Proceedings

Partnership for the
DELAWARE
ESTUARY

Delaware Estuary Science & Environmental Summit 2019

**"Estuary 2029:
Saving Our System Through Collaboration"**

January 27 – 30, 2019
Cape May, New Jersey

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

Partnership for the Delaware Estuary
PDE Report No. 19-02
February 2019

For more information, please see the conference website at:
http://www.delawareestuary.org/delaware-estuary-science-and-environmental-summit/

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Document Navigation

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 300 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 has been held every two years since then. 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 effective science communication
- Thematic sessions and panels that pertain to the central theme of each biennial meeting

2019 marked the 14-year anniversary of the Summit, making a total of 8 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
2017: Reflecting on Progress, Charting the Future
2019: Estuary 2029: Saving our System through Collaboration

This document consists of notable awards for the 2019 summit followed by the program schedule and abstract book. Proceedings of the previous Summit events are available from the PDE website at: www.DelawareEstuary.org/delaware-estuary-science-and-environmental-summit

Delaware Estuary Science and Environmental Summit 2019
Student Presentation Awards

The Partnership for the Delaware Estuary (PDE) thanks all the students who journeyed to Cape May, NJ, to present their original research findings at the Eighth Delaware Estuary Science & Environmental Summit (January 27-30, 2019). We had 340 attendees give 110 oral presentations and 34 poster presentations.

Working with our Science and Technical Advisory Committee and the many others who helped to judge student presentations, PDE was pleased to announce the recipients of the student presentation awards. This competition was designed to recognize the important contributions that students make to the environmental sector in our watershed.

Sixteen students presented this year. The judges chose a **Best Student Talk** and a **Best Student Poster**. Due to close scoring, the judges also awarded an Honorable Mention to a 2nd poster. The caliber of all presentations was very high, and all students should be commended for their outstanding contributions and presentations!

All 3 awardee 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 of >25,000, reviewed by our STAC (great exposure),

Student winners should watch for an email from PDE's marketing and communications coordinator, Kate Layton, to discuss their newsletter contributions.

Best Student Talk Award

Michael Acquafredda, Haskin Shellfish Research Lab, Rutgers University
Possible Niche Partitioning among Four Ecologically and Economically Important Filter-Feeding Bivalves: A Case Study of Bivalve Polyculture

Best Student Poster Award

Lily Smith, Camden Catholic High School
The Shade Trees of Merchantville—A Citizen Science Inventory of Municipal Carbon Sequestration

Honorable Mention Student Poster Award

Spencer Roberts, Drexel University
Creating Flow Refugia to Augment and Restore Freshwater Mussel Populations in the Tidal Freshwater Delaware River

We anticipate that the 9th Delaware Estuary Science and Environmental Summit will be held in two years (January 2021.) 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

Program

Partnership for the DELAWARE ESTUARY

Delaware Estuary Science & Environmental Summit 2019

"Estuary 2029: Saving Our System Through Collaboration"

January 27 – 30, 2019
Cape May, New Jersey

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

Welcome to the 2019 Delaware Estuary Science and Environmental Summit

"Saving our System through Collaboration"

On behalf of the Partnership for the Delaware Estuary, welcome to Cape May and the 8th biennial Delaware Estuary Science and Environmental Summit!

At this year's summit we celebrate a major milestone for the Delaware Estuary and everyone working to protect and enhance it — revision of the Comprehensive Conservation and Management Plan (CCMP) for the Delaware Estuary for the first time since it was created in 1996!

The original CCMP marked the first time that industry, the states, federal and local agencies, nonprofit organizations, and communities all came together for the common goal of a healthy tidal Delaware River and Bay. A newspaper account at the time marveled at the "radical shift in attitude" this represented. More than 20 years later, collaboration across sectors and states for clean water, strong communities, and healthy fish and wildlife habitat is going strong. And the theme of this year's summit, Saving our System Through Collaboration, is more relevant than ever.

As always, the summit plays a critical role for us as home of the National Estuary Program, bringing the latest scientific information, debate, stakeholder input and collaboration together and to bear on our work. This year look for a special exhibit, materials and activities aimed at connecting all the amazing research, projects, and activities presented here at the summit to strategies and actions in the CCMP.

Just like the summit, a successful CCMP relies on YOU. It's your work, and the work of hundreds of people, communities, and institutions like you and yours that will accomplish the actions needed to fulfill the vision of the CCMP. Thank you for all you do for the Delaware River, Bay and Watershed, and for joining us to celebrate this important milestone!

Jennifer Adkins
Executive Director
Partnership for the Delaware Estuary

Plenary Speakers:
Mark Botton and Bob Loveland
"Forty Years on the Beach: Eyewitnesses to the American Horseshoe Crab and its Essential Habitat in Delaware Bay"
Monday PLENARY, 9:00am, Grand Ballroom, 1st Floor

Horseshoe crab populations have risen and fallen over the years. Scientists Dr. Mark Botton and Bob Loveland attribute these changes to geological changes in habitat and human activity. During the late 19th and early 20th centuries, millions of horseshoe crabs were harvested for fertilizer and animal feed. From the 1930's through the 1990's horseshoe crab numbers recovered, then dropped again in the late 1990s due to fishing. With fishing bait regulations now in place, horseshoe crab numbers are back in recovery.

In the four decades that Botton and Loveland have studied horseshoe crabs, major changes in the topography of the Delaware Bay shoreline have impacted spawning for these animals. Given the expected scenario of continued sea level rise and erosion of open bay beaches, Botton and Loveland find that it is imperative for us to identify and protect habitats that will become "hot spots" for horseshoe crab spawning, such as sand bars and spits near salt marsh creeks. In their presentation, Botton and Loveland will discuss their research of the mysterious, humble horseshoe crab, icon of the Delaware Estuary.

Mark Botton

ABOUT BOTTON AND LOVELAND

Dr. Mark L. Botton is professor of biology in the Department of Natural Sciences at Fordham University – Lincoln Center in New York City. He is the co-director of Fordham's environmental science program. He received his bachelor's degree in Biology from Stony Brook University, his master's degree in Biology from Brooklyn College, and his doctorate in Zoology from Rutgers University. He has published more than 50 articles and book chapters on various aspects of horseshoe crab biology, including feeding ecology, mating behavior, the effects of pollution on developmental success, and population and conservation biology. He is the co-chairman of the IUCN (International Union for the Conservation of Nature) Horseshoe Crab Species Specialist Group.

Bob Loveland is happily retired from Rutgers University, but still has an office on the Cook Campus, which he shares with Botton. He is active in publishing articles with Botton, and has delivered a number of presentations on horseshoe crabs, ranging from C W Post on Long Island, and as far away as Flagstaff, Arizona. His research interests and professional activities have shifted somewhat away from the Delaware Bay.

Loveland has a few books in the works. One is about horseshoe crabs, called Kingcrab, NJ, and another on numbers for children called The Book of Evans. He has another book in the process called Prime Primer: This Ain't About Paint. Loveland graduated from Rutgers Camden, New Jersey in 1959, then received his master's and doctorate degrees from Harvard in 1963. He has collaborated with Mark Botton since the early 1980's.

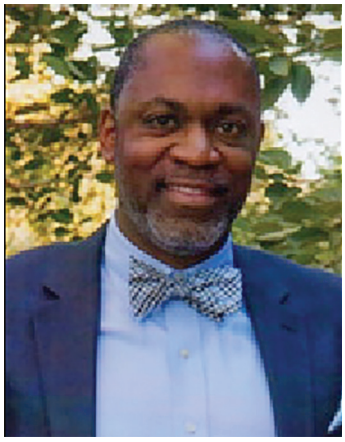
Bob Loveland

Keynote Speaker: Dr. Brandon Jones
"It's All Good: The Reciprocity of Diversity in STEM"
Tuesday Keynote, 11:00am, Grand Ballroom, 1st Floor

Diversity is a vital priority that promotes innovation and strengthens a community's resiliency. The lack of diversity in science, technology, engineering and mathematics (STEM) disciplines is not a new development and the geosciences continue to lag other STEM disciplines in this area.

The main aspects of diversity including the engagement, recruitment and retention of individuals from traditionally under-involved and under-served communities is particularly prominent in the realm of geoscience education and training. Many current and historical geoscience funding efforts have focused on increasing the numbers of participants from the above mentioned groups but the stories about drop-out rates is commonplace.

Preparation of the future professional geoscience workforce includes increasing the pool of educated, well-qualified individuals, but it should also include efforts to develop and sustain supportive learning, research and professional environments to retain said individuals.



Dr. Brandon Jones

ABOUT DR. JONES

Brandon Jones is the program director for the education and diversity efforts in the National Science Foundation's Geosciences Directorate. Jones joined NSF after serving nearly 13 years as a grants and fellowships program manager at the EPA. At the National Science Foundation, Jones oversees programs that focus on undergraduate and graduate workforce preparation for the geosciences and supports initiatives related to increasing diversity, inclusion and belonging in science, technology, engineering and mathematics (STEM).

Jones earned a Bachelor of Arts in biology from the Lincoln University in Pennsylvania in 1991. He earned a Master of Science degree and then a doctorate degree in marine biology and biochemistry from the University of Delaware's College of Earth, Ocean and Environment in 1994 and 2003, respectively.

He taught high school science for five years between earning his master's and PhD. Jones serves on the board of directors for the American Geophysical Union and the Environmental Leadership Program. He also is a member of the Dean's Advisory Council for the University of Delaware's College of Earth, Ocean and Environment. He continues to be an active mentor for under-involved students interested in STEM.

Lunchtime Speakers:

Debbie Mans (Invited), Steve Tambini and Jennifer Orr-Greene

Monday, 11:45 a.m., 5th Floor, Penthouse Ballroom

Debbie Mans

Debbie Mans is deputy commissioner of the New Jersey Department of Environmental Protection. Before taking on that position last February, Mans served as baykeeper and executive director for the Matawan-based NY/NJ Baykeeper since April 2008. Prior to joining Baykeeper, Mans served as environmental and energy policy advisor to Gov. Jon S. Corzine, assisting in the development of a state energy master plan to chart clean energy plans through 2020. She also served as the governor's appointment to the State Planning Commission as the smart growth ombudsman. Before working for the governor, Mans served as Baykeeper's policy director from 2002 to 2006, where she developed policies and programs to promote Baykeeper's mission.

From 2000 to 2002, Mans worked with the Stony Brook-Millstone Watershed Association as a policy and outreach specialist. In that role, Mans directed activities for a program designed to build New Jersey's community-based watershed organizations.

Mans graduated from the University of Michigan and Vermont Law School. She is the former chair of the New Jersey League of Conservation Voters (NJLCV) and a member of her borough council.

Steve Tambini

Steve Tambini is executive director of the Delaware River Basin Commission (DRBC), a federal-interstate agency created in 1961 by compact legislation signed into law by President Kennedy and the governors of the four basin states with land draining to the Delaware River. In this role, he develops and implements plans, policies and projects adopted by the five-member commission relating to the water resources of the Delaware River Basin.

Mr. Tambini brings over 30 years of experience in water supply engineering and water resource planning, management and operations to the DRBC. Prior to assuming the executive director duties on August 1, 2014, he served as Vice President of Operations at Pennsylvania American Water. He previously held important management leadership posts at New Jersey American Water, including the Vice President of Operations and the Vice President of Engineering. Mr. Tambini also provided engineering leadership to American Water subsidiaries serving 12 other states that encompassed a wide range of water resource and water supply challenges and projects.

Mr. Tambini holds a bachelor's degree in Civil and Environmental Engineering and a master's degree in Environmental Engineering, both from Clarkson University in Potsdam, N.Y. He is a registered professional engineer in New Jersey and New York. He is currently a member of the American Water Resources Association and the Partnership for the Delaware Estuary, serves on the board of directors for the Rancocas Conservancy, and is a member of LeadNJ's Class of 2010 and the Pennsylvania Business Council Executive Leadership Program's Class of 2012.

Jennifer Orr-Greene

Ms. Jennifer Orr-Greene is the director of the Compacts and Commissions Office at the Pennsylvania Department of Environmental Protection. Her office manages most interstate and international matters related to contracts/agreements for the Department, as well as the coastal resources program, with focus areas in both the Delaware Estuary and Lake Erie. In addition to the work of her office, Ms. Orr-Greene is currently the acting director for all other programs in the Water Resources Planning Office.

Ms. Orr-Greene began her career with the Susquehanna River Basin Commission in 2000 as a water quality specialist working on watershed assessment and restoration initiatives, with a specific focus in mine drainage restoration and community partnerships. Before becoming the Director of the Compacts and Commissions Office in the Office of Water Resources Planning in 2015, Ms. Orr-Greene worked in the in the TMDL program as a water program specialist through 2009, then assumed the role of section chief managing the Chapter 102 – NPDES construction stormwater and erosion control program.

Ms. Orr-Greene is a native of central Pennsylvania. She earned a bachelor's degree in Biology with a minor in chemistry from Bloomsburg University in 1998, followed by her master's degree in Wildlife and Fisheries Science from the Pennsylvania State University in 2004. She is a member of the Coastal States Organization and on the Board of Directors for the Interstate Council on Water Policy.

Summit Agenda At a Glance

Sunday, Jan. 27

5:00 p.m.	Registration and Networking

Monday, Jan. 28

8:00 a.m.	Registration/Breakfast
8:45 a.m.	Welcome/Info: Jennifer Adkins
9:00 a.m.	Plenary Speakers: Mark Botton & Bob Loveland
10:00 a.m.	Break
10:15 a.m.	Concurrent Sessions
12:00 p.m.	Lunch and Speakers
1:30 p.m.	Concurrent Sessions
3:00 p.m.	Break
3:15 p.m.	Concurrent Sessions
5:00 p.m.	Poster Session
6:30 p.m.	Summit Dinner
7:30 p.m.	Special Session: CCMP Bingo

Go to www.delawareestuary.org/summit to view 2019 summit abstracts, post conference proceedings and presentations, and the *newly revised* CCMP.

Don't miss CCMP Bingo on Monday night!

Tuesday, Jan. 29

8:00 a.m.	Registration/Breakfast
9:00 a.m.	Concurrent Sessions
10:45 a.m.	Break
11:00 a.m.	Keynote Speaker: Brandon Jones
11:45 a.m.	Lunch
1:15 p.m.	Concurrent Sessions
2:45 p.m.	Break
3:00 p.m.	Concurrent sessions
4:45 p.m.	Break
5:00 p.m.	Poster Session and Happy Hour
7:00 p.m.	Dinner on Your Own

Wednesday, Jan. 30

8:00 a.m.	Registration/Breakfast
8:30 a.m.	Concurrent Sessions
10:00 a.m.	Break
10:15 a.m.	Concurrent Sessions
12:00 p.m.	Lunch
1:30 p.m.	Hot Topics (combined session)
3:15 p.m.	Announcements Awards/Closing Remarks

Detailed Agenda
Monday, Jan. 28

8:00	a.m.	Registration/Breakfast
8:45	a.m.	Welcome: Jennifer Adkins
9:00	a.m.	Plenary Speakers: Mark Botton and Bob Loveland
10:00	a.m.	Break
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5:00	p.m.	Poster Session
6:30	p.m.	Summit Dinner
7:30	p.m.	Special Session: CCMP Bingo

* Indicates the name of a student Presentation or Poster

Concurrent Sessions by Room

9:00	**Plenary Speakers, Grand Ballroom** Please welcome our plenary speakers, Dr. Mark Botton and Bob Loveland, who will give their talk, "Forty Years on the Beach: Eyewitnesses to the American Horseshoe Crab and its Essential Habitat in Delaware Bay"		
	Grand Ballroom A	**Grand Ballroom B**	**Crystal Room**
	Water Quality I Moderators: Drew Budelis & Ken Najjar (Associated Posters 26-30)	Strategic Scientific Communication Moderators: Jay Springer & Douglas Janiec	A Decision Tool for Guiding Coastal Wetland Restoration in New Jersey Moderators: Josh Moody & Kaitlin Collins
10:15	Anthropogenic Changes to the Raritan River, New Jersey from Pre-European Settlement Through the Present Margaret Christie et al.	Effective Communication with Decision Makers Jeanne Herb	This workshop will serve as an introduction to the decision tool for guiding coastal wetland restoration, and to solicit feedback from the restoration, practitioner, and regulatory communities of the Delaware Estuary.
10:30	Sediment Diagenetic Processes in the Tidal Fresh Delaware River Paula Kulis, Kinman Leung, Eileen Althouse, Damian Brady, Jeffrey Cornwell, Michael Owens, Joanna York	Strategic Science Communication & Stakeholder Engagement in the Delaware Estuary Dana Patterson	

Detailed Agenda

Monday, Jan. 28, continued

	Grand Ballroom A	Grand Ballroom B	Crystal Room
10:45	Adaptation Planning for Sea Level Rise and Extreme Storms in the Delaware Estuary: Lessons from the Philadelphia Water Department Abby Sullivan, Avery Livengood, Julia Rockwell, Mark Maimone, Paula Kulis	Communicating Environmental Statistics for Public Consumption Salvatore Mangiafico	Decision Tool Continued
11:00	Role of Coastal Modeling in Long Island Nitrogen Managing Efforts Andrew Thuman	Using Data to Maximize Outreach: Philadelphia's Approach Hailey Stern	
11:15	A Field Study of Biochar Amended Soils: Water Retention, Infiltration and Nutrient Removal from Storm Water Runoff Joseph Brown*, Paul Imhoff, Larry Trout, Charles Hegberg, Ali Nakhli	Effective Science Communication: Principles and Visualization Techniques Alexandra Fries	
11:30	Q&A	Psst ... There's Science in Your Water Brian Rademaeker	
11:45	BREAK	Q&A	

Lunch Speakers, 5th Floor Penthouse Ballroom

Please welcome our lunchtime speakers who are members of the Partnership for the Delaware Estuary Steering Committee on the importance of the recently revised Comprehensive Conservation and Management Plan for the Delaware Estuary.

Debbie Mans, New Jersey Department of Environmental Protection

Steve Tambini, Delaware River Basin Commission

Jennifer Orr-Greene, Pennsylvania Department of Environmental Protection

	Grand Ballroom A	Grand Ballroom B	Crystal Room
	Living Resources Moderators: Jerry Kauffman & LeeAnn Haaf (Associated Posters 2-8)	Utilities and Sustainability Moderator: Brittany Musolino	New Jersey RGGI — Carbon Sequestration Opportunities Moderator: Liz Semple
1:30	Investigating the Community of Fishes and Invertebrates Inhabiting Two Living Shoreline Projects Jenny Shinn, David Bushek, Lisa Calbo, Moses Katkowski, Adrianna Zito-Livingston	The Sustainable Treatment Plant Dennis Palmer	The purpose of this workshop is to review and discuss opportunities for using Regional Greenhouse Gas Initiative funding on projects designed to sequester carbon in forests and marshes.
1:45	Variation in Swimming Ability Among Blue Crab (*Callinectes sapidus*) Larval Broods Joseph Caracappa*, Daphne Munroe	Sustainable Energy Management at a Water Utility Emily Hill	
2:00	Six Years of reTURN the Favor: Horseshoe Crab Conservation in New Jersey through Community Engagement Lisa Ferguson, Laura Chamberlin	BREAK	
2:15	Regenerative Stream Channel Serves as a Nature-like Fish Passageway Amanda Poskaitis, Roman Jesien, Katherine Phillips, Kevin Smith, Keith Underwood	South Jersey Scrub Round table "Not Your Typical Cleanup" From Trenton to Cape May Moderators: Amanda Lotto & Brittany Musolino (See abstract book for description)	
2:30	Dove's Nest Pollinator Mitigation Site Ken Dunne, Erika Furlong, Eric Ludwig, Todd Gsell		
2:45	Q&A		

Detailed Agenda

Monday, Jan. 28, continued

	Grand Ballroom A	Grand Ballroom B	Crystal Room
	Monitoring I Moderators: Angela Padeletti & John Yagecic (Associated Posters 9-14)	Environmental Justice Breaking Barriers Moderator: Renee Brecht-Mangiafico (Associated Posters 1)	Oil In the Bay —15 Years After the Athos I Spill Moderators: Peter Rowe, Emily Maung-Douglass, Christopher Petrone & Ann Faulds
3:15	Modeling and Monitoring Conservation Practices with WikiWatershed Steve Kerlin, Dave Arscott, David Bressler	Our Original Instructions Dennis Coker	This special session, organized by Sea Grant, is a retrospective on a major 2004 spill on the Delaware River. Do we have better capacity to respond to spills? How can we prevent spills within the Delaware Estuary? Presenters and panelists include: • Bennett Anderson; Delaware DNREC • Michel Boufadel; New Jersey Institute of Technology • Frank Csulak; NOAA • Rich Gaudiosi; Delaware Bay River Cooperative • Simeon Hahn; NOAA • Ed Levine; NOAA • David Ormes; U.S. Coast Guard • Robert Van Fossen; New Jersey DEP • Jeffrey Wakefield; CARDNO
3:30	View from Above Using Drones for Monitoring Steven Jacobus	UrbanPromise's River Guides Program-Ecology History Rachel Abbott	
3:45	Drone Mapping Dave DuMont	Farm Workers in a Changing Climate Jessica Culley	
4:00	A Next Generation Water Observing System for the Delaware River Basin Jeffrey Fischer, Chad Wagner	A Latin American Conservationist in New Jersey in the 1990's; Planting the Seeds for Conservation in the 21st Century Dennis Miranda	
4:15	Monarch Rapid Assessments on Delaware's Roadsides Jamie Pavona, Erika Furlong, Ken Dunne, Alison Cariveau	Executive Order 23 — Environmental Justice Update Riche' Outlaw	
4:30	Monitoring Inventory and Needs Assessment for the Delaware Estuary Emily Baumbach, et al.	Building an Equitable Watershed Katharina Miguel	
4:45	Q&A	Q&A	

Detailed Agenda
Tuesday, Jan. 29

8:00 a.m. Registration/Breakfast
9:00 a.m. Concurrent Sessions
10:45 a.m. Break
11:00 a.m. Keynote Speaker: Dr. Brandon Jones
11:45 a.m. Lunch
1:15 p.m. Concurrent Sessions
2:45 p.m. Break
3:00 p.m. Concurrent Sessions
4:45 p.m. Break
5:00 p.m. Poster Session and Happy Hour
7:00 p.m. Dinner on your own

Concurrent Sessions by Room

	Grand Ballroom A	Grand Ballroom B	Crystal Room
	Restoration I Moderators: Metthea Yepsen & Larry Malizzi (Associated Posters 15-25)	Science Class Moderators: Emily Baumbach & Brittany Musolino	Delaware River Basin Commission Water Quality Management Moderators: Mark Biddle & Kristin Regan
9:00	Coupling Hydrological Prisms to Inundation Times and Energy Signatures in Salt-Marsh Creation and Restoration Ken Dunne	Using the Preserve as an Outreach Tool Bob Collins, Amy Barra	Water Quality Management Part 1: The Need and Role for Clean Water Regulation Steven Tambini, Nansoo Suk, John Yagecic
9:15	Marsh Restoration Projects: Runnels and Breakwater Enhancement Heidi Hanlon, Nicole Savona	Diverse Outreach Tools Create Resilient Relationships in Cobbs Creek Dan Schupsky	Implementation of Water Quality Management Part 2: Applications, Successes and Challenges John Yagecic, Steven Tambini, Nansoo Suk

Detailed Agenda
Tuesday, Jan. 29, Continued

	Grand Ballroom A	Grand Ballroom B	Crystal Room
9:30	Salt Hay Farm Restoration Notes: Sediment Accretion and Vegetation I Kurt Philipp	What's happening with NGSS? Tonyea Mead	Water Quality Management by DRBC Part 3: Water Quality Challenges Namsoo Suk, Steven Tambini, John Yagecic
9:45	Using Dredged Material to Establish Habitat for Colonial and Marsh-nesting Birds Lenore Tedesco, Lisa Ferguson, Monica Chasten	Can Youth Be the Solution to Healthier, Sustainable Watersheds? Emma Melvin	BREAK
10:00	Let's Get Physical: Post-Construction Results of Structural Monitoring of Oyster Reef Breakwaters at Gandy's Beach, NJ Adrianna Zito-Livingston, Danielle McCulloch, Joshua Moody	Understanding the Urban Watershed Middle School Curriculum: Hands-On Learning About Water Sytems and Infrastructure, the Watershed and How to Ensure a Sustainable Future Ellen Schultz	Philadelphia Water Department Water Quality Planning Moderators: Kelly Anderson & Lance Butler Philadelphia Water Department Ammonia Reduction Planning Jay Cruz
10:15	Sea Grass Plantation: A Model Hybrid Living Shoreline Project Douglas Janiec	Connecting Teachers and Marine Science Researchers in the Science Classroom: Integrating Real Time Data into the Classroom in Order to Improve Student Learning Dina DiSantis	Philadelphia Water Department Salinity Intrusion Planning and Assessment Molly Hesson, Ramona McCullough
10:30	BREAK	BREAK	Philadelphia Water Department Strategic Planning Using High Resolution Water Quality Model in the Urban Tidal Freshwater Delaware River Kinman Leung, et al.

11:00	**Keynote Speaker, Grand Ballroom** Please welcome our summit keynote speaker, Dr. Brandon Jones, who will give his talk, "It's All Good: The Reciprocity of Diversity in STEM."		
	Grand Ballroom A	**Grand Ballroom B**	**Crystal Room**
	Wetlands Moderators: Dorina Frizzera & Martha Maxwell-Doyle (Associated Posters 31-34)	Place making Moderators: Sarah Morales & Kate Layton	Marine Debris and Plastic Pollution Moderators: Virginia Vassalotti & Juni Alam
1:15	A Dendroecological Investigation of the Demise of an Atlantic White Cedar Freshwater Tidal Wetland in Kent County, Delaware Stephanie Stotts, Olivia Gulledge	National Consortium for Creative Place making - How to Work With Artists to Create Environmental Projects Leo Vasquez	Reduce Litter in the Delaware River: An Action Plan to Clean Up and Reduce Debris on the Jersey Side Swarna Muthukrishnan, Alison McCarthy
1:30	Freshwater Wetland Habitat Responses to Saltwater Intrusion and Increased Flooding in Delaware Erin Dorset, Alison Rogerson		The Distribution of Microplastics in the Delaware Bay Jonathan Cohen, Anna Internicola
1:45	Wetland Condition in the Smyrna River Watershed, Delaware Alison Rogerson, Erin Dorset, Brittany Haywood, Kenny Smith		EPA's Trash-Free Waters Program: Regional and National Program Highlights Kelly Somers

Detailed Agenda
Tuesday, Jan. 29, Continued

	Grand Ballroom A	Grand Ballroom B	Crystal Room
2:00	Mid-Atlantic Tidal Rapid Assessment Updates: Development of a Tidal Freshwater Protocol Erin Dorset, Alison Rogerson, Brittany Haywood, Kenny Smith, LeeAnn Haaf	Collaborating With Art: How Science and Art Collaborative Projects Can Both Show and Help Solve Ecological Issues. Stacy Levy	Preventing Plastic Pollution Through Grassroots Activism John Weber
2:15	Determining Suitability of Sediments for Rebuilding Drowned Coastal Wetlands Brittany Wilburn, Kirk Raper, Camila Ibarra, Andrew Gray, Kenneth Raposa, Elizabeth Watson		Q&A
2:30	Q&A		

	Grand Ballroom A	Grand Ballroom B	Crystal Room
	Blue Collar Bivalves Moderators: Joe Tarsavage & Danielle Kreeger	Stem And Education Moderator: Brittany Musolino	Water Quality II Moderators: Kelly Somers & Namsoo Suk
3:00	Trials And Tribulations of Moving Oyster Aquaculture to Subtidal Leases in Delaware Bay David Bushek, Lisa Calvo, Eleanor Bochenek, Kevin Sullivan, Brian Harman, Barney Hollinger	Enviro DIY Sensor Stations for Education & Watershed Monitoring: A Case Study on Pickering Creek at Montgomery School, Chester Springs, Pennsylvania David Kline, David W. Bressler	The American Littoral Society Monitoring for Change: Continuous Water Quality Monitoring Stations in the Cohansey Watershed Sarah Johnson
3:15	Water Quality Benefits of a Shell-fish-Based Living Shoreline Along the Mispillion River, Delaware Josh Moody, Danielle Kreeger, Irina Beal	Going Virtual With Immersive Science Outreach Lisa Tossey*	Multi-Municipal Storm Water Collaborations: Comparisons Between the Chesapeake Bay and Delaware River Watersheds Ellen Kohler
3:30	Possible Niche Partitioning Among Four Ecologically and Economically Important Filter-Feeding Bivalves: A Case Study Of Bivalve Polyculture Michael Acquafredda*, Daphne Munroe	Scaling and Selecting STEM: Designing and Executing Unique, Effective Projects Matthew Fritch	Rally For The Navesink: A Collaborative Microbial Source Track-down With a Find-It, Fix-it, No-Blame Strategy Towards Restoration Swarna Muthukrishan, Bill Heddendorf, Trish Ingelido

* Indicates the name of a student Presentation or Poster

Detailed Agenda
Tuesday, Jan. 28, Continued

	Grand Ballroom A	Grand Ballroom B	Crystal Room
3:45	Exploring the Utility of Sidescan Sonar Imaging for Freshwater Mussel Distribution Mapping in the Tidal Delaware River Matthew Walderon, Samantha Burton, Randall Brown	Citizen Science Cartography Joe Haase	Preservation, Regulation and Restoration of Riparian Buffers: Promoting the Environmental Health of Watersheds in the Mid-Atlantic Region Robyn Leto*
4:00	Status of Freshwater Mussel Propagation at the Fairmount Water Works Interpretive Center, Philadelphia, Pennsylvania: Investing in Blue Infrastructure to Address Restoration Needs in the Urban Corridor Lance Butler, Richard Anthes, Danielle Kreeger, Angela Padeletti, Kurt Cheng, Roger Thomas, Kathryn Longwill		Q&A
4:15	Investing in Native Freshwater Mussel Stocks for Water Quality Enhancement in Mid-Atlantic Watersheds: The Mussels for Clean Water Initiative Danielle Kreeger, Rebecca Kennedy, Maitreyi Roy, Jennifer Adkins, Angela Padeletti, Kurt Cheng, Joshua Moody	Q&A	
4:30	Q&A	BREAK	

Detailed Agenda

Wednesday, Jan. 30

8:00 a.m. Registration/Breakfast
8:30 a.m. Concurrent Sessions
10:00 a.m. Break
10:15 a.m. Concurrent Sessions
12:00 p.m. Lunch
1:30 p.m. Hot Topics - Grand Ballroom

Concurrent Afternoon Sessions by Room

	Grand Ballroom A	Grand Ballroom B	Crystal Room
	Monitoring II Moderators: John Yagecic & Angela Padeletti	Big Storms & Rising Water: Voices Against The Wind Design Charrette, Digital Story Telling And Climate Change Moderators: Jon Cox & Kate Layton	Ms4x3 Moderators: Kate Hutelmyer & Douglas Janiec
8:30	Update to USGS Stream Stats for Delaware Beatrice O'Hara, John Callahan	In this session we will introduce the Delaware resilience awareness project (DELRAP), and then invite the audience to participate in a discussion and discovery through visual exploration around topics related to sea-level rise and intensifying storms. Additional presenters: • Amanda Binning • Greg Shelnutt • Anna Wik • Jules Bruck	Protecting the Environment by Reducing Storm Water Pollution Matthew Klewin
8:45	Wave Attenuation Monitoring of Living Shorelines in the Delaware Bay Katlin Walling, Douglas Gaffney		Highlights of DelDOT's NPDES Program Emily Seldomridge

Detailed Agenda
Wednesday, Jan. 30, Continued

	Grand Ballroom A	Grand Ballroom B	Crystal Room
9:00	Coastal Resiliency Hydrology and Ecological Monitoring in Southern New Jersey Noel Turner, Laura Mitchell	Big Storms & Rising Water: Voices Against The Wind (Continued) Design Charrette, Digital Story Telling And Climate Change	Partnering with Local Municipalities Towards Water Quality
9:15	Hydroacoustic Survey of Submerged Aquatic Vegetation in the Delaware Estuary: Preliminary Results from a Multi-Year Survey Kristin Regan, Kelly Somers		Pennsylvania's MS4 Program: New Requirements, Challenges and Opportunities Renee Reber
9:30	Q&A		Q&A
9:45	BREAK		BREAK

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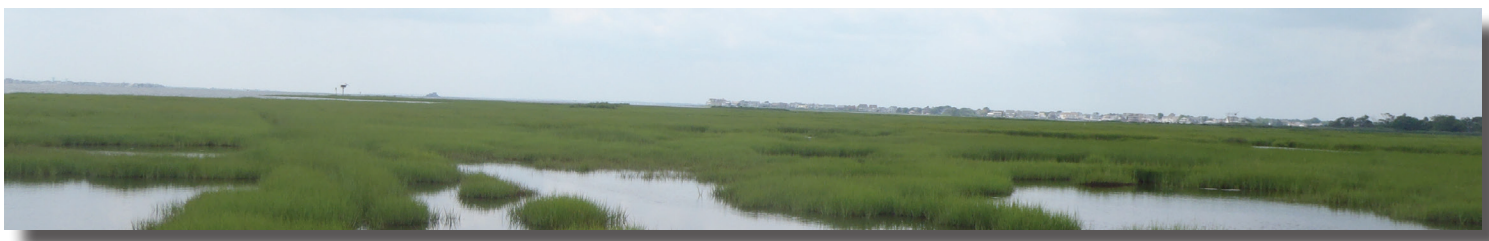
	Grand Ballroom A	Grand Ballroom B	Crystal Room
	Restoration II Moderators: Dave Bushek & Alison Rogerson	Citizen Science Moderators: Kaitlin Collins & Sarah Morales	Improving Your Programming Moderator: Renee Brecht-Mangiafico
10:15	Promoting and Protecting Early Successional Habitats on Electric Transmission Rights of Way Annina Hazel	NJDEP's Coastal Keepers Program Matt Warren, Rick Brown	Making it Click: Using Behavioral Research To Improve Outreach Planning Brittany Musolino
10:30	Collaboration in Studying Past Stream Restorations to Inform Future Action Hayley Oakland*, Stefanie Kroll		How NGOs Collaborating With Extension Can Make Multiple Strides Forward in Watershed Restoration Activities Chris Obrupta
10:45	Lardner's Point Park North End Living Shoreline in Complex Urban River Conditions Ed Morgereth, Brett Long, Chris Streb, Jim Fries	Building Natural Resources Stewardship Beth Offenbacker	Group Decision Making Methods Sarah Clark
11:00	South Wilmington Wetland Park: Wetland Restoration in a Constrained Environment Justin Reel		Using Evaluation to Help You Understand the Impact Of Your Work: A Workshop Rachel Becker-Klein



Detailed Agenda
Wednesday, Jan. 30, Continued

	Grand Ballroom A	Grand Ballroom B	Crystal Room
11:15	Functional Habitat Patch Size vs. Total Habitat Amount: The Importance of Patch Shape at Habitat Thresholds Jeff Keller	Community Based Monitoring in New Jersey: A Mutualistic Relationship Between Volunteers and the State Erin Stretz	Becker-Klein (Continued)
11:30	Q&A		
11:45	BREAK	Community Based Monitoring in New Jersey's High Aquifers Through Student Engagement Zach Nickerson	

Hot Topics
Moderators: Sue Kilham & Juni Alam
Grand Ballroom

1:30	The Aquatic Research and Restoration Center (ARRC): A Collaborative Approach to Addressing Urban Ecosystems in the Delaware Basin	Lance Butler, Danielle Kreeger, Angela Padeletti, Richard Anthes, Roger Thomas, Kurt Cheng, Kathryn Longwill
1:45	A Decade of Restoration and Monitoring: Turing Little Buck Run from Red to Blue	Aaron Clauser, Ph. D, Robert Struble, Jr., Brian Winslow
2:00	Advances in Thin Layer Placement Methods for Wetland Restoration: Design and Construction Considerations	Mark Reemts, PE, Ram Mohan
2:15	Watersheds on the Brink: Applying Sub-HUC12 Watershed Modeling and Scalable Conservation Solutions Towards Stabilizing Natural Landscapes at the Tipping Point for Clean Water	Nathan Boon, Amber Carter, Gregory Barren
2:30	Collaboration, Plant Breeding and Agroecology: Transforming Farming to Protect Fragile Ecosystems and Fight Climate Change	Nate Kleinman
2:45	Planning for a Greener Future: Incentivizing Storm Water Management with Zoning Bonuses	Sara Anderson
3:00	Closing Comments/Awards	Jennifer Adkins, Danielle Kreeger

Thank you for attending the summit!

Fill out our survey, or go online and visit www.surveymonkey.com/r/FL8GQH7

Photo courtesy of The Nature Conservancy

Poster Presentations
Listed by associated topic
Monday & Tuesday 5:00pm 5th Floor

Environmental Justice

1. Vidyarathna, Nayani; Laura Smith, Jonathan Cohen, Kathryn Coyne, Katherine Miller, Mark Warner; How does climate change affect the physiological ecology of *karlodinium veneficum* and its consequences on trophic transfer?

Living Resources

2. Cleary, Niki; Bushek, David (presenting), Josh Daw, Daphne Munroe; Atlantic Horseshoe Crab (*Limulus polyhemus*) Movement Within Oyster Farms on the Delaware Bay Shoreline

3. Jones, Casey*; David Bushek; Horseshoe Crabs, Red Knots, and Coastal Inundation

4. Longwill, Kathryn; Roger Thomas, Lance Butler, Danielle Kreeger, Kurt Cheng, Christopher Vito, Julia Duriske; Preliminary Results of Culturing Freshwater Mussels of the Mid-Atlantic Through In Vitro Techniques

5. McGowan, Andrew; Marianne Walch, Bob Collins, Victoria Spice; Increasing Oyster Populations in the Delaware Inland Bays

6. Smith, Lily*; The Shade Trees of Merchantville – A Citizen Science Inventory of Municipal Carbon Sequestration

7. Whiteside, Michael; Ximing Guo; Shell Color in the Eastern Oyster (*Crassostrea virginica*)

8. Woodruff, Patricia; David Bushek, Robert Loveland, Mark Botton; Horseshoe Crabs on Beaches Near Active Oyster Aquaculture Farms on the New Jersey Delaware Bayshore

Monitoring

9. Donohue, Steve; EPA Scientific Dive Unit

10. McKenna, Thomas; John Callahan, Kevin Brinson, Damaris Slawik; Determining Flow Paths for Flooding and Draining in Slaughter Beach, Delaware

11. Rogerson, Alison; Andrew Howard, Susan Guiteras, Douglas Janiec, Joshua Moody, Danielle Kreeger; Developing Monitoring Plans for Living Shoreline Projects in Delaware: A Goal-Based Framework

12. Soldner, Karly; Reducing Costs Of Green Storm Water Infrastructure Monitoring Data Collection to Inform Site Maintenance Decisions With Real-Time Soil Moisture Sensing Technologies and the Internet of Things

13. Vandeplas, Stormy; Annabella Larsen, Audrey DeRose-Wilson, Stephanie Warshawsky; Restored Barrier Beach Continues to Contribute to Delaware's Piping Plover Productivity

14. Yerk, Walter*; Meghan Rogalus; The Citizen Scientist-Supported Monitoring Program of the Poquessing Creek Restoration

15. Beal, Irina; Joshua Moody, Sarah Bouboulis, Danielle Kreeger; Living Shoreline Assessment for Community Resiliency in Coastal Pennsylvania

16. Bouboulis, Sarah; Joshua Moody, Danielle Kreeger; Delaware Estuary Shell Recycling Program: Lessons Learned Over First Two Years

18. Gentry, Matt; Joshua Moody, Sarah Bouboulis, Danielle Kreeger; Effects of Substrate Protection and Type on Ribbed Mussel Recruitment for Living Shoreline Applications

19. George, Robert; Evan Kwityn, Michael Rehman, Christiana Pollack; Monitoring to Assess Beneficial Reuse of Dredged Material in Salt Marsh Restoration at Fortescue Fish and Wildlife Management Area

20. Henry, Teric*; Stimating Sediment Deposition Rates and the Influence of Slope Along White Clay Creek Using Riparian Trees

21. Kroll, Stefanie; Marie Cruz, Scott Haag, Lin Perez, Meghan O'Donnell, Hayley Oakland, Richard Horwitz; Coordinated conservation through the DRWI-- How Much Improvement Do We Predict?

22. Malizzi, Lawrence; Murat Utku, Gary Emmanuel, James Davis; Natural Resource Damage Assessment Restoration: North Breton Island, Louisiana

23. McGowan, Andrew; A GIS Based Model for Prioritizing Reforestation Efforts

24. Pavona, Jamie*; Erika Furlong, Kenneth Dunne; Investigating Monarch Butterfly Habitat in Delaware Roadside Rights-of-Ways

25. Roberts, Spencer*; Joshua Moody, Kurt Cheng, Danielle Kreeger; Creating Flow Refugia to Augment and Restore Freshwater Mussel Populations in the Tidal Freshwater Delaware River

Water Quality

26. Fry, Katelynn*; Discharge Precipitation Relationship for White Clay Creek, Newark Delaware

27. Hall, Sydney*; Mike Mensiger, Stephanie Stotts; Microplastics in the St. Jones River: An Examination of the Relationship Between Concentration and Proximity to the City of Dover

28. Keyser, Todd; John Cargill IV, Morgan McGee-Solomon; WATAR in the Christina Basin: Achieving Goals Together

29. Parente, Allison*; Charles Shorten; Release and Uptake of Soluble PO4-P from Sediments in the West Branch Brandywine Creek, Chester County, Pennsylvania

30. Rondinelli, Michael; Shaun Gannon, Pioter Domasczynski, Ahintha Kandamby, Joe Imperi; Improving Water Quality for Trout in the West Branch Delaware River

Wetlands

31. Champlin, Lena*; D.J. Velinsky, C. Sommerfield, K. Raper, L. Haaf, K. St. Laurent, E. B. Watson; A Comparison of Annual and Decadal-Scale Carbon Sequestration Rates in New Jersey, Pennsylvania, and Delaware Tidal Wetlands Using Interpolation Mapping

32. Hartman, JeanMarie; The Role of Forests as Green Infrastructure

33 Rodriguez, Kassandra*; Changes in Tidal Marsh Vegetation Communities at Bombay Hook National Wildlife Refuge in Smyrna, Delaware

34. Rodriguez, Christian*; Invasive Species Control and Management at Bombay Hook National Wildlife Refuge in Smyrna, Delaware

Speakers And Their Institutions

Abbott, Rachel; UrbanPromise Ministries, Inc.

Acquafredda, Michael; Haskin Shellfish Research Lab, Rutgers University

Anderson, Bennett; Delaware DNREC

Anderson, Sara; Philadelphia Water Department

Baumbach, Emily; Partnership for the Delaware Estuary

Beal, Irina; Partnership for the Delaware Estuary

Becker-Klein, Rachel; Two Roads Consulting

Boon, Nathan; The William Penn Foundation

Bouboulis, Sarah; Partnership for the Delaware Estuary

Boufadel, Michael; New Jersey Institute of Technology

Brown, Joseph; University of Delaware

Bushek, David; Haskin Shellfish Lab, Rutgers University

Butler, Lance; Philadelphia Water Department

Caracappa, Joseph; Haskin Shellfish Research Laboratory, Rutgers University

Champlin, Lena; Drexel University and the Academy of Natural Sciences

Christie, Margaret; Rutgers University

Clark, Sarah; Institute for Conservation Leadership

Clauser, Aaron; Clauser Environmental, LLC

Cohen, Jonathan; University of Delaware

Coker, Dennis, Lenape Indian Tribe of Delaware

Collins, Bob; Delaware Center for the Inland Bays

Cruz, Jay; Philadelphia Water Department

Csulak, Frank; NOAA

Culley, Jessica; CATA - El Comite de Apoyo a los Trabajadores Agricolas

DiSantis, Dina; Downingtown West High School

Donohue, Steve; US Environmental Protection Agency

Dorset, Erin; Delaware Department of Natural Resources and Environmental Control

DuMont, Dave; NJDEP

Dunne, Ken; DelDOT

Ferguson, Lisa; The Wetlands Institute

Fischer, Jeffrey; US Geological Survey

Fries, Alexandra; University of Maryland Center for Environmental Science

Fritch, Matthew; Philadelphia Water Department

Fry, Katelynn; Wesley College

Furlong, Erika; Delaware Department of Transportation

Gaudiosi, Rich; Delaware Bay River Cooperative

Gentry, Matt; Partnership for the Delaware Estuary

George, Robert; Princeton Hydro

Haase, Joe; 4-H

Hahn, Simeon; NOAA

Hall, Sydney; Wesley College

Hanlon, Heidi; US Fish and Wildlife Service

Hartman, JeanMarie; Rutgers

Hazel, Annina; Pepco Holdings

Herb, Jeanne; Rutgers University Bloustein School of Planning & Public Policy

Hesson, Molly; Sage Services LLC

Hill, Emily, Philadelphia Water Department

Horwitz, Richard; Academy of Natural Sciences of Drexel University

Jacobus, Steven; New Jersey Department of Environmental Protection

Janiec, Douglas; Sovereign Consulting Inc.

Johnson, Sarah; American Littoral Society

Jones, Casey; Rutgers University Department of Marine and Coastal Sciences

Keller, Jeff; Habitat by Design, LLC

Kerlin, Steve; Stroud Water Research Center

Keyser, Todd; DE DNREC Waste and Hazardous Substances

Kleinman, Nate; Experimental Farm Network

Kline, David; Montgomery School

Kohler, Ellen; University of Maryland Environmental Finance Center

Kreeger, Danielle; Partnership for the Delaware Estuary

Kroll, Stefanie; Academy of Natural Sciences of Drexel University

Kulis, Paula; CDM Smith

Leto, Robyn; University of Pennsylvania

Leung, Kinman; Philadelphia Water Department

Levine, Ed; NOAA

Levy, Stacy; self employed artist

Longwill, Kathryn; The Academy of Natural Sciences of Drexel University

Lucas-Odom, Judith; Chester Upland School District

Malizzi, Lawrence; OBG

Mangiafico, Salvatore; Rutgers Cooperative Extension of Cumberland County

McGowan, Andrew; Delaware Center for the Inland Bays

McKenna, Thomas; University of Delaware

Mead, Tonyea; Delaware Department of Education

Melvin, Emma; American Littoral Society

Miranda, Dennis; Pocono Environmental Education Center

Miguel, Katharina, New Jersey Audubon

Moody, Joshua; Partnership for the Delaware Estuary

Morgereth, Ed; Biohabitats, Inc.

Musolino, Brittany; Partnership for the Delaware Estuary

Muthukrishnan, Swarna; Clean Ocean Action

Nickerson, Zach; American Littoral Society

Oakland, Hayley; Academy of Natural Sciences of Drexel University

Obropta, Chris; Rutgers Cooperative Extension Water Resources Program

Offenbacker, Beth; Waterford, Inc./Leadership Nature Center

O'Hara, Beatrice; Delaware Geological Survey

Ormes, David; U.S. Coast Guard

Palmer, Dennis; The Landis Sewerage Authority

Parente, Allison; West Chester University

Patterson, Dana; Princeton Hydro

Pavona, Jamie; Delaware Department of Transportation

Philipp, Kurt; Wetlands Research Services

Poskaitis, Amanda; Maryland Coastal Bays Program

Rademaekers, Brian; Philadelphia Water Department

Reber, Renee; American Rivers

Reel, Justin; RK&K

Reemts, Mark; Anchor QEA

Regan, Kristin; US EPA Region 3

Roberts, Spencer; Partnership for the Delaware Estuary

Rodriguez, Kassandra; Wesley College

Rodriguez, Christian; Wesley College

Rogerson, Alison; Delaware DNREC

Rondinelli, Michael; OBG (O'Brien & Gere)

Seldomridge, Emily; DelDOT

Schultz, Ellen; Fairmount Water Works Interpretive Center

Schupsky, Dan; Trans-Pacific Engineering Corporation (consultant to The Philadelphia Water Department)

Shinn, Jenny; Rutgers University

Smith, Lily; Camden Catholic High School

Soldner, Karly; Drexel University

Somers, Kelly; EPA Region 3

Stern, Hailey; Trans-Pacific Engineering Corp (Consultant to Philadelphia Water Department)

Stotts, Stephanie; Wesley College

Stretz, Erin; The Watershed Institute

Suk, Namsoo; Delaware River Basin Commission

Sullivan, Abby; Philadelphia Water Department

Tambini, Steven; Delaware River Basin Commission

Tedesco, Lenore; The Wetlands Institute

Thuman, Andrew; HDR

Tossey, Lisa; University of Delaware

Turner, Noel; U.S. Fish and Wildlife Service - Cape May NWR

Vandeplas, Stormy; Prime Hook National Wildlife Refuge

Van Fossen, Robert; New Jersey DEP

Vazquez, Leonardo; The National Consortium for Creative Placemaking

Vidyarathna, Nayani; University of Delaware

Wakefield, Jeffrey; CARDNO

Walderon, Matthew; Pennsylvania Coastal Resources Management Program, Department of Environmental Protection

Walling, Katlin; Mott MacDonald

Walker, Nathan; Wood Environment & Infrastructure

Warren, Matt; New Jersey DEP

Weber, John; Surfrider Foundation

Whiteside, Michael; Rutgers University

Wilburn, Brittany; Academy of Natural Sciences of Drexel University

Woodruff, Patricia; Rutgers University

Yagecic, John; Delaware River Basin Commission

Yerk, Walter; Drexel University

Zito-Livingston, Adrianna; The Nature Conservancy

Partnership for the Delaware Estuary Staff

110 S. Poplar Street, Suite 202
Wilmington, Delaware 19801
(302) 655-4990

Jennifer Adkins
Executive Director
jadkins@delawareestuary.org
Ext. 102

Emily Baumbach
Science Planning Coordinator
ebaumbach@delawareestuary.org
Ext. 118

Irina Beal
Science Technical Specialist
ibeal@delawareestuary.org
Ext. 106

Sarah Bouboulis
Habitat Project Specialist
sbouboulis@delawareestuary.org
Ext. 119

Renee Brecht-Mangiafico
Director of Outreach
rbrecht@delawareestuary.org
Ext. 105

Kurt Cheng
Shellfish Coordinator
kcheng@delawareestuary.org
Ext. 107

Kaitlin Collins
Watershed Planning Coordinator
kcollins@Delawareestuary.org
Ext. 108

Nancy Descano
Deputy Executive Director
ndescano@delawareestuary.org
Ext. 111

Karen Forst
Coordinator of Grants
kforst@delawareestuary.org
Ext. 120

Matt Gentry
Science Fellow
mgentry@delawareestuary.org
Ext. 123

LeeAnn Haaf
Wetland Coordinator
lhaaf@delawareestuary.org
Ext. 116

Kylie Hall
Events and Grants Administrator
khall@delawareestuary.org
Ext. 120

Elizabeth Horsey
Development Manager
ehorsey@delawareestuary.org
Ext. 114

Kate Hutelmyer
Watersheds Program Manager
khutelmyer@delawareestuary.org
Ext. 109

Kathy Klein
Director of Donor Engagement
kklein@delawareestuary.org
Ext. 110

Danielle Kreeger
Science Director
dkreeger@delawareestuary.org
Ext. 104

Kate Layton
Marketing & Communications Manager
klayton@delawareestuary.org
Ext. 113

Joshua Moody
Restoration Programs Manager
jmoody@delawareestuary.org
Ext. 115

Sarah Morales
Outreach Associate
smorales@delawareestuary.org
Ext. 106

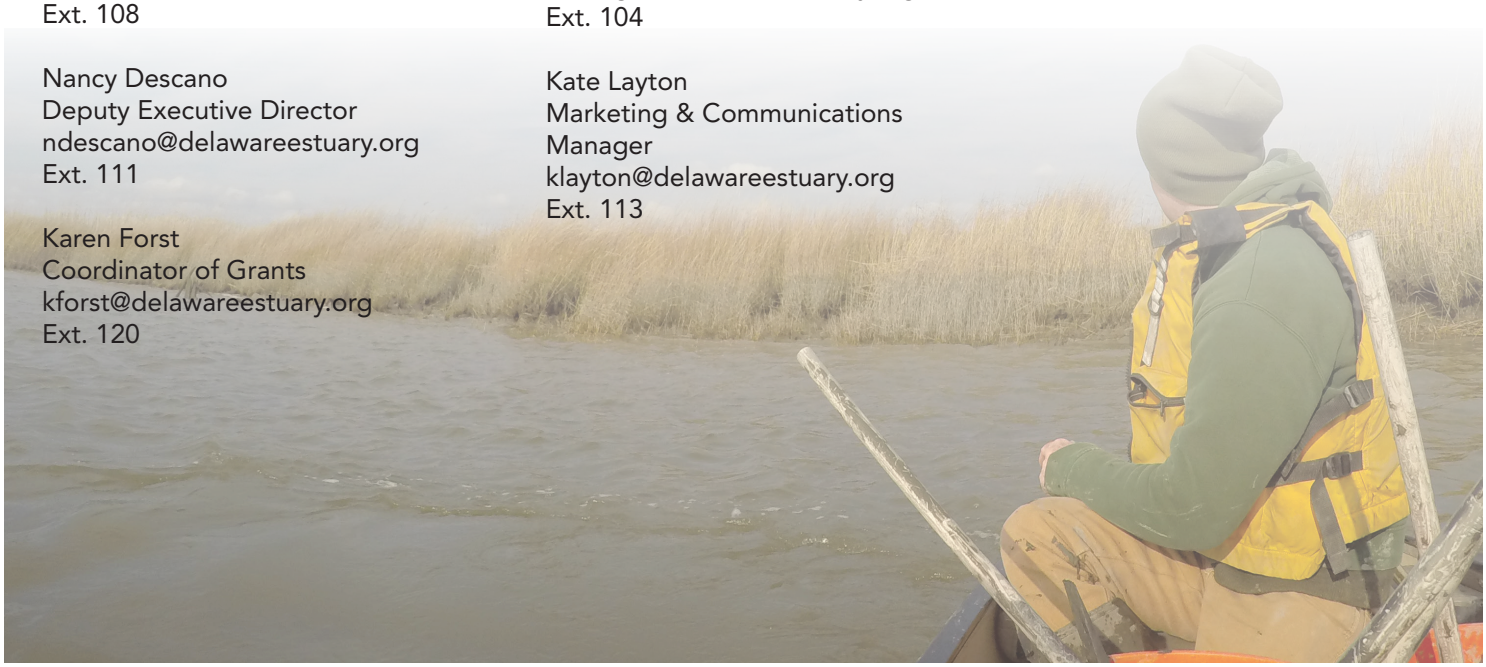
Brittany Musolino
Outreach Program Specialist
bmusolino@delawareestuary.org
Ext. 114

Angela Padeletti
Science Programs Manager
apadeletti@delawareestuary.org
Ext. 103

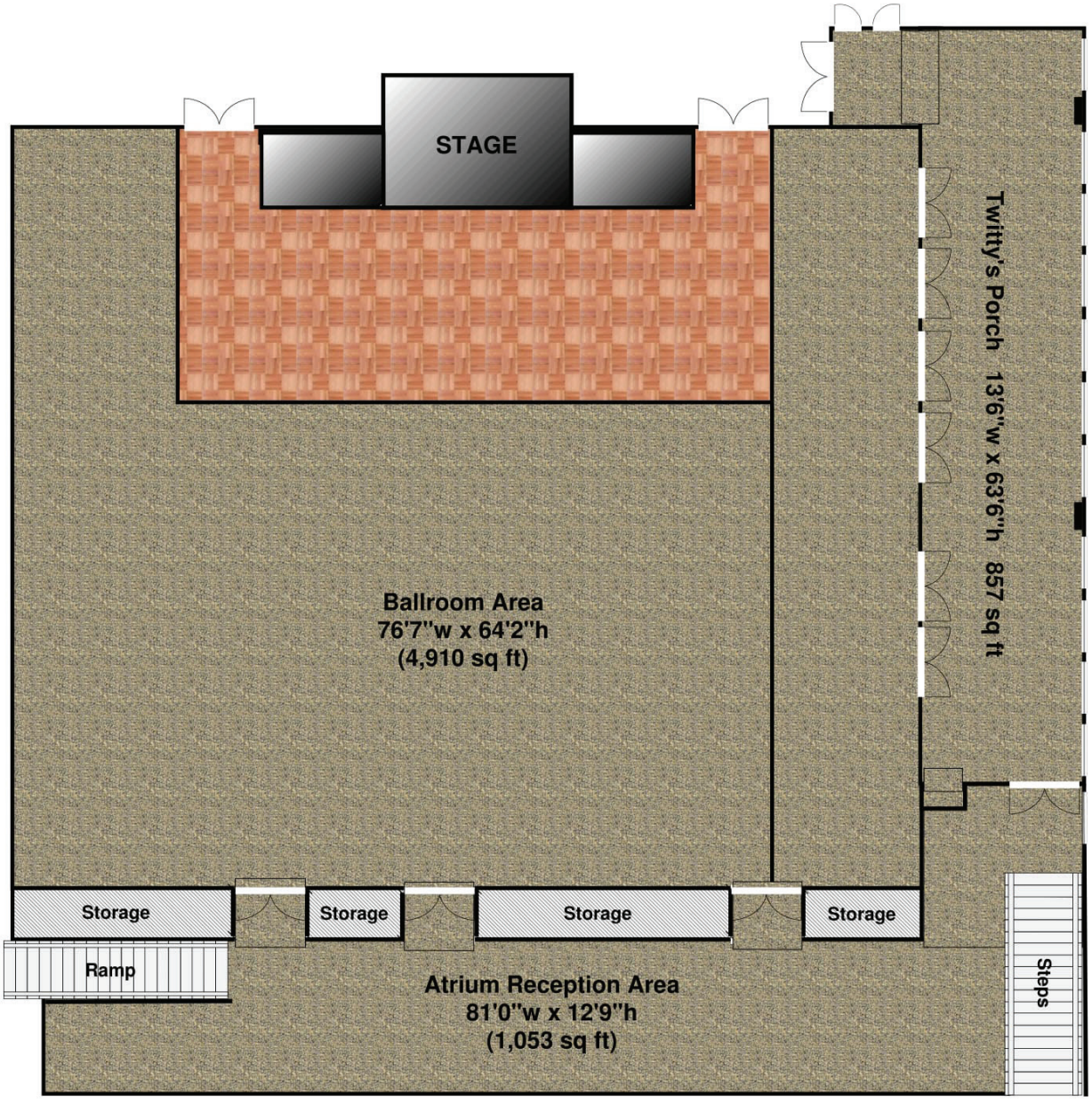
Spencer Roberts
Science Fellow
sroberts@delawareestuary.org
Ext. 123

Erica Rossetti
Outreach Intern
erossetti@delawareestuary.org
Ext. 122

Virginia Vassalotti
SAN Coordinator
vvassolotti@delawareestuary.org
Ext. 121



Grand Ballroom

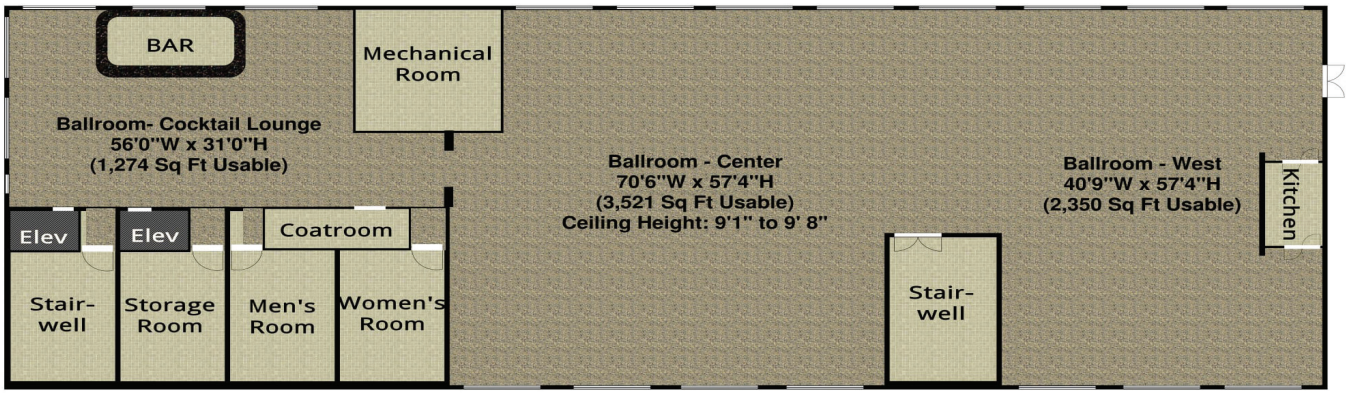


The Grand Hotel
CAPE MAY

Crystal Room

The Grand Hotel
CAPE MAY

Penthouse Ballroom



The Grand Hotel
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*Vegetarian and non-dairy options available

3. Hot Dog Tommy's
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Dinner, Daily 5 - 9 PM
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Lunch 11 AM - 2 PM,
Dinner 5 PM - 9 PM
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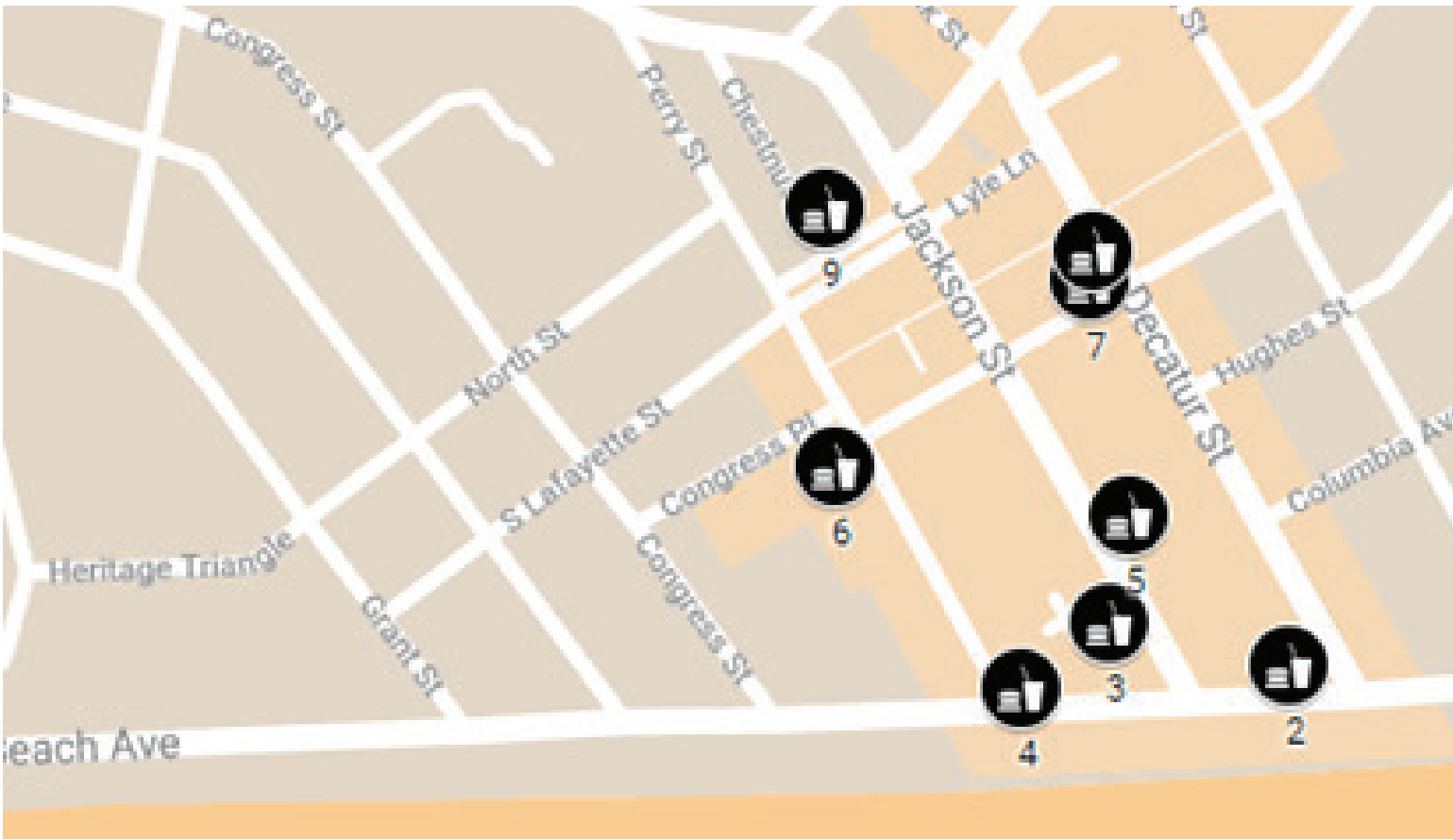

ay Restaurants

7. Fins Bar & Grille
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Dinner, Sunday through
Thursday 4 - 8 PM
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8. Ugly Mug Bar & Restaurant
Open daily from 11 AM - 2 AM
426 Washington St.
(609) 884-3459

9. Iccara Italian Bistro
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311 Mansion St.
(609) 884-0200

10. Bella Vida "Garden Café
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(609) 884-1170
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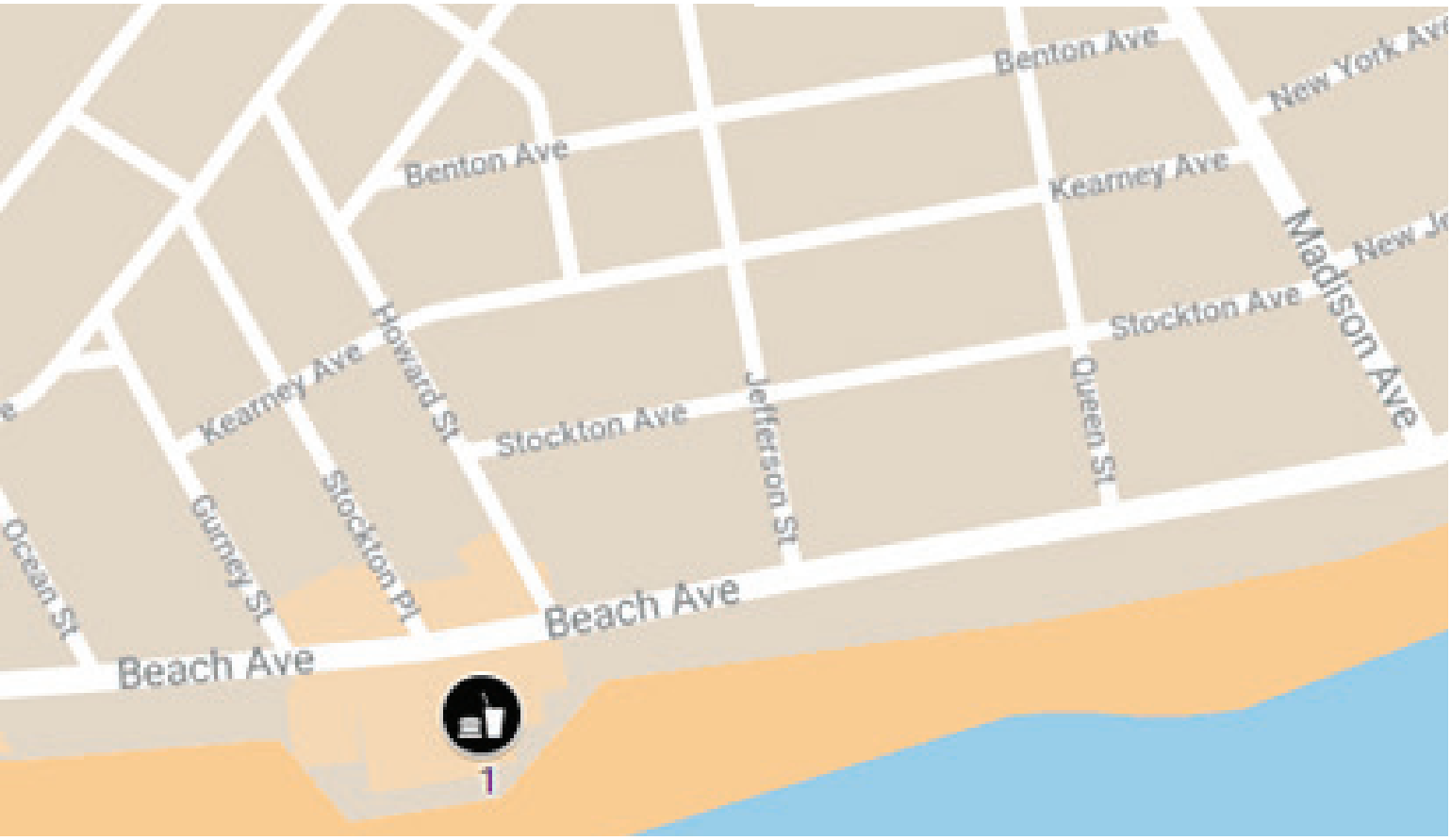
*Vegetarian and non-dairy options available



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Delaware's Department of Natural Resources and Environmental Control stands strong with our partners in the Delaware Estuary Program on the shared goals of ensuring clean water, strong communities, and healthy habitats here in the First State.

By collaborating with other state and federal agencies, municipalities, businesses, community groups, non-profits, and residents statewide, DNREC can accomplish so much more to manage our natural resources, restore damaged habitats, and apply the best available science to ensure the future of our beautiful, fragile, and vitally important estuaries.

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The Mussel Hatchery has been supported by **The Pew Center for Arts & Heritage** and **Philadelphia Water Department**, with additional support from **McLeon Contributionship** and **Department of Conservation and Natural Resources**, in partnership with **Partnership for the Delaware Estuary** and **The Academy of Natural Sciences of Drexel University**.

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Joseph Tarsavage
JTarsavage@kleinfelder.com
610-594-1444

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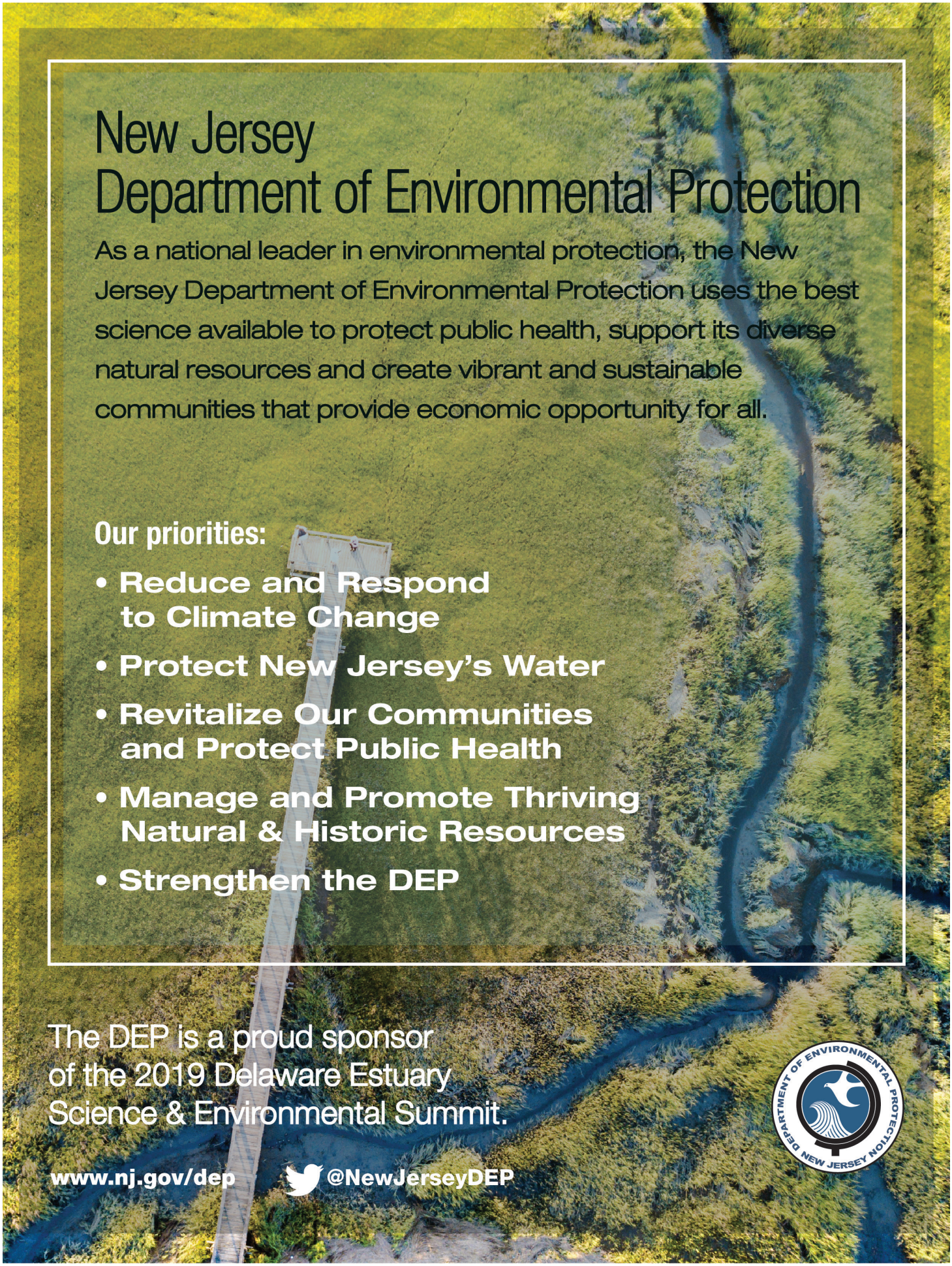
EPA This message has been funded by the USEPA under a Clean Water Act grant agreement to Ocean County College and has not undergone USEPA review.

Ocean County New Jersey
Ocean County College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Department of Environmental Protection
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Our priorities:
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• Protect New Jersey's Water
• Revitalize Our Communities and Protect Public Health
• Manage and Promote Thriving Natural & Historic Resources
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The **Partnership for the Delaware Estuary** leads science-based and collaborative efforts to improve the tidal Delaware River and Bay, which spans Delaware, New Jersey, and Pennsylvania.

Partnership for the DELAWARE ESTUARY

Connecting people, science, and nature for a healthy Delaware River and Bay

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Abstract Book

Delaware Estuary Science and Environmental Summit 2019

January 27-30, 2019, The Grand Hotel, Cape May, NJ

Partnership for the DELAWARE ESTUARY

The Partnership for the Delaware Estuary brings together people, businesses, and governments to restore and protect the Delaware River and Bay.

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This abstract book is an addendum to the printed program for the Delaware Estuary Science & Environmental Summit 2019, held January 27-30th, 2019 in Cape May New Jersey. You can view the program, proceedings and available presentations at www.delawareestuary.org/summit

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Plenaries, Keynotes, Special Sessions, Panels & Workshops


Photo Credit: Spencer Roberts

40 Years on the Beach: Eyewitnesses to the American Horseshoe Crab and its Essential Habitat in Delaware Bay

Monday Keynote, 9:00am, Grand Ballroom, 1st Floor

Botton, Mark, Department of Natural Sciences, Fordham University, *113 West 60th Street, New York, New York 10023*, botton@fordham.edu; **Robert Loveland**, Department of Ecology, Evolution, and Natural Resources, *Rutgers University, New Brunswick, New Jersey 08901,* robert.loveland@gmail.com

The objective of this talk is to discuss the past, present and future population dynamics of the horseshoe crab, an iconic species of the Delaware Estuary. Spawning habitat for horseshoe crabs is highly changeable, affected by geological processes and human activities. Sea level rise and commercial exploitation are considered to be the main factors affecting the stability of populations. During the late 19th and early 20th centuries, many millions of horseshoe crabs were harvested for fertilizer and animal feed. From the 1930's through the 1990's, exploitation was low, allowing for the recovery of the population. During the late 1990's, intensive harvesting of horseshoe crabs for bait took place at levels that approached the fertilizer industry, but since 1998, the fishery has been regulated by ASMFC and is in a state of recovery. Major changes in the topography of the shoreline have impacted spawning during the 40 years that we have studied these animals. Setback of the beach, accompanied by exposure of ancient salt marsh peat in the intertidal, is prevalent along the bayshore. Where beaches could naturally migrate landward, the impact on horseshoe crabs has been minimal in comparison to areas with armored shorelines. Given the expected scenario of continued sea level rise and erosion of open bay beaches, it is imperative that we identify and protect those habitats that will become "hot spots" for horseshoe crab spawning in the future. Our research suggests that sand bars and spits in the vicinity of salt marsh creeks may become increasingly important, even as erosion of adjacent open beaches continues. The identification, preservation and (if necessary) the replenishment of proven spawning sites should be incorporated into the long-term management plan for the Delaware Estuary.

Dr. Mark L. Botton (botton@fordham.edu) is Professor of Biology in the Department of Natural Sciences at Fordham University – Lincoln Center in New York City. He is the Co-Director of Fordham's Environmental Science Program. He received his Bachelor's degree in Biology from Stony Brook University, his Master's degree in Biology from Brooklyn College, and his Ph.D. in Zoology from Rutgers University. He has published over 50 articles and book chapters on various aspects of horseshoe crab biology, including feeding ecology, mating behavior, the effects of pollution on developmental success, and population and conservation biology. He is the Co-Chairman of the IUCN (International Union for the Conservation of Nature) Horseshoe Crab Species Specialist Group.

Bob Loveland is now happily retired from Rutgers University, but still has an office on the Cook Campus which he shares with Mark Botton. He is still active in publishing articles with Mark, and also has delivered a number of presentations on horseshoe crabs, ranging from C W Post on Long Island, and as far away as Flagstaff AZ. His research interests and professional activities have shifted somewhat away from the Delaware Bay. For example, he is currently writing a popular style book on horseshoe crabs, called "Kingcrab NJ"; another on numbers for children called "The Book of Evans"; and yet another work called "Prime Primer: This Ain't About Paint". Bob graduated from Rutgers Camden in 1959, then received his Masters and PhD from Harvard in 1963. He has collaborated with Mark Botton since the early 1980's.

It's All Good: The Reciprocity of Diversity in STEM

Tuesday Keynote, 11:00am, Grand Ballroom, 1st Floor

Jones, Brandon, Program Director, National Science Foundation Geosciences Directorate

Diversity is a vital priority that promotes innovation and strengthens a community's resiliency. The lack of diversity in science, technology, engineering, and mathematics (STEM) disciplines is not a new development and the geosciences continue to lag other STEM disciplines in this area. The main aspects of diversity including the engagement, recruitment and retention of individuals from traditionally under-involved and underserved communities is particularly prominent in the realm of geoscience education and training. Many current and historical geoscience funding efforts have focused on increasing the pool of educated, well-qualified individuals, but it should also include efforts to develop and sustain supportive learning, research and professional environments to retain said individuals.

Brandon Jones is the Program Director for the education and diversity efforts in the National Science Foundation's (NSF) Geosciences Directorate. Brandon joined NSF after serving almost 13 years as a grants and fellowships Program Manager at the Environmental Protection Agency (EPA). At NSF, he oversees programs that focus on undergraduate and graduate workforce preparation for the Geosciences and supports initiatives related to increasing diversity, inclusion and belonging in science, technology, engineering, and mathematics (STEM). Brandon received a BA in biology from The Lincoln University (PA) in 1991 and his MS and PhD degrees in Marine Biology and Biochemistry from the University of Delaware's College of Earth, Ocean and Environment in 1994 and 2003 respectively. He taught five years of high school science in the interim between his MS and PhD matriculation. Brandon currently serves on the board of directors for the American Geophysical Union and the Environmental Leadership Program. He is also a member of the Dean's Advisory Council for the University of Delaware's College of Earth, Ocean and Environment. He continues to be an active member for the under-involved students interested in STEM.

A Decision Tool for Guiding Coastal Wetland Restoration in New Jersey

Monday, 10:15am, Crystal Room, 1st Floor

Moderators: Joshua Moody & Kaitlin Collins

Presented by: Partnership for the Delaware Estuary and New Jersey Department of Environmental Protection

Tidal marsh restoration efforts and activities across the Delaware Estuary have been numerous in the last several years. Many implemented projects have achieved success in meeting goals and past efforts to standardize project monitoring has resulted in an increase of available data. Questions, however, remain regarding the identification of site-specific condition deficiencies and how to pair them with the appropriate tactics.

The New Jersey Department of Environmental Protection (NJDEP) and the Partnership for the Delaware Estuary (PDE) are in the initial stages of the development of a salt marsh restoration decision tool. This tool will aim to provide standardized guidance on identifying wetland conditions and assessing site-specific needs for intervention. This workshop will serve as a means to collect feedback on these ideas from the restoration, practitioner, and regulatory communities working in the Delaware Estuary. Members of NJDEP and PDE will present on:

- Project Background and Regulatory Needs
- Data Structure and Needs
- Concurrent Wetlands Reference Database Development
- Decision Tool Structure and Function

This interactive workshop is designed to stimulate discussion and address the following questions:

- What data or processes are missing?
- How can this tool be designed to best suit the needs of funding entities, practitioners, and regulatory agencies alike?
- Does the model framework incorporate the necessary parameters and interactions?

Throughout the session, live polling, group discussion, and written comment activities will be conducted to gather information.

New Jersey Regional Greenhouse Gas Initiative-Carbon Sequestration Opportunities

Monday, 1:30pm, Crystal Room, 1st Floor

Moderator: Elizabeth Semple

New Jersey Regional Greenhouse Gas Initiative: Carbon Sequestration
Purpose: Review and discuss opportunities for using RGGI funding on projects designed to sequestration carbon in forests and marshes.

Christine Schell, Air Quality, Energy and Sustainability Assistant Commissioner's Office, will give an overview of RGGI in general and discuss NJ status in rejoining RGGI. She will explain how the RGGI proceeds would be dispersed to EDA, BPU and DEP and their general uses.

Elizabeth Semple, Office of Coastal and Land Use Planning, will present on the new and developing planning process for tidal marshes. DEP needs to define how to identify tidal marshes for prioritization of funding for carbon sequestration, ecological resources and community resilience. This planning process will expand the current efforts on tidal shoreline stabilization, elevation assistance and migration opportunities. This works aligns with other coastal resilience planning that OCLUP is currently working on such as coastal-wide resilience planning, NJFRAMES and the NDR grant. Initial mapping and analysis is being done to help formulate the questions that should be asking and the data that will be needed.

Dave DuMont, Research Scientist, NJDEP will present Coastal Management GIS mapping projects that could further inform future (blue carbon) marsh restoration projects. These maps are: DEP Marsh Migration Index, DEP Coastal Vulnerability Index, DEP Dredge Material Placement Screen, Rutgers Flood Mapper, and TNC Restoration Explorer.

Julie Blum, Rutgers Graduate Student, and NJDEP research assistant will discuss the GIS Index Map currently being developed for prioritizing marsh carbon sequestration projects. This mapping is being designed to rank Tidal Salt Marshes on Resiliency, Ecology and Carbon Sequestration values. The goal of this project is to be able to provide additional spatial information in to the decision process of (blue carbon) marsh restoration project prioritization. This mapping and prioritization methodology is currently under development and has not been finalize or approved.

Oil in the Bay-15 Years After the Athos I Spill

Monday, 3:15pm, Crystal Room, 1st Floor

Organizers:

- Ann Faulds, Pennsylvania Sea Grant
- Emily Maung-Douglass, Louisiana Sea Grant
- Christopher Petrone, Delaware Sea Grant
- Peter Rowe, New Jersey Sea Grant

Time	Speaker	Affiliation	Topic
3:15 PM	Emily Maung-Douglass	Louisiana Sea Grant	Welcome and introduction to the session
3:25 PM	Martha Maxwell Doyle	Barnegat Bay Partnership	Needs arising from the Athos I incident
3:35 PM	Rich Gaudiosi	DBRC	Responding to oil spills in Delaware Bay
3:45 PM	Jeff Wakefield	Cardno	Informing spill response in Delaware Bay with plans formed elsewhere
3:55 PM	Michel Boufadel	NJIT/GoMRI	Impact of the physical form of oil on its transport
4:05 PM	**Question & Answer - Panel discussion with State & Federal panelists Moderators: Ann Faulds (Pennsylvania Sea Grant) & Peter Rowe (New Jersey Sea Grant), Christopher Petrone (Delaware Sea Grant)**		
	Bob VanFossen	NJ DEP	NJ state response to spills
	Ben Anderson	DNREC	DE state response to spills
	Rich Gaudiosi	DBRC	DBRC response to spills
	Jeff Wakefield	Cardno	Socioeconomic aspects of spills
	Michel Boufadel	NJIT/GoMRI	Research & oil spills
5:00 PM	**Poster Session**		

The Athos I oil spill occurred in November 2004 after the tanker, en route to a New Jersey refinery, struck a submerged anchor in Delaware River. The allision resulted in more than 260,000 gallons of heavy crude oil into the Delaware River and Bay resulting in clean-up expenses totaling $143M. The impacts were costly to the tri-state area – both ecologically and economically. Shoreline oiling spanned three states, bird mortality estimates totaled over 11,500, commercial traffic in the river halted, and a nuclear power plant was temporarily closed.

What would happen if the Athos spill happened today? This special session will include both invited talks and a panel discussion to present a retrospective including research gained over the years following the spill, and how to improve our capacity to respond to and prevent future spills in the Delaware estuary.

South Jersey Scrub Roundtable

"Not Your Typical Cleanup": From Trenton to Cape May

Monday, 2:15pm, Grand Ballroom B, 1st Floor

Moderators: Amanda Lotto & Brittany Musolino

Description: Trash remains to be a major issue in the Delaware River Watershed despite many efforts to cleanup neighborhoods and discourage littering in the first place. Inspiration for a larger cleanup initiative in New Jersey comes from the Schuylkill Scrub in Pennsylvania, which is a two-month long cleanup extravaganza that now attracts over 20,000 volunteers and boasts over 800 individual cleanup events. The Partnership for the Delaware Estuary is looking to replicate this in the Lower Delaware Watershed of New Jersey with help from the New Jersey Department of Environmental Protection, AmeriCorps Watershed Ambassadors, NJ Clean Communities, and many more partners – perhaps your organization!

Format: 15 minute discussion about the South Jersey Scrub's first year and 2019 goals, plus ways to get involved. 30 minutes will be left for questions, brain storming, and next steps for cleanup event planning.

Topics to be addressed:

- Existing cleanup initiatives and their focus areas
- Framework for Scrub events and data gathering
    - Regional committees and captains
    - Website content and data submissions
- Partner groups
- Defining scale and priorities (i.e. number of cleanups, volunteer base)

Big Storms and Rising Water: Voices Against the Wind

Design Charette-Digital Storytelling & Climate Change

Wednesday, 8:30am, Grand Ballroom B, 1st Floor

After introducing the Delaware Resilience Awareness Project (DelRAP), we invite the audience members to participate in a process of discussion and discovery through visual exploration around topics related to sea-level rise and intensifying storms. This engaging session aims to enable exchange and dialog and to identify patterns of public perception related to the changing landscape. The intended outcome of this unique creative process is to foster resilience through storytelling during a future traveling exhibition. Come ready to engage and share.

Panel Bios:

- **Dr. Jules Bruck** is Director and Professor of Landscape Architecture at the University of Delaware, where she teaches courses in creativity, design process, field sketching, and planting design. Jules, a registered landscape architect, a permanently certified member of the Association of Professional Landscape Designers, and a SITES Accredited Professional (AP) is the founder of the UD Coastal Resilience Design Studio. She currently serves on the Delaware Board of Landscape Architecture and the Board of Trustees of Preservation Delaware. Dr. Bruck also owns and operates Evolution Landscape Design, LLC, through which she engages in design consulting, community revitalization, and innovation education. Her current research interests are in coastal resilience and public perception of sustainable landscape practices such as designing for ecosystem services. Dr. Bruck has a Ph.D. from Texas A&M University.
  Anna Wik is an Assistant Professor in the Department of Plant and Soil Sciences and a professional landscape architect in Delaware and Pennsylvania. She has designed, documented, and managed construction of many landscape projects in the region, working with community and non-profit partners including Philadelphia Parks and Recreation, the Philadelphia Water Department, and numerous community groups. She is passionate about equitable design and is interested in historical, social and cultural influences upon the urban landscape. Other research areas include outdoor learning environments, productive landscapes, such as edible forest gardens, and strategies of coastal resilience. Anna has an MLA from the Rhode Island School of Design.
- **Greg Shelnutt** serves as a Professor and Chair of the Department of Art & Design at the University of Delaware. He has also held faculty positions at Clemson University, the University of North Carolina School of the Arts, the University of Mississippi, and the University of Georgia's Studies Abroad Program in Cortona, Italy. Greg has also been a visiting artist at the Victorian College of the Arts in Melbourne, Australia, the Community Council for the Arts in Kinston, North Carolina, the Association for Visual Artists in Chattanooga, Tennessee, the New York Mills Arts Retreat in New York Mills, Minnesota, and La Trobe University's Visual Arts Centre in Bendigo, Australia. . His work has been exhibited in over 350 solo, invitational and group exhibitions, in galleries and museums domestically and abroad.
- **Amanda Binning** is a student intern for the Coastal resilience Design Studio and DelRAP. This past winter she completed her bachelors of Science in Landscape Architecture from the University of Delaware. Amanda previously worked with two other seniors on a project titled, *Green Infrastructure evaluation using sites assessment: steps towards community revitalization.* The project was located in Laurel Delaware at Tidewater Park. In the future, Amanda hopes to work with sustainable design and continue to engage with local communities.
- **Jon Cox** is a National Geographic Explorer, an assistant professor in the Department of Art and Design and Project Liaison in the Interdisciplinary Science Learning Laboratories at the University of Delaware.

He also serves as a Board Member of the Dorobo Fund for Tanzania and Board member of the Amazon Center for Environmental Education and Research. Cox worked on a six-year collaborative documentary book project with hunter-gatherers in Tanzania titled *Hadzabe, By the Light of a Million Fires*. This project includes a collaborative traveling exhibition titled *Hadza: The Roots of Equality*. Cox has directed over twenty photographic study abroad programs across the globe. He was a pioneer in the field of digital photography, served as the adventure photographer/writer for Digital Camera Magazine and authored two Amphoto digital photography books. Cox is a co-recipient of a National Geographic - Genographic Legacy Fund Grant to support a collaborative cultural mapping initiative with the Ese'Eja foraging people living in the Amazonia basin of Peru.

Submitted Abstracts

Photo Credit: Jeff Long

Abstract Format Guide: Abstract title

Lead Author, Lead Author Title, Lead Author Institution, *Lead Author Address*, Lead Author email; Co-author, Co-author institutuion

Session Title, Sesstion Day, Session Start Time, Session Room & Floor

Abstract Text. Lead author is listed first, with presenting author listed in **bold.**

UrbanPromise's RiverGuides Program- Ecology History Paddles

Abbott, Rachel, Environmental Education Program Director, UrbanPromise Ministries, Inc., *3700 Rudderow St, Pennsauken, NJ, 08105*, rabbott@urbanpromiseusa.org; UrbanPromise Student, UrbanPromise Ministries

Environmental Justice: Breaking Barriers, Monday, 3:15pm, Grand Ballroom B, 1st Floor

UrbanPromise Ministries (UPM) uses an innovative approach to engage youth and the local Camden community in on the water activity and watershed education. UPM is a youth development organization that has served Camden, NJ since 1988. UrbanPromise seeks to equip youth with the skills necessary for academic achievement, life management, spiritual growth, and Christian leadership. The organization works to fulfill its mission through summer and after-school programs, work experiences, two schools, and experiential learning.

UPM's Office of Experiential Learning (OEL) challenges its students to discover themselves, new adventures, and the environment through outdoor, hands-on, and up-close learning and mentoring experiences. One of OEL's programs, RiverGuides, is focused on empowering youth to guide community paddles on the tidal Cooper River.

The RiverGuides program began in 2016, built off a summer paddling program running since 2010. The program employs 4-8 Camden youth to lead 10+ community paddles, and trains them on canoe safety and the ecology and history of the tidal Cooper River. RiverGuides are also responsible for conducting routine water testing at 3 local sites. Throughout the summer, RiverGuides take community members paddling on the river so that they might gain a new and unique view of Camden. Community members learn about the wildlife in the area and local landmarks and history along the waterway. RiverGuides allows Camden youth to not only build knowledge of the Delaware River watershed, but also empowers them to share this information with community members who are interested in seeing their community from an entirely new vantage point. In Summer 2018, UPM employed five RiverGuides, who lead 12 paddling trips for 178 community members and lead watershed education and on the water programming for 174 Camden high school students.

In this presentation OEL staff and RiverGuide participants share their experiences leading this program.

Possible niche partitioning among four ecologically and economically important filter-feeding bivalves: A case study of bivalve polyculture

Acquafredda, Michael, Haskin Shellfish Research Lab, Rutgers University, *6959 Miller Avenue, Port Norris, NJ, 08349*, Michael.Acquafredda@rutgers.edu; Daphne Munroe, Haskin Shellfish Research Lab, Rutgers University

Blue Collar Bivalves, Tuesday, 3:00pm, Grand Ballroom A, 1st Floor

For various metrics of ecosystem functioning, including particle clearance and productivity (total biomass), diverse communities often outperform monocultures. Most bivalve farms currently in existence are artificial ecosystems composed of high-density monocultures. Bivalve polyculture would transform these farms into more diverse and even communities that could lead to greater resiliency, stability, and productivity. We sought to address the following questions: (1) do multi-species bivalve groups have greater particle clearance rates than that of monocultures, and (2) is the productivity of multi-species bivalve groups greater than that of monocultures? A fully replicated, fully combinatorial mesocosm experiment was established using the following species: *Crassostrea virginica*, *Spisula solidissima*, *Mercenaria mercenaria*, and *Mya arenaria*. Literature-based allometric equations relating clearance rate to biomass were identified for each focal species prior to establishing the mesocosms to ensure that regardless of the species combination, the expected filtration capacity across combinations was equal. We found that for particles <25µm, the 4-species polyculture had a significantly greater (23-116%) tank-level clearance rate than that of any monoculture. However, after three-months of monitoring, most biomass metrics (shell length growth rate, percent increase in wet weight, etc) were not significantly influenced by species richness. Our work suggests that multiple bivalve crops could be co-cultured without outcompeting one another. Additionally, while niche partitioning may have occurred, seasonal changes in food quality and quantity likely altered the breadth of these species' niches over time.

Planning for a Greener Future: Incentivizing Stormwater Management with Zoning Bonuses

Anderson, Sara, Environmental Scientist Specialist, Philadelphia Water Department, *1101 Market Street, 4th Floor, Philadelphia, PA, 19107*, sara.anderson@phila.gov

Hot Topics, Wednesday, 1:30pm, Grand Ballroom, 1st Floor

As people flock to walkable communities, municipalities must look for solutions to develop denser housing in popular downtown areas. To avoid blanket upzoning and to mitigate some of the environmental impacts of increased density, Philadelphia is experimenting with zoning incentives, offering development projects height and density bonuses if they incorporate certain green building features like stormwater management. This presentation will delve into how these incentives help meet development needs as well as supporting stormwater management goals of the City's 25-year Green City Clean Waters Program. An overview of Philadelphia's stormwater based zoning incentives will be provided, including a green roof density bonus for mixed used and multifamily residential developments and height bonuses for development projects that manage street runoff or incorporate stormwater management into publicly accessible green space. Planning, implementation, lesson learned, and future directions including wetland enhancement and creation bonuses will also be discussed.

Monitoring Inventory and Needs Assessment for the Delaware Estuary

Baumbach, Emily, Partnership for the Delaware Estuary, *110 South Poplar St., Suite 202, Wilmington, DE, 19801*, ebaumbach@delawareestuary.org; Angela Padeletti, Partnership for the Delaware Estuary; Danielle Kreeger, Partnership for the Delaware Estuary; Sari Rothrock, RK&K; Jim Eisenhardt, RK &K; John Yagecic, Delaware River Basin Commission; Namsoo Suk, Delaware River Basin Commission; Stefanie Kroll, Academy of Natural Sciences of Drexel University; Carol Collier, Academy of Natural Sciences of Drexel University; Kari St. Laurent, Delaware Department of Natural Resources and Environmental Control, Delaware National Estuary Research Reserve

Monitoring I, Monday, 3:15pm, Grand Ballroom A, 1st Floor & Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The Revised Comprehensive Conservation & Management Plan (CCMP) for the Delaware Estuary is a 10-year plan created to guide the work of partners across the region for watershed improvements. The Monitoring Approach section of the Revised CCMP outlines activities that facilitate coordination of monitoring of diverse natural resources, such as water quantity, water quality, living resources, and habitats. Tracking of monitoring programs helps to assess CCMP implementation and supports periodic State of the Estuary indicator reporting. One of the strategies in this approach is to inventory monitoring activities every 5 years, providing an opportunity to identify gaps or redundancies in the overall monitoring infrastructure.

In September 2018, 300 regional scientists and monitoring experts were invited to provide information on past and present monitoring efforts to be incorporated into a baseline draft of a new monitoring inventory. The geographic focus was the Delaware River Basin, especially the lower half that comprises the Delaware Estuary study area. Special attention was given to monitoring programs that were geospatially broad and conducted for longer time periods. The draft inventory compiled information on metric type, temporal and spatial coverage, sampling method, data availability and access, and general project information.. A workshop in October 2018 reviewed programs listed in the draft inventory, identified gaps, and gathered input on future monitoring priorities. The current draft of the monitoring inventory and a summary of future needs will be presented, and Summit participants will be invited to provide final input into the project. A Delaware Estuary Monitoring Assessment Report will be then completed by March 2019 as an addendum to the new CCMP. This assessment will serve as a baseline for tracking regional monitoring, help to promote monitoring efforts, and provides an opportunity to explore connections among ecosysytem features.

Living Shoreline Assessment for Community Resiliency in Coastal Pennsylvania

Beal, Irina, Science Technical Fellow, Partnership for the Delaware Estuary, *110 S. Poplar St., Wilmington, DE, 19801*, ibeal@delawareestuary.org; Joshua A. Moody, Partnership for the Delaware Estuary; Sarah A. Bouboulis, Partnership for the Delaware Estuary; Danielle A. Kreeger, Partnership for the Delaware Estuary

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Freshwater tidal wetlands of the Delaware Estuary are a valuable buffer for rising seas levels and provide vital habitat for diverse fish and wildlife. Unfortunately, over 95% of the coastal marshes in southeast Pennsylvania are estimated to have been lost since colonial times. Living shorelines represent an innovative measure to protect Pennsylvania's remaining coastal wetlands against erosion and/or drowning, and to enhance or restore these vital habitats in some locations where once present. The goal of this study was to identify locations that were amenable to living shoreline implementation within the coastal zone of southeast Pennsylvania and to prepare initial conceptual designs for a subset of candidate living shoreline sites. Locations for conceptual designs were selected based on feasibility of implementation and adaptive management, as well as pre-existing physical and biological conditions.

A two-tiered rapid assessment methodology was developed to assess existing conditions at potential living shoreline locations. First, GIS analysis identified thirteen candidate sites that were both public land and classified as having, or that once had, emergent tidal wetlands. A rapid in situ site assessment was then performed at each candidate location to capture current conditions. A new living shoreline feasibility model was then developed that integrated desktop and field data for each site's historic trajectory, biological and physical condition, community value, public access, and outreach potential. Model outputs identified which sites would be most responsive to implementation of different living shoreline tactics that could address various management goals. Three highly ranked sites were revisited to gather more rigorous topographic and bathymetric data to aid in the development of site-specific conceptual designs. The new rapid assessment method and feasibility model will facilitate the standardization of site assessment methods used to screen and prioritize candidate living shoreline sites in Pennsylvania's coastal zone.

Using Evaluation To Help You Understand the Impact of Your Work: A Workshop

Becker-Klein, Rachel, Two Roads Consulting, *6 East Aldine Drive, Hockessin, DE, 19707*, rachel@consulttworoads.com

Improving Your Programming, Wednesday, 10:15am, Crystal Room, 1st Floor

Organizations that care about the environment and conservation share in common an overarching goal to instill an understanding and appreciation of the natural world in program participants so that they will be connected to nature and work to protect it. These same organizations spend hours developing and refining activities to meet these goals, but may not clearly understand the extent to which they are achieving their desired impact. This workshop will introduce program evaluation, and how evaluation methods and activities can inform and improve your organization's programming by systematically gathering information to improve programming. The workshop will focus on non-traditional methods that go beyond surveys to embedded assessments that are folded into program activities in an effort to understand the learning, attitudes, and skills of participants.

The program will be very interactive, with the facilitator providing some information and then offering participants a chance to apply that information to their own organizations. Participants will engage in an activity to help them articulate goals and outcomes for a particular program or activity at their organization.

The last content area is brainstorming different methods for collecting data about the articulated outcomes. Many people are familiar with surveys, but there are often more appropriate methods that match with the informal and engaging nature of activities that these organizations are engaged in. We will discuss different evaluation methods and match up methods to the questions they have about program outcomes.

Finally, participants will reflect on what they have learned in this session, with the following guiding questions: What is something new you learned? What is something you can apply soon in your organization? What other questions do you still have?

Watersheds on the Brink: Applying sub-HUC12 watershed modeling and scalable conservation solutions towards stabilizing natural landscapes at the tipping point for clean water.

Boon, Nathan, Program Officer , William Penn Foundation, *100 N 18th Street, 11th floor, Philadelphia, PA, 19103*, nboon@williampennfoundation.org; Amber Carter, University of Michigan Environmental Fellows Program; Gregory Barren, Academy of Natural Sciences of Drexel University

Hot Topics, Wednesday, 1:30pm, Grand Ballroom, 1st Floor

It was Luna Leopold who wrote "the health of our waters is the principle measure of how we live on the land" – and cross the 13,500 square mile landscape that drains to the Delaware Estuary, our lands are changing.

Each year we lose between 2,000 and 5,000 forested acres, as pressure from as low density residential and commercial development sprawls ever outward from our urban centers, and industrial development cuts across the landscapes to connect same urban markets to distant energy supplies.

Conservation is key to protecting and restoring these landscapes for clean water, healthy ecosystems, and thriving communities. But when confronted with basin-scale land use change, traditional conservation impacts can appear dwarfed by the scale and diffuse nature of the threats from our growing footprint.

Using an evolving set of watershed management tools developed by the Academy of Natural Sciences through the Delaware Watershed Initiative, this project embarks on a prioritization exercise to model the positive impacts of highly focused investment in the protection and restoration if natural landscapes across over 15,000 sub-HUC12 watershed catchments comprising the entire Delaware River watershed. Furthermore, we present a number of real-world scenarios that demonstrate how the integration of public funding with regulatory protections can complement targeted conservation to advance water quality impacts at scale.

Delaware Estuary Shell Recycling Program: Lessons Learned Over First Two Years

Bouboulis, Sarah, Habitat Specialist, Partnership for the Delaware Estuary, *110 S. Poplar St., Wilmington, DE, 19801*, sbouboulis@delawareestuary.org; Joshua Moody, Partnership for the Delaware Estuary; Danielle Kreeger, Partnership for the Delaware Estuary

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The eastern oyster, *Crassostrea virginica*, has a long history as a commercially and ecologically important species in Delaware Bay. Throughout the 1930s, annual oyster landings ranged from one to two million bushels, and a reduced but sustainable oyster harvest continues today. Post consumption, oyster shells are typically discarded. The removal of oyster shell, combined with other constraints on oyster population recruitment and growth, contributes to a negative "shell budget" in Delaware Bay. Dwindling shell directly affects oyster stocks. Oyster recruitment largely depends on the availability of shell for spat attachment, and the planting of recycled shell is widely regarded as a very cost-effective oyster restoration tactic. In shallow saltwater areas that are amenable to oyster colonization, recycled & bagged shell is quickly colonized, leading to formation of resilient reef structures that filter water and provide wave attenuation. In both freshwater and saltwater, bagged shell readily traps suspended sediment, provides a foundation for vegetation, and imparts structural benefits. The Delaware Estuary Shell Recycling Program (DESRP) began operations in 2016 to help alleviate this negative "shell budget", and to accommodate the demand for oyster shell for restoration projects.

Since 2016, shell has been collected weekly from eight restaurants in the Wilmington/Newark, DE area. Restaurants are provided with shell recycling bins and educational materials to provide to patrons. Recycled shell is deposited at a shell management area in Wilmington where it is cured for 6-12 months. Once cured, the shell is bagged for restoration projects. Over the first 2 years the program has recycled and returned to the water nearly 1000 bushels (50,000 lbs.) of shell creating over 5000 bags. Currently there is strong interest in expanding the DESRP into Philadelphia and central Delaware, but the viability and timing of expansion will depend on start-up funding, volunteers, and in-kind support from partner organizations.

A Field Study of Biochar Amended Soils: Water Retention, Infiltration and Nutrient Removal from Stormwater Runoff

Brown, Joseph, Senior Water Resources Engineer, University of Delaware, *5160 Hillclimb Road, Spring Grove, PA, 17314*, jdbrownsr@rkk.com; Paul T. Imhoff, University of Delaware; Larry Trout, RK&K Delaware; Charles Hegberg, reGENESIS Consulting Services; Ali Nakhli, University of Delaware

Water Quality I, Monday, 10:15am, Grand Ballroom A, 1st Floor

The amendment of biochar into roadside greenways represents an opportunity to improve local infiltration and treatment of urban stormwater runoff through the enhancement of existing roadside filter strips and swales without the high costs of purchasing additional highway right-of-way or constructing new stormwater treatment facilities. These principles could easily be allied to the treatment of stormwater runoff in urbanized areas where open pervious infiltration space is at a premium.

This research project evaluates the effects of biochar amendment in roadside soils on the soils' water retention and infiltration characteristics, as well as biochar's ability to remove nutrients and suspended solids from stormwater runoff. Benefits of this include reduced stormwater runoff rates and volumes and increased groundwater recharge. Biochar also promotes microbial activity while increasing the residence time of water in soils, greatly enhancing denitrification and the pollutant removal capacity of the soils.

In this study, a 4% mix (by mass) of commercial wood biochar, pyrolyzed at 550℃, was amended into existing roadside filter strips and a swale located along a major highway in Delaware. Roadside filter strips amended with or without biochar were carefully instrumented to measure infiltrating water quality, soil moisture, and surface runoff quantity and quality entering and exiting the filter strips. Results for over 125 storm events, measured over the last three years, show that the addition of biochar to the roadside soils decreased the stormwater peak runoff rates by an average of 80% and cumulative runoff volumes by an average of 85%. When compared to soil tillage alone, biochar reduced the peak runoff rate by 56% and the total runoff volume by 68%, respectively. The effect of biochar amendment on reducing stormwater quantity and improving stormwater quality will be presented.

Trials and Tribulations of Moving Oyster Aquaculture to Subtidal Leases in Delaware Bay

Bushek, David, Director/Professor HSRL, Rutgers University, *6959 Miller Ave, Port Norris, NJ, 08349*, bushek@hsrl.rutgers.edu; Lisa Calvo, Rutgers HSRL; Eleanor Bochenek, Rutgers HSRL; Kevin Sullivan, Rutgers NJAES; Brian Harman, Atlantic Capes Fisheries; Barney Hollinger, Atlantic Capes Fisheries

Blue Collar Bivalves, Tuesday, 3:00pm, Grand Ballroom A, 1st Floor

New Jersey's oyster fishermen once practiced extensive oyster aquaculture, transplanting wild submarket oysters to mid-Bay planting grounds for later harvest. This practice was virtually eliminated in 1960s following the onset of MSX disease in 1957. Development of novel cultivation techniques and strains of disease resistant oysters spurred the development of intensive oyster aquaculture. While this newer form of intertidal oyster farming has occurred in the lower Delaware Bay for three decades where more extensive forms of cultivating oysters on racks occurred historically prior to MSX, subtidal culture on the traditional planting grounds has yet to advance, limited by the challenging physical conditions of the Bay and a lack of investment capital and demonstrated success. New industry initiatives are now underway to revitalize production on the planting grounds using subtidal aquaculture methods. We report on efforts to demonstrate and evaluate the practical and economic feasibility of subtidal oyster culture methods for the challenging Delaware Bay conditions. Oysters were grown in two types of subtidal cages at three upbay sites along a salinity gradient and at a single lower bay intertidal site using rack and bag methods. Initial high rates of growth and survival were decimated by the harsh winter of 2017-18 and revealed shortcomings of gear and deployment technologies employed. Nonetheless, experimental results are encouraging and concurrent commercial trials are anticipated to produce high yields.

Status Of Freshwater Mussel Propagation At The Fairmount Water Works Interpretive Center, Philadelphia, Pennsylvania: Investing In "Blue Infrastructure" To Address Restoration Needs In The Urban Corridor

Butler, Lance, Philadelphia Water Department, *1101 Market Street, 4th Floor, Aramark Tower, Philadelphia, PA, 19107*, Lance.Butler@phila.gov; Richard Anthes, Philadelphia Water Department; Danielle Kreeger, Partnership for the Delaware Estuary; Angela Padeletti, Partnership for the Delaware Estuary; Kurt Cheng, Partnership for the Delaware Estuary; Roger Thomas, The Academy of Natural Sciences of Drexel University; Kathryn Longwill, The Academy of Natural Sciences of Drexel University

Blue Collar Bivalves, Tuesday, 3:00pm, Grand Ballroom A, 1st Floor

Over the last decade, the ecological significance of freshwater bivalve communities in the Delaware River Basin has gained considerable support among scientists, restoration ecologists and watershed managers alike. While traditional biomonitoring protocols and post-restoration assessments in rivers and streams have focused on macroinvertebrate and fish assemblages, it has become apparent that freshwater bivalves may be a more practical and realistic sentinel in gauging the health and integrity of our large rivers and tidal freshwater systems. In partnership with the Academy of Natural Sciences of Drexel University and the Partnership for the Delaware Estuary, the Philadelphia Water Department has developed the first municipally-owned and operated freshwater mussel hatchery aimed at propagating and restoring native bivalves throughout the watershed. During its first year of operation, scientists successfully propagated one of the more dominant native species, Alewife Floater (*Utterbackiana implicata*), and reared approximately 10,000 juveniles to Age 1+ year class in our network of grow-out ponds around Philadelphia. During 2018, scientists redirected their efforts to ascertain the feasibility of culturing multiple native mussel species with varying fish hosts. In total, five species (*U. implicata*, *Ligumia nasuta*, *Lampsilis cariosa*, *Leptodea ochracea* and *Elliptio complanata*) were successfully propagated during 2018. During 2019, it is the intent of the group to increase production to ensure maximum likelihood of survival of these key species from laboratory incubation to pond rearing. Data obtained during all phases of propagation and rearing will provide valuable information that will be used to guide the operations of the future large-scale production hatchery and in the numerous freshwater mussel restoration activities planned for the streams in southeastern Pennsylvania and Delaware.

The Aquatic Research And Restoration Center (ARRC): A Collaborative Approach To Addressing Urban Ecosystems In The Delaware Basin

Butler, Lance, Senior Scientist, Philadelphia Water Department, *1101 Market Street, 4th Floor, Aramark Tower, Philadelphia, PA, 19107*, Lance.Butler@phila.gov; Danielle Kreeger, PhD, Partnership For The Delaware Estuary; Angela Padeletti, Partnership For The Delaware Estuary; Richard Anthes, Philadelphia Water Department; Roger Thomas, Academy of Natural Sciences of Drexel University; Kurt Cheng, Partnership For The Delaware Estuary; Kathyrn Longwill, Academy Of Natural Sciences Of Drexel University

Hot Topics, Wednesday, 1:30pm, Grand Ballroom, 1st Floor

Today, populations of freshwater mussels and shad are greatly reduced, and are the subject of restoration efforts across the Delaware River Basin. Successful large-scale restoration efforts of freshwater mussels and shad require hatchery propagation capacity that does not currently exist within the region. Similarly, shell deficits in the Delaware Basin have reduced the ability to replenish and stabilize oyster reefs and shoreline areas. The creation of a regional Aquatic Research and Restoration Center (ARRC) in Philadelphia will provide new opportunities for restoring native bivalves and migratory fish species, implement beneficial reuse strategies to restore reef systems and shorelines along the Delaware Estuary and its tributaries. Moreover, continued development of this ARRC will further advance innovative new science and techniques for restoring urban waters, and engaging students and the public in the process.

Variation in Swimming Ability among Blue Crab (*Callinectes sapidus*) Larval Broods

Caracappa, Joseph, Haskin Shellfish Research Laboratory, Rutgers University, *6959 Miller Ave, Port Norris, NJ, 08349*, jcc290@hsrl.rutgers.edu; Daphne Munroe, Haskin Shellfish Research Laboratory, Rutgers University

Living Resources, Monday, 1:30pm, Grand Ballroom A, 1st Floor

Blue crabs (*Callinectes sapidus*) are an economically and ecologically important species in Delaware Bay that experience inter-annual fluctuations in their populations, partially due to changes in larval recruitment. Blue crab larvae (zoeae) must constantly swim to maintain their position in near-surface waters over their long development in order to survive development and successfully disperse. A zoea's ability to swim is related to its morphology, and recent work has shown that blue crab larval morphology differs among different mothers' offspring. The goal of this study was to determine whether zoeae from different broods differed in their swimming behavior and to whether larval morphology was correlated to swimming ability. The offspring of 6 individual crabs was hatched in the laboratory. Zoeae were placed in small aquaria, and video was taken of their swimming behavior under controlled conditions. Zoeae were then photographed and their morphologies were measured. Zoeae's swimming behavior varied substantially both within and between broods, and their motion highly irregular. Swimming velocity and other behaviors differed between broods. Additionally, some morphologies may be related to larval swimming ability. These differences in swimming ability may have further impacts on zoeae's energy expenditure, survival, and potential dispersal.

A Comparison of Annual and Decadal-Scale Carbon Sequestration Rates in New Jersey, Pennsylvania, and Delaware Tidal Wetlands Using Interpolation Mapping

Champlin, Lena, Drexel University and the Academy of Natural Sciences, *3308 Arch Street, Apt. 1, Philadelphia, PA, 19104*, lkc45@drexel.edu; D.J. Velinsky, Drexel University and the Academy of Natural Sciences; C. Sommerfield, University of Delaware; K. Raper, Drexel University and the Academy of Natural Sciences; L. Haaf, The Partnership for the Delaware Estuary; K. St. Laurent, Delaware National Estuarine Research Reserve; E.B. Watson, Drexel University and the Academy of Natural Sciences

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Blue carbon (C) burial in coastal marsh sediments plays a significant role in climate change mitigation, but coastal wetlands are declining due to development and sea level rise. Spatial and temporal variations of C sequestration were examined in the extensive wetlands of the Mid-Atlantic Region. Recent C surface accumulation rates were compared to C sequestration over longer timescales from sediment cores in marshes within and between Barnegat and Delaware Bays. Data were compiled from short-term rates measured in 10 marshes and longer-term burial rates at 25 marshes in the two bays performed by the Academy of Natural Sciences of Drexel University and the University of Delaware. Short-term C sequestration was calculated as the product of surface sediment C density and sediment accretion measured above a feldspar marker layers (n = 9-X per marsh) seasonally or annually. Decadal scale C sequestration estimates were computed as the product of C density and accretion rates calculated over the past 50 years using 10Pb and 137Cs radioisotopes. Point values were interpolated to the spatial extent of emergent tidal wetlands mapped by NOAA's Coastal Change Analysis Program (2010) using kriging performed in ArcGIS. Accuracy of the interpolation was calculated using leave-one-out cross validation. Delaware Bay was found to exhibit a larger range of C accumulation rates than Barnegat Bay with a trend of declining C accumulation rate from the upper to lower bay. At sites with both field and coring data, the rates generated by these two methods are generally similar and only a few locations display significantly higher or lower rates. Sites with rates that vary from the general spatial trends and between time scales may indicate degrading or restored areas. This assessment of wetland C sequestration can be applied to support restoration and conservation efforts.

Anthropogenic Changes to the Raritan River, NJ from Pre-European Settlement Through the Present

Christie, Margaret, Post-Doctoral Associate, Rutgers University, *74 Abbey Lane, Apt 8B, Apt 8-B, Newark, DE, 19711*, margaret.christie@rutgers.edu; Jennifer L. Clear, Department of Geography and Environmental Science, Liverpool Hope University, UK; Jennifer Walker, Department of Marine and Coastal Sciences, Rutgers University; Timothy A. Shaw, Asian School of the Environment, Nanyang Technological University, Singapore Singapore; D. Reide Corbett, Department of Coastal Studies, East Carolina University; Mihaela Enache, Division of Science, Research, and Environmental Health, Department of Environmental Protection, State of New Jersey; Nina Desianti, Department of Biodiversity, Earth and Environmental Science, Drexel University, Philadelphia, PA; Marina Potapova, Department of Biodiversity, Earth and Environmental Science, Drexel University, Philadelphia, PA; Daria Nikitina, Department of Earth and Space Science, West Chester University of Pennsylvania; Francisco Artigas, Meadowlands Environmental Research Initiative, Rutgers University; Benjamin Horton, Asian School of the Environment, Nanyang Technological University, Singapore and Earth Observatory of Singapore, Nanyang Technological University, Singapore.

Water Quality I, Monday, 10:15am, Grand Ballroom A, 1st Floor

By the start of the 18th Century, the Raritan River, NJ began to suffer impairments associated with deforestation, mineral mining, industrial activity, and intensified agricultural and development pressures. Despite this, anthropogenic changes to the Raritan River have not been quantified for the 20th and 21st centuries. Pollen and diatom assemblages preserved in wetland sediments provide an archive of environmental change. Sediment cores collected from tidal wetlands in the Raritan River expand our understanding of habitat and water quality prior to 17th century European settlement and enable us to establish base-line conditions that can be used to measure the amplitude of more recent, anthropogenically-disturbed conditions.

Here, we present results on changing habitat, nutrient conditions, and water quality over the past 500 years in the Raritan River from three sediment cores collected over a salinity and pollution gradient that extends from Cheesequake, NJ to New Brunswick, NJ. Sediment cores were analyzed for (1) heavy metals (e.g. Pb, Cu, Cd and Ni) and organic pollutants (PCBs and OPCs) associated with local and regional industrial activities; (2) pollen to identify the deforestation horizon and other vegetation changes; and (3) diatoms to reconstruct changing nutrient levels. Sediment chronology was developed using radiocarbon dating of plant rhizomes, timing of onset of European deforestation, and atmospheric deposition of heavy metals and short-lived radionuclides (137Cs).

Extending the pollution history to include pre-European baseline conditions is essential to assess the impacts of anthropogenic activity to help inform restoration targets and improve monitoring guidelines. We found that study sites near former industrial sites had the highest concentrations of heavy metals and organic pollutants, while the site nearest a protected marsh had the lowest concentrations of these contaminants. Additionally, our most polluted study site was located adjacent to a portion of the river where highly contaminated bottom sediments were found, implying that contaminants may be leaking from this site.

Group Decision Making Methods

Clark, Sarah, Senior Associate, Institute for Conservation Leadership, *7000 Carroll Ave, Ste 200-14, Takoma Park, MD, 20912*, sarah@icl.org

Improving Your Programming, Wednesday, 10:15am, Crystal Room, 1st Floor

Does your group keep having the same conversations over and over? Do you think you've made a decision, only to find out later that individual group members are not all on the same page? Effectively making decisions together can strengthen your group's work and increase your ability to make decisions and to continue working together going forward. Come explore approaches and tools you can use in any group you're a part of – whether it's a collaborative effort, committee or team.

A Decade of Restoration and Monitoring: Turning Little Buck Run From Red to Blue

Clauser, Aaron, **PhD**., Owner/ Scientist, Clauser Environmental, LLC, *19 School House Lane, Cape May Court House, NJ, 08210*, aclauser@verizon.net; Robert Struble, Jr., Brandywine Red Clay Alliance; Brian Winslow, Brandywine Red Clay Alliance

Hot Topics, Wednesday, 1:30pm, Grand Ballroom, 1st Floor

A decade ago, Brandywine Red Clay Alliance set out to remove tributaries from the state impaired list with its innovative Red Streams Blue Program. The program began by assessing water quality conditions and developing restoration plans for several small watersheds. After ten years of funding, designing, implementing, and waiting for the high priority stream restoration projects identified in the restoration plan to become established, the sites were again assessed for water quality conditions. Here, we present the monitoring protocol, background on the implemented restoration projects, and data to demonstrate the effectiveness of stream restoration on water quality in the Little Buck Run Watershed.

Atlantic Horseshoe Crab (*Limulus polyphemus*) Movement Within Oyster Farms on the Delaware Bay Shoreline

Cleary, Niki, Villanova University; Josh Daw, Rutgers University; Daphne Munroe, Rutgers University; **Bushek, David**, **Dr.**, Haskin Shellfish Lab, Rutgers University, *6959 Miller Ave, Port Norris, NJ, 08349*, bushek@hsrl.rutgers.edu

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Atlantic horseshoe crabs (Limulus polyhemus) are economically and ecologically important. Their blood is used in the medical industry to detect bacterial diseases in injectable drugs and the red knot (*Calidris canutus rufa),* a threatened migratory shorebird, feeds on crab eggs when stopping in Delaware Bay. Oyster rack-and-bag farming is present on intertidal flats in the Bay where horseshoe crabs spawn and red knots feed. Recently, concerns have been raised that oyster farm gear may impede the crabs' ability to reach spawning habitat, thereby negatively impacting crab abundance. Video data was collected using Dual Frequency Identification Sonar (DIDSON) at two mooring locations, and along parallel transects (control and farm habitats) during high tide on two oyster farms in May 2018. Crabs in each video were counted, and counts were standardized and corrected for farm gear view obstruction. No significant difference was detected among control and farm counts for neither single, nor amplexus crabs in all comparisons with one exception. When counts were corrected for farm gear view obstruction, significantly more amplexus pairs were observed at the farm mooring compared to the control ($p<0.05$). In general, results indicate that crabs can successfully traverse farms and reach spawning beaches, and crabs do not differentially use farm versus non-farm areas of the Delaware Bay flats. These results provide important context for developing frameworks for interactions among farms and species of concern

The Distribution of Microplastics in Delaware Bay

Cohen, Jonathan, University of Delaware, *700 Pilottown Road, Lewes, DE, 19958*, jhcohen@udel.edu; Anna Internicola, University of Delaware

Marine Debris & Plastic Pollution, Tuesday, 1:15pm, Crystal Room, 1st Floor

Microplastics are an emerging pollutant in marine environments. Concentrations of microplastics in Delaware Bay are not well-studied, and therefore any ecological impacts they may have in the region are unclear. We quantified microplastics in surface net samples from sixteen stations in Delaware Bay during April and June 2017. Net samples were processed using wet peroxide oxidation, and microplastics were recovered with a density gradient and sorted manually. The majority of microplastics in both seasons (>60%) were plastic fragments. Bay-wide concentrations ranged from 0.3 to 384 µg m-3 and 0.1 to 6 pieces m-3. Significantly more microplastics were in the 0.3-1 mm size fraction than in the 1-5 mm size fraction. Furthermore, microplastic concentrations were greater in April than in the June, likely due to the difference in discharge. Our data suggest that considering microplastics as either mass or pieces makes a difference as to the spatio-temporal patterns observed. In the most general terms, concentrations were elevated: (1) in spring, (2) at upstream stations, and (3) on the Delaware portion of the bay.

Our Original Instructions

Coker, Dennis, Principal Chief, Lenape Indian Tribe of Delaware, *4164 N. DuPont hwy, Suite 6, Dover, DE, 19901*, lenapedelaware@comcast.net

Environmental Justice: Breaking Barriers, Monday, 3:15pm, Grand Ballroom B, 1st Floor

Beginning with gratitude for the interconnectedness of all living things, our Original Instructions based on the principals of reciprocity still do inform every creature's ability to live together well in this Ancient Homeland of Lenapehokink. These instructions detail how we must honor and respect each life form and their unique contribution to the whole, in order to ensure harmonious coexistence. What some call resources, we relate to as Family and learn from their examples the lessons of reciprocity paramount to a truly spiritual journey with "All our Relations."

Using the Preserve as an Outreach Tool

Collins, Bob, Program Manager, Delaware Center for the Inland Bays, *39375 INLET RD, CENTER FOR THE INLAND BAYS, REHOBOTH BEACH, DE, 19971*, jamesfarm@inlandbays.org; Amy Barra, Delaware Center for the Inland Bays

Science Class, Tuesday, 9:00am, Grand Ballroom B, 1st Floor

The James Farm is a 150-acre preserve, owned by Sussex County and operated by the Center for the Inland Bays. The Center holds several public events there (native plant sale, volunteer appreciation, night-sky viewing) with more being planned. We have a corps of volunteers there that both maintain the property and serve as docents. It is the home of the James Farm Education program that serves the local school district's 7th and 8th grade students. Last year, a private firm partnered with the Center to provide a tourist outdoor educational experience. The Preserve has several miles of trails and a sandy beach for passive recreation, and a private outfitter provides paddlecraft rentals and eco-tours from the site.

In 2014, the Center adopted a Master Plan to guide operation and improvement of the Preserve. As the population of and tourism visits to coastal Delaware grows, user-ship likewise has grown. In October of 2017, a Design, Engineering and Permitting project was completed, in partnership with Sussex County and The Delaware Division of Parks and Recreation. In fall of 2018, the Center expects to begin implementing Phase 1 construction projects, and begin planning for further phases.

The presentation will discuss the James Farm's planned improvements, and how the Center's outreach efforts will be necessary to fund them. It will also discuss how the planning and improvements will allow the Center to expand its educational outreach to varied demographic groups about the Center, its mission, and improvement of the Inland Bays estuary.

Philadelphia Water Department Ammonia Reduction Planning

Cruz, Jay, Environmental Scientist, Philadelphia Water Department, *1101 Market St, 4th Fl ARAMARK Tower, Philadelphia, PA, 19107*, jason.cruz@phila.gov

PWD Water Quality Planning, Tuesday, 10:00am, Crystal Room, 1st Floor

Philadelphia Water Department (PWD) is researching technologies that can reduce ammonia in wastewater effluent and increase dissolved oxygen (DO) conditions in the Delaware River. DO is consumed when ammonia from point and non-point pollution sources is naturally transformed into nitrate through the process of nitrification. It is believed that nitrification is one of the primary causes of low Delaware estuary DO levels, particularly during very warm and dry summer conditions. In 2015 PWD worked with Hazen and Sawyer to develop a conceptual design for an innovative and energy-efficient treatment process using ANAMMOX (ANaerobic AMMonium OXidation) bacteria. The project was centered on the City's Southwest Water Pollution Control Plant. The Southwest plant receives recycled flow from all three of the City's water pollution control plants through biosolids recycling. This high strength "sidestream" flow contributes only approximately 1% of the influent flow to the facility but more than 25% of the ammonia load. Unfortunately the sidestream treatment project was later found to be incompatible with facility planning goals for handling wet weather flow. PWD restarted the planning and process for sidestream treatment at the Southwest plant in 2017. PWD's overall ammonia reduction planning efforts involve collaboration between multiple PWD groups including Bureau of Laboratory Services, Operations, Planning and Research, and Watersheds. Ammonia reduction planning has been enhanced with expanded wastewater characterization and process modeling projects at all three water pollution control plants. PWD has also initiated a DO Partnership among wastewater dischargers in the basin. Dischargers will work together to help identify the most cost-effective solutions to reducing ammonia and increasing DO conditions.

Farmworkers in a Changing Climate

Culley, Jessica, General Coordinator, CATA - El Comite de Apoyo a los Trabajadores Agricolas, *P.O. Box 510, Glassboro, NJ, 08028*, jculley@cata-farmworkers.org

Environmental Justice: Breaking Barriers, Monday, 3:15pm, Grand Ballroom B, 1st Floor

Agriculture is unique in its position to climate change. Our farming system both contributes to, and has the possibility to assuage its impacts; all while being heavily affected by our changing climate. At the center of this are farmworkers and vulnerable communities that are disproportionately impacted by its effects. Jessica will speak about the impacts of our changing climate on farmworkers and steps we can take to protect this vulnerable population.

Connecting Teachers and Marine Science Researchers in the Science Classroom: Integrating Real Time Data into the Classroom in Order to Improve Student Learning.

DiSantis, Dina, Downingtown West High School, *1308 Creek Road, Glenmoore, PA, 19343*, ddisantis@dasd.org

Science Class, Tuesday, 9:00am, Grand Ballroom B, 1st Floor

The use of data in the classroom can provide students with the experience of collecting and manipulating data, while addressing scientific questions. In addition, using on-line data sources provide the opportunity for new kinds of student experiences. Data-enhanced learning experiences are important tools for student learning by preparing students to address complex problems, improves the use of the scientific method, and provides training in scientific, technical, quantitative, and communications skills. MBARI (Monterey Bay Aquarium) EARTH (Education and Research: Testing Hypothesis) is a collaboration that brings scientists and educators together to test new ideas for outreach and education. The program focuses learning on the process of science while capitalizing on new opportunities created by data-sharing and web technology. It provides teachers with the means for integrating near-real-time data from ocean observatories to design and test outreach with the Internet as an interface to scientists, teachers, and students. Teachers work with scientist to create tested curriculum aligned with existing educational standards in an interactive and engaging way. A comprehensive literature review of potential approaches and effective educational practices for the development of a national marine science and estuary observing education product has been generated as part of the results from the EARTH workshops.

EPA Scientific Dive Unit

Donohue, Steve, Senior Environmental Scientist, US Environmental Protection Agency, *(3EA40), 1650 Arch Street Building, Philadelphia, PA, 19103*, donohue.steven@epa.gov

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The US EPA Mid-Atlantic Scientific Dive Unit (SDU) provides collaborative services through inspections, sampling, surveys, video/photography, and contract oversight to protect and restore healthy waters. The SDU works in partnerships with federal, state, and local agencies as well as supporting internal agency customers.

The US EPA Mid-Atlantic Scientific Dive Unit:

• collaborates with federal, state, and local partners to collect robust data that is used to protect aquatic habitats by informing regulatory and non-regulatory decisions

• Designs and performs scientific diving operations to support needs of state partners

• Conducts scientific diving operations in support of EPA regulatory and research programs.

Equipment

The SDU is equipped with dry suits, full face masks with hard line and wireless communication, underwater video cameras, Nitrox tanks, and back-up air supplies. Dive operations are carefully planned to account for all potential conditions.

Mid-Atlantic Tidal Rapid Assessment Updates: Development of a Tidal Freshwater Protocol

Dorset, Erin, Environmental Scientist, Delaware Department of Natural Resources and Environmental Control, *100 West Water Street, Suite 10B, Dover, DE, 19904*, erin.dorset@state.de.us; Alison Rogerson, Delaware Department of Natural Resources and Environmental Control (DNREC); Kenny Smith, Delaware Department of Natural Resources and Environmental Control (DNREC); Brittany Haywood, Delaware Department of Natural Resources and Environmental Control (DNREC); LeeAnn Haaf, Partnership for the Delaware Estuary

Wetlands, Tuesday, 1:15pm, Grand Ballroom A, 1st Floor

Delaware's Wetland Monitoring and Assessment Program (WMAP) updated the Mid-Atlantic Tidal Rapid Assessment Method (MidTRAM) in 2017 to reduce user subjectivity and reflect the range of conditions found in watersheds to date. The protocol now allows for accurate assessment of tidal freshwater wetlands. Based on reference data, tidal freshwater wetlands are scored on a separate scale for bearing capacity than saltwater wetlands. Tidal freshwater wetlands are also assessed for point sources as a hydrology metric instead of ditching. Additionally, to reduce user subjectivity, measurements of ditches and fill piles are now taken in the field for more accurate hydrology scoring. This updated protocol was piloted in 2017 in the Red Lion watershed in Delaware, and preliminary results suggest that the updates were effective.

Freshwater Wetland Habitat Responses to Saltwater Intrusion and Increased Flooding in Delaware

Dorset, Erin, Environmental Scientist, Delaware Department of Natural Resources and Environmental Control (DNREC), *100 West Water Street, Suite 10B, Dover, DE, 19904*, erin.dorset@state.de.us; Alison Rogerson, Delaware Department of Natural Resources and Environmental Control (DNREC)

Wetlands, Tuesday, 1:15pm, Grand Ballroom A, 1st Floor

Sea level rise and intense storm events are major catalysts for change in coastal marshes and adjacent freshwater forested wetlands. Rising sea levels and severe coastal storms increase flooding frequency and duration as well as the occurrence of saltwater intrusion, resulting in changes to sediments and plant communities. Together, such processes can potentially convert freshwater forested wetland to high marsh, high marsh to low marsh, and low marsh to subtidal habitat in a step-by-step fashion over time. However, there remains some uncertainty in how freshwater forested wetlands and marshes are actually responding to these stressors. We performed a field study in 2017 and 2018 to describe physical and biological components of habitats that have likely experienced salt water intrusion and increased flooding in Delaware. Specifically, we wanted to see if freshwater wetland habitats adjacent to estuarine marshes are converting to brackish or salt marshes, open water, or are being rapidly colonized by invasive species such as *Phragmites australis*.

Drone Mapping

DuMont, Dave, Env. Scientist , NJDEP, *401 E. State St., Trenton, NJ, 08625*, h.david.dumont@dep.nj.gov

Monitoring I, Monday, 3:15pm, Grand Ballroom A, 1st Floor

Done Aerial Photography is extremely valuable for coastal and environmental resource management, monitoring and mapping. Aerial photograph that will be acquired from drone monitoring will fill some aerial photography data gaps. Drone aerial photography can be taken within Tide Stages and Leaf On Periods. Drones can reach areas that are not readily or easily accessible to large scale aerial photo capture projects. NJDEP Drone Coastal Management Projects include monitoring the following: 1) Living Shoreline Projects, 2) Shoreline Erosion, 3) Marsh Health, 4) Sea Level Change, 5) Dredge Material Beneficial Use, 6) Coastal Post Storm Assessment, 7) Intertidal and Subtidal Zones.

Utilizing post processing software, aerial photos captured by Drones can be integrated into Geographic Information System (GIS) Mapping as Orthomosaics, 3D Textured Mesh and Digital Terrain Models. These outputs can then be utilized for GIS visualization and spatial analyses. Examples of NJDEP Coastal Drone Projects in GIS will be presented.

Coupling Hydrological Prisms to Inundation Times and Energy Signatures in Salt-Marsh Creation and Restoration

Dunne, Ken, Botanist, DelDOT, *800 Bay Road, Dover, DE, 19901*, ken.dunne@state.de.us

Restoration I, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

In developing salt-marsh creations or restorations, a key element is the hydrologic prism. Besides simply looking at elevation, one should be examining the tidal prism in terms of inundation period per 24 hours. If the tidal prism is fully open and unconstricted, the monitoring can be as little as three months in duration. But in back bay areas or any area of constricted flow or seasonal wind driven tides, the monitoring may need to be examined for a full-year. The inundation time per 24 hours is always referenced to elevation and the values are often determined on 0.1 foot elevation intervals. The inundation times will then be compared to the on-site reference wetlands that depict the upper and lower ends of the vegetative zonation patterns (bio-benchmarks) with emphasis on elevations that exhibit strong vigorous growth and elevations to avoid – lower lip of the marsh plain or *Phragmites* zones. The energy signature inherent to the site will then act as an environmental sieve in determining where marsh will establish and were there will open water. This sieve can be severe, eliminating any potential for marsh establishment. As the inundation time increases marsh stability is likely to decrease. Inundation times for *Spartina alterniflora* salt marsh can extend out as far as thirteen hours per twenty four hours, but values under nine hours per twenty-four hours are more typical. Marsh plains graded to drain with between four and six hours per day of inundation will likely be attractive in terms of restoration. A tall prism can promote the draining of the marsh plain and can allow for increased inundation times. Mapping existing salt marsh system by inundation time may provide some clue on coastal stabilities.

Six Years of reTURN the Favor: Horseshoe Crab Conservation in New Jersey through Community Engagement

Ferguson, Lisa, The Wetlands Institute, *1075 Stone Harbor Blvd, Stone Harbor, NJ, 08247*, lferguson@wetlandsinstitute.org; Laura Chamberlin, WHSRN Executive Office - Manomet

Living Resources, Monday, 1:30pm, Grand Ballroom A, 1st Floor

Conditions at many spawning beaches for horseshoe crabs (*Limulus polyphemus*) along the Delaware Bay are degraded due to erosion, changes in coastal geomorphology, and human development. During spawning, crabs may become overturned by wave action or stuck among rubble and debris, beach armoring structures, and natural features, leaving them vulnerable to desiccation, hyperthermia, and predation. To reduce the loss of stranded crabs on New Jersey beaches, the reTURN the Favor program was initiated in 2013 to provide a means for community members to rescue stranded crabs and collect data during walks on Bayshore beaches. Over the past six years, ten partner organizations have collaborated to train and organize volunteers for walks that have rescued over 325,000 crabs. The data compiled from each walk has identified areas where crabs regularly become stranded in anthropogenic structures and natural features, which can then be addressed through restoration activities. Community volunteers have contributed to small-scale projects organized by the program to address more localized hazards over the past four years. Through trainings, rescue walks, outreach, and restoration projects, reTURN the Favor has provided opportunities for community members to engage in meaningful conservation activities in New Jersey that benefit the horseshoe crabs and other species that rely on a healthy Delaware Bay.

A Next Generation Water Observing System for the Delaware River Basin

Fischer, Jeffrey, Assiciate Director, USGS NJ Water Science Center, US Geological Survey, *3450 Princeton Pike, Lawrenceville, NJ, 08648*, fischer@usgs.gov; Chad Wagner, US Geological Survey

Monitoring I, Monday, 3:15pm, Grand Ballroom A, 1st Floor

A Next Generation Water Observing System for the Delaware River Basin

Jeffrey M Fischer and Chad Wagner, US Geological Survey

In 2018, the USGS selected the Delaware River Basin as a pilot area for implementing the Nation's next-generation (NextGen) integrated water observing system to provide high-fidelity, real-time data on water quantity and quality necessary to support modern water prediction and decision support systems for water emergencies and daily water operations.

When fully implemented, the USGS NextGen water observing system will provide quantitative information on streamflow, evapotranspiration, snowpack, soil moisture, a broad suite of water quality constituents (nutrients, salinity, turbidity, and wastewater indicators), connections between groundwater and surface water, and water use. It will be directly coupled with the National Water Model and other advanced modeling tools to provide state-of-the-art flood and drought forecasts, and water-management decision support tools.

The 2018 activities in the Delaware Basin focused on the addition of new streamgages to address critical data gaps, temperature and specific conductance monitoring, and initial steps to modernize USGS data management and delivery. Seventeen new stream gages were added to help address water supply issues in the upper basin, and issues related to the salt front in the estuary. Real-time temperature monitors were added at 25 sites, and specific conductance added at 10 sites to support fisheries and water-quality monitoring. Communication systems were enhanced at 38 existing streamgages to insure reliable data delivery.

The 2018 pilot activities represent less than 15 percent of planned future investments in a NextGen integrated water observing system for the Delaware River Basin. As funding becomes available in future years stakeholders will be consulted on planned activities to ensure the data collected are relevant to the needs of the basin.

Effective Science Communication: Principles And Visualization Techniques

Fries, Alexandra, University of Maryland Center for Environmental Science, *429 4th Street, Annapolis, MD, 21403*, afries@umces.edu

Strategic Scientific Communications, Monday, 10:15am, Grand Ballroom B, 1st Floor

Effective science communication helps you tell the story of your data or research to multiple non-scientific audiences like policy makers, managers, and the general public. A key part of science communication is using visuals to tell your story and make your data compelling. This presentation discusses the principles and practice of effective science communication, with emphasis on visualizations and science communication tools you can use to enhance your science communication messages.

Scaling and Selecting STEM: Designing and Executing Unique, Effective Projects

Fritch, Matthew, Environmental Engineer, Philadelphia Water Department, *1101 Market St., 4th Floor, Philadelphia, PA, 19107*, matthew.fritch@phila.gov

STEM & Education, Tuesday, 3:00pm, Grand Ballroom B, 1st Floor

Since 2014, the Philadelphia Water Department's greenSTEM program has facilitated environmental technology projects in both formal and informal settings. These hands-on, low-cost DIY projects usually involve learning the fundamentals of writing code and the use of robotics, sensors and solar panels to build and deploy novel and purposeful devices: a smart rain barrel that texts you when it is full; an underwater rover to observe aquatic life; a sewer inlet monitor that tweets when an inlet is clogged with trash or debris; a solar-powered birdhouse equipped with an infrared video camera. This talk is not focused on the technical aspects of these designs, but rather the process of choosing a meaningful and engaging project for your class, group or community. It will also explore how STEM learning can span middle school, high school, university and professional audiences with virtually no difference between the content among age groups (i.e., are you smarter than an 8th grader? No. No, you are not.)

Discharge Precipitation Relationship for White Clay Creek, Newark DE

Fry, Katelynn, Student, Wesley College, *75 Canzonet Drive, Newark, DE, 19702*, katelynn.fry@email.wesley.edu

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The White Clay Creek in Pennsylvania and Delaware is characterized by non-point source pollution, flooding, and most significantly, erosion. In an effort to remedy erosion issues millions of dollars have been spent on restoration projects and best management practices. In this study, we attempt to better understand the hydrology of White Clay Creek by combining discharge data from 1931 to present, collected by the United States Geological Survey (USGS) at station number 01479000, with precipitation data from the National Oceanic and Atmospheric Administration (NOAA) station number GHCND:USC00076410. In addition to downloading data, I assisted several USGS field technicians in the collection of discharge measurements at White Clay Creek near Newark and other USGS sites across the Delaware and Maryland area. High flow events were classified as anything over the 99th percentile (875 cfs), and high precipitation events were also classified as anything over the 99th percentile (1.62 mm per day). The probability of high precipitation resulting in high flow was calculated by dividing the number of high flow events in a year by the number of high precipitation events in that year. The results showed that the average ratio was 1.031, indicating that precipitation and streamflow are very closely related for the White Clay Creek system. Delaware is expected to experience increased precipitation due to climate change. Therefore, land managers should be prepared for an increased occurrence of high flow events.

Dove's Nest Pollinator Mitigation Site

Furlong, Erika, Environmental Planner, Delaware Department of Transportation, *800 Bay Road, Dover, DE, 19701*, erika.furlong@state.de.us; **Ken Dunne**, DelDOT; Eric Ludwig, DNREC; Todd Gsell, Delaware Forest Service

Living Resources, Monday, 1:30pm, Grand Ballroom A, 1st Floor

The Dove's Nest Pollinator Mitigation site, the first of its kind in Delaware, is a 43-acre meadow and the product of a multi-agency partnership to create more pollinator habitat in an area that was predominantly agricultural for hundreds of years (but that is increasingly being developed for residential use). Delaware's Department of Transportation (DelDOT) joined forces with Delaware's Department of Natural Resources and Environmental Control (DNREC) to design and construct the site, which will eventually support native wildflowers that bloom throughout the growing season and a seasonal pond for migrant birds. The Delaware Forest Service will manage the site by performing prescribed burns every 2-3 years. Bird, vegetation, and lepidoptera surveys are being performed to monitor the site's success. The site will ultimately function as part of a larger 65+ acre complex that consists of meadow, wet meadow, forest, and forested wetlands.

Monarch Rapid Assessments on Delaware's Roadsides

Furlong, Erika, Environmental Planner, Delaware Department of Transportation, *800 Bay Road, Dover, DE, 19901*, erika.furlong@state.de.us; Ken Dunne, DelDOT; **Jamie Pavona**, DelDOT; Alison Cariveau, Monarch Joint Venture

Monitoring I, Monday, 3:15pm, Grand Ballroom A, 1st Floor

Delaware Department of Transportation partnered with Monarch Joint Venture to assess monarch butterfly habitat along Delaware's nearly 14,000 lane miles. This presentation will discuss the results of randomly selected samples to provide data on milkweed density and nectar resources in roadside in the Mid-Atlantic. If time permits, presenters will also provide an overview of DelDOT's efforts to increase habitat for monarchs (and other pollinators).

Effects of Substrate Protection and Type on Ribbed Mussel Recruitment for Living Shoreline Applications

Gentry, Matt, Partnership for the Delaware Estuary, *110 S. Poplar St, Ste 202, Wilmington, DE, 19801*, mgentry@delawareestuary.org; Joshua A. Moody, Partnership for the Delaware Estuary; Sarah A. Bouboulis, Partnership for the Delaware Estuary; Danielle Kreeger, Partnership for the Delaware Estuary

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Ribbed mussels are one of the functional dominant species in eastern United States salt marshes, providing ecosystem services including particulate nutrient filtration and enhanced vegetative growth. Wetland loss in the Delaware Estuary has resulted in ribbed mussel population declines. As interest in living shorelines grows, incorporation of ribbed mussels represents an opportunity to enhance ecological structure and function. Since 2008, the Partnership for the Delaware Estuary has implemented and sustained 14 living shorelines, with ribbed mussel recruitment exhibiting temporal and spatial variability. Where ribbed mussel recruitment was high, mussel density was greater in components providing refuge (i.e., oyster shell bags) relative to materials that did not (i.e. coir fiber logs). The goal of this study was to test whether substrate protection or substrate type affect ribbed mussel recruitment.

Two multi-factor experiments were conducted in triplicate at representative rivers of the Delaware Bay, NJ. The first experiment evaluated recruitment on exposed and protected surfaces of oyster shell bags at varying positions relative to the marsh edge. The second experiment assessed interactive effects between substrate protection methods (i.e., shell bag mesh, coir fiber, and no protection) and substrate types (i.e., oyster shell, oyster castles, and coir fiber) on recruitment. Results of the first experiment showed significantly lower ribbed mussel recruitment along exposed surfaces than protected surfaces, but that the majority of recruitment occurred in interstitial space. Results of the second experiment showed that recruitment on materials protected by shell bag mesh was significantly greater than on those protected by coir fiber or without protection, which did not differ from each other. Additionally, recruitment was significantly greater on oyster castle material than on coir fiber and oyster shell, which did not differ from each other. These results indicate that material selection and material protection can affect ribbed mussel colonization in living shoreline projects.

Monitoring to Assess Beneficial Reuse of Dredged Material in Salt Marsh Restoration at Fortescue Fish and Wildlife Management Area

George, Robert, Princeton Hydro, *1108 Old York Road, Ringoes, NJ, 08551*, rgeorge@princetonhydro.com; Evan Kwityn, Princeton Hydro; Michael Rehman, Princeton Hydro; Christiana Pollack, Princeton Hydro

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The application of a thin layer of dredged material to raise the elevation of subsiding and vulnerable salt marsh was recently implemented at the Fortescue Fish and Wildlife Management Area. The application of this novel restoration technique tested the concept that the beneficial reuse of dredged material can increase the resiliency of New Jersey marshes that face the threat of sea level rise, erosion, and subsidence. To contribute to the body of knowledge on salt marsh restoration, the following parameters were evaluated before and after dredged-material application: hydrology, vegetation, nekton, avian surveys, soil and water chemistry. The results of this monitoring are presented herein and represent initial findings regarding this restoration technique, which is the first of its kind in New Jersey.

Citizen Science Cartogtaphy

Haase, Joe, Leader, Cumberland County 4-H Fishing Clubs, 4-H, *Box 181, Heislerville, NJ, 08324*, joseph.haase@yahoo.com

STEM & Education, Tuesday, 3:00pm, Grand Ballroom B, 1st Floor

Generating underwater charts in the past has been at the mercy of government organizations, and private outfits doing research. Using off the shelf components, a network of citizen scientist can be used to passively monitor the sea floor. This data can be trended over time, to monitor bottom change, such as natural progression, or weather events.

Microplastics in the St. Jones River: An Examination of the Relationship Between Concentration and Proximity to the City of Dover

Hall, Sydney, Wesley College, *109 Michael Drive, Smyrna, DE, 19977*, sydney.hall@email.wesley.edu; Mike Mensinger, Delaware National Estuarine Research Reserve; Stephanie Stotts, Wesley College

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Microplastics, plastic fragments smaller than 5 mm, have recently gained attention due to their negative environmental impacts to aquatic and even human health. There are various pathways for plastics to enter the environment, such as direct release, urban runoff, and waste water treatment plants. It seems reasonable to assume that waterways near urban centers would have higher concentrations of microplastics than areas further away because human activity is the source of this pollutant. However, the spatial occurrence of microplastics concerning urban centers has not yet been thoroughly investigated. The objective of this study was to examine the concentration of microplastics in relation to the city of Dover, Delaware. We hypothesized that there would be more microplastics closer to the city than near the Delaware Bay.

Sampling for microplastics was conducted at five locations along the St. Jones River in June and July 2018. The samples were digested and the number of pieces of microplastic debris in each sample was identified. While microplastics, including microbeads, were found at all sampling locations, the results did not indicate a clear relationship between concentration and proximity to the city of Dover. In fact, the highest concentration was found approximately five miles from the mouth of the river, well outside the city. These results are important to the ongoing research in defining the best practices for monitoring the presence and potential sources of pollution.

Marsh Restoration Projects: Runnels and Breakwater Enhancement

Hanlon, Heidi, Wildlife Biologist, US Fish and Wildlife Service, *24 Kimbles Beach Road, Cape May Court House, NJ, 08210*, heidi_hanlon@fws.gov; Nicole Savona, US Fish and Wildlife Service

Restoration I, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

Restoration projects were started at two US Fish and Wildlife Service locations: Cape May National Wildlife Refuge in Cape May County, NJ and Supawna Meadows National Wildlife Refuge in Salem County, NJ. These projects were conducted to increase the resiliency of degraded marshes made possible through the Department of the Interior Hurricane Sandy Relief Act. Hydrology was the focus of the Cape May NWR project where 10,000' of runnels were dug to help drain excess water from the marsh surface. This drainage will help to improve rates of accretion and facilitate a more natural hydrologic regime. Supawna Meadows NWR, adjacent to the Delaware River, is surrounded by a stone breakwater that was built at the turn of the century for coastal protection of commercial interests and farming. A portion of this stone breakwater was removed and another portion was enhanced in order to protect marsh habitat and improve rates of accretion. Both aspects of these projects aim to help the respective marshes progress on a trajectory toward a more natural marsh system while enabling them to develop into areas that can respond favorably to future environmental changes.

The Role of Forests as Green Infrastructure

Hartman, JeanMarie, **Dr**., Rutgers, *93 Lipman Drive, Rutgers University, New Brunswick, NJ, 08901*, jhartman@sebs.rutgers.edu

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Green Infrastructure is widely recommended as a solution for reducing the impacts of development on local stream water quality. Much of the green infrastructure built in central New Jersey relies on a mixture of grey and green materials. This paper compares the impact of tree planting to other green infrastructure solutions. Results include data that shows protection of existing forests is a buffer against damage from increased impervious surface and data that show the economic benefit of planting trees in vacant lots to address CSO problems.

Promoting and Protecting Early Successional Habitats on Electric Transmission Rights-of-Way

Hazel, Annina, Senior Environmental Project Manager, Pepco Holdings, *401 Eagle Run Road, Newark, DE, 19714*, annina.hazel@pepcoholdings.com

Restoration II, Wednesday, 10:15am, Grand Ballroom A, 1st Floor

Electric transmission rights-of-way (ROW) blend into our rural and suburban horizons and have become a mainstay in our urban skylines. Many people have grown so accustom to ROW in the landscape that they are forgotten completely. In the Mid-Atlantic, these existing linear corridors parallel roadways, cross sensitive natural resource areas, and transect private and public properties. It is important to note that transmission ROW are as critical to power delivery as the poles and wires. Electric utilities are strictly regulated businesses whose top priority is to safely and reliably deliver power to their customers. The purpose of ROW are to provide an environment free of obstructions that may cause hazards to the public or cause electrical outages. Vegetation growing within or adjacent to the ROW are managed to minimize tall growing or "incompatible" species that could grow, blow, or fall into electric conductors and cause a power outage. While Mid-Atlantic electric utilities have the difficult challenge of balancing natural resource protection with transmission reliability, they can do more to promote and protect the unique early successional habitats that are achieved using an Integrated Vegetation Management (IVM) strategy. Mid-Atlantic electric utilities have an opportunity to marry their priority of safe and reliable delivery of power to their customers with environmental stewardship. If managed with IVM, ROW can promote sustainable plant communities that are compatible with electric transmission and provide early successional habitats preferred by pollinators, shrubland birds, and other wildlife that are in decline in the Mid-Atlantic. Mid-Atlantic electric utility management organizations need to enable their vegetation management departments to adopt IVM as a programmatic management practice, promote ROW partnerships, and participate in ROW accreditation programs.

STIMATING SEDIMENT DEPOSITION RATES AND THE INFLUENCE OF SLOPE ALONG WHITE CLAY CREEK USING RIPARIAN TREES

Henry, Teric, Wesley College, *120 N STATE ST, Dover, DE, 19901*, Teric.Henry@email.wesley.edu

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

White Clay Creek, which flows through North Western Delaware and Southeastern Pennsylvania, has a history of chronic erosion, requiring costly bank stabilization and restoration efforts. As a result, there is a push to understand the sediment dynamics of the system, including the location of sediment sources and sinks and the calculation of a sediment budget for the system. The goal of this project was to estimate deposition rates using riparian trees and to understand how slope influences sediment deposition in the watershed. Sediment deposition rates were estimated using dendrochronological techniques. Approximately 20 trees were selected randomly from low slope and high slope study sites. Each sample tree was cored with an increment borer. These cores were dried, mounted, sanded, and observed under magnification, allowing for the rings to be counted and the age of the tree to be estimated. The deposition amount was then determined by digging to the root flair of each tree and measuring the distance from the soil surface to the root flair at three locations around each tree. By dividing the average deposition measurement by the age of each study tree, we were able to estimate the sedimentation rate around each tree. The average deposition rate for each site was then calculated and compared between high and low slope study sites. Trees growing on low slopes showed deposition rates varying from 0 cm/yr to 0.86 cm/yr with an average rate of 0.22 cm/yr. The sample trees used to generate these results ranged from 25 to 270 years of age. There was an average deposition of 0 cm/yr for trees growing on high slopes. These results can be used to help establish a sediment budget and indicate that sediment is stored at low slope locations.

Effective Communication with Decision Makers

Herb, Jeanne, Executive Director of the Environmental Analysis & Communications Group, Rutgers University Bloustein School of Planning & Public Policy, *33 Livingston Avenue, New Brunswick, NJ, 08901*, jherb@ejb.rutgers.edu

Strategic Scientific Communications, Monday, 10:15am, Grand Ballroom B, 1st Floor

The presentation will provide an overview of evidence-based strategies to engage and communicate with different type of decision-makers regarding climate change and resilience topics. The talk will include an overview of current science on effective communication as well as examples of how best practices have been developed and applied in New Jersey.

Philadelphia Water Department Salinity Intrusion Planning and Assessment

Hesson, Molly, Sage Services LLC, *7056 Germantown Ave, Suite 302, Philadelphia, PA, 19119*, Molly.Hesson@sageservicesh2o.com; Ramona McCullough, Sci-Tek Consultants

PWD Water Quality Planning, Tuesday, 10:00am, Crystal Room, 1st Floor

The Philadelphia Water Department (PWD) is in the middle of a multi-year water supply planning effort focusing on salinity intrusion in the Delaware Estuary in the vicinity of the Baxter Water Treatment Plant (WTP). Situated along the Delaware River in Philadelphia, Baxter WTP provides the city with approximately 60% of the potable supply to residential, commercial and industrial customers. While the Delaware River remains a high quality drinking water supply, understanding the influence of changing upstream water quality, reservoir and drought management policies, and sea level rise on Baxter WTP requires extensive technical analysis. To support planning efforts a three-dimensional model of the tidal area of influence of the Baxter WTP has been developed and validated. This presentation will include an overview of the history of salinity intrusion, the need for planning, and the PWD technical approach to salinity assessment.

Sustainable Energy Management at a Water Utility

Hill, Emily, City Planner, Philadelphia Water Department, 1101 Market Street, Philadelphia, PA 19107, emily.hill@phila.gov

Utilities & Sustainability, Monday, 1:30pm, Grand Ballroom B, 1st Floor

Alternative energy, resource recovery, and greenhouse gas management at the Philadelphia Water Department.

DO Requirements of Delaware Estuary Biota

Horwitz, Richard, Associate Professor, Academy of Natural Sciences of Drexel University, *1900 Benjamin Franklin Parkway, Philadelphia, PA, 08625*, rjh78@drexel.edu; Allison Stoklosa, Academy of Natural Sciences of Drexel University; David Keller, Academy of Natural Sciences of Drexel University; Raffaela Marano, Academy of Natural Sciences of Drexel University

Hot Topics, Wednesday, 1:30pm, Grand Ballroom, 1st Floor

The concentration of dissolved oxygen (DO) is a critical factor in mortality, growth and reproduction of aquatic animals. Determining critical concentrations of DO for organisms is essential to assessing suitability of waterbodies to maintain aquatic life. We report results of a literature review and compilation of DO requirements of key aquatic species of the Delaware Estuary, based on both lethal and nonlethal endpoints. Data are derived from sources ranging from multi-factor, multi-level experiments through empirical observations of species occurrence. DO requirements are linked to occurrence of sensitive life stages at different times and in different places in the estuary. We discuss important data gaps. For various species, these include absence of data on key life stages and the absence of data on sensitivity to DO at the range of temperatures and salinities at which the taxon occurs. While well-known information on sensitivity of juvenile Atlantic Sturgeon is likely to be a key determinant of habitat suitability, non-lethal effects on other species at relatively high DO concentrations are also noted. We discuss approaches to incorporating additive and interactive effects of different stressors to defining critical levels of DO.

View from Above using drones for monitoring

Jacobus, Steven, Section Chief, New Jersey Department of Environmental Protection, *401 East State Street, Mail Code 401-07B PO Box 420, Trenton, NJ, 08625*, steven.jacobus@dep.nj.gov

Monitoring I, Monday, 3:15pm, Grand Ballroom A, 1st Floor

The commercial use of small unmanned aircraft systems, aka drone, has developed quickly over the last few years. Relatively inexpensive drones can provide high quality photos and video of sites in a fraction of the time it would take to cover the site on foot and in a much less destructive manner. Advances in post-processing software allow for 2D orthomosaics that can be brought into GIS applications and 3D modeling for more detailed analysis. The NJDEP is developing the use of drones to do visual monitoring and documentation of ecologically based projects, assess shoreline erosion and evaluate marsh areas for restoration.

Seagrass Plantation: A Model Hybrid Living Shoreline Project

Janiec, Douglas, Natural Resources Program Manager, Sovereign Consulting Inc., *50 West Welsh Pool Road, Suite 6, Exton, PA, 19341*, djaniec@sovcon.com

Restoration I, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

The Seagrass Plantation community shoreline, located on the Indian River Bay, DE, has been degrading at various rates due to a number of causes, including wake action, storm energy, SLR, and a breached sluice. During 2018, a comprehensive site evaluation, screening, master design, and implementation occurred. The project involved re-establishing proper tidal flush of a marsh, retrofitting an abandoned sluice, designing two unique artificial shallow reefs, incorporating multiple living shoreline tactics and marsh restoration. The project did not receive any State or Federal funding, and the communities outreach and support makes this a true model project for other shoreline communities. The presentation will cover the initial assessment, element of the 6 phased design, construction of the project and the communities involvement and proactive approach.

The American Littoral Society Monitoring for Change: Continuous Water Quality Monitoring Stations in the Cohansey Watershed

Johnson, Sarah, Conservation Coordinator, American Littoral Society, *1025 N High Street, Millville, NJ, 08332*, sarah.johnson@littoralsociety.org

Water Quality II, Tuesday, 3:00pm, Crystal Room, 1st Floor

The American Littoral Society is working to characterize the current water quality conditions in four small tributaries to the Cohansey River to help guide the Society's restoration efforts. There are three components of the program, in stream continuous water quality stations, four water sampling sites and an in-school programs to engage students at the local high schools. The Society is utilizing Mayfly continuous water quality monitoring stations from Stroud Water Research Center to further understand stream hydrology and chemistry dynamics in real time in addition to quarterly stream side sampling using a YSI Exo 1 sonde. Through this approach the Society will be able to understand the baseline conditions of the stream and identify how the streams respond to storm events and road salt application during winter by investigating long term trends and changes in streams. This presentation will focus on the efforts of the Littoral Society use of data loggers for stream monitoring and how the Society is using this technology to educate the surrounding communities.

Horseshoe Crabs, Red Knots, and Coastal Inundation

Jones, Casey, Rutgers University Department of Marine and Coastal Sciences, *27 Wycklow Drive, Robbinsville, NJ, 08691*, cmj112@rutgers.edu; David Bushek, Haskin Shellfish Research Laboratory - Rutgers University

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

From April to June, Delaware Bay beaches are spawning grounds for the largest horseshoe crab (HSC) population in the world. This activity makes the crabs a keystone species in this region where their eggs and hatchlings serve as a primary food source for a plethora of resident and migratory species, both aquatic and terrestrial. One charismatic species, the red knot *Calidris canutus rufa*, feeds predominantly on horseshoe crab eggs when they are present in high abundance. The rufa red knot was listed as threatened by the USFWS in 2014 following declines in abundance that were linked to declining abundances of spawning HSCs putatively linked to overfishing although other causes may be equally or more important. Specifically, with sea levels rising rapidly, spawning habitat along the Delaware Bay could be shrinking, resulting in fewer eggs for the many predators that feed on them. Sea level rise increases tidal inundation and erosion. Both the frequency of inundation exceeding mean high high water (MHHW) and the magnitude of tides exceeding MHHW are expected to increase with sea level rise. Corresponding reductions in horseshoe crab spawning could decreases red knot abundance. We found that both tidal inundation frequency and magnitude above MHHW have increased over time, but in a stepwise fashion with higher frequencies and magnitudes after 2002 compared to prior years. HSC spawning activity was only available since 2003 and has not changed significantly. Red knot data was available back to 1986 and decreased over time with with two distinct periods: higher mean abundance and variability prior to 2002, lower mean abundance and variability thereafter. Because HSC data are limited, it's difficult to associate spawning with tidal inundation. However, red knot abundance clearly changed around 2002. The patterns suggest sea level rise as a potential driver of horseshoe crab spawning and, consequently, the species dependent upon HSC eggs and hatchlings.

Functional Habitat Patch Size vs. Total Habitat Amount: The Importance of Patch Shape at Habitat Thresholds

Keller, Jeff, **Ph.D**., Habitat by Design, LLC, *74 Stagecoach Road, Pipersville, PA, 18947*, habitat@epix.net

Restoration II, Wednesday, 10:15am, Grand Ballroom A, 1st Floor

Some researchers have argued that overall habitat amount is more important than the size or shape of individual habitat patches in determining biodiversity. I evaluated this postulate for an assemblage of 19 guilds of breeding birds in central New York by assessing threshold occupancy of guild-specific solid (e.g., forest) or edge (e.g., shrub-opening) patch types within a variety of successional seres. Under the assumption that the optimal shape of an all-purpose territory is a circle, I used two novel landscape metrics and high-resolution (<0.75 m) aerial photography to measure the maximum diameter circle (MDC) that fit within patch types specific to particular guilds. The best multiple regression models of both guild species richness and density included variables based on the MDC that fit within guild-specific patch types. Additionally, the species most likely to appear in single species occurrences of multi-species guilds was the smallest member of the guild and larger guild members occurred only in larger patches. Results suggest that although total habitat amount may be more important at larger geographic scales, patch size and shape are critical to threshold occupancy and the establishment or maintenance of small populations, as well as to overall biodiversity. The landscape metrics applied here can be used to assess the current functional size of habitats of interest and to optimize habitat management or conservation efforts within the Estuary Watershed.

Modeling and Monitoring Conservation Practices with WikiWatershed

Kerlin, Steve, Director of Education, Stroud Water Research Center, *970 Spencer Rd., Avondale, PA, 19311*, skerlin@stroudcenter.org; Dave Arscott, Stroud Water Research Center; David Bressler, Stroud Water Research Center

Monitoring I, Monday, 3:15pm, Grand Ballroom A, 1st Floor

The WikiWatershed® toolkit of resources help individuals learn about, model changes in land use and conservation practices, monitor, and analyze water quality and quantity data to protect their watersheds. Designed for scientists, teachers, students, conservation workers, municipal decision-makers, and ordinary citizens, WikiWatershed includes six tools: Model My Watershed®, Runoff Simulation, EnviroDIY™, Monitor My Watershed®, Leaf Pack Network®, and Water Quality mobile app. From modelling stormwater effects, a digital data sheet, to an online portal for data sharing and a forum for discussing DIY environmental science and monitoring, this toolkit provides technology resources for individuals and communities to improve their watershed impacts. This presentation will showcase the Model My Watershed web-based GIS. Model My Watershed allows users to analyze their local watersheds, land cover, and soil data by providing rapid visualization of watershed data, advanced geospatial analysis capabilities, and science-based predictions of stormwater runoff and water quality. Users can also create new scenarios and model changes (using a single storm or multi-year model) to land uses or implementation of conservation practices while seeing the effects to hydrology and surface water. Access to USGS river gauge data, stream network overlays, different satellite and map overlays, precipitation, EnviroDIY stream sensor data, and other data are embedded into Model My Watershed. Model My Watershed is useful for scientific research, land use planning for restoration and conservation, education, and communicating about watersheds to the public. It also features a corresponding high school curriculum that has been piloted in eight states. WikiWatershed resources have been funded in part by National Science Foundation and William Penn Foundation grants and are available to the public.

WATAR in the Christina Basin: Achieving Goals Together

Keyser, Todd, Hydrologist V, DE DNREC- Waste and Hazardous Substances, *391 Lukens Drive, New Castle, DE, 19720*, todd.keyser@state.de.us; John G Cargill, IV, DE DNREC - DWHS, DWS; Morgan McGee-Solomon, DE DNREC- SIRS

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The DE DNREC Watershed Approach to Toxics Assessment and Restoration team has been working on a number of projects in the Christina River Basin to determine nature and extent of toxic contaminants on sites and in the water. The team is gearing up to enter the next phase of the remediation and restoration of the Christina River. The target area for this project will be from Newport to the mouth and also include the tidal Brandywine Creek. The WATAR team is seeking participation and feedback on the strategies to remediate and restore the Christina River to fishable, swimmable and potable.

Collaboration, Plant Breeding, & Agroecology: Transforming Farming to Protect Fragile Ecosystems and Fight Climate Change

Kleinman, Nate, Co-Founder/Co-Director, Experimental Farm Network, *109 Oak St, Suite B, Elmer, NJ, 08318*, nathankleinman@gmail.com

Hot Topics, Wednesday, 1:30pm, Grand Ballroom, 1st Floor

Our farming system is broken. Even in a state like New Jersey with a relatively diverse agricultural base, the vast majority of farm acreage is now planted in corn or soybeans. These crops require annual tillage, which causes erosion and releases carbon into the atmosphere with every till, and they are typically grown with artificial fertilizers and toxic pesticides, which ultimately end up in our waterways. Nate Kleinman, co-founder of the Experimental Farm Network (EFN) and a heritage seed farmer based in Salem County, NJ, will discuss ongoing efforts to revolutionize the farming system, including EFN's cooperative model which aims to use widespread collaboration to develop new crops and growing methods with a focus on perennial grains, oilseeds, and vegetable crops, grown in sustainable agroecological systems. Agroecology is all about mimicking natural systems. It is not a new idea, but rather one built on thousands of years of indigenous knowledge on how to sustainably produce food, fiber, and medicine. With massive demographic shifts on the horizon in the farming community, practitioners and policy-makers have an unprecedented opportunity to put our agricultural landscapes to work cleaning our waterways, restoring ecosystems, and perhaps even stabilizing the global climate.

Protecting the Environment by Reducing Stormwater Pollution

Klewin, Matthew, Environmental Specialist Three, New Jersey Department of Environental Protection, *401 E. State Street, P.O. Box 420, Trenton, NJ, 08625*, matt.klewin@dep.nj.gov

MS4 x 3, Wednesday, 2:30pm, Crystal Room, 1st Floor

The presentation that I will be presenting will be an overview of 2018 renewal of the municipal stormwater regulation program Tier A and Tier B permits. As a delegated Agency of the Environmental protection Agency, New Jersey Department of Environmental Protection issued four (4) permits to every owner of MS4s (municipal separate storm sewer systems) including more heavily populated Tier A municipalities, more rural or populated towns-Tier B, 'Public Complexes' and Highway Agencies.
The initial four (4) permits were issued in 2004 in response to EPA's Phase II rules which required all owners of small MS4s to obtain a MS4 permit issued by either EPA itself or a delegated agency (e.g. New Jersey).

New issued the four permits with Statewide Basic requirements (SBRs) which require a town county, etc. to implement best management practices to reduce pollutants in stormwater from their municipal, county, or State operations. Examples of SBRs are street sweeping, maintenance yard operations, catch basin cleaning, community wide ordinances, local public education, and post construction in development and re-development projects.

The permits have become more defined and the SBRs tightened each time the permits are renewed. The Tier A, Tier B, (both 2018) and Public Complex (2019) permits have been renewed. Currently the Highway Agency permit is in the process of being renewed. Municipalities, counties, and certain State and Federal facilities have an obligation to prevent pollutants from entering stormwater and being carried out to our lakes and streams. Through the four MS4 permits NJDEP will continue to carry out its obligation as a delegated agency of EPA to protect the Waters of the State.

EnviroDIY Sensor Stations for Education and Watershed Monitoring: A Case Study on Pickering Creek at Montgomery School, Chester Springs, PA

Kline, David, Educator, Montgomery School, *1141 Kimberton Road, Chester Springs, PA, 19425*, ENVSScienceKline@gmail.com; David Bressler, Stroud Water Research Center

STEM & Education, Tuesday, 3:00pm, Grand Ballroom B, 1st Floor

There is great value in fostering collaboration opportunities between students and scientists to further data collection and analysis, and contribute to research and understanding in the Delaware River Watershed. This is a case study of how Montgomery School, an independent, co-educational day school serving pre-kindergarten through grade eight in Chester Springs (PA), entered a collaborative project with Stroud Water Research Center and other watershed groups to install and use an EnviroDIY automated sensor station on Pickering Creek which passes through the school's campus. Montgomery School is an example of how Stroud Water Research Center is assisting watershed groups in developing technical background and monitoring capacity to support the goals of the Delaware River Watershed Initiative (DRWI) and the William Penn Foundation. This station on Pickering Creek is being managed by teachers, students, and volunteers from the local community - sensors are regularly cleaned, quality control practices are employed to ensure data validity, and additional sampling activities are performed to enhance sensor station data. The EnviroDIY sensor station collects real time conductivity, temperature, depth, and turbidity data and transmits the data to a publicly accessible online portal that includes all sensor stations within the EnviroDIY network. Students are guided by teachers through the process of analyzing the real time data, inspecting data graphs, and evaluating cause and effect responses, which has helped students (and teachers) develop their understanding of ecological relationships between land, water, and human activities in their local Pickering Creek Watershed. This program has enhanced the watershed education curriculum at Montgomery School and provides a real-world application for students, teachers, and volunteers to participate as citizen scientists contributing viable monitoring data for answering ecological questions and building societal science knowledge in the Pickering Creek and Delaware River Watersheds.

Multi-Municipal Stormwater Collaborations: Comparisons between the Chesapeake Bay and Delaware River Watersheds

Kohler, Ellen, Water Quality Program Manager, University of Maryland Environmental Finance Center, *Preinkert Hall, 7480 Preinkert Drive, College Park, MD, 20742*, ejkohler@umd.edu

Water Quality II, Tuesday, 3:00pm, Crystal Room, 1st Floor

Stormwater is the source of most of the stream impairments to water quality in Pennsylvania and throughout the Delaware River basin. Managing stormwater runoff from impervious cover and reducing the pollution in it are the focus of the municipal separate storm sewer system (MS4) program under the Clean Water Act. As a result of the state's local government structure, recent development patterns, and changes in the state's MS4 program, a large number of municipalities in the state were required to submit individual permits for the MS4 permit cycle starting in 2018. Many of these municipalities are more suburban in nature, they do not have extensive gray stormwater infrastructure, and they generally do not have the capacity on staff to address all of the activities required under the stormwater permit. With the encouragement of the Pennsylvania Department of Environmental Protection and support of county agencies and conservation organizations, several sets of municipalities decided to collaborate on required activities, most significantly implementation of best management practices (BMPs) to address pollution in stormwater.

The Environmental Finance Center has provided direct support to several of these collaborations, both in the Chesapeake Bay watershed and the Delaware River watershed. They range in size from two municipalities to 45 municipalities. They are collaborating on a range of activities, from public education and involvement to funding of stormwater BMPs. A major concern for these municipalities is outlining sustainable financing to ensure that all stormwater program activities are supported, including administration, project implementation and operations and maintenance.

The two watersheds cover the vast majority of the MS4 area in the state. There are significant similarities among collaborations in the two watersheds and some interesting differences that will be addressed in the presentation.

Investing in native freshwater mussel stocks for water quality enhancement in Mid-Atlantic Watersheds: The Mussels for Clean Water Initiative

Kreeger, Danielle, Science Director, Partnership for the Delaware Estuary, *110 S. Poplar St., Suite 202, Wilmington, DE, 19801*, dkreeger@delawareestuary.org; Rebecca Kennedy, Pennsylvania Infrastructure Investment Authority; Maitreyi Roy, John Bartram Association; Angela Padeletti, Partnership for the Delaware Estuary; Kurt Cheng, Partnership for the Delaware Estuary; Joshua Moody, Partnership for the Delaware Estuary

Blue Collar Bivalves, Tuesday, 3:00pm, Grand Ballroom A, 1st Floor

Bivalve shellfish perform many important ecosystem services in areas where they are abundant. For example, both natural and farmed populations can filter and transform substantial particulate pollutants in areas where the bivalve population abundance is high relative to the water's residence time and particle load. The ability to promote water clarity and quality through their natural feeding activity has garnered increasing interest by water quality managers in conservation, restoration and aquaculture activities that sustain or enhance populations of bivalve shellfish, including a variety of fresh and saltwater species. Unfortunately, populations of native bivalves have been in decline in mid-Atlantic watersheds such as the Delaware River Basin, and this complicates our efforts to sustain water quality. Since 2007 the Freshwater Mussel Recovery Program has worked to assess the status of mussel populations, identify their habitat needs, reintroduce species to their historic range, develop hatchery propagation methods, quantify their water quality benefits, engage citizen scientists, and educate the public about the value of mussels to healthy ecosystems. The Mussels for Clean Water Initiative (MuCWI) is a new effort to expand several facets of the overall recovery program by addressing the restoration bottleneck of mussel supply. With construction funding from the Pennsylvania Infrastructure Investment Authority, a new mussel hatchery will be constructed at Bartram's Gardens in Philadelphia. Mussel seed that are produced will be reared in suitable ponds at MuCWI satellite facilities throughout the area until they are ready to be used for restoration, research, assessment, and education projects. Funding and new partnerships are being arranged to take advantage of this new seed supply with a top goal of promoting cleaner water in the Delaware Estuary, Chesapeake Bay, and vicinity.

Coordinated conservation through the DRWI-- how much improvement do we predict?

Kroll, Stefanie, Watershed Ecology Section Leader, Academy of Natural Sciences of Drexel University, *1900 Benjamin Franklin Parkway, Patrick Center for Environmental Research, Philadelphia, PA, 19103*, sak345@drexel.edu; Marie Kurz, Academy of Natural Sciences of Drexel University; Scott Haag, Academy of Natural Sciences of Drexel University; Lin Perez, Academy of Natural Sciences of Drexel University; Meghan O'Donnell, Academy of Natural Sciences of Drexel University; Hayley Oakland, Academy of Natural Sciences of Drexel University; Richard Horwitz, Academy of Natural Sciences of Drexel University

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Theories on stream ecosystem recovery trajectories require testing in specific regions relative to the restoration objectives. Large-scale Agricultural Best Management Practice (BMP) programs in multiple small (<10 km2) watersheds are designed to reduce nutrient, sediment and other inputs from runoff to streams. Our research addresses measuring the success of restoration with potential improvements in stream water quality and aquatic biota. We sampled benthic macroinvertebrates and water chemistry near agricultural BMPs in the Delaware River Basin with agricultural land use ranging from 0-83%. We used SRAT to calculate loads of total nitrogen, total phosphorus and total suspended solids. We examined baseline conditions in terms of water chemistry and macroinvertebrate community structure (taxa) and function (functional traits/metrics). For macroinvertebrate communities, sites show different relationships with each other and with environmental variables based on either structure or function. Improved biotic community composition can be predicted using the baseline data across a gradient of sites. For chemistry parameters, several focus areas show potential for measurable change as a result of restoration actions. Our approach to planning that considers potential for change can be a template for restoration ecologists and practitioners to utilize in other regions.

Sediment Diagenetic Processes in the Tidal Fresh Delaware River

Kulis, Paula, **Dr.**, CDM Smith, *CDM Smith, 75 State Street Suite 701, Boston, MA, 02109*, kulisps@cdmsmith.com; Kinman Leung, Philadelphia Water Department; Eileen Althouse, CDM Smith; Damian Brady, University of Maine; Jeffrey Cornwell, Chesapeake Biogeochemical Associates; Michael Owens, Chesapeake Biogeochemical Associates; Joanna York, University of Delaware

Water Quality I, Monday, 10:15am, Grand Ballroom A, 1st Floor

Sediments often play a significant role in oxygen mass balances for surface waters. Water quality in the tidal fresh Delaware River is impacted by sediment oxygen demand (SOD) and ammonium fluxes into and out of the sediment driven by diagenetic processes. As the Philadelphia Water Department continues to refine a DO water quality model of the Delaware River, it is necessarily also evaluating sediment fluxes in the river.

The dataset describing Delaware River sediment processes is one of the most comprehensive datasets available in estuarine systems. Over 100 cores collected over seasons spanning 7 years and 70 river miles in the tidal fresh and oligohaline stretches of the Delaware River provide significant information on sediment processes and their role in water column nitrogen and oxygen mass balances. This presentation will analyze the sediment dataset, an inventory of particulate and dissolved nitrogen, phosphorous and carbon loading to the tidal fresh Delaware River, and modeling work that has been conducted using insights from the dataset. The combination of modeling work and data provides insights into the role sediments play in the river's ability to assimilate wastewater treatment plant ammonium discharges and particulate organic matter pulses from storms throughout the watershed. The process based modeling approach also allows for an analysis of potential future conditions.

We present a conceptual understanding of both sediment processes in the tidal fresh Delaware River, and the nitrogen, phosphorous and carbon loading to the system. We also use modeling applications to infer the influence of sediment processes on water column water quality, including dissolved oxygen. Because settling particulate organic matter, rather than settling biomass, dominates sediment deposition in the study area, observed diagenetic rates are lower than estuarine systems with larger sediment contributions from biomass. Understanding the role of the sediments in this estuarine system informs water column processes.

Preservation, Regulation and Restoration of Riparian Buffers: Promoting the Environmental Health of Watersheds in the Mid-Atlantic Region

Leto, Robyn, Master of Environmental Studies Candidate, University of Pennsylvania, *942 Stony Lane, Gladwyne, PA, 19035*, brleto1@comcast.net

Water Quality II, Tuesday, 3:00pm, Crystal Room, 1st Floor

The inevitable connection between land and water resources highlights the importance of land use planning, best management practices and uniform regulations, and riparian buffer restoration in watershed protection. The clearing of forests along streams and other waterways and the development of residential, commercial and industrial sites as well as agricultural activities, destroy natural riparian buffers that trap and filter nonpoint source pollution before pollutants and nutrients reach source waters. Studies have shown that more forest cover in a watershed results in better water quality and lower drinking water treatment costs. A comprehensive plan for source water protection should be created for important watersheds focusing on reducing nutrient, sediment and pollution runoff, identifying high priority land for preservation, restoring and maintaining riparian buffer protection, enactment of stormwater regulations, uniform setbacks in riparian zones and best management practices that protect riparian buffers.

This paper explores: (1) the literature on the ecological importance of maintaining forest cover and riparian buffers in watersheds as well as state and local initiatives designed to protect water quality of watersheds including the New Jersey Green Acres program and the Delaware River Watershed Initiative, (2) stormwater regulations and best management practices in various states including Maryland where counties adopted 100 and 200 feet setbacks from streams, rivers and lakes, (3) riparian buffer education and restoration programs such as Maryland's ReLeaf program, USDA's Conservation Resource Enhancement Program and Chesapeake Bay Riparian Forest Buffer Initiative, and (4) case studies where conservation easements are created as a means to restrict conversion of land that provide natural forest buffers. Local watersheds must evaluate the effectiveness of land preservation, regulatory action and/or restoration and community education as a means of protecting riparian buffers and incorporate this evaluation in a comprehensive conservation plan for riparian buffer and source water protection.

Philadelphia Water Department Strategic Planning Using High-resolution Water Quality Model in the Urban Tidal Freshwater Delaware River.

Leung, Kinman, Environmental Engineer Specialist, Philadelphia Water Department, *1101 Market St., Philadelphia, PA, 19107*, kinman.leung@phila.gov; Phil Duzinski, Philadelphia Water Department; Julie Midgette, Philadelphia Water Department; Ramona McCullough, Sci-Tek Consultants; Paula Kulis, CDM Smith; Eileen Althouse, CDM Smith; William Bezts, CDM Smith

PWD Water Quality Planning, Tuesday, 10:00am, Crystal Room, 1st Floor

Philadelphia Water Department's primary mission is to plan for, operate, and maintain both the infrastructure and the organization necessary to purvey high quality drinking water, to provide an adequate and reliable water supply for all household, commercial, and community needs, and to sustain and enhance the region's watersheds and quality of life by managing wastewater and stormwater effectively. In fulfilling its mission, the Department seeks to be customer-focused, delivering services in a fair, equitable, and cost-effective manner, with a commitment to public involvement. Having already served the City and region for nearly two centuries, the utility's commitment for the future includes an active role in the economic development of Greater Philadelphia and a legacy of environmental stewardship. The Department had presented its numerical model of the tidal freshwater Delaware River developed for the Philadelphia Green City, Clean Waters program in the previous Summit. The model was applied to simulate in-stream concentrations of bacteria and dissolved oxygen in the Delaware River between Trenton and Delaware City. US EPA Environmental Fluid Dynamics Code (EFDC) was used for modeling hydrodynamics and water quality. Loadings of carbon, nitrogen, Phosphorus, DO, algae, and fecal coliform bacteria from tributaries and municipal and industrial discharges were all considered in model development. In 2015, the Department submitted water quality model results to PADEP as part of the regulatory requirement. The Department continues to update and refine the water quality model as part of a long-term planning strategy. The presentation will focus on the existing water quality model, and how it can be utilized as part of the regulatory deliverable, or as an internal planning tool. Future use of the water quality model includes applying it to source water studies, climate change and sea level rise adaptation planning, implementation or adaptive management, and examine proposed water quality regulation changes.

Collaborating with Art: How Science and Art Collaborative Projects Can Both Show and Help Solve Ecological Issues.

Levy, Stacy, Artist, self employed artist, *576 Upper Georges Valley Road, Spring Mills, PA, 16875*, stacy@stacylevy.com

Placemaking, Tuesday, 1:15pm, Grand Ballroom B, 1st Floor

In recent years, my work has focused almost exclusively on issues of water. From rivers to runoff, I have explored urban watersheds, tides, storm water, aquatic micro-organisms, hydrologic patterns, and water treatment. I have often collaborated with ecologists, zoologists hydrologist and engineers to create these art projects. I want to highlight some of my recent projects, and explore ideas for ways that scientists and artists can collaborate on shared goals. I will also illustrate the ways in which art plays a key role in advancing ecological health and environmental preservation. My work not only tells the ecological story of the site, but it had been be part of the solution to correct some ecological issues on the site.

In contemporary culture, art is a commodity that has been defined by its lack of function. Large-scale earthworks of the 1960s and '70's were built to sit passively on site and spur contemplation. However in the past two decades, public art has taken a new direction that includes action. New works collaborate with nature not only to reveal issues, but to solve problems. As a sculptor making large-scale installations in rivers, streets, parking lots, airports, and nature centers throughout the United States, I make public works that respond to ecological challenges. I believe that art can be instrumental in showing what is going on ecologically, and is a vital player in creating practical solutions.

I will show, through my work and the work of other artists how contemporary eco-artists link the worlds of art and science; instigate new forms of understanding; and respond to the processes and problems we see. Artists share with ecologists a sense of civic responsibility towards nature which is worth exploring and expanding at this conference. Art and Science collaborations may be the next direction for solutions.

Preliminary Results of Culturing Freshwater Mussels of the Mid-Atlantic through In Vitro Techniques

Longwill, Kathryn, The Academy of Natural Sciences of Drexel University, *1900 Benjamin Franklin Pkwy, Philadelphia, PA, 19103*, kab543@drexel.edu; Lance Butler, Philadelphia Water Department; Danielle Kreeger, Partnership for the Delaware Estuary, The Academy of Natural Sciences of Drexel University; Kurt Cheng, Partnership for the Delaware Estuary; Christopher Vito, The Academy of Natural Sciences of Drexel University; Julia Duriske, The Academy of Natural Sciences of Drexel University; Roger L. Thomas, The Academy of Natural Sciences of Drexel University

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Freshwater mussels are ecosystem engineers that provide valuable services such as water filtration, benthic habitat enhancement, and streambed stability. Unfortunately, mussel populations have demonstrated signs of decline likely due to decreased water quality, barriers to fish host migration and increases in watershed land development. Laboratory propagation is often the keystone to bolster diminished mussel populations but can pose numerous challenges, such as obtaining healthy fish of the right species and size to match each mussel species' seasonal reproductive requirements. In vitro methods that circumvent the need for a fish host would improve, and potentially, reduce costs and allow propagation of rare species that are hard to produce using established techniques. Researchers at the Patrick Center for Environmental Research at the Academy of Natural Sciences of Drexel University explored in vitro mussel propagation, in conjunction with scientists from Philadelphia Water Department and Partnership for the Delaware Estuary. Three mussel species (*Utterbackiana implicata*, *Leptodea ochracea*, and *Lampsilis cariosa*) were successfully transformed into juveniles using in vitro techniques. Some challenges that were faced include maintaining proper media pH and controlling fungal growth in vitro and within the grow out containers (Barnhart buckets) at the hatchery. Survival of in vitro juveniles varied among species, though significant mortality was seen up to one month post-transformation. *Lampsilis cariosa* juveniles demonstrated the best transformation and survival rates out of the three species used, and continue to be monitored, with the goal of placing them in baskets at our Green Lane Reservoir until they are large enough to relocate. Healthy juvenile mussels produced in vitro will support the overall goal of re-establishing viable mussel populations in streams throughout southeastern Pennsylvania for future generations.

Natural Resource Damage Assessment Restoration: North Breton Island, LA

Malizzi, Lawrence, Senior Manager, OBG, *21 Sandhurst Lane, Elkton, MD, 21921*, lawrence.malizzi@obg.com; Murat Utku, OBG; Gary Emmanuel, OBG; James Davis, OBG

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

North Breton Island is being restored under a contract to the U.S. Fish & Wildlife Service (USFWS) as part of the Deepwater Horizon Oil Spill Natural Resource Damage Assessment and Restoration (NRDAR)process. Currently, the project scope includes permitting, investigation, and construction design and planning. This project is within the Breton National Wildlife Refuge (BNWR) and is owned and operated by the USFWS National Wildlife Refuge System. The design will restore beach, dune, and back-barrier marsh habitats within the

island platform's footprint to support breeding birds, including brown pelicans, terns, skimmers, and gulls. The project team is collected, compiled, analyzed, and managed topographic, bathymetric, sub-bottom, and magnetometer data of the island and the target borrow area and associated conveyance corridors, access channels, and project fill areas. The team is also provided geotechnical, environmental, and cultural resource investigations and developed strategies to resolve potential conflicts with land rights, oyster leases, and oil and gas infrastructure. North Breton Island construction design includes; approximately 76.2 acres (16,000 linear feet) of beach, 138.7

acres of dune, 137.3 acres of back barrier marsh habitat, a total island width of 1,100 feet, bounded by sloped foreshore and back barrier marsh platforms, an elevated dune platform of 8 to 10 ft. above sea level (optimum elevation to be determined through engineering and design) by 400 ft. wide at the base and 100 ft. wide at the top, a gulf-side beach 3 feet above sea level by 200 ft. wide, a landward back barrier marsh platform approximately 3 ft. above sea level and 500 ft. wide, and a targeted borrow area of approximately677 acres. Construction is planned to begin in late 2018.

Communicating Environmental Statistics for Public Consumption

Mangiafico, Salvatore, County Agent/Associate Professor, Rutgers Cooperative Extension of Cumberland County, *291 Morton Ave., Millville, NJ, 08332*, mangiafico@njaes.rutgers.edu

Strategic Scientific Communications, Monday, 10:15am, Grand Ballroom B, 1st Floor

There is often a large gap in the understanding of statistical language and conventions between scientific communicators and their lay-public or para-professional audiences. This is despite the ubiquity and importance of statistics and graphical presentations in scientific, extension, and popular press literature. The uses of statistics for the researcher include adding rigor to analyses, presenting summaries of results, expressing confidence in results, and having a shared language to facilitate communication. These purposes translate to communications with lay-audiences, but care must be taken to communicate in a manner intelligible to the audience. Principles of this communication include using simple and clear plots, using vernacular explanations, explaining the meaning of commonly presented statistics like p-values and r-square values, and tying results to practical implications. Extension education in understanding and using statistics can facilitate the ability of para-professionals to understand scientific results. Learning goals include understanding the conventions of statistical language and graphical plots, appreciating the limits of scientific investigations, and being aware of the ways in which plots and statistics can be misleading.

A GIS Based Model for Prioritizing Reforestation Efforts

McGowan, Andrew, Environmental Scientist, Delaware Center for the Inland Bays, *39375 Inlet Road, Rehoboth Beach, DE, 19971*, environment@inlandbays.org

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

In 2017 the Delaware Center for the Inland Bays partnered with Sussex Conservation District to create a Watershed Reforestation Plan for the Inland Bays. The objective of the plan was to identify and conceptualize reforestation projects within the Inland Bays watershed, which would provide water quality benefits and improve wildlife habitat. To identify priority parcels for reforestation, a GIS based model was created, which used multiple environmental parameters to rank all agricultural parcels in the watershed greater than 10 acres in size. A total of 1,389 parcels were ranked, with 65 parcels owned by public agencies, and 1,324 parcels privately owned. Using the output from the model, three publicly owned parcels have been conceptualized, and will be reforested by the end of 2018, and two private parcels (both ranked in the 'highest priority' category) are in talks for reforestation. The model has proven to be an effective tool, and will help guide reforestation efforts for years to come.

Increasing Oyster Populations in the Delaware Inland Bays

McGowan, Andrew, Environmental Scientist, Delaware Center for the Inland Bays, *39375 Inlet Road, Rehoboth Beach, DE, 19716*, environment@inlandbays.org; Marianne Walch, Delaware Center for the Inland Bays; Bob Collins, Delaware Center for the Inland Bays; Victoria Spice, Delaware Center for the Inland Bays

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Eastern oysters (Crassostrea virginica) are important both ecologically and commercially, supporting multi-million dollar fisheries while simultaneously improving water quality and providing high quality habitat to numerous species of fish, crabs, and other invertebrates. The Delaware Inland Bays, a network of shallow coastal lagoons situated south of Delaware Bay, have relatively low densities of oysters, though natural recruitment appears to be increasing, and an oyster aquaculture industry is beginning. Recognizing the ecological benefits of a healthy oyster population, the Center for the Inland Bays set out to increase populations of oysters within the Inland Bays. To accomplish this goal, the Center developed an oyster suitability model, which combines physical, biological, and regulatory factors to assess the suitability of all areas within the bays for oyster reef projects. In conjunction with the model, a combination of spat surveys and field inspections were used to prioritize areas deemed suitable by the model. The methods used to develop the model and further prioritize suitable sites, along with the results from the model and field inspections will be presented.

Determining Flow Paths for Flooding and Draining in Slaughter Beach, Delaware

McKenna, Thomas, Hydrogeologist, University of Delaware, *Delaware Geological Survey, 257 Academy St., Newark, DE, 19716*, mckennat@udel.edu; John A. Callahan, University of Delaware, Del. Geol. Survey; Kevin Brinson, University of Delaware, DEOS; Damaris Slawik, Delaware Emergency Management Agency

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Elevated high tides unrelated to storms cause frequent nuisance flooding in the Town of Slaughter Beach, a community on Delaware Bay. During coastal storms, more extensive flooding occurs in the Town. Flooding occurs on the west side of the Town (back barrier) and on two access roads between the Town and the mainland. Delaware Coastal Programs (DCP) worked with the Town as part of their Resilient Community Partnership (RCP) and completed an assessment in 2018 of risks to the community from coastal storms, sea level rise, and extreme tides, among other stressors. Coincidentally, twelve water-level loggers installed by DEOS and DGS on the back-barrier upland documented flooding. DCP also installed two water-level loggers in Cedar Creek west of Town. A new project by McKenna is a follow up to these efforts. Three methods are used to identify flow paths for back-barrier flooding. The first method deploys sensors that measure water level, temperature, and salinity in tidal channels and ditches. This methodology is excellent for looking at time series at a point but is not good for identifying spatial heterogeneity. The second and third methods use heat as a tracer to observe flow in space and time, simultaneously. During one day or seasonally, the water will be warmer than the land or vice-versa. Thermal contrasts in water from different sources or between water and land document flow paths. Areal and temporal thermal patterns are collected using thermal infrared and visual cameras attached to a helikite. The third method observes the temperature every meter along a fiber-optic cable attached to a Distributed Temperature System. Three 2- kilometer cables will be deployed along the back barrier of the Town for two months, both on the upland and in the marsh. As water passes over the cable, the cable temperature changes recording flooding events.

What's happening with NGSS?

Mead, Tonyea, Science Education Associate, Delaware Department of Education, *31546 South Conley Circle, Lewes, DE, 19958*, tonyea.mead@doe.k12.de.us

Science Class, Tuesday, 9:00am, Grand Ballroom B, 1st Floor

Now that most states have adopted the Next Generation Science Standards what is going on across the nation? What are nearby districts and states doing about these new standards? How is environmental education playing a role in these new standards? Learn some interesting facts and studies about how implementation is going. Participants will have a chance to view some successful classrooms that have implemented NGSS.

Can youth be the solution to healthier, sustainable watersheds?

Melvin, Emma, Delaware Bayshore Program Director, American Littoral Society, *1025 N High Street, Millville, NJ, 08332*, emma@littoralsociety.org

Science Class, Tuesday, 9:00am, Grand Ballroom B, 1st Floor

Restoration Corps, an American Littoral Society intern program, is designed to provide youth education and training on watershed science, stormwater management and green stormwater infrastructure while instilling an environmental ethos in participants. The Society recruit youth from underserved communities, both urban and rural in Cumberland County. The program, is designed to provide life skill, job readiness and watershed science education along with in-class education and hands-on training on Green Stormwater Infrastructure practices. Corps interns install, built and maintain GSI practices throughout the Cohansey River watershed. In addition to digging, drilling, shoveling, weeding, and watering, youth engage residents from their community through supporting rain barrel workshops, tabling at community events and talking with pedestrians as their work. Youth are introduced to stream ecology through water quality and macro-invertebrate sampling. The program incorporates maintenance and site preparation, to give interns an understanding of the totality of work involved in restoration. In addition, all interns are train on how to design a small residential rain garden, including sizing out the garden and selecting plants. Not all projects worked on are GSI, community projects are added each year to engage the interns in stewardship. These projects include community litter clean-up, bench building and invasive plant removal. This year, an online aspect was integrated into the program utilizing Google +, including Google Drive for intern paperwork and articles for interns to read, Google Photo to collect photos from interns and staff and Google Community to post work schedules, to introduce interns to global and local issue and research impacting the aquatic health and to create an online dialog of the interns about their experience. Through this program we have trained 24 youth on Green Stormwater Infrastructure, installed 15 rain gardens, built over 130 rain barrels, 4 downspout planter boxes, and planted 400 trees.

Building an Equitable Watershed

Miquel, Katharina, Project Coordinator of the Coalition for the Delaware River Watershed, New Jersey Audubon, *401, E. State Street, Trenton, NJ, 08608*, katharina.miguel@njaudubon.org

Environmental Justice: Breaking Barriers, Monday, 3:15pm, Grand Ballroom B, 1st Floor

The Delaware River Watershed has seen many successes in clean water protection. Despite these successes, communities of color, low-income communities, and indigenous communities continue to experience environmental injustices that increase health risks and prevent access to clean water. The first step to tackling equity issues in the region is integrating the voices of underserved and untapped communities into the conservation community. The Coalition for the Delaware River Watershed adopted Diversity, Equity, Inclusion, and Justice as a priority to help bring new voices into our network and work towards transforming our watershed's conservation story to one that reflects and benefits all communities. This presentation will focus on how the Coalition's workgroup is organizing to advance DEIJ issues in the watershed through identifying challenges and resources, building leadership amongst its members, and fostering a culture that breaks down barriers to participation and collaboration.

A Latin American Conservationist in New Jersey in the 1990's; Planting the Seeds for Conservation in the 21st Century

Miranda, Dennis, Director of Development, Pocono Environmental Education Center, *538 Emery Road, Dingmans Ferry, PA, 19466*, go_native@earthlink.net

Environmental Justice: Breaking Barriers, Monday, 3:15pm, Grand Ballroom B, 1st Floor

The conservation movement was flourishing in the State of New Jersey in the 1990's. The Wetlands Protection Act had passed in the previous decade. The growing movement to save the Highlands of New Jersey had spread to New York, Pennsylvania and Connecticut, and New Jersey was pouring hundreds of millions of dollars in the race to save open space. The last frontier of land preservation was, ironically, the urban centers of the Garden State. Here was a great opportunity to restore urban parks, revive access to waterfronts hidden in abandoned industrial blight for decades, turn brownfields to greenfields and the creation of greenways and trails along rivers began in earnest.

As a Latin-American working in the conservation movement back then was a rare event! As the Urban Parks Project Manager for the New Jersey Conservation Foundation, I was privileged to lead conservation initiatives in New Jersey's cities. These pioneering successes that shaped yesterday's conservation agenda offer civic lessons for today's challenges.

Water Quality Benefits of a Shellfish-Based Living Shoreline along the Mispillion River, Delaware

Moody, Joshua, Partnership for the Delaware Estuary, *110 S. Poplar Street, Suite 202, Wilmington, DE, 19801*, jmoody@delawareestuary.org; Danielle Kreeger, Partnership for the Delaware Estuary; Irina Beal, Partnership for the Delaware Estuary

Blue Collar Bivalves, Tuesday, 3:00pm, Grand Ballroom A, 1st Floor

Since 2008, the Partnership for the Delaware Estuary (PDE) has been testing new living shoreline approaches to stem marsh erosion while strengthening ecological benefits such as water quality enhancement. In 2013 PDE installed a hybrid living shoreline at the mouth of the Mispillion River near Milford, Delaware, consisting of oyster breakwaters in the low intertidal zone and erosion control structures along the eroding marsh in the mid intertidal zone. The primary goal was to provide water quality uplift via an increase in shellfish filtration capacity, as measured by an increase in the population biomass of bivalve shellfish. Oyster and ribbed mussel densities and demographics were tracked between 2014 and 2016 on all materials. These changes in population biomass were then integrated with seasonal measurements of seston filtration to develop allometrically scaled physiological-based filtration models as the living shoreline matured.

Shellfish recruitment increased annually, although counts were conservative due to non-destructive monitoring efforts. Since bivalve biomass and physiological rate functions scale non-linearly with shell length, the community filtration capacity was minimal until 2016 when a dramatic increase was measured. Using population data from the end of 2016, the estimated rate of removal of total suspended solids by new oysters and ribbed mussels was 404.7 and 11.1 kg per year, respectively. The estimated removal of particulate nitrogen by oysters and ribbed mussels was 2.63 and 0.09 kg per year, respectively. Continued colonization and non-linear growth in shellfish were measured after 2016, however those data are currently being analyzed. These results indicate that shellfish-based living shorelines can positively contribute to water quality, but at least 3 years are needed for these benefits to materially develop. Water quality managers should consider the value of protecting established, demographically diverse, shellfish populations while also enhancing bivalve populations where appropriate.

Lardner's Point Park North End Living Shoreline in Complex Urban River Conditions

Morgereth, Ed, Sr. Ecologist/Practice Lead, Biohabitats, Inc., *2081 Clipper Park Road, Baltimore, MD, 21211*, emorgereth@biohabitats.com; Brett Long, Biohabitats, Inc.; Chris Streb, Biohabitats, Inc.; Jim Fries, Riverfront North Partnership

Restoration II, Wednesday, 10:15am, Grand Ballroom A, 1st Floor

The Lardner's Point Park, an urban ecological park along the North Delaware Riverfront front was completed in the Tacony neighborhood of Philadelphia in 2011-2012. The habitats, amenities and site features have maintained by the Riverfront North Partnership (formerly Delaware River City Corporation) since park completion. During and post-Superstorm Sandy, and with regular actions of wind and wave and ship wakes, the northern end of the park shoreline continued to experience scour and erosion of the river bank. This erosion affected the shoreline habitat, the adjacent native meadow edge and park infrastructure and amenities, including a paver plaza and pedestrian trail. The north end of the park site experiences a complex set of influences of fetch-driven waves, river current, periodic PWD outfall flows, boat wake energy, and eddying effects along the adjacent pier interface. A multi-element living shoreline with natural and nature-based features (NNBF) was designed, permitted and constructed under a design-build project. This presentation will cover the elements of the living shoreline design process and the integrated elements for erosion protection, aquatic habitat, and resiliency. The project was also one of the very first in Pennsylvania to utilize the US Army Corps of Engineers Nationwide Permit 54 - Living Shorelines. Employed approaches, materials, procedures and applicable lessons for future project efforts will be discussed.

Making it Click: Using Behavioral Research to Improve Outreach Planning

Musolino, Brittany, Outreach Program Specialist, Partnership for the Delaware Estuary, *110 S. Poplar Street, Suite 202, WILMINGTON, DE, 19801*, bmusolino@delawareestuary.org

Improving Your Programming, Wednesday, 10:15am, Crystal Room, 1st Floor

A majority of outreach efforts in the environmental field are based solely on the knowledge and understanding of science; share what you know and it will click with the public ...right? Wrong. PDE's Outreach Program Specialist will take a deeper dive into the behavioral patterns of different audiences by summarizing environmental psychology research done by other agencies and institutions. The audience will leave with a better understanding of behavioral research and why this should be the way we approach public outreach programs.

Reduce Litter in the Delaware River: An Action Plan to Clean-up and Reduce Debris on the Jersey Side

Muthukrishnan, Swarna, Staff Scientist, Clean Ocean Action, *18 Hartshorne Dr, Ste 2, Highlands, NJ, 07732*, smuthukrishnan@cleanoceanaction.org; Alison McCarthy, Clean Ocean Action

Marine Debris & Plastic Pollution, Tuesday, 1:15pm, Crystal Room, 1st Floor

The ultimate goal of "Reduce Litter in the Delaware" project is to reduce land-based sources of trash including plastics that continue to pollute the Delaware River and flow into the ocean. Clean Ocean Action uses research, education, and citizen action to drive solutions to pollution for more than three decades in the NY-NJ region. The Delaware River is subject to tidal influences in New Jersey from Mercer to Gloucester County. This seemingly-forgotten region of the river has amassed several thousand pieces of trash including plastics that has been accumulating over many years. In 2015, COA partnered with Raritan Valley Community College, NJ and identified several litter "hotspots" with high concentrations of trash accumulation in this region in NJ. Since then, COA has embarked on this ongoing initiative aimed at assessing debris accumulation, tracking down sources, and ultimately removing litter and reducing the litter footprint in tidally-influenced Delaware River in NJ. This is a multi-year initiative and requires a multi-pronged concerted effort and COA has been successful in effecting active collaboration and community participation. The first phase of this project was to identify legacy litter hotspots and conduct pilot clean ups and create a "clean slate" for source trackdown investigations. To date, COA has coordinated with 170 volunteers from various groups including high schools and corporations and conducted eight clean up events. These clean ups have resulted in the removal of over 25, 000 pieces of trash with single-use plastics and plastic trash accounting for >90% of debris removed. COA's notable collaborations include local public works for trash removal and a plastics recycling firm to recycle and repurpose all collected plastic debris. The debris problem in these sites along the Delaware River is complex due to terrain, legacy accumulation, tide impacts, accessibility; COA had tried successfully to overcome these challenges.

Rally For The Navesink: A Collaborative Microbial Source Track Down With A "Find-it, Fix-It, No-Blame" Strategy Towards Restoration

Muthukrishnan, Swarna, Staff Scientist, Clean Ocean Action, *18 Hartshorne Dr, Ste 2, Highlands, NJ, 07732*, smuthukrishnan@cleanoceanaction.org; Bill Heddendorf, NJ DEP; Trish Ingelido, NJ DEP

Water Quality II, Tuesday, 3:00pm, Crystal Room, 1st Floor

The Navesink River in New Jersey has routinely endured pathogen pollution primarily from urban stormwater runoff for more than three decades. NJ DEP downgraded 565.5 acres of the river as "prohibited" for shellfish harvesting in 2016 as it failed to meet the bacterial water quality standards for shellfish harvesting. Prompted by the downgrade, Clean Ocean Action (COA) launched a unique, collaborative grassroots community campaign called "Rally for the Navesink" in 2016 to restore the health of the degraded acres. This "no-blame game" collaborative model has three interconnected and concurrent goals.

- Goal 1 - Find the sources of bacterial pollution
- Goal 2 - Fix the sources of bacterial pollution
- Goal 3 - Break the chronic cycle of pollution by implementing sustainable solutions and runoff reduction strategies through effective community engagement including municipal officials

Goal 1 COA successfully identified "hot spots" of human sources of fecal contamination using scent-trained canines in the Navesink in 2016. COA is now coordinating the second year of a weekly citizen science ambient bacteria source track down in the watershed together with NJ Department of Environmental Protection. Results have helped to pursue Goals 2 and 3.

Goal 2 COA actively advocates direct engagement and action by municipal public works and state officials in fixing bacteria pollution sources: Some successes include: (i) rectifying leaky municipal sewer infrastructure (ii) better practices for farm manure management (iii) impervious cover assessment.

Goal 3 COA engages the entire community including municipal officials in "Watershed Mindfulness", a behavioral understanding that everyone is responsible for the health of the local waterway. COA continuously guides the community through the Rally by hosting bimonthly public meetings, offering a solutions toolkit for various groups, motivating towns to develop and implement impervious area reduction plans, educating K-12 students, and coordinating the water protection actions of over 25 organizations.

Water Champions: Conserving South Jersey's aquifers through student engagement

Nickerson, Zach, Education Coordinator, American Littoral Society, *1025 N High Street, Millville, NJ, 08332*, z.nickerson@littoralsociety.org

Citizen Science, Wednesday, 10:15am, Grand Ballroom B, 1st Floor

The American Littoral Society, in partnership with the New Jersey Department of Environmental Protection, has created an integrated school and community program to advance awareness and a call to action for water conservation in Cape May County. The Society collaborates with several high schools in Cape May County to train a core group of "Water Champions" students to become advocates in their communities for water conservation. Students learn about the regional water use, the relationship between water use and supply, over withdrawal's impact on the aquifer and associated natural resources, threats to source water, and are trained on how to conduct a water audit. Students then put this knowledge into action by conducting water audits at home, at their school, and in local business. They learn about social marketing and community engagement for sustainability to help them engage those local businesses and present to the school board their findings and recommendations in a way that will be most likely to lead to real change. The participating school, receive a bathroom upgrade with all new water efficient fixtures. In addition, the first set of business to participate receive fixture upgrades. This program is about taking STEM topics like groundwater, water audits, and data analysis out into the world through community engagement, facilitated by grants for water efficiency upgrades to high volume water use fixtures identified by the Water Champions themselves, with ongoing monitoring by the next year's Water Champions to track the amount of water saved and use these case studies to promote further water conservation in the community.

Collaboration in studying past stream restorations to inform future action

Oakland, Hayley, Staff Scientist, Watershed Ecology, Academy of Natural Sciences of Drexel University, *1900 Benjamin Franklin Parkway, Attn PCER, Philadelphia, Pa, 19103*, hco23@drexel.edu; Dr. Stefanie A. Kroll, Academy of Natural Sciences of Drexel University

Restoration II, Wednesday, 10:15am, Grand Ballroom A, 1st Floor

Stream restoration has become a ubiquitous tool in managing watersheds such as the Delaware Basin. Collaboration between managers, practitioners, and researchers throughout restoration projects is key; from identifying priority areas, to planning and implementing appropriate management actions, and monitoring conditions surrounding the work.

Through a project funded by the PA DEP 2015 Growing Greener program, the Academy of Natural Sciences of Drexel University studied 17 stream sites where restoration projects were completed at least five years prior to the start of our study. Most of these projects, if originally monitored, were assessed within a few years of implementation. However, ecosystems require time to respond to restoration, if they show any response. Thus, the complete ecosystem response, and associated value, of these projects were not fully measured. These projects are an excellent resource for a comprehensive look at their ecological outcomes. Results can provide a first step toward assessing best design, construction, and maintenance of restoration efforts depending on project type, location in the watershed, receiving stream characteristics, and surrounding land use. In comparing conditions within project reaches to those just upstream of the projects, we have observed varying degrees of long-term "success" physically and ecologically.

Our team worked closely with county conservation districts in southeast PA to identify priorities for what types of projects to study and specific site selection to ensure the utility of study findings to managers. The lessons learned are applicable to project selection, as well as investments in monitoring. Although monitoring incurs additional costs, the combined datasets from detailed studies of aquatic ecosystems before and after projects are implemented can also lead to significant savings. By targeting future actions that will have the greatest chance of improving stream ecosystem integrity and identifying how to best show these changes, financial investments in restoration can be applied much more effectively.

How NGOs collaborating with Extension can make multiple strides forward in watershed restoration activities

Obropta, Chris, Rutgers Cooperative Extension Water Resources Program, *14 College Farm Road, New Brunswick, NJ, 22302*, obropta@envsci.rutgers.edu

Improving Your Programming, Wednesday, 10:15am, Crystal Room, 1st Floor

How NGOs collaborating with Extension can make multiple strides forward in watershed restoration activities

The Delaware River Watershed Initiative has brought together partners from across the watershed. Each partner makes their own unique contribution to achieving the goals within their cluster area. The Rutgers Cooperative Extension (RCE) Water Resources Program has been fortunate to have the opportunity to provide technical support to both the Kirkwood-Cohansey Cluster and the New Jersey Highlands Cluster. The RCE Water Resources Program brings expertise from the university to help support the ideas that are being promoted by the non-governmental organizations (NGOs) within the cluster. The additional level of creditability that the university brings has helped the NGOs move from planning to action.

The RCE Water Resources Program has prepared green infrastructure plans for the municipalities within the clusters. Each plan identifies opportunities for installing green stormwater infrastructure that will reduce the impact of stormwater from impervious surfaces. Using these plans, the RCE Water Resources Program and the NGOs work closely together to educate the municipalities on the need to address stormwater issues and the benefits of using green infrastructure. The NGOs strong relationships with local decision makers in each community help open doors to the municipalities and enable the RCE Water Resources Program to convince communities to install green infrastructure practices. This presentation will discuss the collaborative effort in the Kirkwood-Cohansey Cluster that has brought the RCE Water Resources Program together with the local NGOs to implement green infrastructure projects throughout the cluster area. As the Extension services at the land grant universities across the nation are continuing to expand their work with non-agricultural stakeholders, this effort provides a good example of how Extension can support NGOs' watershed efforts.

Building Natural Resources Stewardship

Offenbacker, Beth, Founder and Executive Director, Waterford, Inc./Leadership Nature Center, *3543 W. Braddock Road, Alexandria, VA, 22302*, beth@waterfordinc.com

Citizen Science, Wednesday, 10:15am, Grand Ballroom B, 1st Floor

A key part of protecting the Delaware Estuary and other natural treasures involves creating and sustaining *stewardship* among community members. Stewardship is more than volunteering to care for our water bodies, trees, streams, creeks, and the animals that inhabit them – it's the practice of sustaining ongoing awareness and active responsible action of a valued community or shared resource. In this presentation, participants will learn about the organizational components that comprise a successful stewardship strategy in support of natural resources at the community level.

Update to USGS StreamStats for Delaware

O'Hara, Beatrice, GIS Analyst, Delaware Geological Survey, *257 Academy St., Newark, DE, 19716*, beaohara@udel.edu; John Callahan, Delaware Geological Survey

Monitoring II, Wednesday, 8:30am, Grand Ballroom A, 1st Floor

The USGS StreamStats application is a valuable online, map-based tool for water resource management and engineering design. StreamStats allows users to obtain drainage basin characteristics and peak streamflow statistics at locations along gaged and ungaged streams. For example, this allows the calculation of the 1% flood event at locations along streams where a bridge may be constructed or upcoming planned development will occur. The statistics behind the existing version of StreamStats was released by USGS in 2006. Numerous peak flood events and changes in the land surface topography have occurred since that time. Supported by the Delaware Department of Transportation, the data behind Delaware StreamStats is being updated through a joint collaboration between the Delaware Geological Survey (DGS) and the USGS.

As part of the project, the Delaware Geological Survey (DGS) is hydro-enforcing the recently hydro-flattened Digital Elevation Model (DEM) for Delaware - derived from the 2014 statewide LiDAR acquisition - and using it along with DEMs obtained from the surrounding states to delineate drainage basins around streamgages in the region. Additionally, the region's National Hydrography Dataset (NHD) and the Watershed Boundary Dataset (WBD) are incorporated in the watershed analysis performed on the DEM mosaic. This presentation will focus on the Brandywine-Christina watershed and describe the steps involved in the data preprocessing, editing/updating of the NHD, and running the StreamStats-specific analysis tools.

Executive Order 23-Environmental Justice Update

Outlaw, Riché, EJ Coordinator, NJ Department of Environmental Protection, *401 East State St. PO Box 402, Trenton, NJ 08625*, Riche.outlaw@dep.nj.gov

Environmental Justice: Breaking Barriers, Monday, 3:15pm, Grand Ballroom B, 1st Floor

Governor Murphy's Executive Order 23 (attached) directs the DEP, as the lead agency, to develop a guidance document for all executive branch departments and agencies to consider environmental justice in implementing their statutory and regulatory responsibilities. This draft guidance document was informed by a public stakeholder process and input from interagency representatives. The draft document is released for public comment until March 22, 2019, before a final version is adopted. The guidance will set the stage for an interagency council to collaborate on environmental justice initiatives at a statewide level.

The Sustainable Treatment Plant

Palmer, Dennis, Executive Director/Chief Engineer, The Landis Sewerage Authority, *1776 So Mill Rd, Vineland, NJ, 08360*, dpalmer@landissewerageauthority.com

Utilities & Sustainability, Monday, 1:30pm, Grand Ballroom B, 1st Floor

The Landis Sewerage Authority (Vineland NJ) facilities encompasses diverse environmental, treatment and sustainable practices. It is the largest land application of treated effluent facility in NJ (10.2 MGD design with ground water recharge by spray irrigation and rapid infiltration basins), it has its own farm (380 acres), farms a power line ROW and woodlands (150 acres) for land application of biosolids. Farm crops are raised including corn, rye, wheat, spelt, and hay and earn over $120,000 in gross revenue. Forestry, woodlands and habitat management/restoration are a critical stewardship responsibility. This includes a Forest Management Plan and a Bobwhite, game and non-game habitat restoration by creating a Pine Savannah. Energy is generated with a small wind turbine, Combined Heat and Power (CHP) from digester methane and 8 MW (over 30 acres) of solar onsite. A receiving station designed for the acceptance of liquid food processor waste, fats, oils and grease (FOG) and manure was constructed to provide environmental sustainable utilization of these waste, to increase methane production and with the goal to generate more electricity and hot water as well as to support a larger CHP in the near future.

Release and Uptake of Soluble PO4-P from Sediments in the West Branch Brandywine Creek, Chester County, PA

Parente, Allison, West Chester University, *105 Hollywood Ave, Trooper, PA, 19403*, allisonparente17@gmail.com; Charles V. Shorten, West Chester University

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Phosphates are essential nutrients for aquatic plants and animals to thrive but when present in excess, eutrophication can occur decreasing fish populations, oxygen, and overall water quality. The West Branch Brandywine Creek has a history of high phosphate levels from agricultural, urban and suburban runoff sources. This research explores the levels of phosphates and release rates of soluble PO4-P from newly transported versus older, in situ sediments. New sediment was captured using gravel buckets placed level with the streambed and left in place for a period of 2-3 weeks, while grab samples of older, in situ sediments were collected as grab samples. Samples were air-dried, passed through a 1mm sieve and continuously stirred in Type-1 lab water for time intervals varying from hours to a week. Aliquots were filtered and analyzed for soluble orthophosphate-phosphorus. Results from a two-stage, first-order kinetic model showed that newly transported sediment had “fast” PO4-P release levels between 0.73 and 0.84 mg/L while those of older, in situ sediments ranged from 0.06-0.09, about an order of magnitude less. Older sediments continued to release PO4-P over the 7-day extraction period while new sediments showed initial release followed by re-uptake after 6-12 hours of extraction. Newly deposited sediment may contain more phosphates at near-surface sites, while older sediments may have both near-surface and deep-particle sites for phosphorus attachment. While total amounts of soluble PO4-P released from newly transported sediments exceed recommended water quality limits, re-uptake by these sediments may reduce overall loading. Older sediments release less total PO4-P but do not show reuptake over a week of extraction. While new sediments, presumably from more terrestrial sources, may be a bigger source of PO4-P than older, in situ sediments, they both contribute significantly to the overall loading of P to streams in amounts known to cause eutrophication.

Strategic Science Communication & Stakeholder Engagement in the Delaware Estuary

Patterson, Dana, Communications Strategist, Princeton Hydro, *1200 Liberty Place, Sicklerville, NJ, 08551*, dpatterson@princetonhydro.com

Strategic Scientific Communications, Monday, 10:15am, Grand Ballroom B, 1st Floor

Looking to brush up your science communication skills when engaging the public, peers, or potential clients? This session will dive into humanistic communication strategies that you can use when talking with your most valued stakeholders and supporters. We'll cover how to use values-driven and science-congruent narratives to reach the right people. Come learn how to translate wonky science findings into interesting, relevant stories that matter to your constituents.

Investigating Monarch Butterfly Habitat in Delaware Roadside Rights-of-Ways

Pavona, Jamie, Delaware Department of Transportation, *910 Lake Seymour Drive, Middletown, DE, 19709*, jamie.pavona@state.de.us; Erika Furlong, Delaware Department of Transportation; Kenneth Dunne, Delaware Department of Transportation

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Over the last couple of decades, monarch butterfly populations have declined primarily due to land use changes, habitat loss and pesticide use. Monarch butterflies lay their eggs exclusively on milkweed, and once hatched the larvae feed on the leaves for two weeks. Milkweed is found in early successional habitat, like roadsides and farm field edges. Roadsides (and other linear rights-of-way) have the potential to form long linear habitat corridors, which has led to the desire to examine best roadside management practices for the monarch butterfly. Delaware's Department of Transportation (DelDOT) partnered with Monarch Joint Venture (MJV) to research the status of monarch butterfly habitat along Delaware's roadsides, using MJV's rapid assessment protocol to compare pollinator habitat at "ideal" versus random sites across Delaware. "Ideal" sites were those where milkweed and/or wildflowers were present. ArcGIS was used to generate random points along roadsides which were reviewed via desktop using Google Maps, and then surveyed in the field. MJV provided DelDOT with ArcMap layers that modeled milkweed density and nectar availability, which were compared to data collected in the field. The ideal sites were consistent with MJV's models, while the random sites seemed far less consistent with the models. The results suggest that the habitat models could be an effective way for DelDOT to prioritize locations that should be managed to benefit pollinators.

Salt Hay Farm Restoration Notes - Sediment Accretion and Vegetation I

Philipp, Kurt, Wetlands Research Services, *5 Amaranth Dr., Newark, DE, 19711*, WetlandsResearchServices@gmail.com

Restoration I, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

Tidal marshes restored by the Public Service Enterprise Group's (PSEG) Estuary Enhancement Program (EEP) in Commercial Twp., have been monitored following the restoration of tidal flow in 1997. The restoration of current tide range elevations to lower elevation brackish salt hay farm marsh plains resulted in an initial drowning of salt hay, cordgrass, and *Phragmites* vegetation, followed by a rapid accretion of sediment as the marsh plain elevations approached current sea levels. The resultant areas of bare mud flats then began to evolve drainage patterns and establish primarily cordgrass, *Spartina alterniflora*, vegetation. Distance to the channel and bay sediment sources and establishment of vegetation were key to sediment accretion rates, as well as, channel evolution and wind/current fetch.

This presentation addresses the trial use of coir logs and salt hay bales to influence vegetation establishment and sediment accretion and similar conditions throughout the site. Twenty inch diameter coir logs were placed in two locations and salt hay bales in one location, in large open wind and tide fetch mud flats. Monitoring sediment marsh plain elevation and vegetation over 12 years at these three sites, suggests that location within the site is very important against the seasonal influences of seedling establishment, drainage and erosional storm events. Vegetation establishment and enhanced sedimentation may be both erratic and steady over the early course of the evolution of these restoration sites.

Regenerative Stream Channel Serves as a Nature-like Fish Passageway

Poskaitis, Amanda, Environmental Scientist, Maryland Coastal Bays Program, *8219 Stephen Decatur Highway, Berlin, MD, 21811*, amandap@mdcoastalbays.org; Roman Jesien, Maryland Coastal Bays Program; Katherine Phillips, Maryland Coastal Bays Program; Kevin M. Smith, Maryland Department of Natural Resources; Keith Underwood, Underwood & Assosciates

Living Resources, Monday, 1:30pm, Grand Ballroom A, 1st Floor

Considering the detrimental effects of dams on fish populations, and an estimated 80,000 dams in the US, innovative techniques for management are needed. We present an approach to providing some of the benefits of an open stream while maintaining an historic mill pond. The Bishopville Stream Corridor Enhancement Project consisted of the modification of a popular but aging mill dam to create a nature-like fish passageway in coastal Maryland. The project goal was to remove the dam while maintaining the existing pond and create fish passage using regenerative stream channel (RSC) techniques. The RSC consisted of a series of rock grade control riffles that served as a stream corridor to transition from non-tidal to tidal waters. Specifically, we removed the existing 85-ft long, 4-ft high steel coffer dam and replaced it with a series of 5 rock riffles 80-120-ft long (measured perpendicular to flow) and 35-ft wide (measured parallel to flow) in which each riffle stepped the stream elevation down in 1-foot increments. The riffle controls consisted of boulders, cobble and clean fill that slowed stream velocity and created resting areas for fish to navigate further upstream. The riffle structures were further stabilized with herbaceous and woody wetland species including Atlantic white cedar (*Chamaecyparis thyoides*) and baldcypress (*Taxodium distichum*). Details of the RSC and a description of the construction sequence are provided. We view that this technique is applicable in situations where pond habitat needs to be maintained concurrent with fish passage. Since the project was completed in fall 2014, anadromous fish including alewife (*Alosa pseudoharengus*), white perch (*Morone americana*) and gizzard shad (*Dorosoma cepedianum*) successfully moved upstream through the project during the 2015 through 2018 spring spawning runs.

Pssst...There's Science In Your Water!

Rademaekers, Brian, Communications Specialist, Philadelphia Water Department, *1101 East Market Street, Aramark Building, 6th Floor East, PHILADELPHIA, PA, 19103*, Brian.Rademaekers@Phila.gov

Strategic Scientific Communications, Monday, 10:15am, Grand Ballroom B, 1st Floor

Surveys conducted over the last three years consistently reported that about 40 percent of Philadelphia Water Department (PWD) customers say they drink bottled water most often at home. Among the top motivators for this choice is a concern over the safety of water provided by the department.

In addressing this audience to dispel unfounded anxiety over safety, PWD continually seeks effective methods of communicating the rigorous science involved in treating and testing drinking water. To this end, staff in the department's Public Affairs unit have forged partnerships and created outreach materials highlighting water chemistry science associated with beer brewing.

In addition to acquiring the powerful third-party testimony of trusted subject matter experts in the brewing industry, this area of communications offers ideal entry points to discuss the role quality water plays in creating quality beer.

Focusing on this aspect of drinking water science likewise provides an opportunity to communicate with audiences not typically impacted through traditional outreach channels and provides a window onto the ubiquitous use of municipal water by the local food and beverage industry.

Bringing together water quality scientists from PWD's Bureau of Laboratory Services and the head brewer from Philadelphia's Saint Benjamin Brewing, the department collaborated to create "Baxter's Best," a batch of beer designed to highlight the mineral and pH profile of drinking water distributed from the Baxter Drinking Water Treatment Plant on the Delaware River. Events and communications materials associated with the collaboration explored various scientific aspects of drinking water quality and treatment and brewing.

The partnership also generated press coverage that gave discussion of water quality science an even larger audience in the region.

This presentation will cover these communication efforts and highlight how exploring the science involved in brewing beer can provide opportunities to engage audiences potentially skeptical of drinking water safety

Determining Suitability of Sediments for Rebuilding Drowned Coastal Wetlands

Raper, Kirk, Academy of Natural Sciences of Drexel University, *1900 Benjamin Franklin Pkwy, Philadelphia, PA, 19103*, klr323@drexel.edu; Brittany P. Wilburn, Drexel University; Camila Ibarra, Arizona State University; Andrew Gray, University of California, Riverside, Riverside, CA 92521; Kenneth Raposa, Narragansett Bay National Estuarine Research Reserve, Prudence Island, RI 02872; Elizabeth Burke Watson, The Academy of Natural Sciences of Drexel University, Philadelphia, PA 19104

Wetlands, Tuesday, 1:15pm, Grand Ballroom A, 1st Floor

Under increasing pressures from sea level rise and land use disturbances, coastal wetland losses remain high in the form of vegetation dieback, formation of interior ponds and erosion along edges. Thin layer deposition (TLD) of sediments is being used with restoration goals of increasing elevations to allow plant stems to penetrate the surface, extending the wetland's lifespan. But recent work has shown cases of oxidizing sediments that can develop acid sulfate in TLD projects, thereby reducing success of plant reestablishment. This study investigates plant growth and porewater acidity in a greenhouse using different sediment types, as well as the potential for soil amendments (biochar and compost) to offset acidity. *Salicornia pacifica*, *Spartina alterniflora*, and *Spartina patens* were grown with simulated tides using four sediment types, including varying raw benthic grain sizes and one quarry fine. Biochar and compost were tested with S. alterniflora in coarse sand, and *S. pacifica* was grown in sediments known to develop acid sulfate conditions with and without biochar addition. Preliminary analyses of net ecosystem exchange rates indicate that coarse sediments promote growth of species less tolerant to flooding (*S. patens, S. pacifica*), likely due to increased drainage. Biochar and compost did not enhance growth or significantly affect porewater pH. However, these amendments did increase respiration through decomposition. These results indicate that coarse sediments without amendments may be the most beneficial for plant growth in TLD projects.

Pennsylvania's MS4 Program: New Requirements, Challenges, and Opportunities

Reber, Renee, Associate Director, Clean Water Supply, American Rivers, *309 3rd Street, New Cumberland, PA, 17070*, rreber@americanrivers.org

MS4 x 3, Wednesday, 2:30pm, Crystal Room, 1st Floor

Urban stormwater is a leading cause of pollution and contributes to stream bank erosion and flood impacts. Since 2003, small urban localities have been managing stormwater through increasingly more protective permits, known as the Municipal Separate Storm Sewer System (MS4) permit. In Pennsylvania, the MS4 is administered by the Department of Environmental Protection (DEP) and implementation of the permits are managed by municipal governments. DEP issues permit coverage to approximately 1,000 small urban municipalities; more than any other state.

In 2018, a new five-year cycle of MS4 permit coverage began with new requirements. For the first-time, the MS4 permit includes a numeric pollution reduction obligation and municipalities may be required to develop and implement a Pollutant Reduction Plan or a Total Maximum Daily Load (TMDL) Plan. Over the course of the 5-year permit term, MS4s that discharge to sediment impaired water, or to the Chesapeake Bay watershed, must reduce their sediment load by 10%. This new requirement has brought with it many challenges ranging from mapping to Best Management Practice (BMP) siting to cost. However, with new challenges come new opportunities for improved stormwater management. Across Pennsylvania, municipalities are beginning to:

- Conduct feasibility studies and develop stormwater authorities in order to provide a steady revenue source to administer the MS4 program and implement BMPs.
- Discuss formation of new collaborative efforts amongst neighboring municipalities to save money and resources.
- Expand their stormwater programming to include more sustainable, cost-effective green stormwater infrastructure BMPs.

American Rivers and our partners are working to educate and assist municipalities and are reporting permit implementation successes and challenges to DEP to benefit their outreach, permit review and development of the 2023 permit.

South Wilmington Wetland Park: Wetland Restoration in a Constrained Environment

Reel, Justin, Manager, Natural Resources, RK&K, *700 East Pratt Street, Suite 500, Baltimore, MD, 21202*, jreel@rkk.com

Restoration II, Wednesday, 10:15am, Grand Ballroom A, 1st Floor

The City of Wilmington's South Wilmington Wetland Park Project illustrates the challenges associated with urban wetland restoration that will only be become more frequent as sea levels rise. The project is located in a degraded brownfield wetland with elevations well below the mean high water elevation of the nearby Christina River and is surrounded by light industrial and residential development which sets the upper limit of allowable tidal flooding well below mid-tide. Inundation studies demonstrated that automated tidal control would be required to develop vegetated tidal wetlands following restoration. Automated tidal controls have the added benefit of resilience to initial sea level rise. Restoration includes an emergent fresh water tidal wetland system with minor shrub and forest components bordered by upland shrub, forest and meadow areas. Site grading was influenced by the need to provide adequate stormwater storage capacity and to reduce costs associated with contaminated soil disposal. Stormwater forebays, passive park amenities and powerline access are significant components of the final design. Despite limitations and challenges this project will provide ecological uplift, stormwater storage, recreation, and educational opportunities in a highly developed urban environment.

Advances in Thin Layer Placement Methods for Wetland Restoration: Design and Construction Considerations

Reemts, Mark, **PE**, Associate, Anchor QEA, *10320 Little Patuxent Parkway, Suite 1140, Columbia, MD, 21044*, mreemts@anchorqea.com; Ram Mohan, PhD, PE, Anchor QEA

Hot Topics, Wednesday, 1:30pm, Grand Ballroom, 1st Floor

Restoring wetlands through the beneficial use of dredged material is an approach that is increasing being implemented. Thin layer placement (TLP) of dredged material is one method being used to restore coastal wetlands. TLP beneficially uses dredged material by converting the material to a consistency that can be aerially distributed, which allows for control of the thickness of material that is placed in each area of the wetland. Using this controlled process to add or "rain-in" the dredged material minimizes stress on the marsh and increases the success of habitat development. One of the biggest benefits of TLP is that sections of interior marshes that are difficult to access but may be subsiding or in danger of permanent inundation can be restored with minimal impacts to the existing marsh. Technologies used to implement TLP projects are most successful when they are based on site-specific characteristics because minor variations can significantly alter the final performance of the marsh vegetation. A variety of methods can be used for TLP, including standard high-pressure hydraulic dredge units, low-pressure spray units, and specially constructed pontoon-based spray units. The latter is often used in combination with booster pump setups for projects requiring larger reach into the marshes.

This presentation will evaluate several case studies where TLP was implemented, discussing the advances in technology to implement TLP projects, engineering design and construction considerations, and successful coordination with regulatory agencies. Lessons learned from these case studies can be directly applied to a variety of wetland restoration sites throughout the Delaware Estuary. Each site has different challenges, but proactive collaboration is the key to choosing the appropriate engineering and construction approach to achieve successful and sustainable wetland restoration.

Hydroacoustic Survey of Submerged Aquatic Vegetation in the Delaware Estuary: Preliminary Results from a Multi-Year Survey

Regan, Kristin, US EPA Region 3, *1650 Arch Street, 3EA50, Philadelphia, PA, 19103*, regan.kristin@epa.gov; Kelly Somers, US EPA Region 3

Monitoring II, Wednesday, 8:30am, Grand Ballroom A, 1st Floor

Submerged aquatic vegetation (SAV) is essential habitat for fish and other wildlife. It provides spawning, nursery, and protective habitat to ecologically important species. SAV is known to remove nutrients from the water column and increase dissolved oxygen concentrations. It also provides sediment stability and wave attenuation, aiding in both decreased erosion and turbidity. Despite these ecologically important attributes, the extent of SAV in the Delaware Estuary has not been quantified or characterized to date. In the summer of 2017, researchers from EPA began a multi-year survey to observe and quantify SAV in the Delaware Estuary. Hydroacoustic monitoring was used to determine the presence and extent of SAV in the system, species composition, density, and how these factors relate to water quality and sediment characteristics. Preliminary results will be discussed as well as the next steps for this effort. Results of this multi-year study will inform management decisions for this essential habitat

Creating Flow Refugia to Augment and Restore Freshwater Mussel Populations in the Tidal Freshwater Delaware River

Roberts, Spencer, The Partnership for the Delaware Estuary, *110 S Poplar St, Suite 202, Wilmington, DE, 19801*, sroberts@delawareestuary.org; Joshua Moody, The Partnership for the Delaware Estuary; Kurt Cheng, The Partnership for the Delaware Estuary; Danielle Kreeger, The Partnership for the Delaware Estuary

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Freshwater mussels (Order Unionoida) remain one of the most imperiled taxonomic groups in North America. Recent attention on population restoration and augmentation in tidal areas of the Delaware Estuary with historic populations has proven challenging as benthic conditions in urbanized areas may not provide readily suitable habitat. Lower benthic shear stress and increased sediment stability may promote mussel retention and recruitment; however, few studies have examined how such physical factors govern habitat suitability in tidal freshwater systems.

In fall 2017, experimental structures comprised of salvaged logs and cobble were constructed along a shallow subtidal shoreline of the Delaware River where the preexisting mussel abundance was greatly reduced compared to a nearby reference site. The structures were oriented to stabilize sediments and reduce benthic shear stress while not interfering with seston delivery. Passive Integrated Transponder (PIT) tagged mussels were subsequently deployed into each structure and untreated controls. Changes in Plaster-of-Paris “Clod” sphere dissolution rates, sediment grain size, and organic content were monitored for a full year starting in Fall 2017. Dissolution rates of clods were significantly lower in experimental structures and mussel retention averaged 71.6% in structures compared to 67.4% in control plots after 1 year. This suggests that the structures may serve as refugia from high flow that typically mobilize the substrate. If confirmed with extended monitoring, these results should support design of living shoreline projects aimed at boosting populations of native unionids.

Changes in Tidal Marsh Vegetation Communities at Bombay Hook National Wildlife Refuge in Smyrna, Delaware

Rodriguez, Kassandra, Student, Wesley College, *23 Marsh Creek Ln, Dover, DE, 19904*, kassandra.rodriguez@email.wesley.edu

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Bombay Hook National Wildlife Refuge in Smyrna, Delaware is dominated by tidal salt marsh with freshwater impoundments and upland habitat, primarily for migratory birds. The refuge is experiencing interior tidal marsh loss and degradation, likely due to a combination of past marsh alterations and sea level rise. We present a comparison of past tidal marsh vegetation surveys (2008-2011) to recent vegetation surveys (2016-2018), to note changes in vegetation community types over the past decade. In the last few years, marsh elevation monitoring has been started on the refuge as well, at a series of surface elevation table locations throughout the marsh. A number of the vegetation survey points and SET sites are located in close proximity. We examine the available marsh elevation data to aid in interpreting shifting vegetation community types throughout the refuge.

Invasive Species Control and Management at Bombay Hook National Wildlife Refuge in Smyrna, Delaware

Rodriguez, Christian, Wesley College, *156 Meadow Ridge Pkwy, Dover, DE, 19904*, christian.rodriguez@email.wesley.edu

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Bombay Hook National Wildlife Refuge in Smyrna, Delaware is a refuge that consists mostly of tidal salt marsh but includes freshwater impoundments for migrating birds and upland habitats that are managed for other wildlife. One of the goals at Bombay Hook NWR is the restoration of wooded areas in the upland habitats, but this goal been hindered due to the presence of invasive species. Invasive species are foreign species that outcompete native species, causing economic and environmental harm. In the upland habitats, the primary invasive species is Canada Thistle (*Cirsium arvense*), a designated noxious weed in 43 states. Prevention and control of this species is difficult because it involves repeated treatments of systemic herbicides. Canada Thistle is also present along the dikes of the impoundments. Other invasive species, including Common Reed (*Phragmites australis*), Autumn Olive (*Elaeagnus umbellata*), and Bog Bulrush (*Schoenoplectus mucronatus*), are present in the area as well. To combat invasive species, problem areas were sprayed with a mixture of water (50 Gallon Tank), 1.5% Garlon 4 Ultra, 1.5% Aquaneat and 1 quart of Aquachem 90 (for upland habitats) or 2% Aquaneat and 1 quart of Aquachem 90 (for any area with water) approximately every two weeks (depending on the rate at which the plants regrow) between May and August 2018. Spraying is conducted with either a backpack sprayer or a spraying rig on the back of a UTV. The treated areas will be monitored through the summer of 2019 to determine the success of the program and to locate areas that need more treatment.

Developing Monitoring Plans for Living Shoreline Projects in Delaware: A Goal-Based Framework

Rogerson, Alison, Environmental Scientist, Delaware DNREC, *100 W. Water St. Suite 10B, Dover, DE, 19904*, alison.rogerson@state.de.us; Andrew Howard, Delaware DNREC; Susan Guiteras, U.S. Fish & Wildlife Service; Douglas Janiec, Sovereign Consulting Inc.; Joshua Moody, Partnership for the Delaware Estuary; Danielle Kreeger, Partnership for the Delaware Estuary

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Delaware's tidal shorelines are a key part of the natural aesthetics of the coastline and provide a variety of ecosystem services. Despite these shorelines having a certain level of adaptability and resilience, severe rates of coastal habitat degradation and loss have translated into losses of ecosystem function. Living shorelines represent a suite of developing technologies that are being used to address these losses using ecologically sound and resilient methods. Since the application of living shorelines is a burgeoning enterprise, it is vital that the performance of this science be consistently evaluated regarding its ability to meet project needs and to guide adaptive management. In tandem with efforts in New Jersey that produced the Framework for Developing Monitoring Plans for Coastal Wetland Restoration and Living Shoreline Projects in New Jersey (Yepsen et al. 2016), the Delaware Living Shorelines Committee produced a goal-based monitoring framework for the evaluation of living shoreline projects in the state of Delaware.

The framework outlines the process of developing a monitoring plan to track the effectiveness of a specific project. Based on the project-specific goal, users are guided to a series of relevant metrics, each of which has a suite of appropriate methods to select from based on their skill level and available resources. Each metric, and its associated method, is inserted into a monitoring metric table. Additional information per metric, including temporal and spatial resolution of collection and analysis questions and methods are subsequently defined. Additional monitoring timeline and progress tracking tables are provided for the user to methodically plan data collection activities. By providing a structural format with a suite of relevant metrics and appropriate methods for a variety of living shorerline goals, this framework will facilitate meaningful data collection and analysis to assess the development of living shoreline projects in Delaware.

Wetland Condition in the Smyrna River Watershed, Delaware

Rogerson, Alison, Environmental Scientist, Delaware DNREC, *100 W. Water St. Suite 10B, Dover, DE, 19904*, alison.rogerson@state.de.us; Erin Dorset, Delaware DNREC; Brittany Haywood, Delaware DNREC; Kenny Smith, Delaware DNREC

Wetlands, Tuesday, 1:15pm, Grand Ballroom A, 1st Floor

DNREC's Wetland Monitoring and Assessment program (WMAP) collects wetland condition data on a watershed basis and reports on the extent and health of wetlands including management recommendations. The Smyrna River watershed is located in Kent and New Castle Countiescontains the Cedar Creek watershed and the Smyrna River watershed and contains the towns of Smyrna, Clayton and Woodland Beach. Similar to the nearby Mispillion River watershed, the local landuse was nearly 50% agricultural and one quarter wetlands. Estuarine wetlands made up almost 50% of total wetland acreage. In 2014 and 2015 biologists completed wetland assessments in 122 random freshwater and saltwater wetlands using standardized Delaware rapid assessment methods. Overall, we gave wetlands a B- grade for health related to hydrology, habitat and surrounding buffer characteristics. Wetlands in the Smyrna watershed had very similar high/medium/low condition proportions to the Leipsic River watershed further south. Tidal wetlands and forested headwater flats both earned B- grades, whereas riverine wetlands registered only a D+. Wetland management in the Smyrna watershed should focus on improving buffers for riverine wetlands, avoiding stream alterations, and ensuring that coastal wetlands continue to be able to migrate inland with rising sea levels and intruding salt water.

Improving Water Quality for Trout in the West Branch Delaware River

Rondinelli, Michael, Senior Ecologist, OBG (O'Brien & Gere), *301 East Germantown Pike, East Norriton, PA, 19401*, michael.rondinelli@obg.com; Shaun Gannon, OBG (O'Brien & Gere); Piotr Domasczynski, OBG (O'Brien & Gere); Ahintha Kandamby, OBG (O'Brien & Gere); Joe Imperi, The Kraft Heinz Company

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

In the tributaries and upper mainstem of the Delaware River, trout serve an important position in the freshwater food web as both predator and prey. Trout also are highly valued recreationally, providing seasonal or year-round enjoyment for freshwater anglers. Trout also are sensitive to physical and chemical stressors, and therefore are excellent water quality indicators. Because coldwater fish like trout have strict physiological requirements, they are vulnerable to human-induced disturbances such as industrial manufacturing and development. These activities, if not properly managed, can lead to physiological stresses on fish, their food sources, or habitat used for foraging, spawning, and rearing of young.

The New York State Department of Environmental Conservation (NYSDEC) is making progress reducing these impacts through systematic implementation of water quality regulations specific to protection of aquatic community health. Trout and other aquatic taxa are often used by the NYSDEC to support establishment of site-specific discharge limits for various water quality parameters such as water temperature.

A work plan for conducting a thermal impact study at a global food company's manufacturing facility was developed to evaluate potential adverse impacts to brown trout (*Salmo trutta*) spawning movements in the West Branch Delaware River. The manufacturer has historically but permissibly released heated wastewater to the river as part of its manufacturing process at temperatures in excess of NYSDEC limits. The proposed study will include placement of temperature sensors, bathymetric and hydroacoustic velocity profiling, and 3D thermal modeling, and will quantitatively evaluate whether the discharge from the Facility's outfall is an impediment to upstream movements of brown trout in the river reach receiving the Facility's thermal effluent. The study will ultimately provide the basis for an alternative effluent temperature limit that can be incorporated into the facility's SPDES permit, and provide critical information for thermal remediation decisions for the facility.

Understanding the Urban Watershed Middle School Curriculum: Hands-on learning about water systems and infrastructure, the watershed and how to ensure a sustainable future

Schultz, Ellen, Associate Director for Education, Fairmount Water Works Interpretive Center, *640 Water Works Drive, Philadelphia, PA, 19130*, ellen.schultz@phila.gov

Science Class, Tuesday, 9:00am, Grand Ballroom B, 1st Floor

As of Fall 2018, the Fairmount Water Works – Interpretive Center (FWWIC), in collaboration with the School District of Philadelphia's (The District) Offices of Curriculum, Instruction and Assessment, and Environmental Management and Services has developed curriculum based on the local urban watershed.

Titled Understanding the Urban Watershed, it has been developed and field-tested over four years by District teachers, integrating urban watershed education with core science and English standards for middle school students, grades 6 through 8.

The Curriculum is designed to increase awareness about sustainability and environmental issues, inspiring stewardship, connecting students and their teachers to real world learning and providing engaging and inspiring learning experiences across the disciplines.

It is a model for future replication and is in direct support of and alignment with the goals and targets outlined in The District's Sustainability Plan, GreenFutures.

Understanding the Urban Watershed is made up o 6 Units, further divided into rich Learning Experiences structured as the 5 Es (Engage, Explore and Explain, Elaborate and Evaluate) . The Units work across all content areas and the Education for Sustainability goals as outlined in the GreenFutures Plan.

The Units are exemplars that can be embedded into the core curriculum because they are directly and explicitly aligned to Academic (primarily Science, ELA, Math and SS) and Education for Sustainability Standards. All standards and indicators are assessed for using performance criteria.

Diverse Outreach Tools Create Resilient Relationships in Cobbs Creek

Schupsky, Dan, Outreach Specialist, Trans-Pacific Engineering Corporation (consultant to The Philadelphia Water Department), *1101 Market Street, 6th Floor, Philadelphia, PA, 19107*, Daniel.Schupsky@phila.gov

Science Class, Tuesday, 9:00am, Grand Ballroom B, 1st Floor

This presentation will cover a myriad of low-cost, yet highly effective and complementary, approaches to outreach and engagement in the Cobbs Creek section of west Philadelphia as it relates to green stormwater infrastructure (GSI) notification. The results show that using diverse techniques can help build a community of "active recipients", in which where residents and stakeholders are invested in both the content and method of delivery for a given message.

Attendees will learn about using different outreach tools to engage varied audiences throughout changing design phases of a GSI project. Topics will include a review of standard community outreach, hosting and "open house" format public meetings, an ArcGIS online storyboard showcasing a virtual walking tour, successfully advocating for a youth-based stewardship program to be housed in the area, waterway clean ups with partner organizations, as well as internally used tools such as NextDoor, Granicus, and Everbridge to reach residents. Not only will different types of engagement strategies be reviewed, any metrics obtained from these strategies will also be shared, as well as a quick SWOT analysis for each scenario.

These field-tested approaches stem from the public engagement component of Philadelphia's Green City, Clean Waters program, the nation's largest legally binding green-centric consent order agreement to reduce combined sewer overflows. This presentation will encourage audience participation, feedback, and group discussion on how these strategies can be applied to outreach for different groups and/or projects related that either require, or desire, public feedback and residential buy-in.

Attendees will also get a glimpse into how GSI projects progress through planning, design, and construction phases, as well as a demographic profile of the Cobbs Creek area in west Philadelphia.

Highlights of DelDOT's NPDES Program

Seldomridge, Emily Dr., DelDOT, 800 S. Bay Road, Dover, DE 19901, emily.seldomridge@state.de.us

MS4 x 3, Wednesday, 2:30pm, Crystal Room, 1st Floor

Under the Clean Water Act and the National Pollutant Discharge Elimination System (NPDES) program, the U.S. Environmental Protection Agency (EPA) regulates the water quality of stormwater runoff that discharges into local waterways. Stormwater runoff is transported through municipal separate storm sewer systems, referred to as MS4. To prevent harmful pollutants from being washed or dumped into an MS4, the EPA requires an NPDES permit. The Delaware Department of Transportation (DelDOT) is responsible for implementing 2 MS4 permits: a Phase I MS4 permit that covers all of New Castle County, and a Phase II MS4 permit that covers the urbanized portions of Kent County. In addition, DelDOT's Maintenance Facilities are covered under Delaware's Industrial Stormwater Program. This presentation will cover a review of past permit implementation, and a glance into future implementation.

Investigating the Community of Fishes and Invertebrates Inhabiting Two Living Shoreline Projects

Shinn, Jenny, Program Coordinator II, Rutgers University, *6959 Miller Avenue, Port Norris, NJ, 08349*, jenny.paterno@rutgers.edu; David Bushek, Rutgers University; Lisa Calvo, Rutgers University; Moses Katkowski, The Nature Conservancy; Adrianna Zito-Livingston, The Nature Conservnacy

Living Resources, Monday, 1:30pm, Grand Ballroom A, 1st Floor

The Gandy's Beach Nature Conservancy Preserve includes undeveloped shoreline adjacent to Nantuxent Creek and along the Delaware Bay in New Jersey. The region has been increasingly vulnerable to coastal erosion and experienced dramatic loss of marsh over several decades. Since 2014, a collaborative project has been underway to construct living shorelines (LS) using coir fiber logs, shell bags, and Oyster Castles to augment the beach and creek shorelines. Fauna sampling was conducted from 2014 through 2018, spanning pre-installation and post-installation of the LS projects; with the goal of characterizing species abundances and diversity at the sites before augmentation and following the colonization of the LS. Recruitment, survival and growth of oysters on the structures was monitored seasonally. A multi-generational population of over half a million oysters and other bivalves, such as ribbed mussels have colonized the LS. Forty different species of fish and crustaceans were collected using block nets and beach seines during the monitoring program. Results indicate that the LS supported communities similar in diversity and species abundance when compared to nearby reference sites. Species of both ecological and economical importance in the local ecosystem utilized the LS habitats. Most frequently, juveniles of a given species were captured in the nets suggesting that the LS will continue to support the nursery function of the natural shoreline while helping to combat erosion.

The Shade Trees of Merchantville – A Citizen Science Inventory of Municipal Carbon Sequestration

Smith, Lily, Student, Camden Catholic High School, *118 Leslie Avenue, Merchantville, NJ, 08109*, calidrissmith4@gmail.com

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The Shade Trees of Merchantville – A Citizen Science Inventory of Municipal Carbon Sequestration

Much emphasis is placed on the ecological service value of natural environments. However, there is an increase in the recognition and study of the value of diversity and ecological processes in urban and suburban settings. Habitat, storm water management and erosion control can be restored, improved and quantified by taking inventory of the species, communities and systems in municipalities. Merchantville, New Jersey, in northwestern Camden County, is a small suburb of Camden and Philadelphia. Having an active Shade Tree Commission and a newly formed Sustainable Jersey Green Team, Merchantville places much value on the natural components of this small community.

A shade tree inventory update was conducted in fall, 2018 to include tree species present and, using DBH and trunk length data, a carbon sequestration inventory was completed for the town. Using GIS a map was created to display tree species diversity and carbon dioxide sequestration estimates for each street and neighborhood in Merchantville. Data collected can be used to track changes in shade tree growth and to make recommendations on species to include in future tree planting initiatives. Additionally, carbon data may be included in a more comprehensive climate and carbon budget as the Green Team explores and implements additional environmental and conservation projects going forward.

Reducing costs of Green Stormwater Infrastructure monitoring data collection to inform site maintenance decisions with real-time soil moisture sensing technologies and the Internet of Things

Soldner, Karly, Drexel University, *3141 Chestnut St, Curtis Hall Suite 251, Philadelphia, PA, 19104*, kms487@drexel.edu

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The performance of Green Stormwater Infrastructure (GSI) is directly related to costly site maintenance activities like irrigation, especially during the two-year establishment period immediately following planting. Though measurement of soil moisture levels could theoretically make for more strategic application of irrigation, GSI monitoring can also be costly and logistically cumbersome. This presentation demonstrates how real-time soil moisture monitoring performed using the Internet-of-Things (IoT) can help to make GSI maintenance activities related to irrigation more cost-effective. Specifically, the quality of soil moisture data collected using commercial sensors connected to Philadelphia's Long Range (LoRa) network (Method 1) is compared to data transmitted over the 3G network using more conventional off-the-shelf soil moisture sensors connected to a custom-built, low-cost data logger (Method 2). Data collected at different rain garden sites are compared. The commercial sensors used for Method 1 cost less than $200 each but are capable of transferring data for almost no cost over existing LoRa infrastructure. The total cost for Method 2 included $100 for the customized logger plus sensor costs, with 3G data transfer fees of about $3 per device per month. The pros and cons of these two approaches are compared, with a focus on data accuracy, cost, and ease of implementation. When the data is of good quality, Method 1 can lead to greatly improved irrigation efficiency, better plant health, and ultimately better GSI system performance.

EPA's Trash Free Waters Program: Regional and National Program Highlights

Somers, Kelly, Physical Scientist - Water Protection Division, EPA Region 3, *1650 Arch Street, Philadelphia, PA, 19103*, Somers.Kelly@epa.gov

Marine Debris & Plastic Pollution, Tuesday, 1:15pm, Crystal Room, 1st Floor

EPA's Trash Free Waters program aims to reduce and prevent trash from entering U.S. waters and the ocean. EPA plays a unique role in helping states, municipalities, businesses, non-governmental organizations, and concerned citizens work together to explore more effective ways to reduce the amount of litter and packaging waste that enters the water. EPA supports and brings together stakeholders to help identify collective actions in communities that enhance trash prevention. The Trash Free Waters program has four focus areas: research, international, public-private partnerships and regional strategies to support state and community trash prevention programs. Through a holistic and strategic national approach with a place-based trash prevention focus, EPA's Trash Free Waters program hopes to collaboratively problem-solve the critical issue of trash in waterways. This presentation will highlight some of the national and regional projects that supports EPA's various trash reduction initiatives.

Using Data to Maximize Outreach: Philadelphia's Approach

Stern, Hailey, Outreach Specialist and City Planner, Trans-Pacific Engineering Corp (Consultant to Philadelphia Water Department), *1101 Market St., 6th Floor, Philadelphia, PA, 19107*, hailey.stern@phila.gov

Strategic Scientific Communications, Monday, 10:15am, Grand Ballroom B, 1st Floor

As Green City, Clean Waters, Philadelphia's 25-year green infrastructure plan, moves into its 8th year, both the number of projects and the amount of community engagement continues to increase. In fiscal year 2018, PWD's public engagement team co-hosted 148 community meetings and events with civic partners., The team spoke to approximately 8,300 residents to garner support for green infrastructure projects and inspire people to take action.

Nearly eight years of meeting with residents has allowed us to refine our outreach approach, but a key question remains: how do we maximize the effectiveness of our engagement? This session will explore the research tools PWD uses to evaluate how people respond to our engagement methods. These tools include surveys, focus groups, analysis of meetings, and message testing. Through this work, we have found that most people we engage with are supportive of Green City, Clean Waters projects but we have also identified gaps in our messaging. By continuously evaluating how people respond to our projects and communication tools, PWD has been able to improve both green infrastructure design and the way we get the message across to residents.

PWD uses a variety of research tools, and session attendees will garner the understanding needed to implement scalable research and evaluation methods to improve community engagement.

A Dendroecological Investigation of the Demise of an Atlantic White Cedar Freshwater Tidal Wetland in Kent County, Delaware

Stotts, Stephanie, Associate Professor of Environmental Science, Wesley College, *120 N State Street, Dover, De, 19901*, stephanie.stotts@wesley.edu; Olivia Gulledge, Wesley College

Wetlands, Tuesday, 1:15pm, Grand Ballroom A, 1st Floor

Once prominent up the entire eastern coast, freshwater tidal wetlands consisting of Atlantic white cedars (AWC) are now vanishing due to salinity intrusion. A major straightening and dredging project ending in the 1930s caused the salt line to shift upstream within the St. Jones River, in Dover, DE leading to a significant die-off of many freshwater-obligates. This study used dendrochronological techniques (i.e., measuring, detrending, and analyzing tree rings) to provide a historic investigation of the AWC response to dredging and increased salinity with the goal of providing insight regarding future coastal forest responses to sea-level rise. Suppression chronologies often allow for the identification and analysis of disturbance signals. Therefore, suppression chronologies were generated and compared to climate variables (temperature and precipitation). The results indicate a significant decrease in ring width for approximately 15 years post dredging and subsequent death, presumably due to increased salinity levels. The suppression chronology analysis indicates that AWC growth became more dependent on climate post dredging. This study highlights the dramatic and rapid changes that salinization can initiate in coastal forests and the need for more transgression studies.

Community-Based Monitoring in New Jersey: A Mutualistic Relationship Between Volunteers and the State

Stretz, Erin, Assistant Director of Science and Stewardship, The Watershed Institute, *31 Titus Mill Road, Pennington, NJ, 08534*, estretz@thewatershed.org

Citizen Science, Wednesday, 10:15am, Grand Ballroom B, 1st Floor

The New Jersey Department of Environmental Protection (NJDEP) has funded the first three years of a new community-based water monitoring network to establish strong relationships with existing volunteer programs, build capacity for additional volunteers and an expanded geographic scope, and provide resources for groups to upgrade their data quality.

In a state focused on "home rule", New Jersey volunteer programs remain independent and subject to their own sampling plans and protocols for data management and sharing. The new network brings a measure of cohesion to this methodology, offering a standardized study design and QAPP approval process depending on the intended data quality and use. Training and one-on-one assistance is provided for each community-based program, including guidance on developing new regional monitoring programs, lab and in-situ parameter certification, and data submission through WQX Web. Now in the early stages of this new program, the focus is on communicating directly with volunteers to understand what their needs are and to clarify what is required to produce data of sufficient quality for inclusion in the Integrated Report.

NJDEP has invested in its monitoring infrastructure by recognizing the value of volunteers and bringing them to the table, resulting in high quality data with which to develop well-informed assessments. Other states can follow this model to leverage their own citizen scientists to help reduce their own data gaps.

Water Quality Management by DRBC: Part 3 – Water Quality Challenges

Suk, Namsoo, Director, Science and Water Quality Management, Delaware River Basin Commission, *25 Cosey Rd., PO Box 7360, West Trenton, NJ, 08628*, Namsoo.Suk@drbc.gov; Steven J. Tambini, Delaware River Basin Commission; John Yagecic, Delaware River Basin Commission

DRBC Water Quality Management, Tuesday, 9:00am, Crystal Room, 1st Floor

The Delaware River Basin Commission (DRBC) and its co-regulators continue to address the current and next generation water quality challenges. (1) With substantial improvements in dissolved oxygen (DO) over the past 50 years, DRBC is currently working on a multi-year project to upgrade the aquatic life uses in the Estuary and corresponding DO criteria. This project includes monitoring and developing a eutrophication model to engineer a remedy to the remaining DO sag, which will pave the way to a fuller restoration of fish propagation in the estuary and achievement of the Clean Water Act goals.

With an eye to the future, this session part will not only discuss why there is still a dissolved oxygen "sag" in the Estuary and what we can do about, it will also examine other challenges on the horizon. These include: improving the swimmable recreational goals for the most vulnerable portions of the Estuary, getting a better understanding of contaminants of emerging concern and the impacts of climate on water quality.

Adaptation Planning for Sea Level Rise and Extreme Storms in the Delaware Estuary: Lessons from the Philadelphia Water Department

Sullivan, Abby, Environmental Scientist, Philadelphia Water Department, *1101 Market Street, Philadelphia, PA, 19107*, abby.sullivan@phila.gov; Avery Livengood, Philadelphia Water Department; Julia Rockwell, Philadelphia Water Department; Mark Maimone, CDM Smith; Paula Kulis, CDM Smith

Water Quality I, Monday, 10:15am, Grand Ballroom A, 1st Floor

Climate change is altering the water cycle, posing a significant challenge to resource managers and water utilities around the world. The Philadelphia Water Department (PWD) provides critical services to over 2 million of customers and has an obligation to ensure that their drinking water, waste water and stormwater systems are being planned, designed, managed and maintained with future climate impacts in mind. To study and plan for climate change and to develop cost-effective adaptation strategies, PWD started the Climate Change Adaptation Program (CCAP) in 2014.

As sea levels in the Delaware Estuary continue rising, the region will experience higher daily tides and higher storm tides, resulting in more frequent and extensive coastal flooding. For PWD this could mean inundated facilities and critical assets, overwhelmed drainage systems, and impacts to source water quality. The CCAP conducted an Inundation Analysis from a risk-based management perspective with a goal to estimate future coastal flood hazards. This talk will cover the challenges, lessons learned and best practices that were developed to understand the impacts that sea level rise will have in the near-term, mid-century, and over the next 100 years. Strategies for communicating about risk and uncertainty as well as methods and tools to make climate science actionable will be shared.

Water Quality Management: Part 1 - The Need and Role for Clean Water Regulation

Tambini, Steven, Executive Director, Delaware River Basin Commission, *25 Cosey Rd., PO Box 7360, West Trenton, NJ, 08628*, Steve.Tambini@drbc.gov; Namsoo Suk, Delaware River Basin Commission; John Yagecic, Delaware River Basin Commission

DRBC Water Quality Management, Tuesday, 9:00am, Crystal Room, 1st Floor

Before the "fishable and swimmable" goals were set under the federal Clean Water Act of 1972, the Delaware River Basin Commission (DRBC) was formed in 1961 in part to "control future pollution and abate existing pollution in the waters of the basin." By the height of World War II, pollution in the tidal Delaware River was rampant. Large portions of the estuary were almost completely devoid of oxygen needed for the survival of fish and other aquatic life. In 1967, the DRBC adopted the most comprehensive water quality standards of any interstate river basin in the nation, which also included bacterial standards for primary and secondary contact recreation, i.e., swimming and boating, respectively. The standards were tied to an innovative waste load allocation program which factored in the waste assimilative capacity of the tidal Delaware River (the predecessor to today's "Total Maximum Daily Loads").

This session part will review the history of water quality in the Delaware Estuary. The presentation will provide an overview of DRBC's role in pioneering and leading water quality improvements that continue today and discuss the collaborative framework of co-regulation with the Estuary states under the Clean Water Act.

Using Dredged Material to Establish Habitat for Colonial and Marsh-nesting Birds

Tedesco, Lenore, Executive Director, The Wetlands Institute, *1075 Stone Harbor Blvd, Stone Harbor, NJ, 08210*, ltedesco@wetlandsinstitute.org; Lisa Ferguson, The Wetlands Institute; Monica Chasten, US Army Corp of Engineers

Restoration I, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

Coastal development, recreational use and management practices limit the availability of habitat for colonial and secretive marsh-nesting birds and other wildlife. In New Jersey, more than 55% of the 125 miles of Atlantic coastline is developed and/or armored, which has greatly reduced nesting site options for wildlife. The state's coastline has a very high vulnerability to impacts from sea level rise and increased frequency and intensity of coastal storms, further diminishing the availability of productive habitat. In areas where marsh accretion rates are unable to keep pace with increasing sea levels, frequent inundation is reducing high and low marsh habitat. Marsh-nesting birds are suffering increased frequency of nest loss due to flooding. Colonial birds are being impacted by a combination of increased flooding risk, augmented predator communities, and human disturbance.

Beneficial reuse projects typically focus on restoring wetland habitat by raising marsh elevation and/or marsh edge restoration for resiliency. We explore strategies for creating high marsh, upland, and sandy beach areas suitable for colonial and marsh-nesting species and present examples and lessons learned from beneficial use projects in southern New Jersey.

Design and construction considerations from habitat placements in Cape May tidal marshes are explored along with adaptive management approaches and wildlife usage results. For colonial birds, maintenance of early successional conditions creates opportunities for repetitive dredged material placement that can be timed to match ecological needs with maintenance dredging needs. We will consider the development of habitat complexes to provide species uplift.

Role of Coastal Modeling in Long Island Nitrogen Management Efforts

Thuman, Andrew, Water Quality Practice Lead, HDR, *1037 Raymond Blvd, Suite 1400, Newark, NJ, 07102*, andrew.thuman@hdrinc.com

Water Quality I, Monday, 10:15am, Grand Ballroom A, 1st Floor

The objective of the presentation is to provide background on nitrogen management efforts on Long Island by the Suffolk County Department of Health Services (SCDHS), Long Island Regional Planning Commission (LIRPC) and New York State Department of Environment Conservation (NYSDEC) as part of the Long Island Nitrogen Action Plan (LINAP). Many efforts to manage nutrient issues around the country have focused on the causal variables of nitrogen and phosphorus rather than considering the effects or response variables (e.g., chlorophyll-a, dissolved oxygen or transparency). This is primarily due to the time and effort required to properly link nutrient causal variables to response variables through water quality modeling.

The SCDHS is in the process of developing a Subwatersheds Wastewater Plan (SWP) to develop a county-wide impact assessment using nitrogen loading rates, receiving water residence times (the focus of this presentation) and baseline ecological conditions, as metrics for the establishment of tiered priority areas for wastewater management upgrades. Establishing tiered priority areas will include: developing baseline water quality using existing data; establishing a final list of primary water quality indicators along with the ranking methodology; and developing a matrix approach to rank subwatersheds using nitrogen loads, flushing times and water quality indicators.

The SCDHS Subwatersheds Wastewater Plan (SWP) is part of early action LINAP efforts to rank water bodies for future nitrogen management efforts. In order to address nutrient response, the SWP included hydrodynamic modeling to calculate water body specific flushing times to provide an additional and important ranking variable in addition to nitrogen loading and existing water quality conditions. This presentation will provide background on the LINAP and SWP efforts along with presenting model development and flushing time results to help with prioritization; and how future water quality modeling in high priority coastal water bodies can build from these efforts.

Going Virtual with Immersive Science Outreach

Tossey, Lisa, Ed.D. Candidate; Multimedia Specialist, Research, University of Delaware, *8 Jefferson St, Berlin, MD, 21811*, tossey@udel.edu

STEM & Education, Tuesday, 3:00pm, Grand Ballroom B, 1st Floor

Storytelling is an ancient art that is increasingly important in today's crowded, fast-paced digital world. One of the most engaging new ways to connect others with science is by immersing them in a place or story using 360° images or video. Creating such immersive environments to highlight an ecosystem or provide a virtual field trip isn't as hard - or expensive - as you might think!

Emerging online platforms and digital camera technologies are making it easier than ever to take viewers "inside a story" or to places where they might not be able to visit easily, like aboard a research vessel or inside a cutting-edge laboratory. We'll take a look at some of these tools and how they can be paired with voiceovers, images, descriptions, and social media-friendly audio and video clips for science outreach to create virtual field trips and educational experiences.

Coastal Resiliency Hydrology and Ecological Monitoring in Southern New Jersey

Turner, Noel, Hydrologist, U.S Fish and Wildlife Service - Cape May NWR, *24 Kimbles Beach Road, Cape May Court House, NJ, 08210*, noel_turner@fws.gov; Laura Mitchell, U.S. Fish and Wildlife Service - Bombay Hook NWR

Monitoring II, Wednesday, 8:30am, Grand Ballroom A, 1st Floor

In an effort to evaluate the success of Hurricane Sandy coastal resiliency marsh restoration projects; hydrology and ecological data will be collected at Cape May, Supawna Meadows, and Edwin B. Forsythe National Wildlife Refuges in New Jersey. Completed restoration activities on the refuges include breaching freshwater impoundments, altering breakwaters, culvert replacement, and constructing runnels; additional restoration activities to be completed are sediment enhancement, improving breakwaters in other locations, and constructing more runnels. Water levels on the marsh platform will be collected at restoration sites to assess the depth and timing of tidal inundation. These data will be compared to water levels in nearby tidal channels and reference tidal marshes. In addition, an array of water quality parameters (temperature, specific conductance, nutrients, pH, and others) and ecological parameters (nekton community, avian community,and vegetation) will help to further characterize the success of the restoration projects. At Supawna Meadows NWR, sediment fluxes will be estimated to determine if altering the breakwaters is resulting in a loss or gain of sediment in Mill Creek, thus augmenting the marsh platform. This resiliency monitoring project started during the summer of 2018 will continue for at least three years. During the course of the project, we expect to work with many federal and academic partners to enhance our knowledge and support strong science.

Restored Barrier Beach Continues to Contribute to Delaware's Piping Plover Productivity

Vandeplas, Stormy, Prime Hook National Wildlife Refuge, *11978 Turkle Pond Road, Milton, DE, 19968*, stormy_vandeplas@fws.gov; Annabella Larsen, Prime Hook National Wildlife Refuge; Audrey DeRose-Wilson, Delaware Division of Fish & Wildlife; Stephanie Warshawsky, Delaware Division of Fish & Wildlife

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

In 2016, Prime Hook National Wildlife Refuge (NWR) completed a barrier beach restoration project at Fowler Beach (FB) to repair breaches and over washes sustained by severe storms over the past decade, culminating with Hurricane Sandy in 2012. The restoration filled four large breaches, reconnecting the beach landscape with coarse sand perfect for shorebird nesting habitat, input sand fencing to aid in the accumulation of sand buildup for the dune, and hand-sewn prominent beach grasses to collectively act as a saltmarsh barrier for future storms. In 2016 one Piping Plover (PIPL, *Charadrius melodus*) pair arrived, nested, and lost their nest to depredation. Since then, PIPL breeding pairs have increased at FB and contributed to a record number for the state of Delaware. Refuge staff worked closely with state partners and other federal agencies at both FB and Cape Henlopen State Park (CHSP) to monitor and actively prevent loss of nests. We partnered with DNREC to monitor elevation levels and AHPIS for the trapping of the non-native red fox. We utilized the PiperEx Decision Support Tool for predator exclosures to determine the outcome (survival rate for unexclosed nests per site, abandonment rates with and without exclosures, and attraction of smart predators) of exclosing nests; based on the output it was determined to keep exclosing each nest at FB, while halting the use of exclosures at the CHSP. Between the two locations, 16 piping plover pairs successfully produced 36 fledglings. The 2018 nesting season for Delaware resulted in a productivity of chicks fledged per pair of 2.25, compared to 2017s of 1.07. The combined effort of collaboration with state and federal agencies lead to a successful season and can be a long-term example of working with other organizations to learn various approaches for the recovery efforts of PIPLs.

Engaging artists in sustainability

Vazquez, Leonardo, Executive Director, The National Consortium for Creative Placemaking, *1021 Stuyvesant Avenue, #3B, Union, NJ, 07083*, leo@cpcommunities.org

Placemaking, Tuesday, 1:15pm, Grand Ballroom B, 1st Floor

Involving artists in promoting sustainability is a great way to convince and persuade people who may not be moved solely by reports or statistics. While artists and scientists are both creative, they tend to address problems in different ways. This talk focuses on how environmentalists and scientists can work more effectively with artists on sustainability issues.

How does climate change affect the physiological ecology of *Karlodinium veneficum* and its consequences on trophic transfer?

Vidyarathna, Nayani, Dr., University of Delaware, *700 Pilotown Road, Lewes, DE, 19958*, nayaniv@udel.edu; Laura Smith, University of Delaware College of Earth, Ocean, and Environment; Jonathan H. Cohen, University of Delaware College of Earth, Ocean, and Environment; Kathryn J. Coyne, University of Delaware College of Earth, Ocean, and Environment; Katherine Miller, Salisbury University; Mark E. Warner, University of Delaware College of Earth, Ocean, and Environment

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Shifts in global temperature as well as carbon dioxide are expected to have potentially profound effects on phytoplankton communities, including harmful algal species, with possible cascading consequences for marine food webs. We studied the combined effects of elevated temperature and CO2 on the physiological response of the dinoflagellate *Karlodinium veneficum*, originally collected from the Delaware Inland Bays. Algae were first acclimated to the ambient (25 °C / 400 ppm CO2) and climate change conditions (29 °C / 1000 ppm CO2) predicted for year 2100, using automated pH stated continuous cultures. When grown under high temperature and CO2, cell growth improved and Primary production increased significantly (x 1.6 times), as compared to ambient conditions. Similarly, high temperature and CO2 resulted in the cellular quota for carbohydrate, protein, total lipids and fatty acids also increasing by 3.1, 1.8, 1.1 and 2-fold, respectively. Cells grown under high temperature and CO2 produced a higher percentage of saturated and a lower percentage of mono-and polyunsaturated fatty acids compared to those grown at ambient conditions. Cell toxicities measured as %fish gill cell mortality were significantly higher in the cells grown at high temperature and CO2, as compared to the ambient conditions while the hemolytic activities did not differ significantly. This work is in tandem to grazing and respiration analyses with the common estuarine copepod *Acartia tonsa*, while grown under the same temperature and CO2 conditions. Ingestion, respiration, and egg production values were converted to carbon equivalents to assess changes in carbon allocation in A. tonsa. No significant differences in ingestion, respiration, egg production and hatching success were found between two conditions. However, mean grazing rates and the egg production were slightly decreased under the climate change conditions which suggests that altered physiology of K. veneficum can have negative effects on trophic transfer in marine food webs in a climate change scenario.

Exploring the Utility of Sidescan Sonar Imaging for Freshwater Mussel Distribution Mapping in the Tidal Delaware River.

Walderon, Matthew, Coastal Resources Specialist, Pennsylvania Coastal Resources Management Program, Department of Environmental Protection, *400 Market Street, 10th Floor RCSOB, Harrisburg, PA, 17105*, mwalderon@pa.gov; Samantha Burton, PA Coastal Resources Management; Randall Brown, PA Coastal Resources Management

Blue Collar Bivalves, Tuesday, 3:00pm, Grand Ballroom A, 1st Floor

Freshwater mussels are threatened in or have been extirpated from much of their historic range in Pennsylvania. However, populations are persisting within certain extents of the tidal Delaware River. Detailed mapping of the remaining populations is vital for their protection as well for the continued research and conservation work focused on freshwater mussel recovery. Physical onsite surveys are labor intensive and involve risks associated with placing people in the water. Onsite surveys are also limited in geographic scope and are not conducive to searching for and locating unknown mussel populations. Remote sensing technologies may allow a small team to survey large areas relatively quickly and more efficiently select productive target areas for further, more detailed investigations. The objective of this project is to investigate the utility of georeferenced sidescan sonar imaging for the detection and mapping of freshwater mussels in varying substrates of the tidal Delaware River in Pennsylvania. During the summers of 2017 and 2018 the river bottom from Biles Island in Lower Bucks County to the Tioga Marine Terminal in Philadelphia was imaged with a towed sidescan sonar system. The resulting acoustic images were mosaicked for display and analysis in GIS. Approximately 150 locations were identified from the image analysis for drop camera ground truthing of substrate and mussel presence. Mussel populations, even low density widely dispersed populations, within soft substrates can be effectively identified in the sidescan sonar imagery. The imagery is less effective for delineating populations within cobble or boulder substrates. The effectiveness is limited by the relatively low-resolution capability of the sidescan sonar system used in this study. Ground truthing by underwater video or other methods is essential for accurate target and substrate identification.

Partnering with Local Municipalities Towards Water Quality

Walker, Nathan, Senior Water Resources Planner, Wood Environment & Infrastructure, *751 Arbor Way, Ste 180, Blue Bell, PA, 19422*, nathan.walker@woodplc.com

MS4 x 3, Wednesday, 2:30pm, Crystal Room, 1st Floor

The health of our streams, rivers, and estuary is dependent on the quality of water flowing off the landscape. Most land use decisions about what the type of development that gets constructed require approval from local governments. We will explore the responsibilities of local governments to keep water clean by preventing the discharge of non-point source pollution from new development into local streams. We will also define the expanding responsibilities of communities to address the discharge of pollutants in stormwater runoff from developments constructed 40 or 50 years ago. What water quality tools do communities have? What are their sources of revenue to implement their water quality programs? How can regional partnerships improve water quality at a reasonable cost to the community?

Wave Attenuation Monitoring of Living Shorelines in the Delaware Bay

Walling, Katlin, Coastal Engineer, Mott MacDonald, *3 Paragon Way, Freehold, NJ, 07728*, Katlin.Walling@mottmac.com; Douglas Gaffney, Mott MacDonald

Monitoring II, Wednesday, 8:30am, Grand Ballroom A, 1st Floor

Living shorelines are becoming a popular approach to shoreline stabilization for low-energy coastlines. The general benefits afforded by living shorelines, such as erosion reduction, habitat enhancement, and increased resiliency, are commonly known; however, project-specific technical data, such as the percent of wave attenuation provided by a living shoreline, is sparse. Moreover, monitoring equipment and analysis techniques required to capture the fine-detailed technical data can be cost and/or labor intensive. This study tests a practical, low-cost method of monitoring and quantifying the wave attenuation performance of a living shoreline project located on the Delaware Bay, at Gandy's Beach, NJ. The living shoreline at Gandy's Beach includes numerous segmented oyster reef structures, all located with different depths and orientations along the project site. This presentation reports on the monitoring, analysis, and performance of the living shoreline oyster reef structures with respect to quantifying the wave attenuation capability of the structures to determine their efficacy at reducing wave energy reaching the marsh under varying wave and tidal conditions.

NJDEP's Coastal Keepers Citizen Science Program

Warren, Garrett, Environmental Specialist 1, New Jersey Department of Environmental Protection, *401 E. State Street, Trenton, NJ, 08608*, garrett.warren@dep.nj.gov; Rick Brown, NJDEP Office of Coastal Land Use and Planning

Citizen Science, Wednesday, 10:15am, Grand Ballroom B, 1st Floor

The New Jersey Department of Environmental Protection's Coastal Keeper Citizen Science Program is part of the Department's Coastal Management Program. A priority of Commissioner Catherine McCabe is public engagement, and the Coastal Keepers are in the forefront of efforts to engage the public in helping with the monitoring and gathering of data on changing coastal conditions brought on by climate change. The Coastal Keepers Program seeks to build a corps of volunteers who will monitor ecological restoration projects, coastal flooding conditions, areas of shoreline erosion, marine debris accumulation and other coastal impacts of climate change. Volunteers will provide observations of coastal conditions while gaining knowledge of the impacts of climate changes and hands-on experience with ecological restoration projects within their communities.

Preventing Plastic Pollution Through Grassroots Activism

Weber, John, Mid Atlantic Regional Manager, Surfrider Foundation, *313 Lareine Ave, Bradley Beach, NJ, 07720*, Jweber@surfrider.org

Marine Debris & Plastic Pollution, Tuesday, 1:15pm, Crystal Room, 1st Floor

While seemingly the entire world has woken up and started to change its ways on single-use plastics in the last year or so, the Surfrider Foundation has formally been working on this issue for over a dozen years and it has always been part of our DNA as a organization protecting the world's oceans waves and beaches.

Our "Rise Above Plastics" program began in 2006. But as the group that does more beach cleanups than anyone nationally, we've been dealing with plastic pollution since we formed in 1984.

Our network of grassroots activists have been instrumental in enacting hundreds of local ordinances curbing single-use plastic items, mostly plastic bags, but more recently straws and balloons. There are just too many to count.

It took some time but NJ towns finally got into the act in 2015 with Longport, NJ going first. To date about 18 towns have taken action on plastic bags in NJ. The ideal local action is to ban plastic bags, but then to put a fee on paper or any other bag in order to encourage consumers to bring their own bag.

More recently, we started a new program called Ocean Friendly Restaurants where establishments pledge to reduce plastic use and implement other environmentally friendly practices. Once done, they are "registered" as an ocean friendly restaurant with us. People are starting to look for these restaurants when they go out to eat and thereby creating a demand and incentive for restaurant owners to follow this path.

Some of the criteria include no plastic bags, no EPS foam, straws are given on request only, and only reusable tableware is used for onsite dining. To date, we have 400 restaurants and over 160,000 plastic-free meals are served each week.

Shell Color in the Eastern Oyster (*Crassostrea virginica*)

Whiteside, Michael, Rutgers University, *Haskin Shellfish Research Laboratory, 6959 Miller Ave., Port Norris, NJ, 08349*, michael.whiteside@rutgers.edu; Ximing Guo, Rutgers University Haskin Shellfish Research Laboratory

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Oyster bar popularity and overall demand has been growing and shell appearance may become increasingly commercially important. Little is known about shell color in the eastern oyster, *Crassostrea virginica*, or of the evolution of color in related species. To better understand the basis for shell pigmentation, four shell-pigmentation color morphs were described - fully pigmented, lightly pigmented, positive stripe, and negative stripe - and crosses between each of the color morphs were performed. Proportions of pigmentation color morphs in the progeny suggest that they are under genetic control. A comparative transcriptome study was then performed to identify differentially expressed genes (DEGs) between black and light colored regions of mantle tissue. Six RNA libraries were produced and characterized using Illumina RNA-Seq technology to replicate this comparison three times with pools of samples from about ten individuals per replicate. Only seven genes were found to be differentially expressed in common across all three replicates, and, of these seven, two genes which code for enzymes involved in the heme pathway (aminolevulinic acid synthase and porphobilinogen deaminase) were upregulated in pigmented mantle tissue. These, as well as several other DEGs found in comparisons, suggest that the heme pathway may be involved in the production of the black coloration of oyster shells.

Horseshoe Crabs on Beaches Near Active Oyster Aquaculture Farms on the New Jersey Delaware Bayshore

Woodruff, Patricia, Rutgers University, *6959 Miller Ave, Port Norris, NJ, 08349*, pattywoo@hsrl.rutgers.edu; David Bushek, Rutgers University; Robert Loveland, Rutgers University; Mark Botton, Fordham University

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

Delaware Bayshore beaches provide important spawning habitat to Atlantic horseshoe crabs (*Limulus polyphemus*) from late April to mid-June with peak activity around new and full moons. Crabs can become stranded as the tide recedes, a portion of which may be flipped or trapped (aka impinged) and unable to return to the water unless they can right themselves or are freed from impingement. The Wetlands Institute runs a program (ReTurn the Favor, RTF) to right flipped crabs and free impinged crabs as a public awareness effort that may help increase crab survival while identifying high impingement areas that could be addressed by management actions to reduce rates of impingement. A few of these beaches are home to several New Jersey oyster farms and some conservation groups have expressed concern that farms may negatively impact spawning by impeding access to or increasing stranding on spawning beaches. This study compared abundances of stranded horseshoe crabs along a stretch of beach with and without farms by expanding the RTF volunteer effort. During nesting seasons from 2016 to 2018 we counted all stranded crabs along five adjacent beach segments three hours after high tide – RTF only counts flipped and impinged crabs. Two segments had active farms, three did not. Crab abundance was not associated with presence or absence of oyster farms regardless of density. Horseshoe crab abundance appeared more strongly associated with beach nesting quality, i.e., beaches with more sand and a gentler slope contained more crabs in agreement with previous studies on optimal spawning habitat. We suggest that changes in beach morphology from the late 1970's to the present have had a dramatic impact on horseshoe crab activity in this region of Delaware Bay, but by comparison, the effects of the oyster farming on adult horseshoe crabs are inconsequential.

Implementation of Water Quality Management: Part 2 – Applications, Successes and Challenges

Yagecic, John, Manager, Water Quality Assessment, Delaware River Basin Commission, *25 Cosey Rd., PO Box 7360, West Trenton, NJ, 08628*, John.Yagecic@drbc.gov; Steven J. Tambini, Delaware River Basin Commission; Namsoo Suk, Delaware River Basin Commission

DRBC Water Quality Management, Tuesday, 9:00am, Crystal Room, 1st Floor

Delaware Estuary water quality has changed dramatically since the establishment of the Delaware River Basin Commission and the Clean Water Act. Three successful implementations of DRBC water quality regulations will be presented. (1) Adoption of water quality criteria and the assimilative capacity determination followed by wasteload allocations by DRBC in the late 1960's, coupled with secondary wastewater treatment and Clean Water Act funding, brought about substantial improvements in dissolved oxygen. (2) In 2003 DRBC developed its first Total Maximum Daily Loads for PCBs for the Estuary. Pollutant minimization plans implementing the TMDLs have resulted in a 76% reduction in PCBs from the top ten-point dischargers under DRBC's oversight and coordination. Lesser restrictive fish consumption advisories issued by all three estuarine states in 2018 indicating continuous improvements in water quality. (3) High water quality has been maintained through the Special Protection Waters program for the non-tidal portion of mainstem Delaware River which continues to benefit the Estuary.

This session part will present a deeper understanding of how the Estuary and sources upstream have been managed to significantly reduce pollution loads and improve river quality. The Clean Water Act goals and the related benefits to the region will be highlighted.

The Citizen Scientist-Supported Monitoring Program of the Poquessing Creek

Yerk, Walter, PhD candidate, Drexel University, *3141 Chestnut St, Curtis 251, Philadelphia, PA, 19104*, wgy23@drexel.edu; Meghan K. Rogalus, Bucks County Conservation District

Poster Session, Monday & Tuesday, 5:00pm, 4th Floor

The 14.5 kilometers Poquessing Creek drains highly urbanized areas of southwestern Bucks and southeastern Montgomery Counties and northeast Philadelphia. Per Pennsylvania DEP assessments, the creek is 100% impaired for aquatic life.

The Poquessing watershed is a part of the Upstream Suburban Philadelphia cluster of the Delaware River Watershed Initiative. In 2015 a three-tier monitoring program was established throughout the cluster. Tier 3 is public engagement through a citizen science monitoring program collecting observational data. Tier 2 is a staff-level water quality monitoring at the organizational level, and Tier 1 is research-grade monitoring completed by Academy of Natural Sciences of Drexel University.

Citizen scientists (known as Streamkeepers) volunteer to visually monitor the main stem of the creek at 16 locations. Per predefined protocols shared throughout the cluster, the data include site photos and assessments of various indicators including but not limited to water clarity, surface coating, odor, stream bed color, erosion, vegetation, and wildlife.

For the Tier 2 monitoring, a smaller group of experienced citizen scientists who received Penn State Master Watershed Steward training together with the staff of the Bucks County Conservation District (BCCD) conduct quarterly water quality sampling at five locations in the watershed. The procedures include collecting grab samples for nutrient analyses, sediment, and chloride concentrations. Also, in situ measurements of pH, temperature, dissolved oxygen, and conductivity are collected along with assessments of stream velocity and channel dimensions to estimate discharge. The same group collects benthic macroinvertebrates at two locations on the main stem which are analyzed by the Stroud Water Research Center

The active involvement of citizen scientists has allowed for regular monitoring of approximately half of the 16 sites to date. The Friends of Poquessing Watershed continue actively recruiting volunteers to monitor the underserved sites. The collaboration between the citizen scientist volunteers and the BCCD secures an uninterrupted quarterly schedule of water quality sampling. The presentation will discuss the challenges the monitoring program faces and the dynamics of the completion of the data collection.

Let's Get Physical: Post-Construction Results of Structural Monitoring of Oyster Reef Breakwaters at Gandy's Beach, NJ

Zito-Livingston, Adrianna, Conservation Project Specialist, The Nature Conservancy, *2350 Rt. 47, Delmont, NJ, 08314*, azito-livingston@tnc.org; Danielle McCulloch, U.S. Fish and Wildlife Service; Joshua Moody, Partnership for the Delaware Estuary

Restoration I, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

The Gandy's Beach Living Shoreline Project is an example of a post-Hurricane Sandy project implemented with the goals of shoreline erosion reduction and habitat enhancement. The Nature Conservancy was funded by the U.S. Fish and Wildlife Service to construct and monitor a hybrid living shoreline across approximately 3,000 linear feet of eroding beach and tidal marsh shoreline. The project was constructed in 2016 using natural shell and Oyster Castles ™ to create "oyster reef breakwaters" that attenuate wave energy and provide hard substrate for attachment and growth of the Eastern oyster (*Crassostrea virginica*). A multidisciplinary monitoring team tracked structural and biological metrics before (2015) and after (2016 and 2017) project construction. Monthly site visits and fixed photo point monitoring have provided a record of structural stability and visible changes. High resolution RTK-GPS surveys were used to quantify: site-wide sedimentation and scour patterns; extent of vegetation coverage; and vertical position of, and elevation around, the breakwaters. Results showed changes in elevation were highly variable across the site one year post construction, but that vegetation loss was greatly reduced in the post-installation northern region (-5%, 2016-2017) relative to pre-construction (-45%, 2015-2016). Average elevation change across breakwaters was minimal (vertical: -5±2cm; waterward: -1±2cm; and landward: 0±2cm). Two years post-construction, the breakwater structures have successfully remained in place. Monitoring efforts are currently funded through 2022 and are expected to provide information regarding developmental trajectories of living shorelines and their associated services.

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Photo Credit: Spencer Roberts