Proceedings

PARTNERSHIP FOR THE DELAWARE ESTUARY INC.

Delaware Estuary Science & Environmental Summit 2015

"Balancing Progress & Protection – 10 Years of Science in Action"

January 25 – 28, 2015
Cape May, New Jersey

For more information visit ***www.DelawareEstuary.org***

Partnership for the Delaware Estuary
PDE Report No. 15-05
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For more information, please see the conference website at:
www.DelawareEstuary.org/summit

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6th Biennial Delaware Estuary Science & Environmental Summit

Balancing Progress & Protection – 10 Years of Science in Action

The Grand Hotel
Cape May, New Jersey
January 25th – 28th, 2015

Sponsors

Benefactor
- New Jersey Department of Environmental Protection

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- Delaware Coastal Management Program
- Delaware Department of Natural Resources and Environmental Control
- Philadelphia Water Department
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- Rutgers Institute of Marine and Coastal Sciences

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- The Academy of Natural Sciences of Drexel University
- Barnegat Bay Partnership
- Delaware City Refining Company, LLC
- McCabe & Associates
- Mid-Atlantic Coastal Wetlands Assessment
- National Oceanic and Atmospheric Organization
- Pennsylvania Sea Grant
- University of Delaware Sea Grant

Additional Funding Support Provided by: U.S. Environmental Protection Agency

Delaware Estuary Science and Environmental Summit Overview and Goals

Since early 2005, the Partnership for the Delaware Estuary: a National Estuary Program (PDE), has convened the Delaware Estuary Science and Environmental Summit every two years as a forum to bring together researchers, resource managers, environmental practitioners and educators in a retreat-like atmosphere to share their latest research findings and experiences regarding the Delaware Estuary and River Basin Ecosystem. The event spans 3 days and typically draws more than 250 participants. By gathering experts from diverse science, restoration, resource management and outreach sectors, the Summit helps to bridge the gaps among these sectors and areas of the watershed, thereby facilitating ecosystem-based management and awareness.

Following the first conference in 2005, PDE and partners used the conference proceedings to craft a "White Paper on the Status and Needs of Science in the Delaware Estuary". The White Paper was then used as a guidance document, capturing top actions and needs. Building on the successful 2005 conference, the Summit was held again in 2007, 2009, 2011, 2013, and 2015. In each, more than 100 presentations were given in various types of sessions such as:

- Regular science and management sessions for the presentation of any type of scientific topic relevant to the region
- Special sessions that address matters of contemporary importance to the region's scientific and management community
- Outreach and training sessions on effect science communication
- Thematic sessions and panels that pertain to the central theme of each biennial meeting

2015 marked the 10-year anniversary of the Summit, making a total of 6 events since the first in 2005. For each summit, a theme was chosen that captured contemporary interests and needs. The following is a list of the themes of past summits:

2005: The State of Science in the Delaware Estuary
2007: Linking Science, Management, and Policy
2009: Planning for Tomorrow's Delaware Estuary
2011: Connections - Land to Sea, Shore to Shore, Science to Outreach
2013: Weathering Change - Shifting Environments, Shifting Policies, Shifting Needs
2015: Balancing Progress & Protection – 10 Years of Science in Action

This document consists of the program schedule, abstracts, and notable awards for the 2015 Summit. Proceedings of the previous Summit evens are available from the PDE website at:
www.DelawareEstuary.org/Summit

A Look Back at the 2013 Delaware Estuary Summit

Welcome to the Delaware Estuary Science and Environmental Summit!

On behalf of the Partnership for the Delaware Estuary (PDE), welcome to Cape May and the 6th biennial Delaware Estuary Science and Environmental Summit!

It's hard to believe it's been 10 years since our first Summit. In 2005 it was called a "science conference," but it's always been not *just* about the science. It's about using the science to guide management, build awareness, and improve stewardship today and in future generations for the greatest positive impact on the Delaware Estuary.

In that spirit, our program this year includes greater opportunities for collaboration across disciplines than ever before. We have special sessions on shellfish aquaculture, outreach, and development, in addition to a growing core of technical sessions on topics related to water, habitat, and living resources, covering timely topics like climate change, coastal hazard management, and urban environmental education. But beware: selecting which sessions to attend will be more challenging than ever!

This sharing and collaborating grows more important with each year, as the challenges facing the Estuary grow more complex. The Summit plays an especially critical role for us as the National Estuary Program for the Delaware River and Bay. It brings the latest scientific information, debate, stakeholder input, and opportunities for collaboration to bear on efforts to improve this estuary of national significance. I'm pleased to report that in December, environmental agencies from New Jersey, Pennsylvania, Delaware, the federal government, the City of Philadelphia and the Delaware River Basin Commission renewed their commitment to the Partnership for the Delaware Estuary. This is a testament to the dedication of scientists and managers across the region who have been working together today and since the Delaware Estuary Program was created in 1996.

Each Summit has exceeded our expectations, and I'm sure this one will be no exception. Because it's YOU, and the hundreds of folks who present, discuss, use, and share information here (and afterward) that make the Summit so special. So thank you for *all* you do for the Delaware Estuary, and enjoy the Summit!

Jennifer Adkins
Executive Director
Partnership for the Delaware Estuary

Jennifer Adkins is the executive director at the Partnership for the Delaware Estuary, where she leads a team of science and outreach professionals devoted to improving the health of the tidal Delaware River and Bay and its tributaries.

Jen has been active in conservation planning and collaboration in the Mid-Atlantic region for nearly 20 years, working for The Nature Conservancy in Delaware, the Land Trust Alliance, and the Brandywine Conservancy, before joining the Partnership in 2005. She is a graduate of the University of Delaware with a Master of Public Administration degree specializing in environmental and energy management, and a Bachelor of Science degree in economics.

Delaware Estuary Jonathan Sharp Lifetime Achievement Award – Susan Kilham

Dr. Susan Kilham is a professor and researcher at Drexel University in Philadelphia, where she specializes in ecology and climate change. She is one of the rare scientists whose contributions span both freshwater and marine ecosystems, and she is internationally known. For more than 30 years, she has dedicated much of her efforts to understanding the Delaware River and Bay ecosystem. As a result, Dr. Kilham has played a leading role in the estuary's improvement. Beginning in 1991, she worked with Dr. Jonathan Sharp and others on the Science & Technical Advisory Committee and its drafting of the Comprehensive Conservation and Management Plan, which launched the Delaware Estuary Program. She also helped evaluate the estuary's environmental health for the first time in 1996, and she has continued to guide successive "State of the Estuary" reports ever since. She has served on the Board of Directors governing the Partnership for the Delaware Estuary, and she has chaired its Science & Technical Advisory Committee for the past five years. Meanwhile, Dr. Kilham has trained over 30 doctoral and masters students, many of whom are now internationally acclaimed in their own right. And she continues to mentor dozens of undergrads, some of whom work in her laboratory.

Student Presentation Awards

The Partnership for the Delaware Estuary (PDE) thanks all the undergraduate and graduate students who journeyed to Cape May last week to present their original research findings at the Fourth Delaware Estuary Science & Environmental Summit. Working with our Science and Technical Advisory Committee and the many others who helped to judge student presentations, PDE is pleased to announce the recipients of the student presentation awards. This competition was added to the 6th biennial conference in recognition of the important contributions that students make to the environmental sector in our watershed.

Thirteen oral and fourteen posters were presented this year. The judges had their work cut out for them as the overall quality of the student talks and posters was high. Two students, one for best talk and one for best poster, will be given certificates acknowledging their awards and will be invited to contribute articles on their research to Estuary News.

In addition to the best talk and poster winners, two oral presentations and three poster presentations scored very high and were honorably mentioned as Outstanding Student Presentations. These are also listed below. All students should be commended for their outstanding contributions and presentations!

Best Student Talk Award

Kurt Cheng, Drexel University
Comparison Of The Retention And Growth Of Native Freshwater Mussels Reintroduced Into Nine Streams Of The Delaware Estuary, 2011-2014
Co-authors: Danielle Kreeger and Roger Thomas

Outstanding Student Talk Award (honorable mention)

Joshua Moody, Drexel University
*Geospatial Variation Of Ribbed Mussel (*Geukensia demissa*) Ecosystem Services Across The Salt Marsh Landscape*
Co-authors: Danielle Kreeger and Beth Watson

Jenny Paterno, Rutgers University
Faunal Community Use of Enhanced and Natural Oyster Reefs in Delaware Bay
Co-authors: David Bushek and Lisa Calvo

Best Student Poster Award

Thomas Santangelo, University of Delaware
Geospatial Analysis Of Nitrogen Removal By Riparian Buffers In The Delaware River Basin
Co-author: Luc Claessens

Outstanding Student Poster Award (honorable mention)

Kurt Cheng, Drexel University
The Asian Clam Corbicula fluminea*: Seasonal Filtration Rates Of Representative Populations In Two Tributaries Of The Delaware River*
Co-author: Danielle Kreeger

Amanda Wenczel, Rutgers University
New Jersey Shellfish Farming Regulations - Past, Present, And Proposed
Co-author: David Bushek

Outstanding Undergraduate Student Talk Award

Michael Gasbarro, Ursinus College
Analysis Of Bacteria In A New Jersey Coastal Lagoon To Locate A Source Of Contamination
Co-author: Kathryn Goddard

The Best Oral and Poster winners are receiving:

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

Contingent upon continued support, we anticipate that the 7^{h} Delaware Estuary Science and Environmental Summit will be held in two years (January 2017.) We look forward to another strong showing from students then.

Thank you to everyone for your support of students at this meeting, and every day!

Danielle Kreeger, PDE Science Director
Angela Padeletti, PDE Senior Science Coordinator

Program & Abstract Corrections

Monday, January 26

Page 6 Session 1 – 11:15 a.m. Larry Niles will be presenting *Evaluating The Success of Horseshoe Crab and Migratory Shorebird Habitat Restoration On Delaware Bay Beaches That Were Damaged By Superstorm Sandy*

Page 6 Session 1 – 11:45 a.m., Maggie Pletta of DNERR is presenting *The Social Science of Sea Level Rise in Delaware: Tracking Trends In Opinions of Delaware Residents on Climate Change and Sea Level Rise* for Kelly Valencik.

Page 7 New poster associated with Session 3 – Kelsey Moxey, Luc Claessens, Gerald Kauffman, Tom Santangelo. Geospatial analysis of mushroom production and the effect on water quality (127).

Page 8 Special Session: Shellfish Culture Now and Tomorrow – 1:30 p.m., Detailed Schedule:
1:30 John Ewart will talk about the status of shellfish culture in Delaware
1:45 Lisa Calvo will talk about the status of shellfish culture in New Jersey
2:00 Short introduction of panelists
2:15 Open Panel Discussion

Page 9 Session 5 – 4:15 p.m., Daniel Tomaso and Raymong G. Najjar have withdrawn their presentation.

Tuesday, January 27

Page 10 Session 8 – 9 a.m., The order of the first two presentations will be reversed. Michael Leff will be presenting *Cross-Sector Collaboration in Action* at 9 a.m, followed by *Update on Urban Water Federal Partnership Activities* at 9:15 a.m.

Page 11 Session 10 – 10:15 a.m., Ed Morgereth will be presenting *Living Shoreline Implementation As An Element In A Coastal Community's Response To Localized Flooding* for Joe Berg.

Page 11 Session 10 – 10:30 a.m., Rejina Sharma will be presenting *Coastal Marsh Restoration/Living Shoreline* for Lawrence Malizzi.

Page 12 Session 15 – 1:45 p.m., New title for talk: *Faunal Community Use of Enhanced and Natural Oyster Reefs in Delaware Bay*. Updated author list: Jenny Paterno, Lisa Calvo, David Bushek.

Page 14 Session 16 – Drexel Siok has withdrawn Poster #89 from the Summit.

Wednesday, January 28

Page 15 Session 20 – 9:00 a.m., Fabien Dubas has withdrawn talk #5 from the Summit.

Panelist Biographies

Page 23 The primary affiliation for Kim Beidler should be listed as Coalition for the Delaware River Watershed.

Agenda at a Glance

Sunday, January 25

5:00 – 8:00 p.m. Registration – *5th Floor*
Networking – *Hemingway's at the Grand Hotel*

Monday, January 26

8:00 a.m. Registration – *5th Floor*
Continental Breakfast* – *Atrium, 1st Floor*
9:00 a.m. Welcome: Jennifer Adkins
Keynote Address: Bruce Stutz, Author of *Natural Lives, Modern Times: People and Places of the Delaware River* – *Grand Ballroom, 1st Floor*
10:30 a.m. Break
10:45 a.m. Concurrent Sessions
Session 1 – Climate Change – *Grand Ballroom A, 1st Floor*
Session 2 – Branding: How Do You Know What People Are Thinking About You? – *Grand Ballroom B, 1st Floor*
Special Session: Trash Talkin' Panel – *Crystal Room, 1st Floor*
12:00 p.m. Lunch & Announcements – *Penthouse Ballroom, 5th Floor*
1:30 p.m. Concurrent Sessions
Session 3 – Water Quality I – *Grand Ballroom A, 1st Floor*
Session 4 – Innovative Outreach – *Grand Ballroom B, 1st Floor*
Special Session: Shellfish Panel I – *Crystal Room, 1st Floor*
3:00 p.m. Break
3:15 p.m. Concurrent Sessions
Session 5 – Water Quality II -*Grand Ballroom A, 1st Floor*
Session 6 – Fundraising: Making the Ask -*Grand Ballroom B, 1st Floor*
Special Session: Shellfish Panel II – *Crystal Room, 1st Floor*
5:15 p.m. Session 7 – Posters & Networking – *Penthouse Ballroom, 5th Floor*
6:30 p.m. Dinner & Presentation: Tom Davidock. Protecting the Delaware Estuary One Beer At A Time – *Penthouse Ballroom, 5th Floor*

Tuesday, January 27

8:00 a.m. Registration – *5th Floor*
Continental Breakfast* – *Atrium, 1st Floor*
9:00 a.m. Concurrent Sessions
Session 8 – Restoration I – *Grand Ballroom A, 1st Floor*
Session 9 – Planning and Administering Focus Groups Part I – *Grand Ballroom B, 1st Floor*
10:00 a.m. Concurrent Sessions
Session 10 – Restoration II – *Grand Ballroom A, 1st Floor*
Session 11 – Planning and Administering Focus Groups Part II – *Grand Ballroom B, 1st Floor*
Session 12 – Ecological Linkages & Ecosystem Services – *Crystal Room, 1st Floor*
11:15 a.m. Break
11:30 a.m. Panel Presentation on the Future of Funding in the Watershed – *Penthouse Ballroom, 5th Floor*
12:15 p.m. Lunch – *Penthouse Ballroom, 5th Floor*
1:30 p.m. Concurrent Sessions
Session 13 – Physical & Chemical Processes – *Grand Ballroom A, 1st Floor*
Session 14 – Social Science 101 for Environmental Outreach Part I – *Grand Ballroom B, 1st Floor*
Session 15 – Living Resources – *Crystal Room, 1st Floor*

3:15 p.m.	Break
3:30 p.m.	Concurrent Sessions
	Session 16 – Wetlands – *Grand Ballroom A, 1st Floor*
	Session 17 – Social Science 101 for Environmental Outreach Part II – *Grand Ballroom B, 1st Floor*
	Session 18 –Monitoring and Assessment for the Delaware River Watershed Initiative – *Crystal Room, 1st Floor*
5:15 p.m.	Session 19 – Posters & Networking – *Penthouse Ballroom, 5th Floor*
7:00 p.m.	Dinner (on your own)

Wednesday, January 28

8:00 a.m.	Registration – *5th Floor*
	Continental Breakfast* – *Atrium, 1st Floor*
9:00 a.m.	Concurrent Sessions
	Session 20 – Mitigating Human Influence on Natural Resources – *Grand Ballroom A, 1st Floor*
	Session 21 – Partnering with Schools and Youth – *Grand Ballroom B, 1st Floor*
	Special Session: Monitoring Standards for Tidal Wetland Enhancement Projects – *Crystal Room, 1st Floor*
10:30 a.m.	Break
10:45 a.m.	Concurrent Sessions
	Session 22 – Monitoring & Modeling – *Grand Ballroom A, 1st Floor*
	Session 23 – Soaking in Storm Water, Sea Level Rise, and Climate Change Outreach – *Grand Ballroom B, 1st Floor*
12:30 p.m.	Lunch – *Penthouse Ballroom, 5th Floor*
1:45 p.m.	Session 24: Hot Topics – *Grand Ballroom A, 1st Floor*
3:00 p.m.	Announcements, Awards, and Closing Remarks – *Grand Ballroom A, 1st Floor*

**Continental breakfast is provided daily, beginning at 8:00 a.m., in the Atrium outside of the 1st floor Ballroom. If you would like a more substantial breakfast, one can be purchased at Hemingway's Restaurant at the front of the Grand Hotel. Hemingway's opens daily at 6:30 a.m.*

Abstracts are available at the registration table and online at: www.DelawareEstuary.org

Detailed Agenda

Sunday, January 25

Registration: 5:00 PM to 8:00 PM *(5th Floor)*

Networking: 5:00 PM to 8:00 PM *(Hemingway's at the Grand Hotel)*

Monday, January 26

Registration: 8:00 AM to 9:00 AM *(5th Floor)*

Continental Breakfast: 8:00 AM to 9:00 AM *(Atrium, 1st Floor)*

Welcome & Keynote: 9:00 AM to 10:30 AM *(Grand Ballroom, 1st Floor)*
Welcome: Jennifer Adkins, Partnership for the Delaware Estuary
Keynote Address: Bruce Stutz, Author of Natural Lives, Modern Times: People and Places of the Delaware River

Break: 10:30 AM to 10:45 AM

Concurrent Sessions: 1, 2, and Trash Talkin' Panel

Session 1: Climate Change & Hurricane Sandy
10:45 AM to 12:00 PM *(Grand Ballroom A, 1st Floor)*
Moderators: Danielle Kreeger (PDE) and Bob Scarborough (DNREC)

10:45	Assessing Climate Change Impacts In Delaware (57)	Jennifer de Mooy
11:00	Sea Level Rise In Delaware Bay: Long-Term Dynamics And Potential Enhancement Of Horseshoe Crab Spawning Habitat (64)	Robert Loveland, Mark L. Botton
11:15	Evaluating The Success Of Horseshoe Crab And Migratory Shorebird Habitat Restoration On Delaware Bay Beaches That Were Damaged By Superstorm Sandy (93)	Joseph Smith, Larry Niles, Dianne Daly, Tim Dillingham, Amanda Dey, Steven Hafner
11:30	Metrics To Identify The Effect Of Hurricane Sandy Projects On Resilience In The Delaware River Watershed (103)	Rachel Muir, Peter Murdoch
11:45	The Social Science Of Sea Level Rise In Delaware: Tracking Trends In Opinions Of Delaware Residents On Climate Change And Sea Level Rise (72)	Kelly Valencik, Susan Love
Associated Posters		
Upland Forest Buffer Loses Due To Inundation Caused By Sea Level Rise In The Upper And Lower Sub-Watersheds Of The Broadkill River (15)		Kyle Frame
Microclimatology Of Hurricanes: The Value Of Weather Stations In Understanding Local Effects Of Hurricane Sandy (90)		Lia Domico, James Spotila, Steven Pearson
A Numerical Model To Evaluate Potential Impacts Of Sea-Level Rise On Groundwater Resources In The Delaware Coastal Plain (92)		Tom McKenna, Changming He

Session 2: Branding: How Do You Know What People Are Thinking About You?
10:45 AM to 12:00 PM *(Grand Ballroom B, 1st Floor)*
Moderator: Lisa Wool (PDE)

10:45	Branding: How Do You Know What People Think About Your Organization? (123)	Richard Wells

Special Session: Trash Talkin' Panel
10:45 AM to 12:00 PM *(Crystal Room, 1st Floor)*
Moderator: Dee Durham (PDE) – Panelists listed on page 24

Lunch & Announcements: 12:00 PM to 1:30 PM *(Penthouse Ballroom, 5th Floor)*

Concurrent Sessions: 3, 4, and Shellfish Panel I

Session 3: Water Quality I
1:30 PM to 3:00 PM *(Grand Ballroom A, 1st Floor)*
Moderators: Tom Fikslin (Delaware River Basin Commission) and Priscilla Cole (PDE)

1:30	Delaware Water Quality Portal: Visualizing Delaware Water Quality Data (56)	Christina Callahan, Kevin R. Brinson
1:45	Preliminary Analysis Of Historical Water Quality In The Tidal Christina River, Delaware (33)	Margaret Christie, Ronald Martin, James Pizzuto
2:00	Development And Implementation Of Site-Specific Nutrient Control Solutions In New Jersey (3)	Thomas Amidon, Marzooq Alebus
2:15	Assessment Of Designated Use Support Within Barnegat Bay, NJ Using The Data Being Collected Between 2008 And 2013 (36)	Hui (Helen) Pang, Patricia Ingelido, Barbara Hirst, Jack Pflaumer, Ariane Giudicelli, Aynan Zaman
2:30	Modeling Role In Setting Site-Specific Criteria And Designated Uses (121)	Andrew Thuman
Associated Posters		
Drinking Water, Pollution And Public Health In 19th Century Philadelphia (7)		Adam Levine, C. Drew Brown, Ellen Schultz
The Crawford Treatment Wetland, A Pioneering Vertical Flow Treatment System (21)		Samantha Weber, Dr. Stephanie Stotts
Geospatial Analysis Of Nitrogen Removal By Riparian Buffers In The Delaware River Basin (38)		Thomas Santangelo, Luc Claessens
Nutrient Cycling In The Blackiston Tax Ditches (47)		James Welsh, Dr. Stephanie Stotts
The Results Of A Water Quality Testing Program Conducted By A High School Aquatic Science Class On The West Branch Of The Brandywine Creek, Pennsylvania (80)		Dina DiSantis
The Asian Clam Corbicula fluminea: Seasonal Filtration Rates Of Representative Populations In Two Tributaries Of The Delaware River (106)		Kurt Cheng, Danielle Kreeger

Session 4: Innovative Outreach
1:30 PM to 3:00 PM *(Grand Ballroom B, 1st Floor)*
Moderator: Lisa Wool (PDE)

1:30	Streets To Tweets: TTF's Watershed Outreach Campaign (19)	Julie Slavet, Brynn Monaghan
1:45	Using The Principals Of The "Children In Nature Network" To Provide Outreach In Local Communities (65)	Maggie Pletta
2:00	Reaching Out: Relevancy In The Age Of Social Media (77)	Jessica Rittler Sanchez, John Yagecic
2:15	Utilizing Delaware Bay In K-20 Education (53)	Christopher Petrone
Associated Posters		
Got Mussels? A PDE Science And Outreach Collaboration (28)		Deanne Ross, Angela Padeletti

Special Session: Shellfish Culture Now and Tomorrow, Part I: Charting a Course for Delaware Estuary Aquaculture 1:30 PM to 3:00 PM *(Crystal Room, 1st Floor)*
Moderators: Daphne Munroe and Lisa Calvo (Haskin Shellfish Research Laboratory) – Panelists listed on page 24

1:30	Shellfish Aquaculture In Delaware's Coastal (Inland) Bays 2015: Status And Outlook (63)	John Ewart, EJ Chalabala
Associated Posters		
New Jersey Shellfish Farming Regulations - Past, Present, And Proposed (75)		Amanda Wenczel, David Bushek

Break: 3:00 PM to 3:15 PM

Volunteer Mussel Survey Workshops, 2014

Concurrent Sessions: 5, 6, and Shellfish Panel II

Session 5: Water Quality II

3:15 PM to 5:15 PM *(Grand Ballroom A, 1st Floor)*

Moderators: Tom Fikslin (Delaware River Basin Commission) and Priscilla Cole (PDE)

3:15	Evaluation Of PCB TMDL Efforts In The Delaware Estuary (26)	Gregory Cavallo
3:30	Spatial And Temporal Trends In PCB Concentrations In Fish Tissue In The Mainstem Of The Delaware River (59)	Thomas Fikslin, Gregory J. Cavallo
3:45	State Of Delaware's "Watershed Approach To Toxics Assessment And Restoration" Program (Watar) (13)	Todd Keyser, Richard W. Greene, John G. Cargill, IV
4:00	Review Of A Comprehensive, Alternate Approach For PCB Congener / Homolog Analysis (10)	James Occhialini, Cynthia McQueen
4:15	Seasonal And Interannual Variations In The Dissolved Oxygen Budget Of An Urbanized Tidal River: The Upper Delaware Estuary (24)	Daniel Tomaso, Raymond G. Najjar
4:30	Application Of Data Mining And Statistical Learning Approaches For Insights Into Dissolved Oxygen (58)	John Yagecic, Thomas J. Fikslin, Erik Silldorff

Session 6: Fundraising: Making the Ask

3:15 PM to 5:15 PM *(Grand Ballroom B, 1st Floor)*

Moderator: Debbie Heaton (PDE)

3:15	Fundraising: Making the Ask	Richard Przywara

Special Session: Shellfish Culture Now and Tomorrow, Part II

3:15 PM to 5:15 PM *(Crystal Room, 1st Floor)*

Moderators: Daphne Munroe and Lisa Calvo (Haskin Shellfish Research Laboratory) – Panelists listed on page 24

3:15	Situation And Outlook, Growing Oyster Culture In Delaware Bay, New Jersey (82)	Lisa Calvo

Session 7: Poster Session & Networking

5:15 PM to 6:30 PM *(Penthouse Ballroom, 5th Floor)*

Dinner & Beer Presentation by Tom Davidock: Protecting the Estuary One Beer at a Time

6:30 PM to 8:30 PM *(Penthouse Ballroom, 5th Floor)*

6:30	Protecting The Delaware Estuary One Beer At A Time: How Creative Partnerships With Breweries Are Helping Keep Our Water Clean (102)	Tom Davidock, Elizabeth Horsey

Tuesday, January 27

Registration: 8:00 AM to 9:00 AM *(5th Floor)*

Continental Breakfast: 8:00 AM to 9:00 AM *(Atrium, 1st Floor)*

Concurrent Sessions: 8 & 9

Session 8: Restoration I
9:00 AM to 10:00 AM *(Grand Ballroom A, 1st Floor)*
Moderators: Josh Moody (PDE) and Moses Katkowski (The Nature Conservancy)

9:00	Update On Urban Water Federal Partnership Activities (100)	Simeon Hahn, Frank McLaughlin, Julie Ulrich, Bobbi Britton
9:15	Cross-Sector Collaboration In Action: The Urban Waters Federal Partnership In The Greater Philadelphia Area / Delaware River Watershed (76)	Michael Leff
9:30	Bringing The Bulldozers To The Benthic Zones Near Brownfield Sites To Improve Regional Water Quality: Integrating Riparian Restoration Projects Into Remediation Activities At Camden's Brownfield Sites (94)	Franklin McLaughlin, Jay Springer, Danielle Kreeger, Josh Moody
9:45	Living Shoreline Techniques In Delaware (109)	Douglas Janiec
Associated Posters		
Multiyear Study Of Leatherman's Run Watershed And Assessment Of The Impact Of Retrofit And Stream Restoration Projects (18)		Marianne Walch, Michael Pieper
Brandywine-Piedmont Watershed Plan (35)		Shyanne Miller, Dr. Jerry Kauffman
Coordinated Conservation Projects And Monitoring Outcomes In The Delaware River Watershed Initiative, Including The Kirkwood-Cohansey Aquifer (84)		Stefanie Kroll, Richard Horwitz, Roland Wall, Jerry Mead, David Velinsky
Delaware Estuary Living Shoreline Initiative (DELSI): Four New Installations In 2014 (104)		Angela Padeletti, Danielle Kreeger, Joshua Moody, Laura Whalen
Scientific Monitoring Protocols To Gauge Living Shoreline Outcomes (115)		Danielle Kreeger, Joshua Moody, Angela Padeletti
Mussels, Marshes And Submerged Grasses: Hybrid Living Shoreline Concepts To Remediate Urban Tidal Freshwater Waterfronts (117)		Danielle Kreeger, Joshua Moody, Franklin B. McLaughlin, Jay Springer, Sari Rothrock
Restoring Horseshoe Crab Habitat On NJ's Delaware Bay After Hurricane Sandy (126)		Dianne Daly, Larry Niles, PhD., Joseph Smith, PhD, Tim Dillingham, Alek Modjedski, Steven Hafner, Amanda Dey, PhD

Session 9: Planning and Administering Focus Groups Part I
9:00 AM to 10:00 AM *(Grand Ballroom B, 1st Floor)*
Moderator: Shaun Bailey (PDE)

Concurrent Sessions: 10, 11, and 12

Session 10: Restoration II
10:00 AM to 11:15 AM *(Grand Ballroom A, 1st Floor)*
Moderators: Josh Moody (PDE) and Moses Katkowski (The Nature Conservancy)

10:00	Break	
10:15	Living Shoreline Implementation As An Element In A Coastal Community's Response To Localized Flooding (9)	Joe Berg
10:30	Coastal Marsh Restoration/Living Shoreline - Pilot Projects In The Mid-Atlantic Region (4)	Lawrence Malizzi, Rejina Sharma, Robert Fiorile
10:45	Beneficially Reusing Dredge Material To Rebuild A Marsh Along Pepper Creek (71)	Andrew Howard, Alison B. Rogerson, Bartholomew Wilson, Daniel J. Brower, Ariane K. Nichols, Maggie K. Pletta, Matthew A. Jennette
11:00	Marsh Futures: Assessment And Mapping Of Elevation Capital And Shoreline Erosion To Guide Restoration Of Coastal Wetlands At The Local Scale (119)	Danielle Kreeger, Joshua Moody, Moses Katkowski, Diane Rosencrance, Meghan Boatright

Session 11: Planning and Administering Focus Groups Part II
10:00 AM to 11:15 AM *(Grand Ballroom B, 1st Floor)*
Moderator: Shaun Bailey (PDE)

Session 12: Ecological Linkages & Ecosystem Services
10:00 AM to 11:15 AM *(Crystal Room, 1st Floor)*
Moderators: Dorina Frizzera (NJ DEP) and Heather Jensen (U.S. Army Corps of Engineers)

10:00	Geospatial Variation Of Ribbed Mussel (Geukensia demissa) Ecosystem Services Across The Salt Marsh Landscape (118)	Joshua Moody, Danielle Kreeger, Elizabeth Watson
10:15	Quantifying The Value Of Delaware's Tidal Wetland Ecosystem To Facilitate Protection And Acquisition (34)	Amanda Santoni
10:30	Measuring The Economic Value Of Ecosystem Services And Coastal Resiliency: A Case Study On Ecological Restoration In Cape May (8)	Elizabeth Schuster
10:45	Toward Innovative Approaches For Improving Water Quality: Linking Eco-Hydrology With Ecosystem Services At The Watershed Scale (125)	Luc Claessens, Gerald Kauffman

Break: 11:15 AM to 11:30 AM

Panel Presentation on the Future of Funding in the Watershed
11:30 AM to 12:15 PM *(Penthouse Ballroom, 5th Floor)*
Panelists and bios listed on page 23

Lunch: 12:15 PM to 1:30 PM *(Penthouse Ballroom, 5th Floor)*

Concurrent Sessions: 13, 14, and 15

Session 13: Physical & Chemical Processes
1:30 PM to 3:15 PM *(Grand Ballroom A, 1st Floor)*
Moderators: David Velinsky (Academy of Natural Sciences of Drexel University) and Bob Chant (Rutgers University)

1:30	Exploring Localized Mixing Dynamics In The Upper Delaware Estuary (25)	Ramona McCullough, Philip Duzinski
1:45	Sediment Dynamics In The Delaware Estuary (27)	Jacqueline McSweeney, Robert Chant
2:00	Estimation Of Nitrogen Removal In Delaware Estuary As A Function Of Spatial Residence Time (30)	Aboozar Tabatabai, John Wilkin
2:15	Carbon, Nitrogen And Phosphorus Sequestration In Delaware River Tidal Wetlands (96)	David Velinsky, Tracy Quirk, Christopher Sommerfield
2:30	Thermal Imaging Of Hydrologic Processes In Streams And Wetlands In The Delaware Estuary Watershed, Delaware And Pennsylvania (29)	Tom McKenna, Jack A. Puleo, Aline Pieterse

Session 14: Social Science 101 for Environmental Outreach Part I
1:30 PM to 3:15 PM *(Grand Ballroom B, 1st Floor)*
Moderator: Shaun Bailey (PDE)

Session 15: Living Resources
1:30 PM to 3:15 PM *(Crystal Room, 1st Floor)*
Moderators: Lance Butler (Philadelphia Water Department) and William Eldridge (Stroud Water Research Center)

1:30	Comparison Of The Retention And Growth Of Native Freshwater Mussels Reintroduced Into Nine Streams Of The Delaware Estuary, 2011-2014 (105)	Kurt Cheng, Danielle Kreeger, Angela Padeletti, Roger Thomas
1:45	Assessment Of Fish Utilization On A Sub-Tidal Oyster Restoration Area In A Mid-Atlantic Estuary (52)	Jenny Paterno, David Bushek, Lisa Calvo, Thomas Grothues
2:00	Upwelling Of Acidified Water: Not Just An Issue For Shellfish Hatcheries On The West Coast Of The US (78)	Daphne Munroe, Matthew Poach, Ian Abrahamsen
2:15	Monitoring Marsh Bird Communities To Support Rapid Wetland Condition Assessments (67)	Alison Rogerson, Andrew Howard, Maggie Pletta, Matthew Jennette
2:30	Examining Nearshore Finfish And Crustacean Assemblages At Bulkheaded And Unaltered Salt Marsh Shorelines Within Hereford Inlet Estuary, NJ (48)	Kathryn Sellers, Lisa M. Ferguson

Associated Posters	
Delaware National Estuarine Research Reserve: Marsh Bird Monitoring Along The St. Jones River (39)	Christina Whiteman
Identifying Tree Species For Ring Analysis At The St. Jones Reserve (54)	Brooke Thompson, Stephanie Stotts
Elevations Of Marsh Bird Nests In A Tidal Wetland In Southern New Jersey (68)	Lisa Ferguson, Mollie Nugent, Kathryn Sellers, Lenore Tedesco
Decadal Re-Evaluation Of Contaminant Exposure And Osprey (Pandion haliaetus) Productivity In Delaware Bay From A Food Web Perspective (98)	Barnett Rattner, Rebecca S. Lazarus
Freshwater Mussel (Unionidae) Distribution In Relation To Water Depth In The Delaware River (107)	Elena Colon, Roger Thomas, Danielle Kreeger, Priscilla Cole, Lance Butler
Exploring Freshwater Mussel Benthic Habitat Preferences In The Urban Tidal Delaware River (114)	Priscilla Cole, Danielle Kreeger, Roger Thomas, Lance Butler, Elena Colon
Sub-Tidal Movements Of Horseshoe Crabs (Limulus polyphemus) In Delaware Bay (124)	Molly Ellwood, Fox, D. A., Hice-Dunton, L.

Break: 3:15 PM to 3:30 PM

Concurrent Sessions: 16, 17, and 18

Session 16: Wetlands

3:30 PM to 5:15 PM *(Grand Ballroom A, 1st Floor)*

Moderators: Ken Strait (PSE&G) and Angela Padeletti (PDE)

3:30	A Use Attainability Analysis Based Alternative Dissolved Oxygen Criteria For Wetland Dominated Tidal Portion Of Murderkill River, Delaware (60)	Hassan Mirsajadi
3:45	Developing Seeding Techniques For Tidal Marsh And Shoreline Stabilization (74)	Christopher Miller, Scott Snell, Melissa Alvarez
4:00	Vegetation Zone Dominance: The Use Of Plant Communities As A Proxy To Estimate Marsh Resilience (110)	LeeAnn Haaf, Jessie Buckner, Joshua Moody, Angela Padeletti, Danielle Kreeger
4:15	Delaware Value-Added Assessment Method For Nontidal Wetlands (70)	Alison Rogerson, Andrew Howard, Maggie Pletta, Matthew Jennette
4:30	Bayshore Sustainable Infrastructure Planning Project (BaySIPP): Use Of Vegetation Growth Form In Elevation Capital Mapping (116)	Joshua Moody, Danielle Kreeger, Moses Katkowski, Diane Rosencrance, Megan Boatright
4:45	The Prime Hook National Wildlife Refuge Coastal Restoration Project: An Overview Of The Project Development To Dredges On The Horizon	Bartholomew Wilson

Associated Posters	
Delaware Wetland Restoration Strategies: Does Planting Make A Difference After 15 Years (42)	John Dougherty, Dr. Stephanie Stotts
Wetland Assessment Report: Christina River Watershed (69)	Alison Rogerson, Andrew M. Howard, Jessie Buckner, LeeAnn Haaf, Danielle Kreeger, Maggie Pletta, Matthew Jennette
Analyzing Long Term Accretion And Subsidence Within The Delaware National Estuarine Research Reserve (89)	Drexel Siok
Variation In Recent Marsh Accretion Along Delaware And Barnegat Bays (101)	Kirk Raper, Tracy Quirk, David Velinsky
Shoreline Changes In The Delaware And Barnegat Estuaries: Historic Shifts And Significance For Marsh Futures (111)	LeeAnn Haaf, Jessie Buckner, Angela Padeletti, Danielle Kreeger

Session 17: Social Science 101 for Environmental Outreach Part II
3:30 PM to 5:15 PM *(Grand Ballroom B, 1st Floor)*
Moderator: Shaun Bailey (PDE)

Session 18: Monitoring and Assessment for the Delaware River Watershed Initiative
3:30 PM to 5:15 PM *(Crystal Room, 1st Floor)*
Moderator: Carol Collier (Academy of Natural Sciences of Drexel University)

3:30	Reach Scale Stream Water Temperature Predictions And Application To Assess Effects Of Land Use, Restoration And Climate Changes On Fish Growth Potential In The Delaware River Basin (86)	Alexander Waldman, Jerry Mead, Lin Perez, Stefanie Kroll, Franco Montalto
3:45	Development Of Rapid Salamander Monitoring And Habitat Assessment Protocols For The Delaware River Basin (31)	David H. Keller, Richard J. Horwitz
4:00	Freshwater Fish Assemblages Of The Delaware River Basin: What Causes Them And How Can They Be Used For Bioassessment (79)	Richard Horwitz, David H. Keller, Stefanie Kroll
4:15	Relation Of Algal Assemblages To The Subwatershed Clusters Of The Delaware River Watershed Initiative (51)	Alison Minerovic, Frank Acker
4:30	Macroinvertebrate Communities In The Eight Subwatershed Clusters Of The Delaware River Watershed Initiative (41)	Stefanie A. Kroll, John K. Jackson
4:45	Web-Based Mapping Applications For Visualizing Monitoring And Modelling In The Delaware Basin (91)	Lin Perez, A. Waldman, J. Mead, S. Kroll

Session 19: Poster Session & Networking
5:15 PM to 7:00 PM *(Penthouse Ballroom, 5th Floor)*

Dinner (on your own): 7:00 PM

Wednesday, January 28

Registration: 8:00 AM to 9:00 AM *(5th Floor)*

Continental Breakfast: 8:00 AM to 9:00 AM *(Atrium, 1st Floor)*

Concurrent Sessions: 20, 21, and Monitoring Panel

Session 20: Mitigating Human Influence on Natural Resources
9:00 AM to 10:30 AM *(Grand Ballroom A, 1st Floor)*
Moderator: John Yagecic (Delaware River Basin Commission)

9:00	Innovative Solution For Coastal Fish Nursery Restoration (5)	Fabien Dubas
9:15	Analysis Of Bacteria In A New Jersey Coastal Lagoon To Locate A Source Of Contamination (113)	Michael Gasbarro, Kathryn Goddard
9:30	Horseshoe Crab Rescue At Fortescue Beach - Implications For Mortality, Beach Restoration Need And Future Assessment Of Spawning Habitat (11)	Rosy Tucker, Raffaela Marano, Jackie Garcia, Ron Smith, Dane Ward
9:45	Product Stewardship Can Resolve Climate Change (17)	William Haaf, Dianne Herrin

Session 21: Partnering with Schools and Youth
9:00 AM to 10:30 AM *(Grand Ballroom B, 1st Floor)*
Moderator: Melissa Bittner (PDE)

9:00	Greenstem Network: Philly Schoolyard Rain Gardens Go High Tech At Low Cost (12)	Matthew Fritch
9:15	City Of Wilmington Green Jobs Program (20)	Martha Narvaez
9:30	Using The Urban Watershed As An Integrated Context For Learning: Classroom To Schoolyard Curriculum Connection (22)	Ellen Schultz
9:45	One Fish, Two Fish: An Educational Pilot Study (66)	Jenny Paterno, Lisa Calvo, David Bushek
10:00	The Development, Implementation And Curriculum Overview Of A High School Aquatic Science Course (73)	Dina DiSantis

Special Session: Monitoring Standards for Tidal Wetland Enhancement Projects
9:00 AM to 10:30 AM *(Crystal Room, 1st Floor)*
Moderator: Danielle Kreeger (PDE) – Panelists listed on page 24

Break: 10:30 AM to 10:45 AM

Concurrent Sessions: 22 & 23

Session 22: Monitoring & Modeling

10:45 AM to 12:30 PM *(Grand Ballroom A, 1st Floor)*

Moderator: Jeff Fischer (USGS)

10:45	Monitoring Stormwater Trash (83)	Kelly O'Day
11:00	Rainfall Interception By Urban Low-Height Shrub Canopy And Its Hydrological Implication - Experimental Study In Philadelphia (50)	Walter Yerk, Franco Montalto
11:15	Analysis Of Storm Surge From Observational Tide Records In The Delaware Inland Bays (46)	John Callahan
11:30	Tidal Marsh Restoration And Monitoring At Prime Hook National Wildlife Refuge, Milton, DE (49)	Kenny Smith
11:45	A Hydrologic Model Of The Delaware River Basin (85)	Jeffrey Fischer, Tanja N Williamson
12:00	Delaware Valley Early Warning System: Automated 3D Tidal Transport Model (95)	Paula Kulis, Elizabeth North, Kelly Anderson
Associated Posters		
Using Citizen Scientists To Monitor Watershed Improvements In Five Philadelphia Area Watersheds (43)		Stephanie Figary, Alex Cooper, Robin Eisman, Patrick Gardener, Brad Nyholm
Development Of A High Water Mark Database And Display System For Coastal Flooding Events In Delaware (45)		Christina Callahan, John A. Callahan, Kevin R. Brinson, Hunter C. Brown, Daniel J. Leathers
Relationships Between Macroinvertebrate Ibi Scores And Land Use In The Delaware River Basin (87)		Kathryn Christopher, Lindsay Perez, Alexander Waldman, Stefanie Kroll, Jerry Mead, Roland Wall
Relationships Between Agricultural Land Use, Lentic Macroinvertebrates And Habitat Quality In The Schuylkill And Brandywine-Christina (88)		Meghan O'Donnell, Stefanie Kroll
PBDEs In The Delaware Estuary: Human Health Criteria And Temporal Trends In Fish Tissue Concentrations, 2004-2012 (99)		Kelly Sand
Using A Rapid Assessment Method To Compare Coastal Wetlands In The Delaware Estuary And Barnegat Bay (120)		Jessie Buckner, Kurt Cheng
Point Density Requirements For Salt Marsh Elevation Determination Using Real-Time Kinetic Surveying And Empirical Bayesian Kreiging GIS Analysis (122)		Joshua Moody, Priscilla Cole

Session 23: Soaking in Storm Water, Sea Level Rise, and Climate Change Outreach
10:45 AM to 12:30 PM *(Grand Ballroom B, 1st Floor)*
Moderator: Melissa Bittner (PDE)

10:45	Delaware Livable Lawns: A Partnership Program To Reduce Nutrient Runoff From Lawns (16)	Marianne Walch, Sara Wozniak, Randy Cole, Susan Barton, Valann Budischak
11:00	The Darby Cobbs Stormwater Initiative: Getting To The New Normal (40)	Jamie Anderson, Diana Andrejczak, Mario Cimino, Peter Puglionesi, David Schwartz
11:15	Working For Our Waterfronts: A Public Engagement Process For Preserving Delaware's Traditional Maritime Communities (44)	Ed Lewandowski, Clark Evans, Bill McGowan
11:30	Re-Framing The Architect's Responsibility For Climate-Sensitive Design: Renewables, Walkables, Geenables, Reflectables (62)	John Mateyko, Patricia Miller, Andrea Trablisi
11:45	From Creek To Sewer: History Of Topographical Change In Philadelphia (6)	Adam Levine

Lunch: 12:30 PM to 1:45 PM *(Penthouse Ballroom, 5th Floor)*

Session 24: Hot Topics
1:45 PM to 3:00 PM *(Grand Ballroom A, 1st Floor)*
Moderators: Susan Kilham (Drexel University) and Laura Craig (American Rivers)

1:45	Energy Attenuation And Hybrid Living Shorelines: A Viable Tool For Coastal Resilience (112)	Douglas Janiec
2:00	Developing Seashore Mallow As An Alternative Crop On Salinized Soils In Delaware And Investigating Its Use As A New Source Of Poultry House Bedding (32)	Jennifer Volk, Kate Hackett, Bill Brown, Donna Hamilton, Denise Seliskar, Jack Gallagher
2:15	Protecting The Environment And Public Health In Camden: A Green & Grey Infrastructure Approach (37)	Meishka Mitchell, Andrew Kricun, Jessica Franzini, Jeremiah Bergstrom, Maurie Smith
2:30	Camden's Waterfront Brownfields And Landfills: Opportunities For Creation Of Environmental Assets That Benefit The Entire Delaware River Watershed (61)	Frank McLaughlin
Associated Posters		
Marine Spatial Planning For Delaware Waters (81)		Robert Scarborough, Bonnie Arvay, Christina Whiteman, Kate Fleming

Announcements, Awards, and Closing Remarks: 3:00 PM to 3:30 PM *(Grand Ballroom A, 1st Floor)*

Abstracts are available at the registration table and online at: www.DelawareEstuary.org

Poster Presentations

Jessie Buckner, Kurt Cheng. *Using A Rapid Assessment Method To Compare Coastal Wetlands In The Delaware Estuary And Barnegat Bay* (120)

Christina Callahan, John A. Callahan, Kevin R. Brinson, Hunter C. Brown, Daniel J. Leathers. *Development Of A High Water Mark Database And Display System For Coastal Flooding Events In Delaware* (45)

Kurt Cheng, Danielle Kreeger. *The Asian Clam Corbicula fluminea: Seasonal Filtration Rates Of Representative Populations In Two Tributaries Of The Delaware River* (106)

Kathryn Christopher, Lindsay Perez, Alexander Waldman, Stefanie Kroll, Jerry Mead, Roland Wall. *Relationships Between Macroinvertebrate Ibi Scores And Land Use In The Delaware River Basin* (87)

Priscilla Cole, Danielle Kreeger, Roger Thomas, Lance Butler, Elena Colon. *Exploring Freshwater Mussel Benthic Habitat Preferences In The Urban Tidal Delaware River* (114)

Elena Colon, Roger Thomas, Danielle Kreeger, Ph.D., Priscilla Cole, Lance Butler. *Freshwater Mussel (Unionidae) Distribution In Relation To Water Depth In The Delaware River* (107)

Dianne Daly, Larry Niles, PhD., Joseph Smith, PhD, Tim Dillingham, Alek Modjedski, Steven Hafner, Amanda Dey, PhD. *Restoring Horseshoe Crab Habitat On NJ's Delaware Bay After Hurricane Sandy* (126)

Dina DiSantis. *The Results Of A Water Quality Testing Program Conducted By A High School Aquatic Science Class On The West Branch Of The Brandywine Creek, Pennsylvania* (80)

Lia Domico, James Spotila, Steven Pearson. *Microclimatology Of Hurricanes: The Value Of Weather Stations In Understanding Local Effects Of Hurricane Sandy* (90)

John Dougherty, Dr. Stephanie Stotts. *Delaware Wetland Restoration Strategies: Does Planting Make A Difference After 15 Years* (42)

Molly Ellwood, Fox, D. A., Hice-Dunton, L. *Sub-Tidal Movements Of Horseshoe Crabs (Limulus polyphemus) In Delaware Bay* (124)

Lisa Ferguson, Mollie Nugent, Kathryn Sellers, Lenore Tedesco. *Elevations Of Marsh Bird Nests In A Tidal Wetland In Southern New Jersey* (68)

Stephanie Figary, Alex Cooper, Robin Eisman, Patrick Gardener, Brad Nyholm. *Using Citizen Scientists To Monitor Watershed Improvements In Five Philadelphia Area Watersheds* (43)

Kyle Frame. *Upland Forest Buffer Loses Due To Inundation Caused By Sea Level Rise In The Upper And Lower Sub-Watersheds Of The Broadkill River* (15)

LeeAnn Haaf, Jessie Buckner, Angela Padeletti, Danielle Kreeger. *Shoreline Changes In The Delaware And Barnegat Estuaries: Historic Shifts And Significance For Marsh Futures* (111)

Danielle Kreeger, Joshua Moody, Franklin B. McLaughlin, Jay Springer, Sari Rothrock. *Mussels, Marshes And Submerged Grasses: Hybrid Living Shoreline Concepts To Remediate Urban Tidal Freshwater Waterfronts* (117)

Danielle Kreeger, Joshua Moody, Angela Padeletti. *Scientific Monitoring Protocols To Gauge Living Shoreline Outcomes* (115)

Stefanie Kroll, Richard Horwitz, Roland Wall, Jerry Mead, David Velinsky. *Coordinated Conservation Projects And Monitoring Outcomes In The Delaware River Watershed Initiative, Including The Kirkwood-Cohansey Aquifer* (84)

Adam Levine, C. Drew Brown, Ellen Schultz. *Drinking Water, Pollution And Public Health In 19th Century Philadelphia* (7)

Tom McKenna, Changming He. *A Numerical Model To Evaluate Potential Impacts Of Sea-Level Rise On Groundwater Resources In The Delaware Coastal Plain* (92)

Shyanne Miller, Dr. Jerry Kauffman. *Brandywine-Piedmont Watershed Plan* (35)

Joshua Moody, Priscilla Cole. *Point Density Requirements For Salt Marsh Elevation Determination Using Real-Time Kinetic Surveying And Empirical Bayesian Kreiging GIS Analysis* (122)

Meghan O'Donnell, Stefanie Kroll. *Relationships Between Agricultural Land Use, Lentic Macroinvertebrates And Habitat Quality In The Schuylkill And Brandywine-Christina* (88)

Angela Padeletti, Danielle Kreeger, Joshua Moody, Laura Whalen. *Delaware Estuary Living Shoreline Initiative (DELSI): Four New Installations In 2014* (104)

Kirk Raper, Tracy Quirk, David Velinsky. *Variation In Recent Marsh Accretion Along Delaware And Barnegat Bays* (101)

Barnett Rattner, Rebecca S. Lazarus. *Decadal Re-Evaluation Of Contaminant Exposure And Osprey (Pandion haliaetus) Productivity In Delaware Bay From A Food Web Perspective* (98)

Alison Rogerson, Andrew M. Howard, Matthew Jennette, Jessie Buckner, LeeAnn Haaf, Danielle Kreeger, Maggie Pletta. *Wetland Assessment Report: Christina River Watershed* (69)

Deanne Ross, Angela Padeletti. *Got Mussels? A PDE Science And Outreach Collaboration* (28)

Kelly Sand. *PBDEs In The Delaware Estuary: Human Health Criteria And Temporal Trends In Fish Tissue Concentrations, 2004-2012* (99)

Thomas Santangelo, Luc Claessens. *Geospatial Analysis Of Nitrogen Removal By Riparian Buffers In The Delaware River Basin* (38)

Robert Scarborough, Bonnie Arvay, Christina Whiteman, Kate Fleming. *Marine Spatial Planning For Delaware Waters* (81)

Kathryn Sellers, Lisa M. Ferguson. *Examining Nearshore Finfish And Crustacean Assemblages At Bulkheaded And Unaltered Salt Marsh Shorelines Within Hereford Inlet Estuary, NJ* (48)

Drexel Siok. *Analyzing Long Term Accretion And Subsidence Within The Delaware National Estuarine Research Reserve* (89)

Brooke Thompson, Stephanie Stotts. *Identifying Tree Species For Ring Analysis At The St. Jones Reserve* (54)

Marianne Walch, Michael Pieper. *Multiyear Study Of Leatherman's Run Watershed And Assessment Of The Impact Of Retrofit And Stream Restoration Projects* (18)

Samantha Weber, Dr. Stephanie Stotts. *The Crawford Treatment Wetland, A Pioneering Vertical Flow Treatment System* (21)

James Welsh, Dr. Stephanie Stotts. *Nutrient Cycling In The Blackiston Tax Ditches* (47)

Amanda Wenczel, David Bushek. *New Jersey Shellfish Farming Regulations - Past, Present, And Proposed* (75)

Christina Whiteman. *Delaware National Estuarine Research Reserve: Marsh Bird Monitoring Along The St. Jones River* (39)

Featured Speakers

Alison JG Krepp

Office for Coastal Management, NOAA

Alison has spent more than ten years in the fields of education, policy, and planning. She works with the National Oceanic and Atmospheric Administration (NOAA) in the Office for Coastal Management where she applies her expertise in strategic planning, process design, and stakeholder engagement to support its state-federal partnership programs. Prior to NOAA, she worked as a planner with the South Carolina Department of Natural Resources. She has a Bachelor of Science in natural resource management from the University of Maine and a Master of Science in environmental policy and behavior from the University of Michigan. When not working on coastal issues, Alison enjoys time outdoors in mid-Maryland with her husband, their three sons, and 2 year-old yellow Labrador retriever.

Richard T. Przywara, CFRE

West Chester University Foundation and University Student Housing, Inc.

In Richard's role as Executive Director, he is responsible for capital, annual, and planned gift fundraising. Currently, the Foundation is running a $50 million capital campaign. In addition to raising funds he led a $240 million revitalization project of the student residence halls. Completed in 2014, this project involved the demolition of existing residence halls and construction of six modern high-rise structures.

Prior to serving in this role, Rich served as Chief of Staff to the County Executive, and General Manager of the Department of Special Service for New Castle County, Delaware. In his role for New Castle County he supervised a staff of over 450 and managed an annual operating and capital budget exceeding $100 million. Previously, Rich held the position of Associated Dean of Alumni and Development at Widener University School of Law and he was the Director of Development for the YMCA of Delaware.

Richard received his B.A. in Criminal Justice and a Masters in Public Administration from the University of Delaware. Rich is a member of the Nonprofit Center at LaSalle University, leading workshops on various fundraising topics over the past decade.

Bruce Stutz

Author of *Natural Lives, Modern Times, People and Places of the Delaware River*

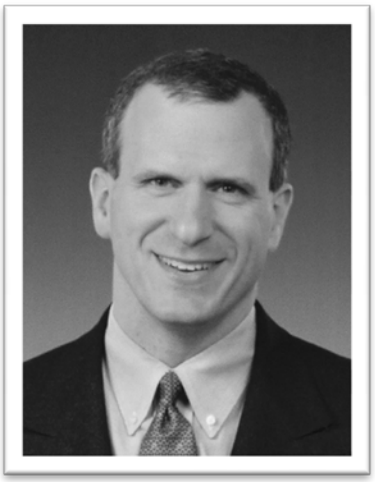
Bruce Stutz is a writer and editor of science, environment, and natural history. For more than thirty years he has traveled the world to report on nature, the scientists who study it, and the challenges of environmental change. His books, articles, and essays take readers on journeys into the natural world and impart to them the joys of scientific discovery. His articles have appeared in national and international newspapers and magazines, among them Discover, Natural History, Scientific American, The New York Times Magazine, Audubon, OnEarth, and Conde Nast Traveler.

Bruce's book *Natural Lives, Modern Times, People and Places of the Delaware River* presents a new kind of environmental history, one that connected the nature of this longest stretch of undammed river on the East Coast to the nature of the civilization that grew up along its banks, a civilization that eventually threatened the very river that gave it life.

At present he is a contributing editor to OnEarth, the magazine of the Natural Resources Defense Council, and to e360, the online environmental journal of the Yale School of Forestry.

Richard Wells

The Wellynn Group, LLC



Richard Wells has almost 30 years experience in all phases of communications, public affairs, public relations, and marketing. His career began as the public relations director for The Center for Literacy in Philadelphia, a non-profit agency working to teach adults to read. In the late 1980s, Richard began working in the healthcare industry, including spending sixteen years with Main Line Health, one of the largest multi-hospital systems in Pennsylvania.

Over his career, Richard has been responsible for all phases of strategy, planning and management of internal and external corporate communications, media relations, community and government relations, crisis communications, marketing, market research, and advertising.

In 2007, Richard left Main Line Health to become the principal and co-founder of The Wellynn Group, a consulting practice in marketing and branding, public affairs, and communications. He has served clients in healthcare, energy, academia and education, real estate development, and the non-profit sectors. The Philadelphia Business Journal has named The Wellynn Group one of the Top Branding, Marketing, and Media Services firms for three years in a row, 2012 – 2014.

Richard earned an English degree from the University of Virginia and an MBA from St. Joseph's University in Philadelphia. He resides in Bala Cynwyd, PA and in his spare time plays bass guitar and sings in a band that performs regularly in the Main Line area.

Future of Funding in the Watershed Panelists

Kim Beidler, New Jersey Audubon

Kim is the Director of the Coalition for the Delaware River Watershed– a network of non-profit organizations working to protect water resources throughout the four states of the Watershed. In this capacity, she has overseen the growth of the Coalition from a dozen founding members to more than 60 organizations, and coordinates Coalition activities, including advocacy efforts, collaborations on watershed-wide initiatives, and an annual conference. Prior to joining the Coalition, Kim worked extensively on complex land use planning and environmental management projects for agencies at all levels of government and not-for-profit organizations. Kim was employed as a Principal Resource Planner at the New Jersey Pinelands Commission where she managed projects involving community design, watershed planning, technology evaluation, and related issues. She also worked as a consultant to the U.S. Environmental Protection Agency and several state agencies, and previously, as a research assistant at the Academy of Natural Sciences in Philadelphia. She holds a Bachelor of Science degree in Biology from Bucknell University and a Master's degree in Resource Economics and Policy from Duke University.

Clare Billett, William Penn Foundation

Clare is a Program Officer for Watershed Protection. For most of her career, she has been invested in preserving, restoring and improving natural resources and ecological systems throughout the Mid-Atlantic Region – working across the conservation practitioner's spectrum from ecological restoration, management and design to land protection, conservation planning, and natural resource prioritization. She led regional SmartConservation efforts that resulted in the development of innovative site assessment and decision-support tools and also generated a regional Greenspace network of conservation hubs and migration corridors that would create a sustainable, connected landscape throughout eastern Pennsylvania. She has worked for private consultants, national and regional conservation non-profits and also recently directed the wildland-urban interface brush management program for the City of San Diego. Clare holds a Bachelor's degree in Geography with a specialization in Biogeography from Nottingham University and a Master's degree in Landscape Architecture from the University of Sheffield, UK.

Rachel Dawson, National Fish and Wildlife Foundation

Rachel joined the National Fish and Wildlife Foundation in 2014, where she manages a $7 million fund for habitat restoration projects in the Delaware River watershed. Prior to that, she was the legislative representative for the water restoration team at the National Wildlife Federation where she advocated on behalf of national and regional clean water laws, policies and programs critical for large-scale ecosystem restoration and a policy analyst at the Northeast Midwest Institute, focusing on issues in the watersheds of the northeast and mid-Atlantic, including the Delaware River Basin. She has worked closely with watershed-based Congressional task forces to address water quality issues and promote improved information, ecosystem restoration and stakeholder collaboration. Rachel received her Master's degree in Environmental and Natural Resources Policy from the George Washington University and her Bachelor's degree in Environmental Planning from the University of Miami.

Margaret Waldock, Geraldine R. Dodge Foundation

Margaret directs the Foundation's Environmental grants and identifies opportunities for Dodge to support innovative and creative approaches to advance sustainability and environmental protection in the Garden State. Prior to joining Dodge in 2011, Margaret was Executive Director of the Hunterdon Land Trust for eight years, where she oversaw an expansion in net assets, staff, members and donors and helped preserve over 5,000 acres of land. As a gardener, she is constantly reminded of the life lessons of gardening: to celebrate the blessings of bounty and accept loss. She has never met an old bicycle she doesn't like and has amassed a collection of 1970's era cruisers. Margaret received a combined Juris Doctor and Masters of Study in Environmental Law from Vermont Law School in 1992.

Special Session Panelists

Trash Talkin'

Moderator: Dee Durham(PDE and BringYourOwnBag.us)

Tom Davidock, PDE and Schuylkill Action Network
Lance Butler, Philadelphia Water Department
Robin Irizarry, Tookany/Tacony-Frankford Watershed Partnership
Kelly O'Day

Shellfish Culture Now and Tomorrow: Charting a Course for Delaware Estuary Aquaculture

Moderators: Daphne Munroe and Lisa Calvo (Haskin Shellfish Research Laboratory)

Mike Deluca, Director, Aquaculture Innovation Center, Rutgers University
John Ewart, Aquaculture Specialist, Delaware Sea Grant
Russ Babb, Chief, Bureau of Shellfisheries, NJ DEP
Will Morey, Cape May County Freeholder, Director of Planning, Education, Engineering and Economic Development
Barney Hollinger, Owner, Elder Point Oyster Company
Marc Zitter, Cape May Oyster Company
Monique Purcell, NJ Department of Agriculture

Monitoring Standards for Tidal Wetland Enhancement Projects

Moderator: Danielle Kreeger (PDE)

Bart Wilson, USFWS, Prime Hook National Wildlife Refuge, Federal Sector
Danielle Donkersloot, New Jersey Department of Environmental Protection, State Sector
Alison Rogerson, Delaware Dept. of Natural Resources and Environmental Control, State Sector
Danielle Kreeger, Partnership for the Delaware Estuary, National Estuary Program Sector
Doug Janiec, Sovereign, Private Sector
Moses Katkowski, The Nature Conservancy, Non-Profit Sector
Capt. Al Modjeski, American Littoral Society, Non-Profit Sector

Thank you for attending the 2015 Delaware Estuary Science and Environmental Summit.

The Partnership for the Delaware Estuary is a nonprofit organization established in 1996 to take a leadership role in protecting and enhancing the Delaware Estuary, where fresh water from the Delaware River mixes with salt water from the Atlantic Ocean. It is one of 28 congressionally designated National Estuary Programs throughout the coastal United States working to improve the environmental health of the nation's estuaries. Its staff works with partners in three states to increase awareness, understanding, and scientific knowledge about the Delaware Estuary, the region's most important cultural, economic, and recreational resource.

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Sari Rothrock, *Watershed Planning Specialist II*
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The Partnership for the Delaware Estuary, a National Estuary Program, leads science-based and collaborative efforts to improve the tidal Delaware River and Bay, which spans Delaware, New Jersey, and Pennsylvania.

Which Summit Was It?

Answers on page 27

Delaware Estuary Word Search

X F B M V F I A X T S P I S D R I B E R O H S C P
P A S X E J Z K S I S D N A L T E W R T G S I C B
A P J J J T K P Z D C F I L W E L Z F E B B B N A
F G Z I L X S E X A M O N I T O R I N G T L B I W
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W Y T A D W A E Q Y S Q P R E S E R V A T I O N J
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T S I M T J Y L H R E J E R N G H V A Y B T Y L V
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Z A E R D P Q P A P Q J F M A V S N W N X V A K S

Bay
Delaware
Ecosystem
Estuary
Fisheries
Freshwater
Habitat
Horseshoe Crab
Living Shoreline
Marsh
Monitoring
Mussel
New Jersey
Oyster
PDE
Pennsylvania
Preservation
Restoration
River
Shorebirds
Storm Drain
Tidal
Watershed
Wetlands

Abstract Program

2015 Delaware Estuary Science & Environmental Summit

January 25 – 28, 2015

Cape May, New Jersey

Index by Last Name

Development And Implementation Of Site-Specific Nutrient Control Solutions In New Jersey (3)

Thomas Amidon, Kleinfelder, 321 Wall Street Princeton, NJ 8540, TAmidon@kleinfelder.com; Marzooq Alebus, New Jersey Department of Environmental Protection

Talk - Session 3: Water Quality I

The development and implementation of site-specific nutrient control solutions in New Jersey provides an excellent illustration of the conference theme: Balancing Progress and Protection. Unlike most toxic contaminants, phosphorus and nitrogen are required nutrients for plants and algae. Nutrients are regulated because they can stimulate excessive growth of plants and algae, leading to eutrophication and consequent impairment of uses under certain conditions. We performed more than a dozen phosphorus evaluation studies on behalf of proactive wastewater authorities throughout New Jersey in order to identify and solve real nutrient impairments in their watersheds. Subsequently, we worked together with NJDEP and wastewater authorities to extend the local phosphorus studies into several large-scale nutrient impact and TMDL studies in watersheds throughout New Jersey, namely Rancocas Creek, Passaic River, and Raritan River.

The over-arching lesson to be learned from all these studies is any nutrient control solutions must be site-specific, designed to solve particular water quality problems. There is no “right” target number, either in treated effluent or in receiving water. The Passaic River TMDL study, for example, identified the two most crucial control points in an entire basin, and developed site-specific criteria effluent limitations accordingly. Compared to the “One Size Fits All” approach that would otherwise have been implemented, it is estimated that the site-specific approach saved more than $500 million to communities in northern New Jersey. In other words, $2 million dollars of diagnostic engineering saved $500 million, and will produce the same degree of environmental benefit when implemented. This presentation highlights not only the science and engineering, but also the regulatory innovations to achieve these results. The lessons learned are equally applicable to the Barnegat Bay and Delaware River estuaries; in fact, significant monitoring and research efforts are underway, directed toward nutrient impact diagnostic studies of Barnegat Bay.

The Darby Cobbs Stormwater Initiative: Getting To The New Normal (40)

Jamie Anderson, Eastern Delaware County Stormwater Collaborative, P.O. Box 315 Morton, PA 19070, jamiea98@yahoo.com; Diana Andrejczak, Pennsylvania Resources Council; Mario Cimino, Pennsylvania Resources Council; Peter Puglionesi, Haverford Township EAC; David Schwartz, Haverford Township EAC

Talk - Session 23: Soaking in Storm Water, Sea Level Rise, and Climate Change Outreach

Reducing pollution from urban stormwater runoff poses challenges on many fronts and requires innovative approaches to find solutions. Through the creation of partnerships amongst key stakeholders in the Darby and Cobbs Watershed, an innovative program was launched to build competency and capacity on Stormwater Best Management Practices (BMPs) and Green Infrastructure. The initiative brings together the Pennsylvania Resources Council, the Eastern Delaware County Stormwater Collaborative (EDCSC), the Haverford Township EAC, the Darby Creek Valley Association, as well as 7 municipalities within the watershed. Highly visible demonstration rain gardens will be constructed on public properties in the 7 EDCSC member municipalities. Creation of the rain gardens will be done as a part of an educational initiative to train a regional Rain Garden Resource Team. This team is designed to work on an ongoing basis to support education efforts of residents, municipal personnel, and other stakeholders on the ecological importance, benefits, and feasibility of rain gardens and other simple Green Infrastructures projects. The Initiative uses the trained team as a part of a Pilot Integrated Rain Garden and Green Infrastructure Program being undertaken by the Haverford Township EAC to create a streamlined process of engaging and assisting watershed residents in creating rain gardens on their private properties. The framework is designed to be transferable to the other EDCSC municipal members creating a watershed wide program supporting the creation of residential rain gardens. The multipronged Initiative focuses on direct engagement of residents, elected officials, administrators, engineers and public works professionals creating a lasting change in behaviors that lead to urban stormwater pollution.

Living Shoreline Implementation As An Element In A Coastal Community's Response To Localized Flooding (9)

Joe Berg, Biohabitats, Inc., The Stables Building Baltimore, MD 21211, jberg@biohabitats.com

Talk - Session 10: Restoration II

Arundel on the Bay is a coastal community of several hundred homes with an increased frequency of local road and lot flooding. In an effort to ameliorate the flooding and 'improve' drainage, Biohabitats evaluated existing site conditions, helped the HOA Board with the alternatives, prepared construction plans, and oversaw construction. The alternatives proposed, selected and implemented included a living shoreline linked to a roadside sand filter and bio-swale and a roadside swale linked to a pocket wetland in a community park. The design and construction of these projects was supported by the Chesapeake Bay Trust and the Maryland Department of Natural Resources. The living shoreline incorporated a novel

beach bar and small, interrupted, intertidal rock breakwater. Coupled with the living shoreline was an enlarged roadside drainage swale designed to perform like a tidal channel during normal tidal periods. During stormflow, this roadside swale delivers runoff to and through the living shoreline. Biohabitats was able to improve drainage performance by removing part of the adjacent road and a section of bulkhead on adjacent property. We also used a series of grade controls in the drainage channel to provide positive drainage and minimize culvert constrictions. In addition to this treatment at the interface with tidal waters, we incorporated other drainage and processing improvements further upstream in a community park including storing additional stormwater in a forested area using a low-head sand seepage berm, increasing the storage volume in the adjacent roadside swale by creating 'pocket' wetlands along the edge of the community park, and adding grade controls in the roadside swale to increase water storage in the swale. Constructed in the spring of 2014, the community has recognized reduced street and lot flooding during this wet spring and summer in areas that previously flooded with any significant storm.

Delaware Water Quality Portal: Visualizing Delaware Water Quality Data (56)

Christina Callahan, DEMAC, University of Delaware, 212A Pearson Hall Newark, DE 19716, tina.callahan@udel.edu; Kevin R. Brinson, Delaware Environmental Observing System (DEOS)

Talk - Session 3: Water Quality I

The Delaware Water Quality Portal (demac.udel.edu/waterquality/) is a web-based tool for the visualization and analysis of data from long-term water quality monitoring sites in Delaware. This site was developed by the Delaware Environmental Observing System (DEOS) and the Delaware Environmental Monitoring & Analysis Center (DEMAC) in coordination with the DNREC Watershed Assessment Section. All data for this site were obtained from the National Water Quality Monitoring Council's National Water Quality Portal.

The Delaware Water Quality Portal provides current and historical data for a limited set of parameters at the DNREC maintained General Assessment Monitoring Network (GAMN) stations, as well as a number of continuous monitoring sites and high frequency sites. Sampled parameters include: water temperature, dissolved oxygen, pH, salinity, total nitrogen, total phosphorus, total suspended solids, and enterococcus. In addition to gaining access to the station metadata and the most recent sampled values, users of the Delaware Water Quality Portal can query, visualize and download historical data values for each water quality station featured within this site.

This presentation will focus on the recently released Delaware Water Quality Portal and will serve an introduction to its many features.

Analysis Of Storm Surge From Observational Tide Records In The Delaware Inland Bays (46)

John Callahan, Delaware Geological Survey, University of Delaware, 257 Academy St. Newark, Delaware 19716, john.callahan@udel.edu

Talk - Session 22: Monitoring & Modeling

Loss of life and damages done to the natural and built-up environment due to severe coastal flooding is likely the most significant natural hazard facing Delaware today. The Delaware coast has been hit hard in recent times by the Mother's Day Storm in 2008, Hurricane Irene in 2011, and Superstorm Sandy in 2012 as well as in the past by the Hurricane of October 1878 and the Ash Wednesday Storm in March of 1962 (still the storm of record at Lewes.)

The current study analyzes data from operational tide gages from NOAA and USGS, along with other gages managed by local agencies, within the Delaware Inland Bays system to study the behavior of the water levels during times of high tide and storm surge events. Tidal parameters are derived and an inundation frequency analysis is performed to determine the average characteristics for each of the gages. Based on various meteorological conditions, statistical comparisons are made among the gages and correlated with storm surge observed at the Indian River Inlet, the primary hydrologic connection between the Inland Bays and the Atlantic Ocean.

In response to Delaware's susceptibility to coastal flooding due to storm surge, increasing coastal community development, and future sea-level rise, the Delaware Environmental Observing System (DEOS) and Delaware Geological Survey (DGS), with support from DNREC, developed the Delaware Coastal Flooding Monitoring System (CFMS), an early warning system and web-based display tool designed to provide emergency managers, planners, and others the information on the extent, timing, and severity of upcoming coastal flood conditions. Results of the current project will be used to facilitate the integration of the Inland Bays into the Delaware CFMS.

Development Of A High Water Mark Database And Display System For Coastal Flooding Events In Delaware (45)

Christina Callahan, DEMAC, University of Delaware, 212A Pearson Hall Newark, DE 19716, tina.callahan@udel.edu; John A. Callahan, Delaware Geological Survey (DGS); Kevin R. Brinson, Delaware Environmental Observing System (DEOS); Hunter C. Brown, Delaware Environmental Observing System (DEOS); Daniel J. Leathers, Delaware Environmental Observing System (DEOS)

Poster - Session 22: Monitoring & Modeling

Delaware's coast is greatly affected by both tropical and extra-tropical systems and has been hard-hit in recent years by the Mother's Day Storm (2008), Hurricane Irene (2011), and Superstorm Sandy (2012). Delaware's geographic location, low-lying elevation, high rates of relative sea-level rise, and expanding

coastal development and population make it increasingly susceptible to abnormally high tides and storm surge. This susceptibility is likely the most significant natural hazard facing Delaware today and supports the need for improved methods for documenting and analyzing the magnitude and extent of coastal flooding throughout Delaware.

High water marks (HWMs), typically observed as water stains on buildings or debris lines on the street or beach, are arguably the best method for capturing the maximum depth and extent of a flood for a large area. In addition, HWMs are helpful in disaster recovery planning and allocation of insurance claims, among others. Together with peak water level measurements (i.e., storm tides) from traditional tidal gages, HWMs are excellent resources for validating hydrodynamic models, assessing the severity of a storm, and hazard mitigation planning.

This project will collect historical HWM and peak storm tide data and develop a database and web-based display system for storing, managing and distributing HWMs and peak storm tide data for past and future storm events in Delaware. Additionally, this project will test the feasibility of deploying low-cost sensors at strategic coastal locations, in an effort to increase spatial and temporal coverage of flood level monitoring. Outreach groups can utilize the resulting data and maps to enhance public awareness for storm-readiness and coastal resiliency in Delaware.

This Delaware Sea Grant funded project is a collaborative effort among the Delaware Geological Survey (DGS), the Delaware Environmental Observing System (DEOS), and the Delaware Environmental Monitoring & Analysis Center (DEMAC).

Situation And Outlook, Growing Oyster Culture In Delaware Bay, New Jersey (82)

Lisa Calvo, New Jersey Sea Grant Consortium and Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Avenue Port Norris, NJ 8349, calvo@hsrl.rutgers.edu

Talk - Shellfish Panel

Oyster aquaculture in New Jersey is poised for significant growth, as recent advances in New Jersey's aquaculture policy, including changes in permitting regulations and the establishment of Aquaculture Development Zones, have created new opportunities for industry expansion. The majority of farms are located in the lower Delaware Bay Cape Shore area where extensive sand flats occur. The moderately high salinity and good food quality characteristic of this area support rapid oyster growth and yield exceptional quality oysters. Here, most farms grow hatchery-reared disease resistant oysters using rack and bag systems. The farms are accessed from the shore at low tide and the oysters are tended for a 1-3 year production cycle. Rutgers University and New Jersey Sea Grant initiated an annual shellfish aquaculture survey program in 2012 to document production and associated statistics of the growing industry. Eight Delaware Bay, NJ farms participated in the survey for the production year 2013. The farms collectively sold 1.7 million oysters, which had a sales value of about one million dollars. At the beginning of 2014, more than 14,000,000 oysters were in production and growers reported an

anticipated harvest of 2.8 million oysters for 2014. The farms supported 30 jobs. The current situation and outlook as well as challenges and opportunities for the emerging industry will be discussed.

Evaluation Of PCB TMDL Efforts In The Delaware Estuary (26)

Gregory Cavallo, Delaware River Basin Commission, 25 State Polkice Drive West Trenton, NJ 8628, gregory.cavallo@drbc.state.nj.us

Talk - Session 5: Water Quality II

TMDLs for PCBs for the Delaware Estuary and Bay were developed by the Delaware Basin Commission on behalf of the States of Delaware, New Jersey and the Commonwealth of Pennsylvania and established by EPA in 2003 for the estuary and 2006 for the bay. The mechanism for reducing PCB loadings to the estuary is the through the development of a Pollutant Minimization Plan (PMP) for each facility. The PMP rule embodies the principle of adaptive management, which requires source identification and reduction, monitoring and annual progress reports. PCB monitoring of effluent using EPA method 1668A was required to provide a numerical basis for evaluating results of PMP efforts. The Commission initially required the development of PMPs for some of the larger facilities, whiles states have been incorporating these requirements as NPDES permits are they are reissued. The Commission coordinates PMP activity between the States and EPA and maintains the database of discharger effluent information. Results of PMP efforts for ten dischargers representing 90% of the point source loadings to the Estuary indicate a 50% reduction from 2005-2010.

The Asian Clam *Corbicula fluminea*: Seasonal Filtration Rates Of Representative Populations In Two Tributaries Of The Delaware River (106)

Kurt Cheng, Drexel University, 3245 Chestnut Street Philadelphia, Pennsylvania 19104, kcheng@delawareestuary.org; Danielle Kreeger, Partnership for the Delaware Estuary

Poster - Session 3: Water Quality

The Asian clam, *Corbicula fluminea*, is an exotic freshwater bivalve that was first introduced to the United States in the early 1930s. *C. fluminea* populations have rapidly spread over the country due to it's high reproductive output and short life cycle. *C. fluminea* was first documented over 40 years ago in the Delaware River. *C. fluminea* is a filter feeding bivalve that has potential to impact water quality through a reduction of turbidity and possibly by helping to remove particulate pollutants such as nutrients. In the Delaware River system, *C. fluminea* generally assumes a dominant position in the benthic community of many streams, often representing a majority of benthic faunal biomass. Despite initial interest in their ecology post-introduction to the area, there have been few studies in the region regarding their feeding behavior and population dynamics. Seasonal filtration rates and representative population abundances

were assessed and contrasted between the Cooper River, NJ and Red Clay Creek, DE. Physiology studies were conducted using natural seston during three temperature regimes to measure filtration rates over the course of three seasons (spring, summer and fall). Population surveys were paired with physiological rate experiments to track changes in population structure. This pairing led to an estimation of the potential ecosystem services these clams may provide. Surveys incorporated juvenile clams to also assess reproductive output of clam populations in both streams. These data will help water quality managers better understand the role of dominant biota in governing water quality in the Delaware River and its tributaries.

Comparison Of The Retention And Growth Of Native Freshwater Mussels Reintroduced Into Nine Streams Of The Delaware Estuary, 2011-2014 (105)

Kurt Cheng, Partnership for the Delaware Estuary, 110 South Poplar Street Wilmington, Delaware 19801, kcheng@delawareestuary.org; Danielle Kreeger, Partnership for the Delaware Estuary; Angela Padeletti, Partnership for the Delaware Estuary; Roger Thomas, The Academy of Natural Sciences of Drexel University

Talk - Session 15: Living Resources

Freshwater mussels are the most imperiled of all animals, despite their important ecosystem services. In most streams, few or no mussels remain, whereas historical data suggest that every stream sampled once had robust numbers of up to 12 species. As part of the freshwater mussel recovery program (FMRP) launched in 2007, streams are being comparatively assessed for their ability to support mussel populations. Relocating electronically tagged mussels is one method being used to test the readiness of candidate restoration streams.

Beginning in 2011 and continuing through summer 2014, over 1000 mussels were collected in small groups from three healthy source beds where extant populations are robust enough to withstand removal. A combination of eastern elliptios (Elliptio complanata) and floaters (Pyganodon cataracta) were collected for relocation. Mussels were tagged with passive integrated transponder (PIT) tags and plastic tags for identification and shell heights were recorded. Groups of less than 40 mussels were then relocated into suitable habitats at each of nine stream locations in southeast Pennsylvania and northern Delaware: Chester and Ridley Creeks (2011), Skippack Creek (2012), White Clay and Red Clay Creeks (2013), and Shellpot, Christina, Ridley, Tacony, and Skippack Creeks and a tidal Delaware River site (2014). Following reintroduction, bed retention and shell growth was measured over time. Despite severe storms and flooding (e.g. Hurricanes Irene and Sandy) mussels have persisted and exhibited positive shell growth at many sites. Streams differed mainly in bed retention; streams with little riparian cover close to urbanization suffer from stormwater and subsequent bed scouring and washout. These streams are less suitable for future mussel restoration than streams where mussels grew faster and stayed in place. These results, combined with other data from the FMRP, are being used to refine strategic priorities and sites for more robust restoration efforts in the future.

Preliminary Analysis Of Historical Water Quality In The Tidal Christina River, Delaware (33)

Margaret Christie, University of Delaware Department of Geological Sciences, Newark, DE 19716, machri@udel.edu; Ronald Martin, University of Delaware; James Pizzuto, University of Delaware

Talk - Session 3: Water Quality I

Understanding the impacts of land-use changes on tidal rivers over millennial time scales is critical to better predict the long-term impact of current management practices on estuarine water resources. The Christina River, a tidal river which flows into the Delaware River near Wilmington, Delaware, has been impacted by diverse land-use changes. Following European settlement, the region was largely deforested and converted to agriculture, increasing sediment and nutrient inputs. Later industrialization and urbanization affected the region with the growth of cities and the installation of refineries and factories, all of which further input nutrients as well as other chemicals. To better understand these changes, diatom samples were collected from vibracores taken in the fresh to oligohaline marshes surrounding the tidal portion of the river. Lead-210, cesium-137, and carbon-14 dating were used to date the sediments. Diatoms were analyzed to determine how the communities changed with time, from the present to approximately 1350-1410 years ago, in response to natural and anthropogenic impacts. Preliminary analyses indicate large shifts in the relative abundances in diatom species, as well as changes in the species present. Species richness and diversity indices were affected as well, generally being higher around and before the start of the 20th century. Additionally, the ratio of centric to pennate diatom species, an indicator of turbidity and phytoplankton productivity, appears to peak early in the 20th century. Continued research will identify additional trends and use the autecology of the species present in each sample to further analyze environmental changes.

Relationships Between Macroinvertebrate IBI Scores And Land Use In The Delaware River Basin (87)

Kathryn Christopher, Academy of Natural Sciences of Drexel University, 1900 Benjamin Franklin Parkway Philadelphia, Pennsylvania 19103, kac388@drexel.edu; Lindsay Perez, Academy of Natural Sciences of Drexel University; Alexander Waldman, Academy of Natural Sciences of Drexel University; Stefanie Kroll, Academy of Natural Sciences of Drexel University; Jerry Mead, Academy of Natural Sciences of Drexel University; Roland Wall, Academy of Natural Sciences of Drexel University;

Poster - Session 22: Monitoring & Modeling

We performed an assessment of biological integrity on the tributaries in specific geographies throughout the Delaware River Watershed by relating land use and macroinvertebrate IBIs. We collected macroinvertebrate data from various organizations from 1990 to 2013 and calculated IBI scores using the PA DEP IBI and MAIS. We associated land uses at different scales with IBI scores using StreamHiker software, an open source GIS tool that analyzes spatial data at the river reach scale. We expect to see a negative impact related to agricultural and urban land use on stream quality and low

overall IBI scores in areas with high percentages of these land use categories. Forested land use within the riparian zone and drainage basin are expected to be related to increases in stream quality and IBI scores. Comparison of the different IBIs in relation to land use will provide insight to which index best quantifies the ecological integrity of tributaries in the Delaware River Basin.

Toward Innovative Approaches For Improving Water Quality: Linking Eco-Hydrology With Ecosystem Services At The Watershed Scale (125)

Luc Claessens, University of Delaware Department of Geography, University of Delaware, Newark, Delaware 19716, luc@udel.edu; Gerald Kauffman, University of Delaware

Talk - Session 12: Ecological Linkages & Ecosystem Services

Agriculture and urban land use have been linked to elevated nitrogen loading which can have a severely harmful effect on aquatic ecosystems. Best management practices are promoted to improve water quality, but evidence suggests that such improvements could take many years to decades. We will report on pilot work to examine other approaches that are innovative, fast-response, and cost-effective. This presentation focuses on the Christina River basin, where we use a combination of empirical methods (water quality monitoring and source tracking), geospatial modeling, and economic analysis. One of our target areas is the mushroom industry near Kennett Square. The area has some of the highest agricultural nitrogen loading in the Delaware River Basin, and it provides unique opportunities for improving water quality through innovative approaches at the watershed scale (vs. farm scale). Our preliminary findings should inform decision makers to target optimal locations and management practices for improving water quality.

Freshwater Mussel (Unionidae) Distribution In Relation To Water Depth In The Delaware River (107)

Elena Colon, The Academy of Natural Sciences of Drexel University, Patrick Center for Environmental Research, 1900 Benjamin Franklin Parkway Philadelphia, Pennsylvania 19103, elc64@drexel.edu; Roger Thomas, The Academy of Natural Sciences of Drexel University, Patrick Center for Environmental Research; Danielle Kreeger, Ph.D., Partnership for the Delaware Estuary; Priscilla Cole, Partnership for the Delaware Estuary; Lance Butler, Philadelphia Water Department

Poster - Session 15: Living Resources

Freshwater mussels (Unionidae) play an important role in maintaining a healthy freshwater ecosystem and make for useful indicators for evaluating habitat quality. As filter feeders, mussels significantly reduce seston in the water thereby influencing water quality. Unfortunately, more than 75% of mussel species in North America are imperiled. The decreases in mussel populations and species assemblages

are a result of years of systematic habitat destruction due to land development, dam construction and channel alterations e.g., and declining water quality. In response, the Freshwater Mussel Recovery Program was developed by the Partnership for the Delaware Estuary to conserve and restore native freshwater mussels in the Delaware Estuary. In 2012-13, researchers from the Academy of Natural Sciences of Drexel University, the Partnership for the Delaware Estuary, the Philadelphia Water Department, and EPA conducted surveys on the tidal Delaware River between Trenton and Philadelphia to assess current populations and the role of micro-habitat factors on the distribution and survival of freshwater mussels. Data resulting from the survey of four sites revealed a strong correlation between mussel density and depth, with density generally increasing with depth. Since then, additional surveys have been carried out on the Delaware River extending from Petty Island to Marcus Hook, and up the Schuylkill River to the Fairmount Dam. Surveys on the Delaware River downstream of Philadelphia have yielded low mussel densities; however, this is not entirely surprising considering the sites are nearer to the estuarine waters of the Delaware Bay.

Restoring Horseshoe Crab Habitat On NJ's Delaware Bay After Hurricane Sandy (126)

Dianne Daly, American Littoral Society, PO BOX 133 STONE HARBOR, power45@comcast.net; Larry Niles, PhD., American Littoral Society; Joseph Smith, PhD, American Littoral Society; Tim Dillingham, American Littoral Society; Alek Modjedski, American Littoral Society; Steven Hafner, Stockton Coastal Research Center; Amanda Dey, PhD, NJ Division of Fish & Wildlife

Poster - Session 8: Restoration

Beaches of the Delaware Bay estuary support the North Atlantic's largest spawning concentrations of the American Horseshoe Crab (*Limulus polyphemus*). The high density of horseshoe crab eggs on Delaware Bay beaches are inexorably linked to shorebirds which undertake exceptionally long migrations from coastal beaches in South America to arctic and subarctic breeding grounds. The availability of abundant horseshoe crab eggs has made the Delaware Bay beaches a critical migratory stopover point for these migrants some of which are threatened. We restored 1.5 miles of storm damaged beaches for Horseshoe Crabs & migratory shorebirds.

Protecting The Delaware Estuary One Beer At A Time: How Creative Partnerships With Breweries Are Helping Keep Our Water Clean (102)

Tom Davidock, Partnership for the Delaware Estuary, 110 S. Poplar St, Suite 202 Wilmington, Delaware 19801, tdavidock@delawareestuary.org; Elizabeth Horsey, Partnership for the Delaware Estuary

Talk - Monday Dinner

Save Water, Drink Beer! Messages like this now have a new meaning because of unique partnerships with the rapidly growing craft beer industry. Within Pennsylvania, New Jersey, and Delaware, there are 144 craft breweries, with nearly a quarter of the them starting up over the past three years. As beer sales fall nationally, craft beer sales have grown 17%. Craft brewers tend to be small, independent, and have a distinctive, individualistic approaches to connecting with their customers and community. Equally important, they place a great deal of value on their ingredients. Clean water is critical to making good beer; and since beer is over 90% water, this creates a natural synergy between the industry and environmental organizations that are working to protect this resource. During this presentation, we will discuss several existing projects with regional breweries and demonstrate how these partnerships are helping to raise both awareness and money for clean water and healthy watersheds. We will also discuss how these partnerships were established, how we're using them to advance our mission, and how it's allowing us to be creative with our marketing and messaging to reach new audiences. So let’s raise a glass, and make a toast to great beer and clean water.

Assessing Climate Change Impacts In Delaware (57)

Jennifer de Mooy, Delaware Division of Energy & Climate (DNREC), 1203 College Park Drive Dover, DE 19904, jennifer.demooy@state.de.us

Talk - Session 1: Climate Change & Hurricane Sandy

In Delaware, scientists and policy makers are working together to understand how the changing climate is affecting our state. We are using the best available science to makes our homes, communities, businesses, and natural resources more resilient to climate impacts.

The Delaware Division of Energy and Climate developed a statewide Climate Change Impact Assessment to link the best available climate science with the impacts that may result from a wide range climate change impacts, including increasing temperatures, changing rainfall, and rising sea levels.

A key component to this Assessment is Delaware-specific climate analysis. This includes future climate projections for temperature and precipitation, developed by Dr. Katharine Hayhoe (ATMOS Research and Consulting). An analysis of historic climate trends was developed by Dr. Daniel J. Leathers (Delaware State Climatologist, University of Delaware).

The purpose of the Climate Change Impact Assessment is to increase Delaware's resiliency to climate change by understanding and communicating the current and future impacts of climate change. The Delaware Climate Change Impact Assessment provides a strong scientific foundation for the development of the state's adaptation planning and strategies.

The Results Of A Water Quality Testing Program Conducted By A High School Aquatic Science Class On The West Branch Of The Brandywine Creek, Pennsylvania (80)

Dina DiSantis, Downingtown High School, Downingtown, Pennsylvania, 445 Manor Avenue Downingtown, Pennsylvania 19335, ddisantis@dasd.org

Poster - Session 3: Water Quality

The Poster will present the results of several years water quality testing conducted by the students of an aquatic science class from Downingtown High School West Campus. Testing is conducted at several locations each year along the West Branch of the Brandywine Creek between Northbrook and Lenape, Pennsylvania. The West Branch of the Brandywine Creek is 33 miles long and confluences with the East Branch just above Lenape. The Brandywine Creek then flows into the Christina, which empties into the Delaware at Wilmington. Physical, chemical and biological tests are conducted each year by students while traveling by canoes along the West Branch of the Brandywine Creek. The testing is part of a full year aquatic science class that is offered as an elective to juniors and seniors at the Downingtown High School West Campus in Dowingtown, Pennsylvania. Physical data collected are: temperature, width, depth, velocity and volume of flow. The chemical tests conducted are: dissolved oxygen, carbon dioxide, pH, nitrates and phosphates. Macroinvertebrates are collected with a kick net, identified and then released. The poster presents the results of several years, data collection.

The Development, Implementation And Curriculum Overview Of A High School Aquatic Science Course (73)

Dina DiSantis, Downingtown High School, Downingtown, Pennsylvania, 445 Manor Avenue Downingtown, Pennsylvania 19335, ddisantis@dasd.org

Talk - Session 21: Partnering with Schools and Youth

Why study water quality? According to the United States Geological Survey, "water quality is critical to the health and habitat of both humans and animals." Studying water quality will help us to understand: how water compares to standards, how conditions may vary locally, regionally, and nationally and if conditions are changing over time, and how natural features and human activities affect those conditions. Development and implementation of a water quality course for high school students will prove to be a valuable experience for both student and teacher. By having students assess the water

quality of a local stream they will better understand how human activity affects this valuable resources. It is important that students gain skills that will help them to have an understanding of water quality analysis and the importance of preserving the quality and quantity of our Earths waters. Developing a water quality course at your school will also give the student hands on approach to studying science; which is both beneficial and more satisfying to students. Students will feel that there is merit to what they are doing since they are conducting the same tests that scientist perform. When students conduct their own studies, collect and analysis data, they will be intimately involved in addressing water quality issues and solving critical water quality problems. An interdisciplinary, field-based science curriculum gives students the opportunity to take an active role as a scientist not just as a student. I will be presenting an overview of the aquatic science curriculum used by the Downingtown High School West Campus located in Downingtown, Pennsylvania, to study water quality and quantity within the Brandywine River watershed and beyond.

Microclimatology Of Hurricanes: The Value Of Weather Stations In Understanding Local Effects Of Hurricane Sandy (90)

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Poster - Session 1: Climate Change & Hurricane Sandy

Microclimate is the climate that affects biodiversity on a daily basis. It is also called the climate near the ground. Weather stations are designed to measure the conditions of the atmosphere for a general area under a set of conditions – long open area, no obstructions, standard height, etc. In measuring microclimate we set up a weather station to measure atmospheric conditions as relevant to the organism of interest in a specific location. In October 2012, Hurricane Sandy barreled through the Atlantic Ocean, to the coast of New Jersey to become the lowest-pressure storm in recorded history north of Cape Hatteras, North Carolina. In this study we compared weather data for two microclimate stations, one at the Drexel Barnegat Bay Field Station and one in a residential location in Haddonfield NJ, to public weather stations at Atlantic City airport, Barnegat Light, and Philadelphia airport. We analyzed data for 48 h between October 29-30. Atmospheric pressure was the lowest (946.6 mb) while the wind and gust speed were the highest at Atlantic City where the eye passed over. Barnegat Bay and Haddonfield pressures were higher, 953.3 mb and 951.7 mb, respectively, and the wind and gust speeds were lower compared to Atlantic City. Rainfall totals were 190 mm in Atlantic City, 136 mm at Barnegat and 64 mm at Haddonfield. These patterns indicate that the storm was most intense in Atlantic City, where it made landfall. Measurements of wind and gust speeds at the Barnegat Station were lower than at Atlantic City and Barnegat Light because of the transect of the eye and because the Station site was protected by buildings and vegetation. The Haddonfield site recorded the passage of the eye wall at the same time as a nearby oak tree blew down. Data from microclimate stations provided insight into local weather events during the storm that was useful in assessing the impact of the storm on a neighborhood scale. It explained the number of trees that blew down in Haddonfield.

Delaware Wetland Restoration Strategies: Does Planting Make A Difference After 15 Years (42)

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Poster - Session 16: Wetlands

Wetland restoration projects are becoming increasingly common, but the impact of planting these wetlands on the long term vegetation assemblage remains unclear. In this project, we investigate the vegetative community composition of wetland restoration projects with natural revegetation and planting restoration approaches. All wetlands are located within the Blackiston Wildlife area and were restored in 1997 with half of the sites planted at the time of restoration and the other half left to revegetate naturally. We surveyed the wetlands with the Stephenson-Adams vegetation sampling method which uses modified Whitaker plots called. The nested sampling allowed us to examine the tree, shrub, and herbaceous cover. Preliminary results indicate that the planted wetlands have higher species diversity in both the tree and shrub category and higher density in the shrub category than naturally revegetated wetlands. However, naturally revegetated wetlands had a higher density in the tree category. Both sites had relatively few invasive species regardless of the restoration strategy. The results of this study provided valuable insight regarding wetland restoration approaches in Delaware.

Sub-Tidal Movements Of Horseshoe Crabs (*Limulus polyphemus*) In Delaware Bay (124)

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Poster - Session 15: Living Resources

The Delaware River Estuary supports the world's largest population of the Atlantic Horseshoe Crab (*Limulus polyphemus*) which plays a major role in our region's economic and ecological well-being. Their designation as a multiple use resource is reflected in their Fisheries Management Plan whose primary goal is focused on their continued utilization by humans, shorebirds, and other dependent fish and wildlife. Although Delaware Bay has been a focal point for the study of Horseshoe Crabs for decades, most research has focused on spawning activities while limited information exists about the migratory patterns and sub-tidal habitat use. During the spring of 2014 spawning season, 65 acoustic transmitters (VEMCO V16-4H) with long-lived (2+ year battery life) were affixed to terminal phase adults encountered on seven of Delaware's bay shore beaches, ranging from Broadkill Beach to Woodland Beach. Through the use of a large scale passive acoustic receiver (VEMCO VR2W) network, we are monitoring telemetered individuals to assess subtidal movements and help refine our general understanding of Horseshoe Crab habitat use in the Delaware Bay. Data collected as part of this study will provide much needed insight into the movements of Horseshoe Crabs outside of their spawning

season and will provide resource managers with more information on the interaction of Horseshoe Crabs between the mid-Atlantic estuaries.

Shellfish Aquaculture In Delaware's Coastal (Inland) Bays 2015: Status And Outlook (63)

John Ewart, Sea Grant Marine Advisory Service, University of Delaware, 700 Pilottown Road Lewes, Delaware 19958, ewart@udel.edu; EJ Chalabala, Restoration Coordinator, Delaware Center for the Inland Bays, 39375 Inlet Road, Rehoboth Beach, DE 19971

Talk - Shellfish Panel

The cumulative impact of agricultural and suburban development and associated nutrient input has degraded water quality and habitat in Delaware's three “Inland” bays (Indian River, Rehoboth and Little Assawoman), and has reduced diversity and abundance of various species of fishes, invertebrates and submerged aquatic vegetation. In 1994 the Delaware General Assembly established the Delaware Center for the Inland Bays (CIB) as a National Estuary Program member to develop a management plan for stewardship of the estuary and its indigenous flora and fauna. Maintaining healthy populations of bivalve shellfish for their ecological, recreational and commercial value is one of the Center’s top priorities. In 1998, the Center and Delaware Sea Grant initiated a program of applied shellfish research, and demonstration field work culminating in 2012 that documented the value and effectiveness of aquaculture technologies as a restoration and management tool for fisheries habitat, shellfish stock enhancement and seafood production. During 2012, the CIB convened a diverse Inland Bays stakeholder work group (Tiger Team) to identify policy constraints and legislative changes needed for reinstatement of commercial shellfish aquaculture bottom leases. House Bill 160 “AN ACT TO AMEND TITLE 3 AND TITLE 7 OF THE DELAWARE CODE RELATING TO AQUACULTURE”, introduced in June 2013 during the 147th session of the Delaware General Assembly, was passed unanimously by the House and Senate and was signed into law by Governor Jack Markell on August 28, 2013. The Delaware Department of Natural Resources and Environmental Control (DNREC) Division of Fish and Wildlife, charged with developing a bottom leasing program and regulatory framework, completed the drafting and public education/hearing process with release of final regulations on August 11, 2014. The present status of commercial shellfish aquaculture development is reviewed with regulatory and additional information available at the Delaware Inland Bays Shellfish Aquaculture website <darc.cms.udel.edu/ibsa>.

Elevations Of Marsh Bird Nests In A Tidal Wetland In Southern New Jersey (68)

Lisa Ferguson, The Wetlands Institute, 1075 Stone Harbor Blvd Stone Harbor, NJ 8247, lferguson@wetlandsinstitute.org; Mollie Nugent, State University of New York College of Environmental Science and Forestry, Syracuse NY; Kathryn Sellers, The Wetlands Institute, Stone Harbor, NJ 08247; Lenore Tedesco, The Wetlands Institute, Stone Harbor, NJ 08247

Poster - Session 15: Living Resources

Marsh nesting bird species can be good indicators of changing habitat conditions. The Willet (*Tringa semipalmata*), Clapper Rail (*Rallus longirostris*), and Laughing Gull (*Leucophaeus atricilla*) are ecologically important species in the abundant salt marsh ecosystem of southern New Jersey. Their breeding populations, however, are threatened by coastal development and the effects of sea level rise. Effective management of these species requires an understanding of the relationship between nest flooding vulnerability as well as frequency and duration of flooding events. The objective of this study was to measure nest elevations of marsh-nesting species to better understand flooding risk during the nesting season. We surveyed Institute property in Cape May County, NJ from May to August 2014 to locate nests of the focal species. For each nest structure, we recorded a waypoint, measured elevation above ground, and recorded the height of water at each nest during full moon tidal flooding events. We examined the relationship between nest characteristics, tidal flooding, and known and estimated elevation above sea level. The elevation of nests above ground differed between species. Compared to Clapper Rails, Willet nests were constructed significantly lower to the ground but located in areas of the marsh that were significantly higher above sea level. Pooling all species, the total elevation of nests above sea level differed significantly between those that flooded and those did not flood during full moon high tides. Results provide a baseline for assessing local populations of marsh-nesting species with regard to the impacts of sea level rise over time.

Using Citizen Scientists To Monitor Watershed Improvements In Five Philadelphia Area Watersheds (43)

Stephanie Figary, Wissahickon Valley Watershed Association, 12 Morris Rd Ambler, PA 19002, stephanie@wvwa.org; Alex Cooper, Tookany/Tacony-Frankford Watershed Partnership; Robin Eisman, Friends of the Poquessing Watershed; Patrick Gardener, Lower Merion Conservancy; Brad Nyholm, Pennypack Ecological Restoration Trust

Poster - Session 22: Monitoring & Modeling

Five watershed organizations in the suburban Philadelphia region are collaborating on a water quality monitoring program for Cobbs, Pennypack, Poquessing Tookany, and Wissahickon Creeks. The five watersheds are part of the Upstream Suburban Philadelphia Cluster, a group created by the Delaware River Basin Initiative. The goal of the Initiative, funded by the William Penn Foundation, is to improve the water quality of the Delaware River by targeting sub-watersheds throughout the Delaware River

Watershed. The water quality improvements will be achieved through (1) water quality monitoring, (2) ecological restoration and green infrastructure, (3) collaboration with municipal officials, and (4) education and outreach. One challenge of the Initiative is documenting the water quality improvements obtained from the diverse range of efforts throughout the region.

Three levels of monitoring are being employed in each watershed to document water quality improvements in the Philadelphia region. The monitoring levels include (1) the University Level preformed by the Academy of Natural Sciences, Temple and Villanova Universities using date loggers, weather stations, and field surveys at restoration sites, (2) the Watershed Association Level, preformed by association staff including quarterly water quality grab samples, and (3) the Citizen Level, preformed by trained citizen scientists using a combination of visual assessments and water quality sampling. This method enables highly focused monitoring at the restoration sites by university partners, while still capturing the changes in the entire watershed with monitoring by the watershed associations and citizen scientists. This project examines the benefits, challenges, and lessons learned in the first six months of monitoring, particularly how the Watershed Association and Citizen Level monitoring was merged to determine the water quality of the watersheds before restoration projects were implemented.

Spatial And Temporal Trends In PCB Concentrations In Fish Tissue In The Mainstem Of The Delaware River (59)

Thomas Fikslin, Delaware River Basin Commission, 25 State Police Drive West Trenton, New Jersey 8628, thomas.fikslin@drbc.state.nj.us; Gregory J. Cavallo, Delaware River Basin Commission

Talk - Session 5: Water Quality II

Monitoring of resident and anadromous fish in the mainstem Delaware River for polychlorinated biphenyls (PCBs) began in earnest in the early 1990s. Sampling was initiated by the Commission in the tidal portion of the river with sampling extended to the non-tidal river above Trenton, NJ in 2000. 5 sampling sites in the tidal river portion and 3 sites above Trenton in the non-tidal portion were established. More sensitive methods for PCB congeners rather than Aroclor mixtures were utilized beginning in 1997. Yearly sampling continued until 2007 when the sampling frequency was reduced. PCB concentrations in fish from the non-tidal portion are 10 times lower than the levels observed in the tidal portion reflecting the numerous sources of PCBs to the tidal portion and the need for regulatory control of these sources through TMDLs established in 2003. Implementation of these TMDLs has produced close to a 50% reduction in PCB loadings from point sources resulting in less restrictive consumption advisories in Zone 5 (PA/DE state line to C&D Canal). River sediments contaminated with PCBs, however, continue to contribute PCBs to tidal waters resulting in minimal reductions in PCB tissue concentrations and continued restrictive consumption advisories in Zones 2 - 4.

A Hydrologic Model Of The Delaware River Basin (85)

Jeffrey Fischer, US Geological Survey, 3450 Princeton Pike Lawrenceville, NJ 8648, fischer@usgs.gov; Tanja N Williamson, US Geological Survey

Talk - Session 22: Monitoring & Modeling

As part of the National Water Census, the U.S. Geological Survey developed a hydrologic model of the Delaware River Basin. Non-tidal stream hydrographs are simulated using the Water Availability Tool for Environmental Resources (WATER), a TOPMODEL-based decision-support tool. WATER uses the variable-source-area concept and water budgets to generate streamflow. Model inputs include topography, climate, soil characteristics, land use, and water use. Soil data, such as thickness, porosity, hydraulic conductivity, and field capacity, are used to calculate infiltration rates, rates of sub-surface flow, and actual evapotranspiration. Land-use data are used to identify areas of impervious surface where a separate model (TR-55 - NRCS) calculates overland flow during precipitation events. Minimally impacted basins were used for initial model calibration in order to optimize parameters for forest, agriculture, and urban environments. The model is driven by daily data on precipitation and temperature and outputs daily flow values that were validated against measured streamflow for the time period 2001 to 2011. The model provides output compatible with Operations Support Tools (such as OASIS) which would allow the WATER results to be used in models that calculate flows in the regulated parts of the Delaware River.

WATER will be used as a decision support tool to evaluate how water stressors such as population growth, land-use change, climate variability, and climate change affect the availability of water resources in the basin. Simulations of future streamflow conditions, centered on 2030 and 2060, will incorporate projected changes in water use, land use, and climate in the watershed. WATER will also be used to make streamflow predictions in ungaged basins where ecological data were collected. This information will be used to evaluate relations between flow and ecological response, and to evaluate how ecological conditions might change in the future.

Upland Forest Buffer Loses Due To Inundation Caused By Sea Level Rise In The Upper And Lower Sub-Watersheds Of The Broadkill River (15)

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Poster - Session 1: Climate Change & Hurricane Sandy

Riparian buffer zones improve water quality by filtering and reducing nutrients that run off of adjacent properties. These important barriers are threatened in Broadkill River Watershed by inundation from sea level rise and infringement by development, especially where buffer regulations are weak. In this study I digitized the upland forested buffers around the high tide mark using 2012 aerial imagery and overlaid this layer with the Bathtub Model Sea Level Rise scenarios of 0.5 meters, 1.0 meter, and 1.5

meters to calculate the geometric acreage of riparian forest inundation extent for both the Lower Broadkill River and the Upper Broadkill River sub-watersheds. I then overlaid areas eligible for potential development to estimate the maximum loss of riparian buffers. With a build out condition and the existing 50 foot buffer, up to 64.13% of the non-protected forested riparian area in the 2 watersheds could be inundated at 0.5 meters sea level rise; 82.53% at 1 meter and 91.51% at 1.5 meters. Similar analyses were run to determine extent of loss width wider buffer requirements. These results will help local governments to understand potential impacts of sea level rise on water quality and to plan for future regulatory or restoration archives.

Greenstem Network: Philly Schoolyard Rain Gardens Go High Tech At Low Cost (12)

Matthew Fritch, Philadelphia Water Department, 1101 Market St Philadelphia, PA 19107, matthew.fritch@phila.gov

Talk - Session 21: Partnering with Schools and Youth

The greenSTEM Network connects students to the environment by monitoring and mining data from gardens, green roofs, and various types of green stormwater infrastructure. Using low-cost, DIY sensor kits, the greenSTEM Network displays real-time environmental data (such as soil moisture, precipitation, sunlight, and temperature) on the web to help students maintain healthy school gardens, learn about water-related issues, and conduct scientific experiments and analyses. This is a hands-on learning project in which students program, solder, design, build, install, calibrate, and monitor the sensors and circuit boards. The Philadelphia Water Department collaborated with civic hackers and software developers to create a website (www.greenstemnetwork.org), database and web animation to help students visualize environmental conditions and track the health of their schoolyard vegetation. In spring 2014, sensor kits were deployed at four Philadelphia schools. In summer 2014, a sensor kit was placed at the Franklin Institute's ozone garden to alert student volunteers when the plants need watering. All software developed for this project is "open source"—free for anyone to use or modify—and an instruction manual documents how to build your own sensor kit. This presentation focuses both on the educational outcomes inside and outside the classroom, and the trial-and-error journey undertaken to develop this technology.

Analysis Of Bacteria In A New Jersey Coastal Lagoon To Locate A Source Of Contamination (113)

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Talk - Session 20: Mitigating Human Influences on Natural Resources

Manmade dead-end canals or lagoons are a popular design used in coastal communities to increase the number of buildable waterfront lots; unfortunately they can have a negative ecological impact. The dense concentration of houses and recreational boating activity increases the lagoons' exposure to contamination. Additionally, their design inhibits water exchange and promotes stagnation. Sampling sites were chosen in six lagoons in a New Jersey coastal community to determine bacterial levels. Bacterial levels were calculated using the membrane filter method to determine if the water is safe for swimming and secondly to understand how rainfall affects bacterial levels. The enterococci level was elevated slightly above the EPA standard while the mean fecal coliform level was many orders of magnitude higher than the acceptable standard at every sampling location and time in the contaminated lagoon. These levels were consistently elevated over the five-week testing period. After a significant rainfall both categories of bacterial levels generally increased; bacterial counts after rainfall were more than double the bacterial counts before rainfall at multiple sites. Five lagoons had very low bacterial levels making the water safe for swimming and recreational activities, however one lagoon had bacterial contamination exceeding both safety standards for swimming and for boating activity. The bays in New Jersey are generally very clean and safe for swimming, but unlike the oceans the authorities don't monitor the bays and lagoons for bacterial contamination. We are investigating further to see if the contamination drops as the population decreases at the end of the tourist season and to determine genetically if the contamination is from humans or wildlife.

Vegetation Zone Dominance: The Use Of Plant Communities As A Proxy To Estimate Marsh Resilience (110)

LeeAnn Haaf, Partnership for the Delaware Estuary, 110 S. Poplar Street Wilmington, DE 19801, lhaaf@delawareestuary.org; Angela Padeletti, Partnership for the Delaware Estuary; Danielle Kreeger, Partnership for the Delaware Estuary

Talk - Session 16: Wetlands

Rising sea level and other environmental changes catalyzed by climate change are serious threats to salt marsh acreage. Marshes are the first line of defense from these destructive forces, yet marsh stability and resilience are difficult to survey. Resilient marshes maintain elevation relative to the tidal prism as sea level rises, a process which is driven by plant community robustness and sufficient sediment loads. Elevation deficits, on the scale of millimeters per year, could be detrimental to this natural maintenance process and put marshes in jeopardy of drowning. Furthermore, recent literature suggests that marshes

of lower elevations are less resilient to rising sea levels. To study ways to determine the condition of marshes based on their vulnerability to sea level rise, absolute elevations in six salt marshes in the Mid-Atlantic were surveyed using real-time kinetic GPS (RTK) which can ascertain elevation readings with an accuracy of ± 2cm. By analyzing patterns between RTK data (from a dataset of > 7,000 points), geomorphological features, and plant community composition, a numerical index, titled vegetation zone dominance (VZD), was developed that allows for the qualitative reporting of marsh elevations relative to sea level. VZD patterns were corroborated with new field datasets and data from long-term wetland studies, which included biomass sampling, surface elevation table-marker horizon readings, and permanent vegetation plot monitoring. VZD can be used to quickly identify the relative elevation of marshes within the local tidal prism, making it a useful tool for rapid condition assessments and for finding long-term trends.

Shoreline Changes In The Delaware And Barnegat Estuaries: Historic Shifts And Significance For Marsh Futures (111)

LeeAnn Haaf, Partnership for the Delaware Estuary, 110 S. Poplar Street Wilmington, DE 19801, lhaaf@delawareestuary.org; Erin Reilly, Barnegat Bay Partnership; Jessie Buckner, Partnership for the Delaware Estuary; Angela Padeletti, Partnership for the Delaware Estuary; Danielle Kreeger, Partnership for the Delaware Estuary

Poster - Session 16: Wetlands

Marsh shoreline morphology operates on dynamic principles of erosion and accretion. Shorelines delineate the lithosphere from the hydrosphere, creating an interface upon which erosive and accretive processes act. These dynamics result in net horizontal movement of the vegetated marsh edge, and are driven by both natural and anthropogenic processes. As sea level rises and storm intensities increase, scientists have become more concerned with the resilience of marshes, which attenuate these destructive forces. Where net erosion outweighs accretion, marsh acreage is lost and functionality is compromised. If shoreline erosion becomes more frequent and intense, the result would be net marsh loss along marsh edges, in addition to marsh loss by drowning from rising seas. Understanding such shoreline change is crucial to our understanding of marsh resilience.

A real-time kinematic global positioning system (RTK) was used to document current shoreline (summer 2014) positions in 3 locations along the New Jersey Bayshore and 3 locations in Barnegat Bay. For comparison, shorelines were also positioned from ArcGIS basemap layers dated spring 2011. Additional historical shoreline layers were added from National Oceanic and Atmospheric Administration's Digital Coast database to ascertain historical shoreline position, where available. Horizontal movement of shorelines was then delineated using NOAA's Digital Shoreline Analysis System. Establishing rates of change allows for analysis of stressors that cause unsustainable rates of change, thereby focusing management practices on activities and areas that can help offset declines in marsh shoreline resilience.

Product Stewardship Can Resolve Climate Change (17)

William Haaf, WCH Consulting, 1923 Marlboro Rd Kennett Square, PA 19348, billhaaf@verizon.net;
Dianne Herrin, Practical Energy Solutions

Talk - Session 20: Mitigating Human Influences on Natural Resources

Ethical Energy is a grassroots organization in southeastern PA formed to accelerate the transition to a low-carbon economy. For years, we have been closely following the science and risks of manmade climate change. We are alarmed by the impacts and inaction by our government and the energy industry. In the interest of all children and grandchildren, we have developed a focused goal and action steps to reduce greenhouse gas (GHG) emissions.

Our goal is to reduce GHG emissions during electricity generation 80% in 40 years.

Our action steps are based on the premise that energy companies must become stewardship leaders of their fuel products by working with customers (e.g., utilities) to help them reduce their GHG emissions. We have generated two initial action steps.

Action step #1: Energy companies must make public their scientific risk assessments for climate change, and invite public input. These risk assessments must focus on the end uses (burning) of fuels, not on industrial fuel processing facilities, as it is the use of the products that releases the vast majority of GHG emissions. If the companies do not volunteer this information in the interest of public safety, the President must request it.

Action step #2: Natural gas drilling and handling companies must have and obtain 3rd-party assessments of their management systems for monitoring and mitigating methane leaks, from well drilling through the entire supply chain. A target "background" methane level should be set.

Background:

There is strong precedent for product stewardship in nearly every other major industry that produces products that pose a risk to our health. Producers have taken responsibility for the impact of their products through the product lifecycle, by adopting and applying standards throughout the supply chain and for end uses. Furthermore, more than any other entity, the energy industry has the resources, scientific know-how, infrastructure, and economic interest to help lead this effort.

This disclosure and open discussion of the energy companies' climate risk assessments is a critical first step toward engaging the energy industry in the issue of climate change. We believe this will open the door to congressional actions and funding of technologies that are desperately needed to reduce GHG emissions at the power plant level. We do not believe in dictating these technologies or solutions. We believe in allowing any path forward that achieves the goal of significant GHG reduction. For example, carbon capture and sequestration, solar power, wind power and nuclear power can all contribute to this goal, and a combination of solutions is necessary. We recognize that all technologies have tradeoffs, different economies, and different scalabilities. However, we must recognize that these tradeoffs – including their own environmental risks – are dwarfed by the urgency of climate change.

Update On Urban Water Federal Partnership Activities (100)

Simeon Hahn, NOAA, 1650 Arch St Philadelphia, PA 19103, simeon.hahn@noaa.gov; Franklin B. McLaughlin, NJDEP; Julie Ulrich, TNC; Bobbi Britton,, Greater Brandywine Village

Talk - Session 8: Restoration I

The Urban Water Federal Partnership Delaware River/Philadelphia Area collaboration has been active for over a year. There are several efforts in Camden NJ; Philadelphia, PA; Chester, PA; and Wilmington, DE that the UWFP is trying to support. The goal of this presentation will be to give an overview of the UWFP and provide an update of UWFP activities in these locations with a focus on Brownfield activities including Harrison Island Landfill and Phoenix Park (Camden), Brandywine Village (Wilmington), and other projects.

Freshwater Fish Assemblages Of The Delaware River Basin: What Causes Them And How Can They Be Used For Bioassessment (79)

Richard Horwitz, Acad. Nat. Sci. Drexel U, Acad. Nat. Sci. Philadelphia, Pennsylvania 19103, rjh78@drexel.edu; David H. Keller, Acad. Nat. Sci. Drexel U; Stefanie Kroll, Acad. Nat. Sci. Drexel U.

Talk - Session 18: Monitoring & Assessment for the Delaware River Watershed

The occurrence of fish species reflects current environmental suitability, historical changes in suitability, and factors promoting or inhibiting extirpation and recolonization of species. Environmental suitability includes both natural and human-caused conditions, which must be distinguished for bioassessment. Indices of Biotic Integrity (IBIs) are based on assemblage characteristics which reflect human effects. Creation of regional IBIs can control for coarse-scale natural variation, and some within-region variation (e.g. stream size) can be treated as covariates. Indices of deviation from expected species occurrence or abundance patterns are an alternate approach to bioassessment; this approach may be able to better control for local variation in conditions and better use individual species characteristics. As part of the Delaware River Watershed Initiative, we have been sampling fish in different parts of the region using standard protocols. Together with historical information on fish occurrence and sampling data from other studies, these data provide a basis for defining existing and expected species distributions. We will present data on occurrence of fish species with respect to natural variation. Although patterns of occurrence with respect to water temperature, acidity and stream order are well documented, many species show a more complex pattern of occurrence. These reflect effects of other factors, constraints on dispersal on various time scales, and interactions between human disturbance and habitat use. For example, associations with stream order are strongly affected by human disturbance. This information can provide a more complex understanding of influences of natural and human-caused conditions and their interactions on fish assemblages.

Beneficially Reusing Dredge Material To Rebuild A Marsh Along Pepper Creek (71)

Andrew Howard, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship, 820 Silver Lake Blvd Dover, Delaware 19904, Andrew.howard@state.de.us; Alison B. Rogerson, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship; Bartholomew Wilson, Delaware Center for the Inland Bays; Daniel J. Brower, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship; Ariane K. Nichols, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship; Maggie K. Pletta, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship;

Talk - Session 10: Restoration II

In 2013, DNREC's Wetland Monitoring and Assessment Program partnered with DNREC's Shoreline and Waterway Management Section and The Center for the Inland Bays to restore a 21 acre state-owned tidal wetland off of Pepper Creek in Dagsboro, Delaware. After extensive site monitoring and evaluation, up to 6 inches of material (~10,000 yd^3) dredged from Pepper Creek for navigational channel maintenance were pumped and sprayed aerially via high pressure onto the emergent wetland surface. Thin layer application of dredge material, or beneficial reuse, is intended to boost sediment elevation and encourage the wetland platform to keep pace with rising sea levels. Systems that are sediment deprived and facing longer tidal inundation show signs of deterioration and conversion to open water. Returning benthic sediments to adjacent wetlands reduces the need for upland disposal and extends the life of coastal wetlands which provide erosion control and storm buffering. Following the completion of spraying in late December 2013 post-application monitoring began to track the reaction and recovery of the wetland area. Detailed real-time kinetic (RTK) elevation surveys and clay marker horizons are tracking sediment dispersal and compaction across the site. In addition, plant community recovery and plant biomass are being tracked to determine if there is a need for planting. Site conditions will be monitored for at least 2 additional years and will be openly offered to guide future thin-layer application projects.

Living Shoreline Techniques In Delaware (109)

Douglas Janiec, Sovereign Consulting, 111-A North Gold Drive Robbinsville, New Jersey 8691, djaniec@sovcon.com

Talk - Session 8: Restoration I

Over the last 18 to 24 months, living shoreline projects in Delaware have taken a significant step forward. A number of different approaches, technique, and/or treatments have been designed, are in the permitting process, and/or have been installed. This presentation will provide an overview, highlighting hybrids, wood log designs, coir fiber logs designs, the application of stuctures (e.g., WADs or

oyster castles), etc. That is, this will be a state-of-the-science presentation including a discussions of certain considerations that lead to the selected approach on selected projects.

Energy Attenuation And Hybrid Living Shorelines: A Viable Tool For Coastal Resilience (112)

Douglas Janiec, Sovereign Consulting, 111-A North Gold Drive Robbinsville, New Jersey 8691, djaniec@sovcon.com

Talk - Session 24: Hot Topics

Superstorm Sandy revealed just how vulnerable our coastlines are to storm energies, increased storm frequencies, and sea level rise. Also, Superstorm Sandy made it abundantly clear that our natural systems tended to fare better than man-made features and certain structures. As such, most agree that a significant part of our coastal resiliency is directly tied to the preservation and protection of our natural areas. Unfortunately, our natural areas, including marshes, dunes, and beaches are also vulnerable, and are being lost the tune of more than 1 acre per day in some areas. If we attenuate the erosive energies contacting our coastlines, we could build in resilience by implementing living shorelines and protecting existing natural systems. Help may be available through the application of a Hybrid Energy Attenuation System, which is a multistep energy reduction system that takes advantage of natural processes and is supplemented with a structural, energy-attenuating, component. The cornerstone of the system is the initial energy attenuation that disperses the brunt of wave energies prior to contacting the coastline. This system transforms an area of higher erosion to an accretion zone. In addition, this system offers unprecedented resilience, and is a valuable tool to the coastal resilience toolbox.

Development Of Rapid Salamander Monitoring And Habitat Assessment Protocols For The Delaware River Basin (31)

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Talk - Session 18: Monitoring & Assessment for the Delaware River Watershed

Salamanders are recognized as being abundant, important members of stream communities that are sensitive to habitat loss and stream impairment. However, most states in the Delaware River basin do not have monitoring programs/protocols for assessing stream salamanders and their habitats. States with monitoring protocols (NJ) use minimal salamander-specific habitat assessment. As a result, determinations from salamander monitoring may confound water quality impairment with habitat quality. To address these needs, and as part of the Delaware River Watershed Initiative, the Academy of Natural Sciences of Drexel University (ANSDU) is developing protocols to assess salamanders and their

habitats. Preliminary findings from 30 sites sampled in 2013 indicate that specific habitat variables are correlated with salamander presence/absence and salamander relative abundance. For example, these preliminary data suggest that percent embeddedness and percent fine substrate may be negatively correlated with the relative abundance of Northern Dusky Salamander, a salamander associated with good water quality. In 2014, ANSDU will sample an additional 30 sites and continue to refine its salamander and habitat assessment protocols by sampling smaller streams, longer reaches, and using a modified substrate assessment protocol. The effect of stream size, reach length and other variables on salamander richness and abundance will be discussed.

State Of Delaware's "Watershed Approach To Toxics Assessment And Restoration" Program (Watar) (13)

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Talk - Session 5: Water Quality II

Objectives: The Watershed Approach to Toxics Assessment and Restoration (WATAR) was conceived to build a bridge between DNREC's Surface Water Toxics and Site Investigation and Restoration programs. The focus of Delaware's WATAR program is the assessment of surface waters, sediments, and fish impacted by toxics and the sites responsible for those impacts. Program goals include:

- Compile existing toxics data for surface waters, sediments, and biota;
- Create a mechanism to maintain the data for remedial decisions and prioritization;
- Implement TMDLs for toxics;
- Develop a framework to assess and manage contaminated sediments, incorporating principles of bioavailability;
- Identify high priority remediation projects with potential to significantly address toxics problems in State waterways;
- Plan for staff succession through knowledge transfer.

Approach: DNREC staff identified the absence of a rigorous and quantitative accounting of the links between waterway contamination, transport pathways, and the sources within a watershed. The evolution of existing programs is essential to address Delaware's remaining toxics problems in a timely manner. The long term goal is to remediate sources along with historically impacted waterways using a stepwise approach in order to achieve fishable, swimmable and potable water in all of Delaware's waterways.

To date, five impacted watersheds have been surveyed for persistent, bioaccumulative, and toxic (PBT) compounds in water, sediment, and fish tissue. Forensic grade analyses of samples collected from throughout the watershed are helping to: characterize current conditions, identify trends and fill data gaps, understand spatial patterns of contamination, understand contaminant partitioning behavior and bioavailability, evaluate relationships between sources and in-stream fate and transport, and validate water quality models.

Results: WATAR successes will be highlighted in the presentation: Meco Ditch Remediation, Wilmington PCB Track-down Study, Mirror Lake Remediation/Restoration, and Fort DuPont Apatite Permeable Reactive Barrier.

Marsh Futures: Assessment And Mapping Of Elevation Capital And Shoreline Erosion To Guide Restoration Of Coastal Wetlands At The Local Scale (119)

Danielle Kreeger, Partnership for the Delaware Estuary, 110 S. Poplar St. Wilmington, Delaware 19801, dkreeger@delawareestuary.org; Joshua Moody, Partnership for the Delaware Estuary; Moses Katkowski, The Nature Conservancy; Diane Rosencrance, Natural Lands Trust; Meghan Boatright, Natural Lands Trust

Talk - Session 10: Restoration II

Storm and flood damage from Superstorm Sandy appeared greatly reduced in communities that were buffered by coastal wetlands. Since the Delaware Estuary is experiencing an acre per day net loss of coastal wetlands, and funding remains elusive, it is vital that wetland restoration efforts target crucial sites with strategically timed and chosen tactics leading to the most robust outcomes. Several important tools are being developed based on remote sensing datasets to guide restoration of coastal marshes and beaches. However, higher resolution topographical, hydrodynamic and ecological conditions indiscernible to remote sensing can affect performance of tactics such as living shorelines and thin-layer sediment application. Therefore, on-the-ground data may be necessary to guide the location and design of projects aimed at offsetting wetland erosion and drowning. Historical and contemporary data were synthesized to test whether local guidance could be developed in three pilot areas of interest in the New Jersey Bayshore: Money Island, Fortescue, the lower Maurice River near Bivalve.

Marsh Futures refers to a two-step, science-based reconnaissance effort to 1) assess and map local conditions in areas where wetland restoration is sought, and 2) produce maps of recommended best management practices that guide the timing, sequence and varieties of suggested mediations. This approach was tested at the three areas of interest, beginning with acquiring available remote sensing data on current elevation (e.g. LIDAR) and past erosion rates (e.g. historical aerials). Field assessments consisted of surveys of actual elevation (RTK-GPS) and indexing of plant diversity and growth morphology to estimate vegetation position in relation to its optimal growth range. These data were evaluated (in Arc-GIS) to produce maps of “elevation capital” for the marsh platform, referring to a temporal vulnerability to drowning as a result of rising sea level. Edge retreat rates were used to estimate vulnerability to horizontal erosion. A weighted measures risk assessment approach was used to score sub-areas of each site for various threats. The vulnerability maps were contrasted with inventories of current and former restoration tactics to develop spatial and temporal recommendations for conservation, enhancement or restoration options at the three pilot areas. Preliminary findings suggest that some areas would benefit more from thin-layer sediment application, other areas more from living shorelines, and in some cases both if the timing and sequence was coordinated.

Scientific Monitoring Protocols To Gauge Living Shoreline Outcomes (115)

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Poster - Session 8: Restoration

Living shorelines represent a promising approach to stabilize eroding shorelines, enhance ecological health, and promote water quality along changing coastal areas. Since 2007, the Partnership for the Delaware Estuary has worked with the Haskin Shellfish Research Laboratory at Rutgers University to study whether and how living shorelines can be developed for the Mid-Atlantic. Despite growing interest in living shorelines within the Delaware Estuary, few projects have been locally installed and there are insufficient scientific studies concerning their performance and long-term viability. It is therefore important that outcomes from new projects are assessed in a standardized manner and that resulting data are intercomparable and sharable. To address this assessment gap, a monitoring framework is being developed by PDE, with input from local, regional, and national partners, to serve the diverse needs of agencies, academics, non-profits and other project implementers.

The framework includes an adaptable set of metrics and methods to be selected based on project goals, budget and timeline. Metrics are parameters used to assess changes in physical, biological and chemical attributes, whereas methods are techniques used to collect data. The framework distinguishes between core metrics gauging general performance and supplemental metrics addressing specific needs. Typically, shoreline stabilization is sought, but additional goals such as habitat creation or water quality enhancement may also be of interest. Methodological options with standard operating procedures are provided for each metric, ranging from basic to rigorous. For all living shoreline monitoring, we recommend use of the Before-After-Control-Impact (BACI) design: a two-way comparative approach between the Impact Area (installed treatment) and Control Area before and after installation. The goal of the monitoring framework is to help assess and share understandable outcomes among the restoration community so that the design of future projects can continue to be improved based on past successes and lessons learned.

Mussels, Marshes And Submerged Grasses: Hybrid Living Shoreline Concepts To Remediate Urban Tidal Freshwater Waterfronts (117)

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Poster - Session 8: Restoration

Living shorelines (LS) consist of an array of new restoration tactics designed to stabilize coastal erosion and help adapt to sea level rise while also enhancing ecology, such as fish and wildlife habitat and water quality. Beginning in 2007, the Partnership for the Delaware Estuary and the Haskins Shellfish Research Laboratory of Rutgers University crafted and implemented the Delaware Estuary Living Shoreline Initiative (DELSI), consisting of planning, design, implementation and scientific monitoring of new types of living shoreline projects that are suitable for our region. A core principle of DELSI is to identify structural and functional dominant fauna and flora at each project site and to tailor designs to maximize ecological relationships among these biota to impart natural resilience. In recent years there has been upswing of interest and activity to restore urban waterfronts in Philadelphia, Wilmington, Chester and Camden, which are situated within the nation's largest freshwater tidal estuary. Although many successful restoration projects have been installed as part of this redevelopment effort, to date none have applied DELSI approaches with the explicit goal of maximizing ecosystem services along the littoral zone, such as related to water quality enhancement.

A new "hybrid mosaic" living shoreline approach is proposed for this freshwater tidal zone that seeks to restore three synergistic habitats: tidal freshwater marsh, submerged aquatic vegetation, and freshwater mussel beds. All three habitats help stabilize substrates, sustain water quality, and enhance fish and wildlife, while also buffering against waves. Preliminary conceptual designs are proposed for prospective locations in Camden (Harrison Landfill, Phoenix Park), to be shown as examples of how living shoreline approaches might be applied to urban redevelopment sites. If implemented and successful, these projects should impart water quality benefits to the urbanized system while also significantly improving coastal resilience, aesthetics, and quality of life for urban communities.

Coordinated Conservation Projects And Monitoring Outcomes In The Delaware River Watershed Initiative, Including The Kirkwood-Cohansey Aquifer (84)

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Poster - Session 8: Restoration

The Watershed Protection Program involves collaboration among professionals from different disciplines to protect aquatic ecosystems throughout the Delaware River Basin and the Kirkwood-Cohansey Aquifer. The projects encompass a combination of place-based restoration, education, conservation, watershed-wide policy, cooperation and innovation. We identified eight "clusters" of subwatersheds, constituting approximately 25 percent of the total Delaware Basin, where analysis has shown that investment in water quality could deliver significant returns. A key component of the program is to monitor restoration and preservation actions and to analyze these systems on multiple scales. Three types of sites are included for monitoring: Integrative (distributed throughout the subwatershed), project-specific and control sites. Monitoring plans are designed to address the diversity of expertise from local groups, and include citizen and stakeholder groups as well as professional researchers. The result is a flexible but comprehensive and consistent approach to monitoring. Unique approaches have been applied to involve diverse stakeholder groups, identify control sites and to measure water quality changes in the short-and long-term. A major challenge is to define ways to demonstrate efficacy of projects when the effects on the ecosystem are expected to be small, especially in the short-term.

Macroinvertebrate Communities In The Eight Subwatershed Clusters Of The Delaware River Watershed Initiative (41)

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Talk - Session 18: Monitoring & Assessment for the Delaware River Watershed

The Delaware River Watershed Initiative (DRWI) is a collaborative program for on-the-ground restoration, targeted land protection, and measuring changes in aquatic communities over time as a result of these actions. The program is focused on 8 priority regions (subwatershed clusters) encompassing roughly one-quarter of the Delaware Basin: clusters targeted for agricultural restoration actions, suburban Philadelphia streams, and clusters with conservation of forested areas. In 2013, we sampled fish, salamanders, macroinvertebrates, algae and water from sites chosen to represent the conditions within each subwatershed cluster ("integrative sites"). We expected macroinvertebrate communities to be grouped by subwatershed cluster type. We performed Redundancy Analysis (RDA) of

macroinvertebrate families and species separately, each constrained by subwatershed cluster. Both analyses resulted in separate groupings of two of the agricultural restoration clusters and two of the conservation clusters, with the New Jersey Highlands (hybrid conservation and agricultural restoration) and Upstream Suburban Philadelphia (urban restoration) clusters demonstrating unique macroinvertebrate assemblages at both taxonomic levels. The Schuylkill Highlands conservation cluster appeared in the conservation cluster grouping at the family level and the agricultural restoration grouping at species. Species-level information will be used to identify taxa that are important to classifying the characteristic biota of the subwatershed clusters. Data on the different bioindicators groups will be used to compare the responses of the indicators to cluster conditions and to relate integrative site biota to the biota in sites close to projects funded through this initiative. These surveys will provide baseline data for changes in aquatic communities in the long-term.

Delaware Valley Early Warning System: Automated 3D Tidal Transport Model (95)

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Talk - Session 22: Monitoring & Modeling

The Delaware Valley Early Warning System (EWS) has added real-time, automated 3D modeling capability to evaluate spill trajectories in the tidal Delaware River. The Delaware Valley EWS is a network of public and industrial water supply stakeholders along the Delaware River and its tributaries. The EWS system disseminates real-time warnings to entities with potentially affected intakes when a spill is reported.

The EWS uses modeled 3D current fields developed by the Delaware Bay Observation and Forecast System (DBOFS version 1.1) to drive the EWS tidal transport model. When a spill is reported to the EWS, the EWS tidal transport model, a fully automated LTRANS version 2 application, releases particles in a "particle cloud" surrounding the location of a reported spill. Particles are transported in the EWS tidal transport model according to estuary currents obtained from DBOFS. The tidal transport model can project spill trajectories as far upriver as Trenton, and as far downriver as Delaware City.

The EWS tidal transport model is configured to run in a fully automated way in real-time, and to provide the most accurate possible projections of spill transport. The EWS queries DBOFS forecasts and nowcasts as they become available from NOAA, and processes the nowcasts and forecasts for use in the tidal transport model as spills are reported. The automated system combines reported spill locations and timing with the most up to date available DBOFS forecasts and nowcasts, and presents resulting spill trajectories on the EWS web interface for EWS users. Trajectories are then updated every six hours, as additional DBOFS current data us made available.

Cross-Sector Collaboration In Action: The Urban Waters Federal Partnership In The Greater Philadelphia Area / Delaware River Watershed (76)

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Talk - Session 8: Restoration I

The Urban Waters Federal Partnership (UWFP), launched in 2011, aims to foster cross-sector networks and support localized revitalization efforts to reconnect urban communities with their waterways. The partnership includes 14 Federal agencies and 18 locations across the country – including the Delaware River Watershed UWFP, which encompasses four major urban areas across three states: Philadelphia and Chester PA, Camden NJ, and Wilmington DE. The goals of the initiative are to break down silos within and between agencies and promote regional collaboration in order to transform overlooked and neglected assets into drivers of urban and ecological revival.

In June 2013, the Greater Philadelphia Area/Delaware River Watershed Partnership conducted listening sessions in each partner city to introduce our initiative and to gather the needs, activities, and interests of stakeholders. Based on that input, we identified five areas of common concern: Water Quality and Quantity; River Protection and Restoration; Climate Resilience; Brownfield Revitalization; and Trails, Parks, and Open Space. In addition, several key themes emerged that cut across all areas: education and outreach; community and economic development; environmental justice; youth engagement; and enhancing green infrastructure.

As a result of that exploratory outreach, the Delaware River Watershed UWFP team has now formed "communities of practice" for each area of concern. (A Community of Practice is essentially a group of individuals who share interest in a specific topic and expand their knowledge, expertise, and effectiveness in this area through ongoing collaboration.) The purpose of this talk is to introduce the UWFP, describe the local goals and activities, and provide an opportunity to network with this interdisciplinary urban-based watershed partnership.

Drinking Water, Pollution And Public Health In 19th Century Philadelphia (7)

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Poster - Session 3: Water Quality

The industrial revolution and indoor plumbing brought prosperity to 19th-century Philadelphia, known as the Workshop of the World, but also polluted its drinking water sources with wastes from households and businesses. Among many water-borne diseases, typhoid fever was the biggest killer, causing more than 27,000 deaths and at least eight times as many illnesses in the half-century after 1860, when

accurate record-keeping began. In 1901, decades after scientist identified the microbes in water that causes typhoid, the Philadelphia Water Department finally undertook the largest public works project in the city up to that time, creating five filtration plants to make the polluted waters from the Schuylkill and Delaware rivers safe to drink. Along with these plants, miles of new pipelines had to be built to carry this water to homes and businesses throughout the city. The largest was a 10.5 foot diameter tunnel running for two and a half miles, 100 feet under the Delaware River waterfront. When completed in 1909, the system included the largest filtration plant in the world, the Torresdale (now Baxter) plant, and the largest pumping station in the world, at Lardner's Point (which is still in operation). With filtration and subsequent chlorination of the water supply, death rates from water-borne diseases fell to almost zero, while the rivers continued to be polluted by the city's sewage and industrial wastes. Three sewage treatment plants and their associated intercepting sewers, first proposed in 1914, were not completed until the mid-1950s.

From Creek To Sewer: History Of Topographical Change In Philadelphia (6)

Adam Levine, Philadelphia Water Department, 314 Gayley Street Media, PA 19063, aelrvpa@hotmail.com

Talk - Session 23: Soaking in Storm Water, Sea Level Rise, and Climate Change Outreach

Walking along Philadelphia's sidewalks, most people are unaware that beneath their feet is a hidden world of streams that once meandered through the city. Adam Levine's illustrated lecture, based on more than 15 years of research undertaken for the Philadelphia Water Department, uncovers a facet of urban history few people ever think about – the drastic changes made in the city's landscape since its founding in 1682. The lecture focuses on the systematic obliteration of hundreds of miles of surface streams. These natural waterways were impediments to the grid of city streets and became polluted when surrounded by homes and industry, but engineers also realized their potential as ready-made drainage channels for the city's expanding neighborhoods. Buried deep underground in pipes as large as 20 feet in diameter, these former streams became main arteries in the city's 2,900 mile sewer system. Some of them, including Wingohocking Creek and Mill Creek, had watersheds that covered thousands of acres. Once the pipes were in place, valleys were filled as high as 40 feet over the former stream beds; streets, water and gas mains were laid; and real estate developers quickly followed with new construction. These massive alterations to the city's landscape, undertaken over the course of two centuries, have environmental repercussions that are still being felt today. Combined sewer overflows are directly attributable to this re-engineering of the landscape, and Philadelphia will be spending billions of dollars over the next 25 years to reduce this source of waterway pollution.

Working For Our Waterfronts: A Public Engagement Process For Preserving Delaware's Traditional Maritime Communities (44)

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Talk - Session 23: Soaking in Storm Water, Sea Level Rise, and Climate Change Outreach

Numerous commercial fishing and water-dependent business activities occur along Delaware's tidal coastline of approximately 381 miles. From Claymont to Fenwick Island, these "working waterfronts" contribute to the State's economic vitality and quality of life and are important to maintaining Delaware's coastal heritage. Unfortunately, many of these working waterfronts have experienced significant decline due to the loss of commercial fishing and processing industries over the last several decades. In addition, the collapse of some recreational fisheries and other water-dependent businesses has caused economic malaise in areas that once supported a robust economy. Also, as populations shift to coastal areas, new growth and development pressures (tourism, residential housing, condos, etc.) are being exerted on communities with working waterfronts. In addition, tourism and recreation are increasingly taking over for other traditional uses of the ocean, such as fisheries, boat building, and marine transportation. Whether a community views these possible changes as opportunities or threats is critical, since each type of economic development could represent a conflict with some types of water-related businesses. These issues can be especially acute for rural coastal economies.

To address the challenges facing Delaware's working waterfronts, it is essential for stakeholders to begin functioning as an interested and engaged community. The stakeholders need to find new ways of thinking and acting together. Strategic thinking and the capacity to translate ideas into action will be critical to achieving success.

Starting in June 2013, the University of Delaware's Sustainable Coastal Communities Initiative began to engage Delaware's traditional maritime communities in a strategic engagement process. This stakeholder activity balanced both open participation and leadership direction. It also helped the participants to identify and keep focused on the transformational questions that moved their community towards implementation and execution of sustainability approaches and practices.

Sea Level Rise In Delaware Bay: Long-Term Dynamics And Potential Enhancement Of Horseshoe Crab Spawning Habitat (64)

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Talk - Session 1: Climate Change & Hurricane Sandy

Previous geological studies have shown that sea level rise (SLR) has been occurring in Delaware Bay for at least 6,000 years. In the late 1800's and early 1900's, the pattern of beach loss in locations such as Cape May, NJ was often attributed to catastrophic storms rather than to ongoing SLR. Comparison of aerial photographs from the 1930's with contemporary satellite imagery clearly indicates a landward movement of the shoreline along the coastline of Delaware Bay. Habitat for horseshoe crab spawning has been adversely impacted over this period of time by the loss or degradation of spawning beaches, which to some extent has been offset by the deposition of this sand in "marginal habitats" such as tidal creeks and sandy deltas. The well-documented natural landward movement of a beach-marsh system in a time of SLR has been compromised in some locations by the hardening of the coastline through construction of bulkheads, groins and jetties. This directly reduces the productivity of these beaches for horseshoe crabs, and, consequently, their use by shorebirds. The response to SLR and storms in the recent past has emphasized the protection of coastal property; however, there has been some effort to restore beach ecosystems through nourishment. Given that SLR is an ongoing process, beach nourishment projects to protect a developed shoreline will require a long-term commitment at considerable cost. From the perspective of horseshoe crab conservation and habitat preservation, we suggest that greater emphasis be given to the strategy of property buy-outs and abandonment, thus enabling a more natural beach response to SLR.

Coastal Marsh Restoration/Living Shoreline - Pilot Projects In The Mid-Atlantic Region (4)

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Talk - Session 10: Restoration II

Matrix and Restore the Earth Foundation (REF) have worked together with multiple partners to implement two coastal marsh/living shoreline restoration pilot projects in the mid-Atlantic region. Both projects involve utilizing an innovative restorative technology, Bay Saver Bags, to stabilize/restore severely eroding sections of shoreline with native coastal marsh vegetation. The methodology uses a biodegradable, self-contained package of custom mixed soil with composted humus amendments to support, feed, and stabilize native plants installed in the bags. This technology has been successfully employed along a number of shorelines in the Gulf region. The purpose of these two pilot projects is to demonstrate that this technology can be successfully adapted to local conditions within the mid-Atlantic

region. The Society of Environmental Toxicology and Chemistry (SETAC) selected the Chesapeake Bay project as a carbon footprint offset for their 2013 North America Annual Meeting. Matrix and REF collaborated with SETAC, the Chesapeake Bay Environmental Centre, Goucher College, Towson University and Wye River Upper School to restore over 150 linear feet of shoreline. In New Jersey, Matrix and REF collaborated with the Ocean County Department of Parks and Recreation and HDR, Inc. along with local organizations to restore a 0.1-acre area of eroded saltmarsh at Cattus Island County Park. Both projects have been strategically located within close proximity to education centers in order to incorporate instructional components. As part of the projects, students actively assisted in the plantings to establish the living shorelines and are participating with the monitoring of the sites to evaluate success.

Bare Root Trees As A Strategy For Increasing Successful Community Tree Plantings (14)

Mindy Maslin, Pennsylvania Horticultural Society, 100 N. 20th St. Philadelphia, PA 19103, mmaslin@pennhort.org; Barley Van Clief, The Pennsylvania horticultural Society

Talk - Session 4: Innovative Outreach

The Pennsylvania Horticultural Society's Tree Tenders program, part of the Plant 1 Million tree planting initiative, first became involved with Bare Root trees about 15 years ago. By the end of the first planting it was true love. Learn the inside story of why this love has lasted... why bare root trees are the easiest, cheapest and most successful stock for volunteer plantings and why bare root trees planted by trained volunteers live long and prosper.

This is the story of a practical love…. a love affair that works for community planters and for the trees. For community plantings, trees need to be affordable, transportable, lift-able and sustainable. The volunteers need to be educated, inspired and capable. Learn about the 21 year-old Tree Tenders program, designed to train citizens in tree care and to empower them to take action in their own neighborhoods. The 4,000 Tree Tenders in SE PA representing 200 neighborhood groups plant nearly 1500 trees each year.

Participants will learn about the Tree Tenders model of citizen training, including: the community organizing component critical to planting; tree care workdays; and follow-up monitoring and care programs. They will learn why bare root trees are a community planter’s best friend, why bare root trees are easier than B&B trees to plant properly, why they establish faster and where in the country we have found them. As with any relationship, there are always “issues” -- the challenges of bare root trees will also be discussed.

This multi-media presentation will include videos on bare root plantings, organizing a community tree planting and tree care.

Re-Framing The Architect's Responsibility For Climate-Sensitive Design: Renewables, Walkables, Geenables, Reflectables (62)

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Talk - Session 23: Soaking in Storm Water, Sea Level Rise, and Climate Change Outreach

This presentation reports the emerging evidence that re-framing of climate preparedness and resiliency in the built environment to matters of public health, safety and welfare by the architect, re-positions the issues from often non-science-based and aspirational, into science-based, legal requirements of the architect's license. Architectural research--and urban design or land use planning often performed by architects--is driving the profession toward this reframing since the latest data (Ed Mazira) finds efficiency and renewables in the US account for only 20-30% of carbon reduction pathways required to mitigate climate disruption while land use planning accounts for 70-80%. Additionally, the medical profession identifies chronic "constructed disease" (obesity, cardiovascular) as partially a responsibility of the architect's built environment. The cure is design for healthy, walkable, active living—another co-benefit of climate sensitive urbanism. Federal climate policy is another driver: the June, National Climate Assessment reports that climate policy is disproportionately focused on the efficiency/renewable pathway to carbon reduction and not sufficiently on the transit-driven, walkable, climate-sensitive land use pathway. Another driver is the growing leadership of cities with their localized 'climate action plans' including green roofs, walls, streets and walkable, non-motorized design (which can re-purposes streetscapes into de-paved urban forest paths, restoring natural hydrological and energy balances through shading, evapotranspirational cooling, and restoration of natural stormwater management--increasing ecosystem services, urban resiliency, efficiency, and social and environmental co-benefits. The architect, in consultation with medical and environmental professionals, must assume legal responsibility for constructed-disease and constructed-microclimate. Architecture is being driven toward science-based data, systems-thinking, design, and knowledge deployment consistent with professional collaboration in public health, urban ecology, urban forestry, hydrology, climatology and other fields central to PDE's mission. Opportunity for collaboration between PDE and institutional structures of architecture (AIA chapters, NCARB testing, state licensing boards) exists to further this pro-environment institutional paradigm shift.

Exploring Localized Mixing Dynamics In The Upper Delaware Estuary (25)

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Talk - Session 13: Physical & Chemical Processes

A recently validated 3-dimensional implementation of the Environmental Fluid Dynamics Code (EFDC) for the tidal-fresh portions of the Delaware Estuary was exercised against the results of a dye release from a sewer outfall during a storm in 1997. The influence on dye distribution in the estuary resulting from variations in wind and local storm water discharges in an urban area is investigated. The modeled domain stretches 116 km from the head of tide and includes hydrologic input from 33 streams and a number of municipal and industrial discharges. Bottom roughness was parameterized from sedimentological and geophysical surveys. Model validation to-date relies upon field observations and tidal harmonics for sea level and currents derived from the NOAA-NOS 1984–1985 circulation survey and a current survey conducted by the Philadelphia Water Department (PWD). Model representation of dye distribution compared favorably for observations of concentrations in the dye plume from 10 cross-sections spanning the extent of the plume over seven tidal cycles. The dye distribution was characterized by an initial period of high local storm water and stream inflows with low wind conditions, lasting for several tidal cycles, followed by a period of reduced fresh water input and increasing wind stress. The dye experiment provided a unique opportunity to observe the performance of the model through the transition between these two very different meteorological periods, and to explore the physical conditions driving the hydrodynamics through both observations and numerical experiments. The influences of local meteorological forcing and channel morphology on lateral mixing, dispersion and longitudinal dynamics are characterized.

A Numerical Model To Evaluate Potential Impacts Of Sea-Level Rise On Groundwater Resources In The Delaware Coastal Plain (92)

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Poster - Session 1: Climate Change & Hurricane Sandy

A 3-D, transient, variable-density groundwater flow model (SEAWAT) is used to simulate groundwater flow in Delaware's surficial Columbia Aquifer adjacent to the Delaware Estuary. The model predicts movement of the fresh-water/salt-water interface and water table changes due to sea-level rise through the year 2100. Three scenarios are modeled 1.5 (S1), 1.0 (S2), and 0.5 (S3) meters of sea level rise by the year 2100. A conceptual model of a single watershed is developed based on the characteristics of ten watersheds including river lengths, watershed and tidal wetland dimensions, salinity of tidal rivers, and hydrogeologic properties of the Columbia Aquifer. By year 2100, in S1 and S2, the toe of the salt water front migrates 4.6 km in the aquifer under the river. At 3.95 km from the river, the toe migrates 1.5, 1.5

and 0.5 km for S1, S2, and S3, respectively. Model results for head change are applied to 18 watersheds using a mapping of coordinates from the model to each watershed. Areas potentially impacted by sea level rise are identified by a critical depth to water of 0m and 0.5m. The latter value was chosen as a conservative representation of the effective rooting depths of local crops. Over 60% of the impacted area in all scenarios is cropland. Total land area impacted ranges from 60 hectares for S3 with critical depth of 0m to 18,500 for S1 with critical depth of 0.5m. For S3, there is minimal impact for the 0m condition (60 ha), but significant impact for the 0.5m condition (4,400 ha). There is 5 to 9 times more area impacted by waterlogging from a rising water table than from surface water inundation for all scenarios except S3 with the 50cm condition where it is 38 times more area.

Thermal Imaging Of Hydrologic Processes In Streams And Wetlands In The Delaware Estuary Watershed, Delaware And Pennsylvania (29)

Tom McKenna, University of Delaware Delaware Geological Survey, Newark, Delaware 0, mckennat@udel.edu; Jack A. Puleo, University of Delaware, Center for Applied Coastal Research; Aline Pieterse, University of Delaware, Dept. of Geological Sciences

Talk - Session 13: Physical & Chemical Processes

Ground-based and low-altitude (< 1,000 m) thermal imaging was used to characterize the hydrology in a variety of environments in the Delaware Estuary Watershed. Hydrologic characterization is important for understanding watershed hydrology, designing and monitoring wetland restoration, managing and remediating contaminated sites, and determining where to take representative water samples. We used handheld and fixed-position thermal imagers in bays, tidal creeks, streams, and tidal and non-tidal wetlands to determine groundwater discharge locations, investigate marsh inundation, measure stream velocity, trace preferential flow in a non-tidal wetland, monitor the interaction of Delaware Bay with a tidal channel, and identify sources of water to wetlands. Groundwater discharge from preferential flow paths and preferential flow in wetlands are the easiest to detect but the method can also be used to detect more subtle processes like diffuse groundwater discharge into an estuary. We used a handheld thermal imager (FLIR P45HSV) from aerial and ground-based platforms and a lab-style imager (FLIR SC660) on a ground-based platform for time-series surveys of tidal wetlands. The ability to use remote sensing to quantify processes in intertidal environments (e.g. velocity of flow, exposure/inundation, changes in moisture content, presence/absence of algal mats) is greatly enhanced over satellite and aerial acquisitions by the ability to collect imagery at time-scales (minutes/hours) below those of the dominant stresses on the system (semi-diurnal tides, day/night).

Bringing The Bulldozers To The Benthic Zones Near Brownfield Sites To Improve Regional Water Quality: Integrating Riparian Restoration Projects Into Remediation Activities At Camden's Brownfield Sites (94)

Franklin B. McLaughlin, NJ Dept of Enviromental Protection Office of Brownfield Reuse, Trenton, NJ 8625, frank.mclaughlin@dep.nj.gov; Jay Springer, NJ Dept of Environmental Protection; Danielle Kreeger, Partnership for Delaware Estuary; Josh Moody, Partnership for Delaware Estuary

Talk - Session 8: Restoration I

The decline of water-dependent industry in Camden New Jersey left large inventories of brownfield sites along the city's broad river frontages which present tremendous opportunities for waterfront restoration projects, including establishment of fresh water mussel habitats that can improve regional water quality. These waterfront brownfield sites frequently require remedial actions of soils and other media, and these remedial activities can be extended to shoreline treatments and improvements in the intertidal and subtidal zones in a timely and cost-effective manner. With proper planning and permitting, the shoreline and intertidal/subtidal environments can be enhanced as part of the overall land remediation activities to maximize environmental revitalization of riverfront sites. In Camden, two brownfield remediation projects, Harrison Ave Landfill and Phoenix Park, are planned that will incorporate living shoreline improvements and freshwater mussel habitat establishment and/or enhancement as part of the overall site restoration. In addition to the remediation of contamination and incorporation of on-site green stormwater management elements, the living shoreline and freshwater mussel components of these projects will also bring substantial in-situ water quality benefits including anticipated filtration of about 5 million gallons of river water per day from these two sites after the freshwater mussel habitat is fully established.

Camden's Waterfront Brownfields And Landfills: Opportunities For Creation Of Environmental Assets That Benefit The Entire Delaware River Watershed (61)

Franklin B. McLaughlin, NJ Department of Environmental Protecton Office of Brownfield Reuse, Trenton, New Jersey 8625, frank.mclaughlin@dep.nj.gov

Talk - Session 24: Hot Topics

The decline of water-dependent industry in Camden New Jersey left large inventories of brownfield sites that present tremendous opportunities for broad multi-faceted waterfront restoration projects that can transform the local riparian environment, catalyze community revitalization, improve water quality on a regional scale, and act as a model for urban environmental restoration efforts in the Delaware River watershed. Due to their large size and strategic waterfront locations, Camden's brownfields and landfills are being targeted for environmental restoration activities including stormwater management, green

infrastructure, living shorelines, habitat creation, open space, recreational opportunities and as catalysts for community revitalization including connection of the neighborhoods to their waterfront assets. Over the last several years, the New Jersey Department of Environmental Protection has worked collaboratively with the City of Camden, local non-profits like Cooper's Ferry Partnership, Camden County Municipal Utilities Authority, the Partnership for Delaware Estuary and other stakeholders in planning for and creating these waterfront restoration projects from brownfield sites and landfills. Two brownfield reclamation projects, Harrison Avenue Landfill and Phoenix Park, have already resulted in the on-site management of about 30 million gallons of stormwater annually, and have planned (or will be soon be implementing) over ten acres of newly-created wetlands, thousands of feet of resilient living shorelines and riparian corridor improvements, enhanced fresh-water mussel habitats with anticipated in-situ treatment of about 5 million gallons of water per day, and re-connected two neighborhoods that were isolated from the Delaware River waterfront for many decades.

Sediment Dynamics In The Delaware Estuary (27)

Jacqueline McSweeney, Rutgers University, 71 Dudley Rd #111F New Brunswick, NJ 8873, jmcsween@marine.rutgers.edu; Robert Chant, Rutgers University

Talk - Session 13: Physical & Chemical Processes

This project explores the importance of cross-channel sediment dynamics in the mid section of the Delaware estuary, near the Cohansey River. Data was collected over the course of two years and included both tidal transects and a 6-month mooring array. Using acoustic backscatter calibrations from moored Acoustic Doppler Current Profilers (ADCPs) to estimate sediment, we construct a sediment flux timeseries at six different locations across the channel. These fluxes are separated into along channel and across-channel components to tease apart the lateral and axial processes. Both estimations of total transport are then decomposed further to analyze the relative contributions of tidal pumping and residual terms.

This analysis highlights the important dynamics the drive sediment transport, deposition, and distribution. It offers insight into how lateral processes on a tidal timescale may contribute significantly to the ultimate fate of sediment in the estuarine turbidity maximum (ETM).

Brandywine-Piedmont Watershed Plan (35)

Shyanne Miller, University of Delaware, 1628 W 2nd Street Wilmington, Delaware 19805, shyanne@udel.edu; Dr. Gerald Kauffman, Water Resources Agency- University of Delaware

Poster - Session 8: Restoration

In 2013 President Barack Obama designated over 1000 acres in New Castle and Kent Counties, Delaware to Delaware's first national park: First State National Monument. The First State National Monument at Woodlawn contains a section of the Brandywine Creek which flows through southeast Pennsylvania and into northeastern Delaware. The Brandywine provides drinking water for residents of Wilmington, DE and the surrounding area, and has multiple tributaries within the Brandywine piedmont watershed which drain to it. The University of Delaware's Water Resource Agency is collaborating with the Nature Conservancy of Delaware and the National Parks Service to create a watershed plan for the Brandywine Piedmont tributaries. The field studies performed over the summer of 2014 provides an assessment of several characteristics of these piedmont tributaries, including water quality, condition of biological habitat, stream channel geometry, and stream channel geomorphology. Stream cross-sections and EPA Rapid Stream Bioassessment measurements were taken at 200 foot intervals along each tributary surveyed. The National Parks Service assisted with water quality samples testing for pH, dissolved oxygen, salinity, conductivity, and other chemicals within the headwaters sampled streams. The Rosgen Stream Geomorphology Classification system was used to characterize the geomorphology and predominant substrate of the streams. Results showed that the lowest EPA Rapid Stream Bioassessment score was approximately 60%, indicating that no surveyed section of the tributaries was below marginal quality. The results of the field work will be used to recommend any necessary restoration as well as areas needing conservation.

Developing Seeding Techniques For Tidal Marsh And Shoreline Stabilization (74)

Christopher Miller, USDA-Natural Resources Conservation Service, 1536 North Route 9 Cape May Court House, NJ 8210, chris.miller@nj.usda.gov; Scott Snell, USDA-NRCS Cape May Plant Materials Center; Melissa Alvarez, NOAA, (formerly with ACOE)

Talk - Session 16: Wetlands

The USDA-NRCS Cape May Plant Materials Center in cooperation with the Army Corps of Engineers have developed a cost effective seeding strategy of establishing smooth cordgrass (Spartina alterniflora) as a component of the Jamaica Bay Marsh Islands Restoration Project in New York City. These results may be transferrable to other shoreline sites in the Mid-Atlantic. An initial seeding trial was accomplished by seeding into dredged sand using a Planter Jr. single row push planter. Four replicated plots (25 ft. by 40 ft.) were seeded in both low and high energy sites for a total of ¼ acre. To ensure continuous flow of seed from the hopper to the opened furrow, the Spartina seed was mixed with non-clump forming (cheap) cat litter. The treatments were (1.) control with no seed applied and (2.) replicated plots seeded

at 1.5"- 2"depths in rows parallel to the shoreline. Rows were on 1.5 foot centers. Stem density counts were taken the first two growing season. The low energy plots were at the highest elevation of daily inundation with a 70 foot wide vegetated buffer of vegetatively planted smooth cordgrass in front of the seeding. Conversely, the high energy site was lower in elevation (about mid-tide) and had only a 20 foot wide planted buffer of smooth cordgrass below it. The results of this small trial led to a 32 acre large scale seeding with refined seeding equipment and preparation techniques. This project was successful even though the site was impacted by Superstorm Sandy. The conclusion is that successful seeding of smooth cordgrass is possible if the site is somewhat protected from wave energy, particularly in environments with a large tidal fluctuations. This study was done on dredged sand which was uniform in particle size and consistency. Results on other types of soil substrate may yield different results.

Relation Of Algal Assemblages To The Subwatershed Clusters Of The Delaware River Watershed Initiative (51)

Alison Minerovic, Patrick Center, Academy of Natural Sciences of Drexel University, 1900 Benjamin Franklin Parkway Philadephia, Pennsylvania 0, fwa23@drexel.edu; Frank Acker, Patrick Center, Academy of Natural Sciences of Drexel University

Talk - Session 18: Monitoring & Assessment for the Delaware River Watershed

Algae were collected from creeks and streams of the physiographic-land use defined subwatershed clusters of the Delaware River Watershed Initiative. Initial analyses of the 2013 diatom data using the subwatershed clusters as the focal points (redundancy analysis [RDA]) indicate overlap of several subwatersheds with three notable separations. The diatom species associated with the subwatershed clusters, Upstream Suburban Philadelphia and Brandywine-Christina were predominantly taxa that tolerate higher nutrient conditions. The subwatersheds Middle Schyukill and New Jersey Highlands had diatom assemblages that had higher percentages of diatoms that are motile and found with increasing siltation along with species that tolerate high nutrients. Several other diatom assemblages, especially many in the Poconos and Kittatinny and Upper Lehigh subwatersheds, were highly uneven and consisted of species considered ‘pioneers’ or early colonizers, indicative of the large precipitation events that were common in 2013 rather than underlying physiographic-land use conditions.

Further analyses use physio-chemical parameters as constraints on the algal assemblage characterizations to identify algal bioindicators and to provide baseline data for measuring changes in aquatic communities in the long-term.

A Use Attainability Analysis Based Alternative Dissolved Oxygen Criteria For Wetland Dominated Tidal Portion Of Murderkill River, Delaware (60)

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Talk - Session 16: Wetlands

Murderkill River watershed in Delaware has a drainage area of about 107 square miles and is located in coastal plain region of the State draining to Delaware Bay at Bowers Beach. Long term water quality monitoring of the river conducted by Delaware DNREC has shown that during summer time, state's applicable Dissolved Oxygen (DO) criteria for marine waters (5.0 mg/l daily-average and 4.0 mg/l daily-minimum) is not attained in tidal portion of the river, which is surrounded by tidal marshes.

In order to investigate the causes of these low DO levels, DNREC and other cooperating agencies initiated a multi-year extensive water quality monitoring, modeling, and research studies. The findings of these studies showed that tidal marshes export significant amount of nutrients, organic carbon, and low dissolved oxygen to the river, hence causing low DO concentrations during summer time. In fact, a modeling scenario analysis showed that tidal marshes are responsible for reducing ambient DO concentration in tidal portion of the river by as much as 2.0 mg/l during summer months.

Based on the above findings, DNREC has adopted a new Designated Use for tidal portion of the Murderkill River and has adopted a UAA based alternative DO criteria for the period of May 16 thru Sept. 30th. In the following presentation, a brief review of results of monitoring, research, and modeling studies of the Murderkill River will be presented and justifications for adopting an alternative DO criteria for wetland dominated tidal River will be provided.

Protecting The Environment And Public Health In Camden: A Green & Grey Infrastructure Approach (37)

Meishka Mitchell, Cooper's Ferry Partnership, 2 Riverside Drive Camden, NJ 8103, meishka@coopersferry.com; Andrew Kricun, Camden County Municipal Utilities Authority; Jessica Franzini, New Jersey Tree Foundation; Jeremiah Bergstrom, Rutgers Cooperative Extension Water Resources Program; Maurie Smith, Cooper's Ferry Partnership

Talk - Session 24: Hot Topics

The Camden SMART (Stormwater Management And Resource Training) Initiative is a community-driven movement to protect human health, improve conditions for economic development, improve water quality, and enhance the quality o life for Camden City, its residents, and the Delaware River watershed through the broad use of green and grey infrastructure techniques for stormwater management. Utilizing the "collective impact" approach, Camden SMART is a public/private collaboration led by CFP,

the City of Camden, the Camden County Municipal Utilities Authority (CCMUA), New Jersey Department of Environmental Protection (NJDEP), New Jersey Tree Foundation (NJTF), and the Rutgers Cooperative Extension Water Resources Program (RCE). Together, this versatile group of leaders works to implement a comprehensive, community-based approach to stormwater management that educates residents and serves as a model for combined sewer communities across the state. Over the past 3 years, the City of Camden and the SMART Team have made great progress on the Camden SMART Initiative with concurrent deliverable activities in strategy, policy, and implementation, completing the Camden SMART Opportunities Analysis, stormwater management policy research, and community workshops, education, and marketing.

Learn how this resident-driven program has expanded from one garden in 2011 to the 2014 SMART Infrastructure Program, a multi-million project that includes 17 green infrastructure projects, creations of a waterfront park, and separation of the storm and sanitary infrastructure and the re-establishment of a channel to the backchannel of the Delaware River to mitigate flooding in one of Camden's most impacted neighborhoods.

THEMES: Innovative Outreach, Green Infrastructure, Restoration & Conservation, Environmental Justice

Geospatial Variation Of Ribbed Mussel (*Geukensia demissa*) Ecosystem Services Across The Salt Marsh Landscape (118)

Joshua Moody, Partnership for the Delaware Estuary, 110 S. Poplar St. Wilmington, DE 19801, jmoody@delawareestuary.org; Danielle Kreeger, Partnership for the Delaware Estuary; Elizabeth Watson, Academy of Natural Sciences of Drexel University

Talk - Session 12: Ecological Linkages & Ecosystem Services

Ribbed mussels are ubiquitous in Mid-Atlantic salt marshes where they help maintain clean water, improve habitat for fish and wildlife, and potentially help marshes keep pace with sea level rise. In the Delaware Estuary, ribbed mussels are the functionally dominant bivalve, potentially filtering more water than all other native bivalves combined. Although ribbed mussels are abundant, their densities and demographics are not consistent across the marsh platform which affects the distribution of mussel mediated ecosystem services.

Ribbed mussel densities and seasonal clearance rates, nutrient porewater concentrations and geospatial elevation profiles were quantified in three habitats of the marsh platform: low marsh banks along large rivers, low marsh along small creeks, and high marsh in four representative marshes. Clearance rates by mussels of natural seston were interpreted in the context of particle removal services and scaled to mussel dry tissue weights using allometric relationships. Weight-specific ecosystem services furnished by ribbed mussels (evidenced here by bulk particle filtration) were not found to vary significantly among habitats within typical marshes, but were dependent on particle availability and temperature. Mussel density and nutrient porewater did vary by habitat as did the proportion of marsh area occupied by the

different habitat types. The removal and transformation rates for particulate nutrients also varied spatially across the marsh platform in relation to bulk particle processing rates. Although mussels may provide ecosystem services at a similar capacity across the marsh platform, spatial differences in ribbed mussel density and habitat size leads to a concentration of ecosystem services in lower marsh habitats along tidal creeks and rivers. Hence, this spatial variation in key ecosystem services furnished by ribbed mussels can help focus conservation and restoration actions aimed at shellfish-mediated water quality enhancement.

Bayshore Sustainable Infrastructure Planning Project (BaySIPP): Use Of Vegetation Growth Form In Elevation Capital Mapping (116)

Joshua Moody, Partnership for the Delaware Estuary, 110 S. Poplar St. Wilmington, DE 19104, jmoody@delawareestuary.org; Danielle Kreeger, Partnership for the Delaware Estuary; Moses Katkowski, The Nature Conservancy; Diane Rosencrance, Natural Lands Trust; Meghan , Natural Lands Trust

Talk - Session 16: Wetlands

BAYSIPP is a joint effort between the Partnership for the Delaware Estuary, The Nature Conservancy and National Lands Trust to build resilience in Delaware Bayshore communities. One goal of BAYSIPP is to prepare “elevation capital” maps , which will attempt to assess the immediacy of restorative interventions to avert loss of wetland acreage with increases in sea level. These will then be used to prescribe a timeline for efforts to avert losses, such as use of living shorelines to stem edge erosion and/or thin-layer sediment application to stem interior drowning of the marsh platform. Salt marsh vulnerability is determined by assessment of their elevation relative to the local tidal prism. Since the growth morphology of vascular plants is typically reflective of local hydrological conditions, we attempted to develop a qualitative index for plant condition that can be used to adapt true elevation maps into elevation capital maps that reflect local conditions. Three salt marsh areas were selected for study in the Delaware Bayshore region of New Jersey: the Maurice River, Fortescue Creek, and Money Island. Elevation, topography, and vegetation communities were surveyed using a high resolution RTK GPS (+/- 3cm accuracy; 400 points/ha) Shoreline position change was assessed using spatial analysis tools in ArcGIS 10.2.1. Six vegetation zones were delineated in each study area based on elevation and dominant vegetation: Low Marsh Low, Mid and High; and High Marsh Low, Mid and High. Vegetation metrics included type, canopy cover, vegetation zone density, blade height, and bearing capacity were collected in triplicate in each zone (n=3 plots/zone). Analysis is ongoing; however, early results indicate that a bio-based index can be developed to ascribe vegetative health to each zone, thereby augmenting GIS-based shoreline position change analysis for developing spatial and temporal maps of elevation capital across typical salt marshes of the Delaware Estuary.

Point Density Requirements For Salt Marsh Elevation Determination Using Real-Time Kinetic Surveying And Empirical Bayesian Kreiging GIS Analysis (122)

Joshua Moody, Partnership for the Delaware Estuary, 110 S. Poplar St. Wilmington, Delaware 19801, jmoody@delawareestuary.org; Priscilla Cole, Partnership for the Delaware Estuary

Poster - Session 22: Monitoring & Modeling

Assessing the vulnerability of salt marshes to drowning due to sea level rise and increased inundation is a complex process. It requires high resolution topographic survey data of the marsh platform and the complex sloping features of the edge and inter-marsh creek systems. Since collecting these data can be time consuming, and it is important to understand the collection resolution needed to capture this data while avoiding redundant information. The goal of this effort was to find the sampling density which maximizes data and spatial coverage while minimumimizing resource investment.

The Partnership for the Delaware Estuary sought to determine the RTK-GPS sample density necessary to characterize the topography of a representative, complex tidal salt marsh in the Delaware Bay. The maximum number of sample points (800) able to be collected in one tidal window (6hrs centered around low tide) in a 5000m^2 marsh area was treated as maximum resolution data. We used geostatistical tools in ArcGIS 10.2.1, including Empirical Bayesian Kriging, to interpolate three elevation surfaces using: 1) 800 points, 2) 400 points, and 3) 200 points. Model cross validation comparison between 800 and 400 point models revealed minimal elevation prediction error differences, while the 400 and 200 point model comparison showed greater heterogeneity. Nearest Neighbor Analysis revealed 800and 400 point models retained clustered point densities ($p < 0.5$) necessary to predict complex topographic changes, while the 200 point model exhibited a random distribution ($p > 0.5$), losing resolution on the complex slopes. Results indicated no significant increase in elevation resolution above 400 points.

We conclude that 800points/ha is necessary to capture high resolution marsh elevation data and minimize collection redundancy on a complex marsh surface.. More uniform salt marshes may not require this high of a point density. Future analysis includes the creation of an edge: total area ratio to adjust findings to specific locals. This knowledge will be applied to future projects including monitoring health metrics, shoreline erosion, storm impacts, and climate change effects.

Geospatial analysis of mushroom production and the effect on water quality (127)

Kelsey Moxey, University of Delaware , kmoxey@udel.edu; Luc Claessens, University of Delaware; Gerald Kauffman, University of Delaware; Tom Santangelo, University of Delaware

Poster - Session 3: Water Quality

Excess nutrient inputs from agriculture can cause eutrophication in coastal environments. An interdisciplinary UD research team is investigating the feasibility of fast-response, innovative, and cost-effective approaches for reducing watershed nutrient export. This study focuses on the largest nitrogen hotspot in the Delaware River Basin: the White Clay Creek and Red Clay Creek watersheds, where mushroom farming is one of the main contributors of excess nitrogen. One component of this study is to identify nitrogen hotspots and this poster focuses on mushroom compost, which temporal and spatial applications are unknown. We applied geospatial analysis to locate nitrogen hotspots associated with mushroom compost field applications, and we combine these spatial estimates with water quality measurements to identify optimal locations to be targeted for innovative nitrogen removal practices.

Metrics To Identify The Effect Of Hurricane Sandy Projects On Resilience In The Delaware River Watershed (103)

Rachel Muir, U.S. Geological Survey, 12201 Sunrise Valley Drive Reston, VA 20192, rmuir@usgs.gov; Peter Murdoch, U.S. Geological Survey

Talk - Session 1: Climate Change & Hurricane Sandy

In 2014 a team of federal scientists evaluated Hurricane Sandy Mitigation-funded restoration and science project proposals and identified common metrics for projects throughout the region affected by Hurricane Sandy. The team conducted the review to determine if there is sufficient information shared across projects to quantify the benefits of resilience projects on a regional scale. We examined project proposals designed to enhanced coastal resilience directly, (such as restoration projects), or indirectly, (such as information and research to support natural resource management and restoration). The team also identified potential gaps in metrics that are needed for a region-wide assessment of Hurricane Sandy projects. We present information on metrics that may be relevant and applicable to the Delaware River watershed and which may contribute to increased knowledge regarding ecosystem and community resilience.

Upwelling Of Acidified Water: Not Just An Issue For Shellfish Hatcheries On The West Coast Of The US (78)

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Talk - Session 15: Living Resources

Periodic summer upwelling events are known to occur off the coast of New Jersey. As with upwelling off the US West Coast, these events can transport deep, acidified water to the surface and shoreward. To determine if upwelling events have the potential to impact shellfish hatcheries in New Jersey, a monitoring study was conducted at the Rutgers University Aquaculture Innovation Center (AIC). The AIC is an important research hatchery that currently supports the New Jersey oyster aquaculture industry through the production of disease resistant and triploid seed oysters. Starting in June of 2014, temperature, salinity, dissolved oxygen, turbidity and pH were continuously monitored at the AIC's intake pipe located in the Cape May Canal. Periodic duplicate grab samples were also collected at the intake and at locations within the facility. One of each duplicate grab samples was preserved and analyzed for pH and dissolved inorganic carbon (DIC), whilst the other was preserved for analysis of the planktonic community. DIC and pH were used to calculate the aragonite saturation state of the sampled water. During an upwelling event in early July 2014, a decrease in pH was measured at the intake. Likewise, grab samples showed that water of low pH and aragonite saturation was entering the facility. These results show that hatcheries along the NJ coast need to be aware that upwelling may bring reduced shellfish production conditions, and highlights the need for continued monitoring.

City Of Wilmington Green Jobs Program (20)

Martha Narvaez, University of Delaware, DGS Annex Newark, DE 19716, mcorrozi@udel.edu

Talk - Session 21: Partnering with Schools and Youth

Today's youth may understand global environmental threats but their connection to the local environment and understanding their role in it is diminishing over time. Schools may teach broader environmental concepts but the value of personal experience in one's local environment is often overlooked or neglected. The City of Wilmington's Green Jobs program seeks to provide youth with first-hand and local outdoor experiences while also exposing them to environmental issues, careers, and professional skills.

The Green Jobs program is truly a collaborative of environmental nonprofits and government agencies in the state and region. Interns are hosted by about a variety of organizations and individuals throughout the six-week program. Groups such as the City of Wilmington, Delaware Department of Natural Resources and Environmental Control (DNREC), Partnership for the Delaware Estuary, The Nature Conservancy (Delaware Chapter), The Delaware Center for Horticulture, The Challenge Program, and the

Delaware Nature Society have been program hosts since the inception of the program. Sample projects with the host organizations include:

- Maintaining street and park trees (watering, pruning, mulching);
- Carrying out outreach and environmental education;
- Installing rain gardens;
- Removing invasive plant species;
- Gardening in community gardens;
- Surveying mussels in local streams;
- Hiking in local natural areas; and
- Canoeing.

The Green Jobs Program is a subset of the City's broader Youth Employment Program. Youth who are 14-18 years old, have been accepted into the City's Youth Employment Program, and express interest in the environment and working in the outdoors are interviewed for the 10-14 positions in the Green Jobs Program. The program is six weeks and the youth work 25 hours/week, earning minimum wage or approximately $1,200 per summer.

This presentation will discuss the program's inception, program logistics, how it has evolved, opportunities and challenges, and future direction and needs.

Review Of A Comprehensive, Alternate Approach For PCB Congener /Homolog Analysis (10)

James Occhialini, Alpha Analytical. 320 Forbes Boulevard Mansfield, Massachusetts 2048, jocchialini@alphalab.com; Cynthia McQueen, Alpha Analytical

Talk - Session 5: Water Quality II

PCB sampling programs have traditionally had to choose between PCB aroclor analysis, which is inexpensive but potentially limiting, and PCB congener analysis by high resolution mass spectrometry (HRMS), which is highly definitive but economically challenging. This paper focuses on another option for PCB analysis - low resolution mass spectrometry (LRMS), which is much more comprehensive than aroclor analysis without the high cost of HRMS methods such as EPA Method 1668. Comparative chemistry and practical applications of this LRMS analytical approach are discussed.

The limitations of PCB aroclor analysis by GC-ECD have been well characterized. The method's reliance on pattern recognition and peak ratios for the identification of aroclors opens it up to both qualitative and quantitative uncertainty. This uncertainty can most impact determinations of "total PCBs" by the summation of aroclors. In this paper, the authors describe how the summation of PCB homologs by LRMS can be a representative and cost effective way to measure total PCBs. The authors also describe how the LRMS technique can be used for the analysis of the 209 PCB congeners, where PCB homologs, congeners and an estimation of what PCB aroclors are present can be determined, all from the same sample aliquot.

Practical applications for this LRMS analytical approach are discussed including: ecological risk assessment programs; habitat restoration programs; human health risk assessment seafood monitoring

programs; environmental monitoring and assessment programs (EMAP); and permit discharge monitoring programs.

Monitoring Stormwater Trash (83)

Kelly O'Day, Citizen, 301 E Durham Street Philadelphia, Pa 19119, dkod@comcast.net

Talk - Session 22: Monitoring & Modeling

Stormwater trash from urban street litter is a serious water quality problem. In this paper, I will discuss my 2 year citizen scientist investigation into the source(s) of creek trash in the Tookany-Tacony-Frankford Creek. Overland flow, separate and combined sewers all contribute plastic bags and bottles, polystyrene packaging, fast food wrappers to the Creek.

My talk will demonstrate systematic Creek trash documentation methods using a digital camera, hand held GPS, and Google Maps to locate outfalls and document trash accumulation areas. http://mtairy.me

Relationships Between Agricultural Land Use, Lentic Macroinvertebrates And Habitat Quality In The Schuylkill And Brandywine-Christina (88)

Meghan O'Donnell, Academy of Natural Sciences of Drexel University, 1900 Benjamin Franklin Parkway Philadelphia, PA 19103, mjo63@drexel.edu; Stefanie Kroll, Academy of Natural Sciences of Drexel University

Poster - Session 22: Monitoring & Modeling

We are performing a study on lentic river habitats and legacy sediment in agriculturally dense landscapes in the Schuylkill and Brandywine-Christina Watersheds. We chose to investigate these aquatic insect communities to examine the utility of different bioindicator groups in agriculturally dense areas and as part of the baseline sampling for the Delaware River Watershed Initiative. This study is designed to assess whether there are relationships between agricultural land use, macroinvertebrate communities and habitat quality in pools. Macroinvertebrates are often sampled from riffle habitats only for use as biological indicators of stream ecosystem integrity because riffles typically display the greatest species diversity. Macroinvertebrates were already collected from lotic habitats in several of the sites in this study. In the lentic areas we expect to collect different taxa, with a high percentage of predators and air-breathing macroinvertebrates that are often absent in riffles. We have chosen sites from two sizes of agriculturally-dominated watersheds as well as reference sites to examine whether watershed size plays a role in the relationships with habitat quality and community composition. A custom quantitative sampler was built for the project, and sampling techniques include traditional D-net sampling in addition to electrobugging.

Delaware Estuary Living Shoreline Initiative (DELSI): Four New Installations In 2014 (104)

Angela Padeletti, Partnership for the Delaware Estuary, 110 South Poplar St Wilmington, DE 19801, apadeletti@delawareestuary.org; Danielle Kreeger, Partnership for the Delaware Estuary; Joshua Moody, Partnership for the Delaware Estuary; Laura Whalen, Partnership for the Delaware Estuary, Alison Rogerson, Delaware Department of Natural Recources and Control, Andrew Howard, Delaware Department of Natural Recources and Control

Poster - Session 8: Restoration

Since 2007, the Delaware Estuary Living Shoreline Initiative (DELSI) has consisted of a regional, science-based effort to design, implement, and monitor new living shoreline projects designed to boost coastal resilience, sustain critical ecosystem services, and showcase more environmentally-friendly approaches compared with traditional shoreline hardening practices. Building on successful bio-based tactics that we previously developed with the Rutgers Haskin Shellfish Research Laboratory, in 2014 we coordinated the design, installation and monitoring of living shoreline projects at four new salt marsh locations. Each location had unique site conditions and permit constraints, and each project had slightly different goals and monitoring needs. None of the projects would have been possible without full collaboration with diverse partners, such as Delaware Department of Natural Resources and Environmental Control, Rutgers Haskin Laboratory, The Nature Conservancy of New Jersey, and the Center for the Inland Bays in Delaware, among others.

Data on physical, chemical and biological conditions are being contrasted among sites and between controls and treatments using a Before-After-Control-Indicator statistical design, with additional context being furnished by long-term monitoring at fixed reference stations as part of the Mid-Atlantic Coastal Wetland Assessment.

Lessons being learned on these new treatments will greatly strengthen outcomes from earlier our living shorelines at Matt's Landing in the Maurice River NJ. These various lessons are being translated into long-term maintenance costs for bio-based living shoreline designs, for which little data exist. Although the general ecological benefits of living shorelines are diverse, we also continue to find that subtle differences in local site conditions and design criteria can lead to large variation in specific ecological outcomes (e.g. water quality, fish and wildlife habitat, sedimentation rates, erosion control). Therefore, living shorelines vary widely in effectiveness for addressing different goals, and considerable plasticity exists to design projects to best target different coastal management priorities.

Assessment Of Designated Use Support Within Barnegat Bay, NJ Using The Data Being Collected Between 2008 And 2013 (36)

Hui (Helen) Pang, Water Monitoring and Standards, NJDEP 401 East State Street Trenton, NJ 8625, Helen.pang@dep.nj.gov; Patricia Ingelido, NJDEP; Barbara Hirst, NJDEP; Jack Pflaumer, NJDEP; Ariane Giudicelli, NJDEP; Aynan Zaman, NJDEP;

Talk - Session 3: Water Quality I

As part of Governor Christie's Comprehensive Plan to address the ecological health of Barnegat Bay NJ, a targeted water monitoring project was conducted within Barnegat Bay Watershed by New Jersey Department of Environmental Protection and multiple partners over a two-year period. The robust dataset produced as part of this project, together with other available data during the time frame of 1/1/2008 and 12/31/2012, was used by NJDEP to assess the water quality condition of Barnegat Bay and tributaries. This special assessment included two parts: Part 1 compared the observed water quality data to the applicable numeric New Jersey surface water quality standards. The Department's Methods for 2012 Integrated Report was used as the basis for the assessment; Part 2 was a comparison between Barnegat Bay data and the targets used by other estuaries in the Northeast United States relative to the narrative nutrient criteria. Part 1 assessments identified the violations of the applicable numeric criteria (such as DO, TP and Turbidity) at a few assessment units, in the open water bay and/or within the tributaries. Part 2 comparisons provided a general sense of the condition of Barnegat Bay in terms of parameters that are related to the narrative nutrient criteria, either by affecting productivity or responding to productivity. The Department currently lacks such interpretive criteria. The findings from this special assessment will help the Department to determine the correct metrics of the numeric criteria to restore the water quality and protect ecological health specifically in the Barnegat Bay.

Faunal Community Use of Enhanced and Natural Oyster Reefs in Delaware Bay (52)

Jenny Paterno, Rutgers University, Haskin Shellfish Research Laboratory 6959 Miller Ave Port Norris, NJ, New Jersey 8349, jenny1390@gmail.com; David Bushek, Rutgers University; Lisa Calvo, Rutgers University

Talk - Session 15: Living Resources

A subtidal three-acre plot in the upper Delaware Bay has been planted with oysters and shell by Rutgers University's, Project PORTS (Promoting Oyster Restoration Through Schools), since 2007. Project PORTS is a community-based outreach program that engages local school children in building shell bags that serve as cultch for oyster (Crassostrea virginica) larvae settlement. This study compared the diversity of nekton and benthic macroinvertebrates on the enhancement area with nearby unenhanced bottoms containing low or high densities of oysters.

Monthly trawl and benthic habitat tray samples were collected from July through November 2013. Individuals (n=3820) representing 47 species were collected and varied seasonally. Multivariate analyses indicated similar fish and macroinvertebrate communities across sites. Cumulative diversity of fish species was greatest at the enhancement site. Average species abundance and richness were, however, highest on sites of high oyster density. Overall, the enhancement area was intermediate to the other habitats in terms of oyster abundance and faunal utilization, and thus, it appeared to represent a transitional stage between degraded natural oyster habitat and high oyster density natural habitat. Project PORTS, a small-scale community based restoration program, created oyster habitat supporting a diverse faunal community comparable to that of natural reefs and enhanced STEM learning in K-12 students.

One Fish, Two Fish: An Educational Pilot Study (66)

Jenny Paterno, Rutgers University, Haskin Shellfish Research Laboratory 6959 Miller Ave Port Norris, New Jersey 8349, jenny1390@gmail.com; Lisa Calvo, Rutgers University, Haskin Shellfish Research Laboratory; David Bushek, Haskin Shellfish Research Laboratory

Talk - Session 21: Partnering with Schools and Youth

Project PORTS: Promoting Oyster Restoration Through Schools is a unique environmental stewardship program that engages K-12 students in the southern New Jersey region in the restoration of critical oyster habitat in the Delaware Estuary. The program was developed in 2007 as an outreach initiative of the Haskin Shellfish Research Laboratory of Rutgers University to expand educational opportunities. Project PORTS' education program facilitates a series of learning activities that utilize the oyster as a vehicle to improve science literacy, acquaint school children with the Delaware Estuary, and promote stewardship.

The community-based restoration project, the core of Project PORTS, extends lessons from the classroom to a real-world application. Students construct shell bags that are deployed in the Bay to serve as cultch for oyster spat. Student-stewards have constructed 14,000 shell bags supporting the restoration of more than 20 million oysters on a 5-acre oyster reef at the Gandy's Beach Oyster Restoration Enhancement Area (GBOREA).

In 2013 we compared the diversity and abundance of resident fishes, transient fishes and benthic macroinvertebrates on the GBOREA with nearby habitats. Data from this study was used to create a classroom activity entitled "One fish, Two Fish- Assessing Habitat Value of Restored Oyster Reefs". The activity is geared towards grades 6-10 and teaches students to define habitat restoration, graph and interpret data and describe how species abundances might change in different environments. Student assessments including a learning task were administered to a group of 25 students grades 6-8 with the activity. Results of the surveys indicate students made strong gains in knowledge about oyster ecology and improved analytical skills by graphing data. Using the oyster as a vehicle to initiate problem-based learning improved science and math literacy in middle school students.

Web-Based Mapping Applications For Visualizing Monitoring And Modelling In The Delaware Basin (91)

Lin Perez, The Academy of Natural Sciences of Drexel University, 1900 Benjamin Franklin Parkway Philadelphia, Pennsylvania 19103, lbp43@drexel.edu; A. Waldman, The Academy of Natural Sciences of Drexel University; Jerry Mead, The Academy of Natural Sciences of Drexel University; S. Kroll, The Academy of Natural Sciences of Drexel University

Talk - Session 18: Monitoring & Assessment for the Delaware River Watershed

In the context of a rapidly changing environment, the conveyance of palatable scientific data has become increasingly important. We are developing a series of user-friendly web-based mapping applications for visualizing monitoring and modelling outputs associated with the Delaware River Watershed Initiative (DRWI). DRWI Mapper gives users the ability to navigate the 8 geographic cluster regions where the DRWI is focused, and explore the environmental conditions and ecological communities identified through our monitoring efforts. Reach Mapper is another interactive mapping application developed for the DWRI, and focuses on providing a suite of environmental statistics generated by Stream Hiker software, an open source GIS tool that analyzes spatial data and aggregates statistics at the river reach (lateral riparian and direct drainage area) and watershed (network riparian and drainage basin) scales. These mapping applications and future developments are intended to enhance public interest and facilitate place-based environmental education within the Delaware River Basin.

Utilizing Delaware Bay In K-20 Education (53)

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Talk - Session 4: Innovative Outreach

The Delaware Bay can be used as a classroom and as a model system inside classroom walls. From the furthest reaches of the watershed to the bottom of the shipping channel, content and skills can be taught and reinforced using the Delaware Bay.

This session will feature three separate Delaware Sea Grant and University of Delaware education and outreach initiatives geared towards K-12 classroom teachers, undergraduate and graduate students, and the science-interested public. Each program uses data-collection and hands-on experiences, on land and water, to increase audience awareness, knowledge, and skills, which foster comprehensive learning and a greater stewardship ethic.

Session participants will receive program information, including best practices, lessons learned, and evaluation instruments, and resources that will help bring the Delaware Estuary into their classroom or

non-formal education setting. Looking to enhance your K-12, undergrad, graduate, or general public curricula/programs with local data and immediate relevance? Delaware Bay's got you covered.

Using The Principals Of The "Children In Nature Network" To Provide Outreach In Local Communities (65)

Maggie Pletta, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship 820 Silver Lake Boulevard Dover, DE 19904, margaret.pletta@state.de.us

Talk - Session 4: Innovative Outreach

Children and families have been disconnecting with nature, this disconnect has been linked to childhood obesity, a lack of understanding about the natural world, and a deficient sense of community ownership. The Children in Nature Network seeks to reverse this trend and get children and adults back outside. A common roadblock for resource management is effective communication and dissemination of scientific information to landowners/nonprofessionals. The idea presented here is to plan outdoor events and activities that engage the communities that are affected by the results of the scientific research. As children and their families participate in the activities they form connections to the resource and their community, while inadvertently learning about the environmental issues affecting their community. For example, we completed our assessment on the wetland health in the Christina River Watershed in 2014, to reach the communities of a watershed we would plan a local outdoor event. The event would include outdoor activities like canoeing or a nature hike, as well as activities on how the members of the community can improve their watershed, like rain barrel building and planting native species. These connections and firsthand learning experiences help to foster a sense of ownership, which leads to personal action and the eventual improvement of the watershed. This presentation will discuss the goals of the Children in Nature Network as well as examples of how this concept can be applied to outreach for disseminating information on wetland health in Delaware.

Variation In Recent Marsh Accretion Along Delaware And Barnegat Bays (101)

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Poster - Session 16: Wetlands

Tidal wetlands provide valuable ecosystem services including nutrient and carbon burial. The rate of nutrient and carbon burial is related to the rate at which both mineral and organic material accumulates on the marsh surface. As part of a larger regional wetland monitoring program in marshes that range from saline lagoonal to urban tidal freshwater, short-term marsh surface accretion has been measured

along with soil nitrogen, organic carbon concentration, and plant biomass. Spatial variation in surface accretion rates were high, as predicted, with rates that ranged from 4 ± 2 mm/yr in a salt marsh on a barrier island in Barnegat Bay, NJ to 32 ± 6 mm/yr in a salt marsh of the Delaware Estuary. Tidal freshwater wetlands had higher accretion rates than the lagoonal saline marshes. Many factors influenced this variation including geomorphic setting, elevation, and sediment availability. Spatial differences in surface accretion also had implications on recent carbon and nutrient accumulation.

Decadal Re-Evaluation Of Contaminant Exposure And Osprey (*Pandion haliaetus*) Productivity In Delaware Bay From A Food Web Perspective (98)

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Poster - Session 15: Living Resources

The last large-scale ecotoxicological study of avian wildlife in the Delaware Bay Estuary and River was conducted in 2002. Major findings revealed that eggs collected from osprey nests in proximity to the C&D canal and Trenton had greater concentrations of the most toxic PCB congeners, organochlorine pesticides and metabolites, and polybrominated diphenyl ether flame retardants compared to more southern sites and coastal regions. In these northern areas, contaminants were found to be a major stressor on osprey productivity, which was below the threshold to sustain populations (<1.15 fledglings/active nest). Since 2002, there has been limited ecotoxicological work on wildlife in Delaware Bay and River (e.g., die-off of Canada geese related to vanadium, Athos I crude oil spill killing >200 waterfowl, mercury in tidal marsh sparrows, and lead poisoning in raptors and waterfowl). Over a decade has elapsed since the last large-scale wildlife contaminant monitoring study in Delaware Bay and River. We are planning to re-evaluate spatial gradients of halogenated compounds and other contemporary contaminants using the osprey as a sentinel. Preliminary surveys in 2014 identified at least 18 potential study nests from Philadelphia to Delaware City, 39 nests from Delaware City to Cape Henlopen, and many more in Delaware's Inland Bays. In 2015, Osprey nests will be visited at 7-10 day intervals to monitor reproduction, a sample egg will be collected for lipophilic contaminant analysis, and blood samples will be collected from 40-45 day old nestlings to measure a suite of pharmaceutical compounds. A food web approach will be used to track contaminants from water to dominant prey species and finally to ospreys. These data will help assess the status of fish-eating birds and overall environmental health and condition of Delaware Bay and River.

Reaching Out: Relevancy In The Age Of Social Media (77)

Jessica Rittler Sanchez, Delaware River Basin Commission, 25 State Police Drive West Trenton, New Jersey 8628, jessica.sanchez@drbc.state.nj.us; John Yagecic, Delaware River Basin Commission

Talk - Session 4: Innovative Outreach

Garnering the recognition and support of the public is necessary for sustaining the mission of the Delaware River Basin Commission (DRBC) and for shaping the public understanding of who we are and how we serve the residents of the basin. Finding ways to engage the public in the 'dry' technical aspects of water resources management work is an ongoing challenge. Our traditional work products are not geared toward the public, and public friendly outreach efforts may not communicate why the work we perform is unique and critical to the ongoing health of the Basin. We seek communications that enhance citizens' spirit of connectedness not only to the waters of the basin, but to the work involved in protecting those waters. In this presentation we will describe the efforts undertaken to understand what parts of our mission resonate with the public and how to serve results in digestible and meaningful bytes. A survey administered by DRBC in 2013 showed that topics of highest interest included drinking water and protecting aquatic life. The same survey also suggested that recipients favored succinct statements and graphical content. We'll review agency progress and highlight two interactive products that allow people to engage with water quality data without diminishing the complexity of the mission or the results.

Monitoring Marsh Bird Communities To Support Rapid Wetland Condition Assessments (67)

Alison Rogerson, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship 820 Silver Lake Blvd. Dover, DE 19904 Andrew Howard, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship; Maggie Pletta, Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship

Talk - Session 15: Living Resources

Monitoring wetland condition using a three-tiered integrated assessment approach is important for evaluating sources of wetland degradation and guiding restoration efforts. In tidal salt marshes, the Mid-Atlantic Tidal Wetland Rapid Assessment Method (MidTRAM) is a Level 2 rapid procedure used to estimate wetland condition based on buffer quality, hydrological impacts, and habitat features. To evaluate the relationship between rapid surveys and intensive measures of biological data, marsh bird surveys were conducted at 29 MidTRAM assessment sites in the Leipsic River watershed. Three replicate surveys were conducted between May 1 and June 15 in 2013 and 2014 to account for variation in breeding phenology among species and included passive point count surveys coupled with broadcasting calls for secretive species. Among the 27 species of birds documented utilizing salt marshes during bird surveys, the most common and abundant were Marsh Wrens, Seaside Sparrows, Red-winged Blackbirds,

and Clapper Rails. Although species richness was not correlated to overall MidTRAM score, there was a significant positive relationship between species richness and the number of habitat features in the wetland. Stepwise linear regression revealed that the presence of shrubs in the wetland accounted for most of the variation in species richness. Multivariate models were also created to examine individual species relationship between habitat features and species abundance. The results of these bird surveys will be used to further calibrate and support individual metrics in MidTRAM.

Delaware Value-Added Assessment Method For Nontidal Wetlands (70)

Alison Rogerson, DNREC Watershed Stewardship, 820 Silver Lake Blvd., Suite 220 Dover, DE 19904, alison.rogerson@state.de.us; Andrew Howard, DNREC; Maggie Pletta, DNREC

Talk - Session 16: Wetlands

Since 2000 the Delaware Department of Natural Resources and Environmental Control's (DNREC) Wetland Monitoring and Assessment Program has used the condition-based Delaware Rapid Assessment Procedure (DERAP) on nearly 1,000 nontidal wetlands to rate their condition based on wetland stressors (e.g. ditches, development, fill) on a watershed basis. In 2013 DNREC created a companion to DERAP: a value-added assessment method to rate nontidal wetlands for unique or significant wetland features and characteristics. The value-added method provides a standardized and reference-based approach for recognizing wetlands that merit additional protection or avoidance. While the traditional method evaluates wetland condition and departure from an unaltered condition, the value-added method awards points for habitat connectivity, wetland size, educational opportunities, rare wetland types, and occurrence of rare or threatened plant and animal species. Wetlands that have rich habitat features, are considered to be a 'core area' on the Delaware Ecological Network, or are estimated to provide significant water quality or flood storage functions are rewarded. The intention is to use both the traditional and the value-added results collectively for a well-rounded evaluation of wetlands being considered for protection from activities or valued for restoration/mitigation credits. Once the user is trained, the information required for this rapid method can be obtained through one site visit and publically available GIS data. The pilot study included 45 sites in the Leipsic watershed in 2013 and was added to in the Smyrna watershed during summer 2014. DNREC is sharing this tool and offering training with resource managers, permit reviewers and other wetland professionals as an option for a quick and user-friendly evaluation tool.

Wetland Assessment Report: Christina River Watershed (69)

Alison Rogerson, DNREC Watershed Stewardship, 820 Silver Lake Blvd. Suite 220 Dover, DE 19904, alison.rogerson@state.de.us; Andrew M. Howard, DNREC; Jessie Buckner, PDE; LeeAnn Haaf, PDE; Danielle Kreeger, PDE; Maggie Pletta, DNREC;

Poster - Session 16: Wetlands

The Delaware Department of Natural Resources and Environmental Control (DNREC) and the Partnership for the Delaware Estuary (PDE) documented wetland trends and ambient condition of wetland resources in the Christina River Watershed in an August 2014 technical report. The goal of this project was to identify historic and recent changes in wetland acreage, assess the condition of tidal and non-tidal wetlands throughout the watershed, identify prevalent wetland stressors, and make watershed specific management recommendations. The Christina River and its wetlands have been altered significantly since European settlement to make way for agriculture, industry, and development. Wetland assessments were performed in 2011 in 30 tidal wetlands using the Mid-Atlantic Tidal Wetland Rapid Assessment Method Version 3.0 and in 74 non-tidal wetlands, (40 riverine, 32 flats, and 2 depressions) using the Delaware Rapid Assessment Procedure Version 6.0. Compared to five watersheds previously assessed in Delaware, non-tidal wetlands in the Christina River watershed were in considerably worse condition. Less than fifteen percent of the watershed's 5,000 acres of wetlands were found to be functioning near reference condition. The most frequent cause of reduced wetland condition and function was development adjacent to wetlands, dominance of invasive plants, forestry activity, and hydrological disturbances (ditching, channelization and filling). Based on the findings of this study we propose seven wetland management recommendations and needs for further data: incorporating wetlands protection and restoration into development plans, expanding the re-use of dredge material for wetland restoration or creation, encouraging living shoreline techniques for shoreline stabilization and habitat improvements, enhancing landowner incentive programs, protecting Delmarva Bays, controlling the spread of Phragmites, and updating state tidal wetland regulatory maps.

Got Mussels? A PDE Science And Outreach Collaboration (28)

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Poster - Session 4: Innovative Outreach

The most at-risk animal in the U.S., freshwater mussels filter the waterways that provide drinking water for millions of people, and they fortify stream beds against erosion. But how do you map and assess them in a 6,500 square mile watershed with only a handful of scientists? "Show Us Your Mussels," a volunteer training workshop program was created to help PDE scientists map locations of rare and elusive freshwater mussels throughout the Delaware Estuary. Post workshop, trained volunteers take their mussel-finding knowledge to their local streams (covering the many miles that a small group of

scientists could only dream of), and then upload findings, photos and stream data on a dedicated web portal. Data provided by these "citizen scientists" is mapped and analyzed by the PDE science team. Even reports of no mussels are valuable in that those waterways can be evaluated for possible reintroduction sites. This program provides volunteers with a fun and important way to get involved in restoring the health of their local waterways, while providing PDE scientists with valuable field data that would otherwise take years and thousands of dollars to collect.

PBDEs In The Delaware Estuary: Human Health Criteria And Temporal Trends In Fish Tissue Concentrations, 2004-2012 (99)

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Poster - Session 22: Monitoring & Modeling

PBDEs are commercial flame retardants that were phased out over the past 10 years due to health concerns. However, they continue to persist in the environment. The Delaware River Basin Commission gathered data on PBDE levels in Channel Catfish and White Perch of the Delaware Estuary from 2004 to 2012 and in water samples from 2007. Four PBDE congeners (BDE 47, 99, 153, 209) with toxicity profiles on IRIS were the focus of this project. These data were used to draft Ambient Water Quality Criteria for the Estuary. Due to the effects of metabolic debromination on Bioaccumulation Factors used to determine the draft AWQC, fish tissue data were also used to draft Tissue Residue Criteria which do not require BAFs. Total Hazard Indices based on the Tissue Residue Criteria were found to decrease over the sampling years to below 1.0, and lipid normalized fish tissue concentrations were found to have significant negative associations with sampling year for all four congeners in Channel Catfish and for BDE 47,153, and 209 in White Perch.

Geospatial Analysis Of Nitrogen Removal By Riparian Buffers In The Delaware River Basin (38)

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Poster - Session 3: Water Quality

The ability of riparian buffers to remove nitrogen depends on hydrology, upslope cropland area, and other factors that vary by location. Extensive farming and other non-point sources of pollution leach nutrients and cause eutrophication downstream, degrading water quality. The objective of our study is to examine spatial variations in the ability of riparian buffers to remove nitrate from subsurface flow and identify priority locations for restoration. We compare three intensely farmed watersheds in three different physiographic provinces in the Delaware River Basin: Appalachian Mountain (AM), Piedmont

(PD), and Coastal Plain (CP). We used a combination of methodologies including geospatial analysis, empirical methods (water quality sampling) and statistical modeling. Our research utilizes and expands on a geospatial tool developed by Baker et al. (2010) along with other model developments. Our results show that incorporating topographic wetness and subsurface flow connectivity, can more accurately identify buffer effectiveness. With these improvements, the prioritization of riparian buffer restoration can better assist watershed managers in developing strategies to reduce nitrogen export and improve water quality.

Quantifying The Value Of Delaware's Tidal Wetland Ecosystem To Facilitate Protection And Acquisition (34)

Amanda Santoni, Delaware Coastal Programs, 5 E. Reed Street, Suite 201 Dover, DE 19901, amanda.santoni@state.de.us

Talk - Session 12: Ecological Linkages & Ecosystem Services

While it is known that tidal wetlands provide many valuable services, from water quality improvement to storm surge protection and wildlife habitat, and that these services support a wide range of commercial and recreational economic activities, tidal wetlands in Delaware are being lost to a variety of reasons. Coastal erosion alone accounted an average rate of 16 acres lost per year from 1992 to 2007. Given current economic limitations, wetland acquisition & protection programs must contend with many other important issues for attention from local stakeholders and decision makers. In order to ensure that tidal wetlands receive the funding necessary for protection in Delaware, the monetary value of these areas and the services they provide must be quantified. Knowing the number of jobs provided from specific wetland activities, values of catches of wetland dependent species, the cost of providing alternative protection from storm surges, and other tangible benefits from tidal wetlands can build an informed argument for their conservation and protection. Previous studies have been conducted to quantify values of wetlands; however the methods were not targeted enough to quantify the value of specific wetland services. The Delaware Coastal Programs' approach to quantifying these benefits will be achieved through a combination of methods including a literature review of ecosystem studies to identify existing services, developing defensible values of specific services; identifying data gaps and developing research projects to address those gaps; and consulting with regional experts and stakeholders to determine non-market values. Areas that are critical for protection based on unique characteristics supporting valuable ecosystem services will also be identified in order to prioritize acquisition of properties. The final report will illustrate the tidal wetland ecosystem services specific to Delaware, and include the value of individual and cumulative ecosystem services in order to effectively communicate the importance of tidal wetlands.

Marine Spatial Planning For Delaware Waters (81)

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Poster - Session 24: Hot Topics

Over the past two years the Delaware Coastal Programs, in conjunction with similar efforts by the Mid-Atlantic Regional Council on the Ocean (MARCO) has been developing a marine spatial plan for Delaware's Ocean and Bay waters. The plan considers numerous uses and resources of the Delaware Bay and near-shore Atlantic, examples of which include recreational activities, commercial fishing, shipping routes, habitat, and infrastructure. Through stakeholder workshops and individual meetings, location data along conflicts and compatibilities of activities and resources was gathered. From this information a planning document was created along with a public access portal of the spatial information collected throughout the process. The usage of this document and information will allow for sound management decisions to be made on multiple, and sometimes competing, marine uses in a manner that ensures the conservation of important marine resources within Delaware's waters.

Using The Urban Watershed As An Integrated Context For Learning: Classroom To Schoolyard Curriculum Connection (22)

Ellen Schultz, Fairmount Water Works/Philadelphia Water Department, 640 Water Works Drive Philadelphia, Pennsylvania 19130, Ellen.Schultz@phila.gov

Talk - Session 21: Partnering with Schools and Youth

The Fairmount Water Works (FWW) is the Philadelphia Water Department's (PWD) urban watershed environmental center. It is recognized by the Pennsylvania DEP as the Delaware River Basin' Official Watershed Education Center and a Gateway Center of the Schuylkill National and State Heritage Area. PWD is a unique national incubator for using green stormwater management solutions to treat storm water and to restore the purity and amenity of our rivers. FWW has developed a broad range of approaches to help citizens understand the concepts behind a healthy watershed and how to become agents of change. Working with partners, FWW has become the regional hub of watershed education, through exhibitions, installations, school, after-school and family programming, guided tours and virtual education using social media tools.

Integrating real world environmental experiences into the formal K-12 classroom will help students become actively engaged in 21st century solutions to urban water issues; FWW has published a Curriculum Framework which encompass the broadest understanding of systems thinking in an urban context—public infrastructure has evolved over two centuries to solve, react to and manage water. It is

divided into Thematic Units, with lessons and activities, aligned with Common Core State Standards, and online Teacher Resources to help students explore and understand this evolution.

The Water Works was awarded a 36-month William Penn Foundation grant to support the creation of a teacher-developed middle school curriculum. Starting Fall 2014, Teaching Fellows will use the Understanding the Urban Watershed Curriculum Guide as a framework for this project. Changing the ways teachers learn in a professional development is the lynchpin of educational reform. Research shows that developing professional learning communities that incorporate successful collaboration, focus on student learning, offer opportunities for continuous teacher learning and give the teacher authority can improve teaching practice as well as student achievement.

Measuring The Economic Value Of Ecosystem Services And Coastal Resiliency: A Case Study On Ecological Restoration In Cape May (8)

Elizabeth Schuster, The Nature Conservancy, 2350 Route 47 Delmont, New Jersey 0, eschuster@tnc.org

Talk - Session 12: Ecological Linkages & Ecosystem Services

Costly storms like Superstorm Sandy and Hurricane Irene are bringing public attention to the need to increase the resiliency of our coastal communities. Protecting and restoring natural systems is one method for reducing risk from coastal hazards. For instance, salt marshes can attenuate waves and reduce wave and flood damage to communities, while leading to water quality improvements, an increase in ecotourism revenues by attracting rare birds, and serving as a nursery for recreational and commercial fisheries. While many of the decisions on shoreline protection and hazard mitigation are made at the local level, few case studies exist of successful ecosystem restoration projects which demonstrate economic benefits to communities at a local scale. This presentation will focus on a case study of the Cape May Meadows ecosystem restoration, which consisted of a beach, dune and wetland restoration, and was a partnership between The Nature Conservancy (TNC), New Jersey Department of Environmental Protection (NJDEP), and Army Corps of Engingeers. The impact of the project was quantified in an economic analysis, showing that the flood damage costs avoided from the restoration were an order of $9 million over 50 years. The economic impact from spending from birders increased 3-4 times after the restoration, with total birding expenditures at $313 million per year in Cape May County. The ecosystem service valuation methods will be presented and lessons learned will be shared.

Examining Nearshore Finfish And Crustacean Assemblages At Bulkheaded And Unaltered Salt Marsh Shorelines Within Hereford Inlet Estuary, NJ (48)

Kathryn Sellers, The Wetlands Institute, 1075 Stone Harbor Blvd. Stone Harbor, NJ 8247, ksellers@wetlandsinstitute.org; Lisa M. Ferguson, The Wetlands Institute

Talk - Session 15: Living Resources

Hardened shorelines disturb nearshore hydrology and can degrade ecosystem services. Bulkheading is a common treatment for hardening natural shorelines in developed areas, including much of coastal New Jersey, and can alter the functionality of estuarine habitats including backbays. These backbay areas provide essential nursery grounds for many commercially and recreationally important fisheries species. To better understand the role and potential effects of bulkheaded shorelines on nektonic communities within a backbay ecosystem, this study aims to characterize the abundance and distribution of nearshore finfish and crustacean assemblages at natural salt marsh and bulkheaded shorelines within the backbays of Hereford Inlet in Cape May County, New Jersey. Nearshore samples were obtained with the use of a 15.24 m bag seine net with 6.4 mm mesh during falling - low tides from June through September, 2014. Seines were conducted against the water current and within waters ranging from 0 - 1.5 m in depth. Finfish families, including Atherinopsidae and Paralichthyidae, and crustaceans groups, including Palaemonidae and Portunidae, dominated samples retrieved during the first field season of sampling. Species richness at bulkhead and salt marsh shorelines was similar, but the composition of species and/or age classes varied by habitat type. Preliminary results suggest bulkheaded shorelines provide habitat for young of the year Paralichthys dentatus, and structure-loving Tautoga onitis, Morone americana, and mature Callinectes sapidus. In contrast, salt marsh shorelines provide habitat for juvenile Callinectes sapidus, mature and juvenile Menidia menidia and Fundulus heteroclitus, and nursery habitat for backbay predatory fish including Pomatomus saltatrix and Cynoscion regalis. During future field seasons, we plan to further examine the role bulkhead and salt marsh shorelines now serve for finfish and crustacean species in an altered backbay ecosystem of New Jersey and compare results to previous studies of the inlet.

Streets To Tweets: TTF's Watershed Outreach Campaign (19)

Julie Slavet & Brynn Monaghan, Tookany/Tacony-Frankford Watershed Partnership, 4500 Worth Street Philadelphia, Pennsylvania 19124, julie@ttfwatershed.org

Talk - Session 4: Innovative Outreach

The Tookany/Tacony-Frankford Watershed Partnership (TTF) faces the same communications challenges as many environmental organizations...plus some. Our mission is to improve the health of our highly urbanized 30 square mile watershed by engaging our communities in education, stewardship, restoration, and advocacy. Located in the difficult Philadelphia media market, TTF is home to a significant number of people who live in poverty, speak a primary language other than English, and have

very little connection to their watershed environment. This proposed presentation will describe how we've had success facing this challenge through the development of an outreach campaign that features a commitment to both traditional and non-traditional tools, while having fun.

Evaluating The Success Of Horseshoe Crab And Migratory Shorebird Habitat Restoration On Delaware Bay Beaches That Were Damaged By Superstorm Sandy (93)

Joseph Smith, LJ Niles Associates, PO Box 784 Cape May, NJ 8204, smithjam@gmail.com; Larry Niles, LJ Niles Associates; Dianne Daly, LJ Niles Associates; Tim Dillingham, American Littoral Society; Amanda Dey, NJ Div Fish and Wildlife; Steven Hafner, Richard Stockton College;

Talk - Session 1: Climate Change & Hurricane Sandy

Superstorm Sandy's impacts on communities along the Atlantic coast are well-known, but the storm also damaged communities and wildlife habitat on the Delaware Bay. The storm stripped sand from beaches on the New Jersey side of the bay, exposing large sections of peat and rubble. Surveys conducted just after the storm revealed that over 70% of the optimal beach spawning habitat for Atlantic Horseshoe Crabs (Limulus polyphemus) had been destroyed. This loss was a potential catastrophe for the Atlantic flyway population of the Red Knot (Calidris canutus rufa), a threatened species that depends on horseshoe crab eggs for food during its spring migration stopover at the Delaware Bay. To prevent this catastrophe, a coalition of biologists, NGOs and public agencies led an initiative to restore beaches for birds and crabs in 2013, with follow up work in 2014. Five restored beaches and several unrestored beaches were intensively monitored following restoration to assess project success and to create a firm scientific basis for future restoration projects.

Tidal Marsh Restoration And Monitoring At Prime Hook National Wildlife Refuge, Milton, DE (49)

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Talk - Session 22: Monitoring & Modeling

The Coastal Delaware National Wildlife Refuge Complex, managed by the U.S. Fish and Wildlife Service, has partnered with the Delaware Coastal Programs and the University of Delaware to address the

substantial management challenges in wetlands that were historically managed as coastal freshwater impoundments in the Prime Hook Wildlife Refuge in Milton, DE. These impoundments were recently impacted by overwash and saltwater intrusion, a subsequent collapse of wetland vegetation, and an increase in flooding in adjacent uplands and communities. During the Comprehensive Conservation Plan (CCP) process, the refuge approved a plan to conduct large-scale proactive restoration of the refuge's 4,000 acres of impounded wetlands to tidal salt and brackish marsh, including some level of repair to the dune breaches. Through discussions with wetland restoration professionals and a review of restoration conducted elsewhere in the country, the refuge contracted with a private firm to conduct hydrodynamic modeling and an analysis of restoration scenarios. Model findings support a proposal to close dune breaches, in combination with the creation of a tidal channel network to improve conveyance. To monitor the restoration before, during, and after completion, the Refuge initiated a comprehensive marsh and water monitoring program. The program consists of real-time monitoring of water level and salinity throughout the Refuge's wetland complex, routine analysis of nutrients and suspended sediments, establishment of surface elevation tables, salinity transects, flow velocity measurements, avian, fish community, and vegetation surveys, and more. This large scale restoration and monitoring program will also provide valuable information to marsh restoration science and will serve as a means of public education and outreach.

Estimation Of Nitrogen Removal In Delaware Estuary As A Function Of Spatial Residence Time (30)

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Talk - Session 13: Physical & Chemical Processes

Estuaries play an important role in trapping and removing the nitrogen carried by rivers before reaching the continental shelf. Nitrogen retention in estuaries depends critically on sediment and water-column denitrification processes. The denitrification rates in different estuarine systems have been found to be inversely correlated with the log mean residence time of water. Similar to studies in many systems, previous estimates of nitrogen export from Delaware Estuary to the shelf were typically calculated by taking the difference between riverine input and an imprecise approximation of total denitrification based on a few time- and location-specific measurements. These estimates could be more reliable by extending the observations to adequately address the spatial and temporal variability in denitrification. In this study, we employed a three-dimensional coupled hydrodynamical and biogeochemical model to investigate the role of spatial water residence time in denitrification rates. The mean annual denitrification rate in the flanks of the bay was 2.92 times larger than the main channel, with ratios ranging from approximately 1 in November to 4.33 in May. Our results also suggest a smaller total annual denitrification than was previously estimated. This approach enables us to study the variability of denitrification in different regions of Delaware Estuary, as well as its temporal trends, to bring more insights into nutrient availability and dispersal in the bay.

Identifying Tree Species For Ring Analysis At The St. Jones Reserve (54)

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Poster - Session 15: Living Resources

Tree ring analysis is a valuable tool that can provide insight into a variety of climate and geomorphic histories. Recently, researchers have begun to use tree ring analysis to investigate and quantify sea-level rise. We are interested in using tree-ring analysis to gain information on flooding frequency and sea-level rise at the St. Jones Reserve near Dover, De. Preliminary work has indicated that some species of trees are not appropriate for this type of analysis due to faint and unclear ring structure (e.g., Black Gum). In this study we collected tree cores from every abundant species of tree at the St. Jones Reserve to assess species usefulness in tree ring analysis. The results of this study will provide direction for future research.

Modeling Role In Setting Site-Specific Criteria And Designated Uses (121)

Andrew Thuman, HDR, 1037 Raymond Blvd Newark, NJ 0, andrew.thuman@hdrinc.com

Talk - Session 3: Water Quality I

The tidal Murderkill River watershed is situated along Delaware Bay in the southeastern portion of Kent County in Delaware and includes several upstream main tributaries and ponds. There are large tidal marshes interfacing with the river from Bowers Beach upstream to near Route 1; and historical water quality monitoring has shown that tidal portions of the river do not meet current dissolved oxygen standards to protect Delaware's "Fish, Aquatic Life and Wildlife" designated use. DNREC listed the tidal river on the 303(d) list of impaired waters that required development of a TMDL.

The TMDL effort included significant monitoring, modeling and related studies that have advanced the science and understanding of water quality dynamics in the river. In part, the studies were conducted to determine whether natural processes associated with significant areas of tidal marshes surrounding the river and tidal input from Delaware Bay were responsible for the observed low DO levels in the tidal river. The studies evaluated whether upstream anthropogenic and agricultural sources would have a significant impact on the observed low DO or if the low DO persists even under modeled conditions without these sources.

As part of the TMDL effort since 2001, DNREC and Kent County completed a Use Attainability Analysis (UAA) to adopt a sub-category of the "Fish, Aquatic Life and Wildlife" that resulted in alternate DO criteria for the smaller more homogenous water body type (i.e., "Tidal Marsh Influenced Aquatic Life"). This presentation or poster will present the modeling component of the TMDL and UAA including: model development; use in estimating natural background DO levels; estimates of DO impacts associated with

tidal marshes; and use in supporting the alternate DO criteria. In addition, it will provide an overview of the various studies completed to support the modeling, TMDL and UAA.

Seasonal And Interannual Variations In The Dissolved Oxygen Budget Of An Urbanized Tidal River: The Upper Delaware Estuary (24)

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Talk - Session 5: Water Quality II

The dissolved oxygen budget was diagnosed from oxygen concentration measurements in the upper Delaware Estuary between 1970 and 2014. The region was found to be heterotrophic, with net oxygen consumption greater in the tidal-fresh portion than in the oligohaline portion. Net oxygen consumption decreased substantially over the study period, with June-July values declining from 6-10 mol m^{-2} mon^{1} in the 1970s to 3-4 mol m^{-2} mon^{-1} from the 1990s onward, a change presumably due to improvements in wastewater treatment, though a comparison with biological oxygen demand measurements in wastewater was equivocal. Combining the results with historical primary production measurements, respiration rates were estimated to be highly seasonal and positively correlated with temperature, with Q_10 values ranging between 1.4 and 2.3. The degree of heterotrophy was great, with annual respiration being several times annual primary production. Exchange with the atmosphere is the main process that balances the net oxygen consumption throughout the study region, with advection also an important process in the tidal-fresh portion. A slight decline in oxygen concentration in the 2000s was found to be due to an increase in net oxygen consumption as opposed to weaker oxygen inputs from the atmosphere or advection.

Horseshoe Crab Rescue At Fortescue Beach - Implications For Mortality, Beach Restoration Need And Future Assessment Of Spawning Habitat (11)

Rosy Tucker, Rutgers University, 116 Lansdowne Ave. Haddonfield, NJ 8033, rosygtucker@gmail.com; Raffaela Marano, Drexel University; Jackie Garcia, Drexel University; Ron Smith, Drexel University and Haddonfield Memorial HS; Dane Ward, Drexel University

Talk - Session 20: Mitigating Human Influences on Natural Resources

Human modifications to coastlines present impediments to Horseshoe Crab spawning on the Delaware Bayshores. The moratorium on Horseshoe Crab harvesting has served to bolster future populations and, as a result, help ensure that a reliable food source will be available to migratory shorebirds on Delaware Bay beaches. The state of the beaches at certain locations, however, presents a situation of great

concern given that crabs trapped in debris, pilings and other human structures, will die if they are not rescued.

Led by Rutgers University undergraduate Rosy Tucker and Environmental Science educator Ron Smith, students from Drexel University and Haddonfield Memorial High School traveled weekly to Fortescue Beach in Cumberland County to complete a systematic count and rescue of trapped crabs along a defined section of affected beach. The group counted total crabs rescued and examined the ratio of male/ female and live/ dead crabs during the 2013 and 2014 spawning seasons. Thousands of crabs were returned to the bay alive as a result of these efforts and the survey sheds light on a critical habitat conservation issue. In combination with sea level rise and storm events like the 2012 hurricane, anthropogenic debris on Delaware Bay beaches presents serious hazard to spawning Horseshoe Crabs and potentially compromises the ecology of the Delaware Bay coastline.

Other beaches were also visited during the 2014 rescue and each revealed unique issues with regards to impingement and potential effects on crabs. Projecting total potential impact of altered beaches around the bay, though difficult, may be possible using the data that we have collected, access to satellite imagery and ground level coastline assessments. In addition, details on male/ female crabs trapped and mortality may assist conservation scientists in developing protocols for restoring certain beaches and/or continuing to conduct precisely targeted bay-wide rescues for Horseshoe Crabs.

The Social Science Of Sea Level Rise In Delaware: Tracking Trends In Opinions Of Delaware Residents On Climate Change And Sea Level Rise (72)

Kelly Valencik, Delaware National Estuarine Research Reserve, 818 Kitts Hummock Road Dover, DE Delaware 19901, kelly.valencik@state.de.us; Susan Love, Delaware Coastal Management Program

Talk - Session 1: Climate Change & Hurricane Sandy

Climate change. Sea Level Rise. Heard of them? After a multi-year effort to increase sea level rise outreach in Delaware this presentation will share the results from a five year update to a 2009 public opinion survey of Delaware residents' opinions on climate chance and sea level rise that explored opinions, behaviors, and attitudes regarding climate change and rising sea levels.

Specifically, this 2014 study compares and assesses changes in Delaware residents' awareness and understanding of key issues regarding climate change and sea level rise; determines their perception of its overall effect on the economy and ecology of the state; and explores public opinion regarding long range planning for sea level rise loss and damage prevention since the 2009 survey. The survey responses are analyzed to determine differences between different demographics. This trend data and analysis will aid in future outreach projects and messaging on sea level rise and climate change to priority target audiences through the most effective means possible.

Carbon, Nitrogen And Phosphorus Sequestration In Delaware River Tidal Wetlands (96)

David Velinsky, The Academy of Natural Sciences of Drexel University, 1900 Benjamin Franklin Pkwy Philadelphia, PA 19103, djv23@drexel.edu; Tracy Quirk, Louisiana State University; Christopher Sommerfield, University of Delaware

Talk - Session 13: Physical & Chemical Processes

Tidal marshes of the NE United States are among the most productive ecosystems in the world. They serve as nurseries for many freshwater and estuarine organisms, and support the productivity of adjacent coastal waters. They are also regional sinks for fine-grained riverine sediments as well as OC, N and P (CNP). In addition, they contain sedimentary indicators, such as the isotopic composition of carbon and nitrogen that reflects changes in the sources and cycling, as well as indicates the overall productivity within the estuary.

To investigate these changes, sediment cores were collected from freshwater tidal and estuarine marshes in the Delaware River estuary to estimate accumulation of CNP and some relevant factors that may control their retention. Chronologies were determined with 210Pb and 137Cs isotopes. Accumulation rates, based on 137Cs, ranged from ~1.1 cm/yr in the upper estuary to ~0.68 cm/yr in the lower estuary, 0.74 ± 0.23 cm/yr (n =22). CNP concentrations generally increased from the more saline portion of the estuary to the tidal freshwater sections and depth profiles exhibited site-specific variations related to localized inputs and biogeochemical processes. In addition, $\delta^{15}N$ and $\delta^{13}C$ data revealed variability related to changes in sources of organic matter. Rates over a 50-yr time frame ranged from 154-362 gC/m^2-yr, 11-25 gN/m^2-yr and 2-3 gP/m^2-yr for a subset of sites. Variations in long-term CNP burial or sequestration rates among sites and stations were much smaller than the variations in mineral inputs. Minor differences in burial rates were noted at sites extending from the lower estuary to the tidal freshwater portion of the study area. Burial of N and P in some tributaries (i.e., Murderkill River) accounted for a substantial portion of the loadings from upland areas. These data reveal that the highly productive Delaware wetlands can be an important sink for bioactive elements .as well as other chemical introduce to the system.

Developing Seashore Mallow As An Alternative Crop On Salinized Soils In Delaware And Investigating Its Use As A New Source Of Poultry House Bedding (32)

Jennifer Volk, University of Delaware-Cooperative Extension, 69 Transportation Circle Dover, DE 19901, jennvolk@udel.edu; Kate Hackett, Delaware Wild Lands, LLC.; Bill Brown, University of Delaware-Cooperative Extension; Donna Hamilton, University of Delaware-College of Earth, Ocean, and Environment; Denise Seliskar, University of Delaware-College of Earth, Ocean, and Environment; Jack Gallagher, University of Delaware-College of Earth, Ocean, and Environment;

Talk - Session 24: Hot Topics

Salt water that washes over agricultural fields during storms and extreme tides can severely degrade a soils' ability to support traditional crops like corn and soybeans. This is already happening to some of Delaware's coastal farmland and the frequency and extent of these flooding events will increase in the future as a result of sea level rise. An alternative, salt tolerant crop that may be able to sustain the productivity of these impacted lands is being investigated. Seashore mallow (Kosteletzkya pentacarpos), a perennial, non-invasive plant native to the brackish Atlantic and Gulf coast marshes of the US, can tolerate salty soils. UD researchers are developing the plant as an alternative agriculture crop, and producing potential marketable products. Most applicable to Delaware and the Delmarva Peninsula is the excellent absorbent capacity of the milled stems, which make an ideal bedding for small animals, such as chickens. A recent small pen study has shown that the chopped stem material proves promising as a new, local source of poultry bedding. If additional research and assessment support these findings, there is great potential for the use of seashore mallow by this regions' poultry industry, as the traditional bedding material, pine shavings, has decreased in availability and increased in cost. Seashore mallow also provides environmental benefits such as carbon sequestration, erosion control, air and water filtration, and suppression of invasive Phragmites. Thus, if able to be utilized as an alternative crop on salt impacted lands (while enabling coastal farmers sustained productivity for a period of time), seashore mallow will ultimately facilitate adaptation to sea level rise as wetland communities migrate inland. UD Cooperative Extension is targeting outreach on this topic to Delaware's coastal farmers and soliciting cooperators to help advance this research.

Multiyear Study Of Leatherman's Run Watershed And Assessment Of The Impact Of Retrofit And Stream Restoration Projects (18)

Marianne Walch, Delaware Department of Transportation Stormwater Quality Section, Dover, DE 19903, marianne.walch@state.de.us; Michael Pieper, KCI Technologies, Inc.

Poster - Session 8: Restoration

Leatherman's Run, a tributary of the Christina River, is a 1,720-acre watershed located in New Castle County, Delaware. A study of the Leatherman's Run watershed was initiated by DelDOT in 2003, and annual stream monitoring was conducted through 2008. The monitoring included water quality

analyses, macroinvertebrate and fish collection, physical habitat assessment, and geomorphic monitoring. Based upon the results of the stream studies, KCI Technologies identified and prioritized more than 30 potential retrofit and restoration opportunities in the watershed.

In 2009, the DelDOT service plaza along Interstate 95 – which discharges directly to Leatherman's Run - was redeveloped with green technology stormwater BMPs. In addition, DelDOT has begun to implement other retrofit and stream restoration projects in the watershed. Comprehensive stream monitoring was reinitiated in 2014 to document current conditions and provide a new baseline for assessing the effectiveness of future retrofits and restoration practices on stream health.

Water quality sampling, biological and physical habitat assessments and geomorphic monitoring were performed at the original monitoring station locations that were selected in 2003. All stream channels in the watershed were walked and surveyed to record and assess infrastructure and environmental features such as bank erosion and buffer breaks. No clear trends were observed with stations being located either upstream or downstream of the I-95 Service Plaza. Indicator bacteria were high at all sites. Overall, sites sampled throughout Leatherman's Run contained impaired benthic macroinvertebrate communities, with biological condition ratings of "poor" to "very poor," using the MBSS BIBI, and "not supporting" using EPA's RBP index, which is consistent with previous assessments. Fish assemblages received "fair" biological condition ratings for all sites. Physical habitat assessment results indicate partially supporting physical habitat conditions throughout the watershed, and geomorphic assessment results show continued bed and bank erosion at several monitoring locations.

Delaware Livable Lawns: A Partnership Program To Reduce Nutrient Runoff From Lawns (16)

Marianne Walch, Delawarer Department of Transportation Stormwater Quality Program, Dover, DE 19903, marianne.walch@state.de.us; Sara Wozniak, Delaware Dept. of Natural Resources & Environmental Control; Randy Cole, Delaware Department of Transportation; Susan Barton, University of Delaware; Valann Budischak, University of Delaware

Talk - Session 23: Soaking in Storm Water, Sea Level Rise, and Climate Change Outreach

The Delaware Department of Transportation (DelDOT) is required by its MS4 permits to implement public education programs to promote the proper use, application, and disposal of pesticides, herbicides, and fertilizers by residents and commercial and private applicators. Although DelDOT had included information about lawn care in its public education materials, no evidence existed that public behavior had changed. Furthermore, existing materials did not adequately educate commercial applicators. A new, more targeted approach was sought that included participation of other stakeholders in the state.

Successful campaigns have been developed in other regions to educate the public about the impacts of overfertilization and to change behavior. DelDOT joined with the University of Delaware, the

Department of Natural Resources and Environmental Control (DNREC) and other partners to create a similar program in Delaware, called “Delaware Livable Lawns” (DLL).

The DLL program certifies lawn care companies that follow specific best practices in fertilizer application, while also meeting homeowners’ needs and educating them on these best practices. In return, DLL helps promote certified companies to potential residential customers. In addition, DLL has produced a variety of educational materials on sustainable practices, which target residents who care for their own lawns.

Currently DLL is expanding the residential outreach component of the program. Additional partner agencies and organizations have joined forces with DLL and will be supplementing its funding. An incentive program for homeowners also is being planned that will encourage both the adoption of DLL practices and planting of native trees. Combination of effort by multiple stakeholder partners has resulted in a model, targeted public education and outreach campaign that not only meets specific MS4 permit requirements, but is also an effective and relatively low-cost tool for meeting broader education and watershed improvement goals in the state.

Reach Scale Stream Water Temperature Predictions And Application To Assess Effects Of Land Use, Restoration And Climate Changes On Fish Growth Potential In The Delaware River Basin (86)

Alexander Waldman, Academy of Natural Sciences of Drexel University, 1900 Benjamen Franklin Parkway Philadelphia, Pennsylvania 19104, amw47@drexel.edu; Dr. Jerry Mead, Academy of Natural Sciences of Drexel University; Lin Perez, Academy of Natural Sciences of Drexel University; Dr. Stefanie Kroll, Academy of Natural Sciences of Drexel University; Dr. Franco Montalto, Drexel University

Talk - Session 18: Monitoring & Assessment for the Delaware River Watershed

Empirical models were developed to predict average daily stream water temperature (ADSWT) for stream channels in the Delaware River Basin, as functions of environmental variables at various spatial scales. Stream Hiker software, an open source GIS tool that analyzes spatial data and aggregates statistics at the river reach (lateral riparian and direct drainage area) and watershed (network riparian and drainage basin) scales, was used to create a database of approximately 250,000 reaches of ~200m in length over the entire basin. Models were developed and selected using the Akaike Information Criterion and multiple linear and non-linear regressions. Historic stream temperature measurements were used for calibration, and recently collected temperature data was used for validation. The final models were grouped by appropriate fit to typologies of environmental conditions and assessed for their predictive power. Finally, selected ADSWT models were combined with published bioenergetic fish models and future climate predictions to assess the effects of future climate, land use changes and riparian reforestation on the growth potential (GP) of three native fishes (Brook trout, juvenile American shad, Yellow Perch) and three non-native fish species (Smallmouth bass, Common carp, Brown trout). Model improvements will be sought by incorporating future data and exploring the significance of representing data with more complex spatial and mechanistic relationships.

The Crawford Treatment Wetland, A Pioneering Vertical Flow Treatment System (21)

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Poster - Session 3: Water Quality

The Crawford Treatment Wetland is a vertical flow treatment system of surface and ground water installed in an attempt to reduce elevated phosphorus levels associated with an egg laying facility from 4.5 mg/L to 0.4 mg/L. The wetland system is located along a tributary to the Sassafras River that eventually drains into the Chesapeake Bay which suffers from chronically high nutrient levels. The purpose of this study is to examine the project effectiveness in the first summer after installation. Water samples were collected with ISCO samplers at the inflow and outflow points for both the surface and groundwater systems at hourly intervals and were sent to University of Delaware for an in depth analysis. We also processed water samples using a Hanna Phosphate Checker for immediate results. No samples have been collected from the groundwater outflow because of relatively low rainfall. Our initial results indicate the surface water treatment system reduced phosphorus levels from 2.49 mg/L at the inflow to 0.918 mg/L at the outflow. Although this project took place in the Chesapeake Bay watershed, the results are applicable in the Delaware Bay Watershed because large feeding operations are located within the watershed.

Branding: How Do You Know What People Think About Your Organization? (123)

Richard Wells, The Wellynn Group, 123 Penarth Road Bala Cynwyd, PA 19004, richard@thewellynngroup.com

Talk - Session 2: Branding

What's your brand? That's not just a question for Fortune 500 corporations: every organization needs to understand how its brand is perceived and experienced by target audiences. Most organizations think they have a good idea of how they are perceived, even with scant evidence or data to support that feeling. But how do you really know what members of the general public or specific audiences (like funders, donors, or volunteers) think about your organization? How can you determine what your organization's brand is--not as you wish it to be or think it might be, but as it is actually understood by your target audiences? This session will explore different market research techniques that can help you determine your organization's brand. The session will describe market research undertaken by the Partnership for the Delaware Estuary and the outcome of that research. Co-presenters will be Lisa Wool, of the Partnership, and Richard Wells, of The Wellynn Group.

Nutrient Cycling In The Blackiston Tax Ditches (47)

James Welsh, Wesley College, 144 Plaindealing RD. Magnolia, DE 19962, James.Welsh@email.wesley.edu; Dr. Stephanie Stotts, Wesley College

Poster - Session 3: Water Quality

Tax ditches were implemented in the 1950s for agricultural drainage; they now drain roads and residential areas as well. In some instances, these ditches are surrounded by vegetated buffers that can protect the water body from nonpoint source pollution. The purpose of this project is to compare the water quality, including phosphate, nitrate, dissolved oxygen, and temperature, of three tax ditches with varying vegetated buffer widths. Water samples were collected from three tax ditches within the Blackiston Wildlife Preserve: one with no buffer, one with minimal buffer, and one with a relatively wide buffer. The samples were collected between June 24th and August 1st with duplicate samples collected each trip to the field. Nitrate levels were tested using the Lamotte's test kit, while the Hanna test was used to analyze the phosphate concentrations. The DO percent, DO level, and temperature for each tax ditch was obtained using the YSI electronic reader. Student's T-Tests were used to compare water quality parameters between sites. The temperature at the ditch without a buffer was significantly higher than the ditch with a wide buffer, and the oxygen levels from the wide buffer site were significantly higher than the minimally buffered site. However, the site with no buffer had significantly higher oxygen levels than the narrowly buffered site. The nutrient data did not support our hypothesis as the nitrate level at the ditch with a wide buffer was actually higher than both the ditches with no buffer and a narrow buffer. Also, the ditch with no buffer had significantly lower phosphate levels than both the narrow and large buffers. Our surprising results may be due to differences in ditch size as the ditch with a wide buffer is much larger than the other two sites.

New Jersey Shellfish Farming Regulations - Past, Present, And Proposed (75)

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Poster - Shellfish Panel

Aquaculture within the State of New Jersey is a slowly expanding industry with the potential to yield various benefits to the industry, local communities, and the State economy. Today, over three-quarters of New Jersey's licensed aquatic farms produce shellfish for human consumption, operating within the state's dynamic and productive coastal zone. As shellfish consumers become more aware of regional flavors and farm specific products, New Jersey farms need to be ready to supplying a fresh, local product to in-state and nearby markets. In order for the state and its coastal communities to fully benefit from the economic and societal gains of current and future shellfish farming, however, the regulatory framework within which this industry is managed must be prepared for industry expansion. Past

regulations on farming within New Jersey's coastal zone lengthened the permitting process by creating multiple departmental reviews, leading to farmer confusion and mistrust of the state. More recently, incremental measures have been implemented by regulatory state agencies to streamline the permitting process and increase communication with stakeholders. This research examines New Jersey's marine shellfish farming regulations- past, present, and proposed- to identify strengths and areas for future enhancement. Shellfish aquaculture within the State of New Jersey is poised for expansion and although the state is supportive of increasing the industry, the current policy regime does not fully project this perspective. Through the provision of a more amenable regulatory structure for shellfish farming, the state can provide fertile grounds for growth within the industry.

Delaware National Estuarine Research Reserve: Marsh Bird Monitoring Along The St. Jones River (39)

Christina Whiteman, Delaware Coastal Programs, 5 East Reed Street Dover, DE 19901, christina.whiteman@state.de.us

Poster - Session 15: Living Resources

In 2012, the Delaware National Estuarine Research Reserve (DNERR) initiated a Marsh Bird Monitoring Program at the St. Jones Reserve to join a nationwide network of marsh bird monitoring within and outside the NERRS. The purpose of this study is to determine baseline data for marsh birds and their habitat, monitor long term population trends, and to link population and community variation to the ecological health of emergent wetlands in the St. Jones estuary. The DNERR Marsh Bird Monitoring Program has also created a citizen science project to give volunteers a unique opportunity to learn about wetland ecosystems and marsh bird ecology while volunteering for the survey. Several other NERRs are currently using a Marsh Bird Monitoring Program as a successful citizen science opportunity including the Guana Tolomato Matanzas NERR (Florida), North Inlet-Winyah Bay NERR (South Carolina) and Sapelo Island NERR (Georgia). The DNERR has completed the third year of participating in this nationwide research effort. The first year of this survey the DNERR followed the National Marsh Bird Monitoring Protocol and modified the study for the second year to use the Saltmarsh Habitat and Avian Research Project (SHARP) protocol. Preliminary baseline data and lessons learned from project implementation will be featured.

The Prime Hook National Wildlife Refuge Coastal Restoration Project: An overview of the project development to dredges on the horizon. (128)

Bartholomew Wilson, Prime Hook National Wildlife Refuge, 11978 Turkle Pond Road Milton, DE 19968, Bartholomew_Wilson@fws.gov

Talk - Session 16: Wetlands

Application Of Data Mining And Statistical Learning Approaches For Insights Into Dissolved Oxygen (58)

John Yagecic, Delaware River Basin Commission, 25 State Police Dr. West Trenton, NJ 8628, John.Yagecic@drbc.state.nj.us; Thomas J. Fikslin, Ph.D., Delaware River Basin Commission; Erik Silldorff, Ph.D., Delaware River Basin Commission

Talk - Session 5: Water Quality II

Mandates for a deeper understanding of dissolved oxygen (DO) processes in the Delaware Estuary have come from numerous sources recently, including addition of Atlantic Sturgeon to the Endangered Species List, and recognition that the current protected use in the Delaware River in Zone 3 is the survival and passage of fish populations only, while some reproduction is clearly occurring. DRBC used techniques associated with data mining and statistical learning to develop models for predicting and understanding DO at the Ben Franklin Bridge. Using 10 years of data reported by the US Geological Survey, National Weather Service, and National Oceanic and Atmospheric Administration, spanning measurements of meteorological conditions, solar radiation, water quality, flow, and tidal conditions, the authors constructed several different forms of models for predicting DO as a percent of saturation, including multiple linear regression models and classification and regression trees. Temporal shifts between potential stimuli and DO response associated with travel and reaction times complicate model development. The authors cycled through various lag, averaging, and aggregation times for each potential explanatory variable, identifying the combination of temporal adjustments that optimized that variable's relationship with DO. Together, the unprocessed and optimized data streams yield 70 potential explanatory variables. The authors derived efficient models that predict DO at the Ben Franklin Bridge, and provide insight into important drivers. This presentation will describe the methods used in developing and assessing the models, highlight open access to data and work products, and show how these approaches may increase our understanding of environmental processes. The presentation will describe how these same approaches when applied to the Delaware River at Chester, PA and Reedy Island, DE provide insight into processes driving DO in different parts of the estuary. Finally, the authors will consider the implications of the model results in the face of climate change.

Rainfall Interception By Urban Low-Height Shrub Canopy And Its Hydrological Implication - Experimental Study In Philadelphia (50)

Walter Yerk, Civil, Architectural & Environmental Engineering, Drexel University, 3141 Chestnut St Philadelphia, Pennsylvania (PA) 19104, wgy23@drexel.edu; Franco Montalto, P.E., PhD, Civil, Architectural & Environmental Engineering, Drexel University

Talk - Session 22: Monitoring & Modeling

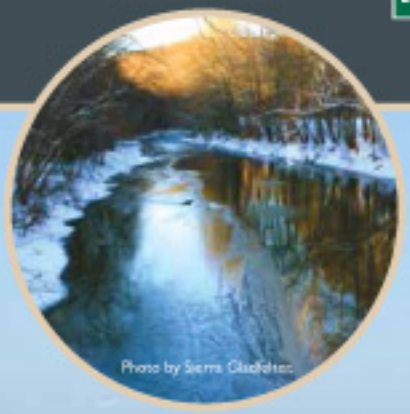
Vegetation canopy is an already present element of Low-impact Development (LID). The rain interception service it provides deserves an accurate quantifying method and predictive model that would be further incorporated into urban watershed models.

A field experiment was designed to directly measure canopy throughfall and stemflow associated with four shrub species commonly included in urban greening programs (Cornus sericea, Itea virginica, Hydrangea quercifolia and Prunus laurocerasus). Data were collected at a high (e.g. five second) sampling frequency, and meteorological data were observed on the site. The 2012 and 2013 results reveal large intra-storm interception of from 10 to 49%, depending on meteorological conditions and species' properties. Measured throughfall rate was directly related to precipitation intensity.

Simulations of potential evaporation based on the Penman-Monteith method showed a large underestimation of evaporation from the wet canopies during the rain events. Approaches other than heat balance models of potential evaporation from a still water surface are being discussed in order to explain large evaporation from within a wet isolated canopy.

Regression models for various canopy types and rainfall properties are expected to provide good estimations of interception.

The **Partnership for the Delaware Estuary**, a National Estuary Program, leads science-based and collaborative efforts to improve the tidal Delaware River and Bay, which spans Delaware, New Jersey, and Pennsylvania.



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