Jr., Amanda DeSantis and Robert Hoke	*A watershed-level tool for assessing ecological conditions in the Delaware Estuary*
4:15	Kathy Bergmann, **Jane Fava,** Aaron S. Clauser	*Streambank erosion and deposition assessment protocol: a tool for monitoring watershed restoration projects*
4:30	**Jessica Rittler Sanchez,** and Robert Tudor	*Environmental results management: the role of indicators*

Posters Aligned with Indicators & Monitoring

- Kelly Bemis, Jeremy Bell, Eric Requa, Lindsay Cappa, Steven Ordog, and **Kathryn Goddard-Doms.** Differences in parasite burden in two species of fish throughout the Darby Creek watershed.
- **Jill R. Brown** and Douglas C. Miller. Changing distributions of the sandbuilder worm *Sabellaria vulgaris* : multiple survey methodology for intertidal habitats in Delaware Bay.
- **Young-Heon Jo** and Richard T. Field. Estimation of water constituents in hyperspectral measurements in Rehoboth and Indian River Bay.
- **Matthew W. Gray,** Danielle Kreeger and Angela Padeletti. Monitoring fitness of caged mussels (*Elliptio complanata*) to assess and prioritize streams for restoration in Southeastern Pennsylvania.
- **Kristen Much,** Lydia Civello, Sarah Wadsworth and Kathryn Goddard. Using macroinvertebrates and fish to assess the effects of Ithan Creek restoration through Radnor Valley Country Club, Delaware Co. PA.

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5:00- 6:30 pm	**Session 6 (Joint)** **Posters** Penthouse 5th Floor	
6:30 pm	**Dinner** on your own in Cape May	

Time	Tuesday, January 13th
3:30- 5:00 pm	**Session 13 (Concurrent with Session 12)** **"Fun"-damental Fundraising** Grand Ballroom B Moderator: **Karen Johnson** (PDE)

Andy Robinson
Marketing Consultant

"Raising Money & Engaging Your Supporters in a Challenging Economy"

Andy Robinson (*www.andyrobinsononline.com*) provides training and consulting for nonprofits in fundraising, grantseeking, board development, marketing, earned income, planning, leadership development, and facilitation. Over the past twelve years, Andy has worked with organizations in 47 US states and Canada. He specializes in the needs of groups working for human rights, social justice, environmental conservation, historic preservation, and community development.

Andy is the author of four books, including *Grassroots Grants, Selling Social Change (Without Selling Out): Earned Income Strategies for Nonprofits, Big Gifts for Small Groups* and *Great Boards for Small Groups.* When he's not on the road, he lives in Plainfield, Vermont

5:00- 6:30 pm	**Session 6 (Joint)** **Posters** Penthouse 5th Floor
6:30 pm	**Dinner** on your own in Cape May

Time	Wednesday, January 14th	
7:30 am	**Continental Breakfast** Atrium 1st Floor *(provided)*	
8:00 am	**Registration** - 5th Floor	
9:00- 10:15 am	**Session 14 (Concurrent with Session 15)** **Water Quality & Quantity (1)** Grand Ballroom A Moderators: **Tom Fikslin** (DRBC) & **Amie Howell** (EPA R3)	
9:00	**Gerald J. Kauffman**, Andrew C. Belden and Priscilla R. Cole	*Water quality trends in the Delaware River basin from 1980 to 2005*
9:15	**Youness Sharifi**, Ali Abdollahi Nasab, Hialong Li and Michel C. Boufadel	*Numerical investigation of contamination transport on beaches under tidal influences*
9:30	**Adane M. Bobo ,** Michel C. Boufadel, Hailong Li and Ali A. Nasab	*Groundwater flow for tide induced Alaska Prince William Sound beach*
9:45	**Yao-Tung Lin**, Yu-Hsiang Weng and Chin-Pao Huang	*Innovative sampling technique for monitoring naturally occurring colloidal particles in groundwater*

Posters Aligned with Water Quality & Quantity

- **Rebecca L Hays** and William J. Ullman**.** Eulerian sampling of marsh effluents for the determination of nutrient exchange between the Murderkill Estuary and adjacent salt marshes.
- **Kenneth F. Najjar**, Maggie Allio, J. Kent Barr, Pamela V'Combe, Michael Stokes, Drew Shaw, Alexis Melusky, Liz Feinberg and Khiet Luong. Water resources planning in estuary watersheds: the Upper Wissahickon Creek pilot study.
- **Roger Reinhart.** Stormwater infiltration practices and class V injection wells.

10:15	**Break** - Atrium 1st Floor	

Time	Wednesday, January 14th	
7:30 am	**Continental Breakfast** Atrium 1st Floor *(provided)*	
8:00 am	**Registration** - 5th Floor	
9:00- 10:15	**Session 15 (Concurrent with Session 14)** **Partnership Approaches:** **Working with Schools, Local Government & Communities** Grand Ballroom B Moderator: Deanne Ross (PDE)	
9:00	**Lisa Calvo**, Bill Shadel and Bushek	*Today's students, tomorrow's stewards—promoting oyster restoration through schools*
9:15	**James M. Eisenhardt** & Dianne F. Daly	*Stone harbor bird sanctuary habitat restoration project. ~it takes a whole village*
9:30	**Karen Johnson** & Laura Whalen	*Partnerships developed through the Corporate Environmental Stewardship Program (CESP)*
9:45	**Lisa Wool**	*Dog waste reduction through education and community partnerships*
10:15	**Break** - Atrium 1st Floor	

Time	Wednesday, January 14th	
10:30- 12:15 pm	**Session 16 (Concurrent with Session 17)** **Physical Processes** Grand Ballroom A Moderators: **Jeffrey Gebert** (ACE) & **Jerry Mead** (Academy of Natural Sciences)	
10:30	**David Osgood**, Tiffany Schell, David Kile, Kristen Kunkel, and Marissa Hartlzer	*Quantifying sediment retention within a restored headwater floodplain in the Delaware Bay watershed*
10:45	**Sherestha Saini,** Nancy L. Jackson and Karl F. Nordstrom	*Transport of horseshoe crab eggs and sediment over a tidal cycle on a sandy foreshore in Delaware Bay, New Jersey.*
11:00	**Erik Haniman**	*Estimating bank erosion in the Wissahickon Creek Watershed: a bank pin monitoring approach*
11:15	**Joe Berg** and Keith Underwood	*Replacing incised headwater channels and failing stormwater infrastructure with regenerative stormwater conveyance*
11:30	**John A. Madsen**, Bartholomew Wilson and Michael Rhode	*Using high-resolution 3D geophysical methods to constrain offshore sand resources for beach replenishment: Results from the Delaware Bay benthic mapping project*
11:45	**Nicole A. Raineault**, Karl F. Nordstrom, Nancy L. Jackson	*Effects of bulkheads on estuarine beach swash zone processes and beach characteristics*
	Poster Aligned with Physical Processes • **Nicole A. Raineault**, Art C. Trembanis and Douglas C. Miller. Hard-bottom benthic habitats in Delaware Bay: Spatial and temporal dynamics.	
12:15 pm	**Lunch -** Penthouse 5th Floor *(provided)* **Presenter: Larry J. Silverman**, Member, Washington, DC Bar "*Advancing environmental organizations in an age of meltdowns, bailouts, stimulus packages, and carbon footprints*"	

Time	Wednesday, January 14th	
10:30- 12:15 pm	**Session 17 (Concurrent with Session 16)** **Water Quality & Quantity II** Grand Ballroom B Moderators: **Tom Fikslin** (DRBC) & **Amie Howell** (EPA R3)	
10:30	**Ali Abdollahi-Nasab,** Hailong Li, Michel C. Boufadel	*Saltwater flushing by freshwater in a laboratory beach*
10:45	**Anthony K. Aufdenkampe**, William J. Ullman, Rebecca L. Hays	*The role of a salt marsh in processing estuarine carbon and nitrogen: A complete species and isotope seasonal balance*
11:00	**Adam R. Pimenta** and Jonathan H. Sharp	*Using DIC analysis to accurately quantify estuarine community metabolism*
11:15	**Thomas E. McKenna**	*Characterizing tidal inundation of wetlands in the Murderkill Estuary (Kent County, Delaware).*
11:30	Kuo-Chuin Wong**, Brian Dzwonkowski,** and William J. Ullman	*Variability of sea-level and volume flux in the Murderkill River Estuary*
11:45	**Andrew J. Thuman**, P.E., Biswarup Guha and Ruta Rugabandana	*Tidal water quality modeling in the Murderkill River*

Posters Aligned with Water Quality & Quantity II

- **William J. Ullman**, Mäella A. Dréan, Joseph R. Scudlark and Hassan Mirsajadi. Preliminary assessment of annual nutrient loads to the Murderkill Estuary, Delaware: watershed, wastewater, and atmospheric contributions.
- **David Velinsky**, Don Charles, Roger Thomas and Christopher Sommerfield. Tidal marshes in the Delaware Estuary: historical reconstruction of chemical loadings and ecosystem effects.
- **Kelly A. Peeler**, Jonathan H. Sharp, Yoana Voynova and Adam Pimenta. Primary production measurements along the Murderkill River.

12:15 pm	**Lunch -** Penthouse 5th Floor *(provided)* **Presenter: Larry J. Silverman**, Member, Washington, DC Bar "*Advancing environmental organizations in an age of meltdowns, bailouts, stimulus packages, and carbon footprints"*

Time	Wednesday, January 14th	
1:30- 3:30 pm	**Session 18 (Joint)** **HOT TOPICS** Grand Ballroom 1st Floor Moderators: **Dan Soeder** (USGS) & **Peter Rowe** (NJ Sea Grant)	
1:30	**Gary R. Brown**	*Dredge sediments: Upgraded and sustainable operations*
1:45	**Daniel Soeder**	*Possible water resource impacts from Marcellus shale gas drilling in the Delaware Basin*
2:00	**Desmond M. Kahn**	*The need to consider the cumulative impact of multiple large industrial water intakes on fish stocks of the Delaware Estuary*
2:15	**Michel C. Boufadel,** Ali Abollahi Nasab, Abhinav Saxena, Youness Sharifi, and Hailong Li	*Contingency planning for oil spills in the Delaware Estuary*
2:30	**Kelley H. Appleman** and Peter Edwards	*Measuring the recreational use value of migratory shorebirds in the Delaware Estuary*
2:45	**Elizabeth Methratta**, Charles Menzie, Theodore Wickwire, William Richkus	*Evaluating the risk of initiating a reproductive population of Suminoe oysters from Triploid Aquaculture in Chesapeake Bay*
3:00	**Jennifer L. Halchak**, Jack L. Gallagher, and Denise M. Seliskar	*Getting to the root of salinized bayside farmland management*
3:15	**Dorina Frizzera** and John D'Agostino	*New Jersey coastal management & planning for Delaware Bay coastal hazards*
3:30pm	**Announcements and Closing Remarks** Grand Ballroom 1st Floor	

Featured Speakers

Dr. Jerry R. Schubel

President and CEO, Aquarium of the Pacific
Long Beach, CA
Keynote Speaker, Monday 12 January, 9:00 am
“You talkin' to me”

Dr. Jerry R. Schubel joined the Aquarium of the Pacific as president in June 2002. He also directs the Aquarium’s Marine Conservation Research Institute. He was dean and director of the State University of New York at Stony Brook’s Marine Sciences Research Center from 1974 to 1994 and for three of those years served as provost at the University. He is a distinguished service professor emeritus, and an endowed graduate fellowship has been created in his honor. He is an honorary Professor of East China University in Shanghai. In 2004 Schubel was selected as a National Associate of the National Academies. He has served on a number of National Research Council commissions, committees, and boards and chaired the Marine Board. He is past chair of the National Sea Grant Review Panel and has served on the National Science Foundation’s Education and Human Resources Advisory Council, and US EPA’s Science Advisory Board. He is a member of the Marine Board, chairs the St. Lawrence Seaway Committee for the National Research Council, chairs the Ocean Research and Resources Advisory Panel, and is a member of the Science Advisory Team for the California Ocean Protection Council. He is president emeritus of the New England Aquarium, where he was president and CEO from 1994 to 2001. He has written extensively for both scientific journals and for general audiences. He has published more than 200 scientific papers and is the author or editor of six books. A Michigan native, Schubel holds a Bachelor of Science degree with honors from Alma College, Alma, Michigan; a Masters degree from Harvard University; and a Ph.D. in oceanography from Johns Hopkins University in Baltimore, Maryland. He received an honorary doctorate from the Massachusetts Maritime Academy in 1998.

Peter Mitchell

Chairman and Chief Creative Officer
Salter Mitchell Inc. Marketing for Change
http://www.saltermitchell.com/
Featured Speaker- Lunch, Monday 12 January, Noon
"Homeland insecurity, pink flamingos and making your goal into a product that sells itself. What's new in social marketing and behavior change"

After 10 years as a reporter, Peter left The Wall Street Journal to work in Florida politics but quickly found himself serving as the founding marketing director of what became the "truth" anti-smoking campaign. Since then, Peter has designed behavior-changing campaigns for the Centers for Disease Control and Prevention, the Chesapeake Bay Program, the Environmental Protection Agency, and many more.

Andy Robinson

Marketing Consultant
Invited Speaker, Session 3; Monday 12 January, 1:00 pm
"Raising Money & Engaging Your Supporters in a Challenging Economy"

Andy Robinson *(www.andyrobinsononline.com)* provides training and consulting for nonprofits in fundraising, grant seeking, board development, marketing, earned income, planning, leadership development, and facilitation. Over the past twelve years, Andy has worked with organizations in 47 US states and Canada. He specializes in the needs of groups working for human rights, social justice, environmental conservation, historic preservation, and community development.

Andy is the author of four books, including *Grassroots Grants, Selling Social Change (Without Selling Out): Earned Income Strategies for Nonprofits, Big Gifts for Small Groups* and *Great Boards for Small Groups.* When he's not on the road, he lives in Plainfield, Vermont

Dr. Katherine E. Bunting-Howarth

Director, Divistion of Water Resources, DNREC
Session 9- Meeting the Challenges of Tomorrow's Estuary Panel, Tuesday 13 January 11:00 a.m.

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 wastewaster 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.

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.

Carol R. Collier, P.P., AICP

Executive Director, Delaware River Basin Commission
Session 9- Meeting the Challenges of Tomorrow's Estuary Panel, Tuesday 13 January 11:00

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.

Jon M. Capacasa, P.E.

Director, Water Protection Division, EPA Region III

Session 9- Meeting the Challenges of Tomorrow's Estuary Panel, Tuesday 13 January 11:00

Jon M. Capacasa has been the Director of the Water Protection Division for EPA Region III since 2003. In this capacity he directs the implementation and enforcement of the federal Clean Water Act and Safe Drinking Water Act for the five Mid-Atlantic States and the District of Columbia, and administers major funding programs including the State Revolving Loan Funds. He works to integrate over 20 Regional water programs with a focus on measureable environmental results, innovative partnerships, and sustainable solutions and presently serves as the Lead Regional Director for input to the national Water programs.

He previously served for nine years as the Deputy Director and Acting Director of the Chesapeake Bay Program Office and assisted in the formation of the new Bay Office. He has directed or supported unique collaborative networks and public/private partnerships: co-founded the Schuylkill Action Network for drinking water source protection, chaired the Potomac Watershed Source Water Partnership, served as the Agency lead for Anacostia Watershed Restoration Partnership since 1992, is a member of the Advisory Committee for the Trash Free Potomac effort, and has been a leading advocate for low impact development and green infrastructure approaches including sponsoring a National LID Conference. His Division also originated the Mid-Atlantic Green Highways Partnership, which promotes sustainable transportation measures nationwide. He works in close cooperation with the Federal Highway Administration and many public and private partners in this effort and has been honored by them.

Barbara A. Finazzo

Director, Division of Environmental Planning and Protection

Session 9- Meeting the Challenges of Tomorrow's Estuary Panel, Tuesday 13 January 11:00

As Director of the Division of Environmental Planning and Protection, Barbara A. Finazzo heads a staff of some 180 scientists, engineers and planners managing major regional programs that include air; surface, ground and drinking water; wetlands, oceans and estuaries; solid and hazardous waste; indoor air and radiation; and pollution prevention. Barbara previously served as Director of the Region's Environmental Science and Assessment Division, responsible for directing and managing a diverse staff of scientists, engineers and technicians engaged in ambient and source monitoring for all environmental media, the generation of data used in enforcement actions, development and implementation of data quality assurance polices and protocols, and the operation of the regional analytical testing laboratory. Barbara was selected for this position in 1996 when she became a member of the Senior Executive Service (SES). Barbara started her career with EPA in 1977, upon completion of her undergraduate studies, working in the microbiology section of the regional laboratory testing waters samples collected from the coastal beaches in the Region for bacteriological parameters. She also served as a regional Quality Assurance Officer, a Special Assistant to the Regional Administrator and as the Regional Program Manager for the Delaware Estuary Program. She became a Branch Chief responsible for Region's laboratory in 1991 managing a staff of analysts engaged in the analysis of air, water, soil and hazard waste samples. Barbara is a recipient of the EPA's Award for Managerial Excellence, the National Quality Assurance Manager of the Year and the 2002 SES Presidential Meritorious Rank Award. She received a B.S. from Wagner College in Staten Island, New York in Bacteriology and Public Health, and an M.S. in Environmental Science from Rutgers, The State University of New Jersey. Barbara is a former resident of Staten Island, New York and currently lives in Jackson, New Jersey.

Christopher J. Christie

Former States Attorney for the District of New Jersey

Invited Speaker Lunch, Tuesday 13 January, Noon- 1:00 pm

Christopher J. Christie was nominated by President George W. Bush to be the United States Attorney for the District of New Jersey on December 7, 2001. He was unanimously confirmed by the United States Senate on December 20, 2001, and sworn into office on January 17, 2002, by the Honorable Joel A. Pisano, U.S.D.J.

Mr. Christie graduated from the University of Delaware with a Bachelor of Arts degree in Political Science in 1984. He graduated from Seton Hall University School of Law with a Juris Doctor degree in 1987. Mr. Christie was admitted to the Bar of the State of New Jersey and the Bar of the United States District Court, District of New Jersey, in December 1987.

In 1987, Mr. Christie joined the law firm of Dughi, Hewit & Palatucci of Cranford, New Jersey. In 1993, Mr. Christie was named a partner in the firm. Mr. Christie specialized in securities law and appellate practice.

Mr. Christie recently completed seven years as the chief federal law enforcement officer in New Jersey. His Office included 142 attorneys with offices in Newark, Trenton and Camden.

Larry J. Silverman

Member, Washington, DC Bar

Lunch, Wednesday 14 January 12:15 p.m.

Larry J. Silverman has been working to reform environmental law since he graduated from University of Pennsylvania Law School in 1969 and joined Ralph Nader to work on clean air and. water legislation. Today he helps municipalities, conservation groups, small businesses, and state agencies improve strategic plans and advance their agendas in Washington, DC and state capitals. He teaches natural resource law and policy at Johns Hopkins University.

Poster Presentations

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

Shaun Bailey. ecodelaware.com.

Kelly Bemis, Jeremy Bell, Eric Requa, Lindsay Cappa, Steven Ordog, and **Kathryn Goddard-Doms.** Differences in parasite burden in two species of fish throughout the Darby Creek watershed.

Jill R. Brown and Douglas C. Miller. Changing distributions of the sandbuilder worm *Sabellaria vulgaris* : multiple survey methodology for intertidal habitats in Delaware Bay.

David Bushek, Susan Ford, Ximing Guo, Iris Burt, Brenda Landau, Coren Milbury, Emily Scarpa and Liusuo Zhang. Field and laboratory studies to understand disease resistance in the Delaware Bay oysters and response to climate.

David Bushek, Brian Marsh and Peter Van Veld. An assessment of a methoprene-containing insecticide on horseshoe crab (*Limulus polyphemus*) using proteomics and observations of embryonic development and survival.

Priscilla Cole and Danielle Kreeger. The Delaware Estuary Climate Ready Pilot: Vulnerability Assessment and adaptation Planning.

Stephen K. Davis, Lawrence D. Malizzi, Dennis Petrocelli and Doug Lashley. How prospective restoration or restoration up front could be used in the Delaware River watershed.

Aaron Gibson, Frank Marenghi, and Gulnihal Ozbay. Assessment of artificial oyster habitat for blue crab (*Callinectes sapidus*) population in Delaware's Inland Bays.

Matthew W. Gray, Danielle Kreeger and Angela Padeletti. Monitoring fitness of caged mussels (*Elliptio complanata*) to assess and prioritize streams for restoration in Southeastern Pennsylvania.

Simeon Hahn, Anthony Dvarskas, Jill Bodnar, Danielle Kreeger, Laura Whalen, Paul Racette, and Lance Butler. Regional restoration planning case study in the Delaware Estuary: Ecosystem valuation along an urban waterfront.

Dale B. Haidvogel, John Wilkin and Joseph Wang. Modeling circulation and transport pathways for oyster larvae in Delaware Bay.

Rebecca L Hays and William J. Ullman**.** Eulerian sampling of marsh effluents for the determination of nutrient exchange between the Murderkill Estuary and adjacent salt marshes.

Andrew Homsey. Development of hydro-geomorphic modifiers for Delaware's wetlands in the Delaware Estuary.

Richard J. Horwitz, Paul F. Overbeck**, David H. Keller,** and Shane M. Moser. American eel abundance: recent trends in southeastern Pennsylvania**.**

Young-Heon Jo and Richard T. Field. Estimation of water constituents in hyperspectral measurements in Rehoboth and Indian River Bay.

R. G. Najjar and M. E. Mann. Potential impact of changing sea level and streamflow on salinity of the upper Delaware Bay.

Danielle Kreeger, Jennifer Adkins, Laura Whalen and Priscilla Cole**.** A science-based regional restoration initiative in the Delaware Estuary.

Jerry Mead, Fredrick Scatena, Richard Horwitz, Yude Pan and Richard Birdsey. The growth potential of stream fishes as affected by changes in water temperature driven by climate and land-use in the Delaware River basin.

Douglas C. Miller and Stephen L. Gardiner. Acquisition, curation and digitization of a collection of Delaware Estuary benthic invertebrates from over fifty years ago.

Douglas C. Miller and Danielle Kreeger. Hard-bottom sampling methodology and characterization of a "sponge garden" in the Broadkill Slough as part of the Delaware Estuary Benthic Inventory.

Joshua Moody and David Bushek, Danielle Kreeger, Angela Padeletti and Laura Whalen. The Delaware Estuary Living Shoreline Initiative (DELSI).

Kristen Much, Lydia Civello, Sarah Wadsworth and Kathryn Goddard-Doms. Using macroinvertebrates and fish to assess the effects of Ithan Creek restoration through Radnor Valley Country Club, Delaware Co. PA.

Kenneth F. Najjar, Maggie Allio, J. Kent Barr, Pamela V'Combe, Michael Stokes, Drew Shaw, Alexis Melusky, Liz Feinberg and Khiet Luong. Water resources planning in estuary watersheds: the Upper Wissahickon Creek pilot study.

Diego A. Narváez, John M. Klinck, Eileen E. Hofmann, Eric N. Powell, Dennis Hedgecock. The effect of immigration on disease resistance in an oyster population: a numerical model study.

Ronald L. Ohrel, Jr, Lisa Tossey, Tamara Beeson, Elizabeth Boyle and Kimberly Doucette. Passport to personal action in Delaware Bay.

Angela T. Padeletti, Danielle A. Kreeger, Catherine M. Gatenby, Steven G. Hughes, Roger L. Thomas, Rosemary Malfi and Heidi Tucker-Wood. Musseling our way to restoration of the Delaware Estuary with the lightfoot mussel (*Elliptio complanata).*

Kelly A. Peeler, Jonathan H. Sharp, Yoana Voynova and Adam Pimenta. Primary production measurements along the Murderkill River.

S. Stephen Platt. Geologic sequestration: a proposed alternative to combat climate change.

Tatjana Prša, Nathaniel B. Weston and Melanie A. Vile. Changes in metabolic activity and community composition of sulfate reducing bacteria in tidal freshwater marsh soils in response to climate change and saltwater intrusion.

Nicole A. Raineault, Art C. Trembanis and Douglas C. Miller. Hard-bottom benthic habitats in Delaware Bay: Spatial and temporal dynamics.

Roger Reinhart. Stormwater infiltration practices and class V injection wells.

Alex Riter, Michael S. Kearney and Amy Jacobs. Assessment of Delaware Bay tidal wetland condition and change from 1993 to 2008.

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

Deanne C.T. Ross. Telling the story…Sharing the successes of the Schuylkill Watershed initiative grant and the Schuylkill Action Network.

Rebecca Rothweiler, Amy Jacobs, Mark Biddle, Gary Kreamer, and Stephen Williams Delaware wetlands conservation strategy**.**

David E. Russell, Danielle Kreeger, Angela Padeletti, Laura Whalen, Rene Searfoss, Jim Gouvas, Steven Donohue, Amie Howell, Charles Strobel, Henry A. Walker, Bartholomew Wilson, Douglas C. Miller and Irene Purdy. Survey of Delaware Estuary soft-bottom benthic communities: sampling design and 2008 field work.

Oluchi Ukaegbu and Gulnihal Ozbay**.** Investigating growth and cellular response of *Prorocentrum minimum* and *Karlodinium veneficum* across salinity gradient: application of molecular methods for species-specific quantification.

William J. Ullman, Mäella A. Dréan, Joseph R. Scudlark and Hassan Mirsajadi. Preliminary assessment of annual nutrient loads to the Murderkill Estuary, Delaware: watershed, wastewater, and atmospheric contributions.

Paula Zelanko, Erin McKinley, Jeffrey T.F. Ashley, Marcel Vasquez, Richard Horwitz and David Velinsky. Trophic relationships within Tinicum Marsh, Philadelphia, PA: Insights from the stable isotopes of carbon and nitrogen.

David Velinsky, Don Charles, Roger Thomas and Christopher Sommerfield. Tidal marshes in the Delaware Estuary: historical reconstruction of chemical loadings and ecosystem effects.

Laura Whalen and Danielle Kreeger. Native Vegetation Classification System (NVCS): On-the-ground application of NVCS and future plans.

Karen Johnson and Laura Whalen. Partnerships developed through the Corporate Environmental Stewardship Program (CESP).

Kelly Wolfe, Erika Farris and Maureen Nelson. It’s easy being blue.

Abstracts

Abstracts are listed alphabetically by last name of first author. Each presentation was assigned a unique reference number and was aligned with one of the session themes. The reference number, session affiliation, and presentation time and date are listed following the lead presenter's email address.

PRIORITIZING LAND PROTECTION TO PROTECT SOURCE WATER IN THE SCHUYLKILL RIVER. Jennifer Adkins, Executive Director, Partnership for the Delaware Estuary, Wilmington DE. **Session 5**, 3:30, 1/12/09 (presentation #121)

A source of drinking water for over 1.5 million people, the Schuylkill River is impacted by numerous threats to its water quality, including drainage from abandoned mines, runoff from agriculture, and discharges of wastewater. But with point sources largely under control and agriculture losing ground, the future of water quality in the Schuylkill lies in preventing and controlling stormwater runoff from residential development. For some communities in the watershed, prevention is no longer an option – urbanized landscapes require costly retrofits to provide even a fraction of the stormwater management value they once had. But in less developed areas, using scarce watershed protection dollars to institute protections and good stormwater management makes the best economic sense. Land prioritization efforts in the Schuylkill River Watershed seek to insure the best possible use of limited watershed protection funds by using sophisticated GIS modeling to identify the areas where protection will provide the greatest return for both source water quality and critical habitat.

The idea behind this project grew out of the Schuylkill Action Network Land Protection Collaborative – one of five work groups of public and private partners collaborating to address a specific threat to water quality in the Schuylkill. The project is implemented through a partnership between the Philadelphia Water Department (PWD), Natural Lands Trust (NLT), and Delaware Valley Regional Planning Commission (DVRPC), guided by other members of the Collaborative, including the Partnership for the Delaware Estuary and other conservation organizations, land trust, and local government representatives.

The project integrates NLT's SmartConservation® model, which identifies and ranks areas in the watershed most important to protect for ecological purposes, with a model developed by PWD that identifies those areas most important to conserve for drinking water purposes. Melded together, the models show high priority areas for both people and habitat. To add a sense of urgency toward protecting these lands, DVRPC developed a model that predicts the spatial location of future development by the year 2020. Overlaying this model onto the priority areas can assist municipalities, counties and land trusts with their land use planning and open space protection efforts. Because actively using the information derived from the model is so critical to its success, the project includes a significant outreach and implementation component that is ongoing, most recently with the completion of two municipal case studies looking at how to apply results locally.

SALTWATER FLUSHING BY FRESHWATER IN A LABORATORY BEACH. **Ali Abdollahi-Nasab[1,*]** , E-mail: abdollahi@temple.edu Hailong Li[1, 2] , Michel C. Boufadel[1] 1. Dept. of Civil and Environmental Engineering, Temple University, 1947 N. 12th Street, Philadelphia, PA 19122, USA 2.School of Environmental Studies & (MOE) Biogeology and Environmental Geology Lab, China University of Geosciences, Wuhan 430074, P. R. China. **Session 17**, 10:45, 1/14/09 (presentation #57)

In this study, freshwater was used to replace the initially uniformly-distributed saltwater (Case 1: 2.0 g/L, and Case 2: 34.0 g/L.) in a laboratory beach with typical slope under falling-concentration and constant-pressure boundary conditions. The observed salinity and pressure data were satisfactorily simulated using the MARUN model. We observed significant pressure variations with time in the onshore beach bottom for high salinity case (Case 2). Numerical simulation indicated that the seaward propagation of the freshwater front resulted in the rising of the watertable and the dropping of the density of the saturated pore water. The former tends to increase the pressure and the latter, to decrease. Their joint action formed the peak of the pressure versus time curves. Due to buoyancy effect, the freshwater front moved fastest at the water table and slowed as depth increased, which lead to considerable vertical velocity. Moreover, it is shown that the seaward groundwater discharge was predominantly located at the intersection of the water table and beach face. Finally, the effect of salinity on the water table shape and also on the fresh water flowing through the domain is discussed.

EFFECTS OF WOODY DEBRIS, MICROTOPOGRAPHY, AND ORGANIC MATTER AMENDMENTS ON THE BIOTIC COMMUNITY OF CONSTRUCTED WETLANDS AND THEIR APPLICATIONS FOR WETLAND MITIGATION. Amy Alsfeld-Nazdrowicz, JCM Environmental, Inc. 100 Lake Drive, Suite 3, Newark, DE 19702, amy@jcmenv.com; and Jacob J. Bowman, Department of Entomology and Wildlife Ecology, University of Delaware, Newark DE 19716; and Amy Jacobs, Wetlands and Subaqueous Lands Section, Delaware Department of Natural Resources and Environmental Control, 89 Kings Highway, Dover DE 19901. **Session 10**, 2:00, 1/13/09 (presentation #22)

To increase wetland acreage and biodiversity, Delaware agencies constructed >220 depressional wetlands between 1989 and 2002. During construction, agencies included amendments thought to increase wetland biodiversity [coarse woody debris (CWD), microtopography, and organic matter]. Because the efficacy of amendments was unknown, we investigated their effects on the frog, bird, aquatic macroinvertebrate, and vegetative communities of 20 standardized constructed wetlands in 2004 through 2006. CWD increased insect biomass ($P = 0.046$), total plant richness ($P = 0.038$), and obligate wetland plant richness ($P = 0.015$). Additionally, bird abundance ($P = 0.045$; $r^2 = 0.10$), insect richness ($P = 0.010$; $r^2 = 0.16$), and insect biomass ($P = 0.023$; $r^2 = 0.13$) increased with CWD volume. Microtopography increased total plant richness ($P = 0.035$), facultative wetland plant richness ($P = 0.034$), and bird richness ($P = 0.023$). Although organic matter amendments did not result in greater percent soil organic matter, they increased insect richness ($P = 0.020$), insect diversity ($P = 0.033$), and macroinvertebrate biomass ($P = 0.024$).

Bird richness ($P \leq 0.001$; $r^2 = 0.34$), bird abundance ($P = 0.008$; $r^2 = 0.17$), and total ($P = 0.027$; $r^2 = 0.12$), native ($P = 0.036$; $r^2 = 0.11$), and FACW ($P = 0.001$; $r^2 = 0.24$) plant richness increased with percent soil organic matter. Growing concern over wetland loss within the Delaware Estuary has resulted in increased efforts to re-establish wetland habitat through restoration, creation, and mitigation. To optimize wetland biodiversity, future constructed wetlands should contain CWD, microtopography, and organic matter amendments. The results from this study can be applied to increase the success of compensatory wetland mitigation projects and examples of their application in mitigation wetlands will be presented.

MEASURING THE RECREATIONAL USE VALUE OF MIGRATORY SHOREBIRDS IN THE DELAWARE ESTUARY: **Kelley H. Appleman,** College of Marine and Earth Studies, University of Delaware, Newark, DE, kapplema@udel.edu; Peter Edwards, College of Marine and Earth Studies, University of Delaware, Newark, DE, pedwards@udel.edu. **Session 18,** 2:45, 1/14/09 (presentation #30)

Each spring hundreds of thousands of migratory shorebirds visit the Delaware Bay on their journey from South America to Canada's Hudson Bay. Red knots, sanderlings, ruddy turnstones, semi-palmated sandpipers, and other shorebirds stop to feed on horseshoe crab eggs in the shallow waters of the Bay and its tributaries. The Estuary is a vital staging area for the survival of these unique birds.

The horseshoe crab is considered a 'multiple-use' resource with a diverse group of stakeholders (fishermen, medical research and shorebirds), and the decreasing population trends in the region have raised concerns that the stock size is not sufficient enough to satisfy the needs these competing interests. There exists market data on the value of the horseshoe crab to fishermen and the bio-medical industry, but there is a lack of information or under representation of the value of shorebirds, and in particular, the recreational use values associated with birding on the Delaware Bay during the annual spring migration. In order to meet stakeholder needs today and in the future and to evaluate how policy intervention leads to economic benefits and costs for all parties involved, understanding the magnitude of these trade-offs is critical in determining how the Estuary's scarce resources should be allocated.

The main objective of our research is to use economic analysis to measure the value of shorebirds in the Delaware Estuary. The current study design combines stated preference techniques that are used primarily to measure non-use values, and revealed preference techniques that capture the demand for trips to a recreational site or sites. During peak migration from early May to mid June, thousands of people visit the area to witness this shorebird/horseshoe crab phenomenon. To gather our data, we administer a survey to visiting birdwatchers by on-site intercept at three main birding locations along the Delaware Bay. With the survey data, we estimate a single-day trip model that provides the value of a household trip to view shorebirds during the migration season. We also include a contingent behavior or stated preference component to see if these estimates are consistent with the per-trip value from the recreational demand model. Our results will be useful in determining value in damage assessments, priority setting for state and federal agencies that manage natural resources, benefit-cost analyses, and for economic analysis of horseshoe crab restrictions.

BIOACCUMULATION OF PCBs AND PBDEs WITHIN A TIDAL FRESHWATER MARSH, Jeffrey T.F. Ashley, School of Science and Health, Philadelphia University, Philadelphia, PA 19144, ashleyj@philau.edu, Marcel Vasquez, School of Science and Health, Philadelphia University, Philadelphia, PA 19144, Heather Stapleton, Nicolas School of the Environment and Earth Sciences, Duke University, Durham, NC 27712, Mike Schafer, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103, Richard Horwitz, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103, and David Velinsky, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103. **Session 8**, 9:30, 1/13/09 (presentation #24)

The John Heinz National Wildlife Refuge (NWR) at Tinicum Marsh contains one of the last few tidal freshwater marsh communities along the Pennsylvania side of the Delaware River Estuary. Biota and sediment were collected from two sites within the NWR. One hundred and ten PCB congeners and 40 PBDE congeners were quantified. Isotopic (^{13}C and ^{15}N) analysis was used to reconstruct the trophic levels existing within this dynamic marsh system. For t-PCBs and t-PBDEs, positive correlations were observed between $\delta^{13}N$ values and concentration suggesting that as organisms placed higher on the trophic hierarchy, contaminant body burdens were higher. Predator prey ratios (PPRs) were calculated for Tinicum Marsh channel catfish and white perch using both amphipods and small prey fish as the "prey items". PPRs from this study ranged from 2.5 to 5.2 suggesting biomagnifications. In an earlier study with the nearby channel system of the Delaware River Estuary, PPRs were significantly lower. This highlights the importance of marsh environments as areas for accumulation and subsequent magnification of PCBs and PBDEs. Moreover, using $\delta^{15}N$ values for a surrogate for trophic position, PDE99/PDE100 concentrations were weakly but negatively correlated with trophic level, also suggesting that there is evidence that debromination pathways within Tinicum Marsh species exist. This study was the first to document PBDE concentrations within biota within the "fringe" marsh environment of the Delaware River Estuary. These data will be valuable in not only assisting further bioaccumation/trophic transfer studies but will serve as benchmarks to which future PBDEs concentrations will be compared to.

THE DELAWARE BAY SHELL PLANTING PROGRAM AFTER 3 YEARS: OYSTER RECRUITMENT ENHANCEMENT AND CARBONATE BUDGET.

Kathryn Ashton-Alcox (kathryn@hsrl.rutgers.edu)[1], Eric Powell[1], Jason Hearon[2], Russell Babb[2], Gulnihal Ozbay[3], Richard Cole[4] 1:Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349, USA 2:New Jersey Department of Environmental Protection, Bureau of Shellfisheries, Port Norris, NJ 08349, USA 3:Delaware State University, Department of Agriculture, Dover, DE 19901-2277, USA 4:Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife, Dover, DE 19901. **Session 2**, 1:15, 1/12/08 (presentation #11)

Three consecutive years of planting shell on the oyster beds of the Delaware Bay have proven very successful in two of the primary goals of any oyster restoration program: first, in enhancing recruitment of young oysters (spat) by supplying clean shell at the right time in carefully chosen places and second by the stabilization of the shell structure in those areas. Recruitment success was monitored each year in the fall using divers on the current year plantings for the smaller spat and commercial dredges for previous years' plantings when the oysters have grown. These methods were chosen after a variety of dredge and diver efficiency experiments.

In 2005 and 2006, the average ratios of spat on planted shell to spat on native cultch from the same area were 3.71 and 7.42. By contrast, in 2007, planted material outperformed native shell by a factor of only 1.35 over all sites. The difference is attributed to the higher overall spat set in 2007 and the fact that the clean shell had been planted over 3 months prior to the large, late set and thus had become more like native shell. Average numbers of spat per bushel were higher in New Jersey for both planted and native shell in 2005 and 2006 but higher in Delaware in 2007. Planted shell in New Jersey in 2005, 2006, and 2007 accounted for 12%, 22%, and 3% of total recruitment in those years. The area of the planted sites for the 3 years was 0.6%, 1.2%, and 1.1% of the New Jersey oyster bed area.

Based on longterm data for the Delaware Bay, survival of spat into yearlings averages 35%. The survival of the spat from the 2006 plants at the end of 2007 averaged about 50% over all sites. In addition to the yearlings contributed, planted shell continues to catch spat in the following year although in numbers closer to the set on native shell. Yields projected for the next 3 years from these shell plantings total 844,227 bushels using 50th percentile mortality rates and 259 oysters per bushel.

Shell is not a permanent resource. The Delaware Bay oyster beds have experienced a period of declining surficial shell content as the loss of carbonate exceeds the addition from the reduced populations present. From 2005 to 2007, planted areas of the Bay have shown a net increase in shell, putting these beds back into carbonate balance.

THE ROLE OF A SALT MARSH IN PROCESSING ESTUARINE CARBON AND NITROGEN: A COMPLETE SPECIES AND ISOTOPE SEASONAL BALANCE.
Anthony K. Aufdenkampe, Stroud Water Research Center, 970 Spencer Road, Avondale, PA 19311, aufdenkampe@stroudcenter.org; **William J. Ullman**, Oceanography Program, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958; **Rebecca L. Hays**, Oceanography Program, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958. **Session 17**, 11:00 am, 1/14/09 (presentation #65)

An important hole in our understanding of the controls on oxygen levels in a salt marsh dominated estuary is whether salt marshes release or remove carbon and nutrient species associated with oxygen demand from estuarine waters during tidal exchange. To determine whether salt marshes are a source or sink of nutrient species contributing to the oxygen demand of the Murderkill River Estuary (Kent County, Delaware), we measured water, salt, and nutrient (N, P, C, Si) balances in and out of a constrained section of polyhaline salt-marsh at Webb's Slough near South Bowers during five 40-hour periods to capture different seasons. Particular attention was made to capture all the major nitrogen species: nitrate, nitrite, ammonium, dissolved organic nitrogen (DON), fine particulate organic nitrogen (FPON, 0.7-63 µm) and coarse particulate organic nitrogen (CPON, 63-2000 µm). Stable nitrogen isotope ratios ($\delta^{15}N$) were measured on all of these species, except for DON, in order to assess the sources of these species and processes associated with sinks.

Preliminary data analyses suggest that organic nitrogen species dominate fluxes, and that the study salt marsh may take up algal nitrogen during the growing season and release it during colder seasons.

This research is part of a larger study of the causes of the anoxic "dead zone" that occurs every August near the mouth of the Murderkill river. The results of this study will be used to directly verify and calibrate the assumptions of the proposed hydrodynamic/water quality model for the Murderkill River Estuary. The integration of research by academic scientists from various disciplines with funding and oversight by local and state authorities has proven to be a very effective means to get the information required to "do the right thing". As such, it is a model that will likely play an increasingly important role in "Planning Tomorrow's Delaware Estuary."

ECODELAWARE.COM. **Shaun Bailey**, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE, 19801. **Joint Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #124)

The Partnership for the Delaware Estuary launched ecoDelaware.com in April of 2008. The mission of this venture is to increase awareness, appreciation and, ultimately, environmental stewardship for the Delaware Estuary.

EcoDelaware.com has experienced success by providing an online resource full of ecotourism opportunities people can experience in Delaware. Visitors are able to search a database of outdoor events and destinations. They can also read several ecotours developed by the PDE to highlight key areas and activities in the Delaware Estuary.

Since its launch, more than 5,600 people from 40 countries have browsed the new website, 15 percent of which have become repeat visitors.

So far, the three most-popular destinations on ecoDelaware.com include Carousel Farm County Park, Valley Garden Park, and Delcastle Recreation Area, all of which are located in suburban Wilmington. The three most-popular events were Pike Creek Community Day in Wilmington, the Horseshoe Crab and Shorebird Festival of Milton, and the Broadkill River Canoe and Kayak Race of Milton.

A similar website is currently under development in southern New Jersey, and related sites promoting ecotourism in southeastern Pennsylvania are already available to the public. Therefore, ecoDelaware.com is helping to fill a critical niche for the region while providing a new tool that connects residents and travelers with places of ecological interest in the First State.

EcoDelaware.com has been made possible thanks to a $10,000 grant provided by the Delaware Office of Tourism in June of 2007. The PDE worked with Talisman Interactive of Philadelphia to make this online resource a reality.

The PDE hopes to improve upon this website in the future by adding certified "green" hotels, guest-authored ecotours, and advertising space, among other tactics.

For more information and to ensure your Delaware-based destination or event is listed properly, please contact Shaun Bailey at (302) 655-4990, extension 113, or SBailey@DelawareEstuary.org.

THANK YOU DELAWARE BAY – DEVELOPING AN ESTUARY AWARENESS CAMPAIGN. **Shaun Bailey**[1], Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE, 19801; **Kimberly B. Cole***, Delaware National Estuarine Research Reserve, 818 Kitts Hummock Road, Dover, DE 19901, Kimberly.cole@state.de.us; **Sarah W. Cooksey**, Delaware Coastal Programs, 89 Kings Highway, Dover, DE 19901, **Kate Hackett**, The Nature Conservancy, 703 Chestnut Street, Milton, DE 19968; **Debbie Heaton**, The Nature Conservancy, 100 West 10th Street, Suite 1107, Wilmington, DE 19801, **Jennifer Holmes**, Delaware National Estuarine Research Reserve, 818 Kitts Hummock Road, Dover, DE 19901,; **Melanie Rapp**, Delaware Department of Natural Resources and Environmental Control, 89 Kings Highway, Dover, DE 19901, **Lisa Wool**[1]
Session 11, 2pm, 1/13/09 (presentation #85)

Delaware Bay is an exceptional estuary comprised of unique natural and human-made resources. This rich estuarine ecosystem is fundamental to the economic well being of the region, supporting industry, fishing, transportation, natural resources, and recreation and is home to millions of people. The challenge for many organizations has been to effectively educate people about how the Delaware estuary benefits both people and nature in a way that encourages them change their behavior.

Thank You Delaware Bay, is a baywide public awareness campaign inspired by California's Thank You Ocean campaign, and is organized by the Delaware Coastal Programs, Delaware National Estuarine Research Reserve, The Nature Conservancy and the Partnership for the Delaware Estuary. With a $75,000 budget from a federal grant, the program team was challenged to effectively develop and communicate messages with limited funds.

The key to developing a good communication plan is to understand and explore the goals, target audiences, and messages in a step-by-step manner. Oftentimes efforts fail due to: Messages not carefully crafted; Messages not field-tested on the target audience; There are too many messages; and these messages tend to be too complex. The goal for *Thank You Delaware Bay* campaign is not to develop advertisements or brochures, but to foster awareness, change attitudes, or increase factual knowledge of natural resources and outdoor recreation opportunities by showing the bay's connection to the things that are important to us in our daily lives – jobs, recreation, food, and a healthy environment.

The TYDB campaign was launched in February 2008. Delawareans throughout the state were targeted with a comprehensive outreach and education campaign that included paid and earned media and outreach at events. Phase I of the campaign included the development of a logo and slogan that are used in print, radio and television advertisements, promotional items and exhibit/display material to promote bay stewardship and direct people to the *Thank You Delaware Bay* website, www.tydb.org, which serves as the comprehensive "portal" for Delaware Bay information and provides ways for people to learn more and "thank the bay", or take action towards bay stewardship. Phase II of the campaign will focus on refining messages and using the most cost effective approach increase outreach to audiences as well as developing new partnerships to maximize outreach and education efforts on both sides of the Delaware Bay and coordinate to measure "actions" that were initiated or implemented as a result of the campaign.

CAN PLANT & MICROBIAL BIOCHEMISTRY CONTRIBUTE TO UNDERSTANDING OF INVASION ECOLOGY? **Gurdeep Bains1,2,** Thimmaraju Rudrappa1,2, Thomas E. Hanson2,3 and Harsh P. Bais1,2 1Department of Plant and Soil Science, University of Delaware, Newark, DE 19716; 2Delaware Biotechnology Institute,15 Innovation Way, Newark, DE 19711;bains@dbi.udel.edu 3College of Marine and Earth Studies, University of Delaware, Newark, DE 19717. **Session 2**, 2:00pm, 1/12/08 (presentation #27)

A number of hypotheses have been suggested to explain why invasive exotic plants dramatically increase their abundance upon transport to a new range. The novel weapons hypothesis argues that rhizo-secreted phytotoxins are more effective against naïve, susceptible competitors in their new range. *Phragmites australis*, a noxious weed in North America (NA), exudes the common phenolic gallic acid to restrict the growth of native plants, but the pathway for gallic acid production in this system requires further elucidation. Here, we show that the exotic *P. australis* synthesizes polymeric gallotannin that can be acted upon by native plant and microbial community biochemistry to release gallic acid. Our results indicate that tannase activity produced by native NA plants and microbes detonates a gallotannin "rhizospheric time bomb" that can explain the phytotoxic persistence of gallic acid in the rhizosphere after *P. australis* biomass has been removed.

DIFFERENCES IN PARASITE BURDEN IN TWO SPECIES OF FISH THROUGHOUT THE DARBY CREEK WATERSHED.

Kelly Bemis, Department of Biology, Muhlenberg College, Allentown, PA. 18101; **Jeremy Bell,** Department of Biology, College of the Ozarks, Point Lookout, MO. 65726, and **Eric Requa, Lindsay Cappa, Steven Ordog, and Kathryn Goddard-Doms*.** Department of Biology, Ursinus College, Collegeville, PA. 19426 kgoddard-doms@ursinus.edu, **Joint Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #52)

We studied the abundance of parasites in blacknose dace (*Rhinichthys atratulus* n = 55 at each site) at five sites and mummichogs (*Fundulus heteroclitus* n= 55) at two sites throughout the Darby Creek watershed, hypothesizing that fish living in poor quality habitats expend more metabolic energy to survive, and thus would be less able to combat parasites than fish in less impaired waters.

The fish were completely dissected and examined for parasites by eye and at 400x under the microscope. The most common parasites found were the black spot, white grub, yellow grub, two species of nematode and an acanthocephalan. Separate chi-square tests were performed for each species of parasite in each fish species to test whether there were significant differences in parasite abundance between geographical sites.

In the black nose dace, we found that black spot, white grub, nematodes, yellow grub and acanthocephalan abundance differed significantly ($p < 0.05$) among the geographical sites. The abundances of the parasites in the mummichog samples were also significantly different among stream sites ($p< 0.05$) with the exception of the yellow grub. The data for parasites in the black nose dace were reanalyzed (chi square analysis) to examine whether parasites were more abundant in areas with greater stream impairment using high human population density as a measure of stream impairment. Further, the data was reanalyzed to determine whether there were higher parasite numbers at sites close to the John Heinz National Wildlife Refuge (JHNWR) due to the availability of bird hosts in the refuge needed for the parasites to complete their life cycles. For two parasites there appear to be significant differences in abundance: the nematodes were much more found frequently in fish from sites with a lower human population density which were also far from the refuge, although these parasites also require the bird hosts. Black spot was significantly more abundant at fish from sites close to the refuge which also have high density human populations. The other parasite species did not differ in abundance according to human population density or proximity to JHNWR. Overall, only one parasite, the black spot, was more abundant in areas of high human population density. Both water quality and host availability may affect the abundance of the black spot parasite.

REPLACING INCISED HEADWATER CHANNELS AND FAILING STORMWATER INFRASTRUCTURE WITH REGENERATIVE STORMWATER CONVEYANCE. **Joe Berg**[1] and Keith Underwood[2]

[1] Biohabitats, 2081 Clipper Park Road, Baltimore, MD 21211 jberg@biohabitats.com
[2] Underwood & Associates, 1753 Ebling Trail, Annapolis, MD 21401 **Session 16**, 11:30, 1/14/08 (presentation #7)

Stormwater conveyance practices are grounded in industrial design that neglects integration with system processes, economics, and aesthetics. As a result, the greater volume of runoff from impervious surfaces, coupled with smooth and hardened conveyance systems (e.g., pipes and trapezoidal concrete channels), magnifies and transfers energies to the discharge or outfall. Conventional stormwater outfalls cause erosion, conveyance structures fail, stream channels are degraded, in-stream sedimentation increases the influence of localized erosion upstream and downstream of the outfall, and an increasing spiral of degradation results. Local governments are forced to spend scare public funds on remediation measures. Alternatively, the technique of using stream restoration techniques to create a dependable open channel conveyance with pools and riffle-weir grade controls is a regenerative design since the use of these elements result in a system of physical features, chemical processes, and biological mechanisms that can have dramatic positive feedback effects on the ecology of a drainage area. This approach results in the delivery of low energy storm water discharge, potential volume loss through infiltration and seepage, increased temporary water storage, restoration of lowered groundwater, increases in vernal pool wetland area, improved water quality treatment, improvements in local micro-habitat diversity, and provides a significant aesthetic value. These projects are generally a win-win-win arrangement, as conventional construction practices and materials are more expensive, conventional conveyance provides no environmental benefits and are more difficult to permit, and people generally enjoy the aesthetics associated with a well vegetated channel form when compared to the conventional conveyance alternative.

IMPROVEMENTS TO NATURAL CHANNEL DESIGN IN URBAN ESTUARINE WATERSHEDS. **Joe Berg**, Biohabitats, Inc., 2081 Clipper Park Road, Baltimore, MD 21211 jberg@biohabitats.com**. Session 7,** 10:30 am, 1/13/08 (presentation #8)

The status quo stream restoration approach focuses on sizing a stream channel to convey a range of flows from seasonal low base flow through the 'channel-forming' bankfull discharge. In addition, the restoration community focuses on sediment competence and the need for a channel to be in equilibrium with its sediment supply (sediment in = sediment out). While we understand and value the connection between the stream and its floodplain, the two are often disconnected as a result of channel incision. In particular, in urban drainage systems, channels are often deeply incised and over-wide. As a result, they may contain and convey much larger storm flows (e.g., 10 yr and greater). Such channels are not connected to their floodplain in a functional manner, and can't really be in equilibrium with their sediment load in the true sense of equilibrium. If we recognize these conditions and seek to restore the stream, we really need to restore the stream's connection to its floodplain. While such an effort is not practical in all areas due to historic floodplain development, many urban floodplains are undeveloped and set-aside in drainage easements, riparian parks, etc., which allow the effective reconnection of the floodplain if we are bold enough to propose and design such a project. In addition to reducing in-channel energies, channel erosion, and sediment supply, and sediment transport as a result of floodplain re-connection, other benefits can include improvements in stream habitat, rehydration of historic floodplain wetlands and habitat , incremental storm flow quantity and quality improvements, and seasonal base flow maintenance. Furthermore, if we credit the theories of elevated nutrient supply being made available through stream bank erosion of legacy sediments, reconnecting urban streams to their floodplains in a meaningful way can have significant positive effects on the project's watershed as well as the larger Delaware Bay.

RED STREAMS BLUE: A SUBWATERSHED APPROACH TO RESTORING THE ESTUARY. **Kathy Bergmann** Red Streams Blue Coordinator, Brandywine Valley Association, 1760 Unionville-Wawaset Road, West Chester, PA 19382, katberg17@verizon.net; Jane Fava, Red Streams Blue Coordinator, Brandywine Valley Association, 1760 Unionville-Wawaset Road, West Chester, PA 19382, janefava@verizon.net; Aaron S. Clauser, Ph.D., CPESC, Senior Environmental Scientist, RETTEW Associates, Inc.,Natural Sciences Group, 950 East Main Street, Suite 220, Schuylkilll Haven, PA 17972, aclauser@rettew.com. **Session 7**, 10:00am, 1/13/08. (presentation #9)

For the past six decades the Brandywine Valley Association (BVA) has been instrumental in implementing programs, educating residents and introducing technologies to improve water quality in the Brandywine Creek. Even with this effort, there are still 127 stream miles, about 21% of the Watershed, considered impaired by the Pennsylvania Department of Environmental Protection (DEP). These impaired streams are shown on our maps in red while the unimpaired streams are mapped in blue.

Recently, BVA has focused on improving the water quality and habitat of its impaired streams, the BVA initiated a program entitled Red Streams Blue in 2006. The goal of this program is to ensure that all streams within the Brandywine Creek Watershed meet water quality standards. To accomplish this goal impaired sub watersheds are completely assessed to identify the impacted reaches and the reasons for their impairment. From the assessment, a comprehensive restoration plan is developed showing the corrective actions necessary for water quality improvement. Finally, projects are selected and implemented. During and after the implementation phase the water quality is monitored for improvements.

Here we present a case study on the assessment, restoration planning and initial implementation stages for Radley Run Watershed. By prioritizing implementation projects of varying scale, strategic partners are able to participate at the local level. A community of partners implements identified projects ranging from rain barrels on their homes to larger on the ground restoration projects. With this watershed approach and a whole tool box of BMP's, we hope improve the water quality and make the red stream blue.

STREAMBANK EROSION AND DEPOSITION ASSESSMENT PROTOCOL: A TOOL FOR MONITORING WATERSHED RESTORATION PROJECTS. **Kathy Bergmann,** Red Streams Blue Coordinator, Brandywine Valley Association, 1760 Unionville-Wawaset Road, West Chester, PA 19382, katberg17@verizon.net; Jane Fava*, Red Streams Blue Coordinator, Brandywine Valley Association, 1760 Unionville-Wawaset Road, West Chester, PA 19382, janefava@verizon.net; Aaron S. Clauser, Ph.D., CPESC, Senior Environmental Scientist, RETTEW Associates, Inc.,Natural Sciences Group, 950 East Main Street, Suite 220, Schuylkilll Haven, PA 17972, aclauser@rettew.com**.** **Session 12**, 4:15pm, 1/13/08. (presentation #10)

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Brandywine Valley Association and RETTEW Associates, Inc. have prepared a bank erosion and deposition assessment protocol for monitoring Radley Run Watershed in Chester County. Volunteer monitoring of rate of change using a simple method allows us to evaluate the stability of the streambanks and gives us an indication of the effectiveness of restoration BMP's. Currently we are conducting background monitoring for stormwater BMP's that will be put in place to meet the sediment TMDL's in the Christina Basin. Here we outline the methodology for implementing this protocol in watersheds throughout the region. This methodology utilizes bank pins to allow for semi-quantitative measurement of bank erosion rates in a straight-forward manner. Documenting the rate of erosion and deposition, the stability of various stream reaches (stream sections) may be comparatively analyzed. Tracking rates of erosion and deposition before and after stream restoration projects could also provide a tool to measure sediment reductions within a stream reaches.

GROUNDWATER FLOW FOR TIDE INDUCED ALASKA PRINCE WILLIAM SOUND BEACH. **Adane M. Bobo *,** Michel C. Boufadel, Hailong Li, and Ali A. Nasab *:Graduate Research Assistance, Dept. of Civil and Environmental Engineering, Temple University, 1947 N. 12th Street, Philadelphia, PA 19122, **adanebobo@temple.edu**, Phone:(215) 204-6394; Fax: (215) 204-4696. **Session 14**, 9:45am, 1/14/08 (presentation #56)

In this study, we report water level measurements of a beach on Eleanor Island in Prince William Sound Alaska and we model the measurements using SUTRA (a Model for Saturated-Unsaturated Variable-Density Ground-water Solute Transport). In this beach the observed data indicated that groundwater table fluctuates with tide and this fluctuation exponentially decreased when one goes away from sea.

The simulation results of groundwater fluctuation for five wells are compared with the field data and the results agree with the observed data reasonably well. It also indicates that water infiltrates vertically into the beach face during the rising tide and seeps essentially horizontally through the beach during the ebbing tide. The result also shows that the maximum velocity always occurs at the intersection of the watertable and the beach surface. Porosity and hydraulic conductivity are exponentially decreased with depth in coastal environment. The model results are very sensitive for small hydraulic conductivity change. This paper also generated a new Kozeny-constant value of 1.06 rather than commonly used value of 5 for tidally influenced beach.

THE IMPORTANCE OF HORSESHOE CRABS IN THE ECOLOGY OF DELAWARE BAY: MORE THAN JUST BIRD FOOD? **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, Cook Campus, Rutgers University, New Brunswick, NJ 08901. **Session 4, 3:30, 1/12/09** (presentation #84)

Horseshoe crabs (*Limulus polyphemus*) in the Delaware estuary are economically important in the production of *Limulus* amoebocyte lysate (LAL) and as bait in the eel and whelk fisheries. The nutritional value of horseshoe crab eggs for migratory shorebirds, such as Red Knots and Ruddy Turnstones, has been supported by numerous scientific studies, and this is the most frequently cited argument for the importance of horseshoe crabs to the ecosystem. To broaden the appreciation of the ecological role of horseshoe crabs in the Delaware estuary, we review published and unpublished studies examining the importance of horseshoe crabs in the food web. Adult horseshoe crabs are dietary generalists, and they may be prominent bivalve predators in some locations. As "biological bulldozers," adult crabs are important in reworking the sediments on spawning beaches and adjacent intertidal sand flats. Animals that are stranded on the beaches by wave action during spawning are vulnerable to predation by large gulls, but much less is known about the causes of mortality among subtidal adults. Based on work in the Chesapeake Bay area, adult *Limulus* may be important as food for the endangered loggerhead turtle in Delaware Bay, but this requires further confirmation. Horseshoe crab eggs that are deposited on sandy beaches cause a seasonal pulsing of organic carbon within the sediments, which may be linked to meiofaunal production. Hermit crabs and surf zone fishes such as killifish and Atlantic silversides consume *Limulus* larvae and small juveniles, thus providing a linkage to higher trophic levels. However, virtually nothing is known about predator-prey relationships involving older juveniles. The significance of *Limulus* eggs as shorebird food, combined with these other trophic relationships, places this species in a prominent position within the food web of Delaware Bay.

CONTINGENCY PLANNING FOR OIL SPILLS IN THE DELAWARE ESTUARY.
Michel C. Boufadel*, Ali Abollahi Nasab, Abhinav Saxena, Youness Sharifi, and Hailong Li *: Professor and Chair, Dept. of Civil and Environmental Engineering,Temple University, 1947 N. 12th Street, Philadelphia, PA 19122, boufadel@temple.edu, Phone:(215) 204-7871; Fax: (215) 204-4696.
Session 18, 2:30pm, 1/14/09 (presentation #128)

We present new data of the Exxon Valdez Oil spill obtained in our field studies in the summers of 2007 and 2008, and use the findings to discuss past and potential oil spills in the Delaware River and Estuaries. Passing by the Athos oil spill in 2004, we explore the various factors affecting the spread of a potential spills and the optimal responses at various stages of the spill to minimize the adverse environmental effects. We focus in particular on bioremediation of oil trapped within the sediment, and we propose techniques that account for variation of salinity and water level due to tide. We used advanced numerical models to explore the spill scenarios and the various responses, and we present the results using numerical simulations (movies).

DREDGE SEDIMENTS-UPGRADED AND SUSTAINABLE OPERATIONS FOR DELAWARE BASIN MAINTENANCE DREDGING – LOGAN SITE. **Gary R. Brown**, P.E., President of RT Environmental Services, Inc. (RT). **Session 18**, 1:45pm, 1/14/09 (presentation #21)

The American Atlantic Site, since the late 1800's, has served as a location for placement of dredge spoils removed from the rivers and estuary of the Delaware Basin. Historic methods of managing dredge spoils involve placing them on land, or filling in low areas, and, eventually, raising dikes, so that more materials could be received. This Logan Township, New Jersey Site has been re-evaluated for long-term sustainability, to serve the Maritime community long-term, as it is uniquely situated and can be managed to meet regional and short-term and long-term environmental goals.

This presentation will focus on site remedial investigation activities, planned expansion and future use of Confined Disposal Facilities (CDF), continued operation of Whites Basin, a sheltered area within which dredge scowls can discharge material efficiently, without significant water quality impact, and a number of other important issues including:

- The role that the site can play in removing PCBs from the river and estuary environment.

- The role that the site can play in properly managing "environmental dredge" materials, so that materials can be treated so that they are of no further concern to the environment.

- The role that the site can play in promoting long-term site and dredge material reuse sustainability, by establishing and building a market for the manufacture and regional reuse of Pozzolanic Dredge Material (PDM), a manufactured soil.

As "close-in" urban quarry material reserves are depleted, and, as energy costs rise, use of PDM becomes more attractive and cost effective. Use of CDFs has largely ceased in the Northern New Jersey/New York market, in favor of maximum recycle of dredge materials, following treatment with Portland cement.

As the Logan Township Site is several thousand acres in size, market studies have been completed, to help guide the future of the operations at the site. Appropriate regulatory agencies have been invited to provide input, along with Maritime community to assure that the Logan Site provides local, and cost effective yet environmentally sound management of dredge materials, as the region and its Ports move forward, to compete in the 21^{st} Century.

The author, Gary R. Brown, P.E., President of RT Environmental Services, Inc. (RT) has completed evaluation work resulting in formulation of short and long term plans for the site, which will be shared during this presentation.

CHANGING DISTRIBUTIONS OF THE SANDBUILDER WORM *SABELLARIA VULGARIS* : MULTIPLE SURVEY METHODOLOGY FOR INTERTIDAL HABITATS IN DELAWARE BAY. **Jill R. Brown,** College of Marine and Earth Studies, University of Delaware, 700 Pilottown Rd, Lewes, DE 19958, jrbrown@udel.edu; and **Douglas C. Miller**, College of Marine and Earth Studies, University of Delaware, 700 Pilottown Rd, Lewes, DE 19958. **Session 6**, 1/12/08-4:30pm, 1/13/08-5:00pm (presentation #87)

The sandbuilder worm, *Sabellaria vulgaris*, is a common polychaete along the Mid-Atlantic coast. Unique to Delaware Bay, this species aggregates and builds worm reefs in the intertidal zone. These reefs support highly diverse and high density populations of marine invertebrates and act as shoreline protectors. Yet these structures vary over short and long-term time scales in size and distribution. Many factors influence these changes, including beach restoration and storm events.

Ground-based surveys of *S. vulgaris* colonies were instituted in summers between 2002 and 2008 during spring low tides. These surveys used GPS locations and photographs to document colonies and reefs. Distributions in 2007 were also determined using orthophotographs. An aerial photograph survey was conducted in fall 2008 during a spring low tide. Photographs were rectified and georeferenced to provide locations of observed worm reefs. The *S. vulgaris* reefs have changed dramatically during our six years of observations. The most variable populations were at Slaughter Beach and Broadkill Beach, both locations of beach nourishment projects. Recovery of reef populations at these beaches took about two years. The most consistent reef populations were at Fowler Beach. However even this site proved susceptible to disturbance during a nor'easter in May 2008 which resulted in a completely different distribution by fall 2008.

Ground-based surveys provide high resolution distribution information including reef formations and smaller colonies. Throughout the ground survey we documented changes within individual beaches. However, the ground-based survey is time intensive and limited by access to the shoreline. The tidal cycle only provides a two hour window of usable time on a handful of days each month, further restricting the available time for ground-based surveys. Timing of the surveys also plays an important factor in the effectiveness of these surveys. For *S. vulgaris,* the survey's effectiveness is best when conducted during spring low tides for maximum exposure and when the colonies are at their maximum abundance in late fall. The orthophotographs and aerial survey provided synoptic views of the entire coastline, allowing for greater coverage of the whole population in areas inaccessible by land. Although we initiated the aerial survey, we lacked control of the orthophotographs, which happened to be taken during a low tide that year. The combination of aerial surveys with ground based verification provides the clearest assessment of current populations. These methods are easily synthesized and adapted to other intertidal features and can be utilized for research and management.

AN ASSESSMENT OF A METHOPRENE-CONTAINING INSECTICIDE ON HORSESHOE CRAB (*LIMULUS POLYPHEMUS*) USING PROTEOMICS AND OBSERVATIONS OF EMBRYONIC DEVELOPMENT AND SURVIVAL.

David Bushek, Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349, bushek@hsrl.rutgers.edu; Brian Marsh, U.S. Fish and Wildlife Service
New Jersey Field Office. Pleasantville, NJ 08232; and Peter Van Veld, Department of Environmental Sciences, Virginia Institute of Marine Sciences, Gloucester Point, Virginia 23062
Session 6, 1/12/08-4:30pm, 1/13/08-5:00pm (presentation #93)

Horseshoe crab (*Limulus polyphemus*) eggs, larvae and juveniles contribute significantly to the forage base of many species in Delaware Bay, including at least 11 species of shorebird. Birds foraging on *L. polyphemus* eggs significantly contribute to the wildlife-watching industry in Delaware and New Jersey. *L. polyphemus* also has significant economic importance to the bait fishery and the pharmaceutical industry. Recent data suggest the population of *L. polyphemus* in Delaware Bay has declined. Overharvesting, by catch and habitat loss are often implicated as causes, however, environmental contamination may also play a role.

This investigation examined potential adverse effects of the endocrine disrupting pesticide methoprene on developing eggs and newly hatched *L. polyphemus*. Methoprene is an insect growth regulator contained in insecticides that are applied aerially to marshes of Delaware Bay to control mosquitoes. We hypothesized that mosquitoes and *L. polyphemus* will experience similar adverse effects from a compound like methoprene. To investigate this hypothesis, adult crabs were collected from Kimbles Beach at Cape May National Wildlife Refuge and spawned in the laboratory. Altosid® was mixed with pore water from Kimbles Beach or artificial sea water of equivalent salinity such that eggs, embryos, larvae, and juveniles were exposed to a dilution series of methoprene concentrations of 0 µg/l, 1 µg/, 10 µg/l, and 100 µg/l. Eggs in each dilution were monitored for fertilization, visible abnormalities, hatching success, and survival. Eggs and larvae from all treatments were periodically removed and archived in liquid nitrogen for later proteomic analysis. The proteomics approach involved three phases: 1) separation and visualization of unknown proteins that are expressed differently in controls as compared to treated eggs, embryos, and potentially larvae; 2) visualization of those proteins that are consistently over- or under-expressed in treated individuals compared to controls; and 3) identification of these proteins by *de novo* amino acid sequencing. The results provided no evidence that a treatment effect occurred. We observed no obvious acute effects of environmentally relevant concentrations of the mosquito larvicide methoprene on developing *L. polyphemus* embryos, larvae, or first molt post hatch juveniles. While methoprene has been shown to negatively impact several non-target organisms, our findings provide evidence that chemical exposure to methoprene may not be a limiting factor to the population of *L. polyphemus*.

FIELD AND LABORATORY STUDIES TO UNDERSTAND DISEASE RESISTANCE IN THE DELAWARE BAY OYSTERS AND RESPONSE TO CLIMATE CHANGE

David Bushek, Susan Ford, Ximing Guo, Iris Burt, Brenda Landau, Coren Milbury, Emily Scarpa and Liusuo Zhang, Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349, bushek@hsrl.rutgers.edu **Session 6**, 1/12/08-4:30pm, 1/13/08-5:00pm (presentation #100)

Despite significant declines over the past century, Delaware Bay oysters continue to support a viable fishery and represent an important ecological resource. In recent decades, the oyster diseases MSX and Dermo (respectively caused by the protozoan parasites *Haplosporidium nelsoni* and *Perkinsus marinus*) have wreaked havoc on extant oyster populations in the Bay and elsewhere in the midAtlantic. This study examines how host genetics, population dynamics and the environment interact with disease organisms to structure the oyster population. Genetic resistance to both diseases has been demonstrated by selective breeding and natural selection has resulted in a high degree of resistance to MSX-disease in most of the wild Delaware Bay population. Field and laboratory studies are grouped into four tasks designed to investigate the role of environmentally-modulated selection and transmission processes in producing genetic changes in the host population. We are particularly interested in the role of potential disease refugia in maintaining susceptible populations. Task 1 has identified and mapped major resistance genes and quantitative trait loci (QTLs) in reference families. Results suggest that some loci may influence both MSX and Dermo infections in the eastern oyster. Task 2 compares phenotypic differences in disease resistance in oysters from putative refugia and non-refugia sites against a known susceptible stock. Results indicate higher resistance to infection development and mortality in Delaware Bay oysters regardless of source when compared to the susceptible control stock. Only minor differences exist among Delaware Bay source populations even though disease pressure is known to vary widely. Task 3 examines potential mechanisms that allow disease refugia to exist. Results suggest that Dermo is widespread throughout the Bay, and is often abundant, at very upbay and upriver sites. Evidence of the MSX parasite is present at all sites sampled, but at much lower abundance in the low-salinity sites. Task 4 is estimating the temporal and spatial differences in the number of parents contributing to spat setting in different regions of the Bay as a measure of the effective population size (N_e). Preliminary analyses indicate a low N_e with considerable spatial and temporal variability. Field and laboratory data will be inserted into numerical models of circulation, larval behavior, genetics, and disease to project the potential impact of climate change on disease and oyster populations in Delaware Bay.
Financial support provided by NSF EID Award 0622672.

EVALUATING THE USE OF FAIRMOUNT DAM FISH PASSAGE FACILITY WITH APPLICATION TO ANADROMOUS FISH RESTORATION IN THE SCHUYLKILL RIVER, PENNSYLVANIA. **Lance H. Butler,** Philadelphia Water Department, Office Of Watersheds, 1101 Market Street, 4th floor, Philadelphia PA 19107, Lance.Butler@phila.gov; and Joseph A. Perillo**,** Philadelphia Water Department, Bureau Of Laboratory Services, 1500 East Hunting Park Avenue, Philadelphia PA 19124, Joe.Perillo@phila.gov. Session 7, 9:45am, 1/13/08 (presentation #1)

Many anadromous fish stocks throughout Atlantic slope drainages have been decimated because of the construction of dams. Prior to the creation of the Fairmount Dam in 1820, migratory species, such as American shad (*Alosa sapidissima*), striped bass (*Morone saxatilis*) and river herring (alewife, *Alosa pseudoharengus* and blueback herring, *A. aestivalis*) enjoyed unimpeded movement throughout the Schuylkill River drainage as far upstream as Pottsville, Pennsylvania (160 rkm). In 1979, a vertical slot fish passage facility was constructed on the west side of Fairmount Dam, however, very few anadromous species were utilizing the passage and by 1984 fish restoration activities were diverted to other drainages within the Delaware River basin. Between 2002 and 2006 the Philadelphia Water Department directed its monitoring efforts above and below the Fairmount Dam fishway. In 2004, 6,438 fish of 23 species ascended the Fairmount Dam fishway, including 91 American shad, 161 striped bass, and 2 river herring. A total of 8,017 fishes representing 25 species were counted passing through the fishway in 2005, including 41 American shad, 127 striped bass, and 5 river herring. In 2006, a total of 16,850 fishes representing 26 species were counted passing through the fishway including 345 American shad, 9 hickory shad, 61 striped bass, and 7 river herring. Electrofishing sampling results between 2004 and 2006 showed *A. sapidissima*, *A. aestivalis* and *A. pseudoharengus* were the dominant species below Fairmount Dam during spring, with peak assemblage contributions in 2006. The interannual trend in relative abundance of American shad below Fairmount Dam increased, as did overall shad passage trends in the fishway. Results also suggest that photoperiod may play a critical roll in movement through the fish passage facility, although additional physiochemical signals can not be ruled out at this time. With expected rehabilitation efforts on the Fairmount Dam fishway to begin in 2008, this study as well as future monitoring activities will be important components in measuring the efficacy of anadromous fish restoration activities within the Schuylkill River watershed.

TODAY'S STUDENTS, TOMORROW'S STEWARDS—PROMOTING OYSTER RESTORATION THROUGH SCHOOLS. **Lisa M. Calvo**, Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, calvo@hsrl.rutgers.edu; William Shadel, American Littoral Society, 18 Hartshorne Drive, Suite #1 Highlands, NJ 07732; and David Bushek, Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349 **Session 15**, 9:00am, 1/14/09 (presentation #42)

Project PORTS: Promoting Oyster Restoration Through Schools is a community-based restoration and educational program focusing on the importance of oyster populations in the Delaware Bay ecosystem. The education program utilizes the oyster as a vehicle to acquaint school children, grades K-12, with the Delaware Estuary and basic scientific concepts. The enrichment programming is hands on and inquiry based. Students are offered cross-curricular lessons that integrate scientific aspects with locally relevant historical and social perspectives relating to the Delaware Bay oyster resource. The educational value of Project PORTS classroom lessons is greatly enriched by bringing future citizen-scientists into direct contact with the Bay Shore environment via the restoration program. The community-based restoration component engages students in the process of restoring oyster habitat. Students construct shell bags, which are deployed in the Bay to become a settlement surface, and home to millions of young oysters. Participation in the restoration project lends a sense of ownership to the student's academic studies and gives students the opportunity to experience the Delaware Estuary and environmental stewardship first hand. The restoration project in itself is important as fringe oyster habitat in the Delaware Bay is enhanced for the purpose of conservation.

In the last 2 years more than 3000 student learning experiences have been offered through Project PORTS with fourteen schools participating. Student stewardship efforts resulted in the construction and deployment of 3250 shell bags. The shell bags caught 2.5 million and 18 million (includes < 3 mm in size) spat in 2007 and 2008, respectively. The spat were transplanted to a 3-acre plot at an upper Bay conservation area, the Gandy's Beach Oyster Restoration Enhancement Area. Assessments of the enhanced habitat conducted in October 2008 indicated both cohorts were growing and surviving well. Shell height of the 2007 plants ranged from 13.2 to 91.2 mm with a mean of 53.2 mm, while that of the 2008 plants ranged from 11.0 to 60.0 mm with a mean of 33.8 mm. Survival was estimated to be >80% for both cohorts. These results demonstrate success of the project, in respect to increased recruitment and early post recruitment oyster abundance within a short-term timeframe. Equally important is the project's stewardship value, which was extended as students gained an appreciation and ownership of their efforts by participating in the scientific assessment of the enhanced oyster habitat.

LOCAL PLANNING FOR CLIMATE CHANGE ADAPTATION IN A SOCIAL ENVIRONMENT OF SCIENTIFIC UNCERTAINTY**.** **David Carter**, Environmental Program Manager II DNREC/Delaware Coastal Programs. **Session 1**, 11:00am, 1/12/09 (presentation #46)

Sea level rise has been referred to as the ultimate planning challenge. Understanding how to address the potential for significant, or perhaps incremental, change is a difficult task. This challenge is further complicated by the broad spectrum of coastal issues and interests involved, as well as the inherent uncertainty associated with projecting changes in sea level rise. Despite these challenges, coastal managers around the world have realized the need to begin planning. The expense of not proactively planning for sea level rise could be astronomical on our economic, environmental, cultural and social assets and infrastructure.

In Delaware, we are just beginning the planning for a response to sea level rise. A process has been outlined for broad stakeholder involvement to identify our vulnerabilities and potential adaptation strategies. These efforts, to be meaningful, must be informed by sound data collection, analysis, and defensible prediction scenarios. The recently collected LIDAR, combined with other data sources, is a major step in this direction for Delaware.

This presentation will look at the proposed planning process and how the integration of LIDAR, modeling, and 3D GIS can help inform the decisions we will need to make regarding Sea Level Rise adaptation in Delaware. Several modeling methods are already being utilized to start to re-assess our preliminary planning efforts based on the new Sussex county LIDAR data, which include calculations of several sea-level and storm inundation scenarios on local coastal areas, as well as some basic model outputs of the Sea Level Rise Affects Marshes Model (SLAMM; which is used to estimate the potential transgression of marshes) and Mike 21 Model.

USING THE IMPORTANT BIRD AREAS PROGRAM AS A MODEL FOR CONSERVATION PLANNING IN THE DELAWARE ESTUARY. **Elizabeth Ciuzio,** NJ Audubon Society, Cape May Courthouse, NJ, beth.ciuzio@njaudubon.org ; Frank, C., NJAS, Cape May Courthouse, NJ; Ettel, T., NJAS, Asbury, NJ. **Session 7**, 9:00am, 1/13/08 (presentation #2)

There are a considerable number of tools available to resource managers to plan for tomorrow's Delaware Estuary. Bird habitat conservation plans, GIS models, population goals, and focal areas have been developed or identified for natural resource planners and land managers. In addition to these tools, overarching documents, such as the Delaware Estuary's Comprehensive Conservation and Management Plan and New Jersey's State Wildlife Action Plan, are available to resource planners to guide development of on-the-ground actions to achieve stated goals. Our presentation provides a model for utilizing all of these resources to affect on-the-ground conservation at sites that have been identified as priority by the Important Bird Areas Program.

The New Jersey Audubon Society initiated the Important Bird Areas Program to identify and protect sites essential to the long-term conservation of native bird populations. With 122 sites identified through out NJ, the program is into the conservation planning phase in which we develop models for comprehensive site-based conservation. Using the Mannington Meadows Important Bird Area as an example, we will present our model for site-based conservation that clearly defines target avian species for management and sets specific habitat goals for grassland breeding birds. Using priority species identified by the State Wildlife Action Plan, population goals identified by Partners in Flight, and habitat models developed by the New Jersey Habitat Incentive Team, the IBA model sets goals for restoration that are based in science. Our presentation provides a model for identify priority species for targeted management, setting habitat goals and techniques to implement the plan. Through careful planning and on the ground implementation, we are achieving the goals of regional and nation plans on the local level and within priority sites.

THE DELAWARE ESTUARY CLIMATE READY PILOT: VULNERABILITY ASSESSMENT AND ADAPTATION PLANNING. **Priscilla Cole and Danielle Kreeger,** Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, pcole@DelawareEstuary.org. **Session 6**, 1/12/08-4:30pm, 1/13/08-5:00pm (presentation #112)

The Delaware Estuary was chosen in 2008 as one of EPA's six national pilots in its new Climate Ready Estuaries Initiative. The purpose of this initiative is to: 1) identify valuable natural resources in the estuary that are most vulnerable to changes in climate, and 2) develop an adaptation strategy that identifies and prioritizes highest value activities that can preserve or enhance these resources as climate effects are realized. For our pilot, a science and technical workgroup will perform these tasks for up to three case studies: drinking water (human need), tidal wetlands (habitat) and shellfish (living resource). These resources were selected based on high perceived vulnerability to factors such as increasing sea level and salinity. Each case study is expected to present unique challenges, and the lessons learned should therefore be helpful in guiding how scientists, managers and policy makers might approach other natural resources in our region and beyond.

Subgroups of the climate workgroup, one per case study, will be tasked with: 1) identifying and ranking likely vulnerability factors associated with the resource, 2) characterizing likely climate change effects on ecosystem goods and services (i.e., natural capital value), 3) identifying adaptation options to preserve or enhance the resource, with perceived natural capital benefits, and 4) providing recommendations regarding the highest value actions that should be taken by managers and policy-makers.

Given the short duration of this project, our aim is to use best scientific judgment to characterize vulnerability, using a qualitative risk assessment approach, and to provide recommendations based on existing information. Our pilot adaptation plan will be contrasted with outcomes from the other five EPA pilots to determine the most pressing national issues, in order to guide the expansion of the CRE program within the pilots, , as well as in other estuaries where little adaptation planning has occurred.

Contingent on resources and perceived utility, the Partnership may later expand this pilot effort with quantitative, geospatial referenced data to strengthen our natural capital assessment and boost the predictive power of outcomes from adaptation scenarios. We also expect to identify monitoring needed to watch for early warning signs of potential ecosystem thresholds. Finally, we wish to learn about and join with other climate adaptation efforts because this type of planning requires a coordinated, multi-disciplinary approach that is watershed-based.

BUILDING CONSENSUS ON PRIORITIES FOR THE DELAWARE ESTUARY: THE PDE ALLIANCE FOR COMPREHENSIVE ECOSYSTEM SOLUTIONS**. Priscilla Cole** and Jennifer Adkins**,** Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, jadkins@DelawareEstuary.org. **Session 5**, 3:45, 1/12/08 (presentation #132)

The PDE Alliance for Comprehensive Ecosystem Solutions (ACES) is an effort to build multi-sector support for priority restoration, protection, and enhancement projects in the Delaware Estuary. Beginning in 2006, PDE began working with collaborating entities to outline a Regional Restoration Initiative (see poster, Kreeger et al.) that 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 "consensus track**" that will synthesize, coordinate, and support/promote specific regional priorities and activities among restoration decision makers and funders, and 3) **a "project registry**" that will serve as a clearinghouse for restoration projects across the watershed. The PDE ACES effort is the critical "consensus track" element of this initiative. It builds upon existing regional collaboration, coordination, and will utilize the project registry and tools developed through the science track. Since August 2007, a group of partners that includes agency, non-profit, funder, and corporate representation has been collaborating with PDE to develop the PDE ACES vision and multi-stakeholder process, the end objective of which is to establish a priority listing of projects and work together to capitalize on public and private funding mechanisms to facilitate their implementation. By harnessing the enthusiasm, expertise, and commitments of public and private sectors, PDE ACES will leverage resources and maximize the overall success of the effort. This presentation will focus on introducing the PDE ACES concept, its development so far, and seeking input on stakeholder priorities in the Delaware Estuary.

UNUSED PHARMACEUTICALS EDUCATION AND DISPOSAL PROGRAM IN PHILADELPHIA. **Paula Conolly**, Philadelphia Water Department, Office of Watersheds, 1101 Market Street, 4th Floor, Philadelphia, PA 19107, paula.conolly@phila.gov.
Session 8, 10:00am, 1/13/08 (presentation #119)

An overview of efforts by the Philadelphia Water Department and its partners to create a sustainable program to reduce amounts of unused pharmaceuticals leading to Philadelphia's drinking water supply. The program includes pilot mail-in programs at senior care centers and long-term care facilities, education of health care workers about impacts of unused prescriptions and accepted disposal techniques, and efforts to work with healthcare companies to lower economic incentives for bulk purchases. The presentation will give an overview of barriers to complete and proper disposal of unused pharmaceuticals and make recommendations for regulatory changes that could facilitate long-term solutions.

THE EXPANDING ROLE OF *LIMULUS* AMEBOCYTE LYSATE (LAL) REAGENT IN THE GLOBAL PHARMACEUTICAL INDUSTRY.

James F. Cooper and Frances D. Cooper, Greensboro, NC 27429, jimandfran@earthlink.net; Benjie Swan, Limuli Labs, Cape May Court House, NJ 08210. **Session 4**, 3:45pm, 1/12/09 (presentation #45)

LAL reagent was recognized circa 1971 as the most sensitive, specific and simplest way to detect harmful levels of bacterial endotoxin in injectable pharmaceuticals. Commercial LAL production sites soon arose in Chincoteague, VA, and Woods Hole, MA. The FDA issued regulations for LAL production in 1977 that included a return-to-sea policy for horseshoe crab (HSC) specimen. The value of HSCs for biomedical use has fostered conservation efforts coast wide. By 2000, endotoxin tests of injectables by LAL reagent were required worldwide. The global LAL market is about $100 million and is primarily supplied by four US producers. LAL reagent preparation requires collection and pooling of hemolymph from healthy HSC under cleanroom conditions. In the past decade, LAL producers have upgraded procedures to assure that specimens are returned to the sea with the same care as that taken in collection. HSC harvest and return practices are monitored by their respective states. Mortality from handling HSCs doesn't exceed 6-to-8 %. At least 600,000 HSC will be needed annually to meet industry requirements in the foreseeable future; about one-half of these are taken from the Delaware Estuary. The labor intensive nature of LAL production and potential decline in HSC availability led the LAL industry to develop test methods that reduce LAL consumption. A recombinant Factor C, functioning as the first enzyme in the enzymatic cascade of the LAL reaction, is now available; however, this method is currently limited by lack of robustness and instrument requirements. A new test system is available that requires only one-tenth of the LAL normally required for an endotoxin test; however, this approach is not amenable to large-scale testing needed in some sectors of the drug industry. Hopefully, continued improvement of these new methods and more efficient pharmaceutical use will slow the growth of LAL production. There is no alternative to the LAL-endotoxin test on the horizon to meet critical biomedical needs, worldwide.

WHITE CLAY CREEK STATE OF THE WATERSHED REPORT

Martha Corrozi Narvaez and Maureen HS Nelson University of Delaware
Institute for Public Administration – Water Resources Agency DGS Annex, Newark, DE 19716, mcorrozi@udel.edu; Martha Corrozi, Andrew Homsey, Gerald Kauffman,
Erika Farris, and Maureen Seymour. **Session 5**, 3:00pm, 1/12/08 (presentation #32)

The White Clay Creek Wild and Scenic watershed, part of the Delaware River Basin, drains 107 square miles between Delaware, Pennsylvania, and Maryland. In 2000, 190 miles of the White Clay Creek (WCC) was designated into the National Wild and Scenic Rivers System. The WCC was the first National Wild and Scenic River accepted on a watershed basis. The WCC is known for its outstanding resources, which include: open space, recreational areas, water supply, fish and wildlife, and historical sites.

Since 1970 the population of the watershed has nearly doubled. If the current trends of population growth and development continue in the area, they will result in negative impacts on the watershed's valuable resources. In order to get a gauge on the overall health of the watershed the White Clay Creek Wild and Scenic Management Committee funded the University of Delaware's Institute for Public Administration-Water Resources Agency (IPA-WRA) to develop the White Clay Creek State of the Watershed Report.

IPA-WRA undertook the task of gathering and assessing data for 21 environmental indicators in four categories: landscape, hydrology, water quality, and habitat. Each indicator was assigned a letter grade (A-F) and an increasing, decreasing, or constant trend symbol. The report concluded that as a whole the WCC watershed is in relatively fair condition across the board yet there are several crucial areas for improvement (e.g. bacteria and total nitrogen levels, flooding, and impervious cover).

Following the letter and trend assessment for each of the 21 indicators, the report provides a set of recommendations related to each indicator. These recommendations are intended to serve as a planning and prioritization tool for the Management Committee. The report suggests that specific actions are a priority based on the assessment determined in the report. This report has helped provide the committee with a comprehensive assessment of the watershed, which ultimately helps to focus the committee's funding priorities.

At a time when budgets in most organizations are being cut, this report serves as a good example of a tool that watershed associations can use to assess a river's health and subsequently use to plan for future watershed funding priorities. This presentation will discuss the White Clay Creek Wild and Scenic River, the process for developing the report, the information contained in the report, and the recommendations and how they have served the Management Committee.

MINGO CREEK FRESHWATER TIDAL WETLAND RESTORATION: WETLAND CREATION IN AN URBAN REACH OF THE SCHUYLKILL RIVER, PHILADELPHIA, PENNSYLVANIA. **Jim D'Agostino, Jr.** Philadelphia Water Department, Office Of Watersheds, 1101 Market Street, 4th floor, Philadelphia PA 19107, Jim.D'Agostino@phila.gov.
Session 10, 1:45pm, 1/13/09 (presentation #37)

Over the past 300 years, freshwater tidal marshes in the Delaware Estuary have been decimated primarily by anthropogenic influences. Nowhere is this trend more evident than along the urban corridors where approximately 5% of the pre-settlement acreage still remains. During spring 2008, the Mingo Creek Wetland Project was undertaken to evaluate the potential for establishing a heterogeneous wetland community along the lower reach of the Schuylkill River, Philadelphia, Pennsylvania. This location was viewed as the most viable option on the Delaware and Schuylkill rivers because of municipal ownership and limited wave and tidal action. Surveys were performed to establish average daily inundation levels as dictated by tidal cycles. Wetland vegetation was chosen based on native ranges and their ability to persist through periods of total inundation. Spadderdock (*Nuphar lutea*), Pickerelweed (*Pontedaria cordata*), Broadleaf arrowhead (*Sagittaria latifolia*), and Arrow arum (*Peltrandra virginica*) were planted in randomized 15 ft x 15 ft fenced grids. Preliminary data based on vegetation persistence and density were met with mixed results. Biotic factors, such as grazing by Canada geese (*Branta canadensis*) and ducks (*Anas sp.*) appears to be the most significant deterrent to the overall reestablishment of native wetland vegetation in this vicinity. Additional protective measures to discourage grazing, such as overhead wire, reaffirmed this initial observation. Abiotic factors also contributed to the demise of some plantings. Large flotsam was responsible for destroying a number of protective grids and allowed grazing by both waterfowl and fish. From this initial phase of the study, questions have been raised regarding passive restoration or creation in urban ecosystems. More specifically, more rigorous protective measurements along with physical structures, such as wavebreaks or groins, may need to be implemented to ensure the survivability of immature plantings and the establishment of a persistent wetland assemblage along the Schuylkill and Delaware Rivers.

HOW *PROSPECTIVE RESTORATION OR RESTORATION UP FRONT* COULD BE USED IN THE DELAWARE RIVER WATERSHED, **Stephen K. Davis, P.G.,** Matrix New World Engineering, Inc., 1116 Milldale Drive, Suite 2, Rochester, IL 62563, sdavis@matrixneworld.com; Lawrence D. Malizzi, P.G., Matrix New World Engineering, Inc., 1521 Concord Pike, Suite 301, Wilmington, DE 19803, lmalizzi@matrixneworld.com; Dennis Petrocelli, P.G., Matrix New World Engineering, Inc., 120 Eagle Rock Avenue Suite 207, East Hanover, NJ 07936, dpetrocelli@matrixneworld.com; Doug Lashley, Esq., Greenvest LLC, 726 Second Street, Suite 3 B, Annapolis, MD 21403, doug@greenvestus.com
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #130)

Natural Resource Trustees (Trustees) and Responsible Parties (RPs) have found over the past decade, that a cooperative natural resource damage assessment and restoration process frequently results in more timely completion of restoration projects. Through this cooperative effort, Trustees and RPs have been searching for an even more expedited method by which restoration can be achieved even more effectively and efficiently when natural resource damages are of concern. This method has recently been coined "Prospective Restoration or Restoration Up Front."

Matrix New World Engineering, Inc., and Greenvest LLC (Matrix/Greenvest) believes that Prospective Restoration could (and should) be utilized as an expedited restoration tool within the Delaware River water shed. Prospective Restoration begins when a Natural Resource Damage claim is initiated by Trustees. An entity then undertakes restoration and receives "credit" for that restoration in a currency (e.g. discounted service acre years) that can be applied to an existing, pending or future liability, or the "credits" may be sold or traded to another entity or even potentially leveraged with other funding mechanisms. The credits are "durable" so long as the habitat or resource that generates the service flows remains in the same or similar condition as when the credits were first assigned.

The restoration may be undertaken up front or prospectively, even before an existing or potential liability is identified, quantified or settled. The restoration is not intended to be in lieu of an entity undertaking actions necessary to mitigate a spill or clean up contamination. It is not a "license to pollute." The restoration is to be applied against interim natural resource service losses, but may, in some cases, be used as part of a primary restoration action.

The trustees would identify and estimate costs for particular projects, ensure compliance with the National Environmental Policy Act (NEPA), and determine the credits that could accrue from a particular restoration. When the "credits" are applied to a liability, the trustees would cooperatively determine the final value of the credits and their applicability to the specific situation.

Matrix/Greenvest has designed a prospective restoration tool that would be directly applicable to expedited restorations in the Delaware River watershed. This tool will be developed and ultimately implemented by Matrix/Greenvest as an objective third party in conjunction with Trustees, and will not only provide an opportunity to compensate for losses to natural resources, but will also aid in the final development of a Brownfield site.

STONE HARBOR BIRD SANCTUARY HABITAT RESTORATION PROJECT. ~IT TAKES A WHOLE VILLAGE. **James M. Eisenhardt, CFM, PWS,** Duffield Associates, Inc., 618 Route 9, Cape May Court House, NJ 08210, jeisenhardt@duffnet.com; and Dianne F. Daly, Duffield Associates, Inc. 618 Route 9, Cape May Court House, NJ 08210. ddaly@duffnet.com. **Session 15**, 9:15am, 1/14/09 (presentation #58)

This project is an exceptional and unique model that demonstrates how the development of active Public-Private partnerships is essential to successful and sustainable ecological restoration and management of critical habitats. The exponentially rising costs of habitat restoration and management of critical ecosystems on public lands can no longer be handled by land owners alone. Creative approaches to funding and collaborative partnerships with natural resource agencies and regional conservation organizations must be explored, nurtured and put into practice in order to achieve long term restoration and management goals of our diminishing critical habitats.

The 21 acre Stone Harbor Bird Sanctuary is a National Natural Landmark, and is internationally known by ornithologists, conservationists, and birders for its value as a significant colonial wading bird breeding habitat and migratory songbird stopover. It is a unique area in the heavily developed barrier islands of New Jersey. The site is a historically successful, thriving heronry, formerly host to thousands of beautiful colonial wading birds such as the Black-Crown Night Heron, Snowy Egret, Great White Heron, Little Blues and Tricolor Herons. At one time, this parcel of land was one of the most successful rookeries in the Northeast region of the country. Over the last 10 years, the wading birds have disappeared due to invasion of non-native plant species, restricted tidal flow, and increased predator issues. The habitat was in dire need of restoration and management.

Within the Sanctuary, there are several ecological systems co-existing: a maritime forest, estuarine emergent wetland, and uplands thus requiring a multi-faceted approach to the restoration actions, permitting matrix, and funding sources. The scope of the project included definition and baseline monitoring of wetlands, redesign of the hydrology of the sanctuary, controlling invasive species, enhancing water bodies and streams, and the redesign of a pipe that allows for tidal and nutrient exchange from the adjacent back bay waters to the Sanctuary. Additionally, the project included the development of educational trails and signage throughout the habitat.

Duffield Associates, on behalf of the Stone Harbor Bird Sanctuary Advisory Committee developed a science-based Restoration Master Plan for the estuarine wetlands and upland habitat.

Additionally, Duffield Associates, in collaboration with the Advisory Committee, and the USF&W Service identified multiple sources of grant funding, corporate and public partnerships, and public in kind services for this unique and complex project.

CONSEQUENCES OF INTERSPECIFIC VARIATION IN NITROGEN AND CARBON POOLS OF SALT MARSH PLANTS. **Tracy Elsey,** Denise M. Seliskar, and John L. Gallagher telsey@udel.edu, Graduate College of Marine and Earth Studies, University of Delaware, 700 Pilotown Road, Lewes, Delaware 19958. **Session 10**, 2:30pm, 1/13/08 (presentation #39)

Nutrient filtering capacity and storage of carbon belowground contributing to vertical accretion are services plants perform in coastal marsh ecosystems. With regional sea level and climate changes affecting coastal marsh plant communities, it is likely that there will be subsequent changes in nitrogen and carbon storage in salt marshes. Sea level rise will reduce the area of present coastal marsh lands through edge erosion and inundation if surface elevation does not keep pace with sea-level rise. In areas where landward migration is inhibited total acreage will decline. While it may be expected that the low marsh will migrate landward to replace higher marsh communities, an increase in regional temperature and higher atmospheric CO_2 concentration may encourage a more southerly C-3 plant species, black needlerush, *Juncus roemerianus*, to be a dominant fixture in Delaware's moderate-to-lower salinity marsh areas. Presently, *J. roemerianus* is restricted to the fringing marshes surrounding Little Assawoman Bay in southern Delaware. To investigate interspecific variation of nitrogen (N) and carbon (C) storage, we determined the percent N and C that is contained in four dominant salt marsh plants, the percentage that is lost through decomposition, and the quantity present in the upper 30-cm of marsh soils. We found that *Spartina alterniflora* and *Spartina patens* had two times the carbon pool in the upper 15-cm and over four times the carbon pool in the 15–30 cm depth compared to the higher marsh, *J. roemerianus*. Nitrogen pool followed a similar pattern, however, varied seasonally. Bulk density and percent carbon in the upper 15-cm were similar among species averaging 0.43 g cm^{-3} and 26.6%, respectively but varied significantly among species in the lower 15-cm. Slow belowground decomposition of organic matter ranged from 0.075 – 0.16% day^{-1}, depending on species, with *Spartina patens* having the slowest decomposition rate. Because *J. roemerianus* had the smallest organic matter contribution and higher belowground decomposition rates, net retention of N and C is less than that of the other species. Differences in net retention of N and C among species is extremely important because species shifts are likely to occur as a result of sea-level rise, temperature changes, and increased atmospheric CO_2 concentration. In addition, with potential declines in marsh land area, belowground standing stock of nitrogen ranging from 31 to 73 g N m^{-2} and carbon ranging from 1672 to 3989 g C m^{-2} depending on species will also decline or will be lost.

A SPATIALLY DETAILED ASSESSMENT OF NUTRIENT LOADING IN THE DELAWARE RIVER BASIN FOR THE YEAR 2000**. Jeffrey M. Fischer**, Mary M. Chepiga, and Susan J. Colarullo. U.S. Geological Survey New Jersey Water Science Center, West Trenton, NJ 08648. **Session 8,** 10:15am, 1/13/09 (presentation #103)

SPAtially Referenced Regressions On Watershed attributes (SPARROW) is a relatively new modeling technique that relates in-stream water-quality measurements to spatially referenced characteristics of watersheds, including contaminant sources and factors influencing terrestrial and stream transport. The model empirically estimates the origin and fate of contaminants in streams, and quantifies uncertainties in these estimates based on model coefficient error and unexplained variability in the observed data. SPARROW is statistically-based and combines the spatial ordering of stream networks with geospatial information such as nutrient loads from urban, agricultural, and atmospheric sources. The model estimates land-to-water delivery and in-stream transport in relation to climate, soils, topography, stream size, and other factors. First-order decay functions for streams and reservoirs are used to describe transport.

A SPARROW nutrient model of the Delaware River Basin was developed to help support the management of nutrients entering streams, reservoirs, ponds, lakes, and estuaries, and to support work in a number of regulatory programs. The model is calibrated to estimates of annual nutrient loads at 87 total nitrogen (TN) sites and 100 and total phosphorus (TP) sites using 60 years of discharge data and 30 years of water quality data at selected monitoring stations. Results of the model include estimates of TN and TP loads in calendar year 2000 for all stream reaches within the Basin, an estimate of the nutrient load delivered to the Delaware Estuary, and an estimate of the amount of nutrients from various sources. Nutrient sources used in the model include: population (a surrogate for urban point and non-point sources), agricultural fertilizer and manure, atmospheric deposition, and diffuse loads from non-agricultural land. SPARROW results include the percent contribution from each source for each stream reach and can be analyzed at any sub-basin scale needed for management purposes.

SPARROW predicted in-stream loads in the non-tidal stream reaches of the Delaware Basin were 57.8 million kg of TN and 4.0 million kg of TP. The percent contribution to the total from each predicted source include: population - 20% for TN, 62.5% for TP; agricultural fertilizer - 22% for TN, 12.5% for TP; agricultural manure - 32% for TN, 17.5% for TP; atmospheric deposition - 35% for TN, and diffuse loads from non-agricultural areas - 1% for TN, 7.5% for TP. Factors controlling the overland transport of nutrients to streams and within stream losses in the Delaware Basin SPARROW model were found to be soil water-holding capacity, stream flow volume, and reservoir size. The predicted amount of nutrient load delivered to the tidal parts of the Delaware River is 39 million kg of TN (67% of the TN load within non-tidal streams) and 3.1 million kg of TP (77% of the TP load within non-tidal streams).

OCCURRENCE OF ORGANIC WASTEWATER-RELATED COMPOUNDS IN STREAMS ENTERING THE DELAWARE ESTUARY, 2001-2008. **Jeffrey M. Fischer[1], Andrew G. Reif[1], Kristin Romanok[1], Paul E. Stackelberg[1], and R. Lee Lippincott[2]** [1] US Geological Survey [2] NJ Department of Environmental Protection. **Session 8**, 9:00am, 1/13/09 (presentation #104)

Studies by the US Geological Survey (USGS) have shown that Organic Wastewater Compounds (OWCs), such as pesticides, pharmaceuticals, fragrances, plasticizers, flame retardants, and other compounds are detected in streams throughout the United States. The occurrence of appreciable concentrations of OWCs are often associated with waste-water treatment plants, industrial outflows, and animal feed operations. Although most OWCs are detected in streams at concentrations in the parts per trillion, there are concerns that even at these low levels some may have carcinogenic or endocrine disrupting effects, especially on aquatic animals, or even humans.

From 2001 to 2008, several USGS cooperative studies in New Jersey and Pennsylvania sampled for OWCs in streams, six of which discharge directly to the Delaware Estuary. OWC occurrence results from these studies are similar to occurrence results from National studies. For instance, in New Jersey, one or more OWCs were detected in 93 percent of 30 streams sampled. The median number of OWCs detected was 12, and the most detected in any one stream was 32. Compounds detected in more than 30 percent of the stream samples include the pesticides prometon, deet, diazinon, and metolachlor, the fragrance compound HHCB, the pharmaceutical carbamazapine, 3 different phosphate-based flame retardants, as well as cholesterol, caffeine, and cotinine. Concentrations of these OWCs were usually less than 1 ug/L. Water-quality guidelines and aquatic-life criteria have not yet been established for most of these compounds. No compounds were detected during these studies at concentrations exceeding established water-quality guidelines.

As with National occurrence studies, the number of OWCs detected was correlated with the percent of total stream flow comprised of waste-water treatment plant discharges. For instance, few OWCs were detected in the Delaware River at Trenton, whereas other tributaries to the Estuary with a large percentage of flow coming from waste-water treatment plants had more frequent detections.

MAPPING PRIORITY AREAS FOR CONSERVATION IN THE DELAWARE ESTUARY: APPLYING A GIS MODEL TO DELINEATE IMPORTANT BIRD AREAS. **Cristina Frank,** NJ Audubon Society, Cape May Courthouse, NJ, cristina.frank@njaudubon.org; Ciuzio, B., NJAS, Cape May Courthouse, NJ; Ettel, T., NJAS, Asbury, NJ. **Session 7,** 9:15am, 1/13/09 (presentation #12)

Successful planning and stewardship begins by identifying priority areas for concentration. Areas under consideration for planning, acquisition or conservation can be prioritized using a variety of information. New Jersey Audubon Society's Important Bird and Birding Areas Program developed and implemented a GIS model using several datasets to delineate Important Bird Area (IBA) boundaries, the area within which we seek to protect, enhance or restore for birds and their habitats. The objective was to develop a methodology that was consistent statewide and to formulate that methodology into a model that can be shared, refined and repeated. This data set is intended to serve as a resource for regulators, land-use planners, conservationists, agency personnel and other key stakeholders throughout NJ and to identify priority areas for restoration of habitat and private lands.

The IBA boundary data set compliments the Delaware Estuary's Comprehensive Conservation and Management Plan and New Jersey's State Wildlife Action Plan in its ability to guide conservation planning efforts. We will present the methodology behind the development of the model and discuss how IBA maps have facilitated conservation planning within priority habitats throughout the Delaware Estuary.

NEW JERSEY COASTAL MANAGEMENT & PLANNING FOR DELAWARE BAY COASTAL HAZARDS. **Dorina Frizzera** & John D'Agostino, Coastal Management Office – NJDEP. **Session 18**, 3:30pm, 1/14/08 (presentation #116)

Given recent assessments of anticipated climate change, associated sea level rise and exacerbated coastal flooding, comprehensive vulnerability planning has emerged as a critical issue for state and local planning officials in order to preempt and mitigate the potential for future damage and loss of life. Seeking to address this vulnerability, scientists and policy-makers have begun promoting "coastal resilience" as a strategic goal. The concept of this goal is to encourage the capacity of prone communities to both resist the impact of flooding and erosion, and "bounce back" in the post-storm period. Despite this definition, attributes that constitute "coastal resilience" have not yet been established due to varying resource limitations, and the diversity of U.S. coastal landscape types. Consequently, there is a pressing need to characterize principal components of resilience in New Jersey while providing an assessment methodology and protocol that may be easily applied and adapted for future use.

As part of New Jersey's efforts to address coastal resilience planning, the Coastal management Office (CMO) has been a principal funder in the acquisition of coastal LiDAR mapping for the Delaware Bayshore region through its federal Coastal Zone Management grants. The CMO will integrate this topographic data with previously acquired geographic data to assess anticipated sea level rise, exacerbated flooding, wetland migration potential, at risk physical infrastructure, and ecosystem services to provide a comprehensive vulnerability and resilience analysis. This product will be developed in coordination with the region's municipal planning and emergency management officials. The resulting product will be shared with local and regional planning entities to support long-term planning that incorporates anticipated landscape changes wrought by local sea level rise. Additionally, this effort will afford the state an integrated understanding of regional planning needs and data limitations in its efforts to provide more effective management of New Jersey's changing coastal landscape.

SURVIVAL OF THE WORLDS FOUR HORSESHOE CRAB SPECIES REQUIRES A GLOBAL PERSPECTIVE. **Glenn A. Gauvry,** President, Ecological Research & Development Group, Little Creek, DE. 19901, erdg@horseshoecrab.org. **Session 4**, 4:15pm, 1/12/08 (presentation #95)

The survival of the world's four horseshoe crab species is due in part to the fact that it is an ecological generalist, which has allowed it to successfully adapt to a multitude of environmental changes for over 445 million years. In contrast, man has walked the planet for less than 200,000 years and has only recently embraced the word "sustainable." We might well be served to borrow a lesson from a true master, who very early in its existence, learned to harmonize with the world it depended upon for survival. The word "sustainable" has become ubiquitous within the environmental movement, most often used to imply meeting the needs of the present without compromising the ability of future generations to meet their needs. However, upon closer examination it is often a word in search of a vision or leadership.

It may be myopic to discuss the sustainability of a species known for its generalist approach towards life within the context of a specific location. The effects of management policies practiced within the Delaware Bay Estuary often ripple throughout the species range--from Maine to Mexico's Yucatan Peninsula, and at times even impacting the survival of the three Asian species. Can we truly be concerned about the sustainability of a species without taking a global perspective?

In the short term, temporal and spatial driven concerns may favor or even mandate a science-driven regulatory/ law enforcement approach. However long term, sustainability will ultimately depend upon a global community of players. Who is this community? What is it willing to sacrifice to achieve sustainability? How do we engage its many facets? And, can we claim to be building community if our methodology will disenfranchise, marginalize or villianize the very stakeholders needed for success?

This talk will explore the sustainability of the horseshoe crab species from a community building perspective, with a review of conservation efforts around the world and/or the lack thereof.

ASSESSMENT OF ARTIFICIAL OYSTER HABITAT FOR BLUE CRAB (*Callinectes sapidus*) POPULATION IN DELAWARE'S INLAND BAYS. **Aaron Gibson*,** Department of Biological Sciences, Delaware State University, 1200 North Dupont Highway, Dover, DE 19901 USA, agibson001@hotmail.com; and **Frank Marenghi,** and **Gulnihal Ozbay,** Department of Agriculture & Natural Resources, Delaware State University, 1200 North Dupont Highway, Dover, DE 19901 USA. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #70)

As part of a larger study of the habitat value of oysters raised in 'Taylor floats' in Delaware's Inland Bays, we specifically addressed the use of these floats as habitat for blue crab, *Callinectes sapidus*. The nearby blue crab fishery of the Chesapeake Bay was designated as a Federal Disaster on September 23, 2008. The ecology of this species and the path to the recovery that the blue crab will need to follow is important to study both for economical and environmental purposes. The focus of this study was to determine blue crab abundance and size class ratios occurring in floats containing living oysters, dead oyster shell, or empty floats at various study sites. In this study, water quality measurements were taken weekly at eight study sites at residential waterfront properties located in Little Assawoman Bay, Delaware, beginning in May 2008. In early June, three Taylor floats were deployed at each of the study sites: one containing live oysters, one with oyster shell, and one empty float with no shell or oysters. The floats were then sampled monthly for fishes and macro-invertebrates, including blue crabs, by surrounding the float with a mesh net and retrieving all specimens from the net. Blue crabs that were collected were then counted and their carapace width measured. This project continued into September and has resulted in wealth of information. Blue crabs showed a preference for floats containing three-dimensional structure provided by oysters and shells. Floats with oysters or shells contained as many as 82 blue crabs while empty floats had significantly less or no crabs during each sampling period. Analyses of the data recovered center on the abundance and size class distribution of blue crabs at specific sites and how water quality influences the population. Examination of the interaction between *Callinectes sapidus* and other species is an important factor considered during data analysis. Upon completion, this project will provide valuable knowledge concerning the use of Taylor floats in the restoration of the blue crab fishery. Information about the importance of oysters to the blue crab fishery in estuarine ecosystem will serve to better protect the fisheries and habitat that so many depend on.

PERKIOMEN WATERSHED CONSERVANCY: THE CHALLENGES OF REACHING AND INSPIRING. **Crystal G. Gilchrist**, Executive Director, Perkiomen Watershed Conservancy, 1 Skippack Pike, Schwenksville, PA 19473. **Session 11**, 2:15pm, 1/13/09 (presentation #120)

The Perkiomen Watershed Conservancy conducted a number of outreach efforts through the Schuylkill Watershed Initiative Grant (SWIG). This session will provide a recap of those efforts and their results, emphasizing the importance and challenges of reaching and inspiring watershed constituents.

MONITORING FITNESS OF CAGED MUSSELS (*ELLIPTIO COMPLANATA*) TO ASSESS AND PRIORITIZE STREAMS FOR RESTORATION IN SOUTHEASTERN PENNSYLVANIA. **Matthew W. Gray,** Department of Biology, Drexel University 3141 Chestnut St., Philadelphia, PA 19104. Danielle Kreeger, Angela Padeletti, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE 19801. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #111)

Freshwater mussels (Order: Unionoida) were once abundant and diverse throughout the Delaware Estuary watershed. However, declines in both species diversity and abundance have been precipitous throughout the 20th century, and they are currently listed as the most imperiled taxa in the watershed as well as across North America. Accompanying the decline of freshwater mussels is the loss of their functional role and ecological services. Long-lived, sessile, and filter feeding, Unionids are usually functional dominants in aquatic ecosystems where they are abundant, having profound beneficial effects when the ratio of filtering capacity to water volume is high. Under these conditions, unionids can substantially reduce particulates and contaminants, redistribute nutrients, and stabilize substrates. Beds of mussels also enhance benthic habitats, benefiting other plants and animals by adding structural complexity. Thus, the restoration of these organisms not only conserves imperiled taxa, but also restores transformative ecosystem services.

Prior to any restoration effort, it is helpful to determine which streams are capable of sustaining viable freshwater mussel populations. Many, perhaps most, streams in southeast Pennsylvania appear to have few or no remaining mussel populations, but only some of these are likely to have improved sufficiently in quality to support self-sustaining populations. As part of the Freshwater Mussel Recovery Program (see poster by Padeletti et al.), a method was developed to screen candidate streams for their ability to support reintroduced mussels. Caged mussels were deployed into 7 streams within 2 watersheds in Southeastern Pennsylvania. Approximately 15 adult mussels were added to each cage, and 4 cages were positioned in similar habitats of each stream. Controls consisted of cages of mussels held in source streams as well as uncaged animals (to test for caging effects.) Sampling of 3 or 4 mussels per cage was conducted 5 times during a one-year period. These mussels were analyzed for condition index and proximate biochemical composition to assess their physiological status.

No caging effects were observed and survivorship was nearly 100% over the study period; however, preliminary results suggest that mussel condition varied significantly among streams (mean = 31-56). Some streams that appear to harbor no mussels (e.g. Chester Creek) supported similar fitness as source streams (Ridley and Brandywine Creeks), suggesting that they are more suitable for restoration than other waterways where condition declined or was perturbed seasonally. These findings, along with future biochemical analyses, will be used to guide site selection for the Freshwater Mussel Recovery Program in 2009.

REGIONAL RESTORATION PLANNING CASE STUDY IN THE DELAWARE ESTUARY: ECOSYSTEM VALUATION ALONG AN URBAN WATERFRONT. **Simeon Hahn**, National Oceanic and Atmospheric Administration Office of Response and Restoration Assessment and Restoration Division, 1650 Arch Street, Philadelphia, PA 19103, USA; Phone: 215-814-5419; Fax: 215-814-3015; Email: simeon.hahn@noaa.gov, and Anthony Dvarskas and Jill Bodnar NOAA NOS ARD, Danielle Kreeger and Laura Whalen, Partnership for the Delaware Estuary, Paul Racette, Pennsylvania Environmental Council, and Lance Butler, Philadelphia Water Department. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #97)

A Regional Restoration Initiative (RRI) is being initiated by the Partnership for the Delaware Estuary, a National Estuary Program, working with several government and non-government organizations including NOAA ORR. The primary goals of this initiative are to (1) facilitate coordination among various conservation, enhancement, and restoration efforts underway, (2) apply scientific principles in evaluating ecosystem services resulting from different types of restoration efforts, (3) provide decision tools and a registry of high value projects for future restoration, and (4) encourage ecosystem-based approaches that maximize natural resource benefits over long time scales within the Delaware Estuary and its watershed. To launch the RRI, up to four case studies will be completed, including urban waterfronts, tidal wetlands, shellfish, and headwater streams.

The Pennsylvania Environmental Council is leading an effort for ecological restoration along the tidal Delaware River in North Philadelphia through a Coastal Zone Management grant. Restoration activities within the urban corridor of the Delaware Estuary face many challenges, and this effort will provide important information for the urban waterfront case study of the RRI. Urban habitat restoration is challenging because of concerns including high costs, potential contamination, and potential impacts on infrastructure. When a broader suite of ecosystem services in addition to local habitat are considered in the evaluation, restoration of urban areas provide substantially more benefits than are traditionally realized. An evaluation of this urban pilot area using the BRM and VARM approach in the Delaware Estuary RRI will be presented with a focus on shoreline protection and stabilization practices.

NOAA served as a natural resource trustee for the November 26, 2004, M/T *Athos I* Oil Spill on the Delaware River near the Citgo Refinery in Paulsboro, New Jersey. Habitat Equivalency Analysis (HEA) was used to quantify natural resource injuries resulting from the spill and to scale restoration benefits of potential restoration projects. Lardner's Point is a proposed restoration site located along the North Philadelphia Delaware Riverfront and is within the area oiled by the *Athos* spill. The shoreline restoration component, proposed to compensate for a portion of the *Athos* losses, involves demolishing existing structures, removing debris, importing fill material, grading the site to restore tidal inundation, and creating and planting intertidal marsh and wet meadow habitat. A "living shorelines" approach will be used, with excavated rock forming a toe sill at the marsh edge to stabilize the area and protect it from erosion. For the RRI pilot an extrapolation of the HEA was conducted to evaluate potential increases in an ecosystem service (productivity) under a potential restoration scenario.

MODELING CIRCULATION AND TRANSPORT PATHWAYS FOR OYSTER LARVAE IN DELAWARE BAY. **Dale B. Haidvogel,** dale@imcs.rutgers.edu; John Wilkin and Joseph Wang, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ 08901
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #101)

As part of a collaborative project, supported by the National Science Foundation Ecology of Infectious Diseases (NSF EID) program, we have developed and validated a three-dimensional circulation model of the Delaware Bay. The model, based upon the Regional Ocean Modeling System (ROMS), is forced by observed tidal, riverine and atmospheric fluxes. Validation of tidal heights, and current and tracer fields, for a target period in 1984 shows quantitative agreement between the model simulations and concurrent observations. Reconstruction of Lagrangian particle tracks has been used to infer transport pathways of larvae of eastern oysters (*Crassostrea virginica*) and MSX and Dermo disease pathogens. Initial results of these drifter release experiments also agree qualitatively with known oyster larval distribution patterns and as such provide a starting point for development of understanding of genetic exchange in Delaware Bay oyster populations. In the next phase of this project, we will add oyster larvae behavior to the Lagrangian particle tracking analysis, and begin to explore the impacts of past and potential future changes to circulation patterns in the Bay.

GETTING TO THE *ROOT* OF SALINIZED BAYSIDE FARMLAND MANAGEMENT.
Jennifer L. Halchak, Jack L. Gallagher, and Denise M. Seliskar. College of Marine and Earth Studies, University of Delaware, 700 Pilottown Road, Lewes, DE 19958, jhalchak@udel.edu.
Session 18, 3:15pm, 1/14/09 (presentation #31)

The Delaware Estuary faces many challenges as climate change alters the ecosystem. Boundaries surrounding the estuary, composed largely of farmland, will be noticeably changed. Two significant storms have flooded these farmlands recently, increasing salt concentration to above the traditional crop thresholds. As a salt-tolerant replacement crop, seashore mallow (*Kosteletzkya virginica*), could provide economic and ecological benefits to the estuary. Seashore mallow has the potential to be used for several products; biodiesel from its oil seeds, cellulosic ethanol from the stems, and animal feed from seed meal remaining after oil extraction. A major benefit of this plant lies in its substantial root system. The roots of *K. virginica* provide some of its salt tolerance, with the root surface excluding the salt from the surrounding water and soils. This exclusion allows for *K. virginica* to tolerate salinities up to 30 ppt, without the aid of excretory glands in the leaves, such as those of *Spartina alterniflora*. Its extensive root system that can reach depths greater than 76 centimeters after only two years growth allows the plant access to deep water sources that annual plants could not reach early in the season. The root system of *K. virginica* is a thick tuber-like structure, storing reserves used for initiating growth every spring. Our examination revealed that after two years of growth each plant root system stores an average of 6.9 grams of recoverable non-structural carbohydrates. These underground reserves help determine the number of stems each plants root crown will generate and their early growth rate. Stem quantity increases for each of the first three growing seasons. Soybeans and corn, annuals grown from seed each year, begin with weights of 0.22 grams and 0.24 grams respectively. Each mature *K. virginica* plant begins growth the third year with reserves greater than 23 soybeans or 21 corn kernels. This large storage capacity allows *K. virginica* to store carbon underground, with an average of 30 grams dry weight underground after two years. Our research determined a small addition of nutrients substantially enhances the storage capacity of *K. virginica*. These attributes from the root system are responsible for many of the reasons the species is attractive for saline agriculture and as a transition plant. As sea level rises the salinized fields would then be set for a natural transition from farm field into wetland, with *K. virginica* acting as a nurse crop for the common salt marsh plants.

ESTIMATING BANK EROSION IN THE WISSAHICKON CREEK WATERSHED: A BANK PIN MONITORING APPROACH. **Erik Haniman**, Philadelphia Water Department – Office of Watersheds, Aramark Tower, 4th Fl., 1101 Market St., Philadelphia, PA 19107, erik.haniman@phila.gov; **Session 16**, 11:15am, 1/14/09 (presentation #41)

In 2003, the United Stated Environmental Protection Agency (USEPA) instituted a Total Maximum Daily Load (TMDL) for sediment in the Wissahickon Creek watershed. In 2005, the Philadelphia Water Department (PWD) initiated a study to estimate the amount of sediment entering the stream system due to stream-bank erosion of Wissahickon Creek's tributary streams in Philadelphia to further inform the TMDL process.

Rosgen's "Bank Assessment for Non-point source Consequences of Sediment" model (BANCS) was utilized to provide an initial estimate of annual stream-bank erosion for Philadelphia's 12.3 miles of tributary streams to Wissahickon Creek. The first component of this method involved qualitative visual assessment of all stream banks. Each stream was divided into reaches classed by the Bank Erosion Hazard Index (BEHI) and Near-Bank Stress (NBS) scores. Using Rosgen's "Colorado Curve", annual erosion rates were predicted. The second component of this method required verification of the BANCS model's predictions based on empirical field measurements. In 2006, PWD installed bank pin monitoring sites at 82 locations along these streams evenly distributed among banks from each BEHI class. The majority of sites were monitored for two years, while the remaining sites were monitored for one year. Rivermorph 4.0 was utilized to calculate erosion rates at each monitoring location. The average erosion rate for each BEHI class was then used to estimate erosion at all banks with a similar BEHI class. An Analysis of Variance was performed to assess the independence of populations based on BEHI class. The 95% confidence interval was also determined for the average annual erosion rate.

The BANCS model predicted annual stream-bank erosion loading of 3.1 millions pounds per year using the "Colorado Curve". The ANOVA of the monitoring data revealed that each monitoring location could not be considered an individual population ($p = 0.29$). Therefore, the average erosion rate was determined by averaging the rates of all 82 sites as one population. Using this estimation method the annual loading to Wissahickon Creek from Philadelphia's tributary stream was 2.4 million pounds per year with a 95% confidence interval of +/- 1.6 million pounds per year. When the individual erosion rate averages by BEHI class are assumed as valid, the annual loading to Wissahickon Creek from Philadelphia's tributary stream was 2.3 million pounds per year with a 95% confidence interval of +/- 2.5 million pounds per year. The results of this study show a significant sediment loading contribution can be traced to streambank erosion in this system. However, actively eroding banks tend to be localized in most tributaries. The rather low erosion rate supports the contention that these streams are concluding their periods of active incision and widening. Given the results of the ANOVA, this study also reveals that one must be careful in implementing the BANCS model without having a considerable level of training and experience.

EULERIAN SAMPLING OF MARSH EFFLUENTS FOR THE DETERMINATION OF NUTRIENT EXCHANGE BETWEEN THE MURDERKILL ESTUARY AND ADJACENT SALT MARSHES. **Rebecca L Hays** and **William J. Ullman**, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958, rhays@udel.edu.
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #66)

Salt marshes are biogeochemically active ecosystems capable of significantly mobilizing and immobilizing nutrients in marsh-dominated estuaries such as the Murderkill (Kent County, DE), a Delaware Bay tributary. The contribution of marshes to nutrient bioremediation and immobilization, however, is often ignored in regional models of nutrient loading, as it is difficult to integrate loads over large and ecological diverse areas and to distinguish marsh-derived nutrients from other sources. We conducted a 40-hour Eulerian sampling of the waters filling and draining a polyhaline salt marsh near Webb's Landing, South Bowers, DE to develop efficient methods for determining marsh contributions to the nutrient budget of the Murderkill estuary. Hourly samples were collected for the determination of dissolved nutrients (NO_3^-, NH_4^+, PO_4^{3-}, and Si) and salinity (S). Tidal height and instantaneous flow velocity were measured by the USGS for determining discharge.

The direct method calculates the marsh nutrient load as the difference between the total integrated loads associated with outputs during ebb tide and the loads associated with inputs during flood tide. This procedure yields an imprecise estimate of the marsh-derived load due to large propagated errors. An alternative statistical method uses principal components analysis to characterize the composition of the three sources of water to the discharge site (Delaware Bay, Murderkill watershed, and marsh) and the relative contributions of each source to each water sample. Marsh loads are determined as the product of the total discharge measured at the site, the fraction of the water that is derived from the marsh, and the composition of the marsh end member. A third method employs a graphical mixing model to determine the excess nutrient concentration at the marsh discharge site above that contributed by the mixing of Delaware Bay and Murderkill watershed waters. Marsh loads are determined as the product of this excess concentration and the total measured discharge at the site. Excess concentrations, however, are negligible, except during the latter stages of ebb tide. Thus, once the other two sources of water are characterized, fewer samples of marsh effluent waters are needed to determine marsh-derived loads.

While all of these methods yield nutrient loads, the two latter approaches yield more precise estimates and, potentially, require fewer samples and analyses. The higher efficiency of the latter methods may make it possible to determine nutrient loads from a wider variety of marsh and estuarine settings and to better include these loads in estuarine nutrient budgets.

DEVELOPMENT AND IMPLEMENTATION OF A POLLUTANT MINIMIZATION PLAN (PMP) FOR POLYCHLORINATED BIPHENYLS (PCBS) IN THE DELAWARE RIVER ESTUARY. **Robert Hindt**, Delaware County Regional Water Quality Control Authority, P.O. Box 999, Chester, PA 19016-0999, HindtR@delcora.org and **John Botts**, Aquatic Sciences Consulting, 2130 Glencourse Ln, Reston, VA 20191.
Session 8, 9:45am, 1/13/08 (presentation #68)

The Delaware County Regional Water Quality Control Authority (DELCORA) was one of sixty Delaware River dischargers required to submit a pollutant minimization plan (PMP) for PCBs in September 2005. Total PCB concentrations in DELCORA's Western Regional Treatment Plant (WRTP) effluent (393 to 591 picograms per liter in 2007) are low compared to other Delaware River dischargers. However, the total maximum daily load (TMDL) established for Zone 4 of the Delaware River, where the WRTP discharges, is based on a water quality criterion of 44.8 pq/L total PCBs. In an effort to meet the TMDL, the Delaware River Basin Commission (DRBC) set an interim goal of reducing the aggregate point and nonpoint PCB loads across the estuary by 50 % within five years. The PMP generally followed DRBC's recommended outline for PMPs; although, the technical approach was tailored to DELCORA's WRTP and service area. This paper will describe how DELCORA identified known and potential sources of PCBs, implemented steps to minimize the release of PCBs to the WRTP and developed a plan for tracking down unknown sources.

When DELCORA began implementing its PMP, PCB sources were not initially apparent because PCBs have been banned since the late 1970s. However, PCB use is still allowed, particularly in sealed electrical and industrial equipment. DELCORA surveyed all of its permitted industrial users and WTRP facilities and found PCBs in transformers, capacitors and light ballasts at seven industrial user facilities, the WRTP and several pump stations. In the past twenty years, nearly three-fold more PCBs (75.7 kg) have been destroyed than remain at the user facilities (28.1 kg PCBs). An additional 5.7 kg of PCBs were removed from industrial user and WRTP facilities since the PMP was submitted. DELCORA inspects industrial user facilities annually and advises users to manage PCBs according to federal regulations. Information on PCB management is also shared with representatives of local industry, who participate in Environmental Advisory Council meetings. DELCORA also reviewed public records and found several current and former PCB waste sites in the WRTP service area. DELCORA proposed to assist the Delaware River Toxics Reduction Program (DelTRiP) in determining if these sites may release PCBs to DELCORA's combined sewers via storm runoff. Finally, DELCORA is in Phase III of the trackback plan in the WRTP sewer system to locate potential unknown PCB sources. Each of these PMP steps represents progress in meeting DRBC's goal.

UNDERSTANDING DISEASE RESISTANCE IN ESTUARINE POPULATIONS AND RESPONSE TO CLIMATE CHANGE. **Eileen E. Hofmann**, John Klinck, Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA 23508, hofmann@ccpo.odu.edu; David Bushek, Susan Ford, Ximing Guo, Eric Powell, Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349; Dale Haidvogel, John Wilkin, Institute of Marine and Coastal Sciences, Rutgers University, 71 Dudley Road, New Brunswick, NJ 08901. **Session 2**, 1:30pm, 1/12/09 (presentation #98)

Delaware Bay oyster (*Crassostrea virginica*) populations are influenced by two lethal parasites that cause Dermo and MSX diseases. Sudden onset of epizootics of these diseases have been documented for Delaware Bay oyster populations, such as the 1986 MSX epizootic that killed 70% of the oysters and coincided with a period of drought, highlighting the role of environmental conditions in regulating this disease. Epizootics result in modification of the genetic structure of oyster populations though removal of susceptible individuals and selection for disease resistance individuals. This selection may be further modified by introduction of individuals from putative refugia, such as low salinity regions. As part of the National Science Foundation Ecology of Infectious Diseases (EID) initiative a program has been developed for Delaware Bay with the objectives of understanding how oyster population genetics and population dynamics interact with the environment and the parasites to structure the host populations and how these interactions might be modified by climate change. Laboratory and field studies undertaken in this program have focused on identifying genes related to MSX and Dermo disease resistance, potential regions for refugia and the mechanisms that allow them to exist, the phenotypic and genotypic differences in oysters from putative refugia and high-disease areas, and the space and time variability in the effective size of the spawning populations. These data provide inputs to models of oyster genetics, population dynamics and larval growth, as well as, providing evaluation criteria for model simulations. The data and models are expanded to the larger system using a three-dimensional circulation model that has been developed for Delaware Bay. The model, based upon the Regional Ocean Modeling System (ROMS), is forced by observed tidal, riverine and atmospheric fluxes. Validation of tidal heights, and surface and bottom currents, for a target period in 1984 shows quantitative agreement between the simulated fields and concurrent observations. Reconstruction of Lagrangian particle tracks is being used to infer transport pathways of oyster larvae and MSX and Dermo disease pathogens. Initial results of the drifter release experiments also agree qualitatively with known oyster larval distribution patterns and as such provide a starting point for development of understanding of genetic exchange in Delaware Bay oyster populations. This presentation will provide an overview of the Delaware Bay EID project, describe results from the laboratory and field and modeling studies, and provide indications for future research directions for understanding long term changes in Delaware Bay oyster populations.

DEVELOPMENT OF HYDRO-GEOMORPHIC MODIFIERS FOR DELAWARE'S WETLANDS IN THE DELAWARE ESTUARY. **Andrew Homsey**, Water Resources Agency, Institute for Public Administration, University of Delaware, Newark, Delaware 19716.
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #77)

Traditionally, wetlands have been described by characteristics such as vegetative associations, substrate characterizations, tidal regimes, and degree of salinity. The U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI), for example, uses a hierarchical classification scheme based on categories published by Lewis Cowardin in 1979. In recent years it has become increasingly important to look at wetlands in functional terms, based on their hydro-geomorphic characteristics. Such a perspective can assist watershed managers in rapid watershed assessment (RWA) efforts, and become a basis for monetary valuation of wetland resources, which some sources have estimated at $5,000 to $7,800 per acre.

Under contract with the Delaware Department of Natural Resources and Environmental Control (DNREC) we developed a GIS dataset of hydro-geomorphic modifiers (HGM) for wetlands and water bodies in the watersheds of the Delaware estuary below the Chesapeake and Delaware Canal. Our approach followed a similar assessment undertaken by Ralph Tiner, of the U.S. Fish and Wildlife Service, in the Nanticoke watershed. Using these procedures we applied HGM attributes to the wetlands defined by the State's Statewide Wetland Mapping Project (SWMP). Since relationships between wetlands and flowing water bodies are critical to determination of HGM category, the National Hydrography Dataset (NHD) of streams and ditches was first augmented using the latest aerial photography. This layer, along with the SWMP layer were used as the basis for HGM determination. Additional data sets were used to inform the attribution process, including the location of hydric soils, tidal v. non-tidal regions, and flood-prone soils.

Several data management techniques and GIS tools were developed to automate much of the delineation process, in order to produce a robust, consistent, and topologically correct data set. Flow charts and data models based on the HGM key were produced, as were interactive menu interfaces which helped enforce data integrity. These tools also facilitated the quality control phase of the project.

The result of this project will be to assist managers by enabling classification of SWMP data based on wetland function, which according to Tiner may include: surface water detention, coastal storm surge detention, streamflow maintenance, nutrient transformation, sediment retention, shoreline stabilization, provision of aquatic habitat, provision of avian and other wildlife habitat, and conservation of biodiversity.

AMERICAN EEL ABUNDANCE: RECENT TRENDS IN SOUTHEASTERN PENNSYLVANIA.

Richard J. Horwitz, Paul F. Overbeck, David H. Keller*, and Shane M. Moser, Patrick Center for Environmental Research, The Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103, Horwitz@ansp.org

Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #83)

Understanding the status and trends of American eel (*Anguilla rostrata*) is important for this ecologically and commercially significant species. We are studying yellow-phase American eels in streams and rivers in Pennsylvania. Goals include re-sampling historically-sampled sites to provide quantitative comparisons of abundance, and assessment of eel abundance upstream and downstream of potential migration blocks. We found few samples with quantitative eel data from before the 1990s, and uncertainties about sampling protocols impeded comparisons with these samples. Most sites which were re-sampled were first sampled between 1997 and 1999, with some sites sampled in the early 1980's. From 2007-2008, we sampled 38 sites with existing eel data using single and multi-pass backpack electrofishing, including forest, meadow, suburban, and urban sites. We sampled several sites following dam removal. Preliminary results indicate variable changes in abundance between the earlier and recent samples. Decreased abundance and shift toward larger eels was seen in some sites. Greatly increased abundance was seen at one Susquehanna River tributary after removal of a dam near the mouth. The results of this study will be important for designing protection and restoration strategies for the American eel in the Delaware drainage.

ESTIMATION OF WATER CONSTITUENTS IN HYPERSPECTRAL MEASUREMENTS IN REHOBOTH AND INDIAN RIVER BAY.

Young-Heon Jo, Center for Remote Sensing, College of Marine and Earth Studies, University of Delaware, Newark, DE 19716,joyoung@UDEL.EDU; and Richard T. Field, Center for Remote Sensing, College of Marine and Earth Studies, University of Delaware, Newark, DE 19716, rtfield@UDel.Edu

Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #64)

The most desirable measurements are collecting information in the large regions of interests at the same time, but it is impossible. Other than that, the best way to collect high quality of data is combining in situ observations with remote sensing measurements. Remote sensing has been used to measure reflected, emitted, or back-scattered electromagnetic radiation from Earth's surface using instruments stationed at a distance from the site of interest. These spectral characteristics can be used to measure biogeochemical and, in turn, ecophysiological properties at various scales. However, it is not easy to work in the case II waters because of the optical complexity of coastal waters.

In order to monitor the environmental changes in the bays, we should know biological, chemical, and geological water constituents. In this study we used three different kinds of measurements. The first observations are water constituent measurements in the laboratory from water sampling, salinity, temperature, Seche depth, water depth, Organic Suspended Sediment (OSS), Inorganic Suspended Sediment (ISS), Chlorophyll a (Chl_a), Phosphorus, and Nitrogen, which are used to identify their signals in the spectral measurements. The second measurements

are spectral measurements using a hand held ASD spectral radiometer as ground truth spectral signals, which are used to calibrate airborne spectral measurements over the bays. The first and the second measurements were conducted at the thirteen stations in the bays. The third data are airborne hyperspectra measurements using AISA. We will discuss how we can apply spectral measurements from airborne hyperspectral measurements to derive various water constituents using various regression models based on band ratios.

Specifically, we developed algorithms to obtain chlorophyll_a concentrations using Florescent Line Height (FLH) based on two bands, 667nm and 748nm, Total phosphorus using a band ratio (*R*554/*R*675,) turbidity using a band difference (*R*710-*R*740), etc. Where *R* is a reflectance at given wavelength in nm.

Since the spectral shape of water leaving radiance integrates the optical signature of biological, chemical, and geological properties, we may identify some of individual radiance components as demonstrated in this study.

PARTNERSHIPS DEVELOPED THROUGH THE CORPORATE ENVIRONMENTAL STEWARDSHIP PROGRAM (CESP): **Karen Johnson, Laura Whalen,** Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, lwhalen@delawareestuary.org. **Session 15**, 9:30am, 1/14/08 (presentation #126)

The Delaware Estuary Corporate Environmental Stewardship Program (CESP) provides corporations within the Delaware Estuary region with the opportunity to take a leadership role in preserving our community's environmental well-being. CESP is designed to provide corporations across the region with the technical expertise to help them better manage and enhance their land by using native species and restoring natural habitat. The program not only helps to improve the environmental health of the Estuary, but also increases employee morale and reduces property maintenance at the participating sites. The companies involved do a variety of projects ranging from planting small native garden to constructing an entire wetland to providing educational programs for local schools or communities. Therefore, through CESP, corporations can conduct on-site habitat projects, provide employee volunteer opportunities, and offer environmentally themed presentations for their employees.

THE NEED TO CONSIDER THE CUMULATIVE IMPACT OF MULTIPLE LARGE INDUSTRIAL WATER INTAKES ON FISH STOCKS OF THE DELAWARE ESTUARY.
Desmond M. Kahn, Delaware Division of Fish and Wildlife
P. O. Box 330, Little Creek DE 19961 desmond.kahn@state.de.us
Session 18, 2:15, 1/14/08 (presentation #117)

The tidal Delaware River is used for cooling water for several large industrial plants, including one of the largest intakes in the world. These facilities are located in the nursery zone for several estuarine spawning and oceanic spawning species of fishes, which are subject to entrainment and impingement impacts. When regulators develop permits for these plants, they often require detailed sampling of plant intakes to develop estimates of total number of animals killed by species, life-stage and season. These data are commonly used to develop estimates of the numbers that would have survived to older life-stages if they had not been killed by the facility. Another modeling exercise often employed is to develop estimates of the mortality rate of the species due to plant mortality. These rates are called conditional mortality rates, because they are conditioned on the assumption that there is no other source of mortality in operation. Because each plant's impact is examined in isolation, the cumulative impact of these plants on a given population is not considered. Yet the cumulative impact should be the main concern. Although the impact of one plant may be judged acceptable, when such an impact is seen as only part of a cumulative impact, the cumulative impact can be far larger and unacceptable. I will discuss the major industrial facilities that cause impingement and entrainment mortality of the fish stocks of the estuary and attempt to develop some estimate of cumulative impacts, where data exists to permit such an estimation.

POTENTIAL IMPACT OF CHANGING SEA LEVEL AND STREAMFLOW ON SALINITY OF THE UPPER DELAWARE BAY. **R. G. Najjar and M. E. Mann,** Department of Meteorology The Pennsylvania State University, University Park, PA 16802, bgk111@psu.edu. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #80)

We analyze a time series of salinity in the upper Delaware Bay from 1963 to 2007 with the aim of quantifying the impact of streamflow and sea level. 80% of the variability in seasonally averaged salinity can be explained with a simple, four-parameter function of streamflow. After removing the streamflow influence we find that salinity has increased 1.08 ± 0.47 over this time period, 22 ± 10% of the long-term mean of 4.8. This increase is greater than expected from sea-level rise, based on relationships between salinity and sea level derived from numerical models and short-term observations. Long-term changes in the bathymetry of the Bay may explain the discrepancy. The projected increase in salinity due to sea-level rise by 2100 is 3.3 ± 3.1 (69 ± 65% of the mean), similar in magnitude to projected streamflow impacts.

WATER QUALITY TRENDS IN THE DELAWARE RIVER BASIN FROM 1980 to 2005. **Gerald J. Kauffman**, University of Delaware, Water Resources Agency, DGS Annex Building, Academy Street, Newark, DE, 19716, jerryk@udel.edu; **Andrew C. Belden and Priscilla R. Cole,** University of Delaware, Center for Energy and Environmental Policy, Graham Hall, Newark, DE, 19716. **Session 14**, 9:00am, 1/14/09 (presentation #79)

In 1940, the Interstate Commission on the Delaware River Basin called the Delaware River at Philadelphia *"one of the most grossly polluted areas in the United States"*. Since then water quality in the Delaware River Basin has improved (except for nitrogen) during an era that coincided with environmental laws creating the 1961 Delaware River Basin Commission compact, 1972 and 1977 Clean Water Act Amendments, and 1996 Delaware Estuary Program. A land grant consortium representing the Basin states - Cornell University, Pennsylvania State University, Rutgers University, and University of Delaware - examined water quality trends from 1980 to 2005 at 15 monitoring stations along the river, estuary, and major tributaries in the

Delaware Basin. The nonparametric Seasonal Kendall test, scatter plots, and box plots of the time series data were applied for detecting trends. Between 1980 and 2005, water quality improved at 63%, remained constant at 10%, and degraded at 27% of the stations. Since 1980, dissolved oxygen improved at 67% and degraded at 33% of the stations. Total phosphorus improved at 71%, remained constant at 21%, and degraded at 7% of the stations. Nitrogen remained constant at 20%, and degraded at 80% of the stations. Total suspended sediment improved at 86% and degraded at 14% of the stations. Since 1980, the number of improving water quality stations (26) outnumbered the degrading stations (11) by a margin of nearly 2 ½ to 1. Water quality is good in the freshwater Delaware River upstream from Trenton and declines to fair to poor where nitrogen and phosphorus levels exceed standards in the tidal estuary near Philadelphia and in large tributaries such as the Lehigh and Schuylkill Rivers. Water quality recovery is coincident with the return of striped bass, American shad, and bald eagle populations to the Delaware River Basin.

ADAPTING TO CHANGING CLIMATE, WATERSHEDS AND ECOLOGICAL INTERACTIONS IN THE DELAWARE ESTUARY. **Danielle Kreeger,** Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, dkreeger@DelawareEstuary.org. **Session 1**, 11:30am, 1/12/09 (presentation #109)

Like most American estuaries, the consequences of climate change in the Delaware Estuary will be complex. Natural resources and ecological relationships typically shift in non-linear fashion to incremental changes in physical forcing factors such as temperature, sea level and salinity. Interactions between fauna and flora, including people, occur in a web of direct and indirect feedbacks. All species depend on others, and have maximum and minimum tolerance limits for physical conditions. Some hallmark resources could be pushed past thresholds where they can no longer support ecological or human health. If lost or diminished species are ecological dominants, then effects can cascade through the ecosystem potentially leading to breached ecosystem tipping points and degradation of life-sustaining ecosystem services. Complicating matters, some changes in physical conditions may not be smooth, such as annual and seasonal precipitation or weather extremes, which may already be more erratic than in the past. Lastly, climate change is happening concurrently with large-scale watershed changes that present their own environmental challenges. Increasing impervious surface and water withdrawals combined with the continued loss of natural buffer lands that furnish resilience are examples of factors that will exacerbate climate change effects.

Despite the complexity and challenges, we can plan for the future by drawing on a wealth of past scientific information and models of cooperative management to develop a coordinated adaptation strategy. To do this, we must rapidly develop and thereafter strengthen a scientifically-based ecosystem model that explains the natural balance and functional importance of key linkages among primary resource components. This is needed to understand current "baseline conditions," and thereafter, climate change will drive a *massive natural experiment* which should provide a wealth of opportunities for fine tuning the model and learning more about the system. Rigorous monitoring, new ecosystem studies, and iterative ecosystem modeling can provide critical information to managers and policy-makers who must now adaptively manage the system from a broader, ecosystem perspective. Adaptation planning efforts are underway in our region, including our Climate Ready Estuaries Pilot (see poster by Cole). To prepare for climate change beyond mitigation measures and reactive management, our scientific, management and planning community can coordinate these efforts into a watershed-based adaptation program. This program could begin with a strategy assessment that shares lessons learned from current efforts and outlines the needed monitoring and scientific infrastructure, operational activities, financial resources, and outcome-based links to policy change and on-the-ground action.

A SCIENCE-BASED REGIONAL RESTORATION INITIATIVE IN THE DELAWARE ESTUARY. **Danielle Kreeger, Jennifer Adkins, Laura Whalen and Priscilla Cole,** Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, dkreeger@DelawareEstuary.org. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #114)

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 our new Regional Restoration Initiative (RRI) is to provide a science-based decision-support system that proactively guides restoration activities to ensure that outcomes: 1) reach their fullest promise, 2) are tailored to maximize ecological needs for specific sub-watershed regions, and 3) 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".)

Beginning in 2006, we began working with collaborating entities to outline a RRI that 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 "consensus 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 RRI began in 2008.

The RRI science track will contrast restoration activities that most appreciably enhance the natural capital of ecologically significant living resources and habitats within each of eight sub-watershed regions (Basic Restoration Matrices, BRM's). The relative importance of different resources in different regions will be characterized according to a natural capital credit system that considers many traits, such as their provisioning, regulating, supporting and cultural services (Value-Added Restoration Matrices, VARM's). Restoration matrices and decision support tools will be linked to projects in the registry, and vice versa, so that 1) projects can be easily prioritized based on projected ecosystem goods and services outcomes, and 2) projects can be cultivated to fill gaps where high value outcomes are not being addressed. Rapid decision tools remain the focus so that project selection can occur at any time using best scientific judgment, but over time a new Regional Restoration Work Group will strengthen these tools. Initially, the RRI science track is focusing on four case studies: urban waterfronts (see Hahn poster), tidal wetlands, bivalve shellfish and headwaters. These focus areas have multiple "stacked" resource values and strong partner interests.

GETTING THE WORD OUT: STORMWATERPA, A MULTI-MEDIA BLUEPRINT FOR SUCCESS. **Barry Lewis**, GreenTreks Network, Inc. 1420 Walnut Street, Suite 1304, Philadelphia PA 19102, blewis@greentreks.org. **Session 11,** 2:45pm, 1/13/09 (presentation #14)

Al Gore's Emmy award-winning documentary "An Inconvenient Truth" not only provided American's with an environmental reality check, it demonstrated the power of grass roots outreach, multi-media marketing, web-video, and blogs… On the lead up to the recent election, President-elect Barak Obama used many of these same methods and technologies to energize and mobilize new blocks of voters, undoubtedly changing the way campaigns will be run. What can environmental groups learn from these examples? What kinds of messages and methodologies can we employ to reach "beyond the choir" and create behavioral change? GreenTreks Network is a nonprofit that has been working to help others answer these questions for years, and is the organization behind the innovative multimedia outreach effort known as StormwaterPA.

Stormwater runoff is the number one cause of water quality impairment in southeastern PA and has a tremendous impact on the Delaware Estuary. As population continues to grow—especially along our waterways—so will the effects of runoff if we don't act quickly to implement policies and practices that get it under control. The release of PA DEPs Stormwater BMP Manual was intended to help municipalities do just that, but despite its forward-thinking approach to stormwater management, it is at great risk of being dismissed and not being put into use. Why? Because the Manual is a highly technical guidance document that has no actual "teeth". It is perceived as a one size fits all prescription that doesn't consider local realities or take into account the wide variation in landscapes, geology, hydrologic conditions, and other factors that affect how runoff is managed in various parts of the state. StormwaterPA aims to dispel these misconceptions by showing that a wide range of stormwater management options exist and that the Manual is actually a flexible toolbox full of solutions. This education and outreach initiative is designed to provide advocates and decision-makers with the inspiration, tools, and techniques to improve water quality through more effective management of stormwater in municipalities all over the state.

INNOVATIVE SAMPLING TECHNIQUE FOR MONITORING NATURALLY OCCURRING COLLOIDAL PARTICLES IN GROUNDWATER

Yao-Tung Lin[1], Yu-Hsiang Weng[2], Chin-Pao Huang[3] , [1] Department of Soil and Environmental Sciences, National Chunhsing University, Taiwan, yaoyung@nchu.edu.tw [2]Department of Civil& Environmental Engineering, University of Delaware, DE 19711, f88541105@ntu.edu.tw [3]Department of Civil& Environmental Engineering, University of Delaware, DE 19711, huang@ce.udel.edu. **Session 14**, 10:00am, 1/14/09 (presentation #63)

Low-flow-purging, bailing and high-flow-purging sampling methods were used to sample well water which contains naturally occurring colloids. The water samples were filtered using the prototype cross-flow electro-filtration system (CFEF) unit at various field strengths (which controls particle size) and pH (which controls surface charge). Results indicate that water-sampling methods appear to strongly affect the particle size distribution, total solid content and total lead concentration. Apparently the disturbance caused by bailer and high-flow-purging technique brings about high total solid concentration in the water samples. Results also show that lead in the well water almost all associated with the colloid. From the total solid content and lead concentration of water samples data, the larger the concentration of total solid the greater the lead concentration in the water samples. The CFEF module consists of an external tube, an inner charged cathodic filter membrane (circular shape), and a co-centric anodic rod. The cathode/filter and the anode collector are connected to a d.c. power supply that provides the electric field. By adjusting the applied field it is possible to differentiate the colloidal particles into various size and surface charge fractions. The concentrations of lead in particles of different size and surface charge are different. Generally, the concentration of lead species increases with increasing field strength, that is, the smaller the particles the greater the metal concentration content regardless of sampling method. While the difference in lead concentration in particles of different charge is not as significant as that of particle size, there is clear indication that the lead concentration is affected by the pH under which the particles are separated. The CFEF process can be an important technique for the speciation of various chemicals in natural water such as groundwater. Moreover, CFEF is able to separate naturally colloidal particles without operational difficulties such as clogging.

LANDSCAPE-SCALE FOREST RESTORATION IN THE WHITE CLAY CREEK WATERSHED, PENNSYLVANIA. **Robert Lonsdorf**, Brandywine Conservancy, P.O. Box 141 Chadds Ford, PA. 19317, rlonsdorf@brandywine.org; and Jessie Benjamin, Taproot Native Design, 1062 Glen Hall Road, Kennett Square, PA 19348. **Session 5**, 3:15pm, 1/12/09 (presentation #6)

Forests are the classic, defining land cover and habitat type under which most Eastern U.S. and Delaware Estuary watersheds, soils, and wildlife evolved and reached a dynamic but stable equilibrium over a very long period of time. Related, forests are the natural land cover type that best supports healthy streams and native wildlife populations; manages stormwater; protects and builds soils; promotes aquifer recharge, groundwater infiltration and a balanced hydrologic cycle; and protects water supply. Today, forests are widely recognized as an important part of an informed societal response to global warming threats. In sum, in this region forests are the natural land cover type that best supports the achievement of society's water quality goals and the broad protection of the Delaware Estuary, located at the "receiving end" of its watershed.

The once-free broad suite of "ecosystem services" that forests provided have been lost and degraded over the past three centuries as the forests were rapidly cleared to make way for Euro-American settlement and growth. The White Clay watershed, part of the broader Brandywine-Christina Basin and the lower Delaware Estuary watershed, received national Wild and Scenic River Status in 2000. The Wild and Scenic management plan calls for the preservation and protection of existing mature woodlands, as well as forest restoration at a "location, scale, intensity and frequency dictated by the ecological characteristics of the landscape." The original forest cover of the 35,000-acre Pennsylvania portion of the White Clay Creek Watershed, the study area for this Reforestation Plan, was perhaps 90-95% of the whole. Current forest cover is calculated to be approximately twenty-four percent (24%). This plan proposes reforesting the watershed to obtain a forty percent (40%) canopy cover as a minimum to retain and protect watershed health. This represents an increase in approximately sixteen percent (16%) or 6,300 acres of forest cover, not quite ten square miles.

The plan analyzes current forest conditions; evaluates reforestation priorities including headwater areas, riparian and wetland buffers, greenway corridors, institutional, suburban and marginal agricultural lands; outlines implementation approaches and identifies funding sources and management and monitoring needs. It recommends a broad-based, steady implementation approach.

SANDS OF TIME: SURVIVAL OF THE GRITTEST. **Robert E. Loveland**, Department of Ecology, Cook College, Rutgers University, New Brunswick, NJ 08901, robert.loveland@gmail.com ; and **Mark L. Botton**, Department of Natural Sciences, Fordham University, 113 West 60th Street, New York, NY 10023. **Session 4**, 3:15pm, 1/12/09 (presentation #69)

Arthropods have been around for a very long time. Among the oldest surviving groups, modern day horseshoe crabs can be traced back about 445 million years to the Late Ordovician, as represented by the recent finding of *Lunataspis aurora* from Manitoba, Canada. Sandstone can be traced back to the earliest existence of sedimentary rocks on earth, and is particularly common across extensive areas of the U.S. west, such as the Grand Canyon and the Colorado Rockies. Unfortunately, sandstone is not a good medium for finding those marine fossils which may have occupied the intertidal zone. Thus, there is no solid record of horseshoe crabs which might shed light on the paleoecology of some sand preferring species. But what we do know is that sand is an incredibly prolific sediment, and has probably existed continuously throughout the earth's geologic history, no matter where the ocean was at the time!

In New Jersey, sand is the dominant feature of the landscape along the Atlantic coast, and extends well onto the continental shelf. Although deeper water sediments of Delaware Bay are largely fine (muddy) sediments, there exists a ribbon of sand along much of the coastline of lower Delaware Bay. It was not always, and may not continue to be, the way it is today. Delaware Bay looked entirely different 10,000 years ago, at the end of the last glacial period. With global ocean rise, the bay will, no doubt, continue to “evolve.” However, we speculate that horseshoe crabs excel at finding suitable beaches, and subsequently spawning there in the spring. Against the odds that beaches will move and change repeatedly, but will always exist, horseshoe crabs have most likely always had good spawning areas in locations like Delaware Bay.

This paper will review the origin of sandy beaches, and discuss those physical characteristics of beaches which are preferred by *Limulus polyphemus* in Delaware Bay. We will demonstrate short term changes in the morphology of the beaches of Delaware Bay, and present evidence of the adaptability of *Limulus* with regard to utilizing marginal habitats as spawning areas.

[grit *n*. 1. Tiny rough particles, as of sand.... 2. *Informal*. Indomitable spirit. American Heritage Dictionary.]

CONTAMINANTS OF EMERGING CONCERN IN THE TIDAL DELAWARE RIVER.
A. Ronald MacGillivray, Delaware River Basin Commission, 25 State Police Drive, West Trenton, New Jersey 08628, Ronald.MacGillivray@drbc.state.nj.us. **Session 8**, 9:15am, 1/13/09 (presentation #18)

A pilot survey in the mainstem of the tidal Delaware River sampled and analyzed ambient waters for pharmaceuticals and personal care products (PPCP), and perfluorinated compounds (PFC) by liquid chromatography/tandem mass spectrometry (LC/MSMS); hormones, sterols and nonyl phenols by gas chromatography/mass spectrometry (GC/MS); and polybrominated diphenyl ethers (PBDE) by high resolution gas chromatography/mass spectrometry (HRGC/MS). Twenty-one out of fifty-four PPCP analytes were detected in ng/L concentrations. Aquatic ecotoxicity data, primarily based on individual compounds and single species tests, are readily available for only sixteen out of the twenty-one PPCP analytes detected limiting assessment of risk to aquatic life. PFC were measured in ng/L concentrations that exceed a benchmark for water quality. Nonyl phenol levels did not exceed current United States Environmental Protection Agency water quality criteria. PBDE were measured in pg/L to ng/L concentrations with homolog distributions similar to those observed in other North American locations. Natural and synthetic hormones were reported in ng/L levels. Concurrent, short-term chronic toxicity tests for survival, growth, and reproduction in the ambient water samples did not indicate toxicity for species and endpoints measured. Assessment of ecotoxicity from emerging contaminants in the tidal Delaware River would be further informed by estrogenicity screening, biomarker measurements and population (sex ratio) surveys.

USING HIGH-RESOLUTION 3D GEOPHYSICAL METHODS TO CONSTRAIN OFFSHORE SAND RESOURCES FOR BEACH REPLENISHMENT: RESULTS FROM THE DELAWARE BAY BENTHIC MAPPING PROJECT. **John A. Madsen**, Department of Geological Sciences, University of Delaware, Newark, DE 19716, jmadsen@udel.edu; Bartholomew Wilson and Michael Rhode**,** Delaware Coastal Program, Division of Soil and Water, Delaware Department of Natural Resources and Environmental Control, Dover, Delaware 19901. **Session 16**, 11:45am, 1/14/09 (presentation #44)

The Coastal Program of the Delaware Department of Natural Resources and Environmental Control is conducting a bottom and sub-bottom imaging project to map the bottom habitat and sub-bottom sediments of Delaware Bay. As part of this project, chirp sub-bottom profiles are integrated with RoxAnn bottom sediment classification data to constrain the thickness and continuity of sediment layers. The data are being used to develop maps of suitable offshore sand deposits for beach replenishment based upon location, thickness, overburden, grain size, and subsequently delineated to areas that would minimize the effects upon essential fish habitat (i.e., *Sabellaria vulgaris* habitat).

As an example of the utility of using these data for the location of potential offshore sand resources, survey results from areas off Kitts Hummock and Bowers Beach, Delaware will be discussed. In these areas, grids of RoxAnn acoustic and chirp sub-bottom profiles were collected from the nearshore (water depths as shallow as 1.5 m) to distances further than 5 km offshore. Reflections observed on the networks of chirp profiles were used to locate vibracores used to ground-truth sediment types and grain sizes. In the Kitts Hummock area, the vibracore data, when integrated with the chirp profiles, show that potential offshore sand resources are limited to a thin (<0.5 m thick) layer of near surface sands or to depths of greater than 1.5 m beneath the bay bottom. The finer-grained silts above the deeper sands are too great of an overburden to make the deeper sands a viable resource for beach replenishment. Vibracores from the Bowers Beach area indicate fine- to coarse-grained sands beneath a relatively thin (~0.5 m) veneer of silts. A three-dimensional map of the lateral extent and thickness of these potential sand resources for beach replenishment was generated by correlating the sediment layers as indicated by the vibracores with digitized chirp reflections.

Within the framework of "Planning for Tomorrow's Delaware Estuary", using geophysical data coupled with "ground-truth" information from cores to constrain the nature of sub-bottom sediments in the estuary provides managers with critical information that can be used to make cost-effective decisions concerning the availability/placement of offshore borrow sites for beach replenishment. If these sites are designated for use in a replenishment project, a critical need would be to set in place monitoring surveys to study how these sites are impacted by, and evolve over time due to, the removal of the sand resource with subsequent sediment infilling.

CHARACTERIZING TIDAL INUNDATION OF WETLANDS IN THE MURDERKILL ESTUARY (KENT COUNTY, DELAWARE). **Thomas E. McKenna**, Delaware Geological Survey, University of Delaware, Newark, DE 19716. **Session 17**, 11:30am, 1/14/09 (presentation #50)

A coupled hydrodynamic and water-quality model is currently being developed to investigate causes of low dissolved oxygen in the Murderkill River. A key component of the effort by the Murderkill Study Group is to incorporate the interaction of the river with an extensive fringing salt marsh into the model. However, it is rare to explicitly simulate wetland inundation and biogeochemical reactions in estuarine-scale models as it is computationally intensive and requires many input variables that are difficult to quantify. Therefore, a parameterization of river-marsh interaction is being developed including this characterization of tidal inundation. In general, the dynamic inundation of a salt marsh by tidal water is a simple concept, but the process remains poorly understood. This is partly due to the sampling requirements to fully describe a shallow flow system on a low relief surface having high temporal and spatial variability. This study integrates data from LiDAR elevation surveys and in-situ sensors (water level, salinity, temperature) to estimate the area and frequency of salt marsh inundation by tidal water. Given the low relief on the marsh platform, small changes in tide elevation (centimeters) result in large changes in inundated area, therefore it is critical to ensure that survey errors and/or bias are minimized and all elevation data are reduced to a common geodetic datum (NAVD88). Initial estimates of the frequency, duration, and potential depth of inundation are based on LiDAR elevations and tidal elevations from tide gages in the Murderkill River. In the initial estimate, inundation is based only on elevation with no explicit hydrodynamic component. Subsequent estimates incorporate information from tide gages in small tidal channels cutting through the salt marsh and tidal channel geometry. Aerial and ground-based thermal imaging is used along with data from in-situ temperature loggers on the marsh platform to test the accuracy of the estimates.

"Planning for Tomorrow's Delaware Estuary:" Forward progress in understanding the complex hydrology of tidal wetlands requires collection of water level, salinity, and temperature at higher frequency than the major stressor on the system (tide). In-situ sensors and data loggers are essential; ground-based, time-lapse remote sensing may also be a viable option in some situations.

THE GROWTH POTENTIAL OF STREAM FISHES AS AFFECTED BY CHANGES IN WATER TEMPERATURE DRIVEN BY CLIMATE AND LAND-USE IN THE DELAWARE RIVER BASIN**.** **Jerry Mead**[1] Fredrick Scatena[2], Richard Horwitz[1], Yude Pan[3], Richard Birdsey[3]. [1]Academy of Natural Sciences, Philadelphia, PA, United States [2]University of Pennsylvania, Philadelphia, PA, United States, , [3]USDA Forest Service, Newtown Square, PA, United States. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #131)

We developed reach-scale models of stream water temperature using measurements of water temperature, reservoir bottom releases of water, and maps of land cover, surface geology, soils, and climate analyzed at the watershed- and reach-scale. These models were then applied to all non-tidal, freshwater streams within the Delaware River Basin to: a) determine how management strategies would effect water temperature considering issues of scale; and b) assess the effects of climate and land-use-change on the GP of three native fishes (Brook trout (Savelinus fontinalus), juvenile American shad (Alosa sapidissima), and Yellow Perch (Perca flavescens)) and three non-native fish species (Smallmouth bass (Salmolnus microptera), Common carp (Cyprinus carpio), and Brown trout (Salmo trutta)) using fish bioenergetic models. Two different sets of water temperature models proved robust; those for streams draining less than or greater than 100 km2. For the smaller watersheds 87% of the variation in water temperature was explained by percentage of the riparian zone covered by forest, limestone, and impervious surface, and four day average air temperature at the reach and watershed. For large streams, models explained about 76% of the variance in water temperature. Average simulated fish GP in grams per individual per unit area was 2.04 Brook trout, 0.88 Shad, 3.73 Yellow Perch, 1.27 Smallmouth bass, 1.18 Carp, and 1.68 Brown trout under current conditions. Respectively, scenarios of GP of these fishes as a percentage of difference from current conditions were 4.6, -7.8, -2.4, -7.9, -3.3, and 76.0 with reforested riparian zones; -11.6, 10.9, 4.2, 11.4, 8.0, and -24.0 with around 2.5 degrees Celsius of global warming; and -6.2, 9.4, 3.9, 9.8, 7.2, and -20.9 with reforested riparian zones including global warming. Therefore, reforesting riparian zones could counteract global warming's affect on GP, but the impacts depended on the region and stream size.

EVALUATING THE RISK OF INITIATING A REPRODUCTIVE POPULATION OF SUMINOE OYSTERS FROM TRIPLOID AQUACULTURE IN CHESAPEAKE BAY.

Elizabeth Methratta*[1], **Charles Menzie**[2], **Theodore Wickwire**[2], **William Richkus**[1] [1]Versar, Inc., Ecological Sciences and Applications, Columbia, MD 21044, LMethratta@versar.com
[2]Exponent, Alexandria, VA 22314. **Session 18**, 3:00pm, 1/14/09 (presentation #94)

Virginia and Maryland have engaged in a five-year program to address how to best restore oysters to Chesapeake Bay. Several alternatives are being considered including introduction of a fertile form of the non-native Suminoe oyster (*C. ariakensis*) and aquaculture of a sterile form of the non-native. We were charged with developing and implementing an approach for evaluating the ecological risks associated with these options. Recent research on the biology of *C. ariakensis* was used to evaluate the potential beneficial and adverse effects of introducing the fertile form of the Suminoe oyster. For the aquaculture option, a multistep invasive species methodology was used to evaluate the probability that the deployment of sterile Suminoe oysters in field-based aquaculture could give rise to a reproductive population. Six pathways that could potentially lead to the unintentional release of reproductive Suminoe oysters from aquaculture were identified, and for all quantifiable pathways, a probability was estimated for each step based upon knowledge of ecological rates. Using these pathways, a conservative estimate for the number of reproductive Suminoe oysters that could arise over one spawning season at a representative hypothetical aquaculture site was estimated. A statistical expansion of this probability estimated that the cumulative probability that cultivation of sterile Suminoe oysters could initiate a reproductive population in Chesapeake Bay over a 10-year time span would be approximately 8%. Restoration goals in estuarine ecosystems must be balanced by estimates of the ecological risks associated with implementing the restoration. The probabilistic approach to risk estimation used here provided a useful method for summarizing the risk of introducing a non-native species with complex life history traits. The results of this analysis may have important implications for oyster restoration and management within the Chesapeake Bay and beyond.

THE USDA-NRCS, CAPE MAY PLANT MATERIALS CENTER-A Case Study in Developing a Revegetation Plan for a Brownfield Site in Cape May County, NJ. **Christopher F. Miller,** *USDA-NRCS, Cape May Plant Materials Center, 1536 Route 9 North, Cape May Court House, NJ 08210, chris.miller@nj.usda.gov*. **Session 7**, 10:15am, 1/13/09 (presentation #33)

A plan to restore native vegetation to the scarred industrial portion of a State acquired Green Acres property along the Delaware Bay was developed by the USDA-NRCS, Cape May Plant Materials Program, in cooperation with the NJ Department of Environmental Protection. This property represents an ecologically important link with Higbee Beach State Wildlife Management Area and Cape May Point State Park.

Previously owned by Dresser Industries, it operated the Harbison-Walker - Cape May Works from 1941 to 1983. Operations at the plant consisted of reacting softened, clarified sea water from Delaware Bay with limestone to produce magnesite (magnesium carbonate) refractory brick. This brick was used to line steel making furnaces during and after World War II. The factory closed in 1983 and was demolished leaving behind a water tower and scars on the landscape including a "landfill" of process waste of magnesite and limestone. The alkalinity (high pH) of the processed waste prevented significant colonization of vegetation. Environmental contamination was cleaned up by Dresser Industries pursuant to the Environmental Cleanup Responsibility Act, however this 56 acre disturbed site had remained relatively unvegetated since the plant closure in 1983.

The revegetation plan involved creating a “soil” which will support native vegetation. The magnesite has no organic matter and a high pH (7.9-9.9), which supports little natural vegetative growth. Consequently, the restoration plan involved amending the magnesite material with incorporated dredge material. The source of this dredge material was the Cape May Canal Dredge Disposal facility. This process will add some needed organic matter as well as lower the pH of the “soil” over time, through oxidation. Initially the dredge material had an alkaline pH (8.1) and contained a high level of soluble salts (4.6 mmho/cm). Any recommended plants would have to tolerate the initial high pH and high soluble salts. The seeding mixture included native cool/warm season grass and forb species such as alkali saltgrass, switchgrass, coastal panicgrass, Canada wildrye, partridge pea, and evening primrose that could tolerate the changing soil chemical conditions.

This paper will discuss the procedure undertaken and the progression of native plant establishment through four growing seasons on this unique site.

ACQUISITION, CURATION AND DIGITIZATION OF A COLLECTION OF DELAWARE ESTUARY BENTHIC INVERTEBRATES FROM OVER FIFTY YEARS AGO. **Douglas C. Miller**, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958, dmiller@udel.edu; and **Stephen L. Gardiner**, Department of Biology, 101 N. Merion Ave., Bryn Mawr College, Bryn Mawr, PA, 19010.
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #88)

William H. Amos made numerous collections of benthic invertebrates in the Delaware Estuary in the 1950's and kept meticulous records of the species he found. Amos sampled at least 130 stations, ranging nearly the full length of the estuary from Philadelphia to just outside the bay mouth. Recently, Amos' collection of over 2100 vials and jars has been reunited with over 500 species cards, and both are now stored in Lewes. We have started curating and digitizing parts of this collection effort, beginning with the polychaetes. Specimens have been individually re-examined, identifications checked and updated, and transferred to new preservative. In total, 541 specimens in 317 vials were examined, resulting in 47 species in 25 polychaete families. Seven species dominated the collection, representing 74% of the specimens collected. To begin digitization, all cards have been scanned for archival purposes, resulting in a total of 761 image files occupying about 1 GB of disk space. As with the specimens, we began key stroking data with the 86 polychaete cards, averaging about 7 records each. Information for each species occurrence includes the date, location and gear used plus hydrographic information (temperature, salinity and dissolved oxygen) in many cases. Even a cursory examination of the vials and cards reveals many familiar benthic species that are still common in the estuary today. However, computerization of the card records, supplemented by the specimen labels, should help address such questions as what species have been lost, what shifts in distribution have occurred, and what new or exotic species have arrived in the last half-century? Our initial efforts in curation and digitization will indicate the level of effort and resources needed to archive, preserve and mine the entire collection and data base. By themselves, these data represent a snapshot of the benthic fauna of the Delaware Estuary at a time before major industrialization and development in the region. Amos' data have even greater value when placed in the context of other benthic survey work conducted in the 1970's, late 1990's, and continuing in the ongoing Delaware Estuary Benthic Inventory (DEBI) project.

HARD-BOTTOM SAMPLING METHODOLOGY AND CHARACTERIZATION OF A "SPONGE GARDEN" IN THE BROADKILL SLOUGH AS PART OF THE DELAWARE ESTUARY BENTHIC INVENTORY. **Douglas C. Miller**, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958, dmiller@udel.edu; and **Danielle Kreeger**, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE 19801, dkreeger@delawareestuary.org. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #89)

One goal of the Delaware Estuary Benthic Inventory (DEBI) project was to determine the best sampling methods for hard bottom communities. Such communities and habitats have long been known to be present in the lower part of the bay, but are poorly characterized by conventional, bottom-grab sampling. Over four days of sampling in July 2008, we compared results and samples returned from an oyster dredge and two epibenthic sleds with those from direct diver observations and a grab with a down-looking video camera. In all we sampled at eight sites on the Delaware side of the lower estuary chosen from published studies, thesis reports and unpublished species records. Based on our initial findings, we focused our effort in the Broadkill Slough where dredging revealed a notable area with large, bright yellow boring sponges *Cliona celata* in the massive, gamma growth form. Sponges were dredged from approximately 8 m depth over a region at least 0.8 nautical miles (1.5 km) in length along the axis of the slough. In that area, SCUBA divers were able to retrieve sponge samples and characterize the three-dimensional structure and spatial arrangement of the "sponge garden." They reported that individual sponges were as tall as 30-40 cm and spaced about 1-2 m apart on the muddy sand bottom. Visibility from both the diver reports (30-50 cm at slack high water) and grab-mounted video further suggests that imaging with an ROV would also be effective at characterizing the areal extent of the sponge garden, its habitat structure and use by other species. Our observations add to the list of hard bottom communities documented and accurately located in the Delaware Estuary, and we propose that these methodologies will aid in ground truthing ongoing and future acoustic bottom mapping from both surface vessels and autonomous underwater vehicles. In general, hard bottom communities are less sampled and studied in the Delaware Estuary compared with easier to sample and more prevalent soft bottoms. However, future integrated efforts to assess biotic diversity, map benthic habitats and assess their functional roles are warranted because the complexity and productivity of these habitats are believed to be very important for the estuary ecosystem as a whole and finfish and shellfish in particular.

COMPLEXITIES AND CHALLENGES OF MANAGING HORSESHOE CRABS IN AN ECOSYSTEM CONTEXT. **Roy W. Miller**, Delaware Division of Fish and Wildlife, 89 Kings Highway, Dover, DE 19901, roy.miller@state.de.us. **Session 4**, 3:00pm, 1/12/09 (presentation #106)

Initially linked with management initiatives for American eel in 1995, the Atlantic States Marine Fisheries Commission soon concluded that management of horseshoe crabs (*Limulus polyphemus*) was complex enough to merit its own fishery management plan which was adopted in 1998. Development of the plan involved not only the standard considerations of the horseshoe crab fishery for an apparently over-exploited species of shellfish (horseshoe crabs are the preferred bait to use in several other fisheries), but also complications because of the importance of horseshoe crabs in the ecological well-being of several species of shorebirds that depend on horseshoe crab eggs as food, and for the importance of horseshoe crab blood to sustain a globally important biomedical industry. Since 1998 in response to perceived declines in horseshoe crab populations, the plan was modified with the adoption of five increasingly restrictive addenda. Continued declines of several migratory shorebird populations, particularly the red knot (*Calidrus canutus rufa*), added urgency to the perceived need for additional restrictions on horseshoe crab harvest.

These horseshoe crab harvest restrictions jeopardized the income of not only the commercial harvesters, but also the harvesters of American eels and whelks (conchs) because the horseshoe crab is widely acknowledged to be the best natural bait for these fisheries. The observed decline in horseshoe crab populations coupled with drastic decreases in the abundance of several shorebird species galvanized the environmental community, resulting in an unprecedented level of public comment on proposed horseshoe crab measures. The harvest restrictions potentially jeopardized the biomedical industry that is dependent on horseshoe crab blood derivatives, but the need for access to horseshoe crabs by this latter industry have been met thus far due to favored treatment from management agencies. The inevitable net result of this convergence of special interests with opposing points of view on the observed declines in shorebird populations and the need for continued harvesting of horseshoe crabs were very contentious public hearings over proposed regulations, followed by legal challenges and court dictates to the agencies charged with managing these resources. Fortunately, recent indicators point to significant recovery of immature and mature male horseshoe crabs in Delaware Bay in response to a total harvest moratorium in New Jersey and very restrictive harvest regimes in Delaware and other states in compliance with Addendum V to the Horseshoe Crab Management Plan. Lessons learned from this experience should be valuable in future management of potentially contentious natural resource issues.

THE DELAWARE ESTUARY LIVING SHORELINE INITIATIVE (DELSI). **Joshua Moody** and David Bushek, Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349, bushek@hsrl.rutgers.edu; Danielle Kreeger, Angela Padeletti and Laura Whalen, Partnership for the Delaware Estuary, Wilmington, DE 19801. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #96)

Habitat restoration is a fundamental component of the overall strategy to improve ecological conditions within the Delaware Estuary. An emerging priority is the need to develop restoration and enhancement tactics to help offset multiple threats to tidal marsh habitats which are a hallmark feature of this watershed. 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 using intertidal shellfish reefs to “soft armor” shorelines that are suffering heavy erosion from sea level rise and other factors. Fringing intertidal oyster reefs are being used in this manner in southern estuaries, but intertidal oysters are not a prominent feature in the Delaware Estuary. Ribbed mussels (*Geukensia demissa*), however, often form dense aggregations along marsh edges of the Delaware Estuary, and shoreline erosion appears most severe along edges having few intertidal mussels. This may indicate that ribbed mussels play a role in protecting the marsh shoreline from erosion. DELSI seeks to arrest shoreline erosion by deploying natural substrates that will enable shellfish communities to become established through natural recruitment and/or directed seeding.

During summer 2008, coconut fiber (coir) mats and logs and shell bags were deployed at three sites in varying arrays along a gradient of energy and erosion near the mouth of the Maurice River, NJ. The installations and marsh edge were mapped and surveyed so that changes can be detected over time and compared to control areas. Within weeks, several log treatments began accumulating sediments. By Fall, oyster bags in the low intertidal had accumulated a good set and mussels had recruited to some log treatments. Furthermore, some adult mussels that had become dislodged from rapidly eroding areas were found attached to the coir products.

During the upcoming year we will quantify physical and biological responses to the installations relative to controls in order to compare the effectiveness of various combinations of logs, mats and shellbags to their installation costs. We also plan to test whether seeding mussels onto the treatments enhances recruitment and accelerates establishment of mussel-based communities along the marsh edge. Ultimately, DELSI aims to provide new tactics for reducing shoreline erosion and protecting vital marsh habitats; ribbed mussels may provide a novel tactic to help plan for "Tomorrow's Delaware Estuary".

USING MACROINVERTEBRATES AND FISH TO ASSESS THE EFFECTS OF ITHAN CREEK RESTORATION THROUGH RADNOR VALLEY COUNTRY CLUB, DELAWARE CO., PA. **Kristen Much*, Lydia Civello*, Sarah Wadsworth*, and Kathryn Goddard-Doms**. Department of Biology, Ursinus College, Main Street, Collegeville, PA 19426, kgoddard-doms@ursinus.edu. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #129)

Radnor Valley Country Club in Villanova, Delaware Co., PA. plans to restore the stream bank along 2,680 ft. of Ithan Creek and its tributaries in the club's golf course. This restoration will be carried out according to best management practices contained in the Pennsylvania Department of Environmental Protection's Stormwater Best Management Practices Manual. The stream bank is currently protected only by turf grass. It is undercut in many places and erosion is constantly occurring. The stream bed is mostly coarse gravel within the area to be restored. The restoration will be accomplished by removing significant quantities of legacy sediments. Then, the stream bank will be reshaped to slope gently towards the creek and native riparian vegetation will be planted on both sides of the stream.

Using the PA DEP bioassessment protocol we are currently studying the macroinvertebrate community within the area to be restored. We will study the community that is established following restoration for three years. Further, we are assessing the fish community using US EPA protocols. We are also assessing the macroinvertebrate and fish communities upstream of the restored area in a forested reach. The reason for studying the forested reach is to determine if there are vibrant enough upstream macroinvertebrate and fish communities to recolonize the stream running through the golf course after restoration occurs. We will continue to study the stream through the forested area post restoration as a control against which to assess the changes that we hypothesize will occur in the restored stream.

We have found significant differences between the macroinvertebrate communities in the forested and grassy areas of the stream. This seems clearly to be accounted for by the lack of shelter for macroinvertebrates in the golf course area of stream with coarse gravel bottom, whereas there are abundant rocks, leaves, sticks, logs and unembedded cobble in the forested area. Our preliminary analysis of the fish indicates that the only differences in fish community are accounted for by species preference for deeper pools or swift shallow water.

A WATERSHED-LEVEL TOOL FOR ASSESSING ECOLOGICAL CONDITIONS IN THE DELAWARE ESTUARY. **Greg Murphy***, Todd Morrison, Barry Baker, and Vincent Pellerito - URS Corporation, Fort Washington, PA; and Ralph Stahl, Jr., Amanda DeSantis, and Robert Hoke - DuPont Corporate Remediation Group, Wilmington, DE. *gregory_murphy@urscorp.com. **Session 12**, 4:00pm, 1/13/09 (presentation #61)

We constructed a watershed-level tool for assessing ecological conditions in the Delaware Estuary by integrating the Relative Risk Model (RRM) approach with an environmental database using the ArcGIS® model builder application. The RRM approach is an adaptation of the traditional ecological risk assessment paradigm that incorporates the interactions and impacts of multiple stressors and their sources occurring in a given region using a rank based method. The RRM was integrated with an environmental database that is comprised of two linked information systems, including a stand-alone searchable Microsoft® Access database and an ArcGIS® geodatabase, developed following best practice database design standards with integrated use in mind. The geodatabase is built on the ESRI ArcHydro® data model, modified for the specific functional needs of the RRM. Information relevant to the RRM was prioritized based on spatial coverage, electronic accessibility, and age of information prior to being incorporated in the environmental database. The database includes information from various categories such as benthic mapping, biological stocks, chemical toxicants, land cover, physiochemical parameters, and water use. The extent of information incorporated in the database was facilitated by joint participation among state and federal agencies, academic institutions, non-governmental organizations, and industry. Integrating the RRM approach with the environmental database using the ArcGIS® model builder application provides the functionality necessary for current and future end user applications of the RRM, such as the ability to conduct more automated model runs to evaluate the results of alternative management scenarios. The integration of these components will also enable more automated updates of the underlying information as more information is collected for future RRM applications. Although the intent of this tool was to support regional risk assessment in the Estuary, it has an array of potential applications for various stakeholders, ranging from resource management to restoration.

WATER RESOURCES PLANNING IN ESTUARY WATERSHEDS: THE UPPER WISSAHICKON CREEK PILOT STUDY **Kenneth F. Najjar**, Maggie Allio, J. Kent Barr, and Pamela V'Combe: Delaware River Basin Commission, Michael Stokes, Drew Shaw, and Alexis Melusky: Montgomery County Planning Commission Liz Feinberg and Khiet Luong Pennsylvania Environmental Council Kenneth.Najjar@drbc.state.nj.us
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #92)

A Special Area Management Plan (SAMP) for the Upper Wissahickon Creek study area in Montgomery County, PA was developed to pilot the Critical Area Resource Plan (CARP) process and guidance document (September 12, 2006) prepared under the Pennsylvania Water Resources Planning Act 220. This plan is expected to be used as a model for future SAMPs and CARPs in Pennsylvania. Since a considerable amount of planning and technical work had already been performed in the Upper

Wissahickon Watershed Creek study area, it seemed an appropriate location for this pilot study.

One of the key topics that the Act 220 requires is the identification of critical water planning areas (CWPAs) where projected future demands exceed or nearly exceed the amount of water that will be available for use or where other significant water resource impacts are expected. Act 220 calls for a CARP to be conducted in these watersheds to evaluate future water conflicts and provide a more detailed analysis of water supply, water quality, stormwater and flooding issues.

The Wissahickon Creek is a tributary of the Schuylkill River, which is the largest tributary to the Delaware Estuary. The Upper Wissahickon Creek study area occupies 40 square miles of the creek's total drainage area, constituting the upper two thirds of the Wissahickon Creek watershed. Wissahickon Creek supports a diversity of uses, including fishing, swimming and drinking water, both within its watershed boundaries and beyond.

The Upper Wissahickon Creek study area is facing numerous issues affecting its water quality and flow. Since 1970, over 7,500 acres were developed, placing an ever increasing demand on the Wissahickon Creek to provide for and support commercial and residential users, within and outside of the study area. Since the Upper Wissahickon study area is projected to continue growing at a steady pace over the next several decades, it is critical to ensure an adequate supply of suitable quality water by balancing existing and anticipated human uses and ecosystem needs. Some of the challenges to achieving this balance include:

- Low base flow
- Channel instability
- Degraded water quality
- Flooding

The study area's challenges have been assessed, corrective alternatives are prioritized, and solutions are recommended. Implementation of the plan will help balance economic vitality and environmental quality in this area. The recommendations developed to address these issues can be helpful to watersheds throughout the Estuary faced with water supply and water quality limitations.

CLIMATE CHANGE PROJECTIONS FOR DELAWARE BAY AND ITS WATERSHED.

R. G. Najjar[1], S. Graham[2], and L. Patterson[1], Department of Meteorology[1] and Population Research Institute[2], The Pennsylvania State University, University Park, PA 16802, rgn1@psu.edu. **Session 1**, 11:15am, 1/12/09 (presentation #81)

To better understand the implications of anthropogenic climate change for the Delaware Bay, we analyzed the regional output of seven global climate models. The simulation given by the average of the models was generally superior to individual models, which differed dramatically in their ability to simulate twentieth-century climate. The model average had little bias in its mean temperature and precipitation and was able to capture the twentieth-century temperature trend. Weaknesses in the model average were too much seasonality in temperature and precipitation, an advance in the phase of the annual cycle in precipitation, interannual variability that was too high in temperature and too low in precipitation, and inability to capture the twentieth-century precipitation increase. There is some evidence that model deficiencies are related to land surface parameterizations. All models warmed over the twenty-first century under the six greenhouse gas

scenarios considered, with an increase of 4.9 ± 1.8ºC (model mean ± 1 standard deviation) for the A2 scenario (a medium-high emission scenario) over the Delaware Bay Watershed by 2070-2099. Precipitation projections had much weaker consensus, with a corresponding increase of 4 ± 7% for the A2 scenario. The projected climate averaged over the four best-performing models was significantly cooler and wetter than the projected seven-model-average climate. Precipitation projections were within the range of interannual variability but temperature projections were not. The implied research needs are for improvements in precipitation projections and a better understanding of the impacts of warming on streamflow and estuarine ecology and biogeochemistry.

THE EFFECT OF IMMIGRATION ON DISEASE RESISTANCE IN AN OYSTER POPULATION: A NUMERICAL MODEL STUDY **Diego A. Narváez**, Center for Coastal Physical Oceanography, Old Dominion University, 4111 Monarch Way, 3rd floor, Norfolk, VA 23508, **diego@ccpo.odu.edu**, John M. Klinck, Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA 23508, Eileen E. Hofmann, Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA 23508, Eric N. Powell, Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349, Dennis Hedgecock, Department of Biological Sciences, University of Southern California, Los Angeles, CA 90089.
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #99)

An individual-based genetics model was used to investigate the effect of addition of individuals by larval oyster transport or transplantation of adult oysters on population disease resistance. Each individual oyster consists of 10 chromosome pairs, with 4 genes per chromosome. Reproduction occurs between a small number of pairs of randomly chosen individuals. An initial population with a random genetic structure was established and a varying number of immigrants with a marker in the gene 1, chromosome pair 2 were added to the population at different intervals. The allele added to the population by the immigrants was either neutral or conferred benefit, which was manifest as a longer life span. Simulations are run for 100 generations and the frequency of the new allele determined. Continual addition of immigrants allowed the new allele to become dominant, even if it was neutral. Dominance occurred in several decades for 1000 immigrants per year. Adding more immigrants reduced the time to dominance. With disease resistance, the new allele was established quicker. The simulation results are similar for larval or adult immigrants. These simulations have implications for the introduction of disease-resistance oysters to populations that are significantly impacted by disease.

PASSPORT TO PERSONAL ACTION IN DELAWARE BAY. **Ronald L. Ohrel, Jr.*, Lisa Tossey, Tamara Beeson, Elizabeth Boyle, and Kimberly Doucette**, University of Delaware College of Marine and Earth Studies and Delaware Sea Grant College Program, 222 S. Chapel Street, Room 103, Newark, DE 19716, rohrel@udel.edu. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #76)

Basic awareness of issues facing the Delaware Estuary is often not enough to motivate the general public to take personal steps to help improve the estuary. A healthy estuary depends, in part, on convincing watershed residents to "turn education into action." We attempted such an approach with an interactive exhibit at Delaware's Coast Day on October 5, 2008.

The 32nd annual event hosted nearly 11,000 visitors who enjoyed hands-on exhibits, lectures, ship and laboratory tours, crab races, seafood cooking demonstrations and contests, and a boat show. The theme for the 2008 edition of Coast Day was Coastal Challenges — Coastal Solutions.

At the heart of each Coast Day is an educational exhibit that follows the event's main theme for that year. The 2008 exhibit was titled *Are You Up to the Challenge?* It was designed to help visitors learn more about how their actions affect the environment. In addition to educating visitors, the exhibit was designed to motivate them to take specific actions in their daily lives to reduce their environmental impacts.

Upon entering the exhibit room, visitors were given a small publication called the Coastal Solutions Passport, which was modeled after a real passport and could be personalized with an individual's information.

Visitors then passed through four stations that focused on different coastal challenges. After learning about each challenge, visitors could choose a few actions in the passport that they were willing to take to help address the challenge or write their own ideas. After pledging to take action, visitors could get their passport stamped before moving on to the next station.

Visitors — especially children — appeared to enjoy the passport/pledge approach. The passport offered several simple actions that could be taken, potentially removing perceptions that some environmental issues are too big for one person to solve. In addition, making a pledge to take specific actions may improve the likelihood that such actions will actually be taken.

We did not incorporate a way to determine whether visitors actually took the actions to which they agreed. We hope to continue testing this approach, perhaps with local teachers who might be able help us track whether the passport/pledge approach motivates people to act upon what they learn.

QUANTIFYING SEDIMENT RETENTION WITHIN A RESTORED HEADWATER FLOODPLAIN IN THE DELAWARE BAY WATERSHED. **David Osgood**, Tiffany Schell, David Kile, Kristen Kunkel, and Marissa Hartlzer, Department of Biology, Albright College, Box 15234, Reading, PA 19607, dosgood@alb.edu. **Session 16**, 10:45am, 1/14/09 (presentation #25)

Maintaining proper function of headwater wetlands within coastal watersheds has taken on increasing importance in efforts to improve estuarine water quality. Headwaters, however, are often inadequately assessed following restoration and ecological function improperly cataloged. We assessed the restoration of a 7 ha floodplain complex on Angelica Creek, a first-order tributary of the Schuylkill River within the Delaware Bay watershed. Recent studies have shown that the Schuylkill River ranked highest among northeast US rivers for nitrogen export, which contributes to a uniquely high nitrogen input for Delaware Bay. These exports are derived in large part from fertilizer inputs which can be conveyed via sediment loading. We quantified retention of sediment loading to the Schuylkill River as a result of the Angelica Creek restoration and quantified site indicators responsible for sedimentation patterns. Floodplain elevation, hydroperiod, wetland sedimentation, vegetation cover, and in-stream sediment load were each measured pre- and post-restoration. Flooding frequency increased significantly in one of two floodplain wetlands as a result of the restoration. Sedimentation during storm events averaged 79.2 g m^{-2} ± 14.9 s.e. in the less frequently-flooded wetland where sedimentation varied spatially. Sedimentation was relatively ubiquitous throughout the more frequently-flooded wetland, averaging 23.8 g m^{-2} ± 5.7 s.e. Sedimentation rate was highest for the riparian zone (1201 g m^{-2} ± 666.8 s.e.) relative to the floodplain wetlands. Spatial variation in sedimentation rates was not significantly correlated with microtopography or vegetation cover and may instead be a function of proximity to surface water inflows. Adaptive management of the wetlands should involve manipulation of surface water inflow to realize the full potential for sediment retention. Improved floodplain sedimentation is predicted to reduce sediment load to the Schuylkill River which was not significantly different upstream (27.5 mg l^{-1} ± 8 s.e.) or downstream (30.2 mg l^{-1} ± 4 s.e.) of the site *prior* to restoration. Analysis of the 5 storm events documented since the restoration indicates a total sediment retention amounting to 9% of sediment load within Angelica creek on a per storm basis. Future reduction of sediment and nutrient loading to Delaware Bay can be accomplished through a combination of source reduction, wetland restoration/creation, and conservation of natural landscapes within the watershed. We intend to present this restoration in context with establishing standardized, ecologically-relevant assessment indicators for headwater restorations. Finally, we emphasize coupling of assessment and adaptive management as vital to achieving restoration success and minimizing project expenditures.

MUSSELING OUR WAY TO RESTORATION OF THE DELAWARE ESTUARY WITH THE LIGHTFOOT MUSSEL (*ELLIPTIO COMPLANATA*). **Angela T Padeletti[1]**, Danielle A. Kreeger[1], Catherine M. Gatenby[2], Steven G. Hughes[3], Roger L. Thomas[4], Rosemary Malfi[4], Heidi Tucker-Wood[3]. [1]Partnership for the Delaware Estuary Wilmington, DE 19801; [2]US. Fish and Wildlife Service White Sulphur Springs, WV 24986; [3]Cheyney University Cheyney, PA 19319; [4]The Academy of Natural Sciences Philadelphia, PA 19103. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #110)

The health of freshwater mussel assemblages represents an ideal indicator of watershed health for many reasons. First, they are imperiled in terms of both biodiversity and population abundance. Second, freshwater mussels require a complex suite of suitable conditions, including healthy riparian and in-stream habitats, good water quality and flow, and free passage of fish that serve as hosts for their larvae. Third, their long life spans (upwards of 100 years) integrates environmental conditions over much longer time spans, compared with short lived fauna. Fourth, being sessile, their status is indicative of local ecological conditions. For these same reasons, freshwater mussels represent ideal targets for ecosystem restoration. Freshwater mussels once thrived across most of the Delaware Estuary, but only one of our native 12+ species can be readily found in the lower watershed and its distribution and reproduction appear greatly reduced. The Freshwater Mussel Recovery Program was implemented to restore diversity, population biomass, and resilience of native mussel communities using conservation, reintroduction, and range expansion. Phase one has consisted of screening candidate streams for restoration (Gray, Poster). Phase two will be achieved by reintroducing hatchery reared juvenile mussels and transplanted adults that are reproductively active. Initial phases of the project have commenced in Southeastern Pennsylvania, where broodstock of the lightfoot mussel (*Elliptio complanata*) were collected from Ridley and Brandywine Creeks which contain two of the remaining populations in southeast Pennsylvania. For hatchery propagation trials, fish hosts were also collected from the study sites, including pumpkinseed (*Lempomis gibbosus*), white suckers (*Catostomus commersonii*), and banded killfish (*Fundulus diaphanous* & *F. heteroclitus*). At Cheyney University, approximately 165 of 508 fish were successfully infested with mussel glochidia (larvae) in 2008. The successful production of seed mussels is scheduled for 2009 using lessons learned from 2007 trials, such as a preference for American eels (*Anguilla rostrata)* which were deemed to be the preferred fish hosts. Enhancing ecosystem services, boosting population resilience, and filling open niches are only some of the objectives we hope to achieve by reintroducing freshwater mussels not only into Southeastern Pennsylvania but throughout the Delaware Estuary.

RESOURCE OVERLAP AND POTENTIAL COMPETITION BETWEEN INVASIVE RED-EARED SLIDER TURTLES AND THREATENED NATIVE RED-BELLIED TURTLES IN THE UPPER DELAWARE ESTUARY. **Steven Pearson** and **Harold W. Avery**, Department of Biology, Drexel University, Philadelphia, PA 19104, hwa22@drexel.edu.
Session 2, 2:15pm, 1/12/09 (presentation #53)

Many species of estuarine organisms are in decline or have been extirpated in areas of the Northeastern United States including the Upper Delaware Estuary due to habitat loss, habitat fragmentation, harvesting of individuals and introductions of invasive species that compete for limited resources. The impacts of invasive species to populations and communities of estuarine organisms have become an emerging concern for managers for the Delaware Estuary, and other estuaries in North America and world-wide. In the Upper Delaware Estuary, the red-eared slider turtle (*Trachemys scripta elegans*) has been introduced through the release of unwanted captive pets over the last half century. Red-eared slider turtles have also become naturalized in this region and are hypothesized to compete with native turtle species inhabiting already degraded freshwater ecosystems for limited food and spatial resources. The native red-bellied turtle (*Pseudemys rubriventris*) is designated as Threatened in the Commonwealth of Pennsylvania due to population declines. The introduction of non-native red-eared slider turtles to wetlands within the range of red-bellied turtles has undoubtedly played a role in their decline, yet their specific impacts are unknown. The goal of our research is to quantify the extent of competition for nutritional and spatial resources between red-eared slider turtles and red-bellied turtles in the Upper Delaware Estuary. We are using radio telemetry to quantify the movements, home ranges, and spatial / temporal overlap of habitat used by free-ranging individuals of both species. Short- and long-term diets of both turtle species are quantified using stomach flushing and stable isotope analysis. We will use these data to determine the extent of competition between red-eared slider turtles and red-bellied turtles. Our research quantitatively addresses the emerging concerns that invasive species have caused in the Delaware Estuary. Our research also provides the necessary data to optimize conservation efforts by 1) identifying areas of greatest impact, and 2) identifying resources that are most utilized by invasive red-eared slider turtles. We suggest that educational brochures should be designed and dispersed to the public that clearly outline the problems that invasive red-eared slider turtles pose to native species. We also suggest that mobilizing volunteers and interest groups to help remove red-eared slider turtles from target locations may greatly enhance the recovery potential of red-bellied turtles. The public is the source of the invasion of red-eared slider turtles to the Delaware Estuary, and through our research and coordination with managers the public can become the solution to the problem.

PRIMARY PRODUCTION MEASUREMENTS ALONG THE MURDERKILL RIVER

Kelly A. Peeler, Jonathan H. Sharp, Yoana Voynova, Adam Pimenta
University of Delaware, College of Marine and Earth Studies, Lewes, DE 19958
kapeeler@udel.edu. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #36)

A joint project based on a cooperative effort between Kent County Delaware, state and federal government agencies, and educational groups seeks an understanding of water quality and ecosystem response along the Murderkill River, a subtributary estuary of the Delaware Bay, in central Delaware. Since April 2007, our lab at the University of Delaware's College of Marine and Earth Studies has been estimating primary production on samples collected monthly, by the Department of Natural Resources and Environmental Control (DNREC), from seven sites transecting the salinity gradient of the Murderkill River. DNREC analyzes their samples for a wide range of ambient parameters; in addition to primary production we also measure ambient dissolved inorganic carbon and particulate carbon. Our lab has measured primary production using the radioactive isotope carbon-14 in the Delaware estuary for 25 years. Recently, we have been using the stable heavy isotope carbon-13 to measure primary production. This presentation will discuss how we measure primary production and the spatial and temporal distribution of primary production in the Murderkill River.

USING DIC ANALYSIS TO ACCURATELY QUANTIFY ESTUARINE COMMUNITY METABOLISM. **Adam R. Pimenta and Jonathan H. Sharp** University of Delaware, College of Marine and Earth Studies 600 Pilotown Rd.Lewes, DE 19958 apimenta@udel.edu.
Session 17, 11:15am, 1/14/09 (presentation #62)

Ecosystem function and health, particularly as it relates to eutrophication, is an important area of study that has profound implications for Federal and State regulatory agencies. The net heterotrophic/autotrophic balance and carbon flux that constitutes microbial community metabolism in estuarine systems is constrained by a number of biological and chemical processes. These processes include primary production by photoautotrophic organisms, chemoautotrophic processes (nitrification) as well as other biologically mediated chemical processes (denitrification, sulfate reduction), respiration by a myriad of autotrophic and heterotrophic organisms and inorganic processes such as calcification. What we refer to as the microbial community is really a mosaic of different populations, changing with time, and having distinct metabolic rates. Study of community metabolism will provide additional understanding of ecosystem function and health and carbon dynamics as well as the transport of carbon between estuaries, the ocean and the atmosphere.

Dissolved Inorganic Carbon (DIC) analysis is particularly suited for determining metabolic processes in water samples; with DIC being directly produced and consumed during the normal metabolic function of both autotrophs and heterotrophs. During photosynthesis, DIC is consumed by autotrophs, leading to a drop in DIC concentrations. This DIC is incorporated into the cell for growth or lost as organic carbon. During respiration CO_2 is released into the water, causing a rise in DIC concentrations. Our lab uses a DIC analyzer developed at the Monterey Bay Aquarium

Research Institute. This instrument has shown to be reliable and gives high precision measurements of DIC in freshwater and seawater. Research conducted over the past two years in the Delaware Estuary and the Murderkill River, DE has shown the functionality of this analysis. DIC analysis holds many methodological advantages through ease of sample handling over previous methods of measuring primary production and respiration. Ambient DIC analysis has allowed us to develop a picture of the spatial and temporal patterns of DIC concentrations in the Delaware Estuary and the Murderkill River. DIC concentrations show strong positive correlation with salinity, significant deviations from this linear relationship can indicate areas of intense biological activity or significant allochthonous input. Discrete bottle incubations have proven effective at quantifying depth-integrated areal production and has shown uptake patterns consistent with ^{13}C analysis. DIC analysis has also allowed us to observe dark-bottle uptake, indicating significant chemoautotrophic activity.

GEOLOGIC SEQUESTRATION: A PROPOSED ALTERNATIVE TO HELP COMBAT CLIMATE CHANGE. **S. Stephen Platt**, Underground Injection Control National Expert, U.S. Environmental Protection Agency, Region 3, 1650 Arch Street, Philadelphia, PA 19103
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #13)

Carbon dioxide is a greenhouse gas which contributes to global warming and, therefore, to climate change. Most of the large sources of carbon dioxide emanate from coal-fired electrical generation power plants. It is estimated that greater that twenty percent of the world's carbon dioxide is generated from these facilities.

The Environmental Protection Agency (EPA) has developed proposed regulations to geologically sequester carbon dioxide. The proposed geologic sequestration rule, if finalized, will add a new well classification under the present underground injection control (UIC) regulations. These regulations were promulgated under the Safe Drinking Water Act in 1980 and are designed to protect underground sources of drinking water (USDWs) from the subsurface emplacement of fluids.

Underground Injection of carbon dioxide, used in enhanced oil recovery (EOR) and enhanced gas recovery (EGR), is a long standing practice. Thousands of wells, worldwide, employ this practice to increase oil and gas production. However, the injection of carbon dioxide, specifically for geologic sequestration, involves different technical issues and potentially much larger volumes of carbon dioxide than in the past.

The idea behind geologic sequestration is to employ the use carbon capture technology at the power plants, transport the carbon dioxide, generally through pipeline, to an injection well site and inject the carbon dioxide deep underground into saline formations. The injection wells will require proper construction, testing, inspection and monitoring to prevent the migration of the carbon dioxide out of the intended injection zone.

Research efforts to evaluate the technical aspects of geologic sequestration are presently underway. Individual states and EPA regions are evaluating sequestration projects on a case-by-case basis and are issuing permits to ensure the protection of USDWs. These projects are generally small in scale and are intended to provide EPA with technical information which will be employed to evaluate future full-scale geologic sequestration operations and assist in the development of the final regulations.

MULTIPLE STABLE POINTS IN OYSTER POPULATIONS. **Eric N. Powell[1],**
eric@hsrl.rutgers.edu; John M. Klinck[2], Kathryn A. Ashton-Alcox[1], and John N. Kraeuter[1], [1]Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ 08349, [2]Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA 23529.
Session 2, 1:00pm, 1/12/09 (presentation #5)

A 54-year time series for the oyster population of Delaware Bay was analyzed to identify biological reference points and rebuilding goals. The time series is characterized by two regime shifts delineating alternate stable states. Multiple stable states are described by a complex array of reference points. A carrying capacity exists for each stable state. Each carrying capacity has associated with it a point at which surplus production reaches a local maximum. These represent rebuilding goals for each of the stable states. Between them is an intermediate low in surplus production. If this minimum is negative, a point-of-no-return exists below which the population has little chance of recovery to the higher stable state. The differential in surplus production between the lower maximum and the minimum expresses the difficulty of rebuilding to the higher stable state. The depth of the minimum expresses the sensitivity of the population to collapse from high abundance. The abundances defining the minimum and maxima are relatively stable over a range of uncertainties in recruitment and mortality. The surplus production values associated with them are much more uncertain. Thus, different models are needed for management decisions, one for short-term catch forecasts; the other for establishing long-term abundance goals.

CHANGES IN METABOLIC ACTIVITY AND COMMUNITY COMPOSITION OF SULFATE REDUCING BACTERIA IN TIDAL FRESHWATER MARSH SOILS IN RESPONSE TO CLIMATE CHANGE AND SALTWATER INTRUSION. Tatjana Prša,
Department of Biology, Villanova University, 800 E Lancaster Avenue, Villanova, PA 19085, tatjana.prsa@villanova.edu**; Nathaniel B. Weston**, Department of Geography and the Environment, Villanova University, 800 E Lancaster Avenue, Villanova, PA 19085, nathaniel.weston@villanova.edu; and **Melanie A. Vile**, Department of Biology, Villanova University, 800 E Lancaster Avenue, Villanova, PA 19085, melanie.vile@villanova.edu.
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #71)

One manifestation of ongoing climate change is the global rise in sea-levels, which will potentially result in the up-estuary migration of seawater and the intrusion of saltwater into previously freshwater tidal marshes (TMF) in coastal ecosystems. For marshes to keep pace with rising sea levels, vertical accretion of material in the marsh is necessary. One key factor determining the accretion rate in marshes is the amount of the microbial organic matter decomposition. While methanogenesis is a dominant pathway of carbon mineralization in TFM, sulfate reducing bacteria (SRB) often

outcompete methanogens in saline environments due to a greater availability of SO_4^{2-} and the higher energy yield of sulfate reduction. We examined the impacts of saltwater intrusion on the structure and metabolic activity of SRB in TFM soils via a field transplant experiment in the Delaware River Estuary. In the spring 2007, we transplanted 6 intact soil cores (30 cm diameter, 25 cm deep) from a TFM to the same TFM (Rancocas) and to a down-estuary brackish marsh (Stow, salinity ~11). We collected soil sub-cores from transplants at both sites at the time of transplant (t=0) as well as 3 and 6 months post-transplant (mid-summer and early fall). We determined rates of dissimilatory sulfate reduction using radiotracer techniques and examined the community composition of SRB by targeting the dissimilatory sulfite reductase alpha subunit (*dsr*A) functional gene. We constructed *dsr*A clone libraries for both control and salinity-impacted soils at 0, 3 and 6 months post-transplant. We used phylogenetic analyses to determine changes in the composition of the SRB community between the TFM and down-estuary brackish marsh over time. Rates of sulfate reduction were significantly higher at Stow than Rancocas (35.6 ± 17.9 and 2.5 ± 0.9; mean ± standard deviation, respectively; p = 0.0141, ANOVA). SRB community composition at Stow was significantly different from Rancocas at both 3 and 6 months post-transplant, and the community composition of SRB changed significantly at Stow after 3 months, with no significant change between 3 and 6 months post-transplant ($p < 0.05$; weblibshuff). The SRB community composition did not change significantly over time at the Rancocas site ($p > 0.05$; weblibshuff). Our results suggest that saltwater intrusion into TFMs will result in increased organic matter decomposition by SRB accompanied by shifts in SRB microbial populations. These shifts may alter accretion rates and put TFMs undergoing saltwater intrusion in jeopardy as sea levels continue to rise.

EFFECTS OF BULKHEADS ON ESTUARINE BEACH SWASH ZONE PROCESSES AND BEACH CHARACTERISTICS. **Nicole A. Raineault,** Department of Geological Sciences, 255 Academy Street, Newark, DE 19716, nrain@udel.edu; **Karl F. Nordstrom**, Institute of Marine and Coastal Sciences, New Brunswick, NJ, 08901, nordstro@marine.rutgers.edu; **Nancy L. Jackson**, Department of Chemistry and Environmental Science, New Jersey Institute of Technology Newark, NJ 07102, jacksonn@njit.edu.
Session 16, 12:00pm, 1/14/09 (presentation #60)

A field study was conducted over a 14-day tidal cycle on a sandy estuarine beach in Delaware Bay to identify the effects of bulkheads on interactions between reflected and incident waves and swash, depths of sediment activation, topographic change, and sediment grain size. Data were gathered along cross-shore profiles fronting two wooden sheet pile bulkheads of different design, two sites in an 8.6 m long enclave between the bulkheads, and an unarmored site 45 m updrift. Mean wind speeds ranged from 1.1 to 7.7 m s^{-1}; daily mean significant wave heights ranged from 0.10 to 0.29 m. The beaches in front of the two bulkheads differed from the equivalent elevations at the unarmored site in having a smaller magnitude of change in beach elevation but more frequent reversals in erosion and accretion over tidal cycles, 2-3 times greater sediment activation depths at the structures, and finer sediment close to the structures. The greatest variability in surface elevation changes at the unarmored and enclave sites occurred above the elevation at which the bulkheads intersect the beach. The greatest topographic variability of all sites was on

the downdrift side of the enclave between the bulkheads. No evidence for increased erosion of the beach surface in front of bulkheads was found, but truncation of exchanges of water and sediment between the upper and lower foreshore and increased mobility on the downdrift side of the enclave may be negative collateral effects.

HARD-BOTTOM BENTHIC HABITATS IN DELAWARE BAY: SPATIAL AND TEMPORAL DYNAMICS. **Nicole A. Raineault,** Department of Geological Sciences, 255 Academy Street, Newark, DE 19716, nrain@udel.edu; **Art C. Trembanis**, Department of Geological Sciences, 255 Academy Street, Newark, DE 19716, art@udel.edu; and **Douglas C. Miller**, College of Marine and Earth Studies, 700 Pilottown Road, Lewes, DE, 11958, dmiller@udel.edu. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #59)

The goal of this study is to provide new information on the spatial extent of hard-bottom habitats in Delaware Bay and the physical conditions that affect these areas over storm, seasonal, and annual timescales in the intertidal and offshore regions. Understanding the feedbacks between sediment transport and hard-bottom habitats is important since these regions are highly productive and support great biodiversity, including commercial and recreationally fished species. Currently, little is known about the feedbacks between hard-bottom areas and sediment transport processes on and around these habitats. Interferometric sonar and sediment samples will be used to map these areas and collect information on bottom bathymetry and sediment characteristics. The high resolving power and wide-swath of the interferometric sonar, mounted on an autonomous underwater vehicle (AUV) will extend mapping capabilities to shoal regions and allow for repeat mapping of target areas. After an initial study to identify the areas where sandbuilder (*Sabellaria vulgaris*), Serpulid (*Hydroides dianthus*), and tubeworm nodule (mixed *Sabellaria* and *Hydroides*) habitats exist, a more in-depth study of specific sites will be undertaken to understand the feedbacks between hard-bottom habitats and sediment processes. Target sites will be monitored more frequently with an array of other instruments including Acoustic Doppler Current Profilers (ADCP) and rotary sonar to measure sediment flux and current and wave properties. Some of these sites will be in the intertidal zone, to test natural and human impacts of sediment flux and mixing on hard-bottom habitats. The intertidal zone is known as an area of naturally high sediment flux and mixing, with high flow velocities. Furthermore, human shore-protection structures usually exacerbate these conditions. A comparison to offshore hard-bottom habitats will provide insight on how organisms adapt to different hydrologic regimes. Monitoring these environments will provide information on the ability of these organisms to thrive under varying hydrologic conditions.

STORMWATER INFILTRATION PRACTICES AND CLASS V INJECTION WELLS.
Roger Reinhart, U.S. Environmental Protection Agency Region III, 1650 Arch Street, Philadelphia, PA 19103-2029, reinhart.roger@epa.gov. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #35)

Stormwater runoff from urban and farming communities is the biggest threat to water quality in our rivers, lakes and streams. Over development has created increased impervious surfaces which has led to pollutant loading to the receiving waters, sewer overflows, and urban flooding. In recent years, considerable attention has been focused on effective stormwater management practices. In April 2007, EPA entered into a collaborative partnership with several national environmental and regulatory groups in order to promote the use of "low impact development" (LID) or "green infrastructure" practices as a cost effective approach for stormwater management. Infiltration of stormwater through LID technologies has been encouraged to effectively reduce stormwater runoff and sewer overflows, and to increase ground water recharge.

LID technologies include an array of best management practices that incorporate the use of soils and vegetation for infiltration, treatment and evapotranspiration of stormwater. Rain gardens, vegetated swales, riparian buffers and porous pavements are examples of such techniques. However, it should be noted that some of the LID infiltration devices may be Class V injection wells which are regulated by the Underground Injection Control (UIC) program.

The primary objective of the UIC program (Safe Drinking Water Act) is to protect Underground Sources of Drinking Water (USDWs) from contaminants in fluid discharges to the subsurface through injection wells. If a LID infiltration practice is determined to be a Class V injection well, the owner or operator of the well is required to submit specific information to the applicable UIC program. If the stormwater has a potential to carry contaminants which may endanger a USDW, the UIC program may require pretreatment to eliminate that potential. Typically, UIC program review and approval of Class V injection wells is fairly quick and will not delay project implementation. The poster board display will serve to clarify which LID infiltration practices may be Class V injection wells, and highlight the reporting requirements for operators of such wells.

ASSESSMENT OF DELAWARE BAY TIDAL WETLAND CONDITION AND CHANGE FROM 1993 TO 2008.
Alex Riter, Department of Geography, 2181 LeFrak Hall University of Maryland, College Park, MD 20742, ariter99@yahoo.com; Michael S. Kearney, Department of Geography, 2181 LeFrak Hall University of Maryland, College Park, MD 20742, mkearney01@yahoo.com; Amy Jacobs, Delaware Department of Natural Resources and Environmental Control, Division of Water Resources, 820 Silver Lake Boulevard, Ste. 220, Dover DE 19904, Amy.Jacobs@state.de.us. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #73)

We assessed changes in surface conditions that occur as marsh substrates degrade and/or substrates become submersed through relative sea level rise or marsh subsidence with the model described in Rogers and Kearney (2004) and seven Landsat TM and ETM + Path 14 Row 33 scenes of the Delaware Bay collected on August 29, 1993, July 5, 1999, August 25, 2003, August 11, 2004, August 14, 2005, August 17, 2006, and September 7, 2008. The model is based on changes in reflectance from marsh vegetation through a transitional shift to increased soil reflectance as the vegetation thins, and finally of water reflectance in the final stages of marsh degradation. The model classifies tidal wetlands into the four categories: non-degraded, moderate deterioration, severe deterioration, and total degradation based on the percentage of vegetation, water, and soil detected in 30 meter x 30 meter pixels with normalized difference indices. Results are dependent on model operation and the ability to remove atmospheric and other effects.

Marsh surface condition varies spatially within most Delaware Bay marshes with marsh classification ranging from non-degraded to severely degraded. The majority of salt marshes are classified as moderately degraded for the years 1993, 1999, 2004, 2006, and 2008. Marshes on the New Jersey side of the Delaware Bay are typically more degraded than Delaware state marshes, especially the marshes located southwest of Port Norris, New Jersey. Areas of marsh located near large ponds such as the Bombay Hook National Wildlife Refuge are more degraded than pond-free marshes.

Marsh health varies annually, possibly due to weather related factors. Overall, marsh surface conditions generally deteriorated over most Delaware Bay marshes between 1993 and 2006, although marsh conditions in 2003 and 2005 were markedly better than in 1999 and 2004. The tidal stage of the July 5, 1999 image was 0.75 meters over Mean Low Low Water (MLLW); significantly higher than the typical tidal stage range of 0.2 to 0.45 meters over MLLW. This may account for the large area of marsh on the July 1999 marsh classified as moderately deteriorated. Based on analysis of a Landsat ETM + August 14, 2008, and field work in the Bombay Hook area of Delaware completed the first week of November 2008, marsh surface conditions in most Delaware Bay marshes improved since August 2006.

ENVIRONMENTAL RESULTS MANAGEMENT: THE ROLE OF INDICATORS. **Jessica Rittler Sanchez,** Delaware River Basin Commission, POBox 7360, West Trenton, NJ 08628-0360, Jessica.Sanchez@drbc.state.nj.us; and **Robert Tudor**, Delaware River Basin Commission (same address). **Session 12**, 4:30pm, 1/13/09 (presentation #82)

Environmental Results Management (ERMS) requires a systematic approach: setting goals and objectives, taking action to accomplish the objectives, monitoring and assessing progress, and adapting the plan or actions to accomplish the objectives. It is necessarily an iterative cycle of planning, monitoring, assessing and adapting, or a framework of Plan, Do, Check, Adapt. Environmental results management promises a valuable adaptive approach to environmental resource management.

ERMS promotes information-based decision-making and requires coordinated and consistent data collection, reporting and evaluation. The selection of indicators – what to measure - is a crucial component of the cycle. Linkage to a specified planning goal or objective is essential to complete the feedback loop.

Three environmental condition reports relating to the health of the Delaware Estuary were issued in 2008: *The State of the Estuary 2008*, the *State of the Delaware River Basin 2008*, and the *Technical Summary: State of the Delaware Basin Report*. The usefulness of the results within these reports is partly dependent on the robustness of the data, and partly related to how well the selected indicators relate to management goals and objectives. Unfortunately, the selection of indicators is frequently driven by data availability - what we have historically been monitoring for - rather than the relationship of a measurable parameter to a preferred outcome.

Several lessons can be gathered from these efforts.

1. The general language of management goals and objectives needs to be honed to incorporate the nature of corresponding environmental indicators.
2. Monitoring programs need to be re-evaluated and aligned to provide the scientific information necessary for assessing environmental results.
3. Coordination and collaboration among agencies must be improved to ensure consistency and comparability of information across political, programmatic and watershed divides.
4. Additional emphasis is needed to confront monitoring challenges. For example, dissolved oxygen is a fundamental condition for aquatic life, yet real-time monitoring is available for only 4 sites in the tidal Delaware main stem and one (new) site on the non-tidal river.
5. Additional attention needs to be paid to the stressors that impact water and living resources, especially landscape changes. A unified land use/land cover data set at a useful resolution is not available for the basin as a whole; available satellite imagery is too coarse and too old; and state data sets are incompatible.

The full values of these reporting efforts can only be realized when they are used to systematically and routinely inform an environmental results management system. Evaluating the indicator reports against programs and absorbing the message into monitoring programs is a real-world application of the ERMS for adaptive management of water resources in the Delaware Estuary.

THE USE OF TWO WETLAND RAPID ASSESSMENT METHODS IN DELAWARE

Alison B. Rogerson, Amy D. Jacobs, Andrew M. Howard.Delaware Department of Natural Resources, Watershed Assessment Section, 820 Silver Lake Boulevard, Dover, Delaware 19904, alison.rogerson@state.de.us. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #86)

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 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 21 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.

THE CONDITION OF WETLANDS IN THE ST. JONES WATERSHED, DELAWARE AND APPLICATION TO RESTORATION AND PROTECTION TARGETING. **Alison B. Rogerson**, Amy D. Jacobs, Andrew M. Howard. Delaware Department of Natural Resources and Environmental Control, Watershed Assessment Section, 820 Silver Lake Blvd., Suite 220, Dover, DE 19904. alison.rogerson@state.de.us. **Session 10**, 2:15pm, 1/13/09 (presentation #75)

Wetlands are vital components to the health of the Delaware Estuary, its biodiversity and water quality. The Delaware Assessment and Monitoring Program is dedicated to better understanding the health of wetlands and the stressors that are degrading wetlands in order to protect and enhance the functions and services that they provide to citizens of the Delaware Estuary watershed. In 2008 we assessed the condition of tidal wetlands in the St. Jones watershed. We used a probabilistic sampling design to assess 50 tidal sites using the Mid-Atlantic Tidal Rapid Assessment Method (MidTRAM). Results showed that site scores ranged 41-98 and averaged 74±13. Although the Hydrology attribute group averaged the highest with 90±15, one third of our sites were affected by evidence of ditching and wetland draining. The Landscape and Buffer attribute group averaged 86±12 and most sites scored in the highest scoring bucket for 6 metrics. One quarter of our sites had some amount of physical barriers (e.g. roads, yards or berms) in the upland that would prevent wetland migration in the future. Plant Community metrics were the lowest, with a group average of just 67±10. We will continue to refine the MidTRAM to maximize its utility in identifying tidal wetland stressors across the region. The information gained from assessing the condition of wetlands in combination with changes in wetland acreage is used with other conservation data to prioritize protection and restoration activities.

TELLING THE STORY…SHARING THE SUCCESSES OF THE SCHUYLKILL WATERSHED INITIATIVE GRANT AND THE SCHUYLKILL ACTION NETWORK. **Deanne C.T. Ross**, Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 S. Poplar Street, Wilmington, DE 19801, Dross@DelawareEstuary.org. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #125)

Over 2,000 square miles in size, the Schuylkill River watershed provides drinking water to a population of 1.5 million people in Southeastern Pennsylvania. In the interest of source-water protection, the Philadelphia Water Department conducted a watershed-wide Source Water Assessment in 2003, revealing the necessity for region-wide cooperation to address priority needs.

Federal, state, and local officials formed a collaborative network, eventually branching out to water utilities, nonprofit organizations, businesses, schools, and individuals. Devoted to improving water quality in the Schuylkill River Watershed, the Schuylkill Action Network (SAN) was thereby formed.

In 2004, the U.S. Environmental Protection Agency (EPA) awarded a $1.15 million Targeted Watershed Initiative Grant for water quality improvement and demonstration projects in the Schuylkill River Watershed. This grant provided seed funding for an impressive collection of projects. Most of these projects addressed water quality issues by reducing abandoned mine drainage, agricultural runoff, and stormwater management challenges. Other projects focused on public education and outreach, helping to make the land-water connection for thousands of watershed residents.

Since 2004, over 100 member organizations in the SAN have implemented on-the-ground restoration and enhancement projects throughout the entire region. More than 40 projects have tackled water pollution issues, and leveraged an additional $2 million for an investment of over $3 million in protecting Schuylkill waters.

To share the SAN and SWIG success stories with a public audience, a full-color folder titled "Protecting Schuylkill Waters" was created to house individual story sheets for 20 of the 40+ completed projects. The story sheets are color coded for Agriculture, Abandoned Mine Drainage, Stormwater Runoff, and Education and Outreach topics. Project managers were interviewed and asked to share not only project details, but personal insights and other project notes of interest as well. The story sheets can be used individually in outreach efforts, or as a collection, depending on the recipients. The folder itself, a stand-alone piece explaining both the SAN and the SWIG, can be used by SAN members for their meetings and public outreach purposes. Attractive in design and detail, the SAN/SWIG story folder captures the essence of the overall SWIG project successes, and highlights the SAN as a collaborative networking model.

SHHH – DON'T TELL THEM YOUR TEACHING – PA COAST DAY. **Dee Ross**, Partnership for the Delaware Estuary, One Riverwalk Plaza 110 South Poplar Street, Suite 202, Wilmington, DE 19801, DRoss@DelawareEstuary.org; **Session 11**, 1:45pm, 1/13/09 (presentation #122)

Pennsylvania Coast Day was funded by the Pennsylvania Coastal Zone Management Program to increase awareness, educate the public, and promote the public's involvement in coastal issues. In order to raise awareness and build stewardship for the coast, the event has been designed to target families and youth, though participants of all ages are welcome. Our goal was to attract people without a strong interest in the environment, rather than individuals already aware of environmental issues. The event was advertised as a family fun event with games, prizes, make your own crafts and free "Duck" boat rides on the Delaware River. While all of these activities were used as tools to educate the attendees about coastal issues, no where were the words "environmental" or "educational" used in any of the marketing pieces. Another aspect of the event was giving prizes to participants in mini activities, which taught them about different environmental issues and what they could do to help. Exhibitors from over 20 local environmental organizations and agencies led these mini activities, each teaching about a primary environmental concern for their organization. Through the activities the participants become aware of how their daily actions affect their local natural ecosystems. Rather than having people take home bags full of brochures, that they may never read, we tried to fill the day with fun educational activities, leaving the attendees with positive feelings and better understanding of their local waterways.

DELAWARE WETLANDS CONSERVATION STRATEGY. **Rebecca Rothweiler,** Amy Jacobs, Mark Biddle, Gary Kreamer, and Stephen Williams, Delaware Department of Natural Resources and Environmental Control, 89 Kings Highway, Dover, DE 19901, Rebecca.Rothweiler@state.de.us. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #40)

The Delaware Wetlands Conservation Strategy is a collaborative effort among the Delaware Department of Natural Resources and Environmental Control (DNREC), other State agencies, and conservation partners to identify priorities that will slow wetland loss and improve existing wetland conditions. The strategy will guide the efforts of State agencies to improve Delaware's wetland resources through increased agency coordination, data availability, education, monitoring, and restoration efforts. The document outlines six goals to focus efforts with the aim of maximizing the use of resources to best protect wetland resources in the state and the ecosystem services that they provide. Goals will be implemented over the next five years and will be reevaluated in 2013. Implementation of the goals will be a collaborative effort amongst the organizations who contributed to its design. Outreach efforts will be made to encourage other government and non-governmental conservation agencies in Delaware to adopt the strategy and collaborate with the State to enhance our capacity to conserve wetlands.

THE DELAWARE ESTUARY BENTHIC INVENTORY: SOFT-BOTTOM SAMPLING DESIGN AND 2008 FIELD WORK. **David E. Russell**, Environmental Assessment and Innovation Division (EAID), U.S. Environmental Protection Agency (USEPA)—Region III, 701 Mapes Road, Fort Meade, MD 20755, russell.dave@epa.gov; Danielle Kreeger, Angela Padeletti, Laura Whalen, Partnership for the Delaware Estuary, 110 S. Poplar Street, Suite 202, Wilmington, DE 19801; Rene Searfoss, Jim Gouvas, Steven Donohue, EAID, USEPA—Region III, 1650 Arch St., Philadelphia, PA 19103; Amie Howell, Water Protection Division, USEPA—Region III, 1650 Arch St., Philadelphia, PA 19103; Charles Strobel, Henry A. Walker, Bartholomew Wilson, USEPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett, RI 02882; Bartholomew Wilson, Delaware Dept. of Natural Resources and Environmental Control, 89 Kings Highway, Dover, DE, 19901; Douglas C. Miller, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958; and, Irene Purdy, Division of Environmental Planning and Protection, USEPA—Region II, 290 Broadway, New York, NY 10007. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #20)

Funded by RARE (Regionally Applied Research Effort) grants from EPA Regions II and III to the Partnership for the Delaware Estuary (PDE), the most comprehensive benthic survey ever performed on the estuary was undertaken in 2008. The survey supports multiple goals: 1) a comprehensive inventory of benthic invertebrate communities that can be used for future protection and restoration efforts; 2) an assessment of the health of benthic communities that will provide a baseline for future monitoring and assessment; 3) spatial integration of biology with on-going bathymetric and sediment distribution mapping; and, 4) further development of the estuary's sediment PCB dataset.

A technical workgroup comprised of representatives from the PDE, the states of Delaware and New Jersey, EPA Regions 2 and 3, EPA's Office of Research and Development, the Delaware River Basin Commission, the University of Delaware, and Rutgers University designed a probabilistic survey of soft-bottom benthic communities from head of tide at Trenton, NJ, to the mouth of the Delaware Bay. The stratified random design consisted of three salinity strata (oligo-, meso-, and polyhaline) and three sediment strata (silt-clay, mixed sediments, and sand). Using the sediment-type distribution maps produced by the Delaware Dept. of Natural Resources and Environmental Control, each sediment stratum was, where possible, delimited within each salinity stratum. Within each of the resulting salinity-sediment combinations, twenty-five sampling sites were randomly located. The polyhaline stratum lacked sufficient sediment mapping and was stratified geographically; however, post-sampling sediment analysis will allow classification of these sampling sites according to sediment type. Likewise the accuracy of the pre-sampling allocation of all sites into salinity and sediment strata will be assessed using summer 2008 data. Some post-sampling re-classification of sites is anticipated. Sampling sites were also randomly located in the tidal freshwater portion of the estuary, but not stratified according to sediment type.

Over the course of 36 days from July to September, volunteers coordinated by PDE and EPA, covered 91 river miles, visited 230 sampling sites, and collected over 460 bottom grabs. At each sampling site field crews recorded water quality data (for a survey total of about 1,500 data points), collected sediment for benthic community, grain size, metals, PCBs, and total organic carbon analyses, and, whenever possible, produced a digital video record of the bottom using a camera attached to the bottom grab frame.

An investigation of hard-bottom communities conducted last summer is described in a separate poster.

TRANSPORT OF HORSESHOE CRAB EGGS AND SEDIMENT OVER A TIDAL CYCLE ON A SANDY FORESHORE IN DELAWARE BAY, NEW JERSEY. **Sherestha Saini**, Department of Chemistry and Environmental Science, New Jersey Institute of Technology, University Heights, Newark , NJ 07102, ss537@njit.edu, Nancy L. Jackson, Department of Chemistry and Environmental Science, New Jersey Institute of Technology, University Heights, Newark , NJ 07102 and Karl F. Nordstrom, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ 08901. **Session 16**, 11:00am, 1/14/09. (presentation #38)

Delaware Bay is an important location for spawning horseshoe crabs and a suite of shorebird species that migrate thousands of miles to feed on nutrient rich horseshoe crab eggs. Eggs are released from the sand matrix, by bioturbation or wave action, and delivered to shorebirds via the swash zone. Processes within the wave breaking and swash zones increase in importance for exhumation and transport when spawning densities are low. This study presents results of a field investigation to measure wave and swash processes and exhumation and transport of horseshoe crab eggs and terrigenous sediment in the swash zone of a sandy foreshore in Delaware Bay.

Data on wave characteristics, swash uprush and backwash velocities, and swash width, depth and duration were gathered over a spring tidal cycle. Nine kilograms of dyed terrigenous sediment was well mixed with approximately 400,000 dyed horseshoe crab eggs and injected in two locations on the foreshore. The first injection site was located where wave breaking and swash influenced exhumation and transport. The second injection site was located where swash processes alone influenced exhumation and transport. Total load sediment traps were used to measure the quantity of terrigenous sediment and eggs transported over a total of 110 individual swash cycles.

Winds approached onshore during monitoring. Significant wave height averaged 0.28 m with a peak period of 3.0 s. Wave and swash conditions during trapping exhumed and mobilized terrigenous and biogenic sediment from both injection sites during the rising tide. During the falling tide, the quantity of terrigenous sediment tracer trapped decreases and the number of eggs trapped during the falling tide represented <3% of the total number of eggs trapped over the tidal cycle. Total number of eggs and terrigenous sediment tracer trapped was greater from the injection site where both the swash and breakers transgressed past the injection point. Preliminary results reveal that terrigenous sediment tracer remains in the swash system but egg tracer is rapidly dispersed.

NUMERICAL INVESTIGATION OF CONTAMINATION TRANSPORT ON BEACHES UNDER TIDAL INFLUENCES. **Youness Sharifi***, Ali Abdollahi Nasab, Hialong Li, Michel C. Boufadel, boufadel@temple.edu; Temple University, 1947 N 12th st., Philadelphia, PA, 19122
Session 14, 9:30am, 1/14/09 (presentation #55)

The main challenge of tidally influenced beaches is to understand how water level moves when tide is rising and/or falling also it is important to understand how tidal changes effect the contamination on the beach, in the case bioremediation is considered to be one of the shore cleanup methods. Primary goal of this work was to develop a numerical strategy for better understanding of tidal and

contamination behavior. The numerical model regenerated the results from a prior experiment, simulating tide and tracer study on a laboratory beach. Injection of a conservative tracer was used to represent a contamination introduced to the system. Changes in the plume concentration shape and size were reproduced along with water table fluctuations. Simulation results were then used to investigate in details the flow patterns, effect of different parameters on the flow, and the residence time of the plume. Based on the simulations, it was found that injected plume has tendency to move seaward as tide is falling and downward with rise of the tide, while seaward movement is much greater than downward movement. Besides it was found that in order to have the longest retention time and most effective remediation, tracer (nutrients) should be injected during low tide close to a high tide line. Model provided better match with real case when it was considered that the beach was consisted of two layer with different hydraulic conductivity values. Seepage effects were also considered in the model as they exist in laboratory and prototype beaches. Mass balance studies indicated that flow in seepage zone is less than that of below seepage zone and most of mass is leaving system below the seepage zone.

REFRAMING INTRODUCED SPECIES POLICY IN THE DELAWARE ESTUARY WATERSHED. **Shawn Shotzberger**, Senior Environmental Scientist - AKRF, Inc., 100 Centre Blvd., Suite 102 H/J, Marlton, NJ 08053, sshotzberger@akrf.com. **Session 2**, 1:45pm, 1/12/09 (presentation #15)

Over the past few decades, there has been an outcry from resource managers, academic institutions, and environmental advocacy groups regarding the dangers of invasive species. Some arguments against the introduction of particular species have merit; there is no doubt that the capacity for some introductions to cause irreparable damage is manifest. Nevertheless, when considered at the policy-level scale, there is at the heart of the invasive species issue a cognitive dissonance on the part of many who hope to halt further invasions. The purpose of this presentation is not to impugn any specific resource management strategy regarding its stance on invasives; instead, it highlights broad inconsistencies in how introduced species are viewed and attempts to reframe the discussion by urging scientists and resource managers to consider the real question at the core of the debate.

This presentation contends that ecology and economics are explicitly linked in many policy decisions regarding invasive species and stakeholders, collectively and subconsciously, are more willing to disregard those introduced species that provide greater perceived benefits. This presentation also advances the argument that the ecology/economic linkage should not be dismissed out of hand – discourse should begin to reconsider species introductions in light of increasing human development and our increasing demand on natural resources.

Wholesale prevention of species introductions is impossible – nature will mix species even if humans do not. Elimination of extant non-native species is often impractical, and many of them are so embedded in our landscape and economy that we no longer notice them. On the other hand, no rational person would advocate the unrestricted and/or unmonitored introduction of species.

Our future challenge, then, is to develop policies and guidance that consider both ecology and economics in a rational framework – no small task given that our understanding of the system as a whole is necessarily incomplete and the system itself works in a non-linear way. Any viable framework must also acknowledge inherent uncertainties in the system, and should consider both costs and benefits of any species introduction and the responses to it. Lastly, rational introduced species policy making cannot be accomplished without first considering and answering the larger

ADVANCING ENVIRONMENTAL ORGANIZATIONS IN AN AGE OF MELTDOWNS, BAILOUTS, STIMULUS PACKAGES, AND CARBON FOOTPRINTS. **Larry J. Silverman**, Member, Washington, DC Bar 7308 Birch Avenue Takoma Park, MD 20912 301-346-3757 ljoelsilverman@gmail.com **Lunch**, 12:15pm, 1/14/09 (presentation #34)

1. Economic crisis need not signal retreat from environmental goals. The Great Depression was a period of significant environmental advancement, especially in rural areas, where soil conservation programs were for the first time initiated, and in urban areas where public works money was invested in water and sewer infrastructure. How did that happen?
2. A key to advancement is to find and highlight the environmental problems associated with economic troubles. Example: the failure of American car makers to market fuel efficient cars is a cause of both the economic troubles of Detroit and the air pollution problems of American cities. Similarly, the catastrophic economic consequences of Katrina are linked to the destruction of coastal wetlands and climate change. These are analogous to the Dust Bowl, when poor land stewardship led to a collapse of the agricultural economy.
3. Increasing public investment is the likely response to slowdowns in private investment. A key is to insist that public investment provide public goods, including environmental protection. Another response is to incentivize private investors to provide public benefits. Example: the recent set of tax incentives that passed along with the bailout bill, providing generous tax advantages for renewable energy. Environmental groups have an important role in directing public and private investment.
4. How to profit from stimulus: This is not the time for environmental advocates to scale back their plans. On the contrary, the motto should be Get Ready, Get Set and Get Ready to Go. Ready-to-go projects are the ones that will get funded, the bigger the better.
5. Green collar jobs are another response to economic crisis. The time is right for a reuniting of labor groups and environmental advocates.
6. Environmental issues have never weighed so heavily on the public mind. However, global climate change and CO_2 seem to dominate consciousness. How does an estuary group respond? The key is to provide measures of benefits of important projects in terms of carbon offsets. Example: What are the carbon impacts of restoring a tidal marsh?
7. Some groups hop from trend to trend in an endless quest for money, often losing focus, effectiveness and reputation. On the other hand, no organization that hopes to thrive in the next decade can afford to ignore the mega-trends that are roiling the globe. The challenge: How do core beliefs and missions address larger social and economic forces? Right answers will lead to success.

ADAPTIVE MANAGEMENT OF HORSESHOE CRABS AND RED KNOTS IN DELAWARE BAY: COULD IT BE HOME AT LAST? **David R. Smith,** USGS – Leetown Science Center, 11649 Leetown Road, Kearneysville, WV 25430, 304-724-4467, drsmith@usgs.gov, James D. Nichols, USGS – Patuxent Wildlife Research Center, Laurel, MD, Conor P. McGowan, USGS – Patuxent Wildlife Research Center, Laurel, MD
Session 4, 4:00pm, 1/12/09 (presentation #16)

Management of Delaware Bay horseshoe crabs and migrant shorebirds has followed traditional species-specific assessments with only qualitative linkages between them. During this time, the management process has been marked by dispute and ad hoc decision making. Recently, a group of managers and researchers embarked on a journey to develop and implement an adaptive management framework that explicitly accounts for the linkages and uncertainties in the species' associations. Under the proposed framework, horseshoe crab harvest will be explicitly constrained by red knot population size or departure weight. Population models will quantitatively link the species' dynamics and predict consequences of harvest actions. Optimal harvest actions will be identified through stochastic dynamic programming. This is an ongoing project and so far, so good. In this talk, we outline the adaptive management framework and highlight the successes and challenges encountered, as well as the challenges that lie ahead.

CASE STUDY – BEST MANAGEMNET PRACTICES AND CONSERVATION EDUCATIONIN THE AMISH COMMUNITY, CHESTER COUNTY, PA. **Chris Strohmaier** and Charlotte Sprenkle. Watershed Coordinator and District Manager. Chester County Conservation District, 688 Unionville Road, Suite 200, Kennett Square, PA 19348, 610-925-4920 EXT. 111 FAX 610-925-4925 csprenkle@chesco.org dgreig@chesco.org **Session 11**, 2:45 pm, 1/13/08 (presentation #26)

The Octoraro watershed and the Brandywine watershed, Chester County, PA has a large population of plain sect farmers, each with small, family agriculture operations of livestock and crops. The Chester County Conservation District (CCCD) has had great success enlisting these conservative, religious farmers to become District Cooperators, and install livestock crossings, fencing with forested riparian buffers and pioneered the use of no-till planting.

In 1998, Christian Strohmaier, CCCD, initiated contact with these farmers to get these BMPs on the ground. He tapped into non-government funding sources dedicated to improving the water quality of the Chesapeake Bay. The Octoraro watershed drains directly into the tidal waters of the Susquehanna River. As those funding sources decreased, he was able to redirect government funding through the watershed association to continue the work. In 2004, Kathleen McGinty, Secretary, PA DEP, celebrated the 1000th mile of riparian buffer installed by CBF (PA), Maple Arch Farm, Octoraro watershed, Chester County.

In 2006, the CCCD and the Octoraro Watershed Association received $8000 to initiate a conservation education program for the one room Amish schools in the watershed. An Amish liaison and watershed members visited schools and Amish bishops to receive permission to implement the program. These personal visits were critical in relation to trust and a tragedy in the Amish community in October 2006. In spring 2007, representatives returned to deliver a conservation curriculum and a native tree seedling to 300 students in 11 schools, which were planted at their home farm. There are many Amish farms in the headwaters of the Brandywine Creek. Many of this lessons learned of this program have been transferred to the Delaware Estuary Amish population. Technology was also tranfered including horse drawn modern equipment. Grant funding for the Best Management Practices in the Brandywine Watershed include EPA Christina Basin Estuary funds, Chapter 319 funds from both PA and DE, Brandywine Valley Association and the farmer's pocket. A Power Point features communication with plain sect farmers, government and non-government funding issues, buffer comparison and contrast (English/Amish) on width, plant material, invasives management, and success measures.

UNDERSTANDING SEA LEVEL. **Mike Szabados**, Center for Operational Oceanographic Products and Services, 1305 East West Highway, Silver Spring, MD 20910, Mike.Szabados@noaa.gov. **Session 1**, 10:30am, 1/12/09 (presentation #114)

Today, climate change and how it influences sea level is on the forefront of everyone's mind. How will society be impacted by an increased rate in global sea level rise? The Intergovernmental Panel on Climate Change (IPCC) reported in their 2007 assessment that the average rise in global sea level during the 20th Century was 1.7 mm/yr. Based on satellite altimetry observations since 1993, sea level has been rising at about 3 mm/yr – a rate that is nearly twice that of the average for the Century. It is still unclear whether this accelerated rate is simply a reflection of decadal variability or is indeed due to an increase in the longer-term trend. These issues are very relevant to coastal surveyors, coastal managers, and everyone working, playing, and living along our coasts. Scientists and managers must know where to find accurate information, and how to interpret it. The Nation's nautical charts, shoreline maps, and elevations relative to homes, levees, and other coastal infrastructure depend on the accurate determination of sea level. Sea level rise can also have legal ramifications on national, state, and private boundaries along the coast. Establishing NOAA's nautical chart datum (Mean Lower Low Water), the shoreline (Mean High Water) and the National Tide Tables also require accurate determination of sea level. To ensure that NOAA's nautical charts and tide tables remain accurate and relevant, NOAA's Center for Operational Oceanographic Products and Services and its predecessors have determined sea level for the United States since the mid 19th Century. This session will discusses how NOAA monitors sea level rise using tide stations, and address changes in Local Mean Sea Level in the Delaware Estuary and around the country. Estuaries and coastlines will continue to be dynamic in the face of climate change and sea level rise, and sound management decisions must be based on understanding not just global sea level trends, but local and regional Relative sea level trends.

PROJECT HEADWATERS: A NEW FRAMEWORK FOR WATERSHED RESTORATION IN THE DELAWARE ESTUARY. **Shandor J. Szalay,** AKRF, Inc., 100 Centre Blvd. Suite H/J, Marlon, NJ 08053, sszalay@akrf.com; **Jason Cruz,** Philadelphia Water Department, 1101 Market St. 4th Floor, Philadelphia, PA 19107; and **Mike Wilson,** Southeast Montgomery County Chapter of Trout Unlimited, 6216 Argyle St., Philadelphia, PA 19111. **Session 7**, 9:30am, 1/13/09 (presentation #54)

Headwater streams are critical components of river systems providing a key link between upland areas and larger streams; regulating the flow of organic matter, nutrients, sediment, and organisms to downstream areas; and providing key repositories of biodiversity. Physical disruptions to headwater streams (e.g., burial, destabilization due to hydromodification, etc.) associated with urbanization and other land use changes can significantly degrade downstream aquatic resources and act to undermine restoration efforts within downstream channel networks. However, despite the critical role of headwater streams in maintaining river systems, they have been historically undervalued by many watershed restoration efforts, which have tended instead to focus implementation funds within downstream areas.

The authors argue that headwaters restoration should occupy a more central role within integrated watershed planning efforts and present *Project Headwaters*, a cooperative and diverse partnership focusing on restoration of headwater sections of the Pennypack Creek watershed in Southeastern PA. The authors present the scientific basis for a headwaters focused restoration approach, discuss the guiding principles of the *Project Headwaters* effort, provide a review of *Project Headwaters'* recent and planned work within the Pennypack Creek watershed, and discuss how the *Project Headwaters* concept could be expanded to play an increasingly important

TIDAL WATER QUALITY MODELING IN THE MURDERKILL RIVER
Andrew J. Thuman, P.E.*, Biswarup Guha and Ruta Rugabandana. HydroQual, Inc. 720 King Georges Post Rd., Suite 101, Fords, NJ 08863 (732) 582-4004 athuman@hydroqual.com.
Session 17, 12:00pm, 1/14/09 (presentation #90)

TMDLs for the Murderkill River watershed were completed by the Delaware Department of Natural Resources and Environmental Control (DNREC) and approved in 2001 (amended 2005). The watershed modeling framework developed to establish these TMDLs was challenged and resulted in an agreement to jointly:

- Form a study group to plan and implement a monitoring effort for quantifying the impact of tidal marshes and other sources on water quality;
- Utilize the information obtained to develop a state-of-the-science watershed and water quality model; and
- Develop site-specific water quality standards for DO and nutrients if warranted by the results.

The study group includes representatives from DNREC**,** Kent County**,** Universities of Delaware

and Maryland, USGS and other researchers.

The monitoring program designed for the study included: tidal salt marsh sampling; algal production studies; sediment flux (SOD and nutrients) measurements; tidal and water quality monitoring. These new monitoring efforts were designed to support calibration of the watershed and tidal hydrodynamic/water quality models (HSPF, ECOM/RCA) and also to quantify the interaction of the extensive tidal salt marshes with water quality in the main stem of the river. The marsh monitoring was designed to estimate: whether the marshes are a nutrient source or sink; the loading of particulate organic matter to the river and its contribution to SOD; and the importance of the marsh storage volume on tidal circulation in the river.

The tidal modeling includes wetting and drying of the tidal salt marshes, marsh nutrient uptake/loading, a sediment flux model to properly account for SOD and nutrient fluxes, and linkage to the upstream watershed model to provide NPS loadings. After model calibration is complete, the model will be used to determine if existing water quality standards can be met or if background, naturally occurring loads prevent attainment of the DO standard. If the monitoring/modeling results suggest that background sources to the river prevent attainment; site-specific water quality standards will be developed.

The focus of this presentation will provide an overview past monitoring/modeling studies, a brief summary of the TMDL history, and the modeling being completed to support the effort. The unique aspects of the modeling will be highlighted and how the monitoring data collected was incorporated into the model development and calibration but also how the modeling framework can be used to assist in the development of site-specific water quality standards.

WILL PEOPLE ALLOW ECOSYSTEMS TO MIGRATE INLAND? **Jim Titus** Climate Change Division (6207J) U.S. Environmental Protection Agency, Washington, DC. 20460
ession 1, 10:45am, 1/12/09 (presentation #108)

Environmental regulations and acquisition programs have largely curtailed--and in Delaware Bay reversed-- the conversion of tidal wetlands, mudflats and beaches (tidelands) to dry land. But the policymakers that have devised and implemented those important programs have generally focussed on protecting these resources in their current locations. As sea level rises, the existing tidelands are converted to open water, and their landward migration is blocked by efforts to protect real estate from the rising water. To meet the original objectives of existing environmental policies, the time is now to devise plans for enabling tidelands to migrate inland where possible.

The most effective options for ensuring that ecosystems can migrate inland as sea level rises are (a) prevent development, (b) allow development but prohibit shore protection. These approaches can be implemented either by regulation, public purchases of property rights, donation, or dedication. Other options that are less effective but may work in some cases include ending subsidies for shore protection, and directing infrastructure away from vulnerable areas. To a greater extent than most other large estuaries, the low land along the Delaware Estuary is already off-limits to development. Therefore, actions to ensure landward migration may seem less urgent. On the other hand, this situation also creates the opportunity to obtain iron-clad guarantees against shore protection, since conservation easements are less expensive when no one is planning to do the things that they preclude.

A PSA FACELIFT – BRINGING TRADITIONAL MEDIA UP TO THE MULTIMEDIA AGE. **Lisa D. Tossey**, Delaware Sea Grant, University of Delaware Marine Public Education Office, Newark, DE, 19716, tossey@udel.edu; and **Elizabeth Boyle**, Delaware Sea Grant, University of Delaware Marine Public Education Office, Newark, DE, 19716, boylee@udel.edu.
Session 11, 2:30pm, 1/13/09 (presentation #78)

The rise of high-speed Internet connections has revolutionized how information is accessed and disseminated, and has led to new avenues of communication and a growth in online multimedia applications like streaming video.

In 2008, Delaware Sea Grant examined how to use digital applications to spread the reach of SeaTalk, a bimonthly series of 30- and 60-second radio announcements on subjects ranging from sharks to sand dunes to current marine science research. As a public service in conjunction with more than 35 area radio stations, Delaware Sea Grant has produced SeaTalk for more than 30 years.

Traditionally, SeaTalk has been distributed to stations through mailings. Since 1998, the 60-second recordings have also been available online in MP3 format through the Delaware Sea Grant Web site. In an effort to distribute these digital recordings more widely, a RSS (Really Simple Syndication) feed was created. The feed allows users to subscribe to SeaTalk, so they are automatically notified when new episodes are posted.

The RSS feed also allows other Web sites and applications to subscribe to and automatically update SeaTalk episodes, expanding its presence to widely used programs like iTunes and to podcasting Web sites and Internet radio stations. All of this was done at no cost, except for the time it took to create the feed.

It was also decided to put a visual face on SeaTalk by synching photos with the existing 60-second audio clips to make short videos. Photos are pulled from an existing image database, matched to the audio using iMovie, and effects are added to give the photos a sense of movement. The resulting movies can be exported in a compressed format for Web viewing.

The videos are also added to the SeaTalk RSS feed and are released every other week to keep the feed fresh. Their creation also allowed Delaware Sea Grant to create a channel on the popular video Web site YouTube. Again, since everything is done using existing materials and personnel, the only cost for this expansion in outreach is the time it takes to produce the videos.

To date, these changes have greatly increased SeaTalk's reach online. The RSS feed was launched in February 2008, and quickly grew to be the most visited page on the Delaware Sea Grant site, pulling in over 4,500 visitors a month just six months after its inception.

INVESTIGATING GROWTH AND CELLULAR RESPONSE OF *PROROCENTRUM MINIMUM* AND *KARLODINIUM VENEFICUM* ACROSS SALINITY GRADIENT: APPLICATION OF MOLECULAR METHODS FOR SPECIES-SPECIFIC QUANTIFICATION. **Oluchi Ukaegbu*,** Department of Biological Sciences, Delaware State University, Dover, DE, 19901, USA, lululuch@hotmail.com; and **Gulnihal Ozbay,** Department of Agriculture & Natural Resources, Delaware State University, Dover, DE, 19901, USA.
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #74)

In both Delaware and Chesapeake Bays *Karlodinium veneficum* and *Prorocentrum minimum* are superior members of the phytoplankton community. Both species are members of dinoflagellate and they produce very complex organic compounds using inorganic chemicals and light energy. Similar to other types of phytoplankton, dinoflagellate species can produce population explosions when habitat settings such as light, temperature, nutrients, turbulence, and predator levels are ideal. At high density blooms, these dinoflagellates such as *P. minimum* and *K. veneficum* can potentially be very toxic. Our world as a whole is undergoing dramatic environmental modulations and global warming plays a major role concerning salinity densities and desalinization of our ocean waters as reported in previous studies. Global warming is now melting glaciers and dumping of fresh water into our oceans which is potentially causing changes in salinity gradient. This freshwater input may change *P. minimum* and *K. veneficum* function, existence, growth, and most importantly its survivorship and co-existence as a group along with their competitions. The primary objective of this research project is to investigate the growth and survivorship of *P. minimum* and *K. veneficum* cultured in two different salinity regimes; 28ppt and 18ppt. The other objectives are to isolate DNA from those algal species cultured in two different salinity regimes and monitor cellular activities that lead to salinity tolerance in those species using RT-PCR. Both species were cultured in F/2 media at 12/12 hour light/dark cycle at 24°C room temperature and dissolved oxygen above 5mg/L. Four replicates of each species were treated with salinity at 18ppt as the treatment and 28ppt as the control. The algal growth was measured using a hemocytometer until the lag phase. There was no significant difference between their growths in two salinity regimes, but *K. veneficum* had higher growth rate at low salinity as compared to *P. minimum*. These algae are further retained on a 0.7mm pore size filter to extract the DNA for gel electrophoresis and PCR. Primary purpose of DNA extraction and PCR are to find out if sample sizes are sufficient enough to obtain DNA of filtered algae. We hope to identify polymorphism between the salt sensitive and salt insensitive species, and to find if there is a relationship of polymorphisms to salinity tolerance using RNA isolation. Information on salinity tolerance may help algal ecologists to determine how physical and other environmental conditions effects the overall species abundance and toxin production in the two dinoflagellates.

PRELIMINARY ASSESSMENT OF ANNUAL NUTRIENT LOADS TO THE MURDERKILL ESTUARY, DELAWARE: WATERSHED, WASTEWATER, AND ATMOSPHERIC CONTRIBUTIONS. **William J. Ullman**, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958 ullman@udel.edu; **Mäella A. Dréan**, Institut Universitaire de Technologie, Université de Perpignan, Perpignan, France; **Joseph R. Scudlark**, College of Marine and Earth Studies, University of Delaware, Lewes, DE 19958; and **Hassan Mirsajadi**, Watershed Assessment Branch, Delaware Department of Natural Resources and Environmental Control, 820 Silver Lake Boulevard, Suite 220, Dover, DE 19904.
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #51)

Nutrient budgets are an essential tool for the management of estuarine eutrophication, which serve to direct managers toward the most efficient and cost effective mitigation strategies. As part of a comprehensive study of nutrient cycling in the Murderkill Estuary funded by the Kent County Levy Court (Delaware), we have used existing and new monitoring data to determine nitrate (NO_3^-), total ammonia(um) ($TNH_3 = NH_4^+ + NH_3^o$) and soluble reactive phosphorus (PO_4^{3-}) loads from the upland watershed, the Kent County Wastewater Treatment Facility KCWTF), and the atmosphere to the Murderkill Estuary, a tributary to Delaware Bay.

Unit nutrient loads ($kg/km^2/day$) from the Murderkill watershed were determined from the product of bimonthly nutrient concentrations and discharge at three USGS gauging sites in the watershed (Murderkill River near Felton DE; Pratts Branch near Felton DE; and Browns Branch near Harrington DE) from May 2007 to April 2008. Based on a watershed area of 255 km^2, this represents average daily loads to the Murderkill estuary of 1520, 49, and 7.0 kg/day, for NO_3^-, TNH_3, and PO_4^{3-}, respectively. There is a large uncertainty in these values that results from both seasonal variations in concentrations and differences between the three sampled subwatersheds.

Direct total atmospheric deposition to the tidal waters and salt marshes of the Murderkill estuary was determined from wet deposition data collected at the NADP-AIRMon site at Cape Henlopen Delaware and estimates of dry deposition. Total direct atmospheric deposition to the Murderkill estuary and marsh represents 5.5, 11.7, and 0.4 Kg/day for NO_3^-, TNH_3, and PO_4^{3-}, respectively.

Average annual loads of NO_3^-, TNH_3, and PO_4^{3-} from the KCWTF were determined from reported weekly average concentration and discharge: 153, 45, and 84 Kg/day for NO_3^-, TNH_3, and PO_4^{3-}, respectively.

Total loads of NO_3^-, TNH_3, and PO_4^{3-} to the Murderkill estuary are estimated to be 1680, 105, and 92 kg/day. The watershed is responsible for 91% of the total NO_3^- load, 46% of the total TNH_3 load and 8% of the PO_4^{3-} and the Kent Count Plant is responsible for 9% of the total NO_3^- load, 43% of the total TNH_3 load, 92% of the PO_4^{3-} load to the Murderkill Estuary. These preliminary results suggest that the most efficient strategy for reducing the impact of nutrient loads on the the Murderkill estuary should focus on mitigating N loads from the watershed and P loads from the KCWTF.

TIDAL MARSHES IN THE DELAWARE ESTUARY: HISTORICAL RECONSTRUCTION OF CHEMICAL LOADINGS AND ECOSYSTEM EFFECTS. David Velinsky*, Don Charles, and Roger Thomas, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103 (velinsky@ansp.org) and **Christopher Sommerfield**, College of Marine and Earth Studies, University of Delaware, Lewes, DE. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #49)

Tidal marshes of the northeastern United States are among the most productive ecosystems in the world. They serve as nurseries for many important freshwater and estuarine organisms, and support the productivity of adjacent coastal waters by exporting nutrients. They are also regional sinks for fine-grained riverine sediments and organic carbon, and contribute to the seasonal patterns of turbidity in riverine and coastal waters. In addition, they contain sedimentary records reflecting Holocene fluctuations in sea level. Because of their ability to adsorb trace metals and organics, fine-grained sediments trapped in tidal marshes, also 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 earlier part of the 20th century, extensive eutrophication in the Upper Delaware estuary, from production and decomposition of freshwater and estuarine algae and phytoplankton, resulted in depressed dissolved oxygen values 100-160 km upstream from the mouth of Delaware Bay. In addition, there were substantial loadings of chemical contaminants, such as PCBs, PAHs and DDT, that biomagnified in resident and migrating finfishes. However, since the early 1960's, there has been a substantial effort to reduce the chemical loadings, and improve ecological conditions within the estuary.

To investigate these changes; sediment cores were obtained from freshwater tidal 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 and sediment pollution records extending back through much of the past century. A preliminary analysis suggests an average sediment accumulation rate of 0.69 ± 0.08 cm/yr (12% RSD; n =12) with a range of from 0.56 to 0.83 cm/yr. There is a dramatic increase in sedimentary PCBs and in some cases nitrogen and phosphorus starting in the late 1930s and mid-1950s, respectively. Many organic contaminants showed peak concentrations in the 1960s to 1970s. Diatom assemblages and stable isotopes of C and N exhibited large changes due to watershed-wide improvements in overall water quality. The benefits of coring, and looking back over time, can help support pollution control programs by showing that real time improvements are possible. Knowledge of the concentrations of pollutants in sediments is key to reconstructing anthropogenic impacts on the environment, and will help to evaluate current environmental conditions and guide restoration efforts in the future.

NATIONAL MONITORING NETWORK FOR COASTAL WATERS AND THEIR TRIBUTARIES: THE DELAWARE RIVER BASIN DEMONSTRATION PROJECT, **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; and **Robert Tudor**, Delaware River Basin Commission, 25 State Police Drive P.O. Box 7360, West Trenton, NJ 08628-0360. **Session 12,** 3:30pm, 1/13/09 (presentation #72)

The National Water Quality Monitoring Council (NWQMC) selected the Delaware River Basin, San Francisco Bay, and Lake Michigan as Demonstration Project areas to test the design of the National Water Quality Monitoring Network for Coastal Waters and their Tributaries (Network). The Network is designed as a "network of networks" containing discrete, probabilistic, real-time continuous, and satellite data collected by the Federal, State, and local agencies and universities in the Delaware River Basin (DRB). An objective of the Network is to improve the linkage to the Integrated Ocean Observing System (IOOS), which is an integrated system of observations and data management that routinely provides information about coastal waters and coastal ecosystems for eleven IOOS Regions areas across the United States. Network project areas are monitored for physical, chemical, and biological water-quality characteristics and constituents in the major water resource compartments of the hydrologic cycle--the atmosphere, rivers above the head of tide, ground water, wetlands, estuaries, beaches, and near- and off-shore coastal areas. In 2008-09, U.S. Geological Survey monitoring funds were used to improve the comparability of monitoring entities in the DRB with respect to: (1) nutrient and carbon sampling and analyses at river sites above the head of tide and in the estuary; and (2) continuous real-time monitoring of temperature, pH, dissolved oxygen, conductance, and turbidity at river and estuary sites. The objective is to store the aggregated data in a centralized data access system so that water-quality data can be retrieved from a single web site. Results of nutrient, carbon, and continuous monitoring in the rivers, estuaries, and other hydrologic compartments in the DRB will be presented.

LONG-TERM WATER QUALITY TRENDS IN THE DELAWARE ESTUARY FROM THE BOAT RUN DATABASE**. Y. Voynova** and J.H. Sharp, College of Marine and Earth Studies, University of Delaware. **Session 12**, 3:45pm, 1/13/09 (presentation #67)

The Boat Run database, maintained by DRBC and based on sampling and analyses by DNREC, contains data for various water quality parameters collected regularly from 1967 until present. This is the longest continuously maintained record on the Delaware Estuary and is extremely valuable for assessing long-term water quality trends and understanding ecosystem conditions in this region. The Boat Run database is publicly available via the EPA STORET website. However, there are a number of obstacles end users need to pass before they can access the database; in this presentation we will address some of them. The Boat Run Database is divided between the Legacy and Modern STORET, each of which has different prerequisites for data extraction. Neither the descriptions and numbers, nor a map of the regular boat run stations are readily available on the STORET database, to allow for end users to find the station locations in the Delaware Estuary they need. Through the years, parameter definitions may vary, but these variations are not communicated to end users: for nitrate alone, there are 4 parameter descriptions. Finally, parameter numbers and definitions have changed over time, and boat run stations have been added or abandoned. These changes are difficult to trace from the available metadata online, but are essential for obtaining a full record of the database. In the past, we have extracted selected data to conduct some trend analyses. We are currently developing protocols to download and use the complete dataset and will present examples of our work so far.

THE IMPACT OF CLIMATE CHANGE AND SEA-LEVEL RISE ON TIDAL FRESHWATER MARSHES OF THE DELAWARE RIVER ESTUARY **Nathaniel B. Weston,** Department of Geography and the Environment, Villanova University, Villanova, PA 19085, nathaniel.weston@villanova.edu Melanie A. Vile, Department of Biology, Villanova University, Villanova, PA 19085 Scott C. Neubauer, Baruch Marine Field Laboratory, University of South Carolina, Georgetown, SC 29442 David J. Velinsky, Patrick Center for Environmental Research, The Academy of Natural Sciences, Philadelphia, PA 19103. **Session 10**, 1:30pm, 1/13/09 (presentation #29)

Global climate change and rising sea-levels will exert a particularly powerful influence on tidal marsh ecosystems. Tidal marshes must accrete material in order to keep pace with rising sea-levels. The storage of organic matter in marsh soils contributes substantially to marsh accretion. Plant and microbial processes play an integral role in regulating marsh accretion rates through creation (plant photosynthesis) and decomposition (microbial mineralization) of organic matter in marsh soils. Rising sea-levels will impact plant and microbial communities in tidal marshes, especially in freshwater tidal regions in which rising sea-levels result in the intrusion of salt-water. We examined the effects of salt-water intrusion on tidal freshwater marsh (TFM) plant processes and microbial organic matter mineralization rates in the Delaware River Estuary using a combination of experimental approaches including a laboratory incubation experiment and a field transplant manipulation.

Rates and pathways of microbial organic matter decomposition in TFM soils from the Delaware River Estuary shifted after salt-water intrusion. Rates of microbial sulfate reduction increased, while, surprisingly, methanogenesis rates were not inhibited, resulting in an increase in the amount of organic matter mineralized. There was a substantial increase (43%) in gaseous carbon (carbon dioxide and methane) emission from TFM soils following salt-water intrusion compared with freshwater controls. As a consequence, there was significantly more (7%) organic matter lost from soils experiencing salt-water intrusion. In a field transplant experiment simulating the effects of salt-water intrusion into a TFM marsh, TFM plant biomass and photosynthesis rates declined with increasing salinity. Taken together, these results suggest that rising sea-levels accompanied by salt-water intrusion into TFMs will decrease organic matter inputs (plant response) while increasing organic matter loss (microbial processes), dramatically decreasing marsh accretion potential.

A better understanding of the complex interactions between marsh accretion and biological as well as abiotic processes is required. Our work to date addresses the biological responses of plants and microbes in TFMs to salt-water intrusion. However, inorganic sediment deposition is also important to marsh accretion, and climate change together with shifts in land-use will influence rates of sediment delivery to tidal marshes. In addition, sea-level rise (rather than just salt-water intrusion) will have a major impact on plant processes in tidal marshes. Further research is required to gain a comprehensive understanding of these various processes and to predict the overall response of TFM ecosystems to various scenarios of climate change.

NATIVE VEGETATION CLASSIFICATION SYSTEM (NVCS): ON-THE-GROUND APPLICATION OF NVCS AND FUTURE PLANS. **Laura Whalen** and **Danielle Kreeger,** Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, lwhalen@delawareestuary.org. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #113)

Natural communities are unique assemblages of plants and animals that reoccur within specific environmental settings. These unique assemblages can reflect ecological conditions at a scale broader than the species' population, yet more refined than the landscape. ***The Guide to the Natural Communities of the Delaware Estuary*** describes 35 ecological systems and 185 natural community types known to occur in the region. The Guide also contains a cross-walking table between the NVCS classification and the New Jersey, Pennsylvania and Delaware state classification; therefore, assisting in regional resource management, conservation and restoration. Over the past two years, the Partnership has worked with NatureServe and the Nature Consevancy to prepare comprehensive maps of the ecological systems across the Delaware Estuary Program's study region, including areas of Delaware, New Jersey and Pennsylvania. Initial maps have been completed for the watershed in Delaware, New Jersey, and the Brandywine River area of Pennsylvania, and this work continues in Pennsylvania. In addition, an *Addendum to the Guide to the Natural Communities of the Delaware Estuary* has been drafted and will soon be finalized.

In addition to the ecological systems maps and guide, two demonstration projects for the Native Vegetation Classification System (NVCS) were completed in fall 2008 to show how restoration targets can be set based on native plant communities. One demonstration was Phase 1 of an environmental enhancement project at the Hatboro-Horsham School District's Jarrett Nature Center. After pinpointing the location on the draft Ecological Systems Map for PA, two native plant classifications were selected as being most representative for the area, including Northeaster Interior Dry-Mesic Oak Forest and Central Appalachian Riparian. Approximately 100 trees and shrubs and 200 perennials and ferns were planted that are characteristic of these ecological systems, including black gum, white oak, and sensitive fern. Over 100 students from the school district's elementary, junior high, and high schools volunteered to help plant. These plants will remove pollutants picked up by rainwater and snowmelt before they can wash into an onsite tributary that leads to the Neshaminy Creek. The next steps for these two demonstration projects are to continue with Phase 2 for the on-the-ground projects in spring 2009, incorporate signage to explain the NVCS project, and hold a workshop to teach how to use the NVCS maps and guide in the field as well as for restoration project design.

CORPORATE ENVIRONMENTAL STEWARDSHIP PROGRAM (CESP): CORPORATIONS TO COMMUNITIES TO CONSERVATION. **Laura S. Whalen, Karen Johnson,** Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE 19801, lwhalen@delawareestuary.org. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #115)

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. One example of a project that will be presented in this poster is the restoration of a riparian buffer sponsored by several Johnson & Johnson companies including Noramco, McNeil, Centocor, and GBSC.

The first phase of this large restoration project at the University of Pennsylvania's New Bolton Center in Kennett Square, PA took place in October 2008. The Johnson & Johnson Companies worked together to provide funds to purchase native trees, shrubs, and grasses to start a riparian buffer along an important tributary to the Red Clay Creek, which flows through the estuary to Delaware River. This phase of the project included planting a 10 foot wide buffer along a section of stream in a horse pasture where the animals can freely roam in the stream causing excess nutrients to choke out the life in the stream and increase bacteria and algae growth downstream in the Red Clay. The buffer will eventually prevent the horses and cows from walking in the stream bed, as well as help filter the nutrients from the manure that runs off from the slope in the pasture above the stream. Over forty employees came to the farm to help plant about 600 native plants specific to this region determined by the Native Vegetation Classification System, and they plan to continue this project in the spring of 2009 with additional plantings and water quality monitoring.

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 2008 CESP members for their continued commitment to improve the Delaware Estuary.

SEA-LEVEL RISE AND STORM EFFECTS ON COASTAL SYSTEMS UNDER CHANGING GLOBAL CLIMATE. **S. Jeffress Williams** (jwilliams@usgs.gov), Coastal Marine Geologist, U.S. Geological Survey, Woods Hole Science Center, Woods Hole, MA 02543. **Session 1**, 10:15, 1/12/09 (presentation #4)

Research in coastal sciences has focused on understanding how coastal landforms have evolved to the present and forecasting future change in response to sea-level rise (SLR) and increased storms. Research over the last 50 years has formulated a conceptual framework regarding the primary factors and processes that drive coastal change and evolution. The geologic record shows that sea level is highly variable with levels ~ 5 m higher during the last interglacial stage and ~120 m lower during the Last Glacial Maximum. Regional and local land subsidence can further add to SLR, particularly along the Atlantic (e.g., Delaware Bay) and Gulf coasts. Nonetheless, current techniques used to predict coastal-change such as inundation modeling, historical shoreline-change analysis, and equilibrium-profile modeling do not accurately reflect the current scientific understanding of coastal change due to SLR. While research illuminates the complexity of coastal behavior and the inadequacy of current models to predict coastal change, our ability to quantify impacts of SLR on local scales to inform policymakers and planners remains limited.

An abundant body of scientific information shows that global climate throughout Earth's history is highly variable with complex driving forces and feedbacks. Scientific consensus, however, is that the rapid build-up of greenhouse gases from fossil fuel burning since the late 19th century has increased global mean temperatures and is primarily responsible for the wide spread environmental changes being observed. Climate-change assessments (e.g., IPCC 2007) for this century suggest global sea-level will rise 0.2 to 0.5 m, more than 2 times the rise over the past century. Impacts will include increased coastal erosion, storm-surge flooding, saltwater intrusion into aquifers and estuaries, wetland loss, and threats to cultural resources and human infrastructure.

Future rise will result from thermal expansion of warming oceans and addition of melt water from land-based glaciers and ice sheets. In addition, consensus is strengthening that the rate of SLR will accelerate in the decades ahead due to climatic factors that are more robust than predicted and processes (e.g., Greenland melting, West Antarctic ice-shelf breakup) that have not been observed and fully considered until very recently. These could accelerate sea level rise by 4-6 m over the next several hundred years to millennia and would have great impact on natural ecosystems and societies world-wide.

To evaluate the potential physical impacts of future SLR, the USGS has completed the Coastal Vulnerability Index study on a national scale as well as studies of 22 National Park Service coastal parks (http://marine.er.usgs.gov/). In addition, the USGS, with EPA and NOAA, as part of the U.S. Climate Change Science Program (http://www.climatescience.gov/), has just completed a state-of-the-science review (SAP 4.1) assessing potential future coastal changes associated with SLR. One finding is that current approaches to predicting coastal change due to SLR result in an oversimplification of potential coastal hazards and a wide disparity in public awareness of coastal risks and vulnerabilities to SLR and storms.

UTILIZING BENTHIC MAPPING, BIOTELEMETRY, AND 3-D GIS TO ASSESS STURGEON HABITAT IN THE DELAWARE RIVER AND BAY. **Bartholomew Wilson** and Michael Rhode**,** *Delaware Coastal Program, Division of Soil and Water, DNREC, Dover, Delaware 1990,*Bartholomew.Wilson@state.de.us*;* John Madsen, *University of Delaware, Department of Geological Sciences, Newark, Delaware 19711;* Dewayne Fox and Phillip Simpson, *Delaware State University, Aquatic Sciences Department, Dover, De 19901.*
Session 10, 2:45pm, 1/13/09 (presentation #43)

It has become imperative for managers to better understand the resources of coastal ecosystems and their interrelationships. To address this issue, an integrated program by the Coastal Program of Delaware's Division of Soil and Water Conservation (DNREC), the University of Delaware, and Delaware State University to identify and map the benthic habitat and sub-bottom sediments of Delaware Bay and River was initiated. This project has resulted in many major milestones, which include: mapping over 350 square miles of the estuary, identifying the spatial extent and relative density of shellfish beds, facilitating a greater understanding of the local and regional sediment distribution patterns and pathways, and locating key habitats for several important species, including sturgeon.

The Delaware River currently supports populations of both Atlantic (*Acipenser oxyrinchus oxyrinchus*) and shortnose (*A. brevirostrum*) sturgeon. Shortnose sturgeon received protection under the Endangered Species Act (ESA) in 1967. A recovery plan for this species has been developed with an overall goal of protecting Shortnose Sturgeon and their habitat. At this time, microhabitat requirements for the shortnose are not well understood. The estuary historically supported the world's largest population of Atlantic sturgeon. Much of the existing information on the location of habitat utilization for this species was collected at the peak of the fishery over 100 years ago (Ryder 1888, Cobb 1900, Borodin 1925), and its present day status is poorly understood. Their abundance declined rapidly after 1900 and the present status of the population is poorly known (Brundage and Meadows 1982, NMFS-USFWS 1998, Waldman and Wirgin 1998). Atlantic Sturgeon are currently being considered for listing under the Endangered Species Act.

As part of the benthic mapping project, we are integrating bottom and sub-bottom sediment data with species tracking information (biotelemetry), in a 3-D GIS environment, to assess the temporal and habitat relationships between sturgeon and several key regions in the Delaware River. In the past, fisheries managers have struggled with developing a better understanding of critical habitat for threatened and endangered species including both Atlantic and Shortnose Sturgeon. This integrated project hopes to identify the essential habitats necessary to aid in the recovery of these key Delaware Estuary charismatic species.

IT'S EASY BEING BLUE. Kelly Wolfe, Erika Farris, and Maureen Nelson
Research Assistants at the University of Delaware's Institute for Public Administration-Water Resources Agency, DGS Annex, Academy St., Newark, DE 19711, kelwolfe@udel.edu.
Session 6, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #102)

The Water Resources Agency provides regional water resources planning, management, and policy assistance to state and local governments and the public in Delaware and the Delaware Valley through its service, education, and research role at the University of Delaware.

The Water Resources Agency strives to educate students and the general public in areas related to water conservation, water supply, and water quality. This poster will describe the initiatives conducted by the Water Resources Agency's research assistants to educate the public about the importance of water resources in our daily lives, and how each individual in our society can protect and conserve this valuable resource. Over the past two years, the research assistants have reached out to the public in numerous ways including: participation in community events such as Newark's Community Day, the University of Delaware's Coast Day; the What-In-the-World program, an in-school program for students in grades 3-12, and initiation and coordination of the Delaware Student Chapter of the American Water Resources Association (AWRA).

This poster will highlight the interactive approaches used to engage the public and students about water resources, with the main focus being water resources in the state of Delaware. Our outreach efforts strive to show the public and students that water conservation and protection should be incorporated into our every day lives, and that it's easy to be blue! Concepts that will be showcased include: a water facts memory game, a water usage quiz game, and undergraduate and graduate student activities with the Delaware Student Chapter of AWRA. The benefits and challenges of these outreach and education opportunities will also be showcased. Recognizing that planning for tomorrow's Delaware estuary starts with today's youth, we hope that the students we reach will continue to value water resources throughout their lives.

VARIABILITY OF SEA-LEVEL AND VOLUME FLUX IN THE MURDERKILL RIVER ESTUARY. **Kuo-Chuin Wong**, College of Marine and Earth Studies, University of Delaware, Robinson Hall, Newark, DE 19716, **Brian Dzwonkowski**, College of Marine and Earth Studies, University of Delaware, Robinson Hall, Newark, DE 19716, briandz@udel.edu, and William J. Ullman, College of Marine and Earth Studies, University of Delaware, Cannon Lab, Lewes, DE 19958. **Session 17**, 11:45am, 1/14/09 (presentation #28)

Observations of sea-level and volume flux were examined in the Murderkill River estuary, a small tributary estuary of the Delaware Bay. Approximately two months (11 March to 2 May 2008) of data from the United States Geological Survey at two sites (Bowers, USGS DEO1484085 and Frederica, USGS DEO01484080) in the estuary, in conjunction with sea level at the mouth of Delaware Bay (Lewes) and wind data at Kitts Hummock near the Murderkill, were used to characterize their spatial and temporal variability. The instantaneous sea level represents a superposition of variability operating over different time scales. Over the relatively short tidal time scales, the semidiurnal tides represent the dominant tidal constituents in lower Delaware Bay, with tidal amplitudes showing a modest increase from the bay mouth up to Bowers. However, as the tides propagate into the Murderkill River estuary, the semidiurnal constituents undergo heavy attenuation, resulting in a 48% reduction in amplitude from Bowers to Frederica. The diurnal tide, on the other hand, experiences only a 25% reduction in amplitude. At longer time scales, the subtidal sea level experiences no attenuation. The Murderkill thus behaves like a low pass filter to preferentially damp out high frequency sea level forcing from lower Delaware Bay. The subtidal volume flux in the Murderkill is highly coherent with the time rate of change of sea level, indicating that the Murderkill basically co-oscillates with Delaware Bay in a standing wave fashion over the subtidal time scale. This remote coupling controls more than 90% of the variance in subtidal sea level in the Murderkill. There is evidence that the surface slopes in the lower bay and the Murderkill are closely correlated with winds along the orientation of the two waterways, consistent with the effect of local wind on subtidal sea level. By better understanding the physical driving mechanisms of sea-level and volume flux in the Murderkill River estuary, the biological and chemical processes directly affected by these physical properties can be better assessed. This in turn can lead to better strategies for managing nutrient loads to the Murderkill River estuary and ultimately to the Delaware Bay.

DOG WASTE REDUCTION THROUGH EDUCATION AND COMMUNITY PARTNERSHIPS. **Lisa M. Wool**, Partnership for the Delaware Estuary, One Riverwalk Plaza 110 South Poplar Street, Suite 202, Wilmington, DE 19801, Lwool@DelawareEstuary.org.
Session 15, 9:45am, 1/14/09 (presentation #123)

Targeted at the individuals with the greatest ability to decrease specific pollutants entering our local waterways is one of the most vital aspects of environmental education. Reaching these people, educating them, and causing a behavior change are crucial to eventually seeing a measurable improvement. Initially, the Delaware Department of Transportation (DelDOT) and the Partnership for the Delaware Estuary (PDE) teamed up to develop a dog waste reduction program targeted at dog owners and pet industry professionals in the Pike Creek Watershed. Animal waste acts like a fertilizer in the water, just as it does on land. This promotes excessive aquatic plant growth that can choke waterways, nourish algae blooms and rob the water of vital oxygen when plant materials begin to decay. Water contaminated with disease-causing bacteria is a threat not only to aquatic life, but to human life as well. The program consists of not only directly instructing pet owners, but also partnering with local park managers, civic associations, local newspapers, veterinarians, groomers, dog trainers, and other pet industry professionals to launch a coordinated watershed-wide educational blast. Information as well as the actual supplies to clean up dog waste was placed in places frequented by pet owners. Surveys performed found that the majority of pet owners were unaware of dog waste being a pollutant. They previously considered it to be more of a public nuisance and an “ok” source of fertilizer for their lawn. This project was also an excellent gateway to teaching pet lovers about other sources of nonpoint source pollution.

TROPHIC RELATIONSHIPS WITHIN TINICUM MARSH, PHILADELPHIA, PA: INSIGHTS FROM THE STABLE ISOTOPES OF CARBON AND NITROGEN

Paula Zelanko*, Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103 (zelanko@ansp.org), **Erin McKinley,** Department of Biology, Northland College, Ashland, WI **, Jeffrey T.F. Ashley**, School of Science and Health, Philadelphia University, Philadelphia, PA 19144, **Marcel Vasquez**, School of Science and Health, Philadelphia University, Philadelphia, PA 19144, **Richard Horwitz,** Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103, and **David Velinsky,** Patrick Center for Environmental Research, Academy of Natural Sciences, Philadelphia, PA 19103. **Session 6**, 1/12/09-4:30pm, 1/13/09-5:00pm (presentation #47)

Long-term feeding habits and trophic levels of organisms within a food web can be assessed by examining isotopic abundances of carbon and nitrogen. Stable isotopes ^{13}C and ^{15}N are used for reconstructing trophic positions within food webs by identifying carbon and nitrogen signatures and tracing the extent of elemental transfers from one trophic level to another. This information is critical in understanding the transfer of organic chemical contaminants in aquatic and terrestrial systems. In this study, isotopic analyses were used to determine dietary preferences and trophic hierarchy of characteristic organisms collected within John Heinz National Wildlife Refuge (Philadelphia, PA) at two distinct sites. Ratios of stable isotopes $^{13}C/^{12}C$ and $^{15}N/^{14}N$ were measured using a mass spectrometer coupled with an elemental analyzer to trace the transfer of isotopic signatures between trophic levels. Results show a significant difference in isotopic values of nitrogen between the two sites, which may be due to spatial and biogeochemical effects. Within each site there was a 3-5‰ nitrogen shift between expected trophic levels. Smaller isotopic differences were observed in the upper trophic groups (i.e., channel catfish), which may have been a result of tertiary consumer mobility and alternative food sources not considered by this study. These findings, in addition to previous data from the same location, will be used as part of an ongoing study to help trace the accumulation of PCB and PBDE chemical contaminants in the food web.

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Moderators and presenters are listed in bold

We thank you for coming to the 2009 Delaware Estuary Science and Environmental Summit. If you would like further information please feel free to contact any of our staff at the Partnership.

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