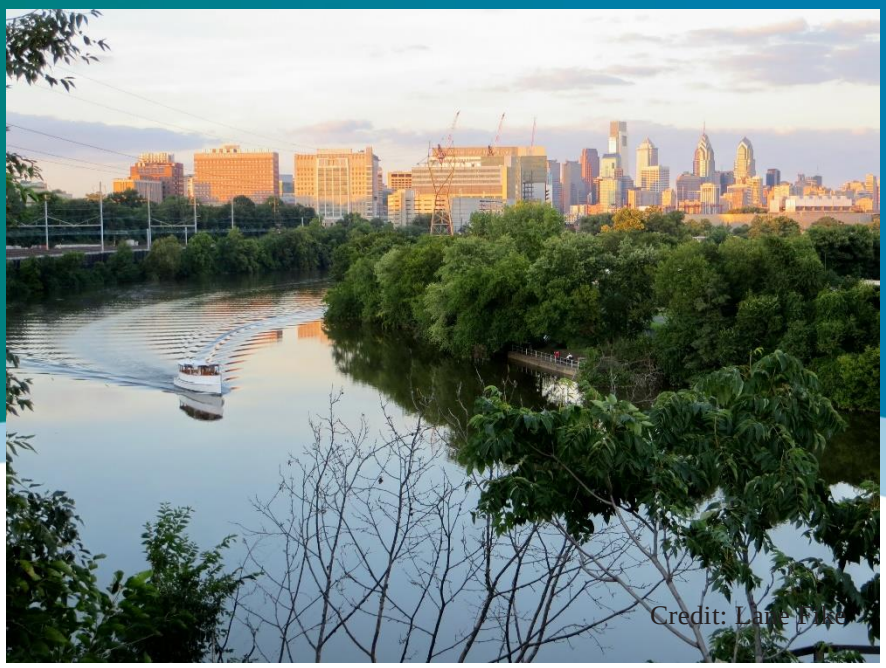

Abstract Book

Delaware Estuary Science and Environmental Summit 2017

January 22-25, 2017, The Grand Hotel, Cape May, NJ

Partnership for the DELAWARE ESTUARY

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

A publication of the Partnership for the Delaware Estuary—A National Estuary Program

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Special Panel and Workshop Descriptions:

Establishing the "Explore the Delaware River Watershed" Branding

Delaware Estuary Science and Environmental Summit

Monday, 10:45am, Crystal Room, 1st Floor

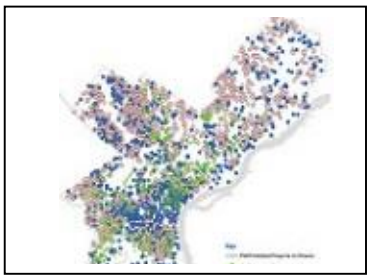
Moderator: Kathy Klein

Description: The Delaware River Watershed is the lifeblood of our region that spans four states; provides water for drinking and industrial purposes for more than 5% of the United States' population; is home to critical living resources including shad, sturgeon, eel, horseshoe crabs, mussels, and oysters; a migratory stop-over for more than 200 species of birds; is home to the nation's largest freshwater port; and is an economic engine that generates $22 billion annually to the region's economy. The Watershed has hundreds of federal, state and local agencies, and environmental organizations working to protect, enhance and sustain the resource.

What the Delaware River Watershed does not have is a shared identify or a "brand" or a cohesive platform for telling the Watershed's story and promoting all the opportunities to experience and become a steward of the resource. To address this need, the Water Resources Association of the Delaware River Basin is taking the lead in establishing the *Explore the Delaware River Watershed* initiative.

Please join us for a facilitated brainstorming session to get your input on "branding" the watershed and creating a shared information/promotion platform.

Contact: Kathy Klein, wradrb@comcast.net



Green City, Clean Waters: Planning and Outreach for the First 5 Years

Delaware Estuary Science and Environmental Summit

Monday, 1:30pm, Grand Ballroom C, 1st Floor

Moderator: Michelle Knoll

Description: This year marks the five-year anniversary of Philadelphia's Green City, Clean Waters plan, but with a 25-year commitment to PADEP and the EPA, there is still a long way to go. While the scale of Philadelphia's green stormwater infrastructure plan is larger than most, lessons learned in planning stormwater management projects and working with communities to embrace green infrastructure can apply to any implementation plan. We'll provide a detailed look at our process for identifying and selecting potential projects in neighborhoods across the City. Then we'll explore our systematic outreach process and discuss ideas for quantifying both our outreach efforts and their relative success.

Panel:

Christopher Anderson, Watersheds Program Manager, PWD Public Affairs, City Government Sector

Stephanie Chiorean, Green Stormwater Infrastructure Planning, PWD Office of Watersheds, City

Government Sector

Maggie Dunn, Planner & Outreach Specialist, Trans-Pacific Engineering Corporation, Private Sector

Format: Two 30 minute in-depth presentations followed by 15 minutes of discussion after each presentation.

Questions to be addressed:

1. How does PWD identify projects for green stormwater infrastructure (GSI) implementation?
2. What processes can communities use to manage a comprehensive GSI planning effort?
3. How can proactive public engagement address community concerns about GSI?
4. How can outreach groups quantify the success of their outreach in communities?
5. Can public support for green infrastructure inspire behavior change?

Contact: Maggie Dunn, maggie.dunn@phila.gov

The Delaware River Watershed Initiative – Reflecting on Phase 1 and Charting Phase 2

Delaware Estuary Science and Environmental Summit

Monday, 3:45pm, Grand Ballroom A, 1st Floor

Moderator: Carol Collier, ANS

Description: Founded on strong science and research, the Delaware River Watershed Initiative (DRWI) is a conservation and watershed protection movement focused on water quality outcomes for the entire Delaware Basin, including the Estuary and upper basin. The DRWI has been in place for almost four years with 50 NGOs mobilizing over $75MM in funding to implement on-the-ground restoration and protection strategies, complimentary outreach and education, and a $6MM investment in aligned monitoring and research to track progress and assess project impacts.

The goal of the Initiative is to protect and restore watersheds that provide high quality and sufficient water quantity to support healthy ecosystems and human communities. Envisioned as a 10-year strategy, an initial 3-year Phase of the DRWI was kick-started in 2013 with funding from the William Penn Foundation (WPF). Early learning and success indicates that a second phase can accelerate current momentum with better integration of watershed science, modeling, and data collection. During the past year a team, working with the watershed cluster organizations, has been developing a framework for Phase 2 planning that includes a guidance document, performance and outcome metrics, goals and capital and complementary strategies. One goal is to make the scientific basis for Phase 2 even more rigorous than in Phase 1, including development of additional planning and assessment tools: new and improved water quality models, data management system, better resolution mapping and land use change forecasting, focused monitoring and assessment, strong citizen science programs. Panel members will discuss the changes in place and the desired outcomes, with an emphasis on the scientific basis. There will be time for extended Q&A and audience interaction.

Panel: Clare Billett - William Penn Foundation
Scott Haag - Academy of Natural Sciences of Drexel University (ANS)
Amanda Bassow - National Fish and Wildlife Foundation (NFWF)
John Jackson - Stroud Water Research Center
Questions to be addressed:

- What were important lessons learned from Phase 1 of the Initiative?
- With so many organizations involved, how is the process working?
- How will the monitoring strategy change from that of Phase 1?
- Are there any early results from the collected data?
- What is a complementary strategy?
- What is the difference between performance and outcome metrics?
- How do you compare results of monitoring with rigorous protocols with those collected by citizen teams?
- Do you really expect to change the water quality in the Delaware River?

Contact: Carol Collier, crc92@drexel.edu

Conncet the Dot-Leveraging Community Partnerships and Media Relations to Elevate Nonprofit Success

Delaware Estuary Science and Environmental Summit

Monday, 3:45pm, Grand Ballroom C, 1st Floor

Moderator: Joe Tarsavage

Description: Nonprofit organizations are continually seeking ways to secure the resources needed to accomplish their mission, yet they often overlook amazing opportunities where partnerships could prove extremely effective. In a time when grant funding is more competitive than ever, and donors are bombarded with requests for support, what additional tools and resources can you use to help ensure success? How can effective partnerships among nonprofits, educational institutions, businesses, foundations and communities help to expand the reach of your message and attract the monetary support, in-kind donations, volunteer services, community awareness/involvement and media coverage you are seeking?

Partnerships are the true key to success in the nonprofit community and can elevate your nonprofit to a new level of public recognition and achievement. This session will explore some successful local examples of effective nonprofit, school district and business partnerships, and will focus on helping you to "connect the dots" within your organization, including:

- Identify your organization's strengths, challenges and needs
- Identify and build upon commonalities you share with businesses/corporations as well as other nonprofits (especially looking outside of the environmental sector)
- Tips on how to look for "hidden" opportunities
- Tips on how to refine your partnerships for increased success
- Strategies to help ensure that partnerships are mutually beneficial and aligned with your mission
- How to leverage media coverage and social media engagement to accomplish your goals and build your organization's success

Presenters: Laura Bishop and Karen Forst, Laura Bishop Communications

Contact: Laura Bishop, laura@laura-bishop.com

Charting the Future of the Delaware Estuary – CCMP Revision Progress and Perspectives

Monday, 7:30pm, 5th Floor

Overview: After 20 years, the Comprehensive Conservation and Management Plan for the Delaware Estuary (CCMP) is being revised. PDE is leading the revision effort, working closely with partners at the US Environmental Protection Agency (Regions 2 and 3), the Delaware River Basin Commission, the Delaware Department of Natural Resources and Environmental Control, the Pennsylvania Department of Environmental Protection, the New Jersey Department of Environmental Protection, and Philadelphia Water. Together, we're guiding and participating in a process that started in 2016 with a short series of public listening sessions and reaching out to hundreds of key "experts" in the watershed.

PDE has engaged RK&K to plan, organize, and facilitate workshops to collect input from these experts on CCMP topics, in different locations throughout the region. Seven workshops have been conducted so far, with two more planned for the week following the Summit. So far, some common themes have emerged, including the need to consider green jobs and natural infrastructure and emphasize the importance of experiential learning. Workshop results will be used to craft draft action plans for even more stakeholder input in 2017.

Format: Hear from Jim Eisenhardt and Sari Rothrock of RK&K about workshop results so far, as they reflect on common themes and ideas, in a fun, interactive format. (Bring your cell phone!) Participants will have the opportunity to provide input on priorities for revising the CCMP, and hear what their colleagues are saying about the actions needed for clean water, strong communities, and healthy habitats over the next 10 years.

1 Sari Rothrock and Jim Eisenhardt from RK&K facilitate a Healthy Habitats workshop at the Abbotts Mill Nature Center. Two more workshops are coming up in Pennsylvania – Healthy Communities on January 31st in Montgomery County and Healthy Habitats on February 1st in Philadelphia.

For more information on Healthy Waters, Healthy Communities, and Healthy Habitats goals, visit our poster on display on the 1st floor and provide your feedback!

Planning for the Future of Long Term Monitoring of Coastal Wetlands

Delaware Estuary Science and Environmental Summit
Coastal Wetland Monitoring Panel, Tuesday, 9:00am, Crystal Room, 1st Floor
Moderator: LeeAnn Haaf

Description: Current and potential members of the Mid Atlantic Coastal Wetland Assessment (MACWA) workgroup are invited to participate in a brief round table meeting and discussion. Discussion topics will include planning for the 2017 MACWA workgroup meeting and the following challenge questions:

1) How can we help other agencies use these data to make decisions?

2) How might we encourage sustained long term monitoring funding as a research collective?

3) What questions can we ask together as the MACWA community, that we can't answer alone?

Contact: LeeAnn Haaf - lhaaf@delawareestuary.org

Revising the CCMP for the Delaware Estuary Panel Discussion

Tuesday, 11:30am, Grand Ballroom, 1st Floor

The Comprehensive Conservation and Management Plan for the Delaware Estuary (CCMP) is a blueprint for collective action over time to make our region's waters drinkable, fishable, and swimmable. Created in 1996, the CCMP guides the work of PDE and its partners.

This panel presentation will share perspectives from the PDE Steering Committee on priorities and needs for revising the CCMP, looking into the future.

Moderator:
Jennifer Adkins, Executive Director, Partnership for the Delaware Estuary

Panelists:
Dan Kennedy, Assistant Commissioner - Water Resources Management, New Jersey Department of Environmental Protection
Javier Laureano, MPA, PhD, Director - Clean Water Division, US Environmental Protection Agency Region 2
Roy Denmark, Chairman of the Board, Partnership for the Delaware Estuary

Format:

Jennifer Adkins will open the session with a brief introduction to the Steering Committee and CCMP revision. Each panelist will give brief opening remarks, providing national, regional, and state level perspectives on the importance of the CCMP and revising it to guide protection and enhancement of the Delaware Estuary over the next 10 years.

The remainder of the session will be devoted to allowing panelist to respond to questions related to revising the CCMP. As moderator, Jen will pose the first question, then solicit additional questions from the audience.

Schuylkill River, East Coventry, PA

Social Marketing: Hands on Workshop

Delaware Estuary Science and Environmental Summit

Part I: Tuesday, 2:00pm & Part II: Tuesday, 3:30pm, Grand Ballroom C, 1st Floor

Moderator: Tom Amidon

Description:

Part I:

Social marketing is, "a process that applies marketing principles and techniques to influence target audience behaviors that benefit society as well as the target audience," (Lee and Kotler, 4th ed.). Trained social marketing service providers will be delivering a hands-on, interactive session where participants will learn the steps for creating robust social marketing campaigns and work in groups to build a campaign around mock case studies. The goal is to provide background education about social marketing and help participants become familiar with the process of developing these programs so that they can enhance existing and develop new behavior change efforts. Participants will then learn and practice techniques for conducting intercept surveys to collect audience barriers and benefits data, and will be given examples of effective questions. Emphasis will be placed on identifying groups of people more open to trying suggested stewardship behaviors and identifying existing behavior(s), attitudes, and facilitating value.

Part II:

Would you like to modify your existing outreach program to focus more on specific behaviors and target audiences? In this interactive roundtable session with the University of Maryland Sea Grant Extension and the Chesapeake Bay Trust, participants will learn about the draft Rapid Assessment Tool and run a mock program through the tool to identify elements of the program that align with social marketing principles and elements that could be modified. The concluding discussion following the Rapid Assessment training will help participants understand how to modify their existing programs and help to improve the Tool for future use.

Presenters: Jennifer Dindinger, UMD Sea Grant Extensions; Amanda Rockler, UMD Sea Grant Extension; Kacey Wetzel, Chesapeake Bay Trust

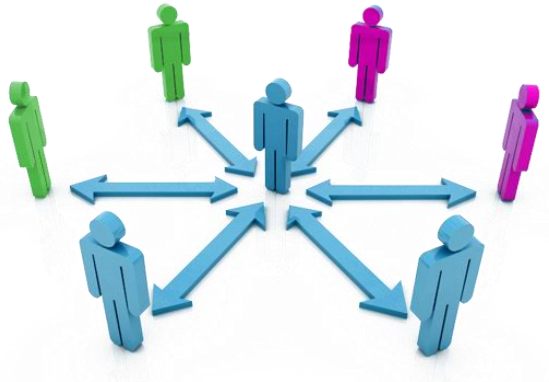
Contact: Jen Dindinger, jdinding@umd.edu

Leading in a Network or Coalition

Delaware Estuary Science and Environmental Summit

Wednesday, 10:30am, Grand Ballroom C, 1st Floor

Moderator: Kelly Valencik



Description:

This workshop, based on ICL's publication, "The Less Visible Leader," will provide staff, board members, and volunteers with a framework for improving results in a network or coalition. Using individual and group exercises, workshop participants will identify strategies for being a more effective leader when engaging diverse partners in collaborative processes. This session will be most helpful for those already in a network or coalition. Learning objectives include: 1. Identifying your strengths and your growing edge for leading in a network or coalition 2. Discussing tools for assessing and improving the performance of your network or coalition 3. Strengthening your influencing and communication skills to increase effectiveness 4. Sharing new ideas and practices with colleagues from other organizations Workshop participants will leave the session with practical steps for their work

Presenter: Sarah Clark, Institute for Conservation and Leadership

Contact: Sarah Clark, sarahc@icl.org

Talk and Poster Abstracts:

Presenting author names are **bolded**

Thermal tolerance of juvenile Atlantic surf clams (Spisula solidissima): A step towards diversifying the New Jersey shellfish aquaculture sector

Acquafredda, Michael, Haskin Shellfish Research Laboratory, Rutgers, The State University of New Jersey, 6959 Miller Avenue, Port Norris, New Jersey 08349, Michael.Acquafredda@rutgers.edu; Daphne Munroe, Haskin Shellfish Research Laboratory, Rutgers, The State University of New Jersey; Lisa Calvo, Haskin Shellfish Research Laboratory, Rutgers, The State University of New Jersey; Michael P. De Luca , New Jersey Aquaculture Innovation Center, Rutgers, The State University of New Jersey

Poster Session, Monday, 5:15pm, 5th Floor

In the United States, shellfish aquaculture is an important part of many regional economies, and the sector is expanding rapidly. In New Jersey, shellfish aquaculture is currently limited to two species: the hard clam (Mercenaria mercenaria) and the Eastern oyster (Crassostrea virginica). Shellfish farmers in New Jersey have recently expressed interest in culturing new species, thereby diversifying their farms. The Atlantic surf clam (Spisula soldissima) represents an ideal target species for diversification because it is native, grows rapidly, and fits into the established farming framework. To optimize the husbandry techniques required for sustainable and profitable farming, it is necessary to gain a thorough understanding of how temperature impacts the performance of the surf clam throughout different stages of its development. This study, conducted in July 2016, examined the effect of five different temperatures (17˚C, 20˚C, 23˚C, 26˚C and ambient) on the growth and survival of early juvenile surf clams (shell length ≈700 µm). Three independent cohorts were tracked for 32 days and cultured using standard, nursery phase procedures (236 µm screen downwellers, and 500 µm/750 µm screen upwellers). Shell height, shell length, and abundance estimates were collected 2-3 times per week. Results suggest the colder temperatures reduce mortality, while warm, but not hot temperatures sustain the greatest growth; the optimal culture temperature at this development stage is likely 20˚C. These results will be used with an on-going study examining the optimal grow-out phase techniques for surf clam culture. Ultimately, these findings will be incorporated into a manual of best practices, which will be made accessible to the state's local shellfish farmers.

Storm Control Treatment Facility – A Novel Solution to Sanitary Sewer Overflows

Amidon, Thomas, Kleinfelder, 321 Wall Street, Princeton, NJ 08540,
TAmidon@Kleinfelder.com

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

The issue of sanitary sewer overflows (SSOs) has received much less attention than combined sewer overflows (CSOs), although SSOs may be just as common as CSOs and more important from a water quality standpoint. A stroll during the pouring rain through low-lying areas of older cities and towns throughout the country would reveal untreated wastewater, diluted with significant quantities of inflow and infiltration (I/I), gurgling out of manholes and even pouring out of other manholes with covers that have been dislodged by the extreme pressure. Because of their intermittent, inadvertent nature, SSOs are often never identified or ignored.

The Somerset Raritan Valley Sewerage Authority (SRVSA) operates a 23 MGD advanced wastewater treatment plant that serves a population of 120,000 in seven communities in central New Jersey. SRVSA identified a significant Sanitary Sewer Overflow (SSO) in the Borough of Somerville's sewer system just upstream of its connection point with SRVSA's interceptor. During extreme wet-weather conditions, untreated wastewater escapes from Somerville's sewer into Peters Brook, which flows directly to the Raritan River.

A novel solution was developed to solve the Somerville SSO problem, namely an auxiliary treatment facility that will be operational only under certain high-flow conditions to control and treat overflows (Storm Control Treatment Facility SCTF). A detailed alternatives analysis was performed, which relied on several significant technical studies, including developing a hydraulic model of the sewer system, a hydraulic and water quality model of the receiving streams, and a wasteload allocation study to establish effluent limitations for the auxiliary SSO treatment facility alternative. These studies, along with substantial wet-weather monitoring, were used to characterize the frequency and magnitude of the overflows, and to establish design criteria for the various abatement alternatives. NJDEP has approved the SCTF as the preferred alternative and issued a discharge permit for this new facility.

Rancocas Creek National Water Trail, Nomination: 4,000 Years of Multi Use Impacts

Anderson, John, Rancocas Pathways, Inc, a 501c3 organization, 16 Broad Street, Mt. Holly, NJ 08060, ingvarja@verizon.net

Hot Topics, Wednesday, 1:45pm, Grand Ballroom, 1st Floor

The Rancocas Creek, NJ's largest tributary of the Delaware River Estuary originates in the NJ Pine Barrens. The 3 different branches of the Rancocas flow's westerly to meet the tidal reach in Lumberton and Mt. Holly. Commencing 3 years ago a citizen driven initiative forged innovative paths so to allow the Rancocas Creek nomination to the National Water Trail System. Letters of endorsement are collected and submitted from local and state elected officials (reaffirming all politics are local), municipalities, business entities, community members, environmentalists, government agencies and others. Numerous Barn Door Workshops (community meetings and public forums) cultivate a progression of ideas, thoughts and concerns to promulgate and coalesce into the nomination process, proper. Best management practices for planning, access, routes, maps, mitigation of safety hazards and water quality characteristics are established and evolving. Multi-use recreation activity incubators and creek front facilities are under development and maintained. Melpine Landing on the Rancocas State Park Blue Trail, NJ's Finest Water Trail is an example of a creek-front water trail landing. Key questions solicited public opinion and addressed ways to leverage free market environmentalism to support the Water Trail application. Clean-ups, restorations, monitoring, inventory's and mapping r/t fundamental principles of conservation facilitate the nomination and associated activities. Maintenance is a bugaboo notable at launch sites and public access points. Education and enhancing public awareness promotes solutions to numerous issues and problems faced. Looking into the future the National Water Trail grant application and process thrives on the natural vibrancy of direct citizen action. Such actions as a National Water Trail bridge pillars of a healthy community: access and recreation.

Water Quality Modeling of Urban Streams in Philadelphia Pennsylvania

Bezts, William, CDM Smith, 1500 John F Kennedy Boulevard, Suite 1208, Philadelphia, PA 19102, beztswm@cdmsmith.com; Eileen Althouse, CDM Smith; Josef Kardos, Philadelphia Water; Kinman Leung, Philadelphia Water

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

Extensive stream surveys, infrastructure surveys, and field monitoring data were used to develop hydrodynamic and water quality models, which simulate existing dissolved oxygen (DO) conditions and underlying stream processes in the non-tidal receiving waters of urban streams within the city of Philadelphia. The USEPA Storm Water Management Model (SWMM) 5 model platform was used to simulate rainfall runoff and infiltration, watershed water quality loadings, and instream hydrodynamics. The USEPA Water Quality Analysis Simulation Program (WASP) 7.5 Advanced Eutro model platform was used to represent the physical, chemical, and biological processes driving instream DO concentrations. Instream hydrodynamics from the SWMM model were linked to the WASP model and drove water quality transport and instream reaeration. This presentation will describe the process of model development while tying the development and results to field monitoring data.

The Delaware Watershed Resource Registry

Biddle, Mark, DNREC, Division of Watershed Stewardship, 100 W. Water Street, Suite 10-B, Dover, Delaware 19904, mark.biddle@state.de.us; LaTonya Gilliam, Delaware Department of Transporation

Estuary Restoration, Wednesday, 10:30am, Grand Ballroom A, 1st Floor

The Delaware Watershed Resource Registry (WRR) is collaborative project of state agencies, federal partners, and non-profits. The WRR is web-based interactive GIS mapping tool that analyzes watersheds to find and score opportunity areas for protecting and restoring high-quality resources. Earlier in 2016, Delaware was able to secure funding through a grant from Federal Highways (FHWA) to develop Phase 1 of the WRR. The WRR concept originated as a pilot project in Maryland funded by the Environmental Protection Agency (EPA). EPA invited Delaware to be the second state with a WRR and is working with other mid-Atlantic states to establish their own WRR's. The Delaware WRR uses the framework from the Maryland project then customizes the models within to better reflect the landscape conditions and resource management needs in Delaware. Existing statewide, watershed-based, and site-specific spatial data was identified to inform the WRR. The WRR identifies and scores each ecological opportunity area using one to five stars, with five being the greatest value. These scores are based upon eight suitability analyses including: Wetland Restoration, Wetland Preservation, Upland Restoration, Upland Preservation, Riparian Restoration, Riparian Preservation, Stormwater Natural Infrastructure Preservation, and Stormwater Compromised Natural Infrastructure Restoration. The WRR can be used for an array of activities such as transportation project siting and mitigation, targeting ecological opportunities for restoration or preservation, TMDL implementation strategies and NEPA related projects, and with permitting activities. This presentation will explain the WRR in detail, give insight on how the WRR is tailored to Delaware, showcase capabilities for a wide range of watershed-level activities, and discuss plans for expanding the WRR in Phase 2.

Early Post-Settlement Growth in Wild Eastern Oyster (Crassostrea virginica Gemlin 1791) Populations

Borsetti, Sarah, Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Ave, Port Norris, NJ 08349, sarahbor@hsrl.rutgers.edu; Daphne Munroe, Haskin Shellfish Research Laboratory, Rutgers University; Kathryn Ashton-Alcox, Haskin Shellfish Research Laboratory, Rutgers University; David Bushek, Haskin Shellfish Research Laboratory, Rutgers University

Poster Session, Monday, 5:15pm, 5th Floor

Management and restoration of wild oyster populations with the ecosystem services they provide require detailed understanding of oyster population dynamics, including temporally and spatially varying growth. Much of the existing literature documenting growth rates for eastern oysters (Crassostrea virginica) reports growth for large, protected, and/or hatchery-spawned oysters. By following growth of wild oysters set on planted clamshells in Delaware Bay, we document early growth (within the first year) of 21 wild oyster cohorts settling over 8 years and assess the importance of interannual variability in temperature and salinity. In general, oysters follow a linear growth trajectory in the first year of life, interspersed by periods of little to no growth in the colder months. Wild oysters settling in the Delaware Bay mid-salinity region reach a size between 27 and 33 mm in their first year and tend to reach greater shell heights at 1 year of age in higher salinity years and at temperatures averaging 23 °C. Multi-year, population-level estimates of wild growth such as these are important for understanding changes in restored and managed oyster populations, and resulting ecosystem services, under naturally variable conditions.

Connecting the Drops: Stormwater Management in Bridgeton City and Upper Deerfield

Brown, Meredith, American Littoral Society, 135 N High St, Millville, NJ 08332, meredith@littoralsociety.org

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

When it rains, water runs off the surfaces of parking lots, roads, and pavements as it makes its way to our water ways. Storm water runoff can have a significant impact in both urban and rural communities. This pollution can have an impact on both our watersheds and groundwater. In late 2015, the american Littoral Society received a multi-year grant from the National Fish and Wildlife Foundation (NFWF) to do storm water management projects throughout Cumberland County, NJ. The county hosts both urban and rural townships that were interested in addressing the storm water runoff issue. In 2016, the American Littoral Society has implemented several storm water management projects in the city of Bridgeton and elsewhere in Cumberland County. With the help of our Restoration Corps interns, these projects included rain gardens, rain barrels, planter boxes, and more. This presentation will cover the idea of solutions to storm water management in NJ and how the American Littoral Society tackled this problem through education, outreach, and publicly visible demonstration projects.

Field Study Of Biochar Amended Soils: Water Retention And Nutrient Removal From Stormwater Runoff

Brown, Joseph, University Of Delaware, 127 The Green Room 301, Civil and Environmental Engineering, Newark, Delaware 19716, jdbrown@udel.edu;

Estuary Restoration, Wednesday, 10:30am, Grand Ballroom A, 1st Floor

Practical and economic treatment of stormwater runoff is of vital importance in the cleanup of the Chesapeake Bay and for Delaware municipalities as they try to meet the nutrient loading requirements of the Bay's TMDL reduction program. Roadway greenways represent a marvelous opportunity for the 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.

This research project evaluates the effects of biochar amendment in roadside soils on the soils' water retention capacity, infiltration characteristics, and ability to remove nitrogen from stormwater runoff. Previous research at the University of Delaware indicates that the addition of as little as 2% biochar, by mass, to the existing soil increases porosity and permeability in the soil which significantly increases water retention and infiltration. Benefits of this include reduced stormwater runoff rates and volumes, which reduces soil erosion and sedimentation, and increased groundwater recharge. Biochar also promotes microbial activity while increasing the residence time of water in soils, greatly enhancing denitrification and the nutrient removal capacity of the soils.

In this study, a commercial wood biochar, pyrolyzed at 550°C, was amended into a constructed roadside filter strip and a swale located along RT 896 in Middletown, DE. Two roadside filter strips, one amended with and one without biochar, were carefully instrumented to measure infiltrating water quality, soil moisture content, and stormwater runoff quantity and quality entering and exiting the filter strips. Results for 25 rain events show that the addition of biochar to the roadside soils decreased the stormwater peak runoff rates by an average of 54% and runoff volumes by an average of 75%. The effect of biochar amendment on reducing stormwater quantity and improving stormwater quality will be presented.

Bearing Capacity: Correlating Sediment Penetration Resistance and Vegetation Recovery in Salt Marsh Restoration Using Dredge Material

Buckner, Jessie, New Jersey Nature Conservancy, 2350 Route 47, Delmont, New Jersey 08314, Jessie.Buckner@TNC.org; Metthea Yepsen, New Jersey Nature Conservancy

Thin Layer Placement in Coastal Wetlands, Monday, 3:45pm, Crystal Room, 1st Floor

The Nature Conservancy, New Jersey Department of Environmental Protection, and New Jersey Department of Transportation and others partnered together for a pilot project in the region reusing dredged material for salt marsh restoration to raise elevation on degraded, eroded, or subsided marsh platforms. Increased elevation should improve overall marsh health by allowing native species to recolonize at their desired elevational zonation and increase the marsh's resiliency to sea-level rise. However, every application of dredged material is different because of the variations in the dredge material itself (like grain size and composition) and the marsh to which it is being applied. Sediments play a crucial role in this project so they must be measured accordingly. Bearing capacity, as measured by a dynamic penetrometer, is being used on this project as a rapid assessment metric for soils that can be done regularly and affordably.

Bearing Capacity measures soil's ability to resist penetration. Traditionally bearing capacity as a metric was designed for xeric use in agricultural and range lands to measure soil compaction and see its effects on root growth. Compacted soil affects air and water availability to roots and the ability of roots to penetrate. In the hydric soils of wetlands, bearing capacity has been used as a corollary proxy for belowground biomass. Bearing capacity yields very different results depending on whether the soils are hydric or xeric, however both soil types possess an optimal bearing capacity range for growth of plants, edaphon and infauna, and overall healthy systems. Bearing capacity has not been extensively used in other beneficial reuse projects so this new data will show the relationship between bearing capacity and vegetation recolonization and provide insight into bearing capacity trends over time as placed material settles. An understand of bearing capacity and marsh recovery can greatly assist in future project design.

Maternal and Salinity Effects on Blue Crab (Callinectes sapidus) Larval Morphology: Implications for Biophysical Interactions

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

Poster Session, Monday, 5:15pm, 5th Floor

Adult blue crab (Callinectes sapidus) population abundance is highly variable, and may be related to variability in larval recruitment. Larval success partially depends on morphology, as it affects predation risk, feeding and swimming ability, and ultimately dispersal capability. The goal of this study was to determine how maternal differences and the physical environment influence larval morphological development. Salinity varies in coastal environments where blue crab larvae develop, and is a key environmental parameter in crab larval development. To test maternal effects, larvae from six ripe adult female crabs, caught in the Delaware Bay, were reared in laboratory cultures under constant conditions. Early stage larvae (day 1) were sampled and morphology of 125 individuals was measured microscopically. Additionally, one female's larvae were split and reared under two salinity treatments (28 and 33 ppt), with temperature and diet constant, and sampled every 3 days for morphological measurements. Measurements for all larvae included overall size and shape, spine length and orientation, and length of swimming appendages. Physical properties (Reynolds number and drag) were derived from measured morphology. Morphology and physical properties of early stage larvae were significantly influenced by maternal identity; therefore, maternal effects must be controlled for in future developmental studies. After 22 days larvae from lower salinity (28) were larger, experienced higher Reynolds numbers and drag; however, there was no difference in swimming appendage size. This suggests that larvae developing in lower salinity, while still able to survive, may have weaker swimming and feeding ability, possibly influencing settlement success.

Camden Youth Lead Ecology History Paddle Tours On The Cooper River To Educate The Community About The Watershed And Promote Conservation Efforts

Carberry, Victoria, UrbanPromise Ministries, PO BOX 1479, Camden, NJ 08105, vcarberry@urbanpromiseusa.org;

Connecting Youth to the Environment, Wednesday, 9:00am, Grand Ballroom C, 1st Floor

Last summer, Urban BoatWorks hired 5 youth to lead the summer ecology paddling program in Camden, New Jersey. After receiving training in on-the-water safety, canoe rescue, ecology and history of the Cooper River, and paddling, these students built and restored boats in the Urban BoatWorks boat shop (housed at the Camden Shipyard and Maritime Museum) and lead community paddles on the tidal Cooper River. The river is situated in an often overlooked and neglected stretch of the city; it flows from the Kaighn Avenue dam, parallel to Admiral Wilson Boulevard, and runs north until it empties into the back channel of the Delaware River. Like many cities recovering from an industrial past, the Cooper River wasn't always viewed or treated as a valuable natural resource. Despite the impacts, the river has made a comeback with the help of many partners within the city working on clean water initiatives. The river is now teeming with wildlife and is home to a variety of shorebirds, nesting bald eagles, otters, even deer all within the city limits of Camden.

The ten week pilot program aims not only to empower young leaders to speak about environmental issues but to also advocate for better access to the city's waterways for recreation and enjoyment by the community. In addition to building boats and paddling, the youth monitor the water quality and ecosystem health through water chemistry testing and visual bioindicator recordings. What the students learn provides them with a firsthand experience to use as they raise awareness and educate the public on the importance of the health of the Cooper River and the greater Delaware River Watershed. The RiverGuides program hopes to continue to inspire community engagement to protect the natural resources that play such a vital role in the health of the city and region

Beyond Sandy: How NJ's Utilities Included Resiliency in their Designs after Superstorm Sandy

Chebra, P.E., Eugene, New Jersey Department of Environmental Protection - Division of Water Quality - Municipal Finance and Construction Element, Mail Code 401-03D, P.O. Box 420, Trenton, NJ, Eugene.Chebra@dep.nj.gov (**Heather Knizhnik** presenting)

Post Sandy Lessons, Monday, 10:45am, Grand Ballroom A, 1st Floor

In October 2012, Superstorm Sandy hit New Jersey and subjected it to extremely heavy and damaging wind and rain for multiple days. Water and Wastewater infrastructure facilities found themselves vulnerable to such an extreme weather event, and the resulting damage resulted in a long recovery period. Aside from direct impacts to people and property around the State, many of New Jersey's water utilities, sewage plants and pump stations, along the coast were inundated with flood waters, incapacitated due to heavy damage to equipment, and without power for days. Statewide, the estimates to repair, replace, and mitigate the damaged facilities were in the billions of dollars.

Leaders around the State realized that simply repairing the sewage plants and pump stations would not be sufficient, as this would leave them prone to similar damages in subsequent extreme weather events. They had to implement innovative designs and modifications to make the utilities resilient for the future. Along with FEMA, the NJ Department of Environmental Protection and the New Jersey Environmental Infrastructure Trust, an independent financing agency, through the Environmental Infrastructure Financing Program (NJEIFP) took a leading role in getting facilities back online as quickly as possible, while also promoting better, more resilient solutions. The NJEIFP has provided very low interest loans and technical assistance to affected municipalities to reduce the risk of a similar disaster through mitigation measures that include elevating sensitive equipment, constructing flood walls, and relocating vulnerable facilities. A few of the projects that demonstrate this proactive strategy are flood proofing at Bayshore Regional Sewerage Authority, relocation of the Lake Como Pump Station, and the South Monmouth Regional Sewerage Authority Mobile Pump Stations. This presentation will highlight these and some of the other best examples of resilient design that are being implemented around NJ.

Freshwater Mussel Propagation: Propelling Restoration Into The Future

Cheng, Kurt, Partnership for the Delaware Estuary, 110 South Poplar Street, Suite 202, Wilmington, Delaware 19801, kcheng@delawareestuary.org; Danielle Kreeger, Partnership for the Delaware Estuary; Angela Padeletti, Partnership for the Delaware Estuary

Poster Session, Monday, 5:15pm, 5th Floor

Freshwater mussels have experienced major declines in their range, abundance, and species richness globally as well as within the Delaware River basin. Since they are the most imperiled animal group in the United States and are diagnostic long-term indicators of watershed integrity, they represent ideal targets for conservation and restoration. There is growing interest in restoring mussel beds for their ecosystem services such as improving water quality and enhancing the benthic habitats. One major obstacle for mussel recovery is the lack of widespread natural reproduction, due in part to the disconnection (e.g. dams) between mussels and their fish hosts for their larvae. Fortunately, recent advances in hatchery propagation provide new opportunities for producing viable mussel seed to bolster diminished populations and reestablish extirpated populations. Working with Cheyney University and other PA partners, Partnership for the Delaware Estuary tested and refined mussel propagation protocols, successfully producing viable offspring from 2009-2011. Building on these lessons and insights from a VA-based hatchery, two hatchery facilities are being planned to meet the growing demand for mussel seed in the Delaware River basin and vicinity. A production hatchery is envisioned that will be capable of producing over 500,000 juvenile mussels yearly. This facility would support propagation of multiple species and include biosecurity protection to preserve basin-specific genotypes. A demonstration hatchery is also being developed within a freshwater mussel exhibit at the Fairmount Water Works Interpretative Center in Philadelphia to promote awareness of the need for mussel restoration and to showcase the mussel's unique life cycle. The exhibit will feature the alewife floater, Anodonta implicata, as our species of interest with goals to produce juveniles to provide a unique outreach experience and seed for restoration projects. In addition to promoting mussel restoration and outreach, these new facilities will provide diverse research opportunities for scientists and students.

Reconstruction of Historic Water Quality in the Tidal Christina River from Pre-European Settlement through the Present

Christie, Margaret, University of Delaware, Department of Geological Sciences, Penny Hall, Academy St., Newark, DE 19716, machri@udel.edu; Donald Charles, Academy of Natural Sciences of Drexel University; Ronald Martin, University of Delaware; Peter McLaughlin, Delaware Geological Survey; James Pizzuto, University of Delaware

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

Tidal rivers represent an environment that is both under-studied and vulnerable to changes caused by human activities. Widespread deforestation, agriculture, urbanization, and industrialization have impacted the tidal Christina River from before European settlement through the present. Cores from three sites along the tidal Christina River were collected and sediments deposited over the past 1000-1400 years were analyzed in order to compare how water quality has changed pre- and post- European settlement. Age-depth relationships were constructed for the cores using a combination of radiocarbon dating, Pb-210, Cs-137, and pollen-based deforestation horizons. The relationship between age and depth was consistent among the cores. Diatoms from the sediments were analyzed using established indices and autecological groupings to better understand trophic level and other changes in water quality. Generally, nutrient concentrations increased concurrently with use of the land for agriculture following European settlement, then increased further in the 1950s following the introduction of industrial fertilizers. Diatom assemblages cluster into groups which correspond to known ecological transitions such as deforestation and increased use of industrial fertilizers. The concentrations of metals in the sediments were analyzed to assess the impacts of urbanization and industrialization. Sediment analyses showed that zinc and other heavy metals increase in concentration following industrialization, peaked in the 1950s, and decreased after environmental legislation restricted the release of pollutants into waterways in the 1970s. Nitrogen and phosphorous concentrations were also measured to provide support for the diatom indices. Together, diatom and chemical analyses enable a detailed reconstruction of water quality changes in a tidal river. Diatom indices help to reconstruct the impact nutrients have had on water quality, which does not necessarily correlate well with sediment nutrient analyses. Chemical analyses of the sediments pinpoint the timing and influence of other activities that can degrade water quality, such as industrialization.

Developing Sources of Raw Material for Oyster Restoration projects in the Inland Bays

Collins, Bob, Delaware Center for the Inland Bays, 39375 Inlet Road, Rehoboth Beach, Delaware 19971, jamesfarm@inlandbays.org; Marianne Walch, Delaware Center for the Inland Bays; Andrew McGowan, Delaware Center for the Inland Bays

Estuary Restoration, Monday, 1:30pm, Grand Ballroom A, 1st Floor

In order to help restore wild oysters in the Delaware Inland Bays, the Delaware Center for the Inland Bays (CIB) is integrating two existing programs. In 2003, an Oyster Gardening demonstration project determined oysters could survive in various inland bays areas, including dead-end canals. In 2014 the "Don't Chuck Your Shucks" program began recycling spent oyster shell. Now, this cooperative effort (CIB, University of Delaware Marine Advisory Service, Delaware State University, Sussex County, The Nature Conservancy, waterfront property owners, local restaurants and volunteers) brings together scientists, volunteers and communities together to produce the raw materials for oyster restoration and research activities.

Shell is collected from sixteen restaurants in the Inland Bays watershed, cured and typically bagged by volunteers. Waterfront homeowners provide space and basic husbandry to small quantities of disease-resistant oysters, spawned at the Rutgers University Haskin Shellfish Research Laboratory, remote-set and grown to spat size at the University of Delaware Sea Grant lab.

Through this cooperation with many partners, CIB has built the capacity to produce raw materials to undertake significant restoration activities in the Inland Bays. In 2017, a shellfish restoration plan will be developed that will prioritize restoration projects, using these materials in living shorelines, reefs or other features. The combined efforts will allow CIB and others to make concrete strides in re-establishing a significant and healthy population of oysters in the Inland Bays, realizing clean water and habitat creation benefits. The presentation will discuss practices and lessons-learned, but will also look forward to the challenges of implementing an ambitious shellfish restoration effort.

A Marsh Futures Case Study: Cox Hall Creek (Lower Township, NJ) Marsh Vulnerability Assessment Using Streamlined Survey Methods

Collins, Kaitlin, Partnership for the Delaware Estuary, 110 S. Poplar Street, Suite 202, Wilmington, DE 19801, kcollins@delawareestuary.org; Joshua Moody, Partnership for the Delaware Estuary; Erin Reilly, Barnegat Bay Partnership; Martha Maxwell-Doyle, Barnegat Bay Partnership; Danielle Kreeger, Partnership for the Delaware Estuary

Poster Session, Monday, 5:15pm, 5th Floor

Marsh futures is a methodology for the evaluation of site-specific marsh vulnerabilities to furnish appropriate best management practices, including shoreline stabilization (e.g. living shorelines), elevation augmentation (e.g. thin-layer application of dredge material), or hydrologic enhancement using a four-step field-based and Arc-GIS analysis approach. A new version of the Marsh Futures protocol (v.3) was developed and tested as part of a NJDEP-led coastal resilience project funded by the National Fish and Wildlife Foundation. Step 1 consists of a RTK-GPS survey for elevation modeling and feature (e.g. vegetation community boundaries, water, etc.) delineation. Step 2 uses these data to stratify positions of vegetation communities across zones of the local tidal datum. In step 3, vegetative health is assessed in each elevation zone using field-based methods. Step 4 spatially integrates vegetative health across the topography of the site to identify vulnerabilities and vegetation zone projections. Previous versions of marsh futures have proved successful, but the current version eliminates sampling redundancy by implementing a systematic grid sampling protocol, supplemented by a feature-based survey along boundaries.

This version of marsh futures has been implemented in 1.5ha of Cox Hall Creek marsh in Lower Twp, NJ. The new survey methods efficiently delineated vegetation, which were superimposed on elevation models for health trajectory analysis. This particular area of marsh has been the focus of a successful restoration effort where invasive *Phragmites* was eradicated and a more natural salt marsh has developed. Nonetheless, this marsh is disconnected from Delaware Bay, its main water source, by a tide gate and a non-functioning culvert. The township is considering replacing the culvert to increase tidal flooding of the marsh, which would also decrease flood risk from storm-driven runoff. Our assessment provides valuable information regarding the current trajectories of marsh condition and likely future responses to changes in hydroperiod.

Gandy's Beach Living Shoreline Project

Conrad, Katie, USFWS, 4 E Jimmie Leeds Rd., Unit 4, Galloway, NJ 08205, katie_conrad@fws.gov; Moses Katkowski, The Nature Conservancy

Poster Session, Monday, 5:15pm, 5th Floor

Shoreline erosion and degradation of beaches and tidal marsh habitats due to sea level rise and major storm events is a major concern in New Jersey. The Nature Conservancy's (TNC) Gandy's Beach Preserve (Preserve) contains approximately one mile of Delaware Bay shoreline that is important habitat for spawning horseshoe crabs (*Limulus polyphemus*) and foraging migratory shorebirds, such as the red knot (*Calidris canutus rufa*). Federal funding for a Resiliency Project from the Disaster Relief Appropriations Act of 2013 (Public Law 113-2) was awarded by the U.S. Fish and Wildlife Service to TNC to construct 3,000 linear feet of living shoreline. The purpose of the living shoreline is to stabilize shoreline habitats used by red knots and horseshoe crabs; buffer local infrastructure and residences from further erosion; and increase oyster reefs to benefit ecologically and economically important fish and crab species. The living shoreline consists of nearshore oyster reef breakwaters (constructed of oyster castles or shell bags) and coir biologs. Other partners include the Partnership for the Delaware Estuary (PDE) and Rutgers University's Haskin Shellfish Research Laboratory (HSRL). One year after oyster reef installation, we are finding high recruitment of oysters to the structures, a more diverse fish community using the structures compared to the mud flat habitat it replaced, and that the structures are reducing wave energy by an average of 50% when water levels were below the crest of the structures.

Engaging With Diversity: From Latinas In Motion To Pokémon Trainers

De Angel, Doryán, Tookany/Tacony-Frankford Watershed Partnership, 4500 Worth Street, Philadelphia, PA 19124, doryan@ttfwatershed.org; Robin Irizarry, Tookany/Tacony-Frankford Watershed Partnership

Beyond Education to Engagement, Tuesday, 10:00am, Grand Ballroom C, 1st Floor

Many environmental organizations rely on outdoor programs to create awareness of environmental issues and encourage stewardship. The Tookany/Tacony-Frankford Watershed Partnership (TTF) has found that increasing community participation in these events, while also reaching more diverse audiences, often requires multiple outreach strategies. Understanding, developing, and using tools to communicate with your target audience, including spoken language, is essential in connecting to and building relationships with surrounding communities. This requires getting to know community based organizations, participating in local meetings, and engaging with neighbors and leaders to gather feedback on the types of programs in which people would be interested in participating. This information is critical to successful program development. Today, there are numerous social platforms available --Twitter, Facebook, Instagram, SnapChat, E-Newsletters -- to share information with constituents and gather their input. Other effective promotional methods include on-the-street and traditional media including formats such as ads in local newspapers, lawn signs, and even door-hangers. This multi-faceted approach to outreach and program design has enabled TTF to overcome some of the challenges we face in building an active Tacony Creek Park constituency in urban Philadelphia.

The Results From A Water Quality Testing Program Conducted By A High School Aquatic Science Class On the East and West Branches Of The Brandywine Creek, Pennsylvania.

DiSantis, Dina, Downingtown High School West Campus, 445 Manor Avenue, Downingtown, Pennsylvania 19335, ddisantis@dasd.org; Christopher Vandergoes, Downingtown East High School

Monitoring, Wednesday, 9:00am, Grand Ballroom A, 1st Floor

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

The Development, Implementation and Curriculum Overview Of A High School Aquatic Science Course.

DiSantis, Dina, Downintown High School West Campus, 445 Wallace Avenue, Downingtown, Pennsylvania 19335, ddisantis@dasd.org; Christopher Vandergoes, Downingtown High School East Campus

Connecting Youth to the Environment, Wednesday, 9:00am, Grand Ballroom C, 1st Floor

Why study water quality? According to the United States Geological Survey, "water quality is critical to the health and habitat of both humans and animals." Studying water quality will help us to understand: how water compares to standards, how conditions may vary locally, regionally, and nationally and if conditions are changing over time, and how natural features and human activities affect those conditions. Development and implementation of a water quality course for high school students will prove to be a valuable experience for both student and teacher. By having students assess the water quality of a local stream they will better understand how human activity affects this valuable resources. It is important that students gain skills that will help them to have an understanding of water quality analysis and the importance of preserving the quality and quantity of our Earths waters. Developing a water quality course at your school will also give the student hands on approach to studying science; which is both beneficial and more satisfying to students. Students will feel that there is merit to what they are doing since they are conducting the same tests that scientist perform. When students conduct their own studies, collect and analysis data, they will be intimately involved in addressing water quality issues and solving critical water quality problems. An interdisciplinary, field-based science curriculum gives students the opportunity to take an active role as a scientist not just as a student. I will be presenting an overview of the aquatic science curriculum used by the Downingtown High School West Campus located in Downingtown, Pennsylvania, to study water quality and quantity within the Brandywine River watershed and beyond.

Apps Aren't Just for Your Smartphone: Facilitating Living Shoreline Projects with Technology and Community Engagement

Doerr, Patty, The Nature Conservancy, 2350 Route 47, Delmont, NJ 08314, pdoerr@tnc.org; **John Truscinski**, The Nature Conservancy, Richard Lathrop, Rutgers University - CRSSA; Jon Miller, Stevens Institute of Technology; Danielle Kreeger, Partnership for the Delaware Estuary; Martha Maxwell-Doyle, Barnegat Bay Partnership; Alek Modjeski, American Littoral Society

Living Shorelines, Tuesday, 3:30pm, Grand Ballroom A, 1st Floor

As coastal communities throughout New Jersey continue to adapt to the impacts of climate change, it is important to consider the role that healthy coastal habitats play in ensuring a resilient coastline. Healthy coastal habitats like salt marshes and oyster reefs can help to address community challenges such as flooding, erosion and degraded water quality. Therefore, it is very important to restore and enhance these habitats to ensure their lasting natural functions for the many benefits they provide. Integrating the restoration and enhancement of these habitats into community resilience planning efforts in a way for them to be "nature-based solutions" to coastal hazards requires not only the scientific and engineering information to make science-based decisions, but also the relationships with communities looking for new alternatives.

Living shorelines are one specific type of nature-based solution that seek to reduce coastal erosion while maintaining the land-water interface as much as possible. Working with several partners, The Nature Conservancy in New Jersey recently developed the Restoration Explorer – a first of its kind web-based application that visualizes which living shoreline technique may be appropriate along a particular stretch of coastline. The decision-support tool integrates engineering guidelines developed by Stevens Institute of Technology and available spatial data on shoreline characteristics. Once completed, the Restoration Explorer was paired with a community outreach effort where conservation partners throughout the state engaged community leaders to educate them on role and benefits of nature-based solutions and to develop potential living shoreline projects.

This project was part of the NJ Resilient Coastlines Initiative, a network of partners including American Littoral Society, Barnegat Bay Partnership, Partnership for the Delaware Estuary, Rutgers University, Stevens Institute of Technology, and The Nature Conservancy. It was funded by the National Oceanic and Atmospheric Administration.

Bird's Eye View: Quantifying Short-term Beach Morphology Using UAV Photogrammetry

Dohner, Stephanie, University of Delaware, 700 Pilottown Road, Lewes, DE 19958, sdohner@udel.edu; Arthur Trembanis, University of Delaware; Douglas Miller, University of Delaware

Monitoring, Tuesday, 10:00am, Crystal Room, 1st Floor

Quantitative short-term morphology change can be an elusive data set at any coastal study site. The dynamic environment and large-scale characteristics of many coastal areas makes rapid response data physically and financially difficult. Through the use of unmanned aerial systems (UAS), specifically DJI Phantom 3 quadcopters, beach topography at Broadkill Beach, Delaware was collected before and after Winter Storm Jonas. This collection captured the subaerial beach morphological signal of the extreme weather event using aerial imagery and photogrammetry processing. Monitoring interests then fall to seasonal and weekly response following an extreme storm event to evaluate construction and resiliency needs. The quadcopter was used to survey Broadkill Beach in July 2016 for morphological response since Winter Storm Jonas in January 2016. Aerial surveys were performed weekly for two weeks, then biweekly to determine if morphological change could be detected on such a time scale. Volume changes for Broadkill Beach and shoreline location, using the MHW line determine by the rack line and sand color change, were determined for post Winter Storm Jonas, July 2016, weekly, and biweekly surveys. The expected results following Winter Storm Jonas and during the summer months is overall accretion at Broadkill Beach due to low-energy summer conditions inside Delaware Bay, where Broadkill Beach is located. Results of the volume calculations will determine where the beach experienced accretion, erosion, and shoreline change. Preliminary results are promising for topographical monitoring using quadcopter platforms, particularly in short-term time frames when the small, lightweight, and inexpensive platforms provide elevation data with centimeter error. This work aims to show the capabilities of quadcopter unmanned aerial systems (UAS) in quantifying short-term and post storm morphology response as a rapid and economical alternative to traditional aerial LiDAR.

The Marshian: Determining a Drone's Ability to Monitor Tidal Marshes

Dohner, Stephanie, University of Delaware, 700 Pilottown Rd, Lewes, Delaware 19958, sdohner@udel.edu; Douglas Miller, University of Delaware; Arthur Trembanis, University of Delaware

Monitoring, Wednesday, 9:00am, Grand Ballroom A, 1st Floor

Tidal marshes are fragile and essential transitional zones within the coastal system. This zone is easily affected and altered by external forces such as land use change, sea level rise, sediment transport changes, and storm events. Monitoring changes with elevation and vegetation can quantify these affects, but marshes provide a challenging environment for surveying. This work took a cutting edge surveying platform and adapted it for the marsh environment to monitor elevation and vegetation changes. A DJI Phantom 3 quadcopter, an unmanned aerial system (UAS), was outfitted with a single near infrared (NIR) camera and flown Canary Creek Marsh, Lewes, Delaware to determine the capabilities of a drone for marsh monitoring. Flights were conducted at 10, 20, and 40 meters altitude and images were processed in Agisoft Photoscan to create digital elevation models (DEM) and orthomosaics using the RGB (red, green, blue) and NIR cameras. NDVI was calculated using the NIR camera to determine vegetation density and health while the RGB photos provided insight into vegetation species, location, and organization. A real time kinematic (RTK) GPS measured an elevation transect through aerial survey domain and then compared with the DEM from the copter images. Ground truthing of species, locations, visual percent cover, and percent composition were conducted using a handheld GPS and 0.25 square meter quadrats. Preliminary results show that at lower altitudes (10 and 20 meters) species and density can be determined when vegetation patches are domination by a single species. Mixed species groupings are difficult to confirm from nadir images, however oblique images aid in identification of vegetation structures when visible. NDVI allowed for identification of water features and vegetation densities, which will be compared with ground truthing of quadrat counts and species GPS locations. Results thus far hold promise for quadcopter platforms as efficient, multi-parameter monitoring methods with accurate results of marsh elevation and vegetation conditions.

Tidally-Induced Dispersion in the Delaware River near Philadelphia: Insights from Large-Scale Dye Experiment

Duzinski, Phil, Philadelphia Water, 1101 Market Street,4th Floor, Philadelphia, PA 19143, phil.duzinski@phila.gov; Robert Chant, Rutgers University; Elias Hunter, Rutgers University; David Walsh, Woods Hole Group

Physical and Chemical Processes, Tuesday, 2:00pm, Grand Ballroom A, 1st Floor

Results of a dye release in the freshwater portion of the Delaware Estuary provide a basis for estimates of the rate of dispersion in a tidally forced reach in the Philadelphia region of this heavily urbanized estuary. These estimates are intended to inform hydrodynamic and water quality model refinements for use in further numerical-based investigations of tidally-induced dispersion, and also for environmental regulatory compliance assessments.

The dye study was conducted over four days in August of 2014 using Fluorescein dye that was tracked with two research vessels equipped with fluorometers mated to a CTD package. Over the course of the study, 17 near-synoptic realizations of a patch of dye were obtained. The dye was injected offshore of northern Philadelphia, and surveys of the dye patch during the study period were conducted throughout a 24 kilometer reach of the tidal river.

The core of the dye patch was vertically well mixed, although there was persistent across-channel structure with the dye concentration remaining slightly elevated on the Philadelphia side of the river. Along channel dispersion of the dye patch appeared to increase over time with estimates exceeding that of vertical shear-induced dispersion, suggesting that other processes contribute to the along-channel spread of the dye. Possible candidates for the elevated dispersion are lateral shear dispersion, and tidal trapping of the dye in channel irregularities such as the “corrugated” shoreline associated with urban Philadelphia. Successful numerical modeling in this region of the tidal River likely requires representing these lateral processes to adequately capture the dispersive nature of this system. A 3D hydrodynamic model will be used to further investigate the potential roles that lateral processes play in longitudinal dispersion.

Updating TMDLs For PCBs For The Delaware Estuary

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Water Quality, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

In 2003 and 2006, the U.S. Environmental Protection Agency established Total Maximum Daily Loads (TMDLs) for PCBs for the tidal Delaware River and Delaware Bay, respectively. The goal of these TDMLs was to reduce PCB levels in resident and anadromous fish residing in those waters that had caused states bordering these waters to issue fish consumption advisories. There are many sources of PCBs to the estuary including wastewater from industries and municipal sewage treatment plants, contaminated sites, stormwater runoff, tributaries and air deposition. Achieving the goal and reducing or eliminating the consumption advisories required a collaborative approach lead by the DRBC and involving the three states bordering these waters and the U.S. EPA to identify and address each of these sources.

This approach was updated in 2016 to address the new water quality criterion of 16 picograms/Liter, utilize more recent data on PCB concentrations, and utilize a more equitable procedure for apportioning the TMDLs among the sources, and include a key additional element to the implementation strategy that will ensure that the dramatic reductions in PCB loadings from point source dischargers are maintained.

When the initial TMDLs were established, DRBC noted that achieving reductions in PCB concentrations in both the estuary waters and fish would take decades due to the current and historical concentrations of PCBs in the sediments of the estuary and bay. Diligent, long-term oversight of the adaptive management of these TMDLs along with periodic monitoring of the waters, fish tissue and sediments is necessary if the goal of reducing or eliminating fish consumption advice is to be achieved.

Dirt Cheap: Low-Cost, Real-Time Remote Soil Moisture Sensor Network For Rain Gardens

Fritch, Matthew, Philadelphia Water, 1101 Market St,4th Flr, Philadelphia, PA 19107, matthew.fritch@phila.gov;

Monitoring, Tuesday, 10:00am, Crystal Room, 1st Floor

In summer 2016, Philadelphia Water developed, prototyped, and tested hardware and software for a web-connected network of real-time soil moisture sensors in green stormwater infrastructure (GSI). The goal of the project was to gather data in order to make better decisions about watering vegetation in rain gardens. Watering large rain garden sites—especially those not near a water source—can be expensive, as can the replacement of emerging plants that did not get enough water. Using low-cost, open-source technology, we custom-built 10 soil moisture sensor units at a fraction of the cost of commercially available products. The sensor units were deployed underground at 6 GSI sites citywide and reported soil moisture data to the web via the 3G cellular network. Email or text alerts were configured to alert the maintenance team when sites required watering; soil moisture data and weather forecasts could be analyzed to cancel planned watering events based on need. Lessons were learned in the areas of waterproofing, battery efficiency, solar panel improvements, temperature effects, sensor data interpretation, variation in soil types, and code modifications. This talk focuses on the DIY nature of building the digital and physical infrastructure for the sensor network and the extensibility of this technology to other monitoring applications.

Using the Urban Watershed as an Integrated Context for Learning: Classroom Curriculum Program

Freedman Schultz, Ellen, Fairmount Water Works, 640 Waterworks Drive, Philadelphia, PA 19130, Ellen.Schultz@phila.gov; Rachel Odoroff, Fairmount Water Works; Karen Brinkley, Cook-Wissahickon School, Philadelphia; Aliya O'Neal, ; Blaine School, Philadelphia

Connecting Youth to the Environment, Wednesday, 9:00am, Grand Ballroom C, 1st Floor

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

Integrating real world environmental experiences into the formal K-12 classroom will help students become actively engaged in 21st century solutions to urban water issues; FWW is developing and piloting a Middle School Curriculum which encompass the broadest understanding of systems thinking in an urban context—public infrastructure has evolved over two centuries to solve, react to and manage water. The curriculum is divided into Thematic Units, with Learning Experiences aligned with Common Core and NGSS Standards, and an online web application to support teachers as they help students explore and understand this evolution.

In 2014, William Penn Foundation awarded a three- year grant to support the creation of a teacher-developed middle school curriculum for Philadelphia schools. Teaching Fellows from 9 selected schools dedicated 60 hours of professional development training to create the "Understanding the Urban Watershed" Curriculum Units, themed hands-on learning experiences for the classroom. Changing the ways teachers learn in professional development is the lynchpin of educational reform. Research shows that developing professional learning communities that incorporate successful collaboration, focus on student learning, offer opportunities for continuous teacher learning and give the teacher authority can improve teaching practice as well as student achievement.

Incorporating Resiliency Features into Bayshore Designs

Gaffney, Douglas, Mott MacDonald, 3 Paragon Way, Freehold, NJ 07728, douglas.gaffney@mottmac.com;

NJ Bayshore and Vicinity: Planning, Projects, Resiliency, Tuesday, 2:00pm, Crystal Room, 1st Floor

A restoration project is being designed for Gandy's Beach in Downe Township, NJ. Gandy's Beach is on the eastern shore of the Delaware Bay and was hard hit during Hurricane Sandy, affecting both the developed community and the natural area. The natural area suffered severe shoreline recession and overwash of the sandy beach. The community suffered property damage and loss of sand in front of the bulkhead and seawall. This has exacerbated the chronic shortage of sand in the littoral zone, impacting the seawall.

Bayshore environments such as Gandy's Beach require design adaptation from standard coastal engineering approaches. The environment is unique from at least two perspectives. The physical environment tends to be more complex than a sandy beach, with a wide range of sediment types and marsh erosion. The hydrodynamics are also complicated by higher tide ranges, bimodal waves and complexities associated with inlets and creeks. When these intricacies are incorporated in the designs, the results can increase resiliency for both the developed community and natural areas.

The design at Gandy's Beach started with an analysis of coastal processes affecting the project site and included an alternatives analysis. A variety of features and alternatives were evaluated for their ability to provide ecosystem services, community protection and interrelationship to neighboring habitats, all with an eye toward increasing resiliency of the system to future storms. The preferred design includes increased beach width, bayshore dunes, and tuned coastal headland breakwaters. The breakwaters will allow a degree of sediment bypassing to nourish updrift beaches while maximizing the residence time on the developed beaches. The shoreline shape will enhance horseshoe crab spawning habitat which, in turn, enhances Red Knot foraging. The bayshore dunes will add resiliency while affording enhanced protection and a reservoir of sediment to the system.

PowerCorps – Camden: Connecting Youth to the Environment Through Employment Opportunities

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Connecting Youth to the Environment, Wednesday, 9:00am, Grand Ballroom C, 1st Floor

In partnership with the City of Camden, Center For Family Services launched the PowerCorps Camden program in December 2015, with the goals to improve outcomes for opportunity youth and improve green infrastructure in the Camden City.

The three-year AmeriCorps PowerCorps Camden program will increase economic opportunity through job training and readiness for 60 youth each year. PowerCorps members are a team of young leaders from Camden City serving to tackle pressing environmental challenges in their community. Projects aim to improve stormwater management, clean and green vacant lots, improve community space and parks for Camden's youth, and revitalize public land in the City. Through projects focused on Camden's green infrastructure network, PowerCorps members will play a key role in maintaining over 53 green infrastructure installations including 20 rain gardens, 10 city and county parks, 400 vacant lots, and 5,500 stormwater inlets that comprise Camden City's network. Through knowledge and skills training, PowerCorps Camden will develop the next generation of Camden's environmental stewards.

Cohort One collectively maintained over 114 acres of city or county owned land, removed over 34 tons of solid waste from Camden's parks and vacant lots, and assisted with recycling .4 tons in only six short months!

In addition to being environmental stewards, PowerCorps members are also provided with social and supportive services. The social services aspect of PowerCorps Camden aims to assist members in removing barriers to their success in the program and in their future endeavors. Through trainings, partnerships, one on one sessions, referrals, and group meetings, the social service staff is tasked with removing barriers surrounding housing, substance abuse, mental health, family reunification, probation/parole, trauma/grief, and public assistance. Removal of these barriers will assist in both personal and professional development and ensure the ability of each member to be employment ready upon completion.

Monitoring Bird and Vegetation Communities at Prime Hook NWR Before, During, and After Tidal Marsh Restoration

Guiteras, Susan, U.S. Fish & Wildlife Service, Coastal Delaware NWR Complex, Bombay Hook NWR,2591 Whitehall Neck Rd., Smyrna, DE 19977, Susan_Guiteras@fws.gov; Tim Freiday, University of Delaware; Greg Shriver, University of Delaware; Elizabeth Tymkiw, University of Delaware; Mack McGraw, University of Delaware; Annabella Larsen, U.S. Fish and Wildlife Service; Jennifer McAndrews, U.S. Fish and Wildlife Service

Monitoring, Tuesday, 10:00am, Crystal Room, 1st Floor

Prime Hook National Wildlife Refuge in Delaware has restored tidal marsh in 4000 acres of wetlands previously managed as freshwater impoundments, which were impacted by saltwater intrusion through substantial dune breaches during storms, including Hurricane Sandy. The restoration project consisted of reconstructing the breached dune and beach complex along 7000 feet of shoreline, planting marsh and dune vegetation on a created back barrier platform, and dredging over 20 miles of historic tidal channels within the wetland interior to improve tidal circulation. To document ecosystem recovery associated with the restoration project, a comprehensive biological and abiotic monitoring program was developed by the U.S. Fish and Wildlife Service in conjunction with the Delaware Department of Natural Resources and Environmental Control (DNREC) and the University of Delaware. Most monitoring activities began around 2010 and marsh restoration activities were conducted during 2015-2016. Avian community monitoring consists of secretive marsh bird and salt marsh passerine breeding season surveys, beach-nesting bird monitoring, and year-round surveys of shorebirds, waterfowl, and other waterbirds. Vegetation surveys, including marsh elevation monitoring and photopoints, are conducted in conjunction with these efforts, to document the recovery of salt marsh vegetation following restoration activities. Prior to restoration, there were very few salt marsh obligate birds found in the restoration units, although waterfowl and shorebirds were seasonally abundant in some areas. The restoration units were dominated by shallow open water with very little vegetation except *Spartina* marsh colonizing along the periphery. In the first season post-restoration, beach-nesting birds utilized the new beach, salt marsh obligates returned in some limited areas, and vegetation response is already substantial. Results of bird and vegetation surveys from the first season post-restoration are presented.

Green Infrastructure and Storm Events: Combining Insights from Two Studies

Gurian, Patrick, Drexel University, CAEE Dept,3141 Chestnut, Philadelphia, PA 19104, pgurian@drexel.edu; Stephanie Miller, Drexel University; Bita Alizadehtazi , Drexel University; Franco Montalto, Drexel University; Kimberly DiGiovanni, Drexel University; Romano Foti , Drexel University

Post Sandy Lessons, Monday, 10:45am, Grand Ballroom A, 1st Floor

Two recent studies on the impact of green infrastructure on storm damage risk are reviewed. The first study investigated the effect of NYC coastal green infrastructure on the risk of building damages during Hurricane Sandy. Large scale landscape features were not consistently associated with increased or decreased risk. However, the study found that small scale features were significantly and more consistently associated with damage probabilities. On the Rockaways tree cover is significantly associated with lower risks of damage, on Coney Island bare ground is significantly associated with an increased risk of damage, and on the South Shore both tree cover and bare ground are significantly associated with decreased risks. While large scale landscape features such as elevation and distance from the coast are difficult to modify, these small scale, lot-level characteristics can be modified by property owners and municipalities to reduce damage risks from future storms. The second study investigated the infiltration capacity of 39 green infrastructure sites in New York City and Philadelphia. The infiltration rates measured for most of the sites are similar or greater than the local design storm, suggesting that minimal rainfall excess would be generated from these surfaces as long as sufficient subsurface storage space is available. However, they would have limited ability to absorb runoff generated elsewhere. The results of these two studies suggest a role for decentralized green infrastructure in managing some aspects of storm risk.

The Utility of LongTerm Reference Data for Understanding Elevation Dynamics and Designing Thin Layer Placement Projects in New Jersey Coastal Marshes

Haaf, LeeAnn, Partnership for the Delaware Estuary, 110 S. Poplar Street, Suite 202, Wilmington, DE 19801, lhaaf@delawareestuary.org; Angela Padeletti, Partnership for the Delaware Estuary; Sandra Demberger, Partnership for the Delaware Estuary; Martha Maxwell-Doyle, Barnegat Bay Partnership; Danielle Kreeger, Partnership for the Delaware Estuary

Poster Session, Monday, 5:15pm, 5th Floor

Coastal marsh decline is a major concern for Mid Atlantic estuaries. Because the causes of decline vary widely, there are several different restoration tactics which can be used to stem losses based on site specific impairments. In areas not keeping pace with rising sea level, for instance, thin layer placement (TLP) of dredged sediments can add needed elevation, thereby prolonging a marsh's lifespan. In New Jersey, TLP has recently gained traction as a means to prevent marsh loss and manage dredge spoils. Since coastal marsh impairments and vulnerabilities are complex, utilizing long term data from reference benchmarks to understand stressor-response dynamics is pivotal for implementing restoration tactics successfully. To aid TLP efforts in New Jersey, vegetation, surface elevation table (SET), and marker horizon (MH) data from several long term monitoring stations across the state were analyzed. Five of the eighteen SET-MH analyzed showed a deficit in elevation change with respect to sea level rise. For example, at Island Beach State Park, this deficit would be approximately 48 mm (1.89 in) over the next five years; this location also lost significant vegetation due to internal pooling. In contrast, at one of three SETs along the Maurice River, elevation has been increasing at ~8 mm/yr, faster than sea level rise, and nearby vegetation has been shifting from *Spartina alterniflora* to *Phragmites australis*. These results provide numerical frames of reference for setting TLP placement depths and designing vegetation community goals. They also highlight the importance of understanding whether a marsh is most at risk of loss due to elevation deficits or other threats, such as edge erosion or hydrological conditions. long term reference data is therefore an essential tool for understanding how these systems respond to natural or anthropogenic stress and how restoration professionals can best intervene to sustain these ecosystems over time.

Milford Neck Conservation Area Marsh Restoration

Hammond, Jessica, The Nature Conservancy, 703 Chestnut Street, Milton, Delaware 19968, jessica.hammond@tnc.org; Bob Hamilton, Woods Hole Group, Inc; Mara Orescanin, Woods Hole Group, Inc

Poster Session, Monday, 5:15pm, 5th Floor

Located on the Central Delaware Bayshore, Milford Neck is a rural landscape of undeveloped beaches, dunes, marsh, forest, and farmland. This unique landscape contains 10,000 acres of protected land and is rural in character with relatively low development compared to other regions of the Bayshore, however physical changes to the land and consequently hydrology, have compromised the resilience of this historic marsh to future climate conditions and storm surge. In partnership with Delaware Department of Fish and Wildlife and Delaware Wild Lands, The Nature Conservancy secured Hurricane Sandy Relief funds from the National Fish and Wildlife Foundation restore a portion of the marsh. The initial phase of this project has yielded a comprehensive hydraulic model that is being used to examine proposed restoration alternatives to the site to reduce pooling and increase tidal exchange. Sediment accretion and composition are also being tested to determine if restoration alternatives will be sufficient to restore conditions for the re-establishment of marsh grasses (primarily *Spartina alterniflora*) into what is currently open water. The restoration of the marsh grasses is desirable for this site for increasing coastal resilience to erosion and storm surge from events such as Hurricane Sandy. This will be especially important as storm frequency and intensity are projected to increase over the next century. Carbon storage and sequestration are also important benefits that will result from this project as coastal wetland and marshland habitats have the potential to capture and store carbon at a higher rate than a comparable acreage of tropical forest. Here we present the data from the modeling study conducted by Woods Hole Group, Inc. and the results of the simulated hydrology under two restoration alternative scenarios.

Brandywine-Christina Healthy Water Fund Model-based Prioritization

Homsey, Andrew, University of Delaware, Water Resources Center,261 Academy St., Newark, DE 19716, ahomsey@udel.edu; Jerry Kauffman, University of Delaware; Brian Boutin, The Nature Conservancy; Kash Srinivasan, KSGroup LLC

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

The University of Delaware Water Resources Center (UD-WRC) and The Nature Conservancy, Delaware chapter (TNC) are collaborating on an effort to establish a sustainable watershed-wide funding mechanism for water quality and watershed health in the Brandywine-Christina basin in northern Delaware and southeastern Pennsylvania. An essential component of this project is a defensible, science-based quantification of the levels, sources, and costs to effectively reduce several key impairments to water quality: sediment, nitrogen, and phosphorus. Using as a basis the MapShed™ model developed at Penn State for the Chester County (PA) Water Resources Authority (CCWRA) we determined the loads and the sources of pollutants at the sub-watershed scale across the entire basin. We examined the level of key agricultural BMPs their associated costs and pollutant reduction effects to derive the unit costs for reduction, as well as total cost, by sub-watershed, to achieve USEPA pollution reduction goals.

Using this method is helpful to determine the most cost-effective pollution reduction activities and the most crucial locations within the basin to apply those methods. Knowing the level of contamination that needs to be addressed to achieve fishable and swimmable status will allow the Water Fund to prioritize potential water quality projects.

Building Ecological Solutions to Coastal Community Hazards – Projects update

Jacobus, Steven, New Jersey Department of Environmental Protection, 401 East State Street, P.O. Box 420, Mail Code 401-07B, Trenton, New Jersey 08625, steven.jacobus@dep.nj.gov;

NJ Bayshore and Vicinity: Planning, Projects, Resiliency, Tuesday, 2:00pm, Crystal Room, 1st Floor

In June 2014, the New Jersey Department of Environmental Protection, Office of Coastal and Land Use Planning received a Hurricane Sandy Coastal Resiliency Competitive Grant from the Department of the Interior through the National Fish and Wildlife Foundation to explore Building Ecological Solutions to Coastal Community Hazards. One aspect of the grant was to provide direct assistance to communities to develop ecologically-based natural hazard mitigation projects. Assistance in design and permitting was provided to 9 communities and 1 county for projects covering a range from single site solutions to larger shoreline and marsh protection projects.

Site Assessment for Salt Marsh Restoration via Beneficial Use of Dredged Material: Insights from Recent Projects in New Jersey

Jahn, Jackie, GreenVest, LLC, 91 Fieldcrest Avenue, Suite A-1, Raritan Plaza II, Edison, New Jersey 08837, jackie@greenvestus.com; Metthea Yepsen, The Nature Conservancy; Mary Paist Goldman, Princeton Hydro

Thin Layer Placement in Coastal Wetlands, Monday, 3:45pm, Crystal Room, 1st Floor

Site assessment is a critical first step for restoration project planning and implementation. It is necessary in order to identify and fully characterize the problem at hand, set project goals, establish success criteria, design the most appropriate solution and set the stage for project monitoring. As the restoration community turns its attention to the coast and its salt marshes it is important that we develop site assessment protocols that are comprehensive yet efficient and standardized. It is especially important now as the New Jersey Department of Environmental Protection is opening the doors for the use of dredged material to restore salt marshes. The use of dredged material adds a new element to the current salt marsh restoration practice in NJ. Besides ensuring that the appropriate solution is applied to a given site, standardized site assessment can also be leveraged to help build a regional dataset for salt marshes that can be referenced and built upon by future project managers.

This presentation will walk the audience through the site assessment process as it was performed for a series of pilot projects undertaken to trial the beneficial use of dredged material in the salt marsh environment. The presenter will not only address what was done but also what couldn't be done given various limitations. The objective of the presentation is to present one project team's experience with the salt marsh site assessment process and highlight the challenges that were encountered.

These projects trialed a few different beneficial use techniques including "thin" layer application over the marsh plain, filling large pools within marsh interior to recreate marsh plain, dune fortification, beach nourishment and shorebird habitat creation. Project partners include: NJ Division of Fish & Wildife, The Nature Conservancy, GreenVest, Princeton Hydro, The Wetlands Institute and others.

Green vs. Gray - A Business Perspective

Janiec, Douglas, Sovereign Consulting Inc., 50 West Welsh Pool Road, Suite 6, Exton, PA 19341, djaniec@sovcon.com;

Hot Topics, Wednesday, 1:45pm, Grand Ballroom, 1st Floor

The practice of providing nature-based and/or green infrastructure solutions to the private sector is nearly universally supported by NGOs and agencies alike. In fact, there are numerous initiatives and outreach efforts targeting consultants and contractors (practitioners) in an effort to promote this type of practice. However, a common responses from practitioners include "show me how" or "convince me I can make a living doing it." This presentation is geared around lessons learned by a successful practitioner who works a great deal with the private sector and NGOs, providing green services such as living shoreline, marsh restoration, etc. It will not provide a distinct business plan, but it will definitely identify pitfalls and present considerations that may help a practitioner develop his/her own successful green, private sector-based business. The presentation will touch upon:

- Selling the right perception
- Special considerations
- Guidance/options on how to start this service line
- Branding and re-branding
- Knowing your client's profile
- Pitfalls
- Keys to success
- Demonstrating return on investment

The presentation is based off of a similar well received presentation given on June 15, 2016, at the National Wildlife Federation's Nature-Based Solutions to Enhance Coastal Resilience Workshop, Richmond, VA.

Siting Plan and Concept Designs for Living Shoreline Projects on the Inland Bays

Janiec, Douglas, Sovereign Consulting Inc., 50 West Welsh Pool Road, Suite 6, Exton, PA 19341, djaniec@sovcon.com; **Marianne Walch**, Ph.D., Delaware Center for the Inland Bays

Living Shorelines, Tuesday, 3:30pm, Grand Ballroom A, 1st Floor

Multiple agencies and organizations in Delaware – including DNREC, the Delaware Center for the Inland Bays (CIB), the Partnership for the Delaware Estuary (PDE), The Nature Conservancy, and others – have undertaken initiatives to maximize the use of living shoreline stabilization techniques in order to protect the water quality and habitat of Delaware's estuaries. In the Inland Bays watershed, this effort is led by the CIB. A Living Shoreline Initiative is a component of the Comprehensive Conservation and Management Plan (CCMP) for the Inland Bays. An important part of the Inland Bays Living Shoreline Initiative is the creation of publically accessible, local demonstration projects that can be used as tools for educating the public and marine contractors about living shoreline techniques and benefits.

During the spring and summer of 2016, an Inland Bays-wide living shoreline demonstration site screening was conducted. This two-tiered screening process, funded and/or sponsored through a Delaware Water Infrastructure Advisory Council - Surface Water Matching Planning Grants, DNREC- Division of Watershed Steward, Sussex Conservation District, and CIB, considered all the shorelines within the Delaware Inland Bays. The goal was to identify, assess, select, and prioritize potential living shoreline project locations and then develop permit-level concept designs for up to 6 of these locations. The purpose of these projects is to improve water quality in impaired waters through shoreline stabilization and ecosystem enhancement, while providing opportunities for public education, research and shoreline contractor training. The educational nature of these demonstration projects is intended to result in increased adoption of the practice by private landowners and municipalities, leading to statewide water quality benefits for the public. The proposed presentation will outline the screening process, review the findings, and present the resulting permit level designs.

High-Resolution Water Quality Model in the Urban Tidal Freshwater Delaware River

Kardos, Josef, Philadelphia Water, 1101 Market Street,4th Floor, Philadelphia, PA 19107, Josef.Kardos@phila.gov; Phil Duzinski, Philadelphia Water; Kinman Leung, Philadelphia Water; Paula Kulis, CDM Smith; Ramona McCullough, Sci-Tek Consultants

Water Quality, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

A numerical model of the tidal freshwater Delaware River was developed for the Philadelphia Green City, Clean Waters program. The model was applied to simulate in-stream concentrations of bacteria and dissolved oxygen (DO) in the Delaware River between Trenton and Delaware City. The USEPA Environmental Fluid Dynamics Code (EFDC) was used for modeling hydrodynamics and water

quality. The model was validated from April to October of 2012 and 2013. Loadings of carbon, nitrogen, phosphorus, DO, algae, and fecal coliform bacteria from tributaries, and municipal and industrial discharges were all considered in model development. Meteorological data was used to achieve accurate representations of water temperature, wind, and solar radiation. An extensive database of water quality data was compiled from multiple agencies for comparison to model output including 175,370 observations. Continuous DO data at six sites along the mainstem Delaware River and Philadelphia tributaries were used for high frequency comparison of simulated and observed DO concentrations. A sensitivity analysis was conducted to identify the key global and spatially variable rate constants. Spatially variable constants were parameterized with the aid of extensive measurements of nitrification rate, sediment oxygen demand, and benthic nutrient fluxes. Time series plots, CDF plots, box plots, along-channel plots, target diagrams, and error statistics were used to evaluate water quality model performance. This paper demonstrates the use of comprehensive data to understand biochemical processes and in turn enhance water quality modeling in an ecologically and societally important estuary.

Implementation of a Hybrid Living Shoreline Project in Gandy's Beach/Money Island, New Jersey

Katkowski, Moses, The Nature Conservancy, 2350 Route 47, Delmont, New Jersey 08314, mkatkowski@tnc.org; Katie Conrad, United States Fish and Wildlife Service

Living Shorelines, Tuesday, 3:30pm, Grand Ballroom A, 1st Floor

In 2014, The Nature Conservancy and the United States Fish and Wildlife Service, along with our partners, The Partnership for the Delaware Estuary and the Rutgers University Haskin Shellfish Research Laboratory, began work to implement a hybrid living shoreline project in Downe Township, Cumberland County, New Jersey. The project was funded through the federal government's post-Hurricane Sandy Resiliency Program. The goal of the project was to implement a hybrid living shoreline in New Jersey across a gradient of wave energies to reduce shoreline habitat degradation and to provide hard substrate for oyster attachment and growth. The project utilized various materials and methods including coir logs, oyster and clam shell bags, and oyster castles. The lower energy sites utilized coir logs, *Spartina alternifora* plantings along the salt marsh edge along with oyster castle structures of various sizes to act as breakwaters to reduce wave energy hitting the marsh edge. The higher energy sites utilized larger oyster castle breakwaters to attenuate wave energy and shell bags to capture sediment and provide hard substrate for oyster recruitment. When complete, in 2016, the project will enhance approximately 3,000 feet of salt marsh and beach shoreline in the Delaware Bay. Post-construction monitoring will continue for multiple years following the completed construction. The monitoring results will be used both to demonstrate how the project functioned but also inform adaptive management and future enhancement and restoration at the site. The presentation will discuss all aspects of the project including planning, design, permitting and construction. Preliminary monitoring and lessons learned will also be discussed.

Protecting Jersey Shore Residential and Ecological Communities by Changing the Culture of Beach Management

Kelly, Jay, Raritan Valley Community College, 118 Lamington Road, North Branch, New Jersey 08876, Jay.Kelly@raritanval.edu; Jaclyn Rhoads, Pinelands Preservation Alliance; Ryan Rebozo, Pinelands Preservation Alliance

Estuary Restoration, Monday, 1:30pm, Grand Ballroom A, 1st Floor

Approximately 70% of the New Jersey ocean shoreline is currently impacted by human activities such as beach raking and/or off-road vehicles (ORVs). These practices disturb beach sediments and increase their vulnerability to erosion, inhibit the natural development of beach vegetation and dunes, and reduce their ability to support rare and endangered beach nesting birds and plant species. Although raking and ORV use impact the majority of the beach surface, the recreational uses they are intended to support (e.g., sunbathing and fishing) are concentrated on the lower portions of the beach near the ocean, suggesting that protection of upper beaches from raking and ORVs are compatible with continued recreational use. In 2016, Pinelands Preservation Alliance and Raritan Valley Community College began a partnership through NJ Sea Grant to implement compromise beach management strategies of this kind in coastal parks and municipalities in New Jersey, protecting portions of upper beach areas with fencing and interpretive signage. Approximately 16 miles of beaches in coastal parks were surveyed and protected in Island Beach State Park, Brigantine Natural Area, Corson's Inlet State Park and Cape May Point State Park, protecting 20-50% of the beach surface depending upon local conditions and constraints. This resulted in dramatic increases in beach vegetation, wrack, and other beach characteristics compared to previous years and other areas where no protections were present. Profiles of beach topography were collected to determine rates of sediment accretion, and surveys were conducted to determine the degree to which these areas supported rare beach species. In addition to management and research, collaboration was initiated with government officials to integrate these practices into existing beach management policies, and outreach was conducted to expand these programs to other coastal communities in 2017.

Identifying litter accumulation areas on the tidal portions of the Delaware River: Field surveys, laboratory analyses, and cleanups

Kelly, Jay, Raritan Valley Community College, Department of Science & Engineering,118 Lamington Road, North Branch, NJ 08876, jkelly@raritanval.edu; Catie Tobin, Clean Ocean Action; Cindy Zipf, Clean Ocean Action; Kristen Greaney, Raritan Valley Community College; Stephanie Pavona, Raritan Valley Community College

Trash Talking the Waterways, Monday, 10:45am, Grand Ballroom C, 1st Floor

Raritan Valley Community College (RVCC) and Clean Ocean Action (COA) are collaborating to assess levels of anthropogenic macro- and micro-debris in the tidal portions of the Delaware River, which receive inputs of litter from both stormwater and tidal action. The presence of micro-plastics (<0.5 mm) in tidal rivers has not been as widely documented as in marine environments, nor have these ecosystems received the same level of attention in coastal cleanup efforts as ocean shorelines. We conducted field surveys of this 47-mile section of the lower Delaware River in the summer 2015, and laboratory analysis of water samples in spring 2016, and cleanups of a litter accumulation area in fall 2016. In order to estimate and compare the amounts of anthropogenic debris present, we measured the size, depth and area of litter accumulation areas, as well as the quantity and kinds of anthropogenic surface litter at each site. Litter, sediment and water samples were also collected at each site in order to analyze the % composition of anthropogenic litter vs. natural debris, and to determine the quantities of chemical and microplastic pollution occurring at each site. Two different methods of analyzing microplastics were also tested to determine their relative effectiveness. This results of this study will be used to raise awareness about the problem of anthropogenic litter accumulating in our local waterways and to develop policy strategies to help prevent it. It will also provide baseline data to gauge the effectiveness of future cleanups at each site, as well as the levels of litter accumulating over time. The results of our field surveys, laboratory analyses of microplastics, and effectiveness of pilot efforts at organizing clean-ups in these areas will be discussed.

Pennsylvania Master Watershed Stewardship Program

Kennedy, Rebecca, PennVest, Pennsylvania Infrastructure Investment Authority, 607 South Drive, Harrisburg, PA 17120, rebkennedy@pa.gov

Motivate Volunteers and Make a Difference, Tuesday, 9:00am, Grand Ballroom C, 1st Floor

Raritan Valley Community College (RVCC) and Clean Ocean Action (COA) are collaborating to assess levels of anthropogenic macro- and micro-debris in the tidal portions of the Delaware River, which receive inputs of litter from both stormwater and tidal action. The presence of micro-plastics (<0.5 mm) in tidal rivers has not been as widely documented as in marine environments, nor have these ecosystems received the same level of attention in coastal cleanup efforts as ocean shorelines. We conducted field surveys of this 47-mile section of the lower Delaware River in the summer 2015, and laboratory analysis of water samples in spring 2016, and cleanups of a litter accumulation area in fall 2016. In order to estimate and compare the amounts of anthropogenic debris present, we measured the size, depth and area of litter accumulation areas, as well as the quantity and kinds of anthropogenic surface litter at each site. Litter, sediment and water samples were also collected at each site in order to analyze the % composition of anthropogenic litter vs. natural debris, and to determine the quantities of chemical and microplastic pollution occurring at each site. Two different methods of analyzing microplastics were also tested to determine their relative effectiveness. This results of this study will be used to raise awareness about the problem of anthropogenic litter accumulating in our local waterways and to develop policy strategies to help prevent it. It will also provide baseline data to gauge the effectiveness of future cleanups at each site, as well as the levels of litter accumulating over time. The results of our field surveys, laboratory analyses of microplastics, and effectiveness of pilot efforts at organizing clean-ups in these areas will be discussed.

Online Advertising

Knoll, Michelle, Partnership for the Delaware Estuary, 110 S. Poplar St., Wilmington, DE 19801, mknoll@delawareestuary.org;

Beyond Education to Engagement, Tuesday, 10:00am, Grand Ballroom C, 1st Floor

Online advertising is a great way to reach diverse auidences through the different platfroms people use everyday to get their news. Today most adult Americans rely on the internet for their source of entertainnent and news. So instead of using traditional ads, its time we meet people where they spend most of their time – online. Online advertising is simple and easy to do. It can be done through a online newspaper source or by using social media ads. This presentation will explore both types of online advertising using previous campaigns and outcomes to demonstrate the usefulness of these alternative ads.

Blue Collar Bivalves, Water Quality and Project ROI, Oh My

Kreeger, Danielle, Partnership for the Delaware Estuary, 110 S. Poplar St., Wilmington, DE 19801, dkreeger@delawareestuary.org; Joshua Moody, Partnership for the Delaware Estuary; Kurt Cheng, Partnership for the Delaware Estuary; David Bushek, Rutgers HSRL

Hot Topics, Wednesday, 1:45pm, Grand Ballroom, 1st Floor

Populations of native bivalves continue to decline in both fresh and marine waters of North America. Since bivalves furnish diverse ecological benefits, and some species are commercially valuable, there are different motivations for investing in bivalve conservation and restoration. An emerging interest is to promote water quality since both natural and farmed populations filter and transform substantial particulate pollutants. Uplift in water quality via investments in bivalve shellfish can theoretically be achieved by enhancing the population abundance of any native species, by alleviating stressors, increasing suitable habitat, or otherwise enhancing growing conditions. Many proven tactics exist (e.g., oyster shell planting, aquaculture) and diverse new tactics are being developed (e.g., nutrient bioextraction farms, living shorelines).

Missing from this dialogue is a science-based comparison of the expected return on investment (ROI) of different tactics aimed at different species to facilitate strategic planning. We compared physiological rates, standing stocks, and restoration viability among common freshwater and marine bivalves living in the Delaware Estuary and vicinity. Freshwater mussels clear particles from the water column at similar seasonal rates compared to marine species such as oysters and ribbed mussels. Models of potential water quality benefits from projects can therefore be constructed using information on the seasonal availability and composition of suspended particles, seasonal water temperatures, and the current and future population biomass of the bivalves.

A preliminary comparative analysis indicates that all shellfish-based strategies yield a high ROI (e.g., for nitrogen removal) compared with established investments in nature-based water quality enhancement. Since bivalves inhabit diverse niches along the river-to-estuary continuum, there are many opportunities to address water quality targets from both conservation investments aimed at preserving dwindling natural populations and future-minded restoration investments. Greatest improvements in water quality will result from tactics that are tailored to the unique life history needs of the target species.

Perspectives on Linking Sediment Management to Science-Based Coastal Wetland Monitoring and Restoration

Kreeger, Danielle, Partnership for the Delaware Estuary, 110 S. Poplar St., Wilmington, DE 19801, dkreeger@delawareestuary.org; LeeAnn Haaf, Partnership for the Delaware Estuary; Martha Maxwell-Doyle, Barnegat Bay Partnership; Joshua Moody, Partnership for the Delaware Estuary; Erin Reilly, Barnegat Bay Partnership; Angela Padeletti, Partnership for the Delaware Estuary

Thin Layer Placement in Coastal Wetlands, Monday, 3:45pm, Crystal Room, 1st Floor

Populations of native bivalves continue to decline in both fresh and marine waters of North America. Since bivalves furnish diverse ecological benefits, and some species are commercially valuable, there are different motivations for investing in bivalve conservation and restoration. An emerging interest is to promote water quality since both natural and farmed populations filter and transform substantial particulate pollutants. Uplift in water quality via investments in bivalve shellfish can theoretically be achieved by enhancing the population abundance of any native species, by alleviating stressors, increasing suitable habitat, or otherwise enhancing growing conditions. Many proven tactics exist (e.g., oyster shell planting, aquaculture) and diverse new tactics are being developed (e.g., nutrient bioextraction farms, living shorelines).

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Statistical tools for connecting baseline conditions to potential responses of macroinvertebrate communities to restoration activities through the Delaware River Watershed Initiative

Kroll, Stefanie, Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, Pennsylvania 19103, sak345@drexel.edu; Meghan J O'Donnell, Academy of Natural Sciences; Brian L Brown, Virginia Tech; John Jackson, Stroud Water Resources

Estuary Restoration, Wednesday, 10:30am, Grand Ballroom A, 1st Floor

Agricultural Best Management Practices (BMPs) are some of the main restoration activities in the Delaware River Watershed Initiative (DRWI). Many BMPs are designed to reduce runoff from farmland and thereby reduce inputs of nutrients, sediment, and other non-point source pollutants into nearby streams. Agricultural BMPs have been implemented extensively throughout the U.S., with measurable changes on the scale of the Mississippi Basin or the Great Lakes. To date there have been few studies on 1) the effects of these projects in smaller watersheds and 2) how reductions in runoff correlate with the responses of aquatic biota. We are performing research on how to measure the success of restoration projects by projecting potential improvements in stream quality to aquatic biota in smaller streams. We sampled macroinvertebrates in streams near DRWI projects, which range from less than 1 to 300 km2 and agricultural land use percentages ranging from 0 -83 %. We will perform various analyses to relate individual macroinvertebrate taxa to stressors in the watershed, including the ratio of agricultural/forested land, and to determine which organisms are occurring together (i.e. assemblage types) in the same streams. Knowledge of specific macroinvertebrate responses to watershed conditions, as well as cohabitating macroinvertebrate assemblages will provide a basis for predicting how improvements in water and habitat quality in these watersheds will be correlated with increased biotic integrity in DRWI stream reaches.

Patterns in Stream Chemistry Across the 8 Sub-watershed Clusters of the Delaware River Watershed Initiative

Kurz, Marie J., The Academy of Natural Sciences of Drexel University, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103, marie.kurz@drexel.edu; Stefanie A. Kroll, The Academy of Natural Sciences of Drexel University; David Velinsky, The Academy of Natural Sciences of Drexel University

Poster Session, Monday, 5:15pm, 5th Floor

The Delaware River Watershed Initiative is a collaborative program of coordinated, large-scale land protection and restoration projects to maintain and improve water quality and ecological integrity locally and in the larger watershed. The Initiative focuses on 8 sub-watershed "clusters" of ecological significance encompassing roughly one-quarter of the Delaware Basin. These clusters encompass the continuum of catchment landscapes, from pristine headwaters to urban centers, and impacts from a range of key stressors including loss of forested headwaters, agricultural run-off and polluted stormwater. From 2013 to 2016 we sampled stream water chemistry quarterly at 35 "Integrative Sites" chosen to represent the land use and stream conditions within each cluster. These integrative samples provide a baseline against which to evaluate future changes in water quality resulting from restoration and protection projects in the clusters, context for specific projects, and allow for the determination of patterns across the larger watershed. Spatial and temporal patterns in chemistry at the cluster and watershed scale will be related to indicators of ecological integrity and to catchment land use and geology. We expect stream chemistry to reflect the land use and geology of the upstream catchment, potentially mediated by existing management activities in regions of high stressor impact. We also expect ecological indicators to be correlated with stream chemistry.

Effects of Predator Availability and Substrate Position on Ribbed Mussel Recruitment for Living Shoreline Applications

LaForce, Kathleen, Partnership for the Delaware Estuary, 110 S Poplar St. Suite #202, Wilmington, DE 19801, klaforce@delawareestuary.org; Ryan Flannery, The Partnership for the Delaware Estuary; Joshua Moody, The Partnership for the Delaware Estuary; Dr. Danielle Kreeger, The Partnership for the Delaware Estuary

Poster Session, Monday, 5:15pm, 5th Floor

The Delaware Estuary is currently losing approximately one acre per day of coastal wetlands and the associated ecosystem services that they provide, including: habitat, fisheries, flood protection, and water quality enhancement. Ribbed mussels are one of the functional dominant species in eastern USA salt marshes mediating many of these ecosystem services. Ribbed mussels promote marsh resilience by binding to roots of vascular plants, stabilizing substrates, and enhancing vegetative growth. At current rates of marsh loss, the Delaware Estuary is losing approximately 70,000 mussels per day. There is growing interest in living shorelines to protect and restore coastal marshes, and since 2008 the Partnership for the Delaware Estuary has implemented and sustained 14 active treatments. This array of project sites provides an excellent laboratory for studying ways to enhance mussel-mediated ecosystem services. The goal of this study was to test new tactics for enhancing mussel populations in living shorelines by addressing potential limiting factors including recruitment and predator susceptibility. To test whether vertical/horizontal location affects mussel recruitment and whether predation constrains mussel survivorship, a stratified, multi-factor field experiment was conducted at four living shoreline treatments. At each site, three replicate plots were positioned at three locations relative to the marsh platform: in the vegetated edge, directly in front of the edge, and 1m waterward. To test for predation, each plot consisted of a pair of oyster shellbags. One bag had full netting to inhibit predator access and the other was partially opened to allow foraging by predators. Preliminary results indicated that recruitment did not vary significantly with position. However, predation appeared to be a significant constraint because sealed bags had significantly more ribbed mussels than open bags consistently across positions. Based on these results, new tactics will be tested to enhance ribbed mussel colonization at multiple living shorelines in 2017.

Advances in Implementation of Antidegradation Policies and Practices in Delaware River Basin Commission Special Protection Waters

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

The Delaware River Basin Commission (DRBC), with the states of New Jersey, Pennsylvania and New York, has implemented Special Protection Waters (SPW) regulations since 1992 (Upper and Middle Delaware) and 2008 (Lower Delaware). This is an overview of progress since rule inception, with short overviews of DRBC relationships between permitting, modeling monitoring and assessment. In permitting, DRBC has streamlined project review and approval through the "One Project, One Permit" process, creating administrative agreements with basin states. DRBC has implemented cumulative water quality modeling of the Neversink River, NY; Lehigh River, PA; Brodhead Creek, PA; and the Lower Delaware River, PA/NJ. DRBC and the National Park Service monitor to create Existing Water Quality (EWQ) targets for antidegradation; to build and calibrate the water quality models used in project review; and to assess the water quality status and trends at EWQ sites called Control Points. DRBC recently completed the first Lower Delaware River Measurable Change Assessment to document water quality changes from 2000-2011 and find out if any degradation has occurred. Methods and results of the assessment are discussed. Of 440 assessments for measurable changes, 88% improved or remained unchanged. There were increases in chlorides and specific conductance at most sites, and E. coli increased in watersheds and river sites along the lowest 20 miles of the Lower Delaware from Frenchtown to Trenton. Finally, DRBC has completed expansion of its site-specific EWQ network to include the Upper and Middle Delaware. From its original 24 sites, the network now includes 85 sites – 28 Interstate Control Points (ICPs) and 57 PA, NJ and NY tributary watershed Boundary Control Points (BCPS) where EWQ has been defined and summarized in a new publication, the Existing Water Quality Atlas of the Delaware River (2016). With the expanded network in place, sampling for the second Measurable Change Assessment will take place from 2019-2021.

Delaware Bay Oyster Shell Deficit Reduction Via Post Consumer Recycling Program

Long, Jeff, Partnership for the Delaware Estuary, 110 South Poplar Street, Suite 202, Wilmington, DE 19801, jlong@delawareestuary.org;

Beyond Education to Engagement, Tuesday, 10:00am, Grand Ballroom C, 1st Floor

Delaware Bay Oyster Shell Deficit Reduction via Post Consumer Recycling Program

The Partnership for the Delaware Estuary's Shell Recycling Program is designed to fill a vital niche and address shell needs in the Delaware Estuary and vicinity, defined as the area from coastal New Jersey to coastal Delaware where no existing recycling efforts exist. Restoration projects and revitalization of oyster reefs:

- improve water quality
- reduce erosion
- support fish habitat
- act as a PH buffer
- enhance seafood industry
- additional ecosystem services

The eastern oyster, *Crassostea virginica,* has a long history as a commercially and ecologically important species in the Delaware Bay. Once oysters are eaten the shells are typically landfilled. Since shells are not returned to the ecosystem these harvests contribute to a negative "shell budget," meaning growth and survival of new oysters is insufficient to replace the removed shell harvested oysters.

The availability of oyster and other shell is therefore a major constraint on oyster population health in Delaware Bay, similar to most other large estuaries along the Atlantic coast of the United States. The simplest and most cost effective way to restore oyster beds is to plant shell on historic oyster reefs just before the larvae settle. Shell is also used to stabilize shorelines and enhance habitat in living shorelines. In recent years there has been too little shell to support such restoration needs. The success of shoreline and habitat restoration efforts in our region including PDE's Delaware Estuary Living Shoreline Initiatives, hinge on the availability of shell.

With ten participating restaurants and an expanding enrollment PDE's program is gearing up to supply badly needed oyster shell while educating the public regarding this important fishery.

Delaware Estuary Data Visualization Techniques

Mardani, Shirin, U.S. EPA, 290 Broadway, 2.40E-05, New York, NY 1007, mardani.shirin@epa.gov; Angela McFadden, U.S. EPA

Poster Session, Monday, 5:15pm, 5th Floor

Many types of environmental data are collected within the Delaware River Estuary by State, Federal, and Interstate agencies and are available free to the public. Distilling and displaying meaningful trends from larger (10,000+ data points) data sets can be challenging and require specialized knowledge to support interpretation, representation, and data processing efforts. Data visualization and data mining techniques have always played an important role in understanding temporal changes in environmental conditions and relationships between environmental parameters. Advanced visualization techniques can be used to illustrate significant trends and simplify the display of multivariate data for the lay audience. Today, the Delaware River Estuary faces significant environmental challenges, and communicators may find advanced data visualization techniques helpful in describing these issues clearly. The primary goal of this study is to introduce methods for efficient analysis and visual representation, including using R coding for enhancing capabilities to analyze large data sets and automate information updates.

One Man's Trash (Observations)

Maule, Bradley, , 200 West Sedgwick Street, Apt 218, Philadelphia, PA 19119, mauleofamerica@gmail.com;

Trash Talking the Waterways, Monday, 10:45am, Grand Ballroom C, 1st Floor

When I left Philadelphia for Portland, Oregon in 2009, I'd reached an exhaustion point, suffering from the fatigue of day-to-day litter in my neighborhood and across the city. Before moving, I took one last hike in the Wissahickon Valley Park, and was stunned and depressed by the amount of litter I saw on trails and in the creek. But after three and a half years living in one of America's cleanest cities and spending nearly every weekend hiking the pristine trails of the Pacific Northwest, I felt a calling to come home to Pennsylvania.

In 2014, I relocated to Mt. Airy, a Philadelphia neighborhood adjacent to the same Wissahickon park, and undertook a yearlong study on litter throughout the park's 1,800 acres. I collected and documented every piece of litter I encountered, and presented an exhibition of its nearly 4,000 items at the historic Fairmount Water Works, home to Philadelphia's best environmental interpretive center. In 2016, I was thrilled and honored to be selected as the first Sojourn Steward, an opportunity to kayak 112 miles down the Schuylkill River as part of the annual Schuylkill Sojourn. Over the seven-day trip, I made similar observations on trash and litter hot spots and the types of objects seen. With a GPS-enabled camera, I created a map from the photos, and I posted daily reports and photo galleries on my web site, as well as posts on social media in real time. The goals were twofold: 1, to raise awareness about the journey of litter and the impact of man on the natural world, and 2, to help Schuylkill Action Network coordinate with local communities in areas of cleanup need.

My presentation will cover these two projects and what I hope others might gain from my experience.

Monitoring and Site Assessment for Post-Sandy Coastal Resilience Projects in New Jersey

Maxwell-Doyle, Martha, Barnegat Bay Partnership, Ocean County College, College Drive, Suite 202, Toms River, NJ 08754, mmdoyle@ocean.edu, **Angela Padeletti**, The Partnership for the Delaware Estuary, apadeletti@delawareestuary.org;

NJ Bayshore and Vicinity: Planning, Projects, Resiliency, Tuesday, 2:00pm, Crystal Room, 1st Floor

In response to Superstorm Sandy and increasing flooding from rising sea levels, natural and nature-based shoreline enhancement projects are being implemented in multiple New Jersey communities. For example, NJDEP is leading a project supported by the National Fish and Wildlife Foundation to assist dozens of municipalities in identifying and implementing nature-based tactics that address local concerns. Goal-based monitoring and site assessment that is linked to established long-term monitoring programs assists in matching appropriate tactics to local conditions, design successful projects, and track and share outcomes. Using a goal-based monitoring framework and datasets from the Mid-Atlantic Coastal Wetland Assessment, the Partnership for the Delaware Estuary and Barnegat Bay Partnership are assisting the state in using a protocol to establish best management practices based on quantitative measures at two locations and monitoring projects with varying goals at five other locations. The Marsh Futures protocol is being used to assess vulnerabilities and guide resiliency tactics at salt marsh sites in Upper and Lower Townships. A living shoreline project is being monitored in Upper Township with the goal of erosion control. At Brigantine, vegetated berms will be installed to provide storm surge protection and stormwater management. In Secaucus, drainage capacity will be enhanced to reduce flooding associated with two tidal ditches. In the Sedge Islands in Barnegat Bay, a living shoreline is being installed to protect a house and educational center from erosion and storm surge. In all cases, a consistent monitoring plan and statistical approach is being followed that will help gauge outcomes pursuant to goals as well as yield lessons to guide future restoration projects elsewhere.

Hydrodynamic Processes Influencing Transport in the Upper Tidal Delaware River

McCullough, Ramona, Sci-Tek Consultants, 1500 Market Street,12th Floor – East Tower, Philadelphia, PA 19102, rmccullough@scitekanswers.com; Paula Kulis, CDM Smith; Phil Duzinski, Philadelphia Water

Physical and Chemical Processes, Tuesday, 2:00pm, Grand Ballroom A, 1st Floor

The Philadelphia Green City, Clean Waters program has developed a high resolution, 3-dimensional hydrodynamic and water quality model of the upper Delaware Estuary. The model is a finely resolved 3-dimensional hydrodynamic model of the upper Delaware Estuary It includes inflows from 43 tributaries, over 300 municipal and industrial discharges, and direct river runoff from the local watershed not represented by tributaries.

The model, developed using US EPA Environmental Fluid Dynamics Code (EFDC), is capable of representing transport dynamics driven by several complex processes. We present the model's features and supporting data collection efforts, and discuss key insights into the river's hydrodynamic and transport processes that were gained in the model validation process. These processes and features include:

- Representation of the Delaware River from Delaware City to Trenton, a 117-kilometer stretch of river;
- Representation of the Delaware River network, industrial and municipal inflows and rainfall runoff;
- Tidal harmonics analysis and comparison with observed harmonics at several water level and velocity measurement stations;
- Velocity and water level tidal amplitude changes with distance upstream;
- Representation of sediment composition as a bottom roughness height in various portions of the river and its effects on modeled tidal energy;
- Tidal asymmetry and overtide dynamics (the evolution of secondary tidal signals); and
- Non-tidal transport due to local processes such as river flows and wind events.

Acceptable validation of shallow water overtides for both water level and velocity measurements, accompanied by validation of overtide ratios to the principal semi-diurnal lunar tides, yielded reliable estimates of tidal energy transfer, tidal asymmetry and associated non-tidal transport. Proper validation of these processes is important for subsequent uses of the model to support water quality simulations for dissolved oxygen and bacteria.

Floating Oyster Cages and Wetlands As An Alternative Bio-Enhancement Strategy

McGowan, Andrew, Delaware Center for the Inland Bays, 39375 Inlet Rd, Rehoboth Beach, Delaware 19971, environment@inlandbays.org; Marianne Walch, Delaware Center for the Inland Bays; Robert Collins, Delaware Center for the Inland Bays

Estuary Restoration, Monday, 1:30pm, Grand Ballroom A, 1st Floor

Dead-end canals are common features of residential developments in Delaware's Inland Bays. These canals are generally poorly flushed, with very long water residence times. Previous research has shown that dead-end canals lead to degraded water quality, sediment quality, and a lower diversity in the biological community. Efforts to improve water quality in dead-end canals have generally focused on pollution control at the watershed level, with an emphasis on limiting the amount of nutrients that enter watershed. Likewise, storm water quality retrofits are often implemented, but again, at watershed level. Few projects focus on improvements within the canals themselves. In the spring of 2015, the Center for the Inland Bays deployed 100 floating oyster cages (total of 198 bushels of oysters), as well as 8 floating treatment wetlands (total area of 600 sq ft) along bulkheads in a dead-end canal. Oysters are expected to filter approximately 28% of the canals water volume per day, dramatically improving flushing time. An adjacent canal is being used as a control. We hypothesize that increased filtration from the oysters, the uptake of nutrients and suspended particles from the floating wetlands, and the shading effect of the cages and wetlands themselves, will significantly reduce turbidity and temperature, and significantly increase dissolved oxygen. Oyster mortality, disease, turbidity, dissolved oxygen, temperature, and phytoplankton communities are currently being monitored at two sites in the treatment canal, and one location in the control canal. This project represents a unique approach to combating degraded water quality, and will provide valuable data on the viability of this method. Data from the first two years of monitoring, as well as the challenges, lessons, and successes of the project will be presented.

Inland Bays Inshore Fish Survey: Citizen Science At Work

McGowan, Andrew, Delaware Center for the Inland Bays, 39375 Inlet Rd, Rehoboth Beach, Delaware 19971, environment@inlandbays.org; Marianne Walch, Delaware Center for the Inland Bays; Dennis Bartow, Delaware Center for the Inland Bays; Roy Miller, Delaware Center for the Inland Bays

Poster Session, Monday, 5:15pm, 5th Floor

Data on the current populations of fish species, including size-frequency distributions, long term trends, and abundance estimates, are necessary to the sustainable management of fisheries. While the Department of Natural Resources and Environmental Control (DNREC) performs open water trawl surveys in the Inland Bays in order to assess stocks, these trawl surveys do not capture the inshore fish communities (waters less than 3 feet). The identification of this gap in survey methodology led to the implementation of a large scale citizen science program which would sample the inshore fish communities through intensive seining at 16 locations. Since 2011, over 200 seine samples have been collected each year in the Inland Bays through an all-volunteer effort. With more than 1200 seine samples, and six years of data, this incredible program is allowing us to assess the importance of the inshore areas on species of interest such as bluefish and summer flounder, as well as supplement the data collected by the DNREC open water trawl surveys. In the next four years, enough data will be gathered to begin investigating long term trends in the nearshore fish communities. Data on species collected, findings from the first 6 years, and lessons learned in conducting citizen science based programs will be presented.

Hydrologic Interaction of Fresh and Salt Water During Salt Marsh Reconstruction in 2015 at Prime Hook National Wildlife Refuge, Delaware

McKenna, Thomas, University of Delaware, 257 Academy St, DGS Building, Newark, Delaware 19716, mckennat@udel.edu;

Physical and Chemical Processes, Tuesday, 2:00pm, Grand Ballroom A, 1st Floor

Multiple aerial remote sensing missions and in-situ measurements evaluated the

hydrologic Interaction of fresh and salt water during salt marsh reconstruction in the Refuge. Aerial remote sensing missions used a thermal imaging radiometer and visual camera. Mixing is evident via the thermal contrast between fresh water from the uplands and tidal water from Delaware Bay. The thermal band from sensor on the Landsat satellite was also examined for evidence of mixing.

Evolution of mixing patterns was most evident where Prime Hook Creek flows out of the upland areas into the open water /marsh area. Existing and new channels were dredged in this area for the marsh reconstruction effort. In-Situ data are being collected by DNREC and others using an automated sensor network. Data from select sensors will be analyzed for thermal and salinity trends indicative of fresh/salt water mixing through the marsh reconstruction period.

Review and Application of New Jersey's Living Shorelines Engineering Design Guidelines

Miller, Jon, Stevens Institute of Technology, Davidson Laboratory, Castle Point on Hudson, Hoboken, NJ 07030, jmiller@stevens.edu; Andrew Rella, InterTidal Habitat Consulting; Thomas Herrington, Stevens Institute of Technology; Amy Williams, Stevens Institute of Technology

Post Sandy Lessons, Monday, 10:45am, Grand Ballroom A, 1st Floor

In 2015, New Jersey released a set of living shorelines engineering design guidelines intended to complement Coastal General Permit 24 (N.J.A.C. 7:7-6.24), or "the living shorelines general permit", which was officially adopted in 2013. The guidelines provide an outline of the parameters which should be considered during the design of living shorelines projects, and include both traditional and non-traditional engineering parameters such as wave height, tidal range, and sunlight availability. The guidelines discuss methodologies and resources for obtaining information about these parameters, and the ranges for which certain types of projects are appropriate. A tiered design process is proposed which begins with the collection of baseline information, mostly achievable through desk-top analyses, to help select between potential alternatives. This information is frequently sufficient for the development of a basic conceptual design; however higher levels of analysis are suggested for select parameters for larger and/or more complex projects. As part of a NOAA CRest grant led by The Nature Conservancy, the design process outlined in the New Jersey Living Shorelines Design Guidelines was used to develop conceptual designs for four unique projects. The projects provide a useful example of the role of the guidelines in the design process.

Delaware Bay Resiliency Restoration Projects: An Update

Modjeski, Capt. Al, American Littoral Society, 18 Hartshorne Drive, Ste. 1, Highlands, NJ 07732, alek@littoralsociety.org; Tim Dillingham, American Littoral Society; Larry Niles, LJ Niles and Associates; Joseph Smith, LJ Niles and Associates; Shane Godshall, American Littoral Society; Steve Hafner, Stockton University; Dianne Daley, LJ Niles and Associates

Post Sandy Lessons, Monday, 10:45am, Grand Ballroom A, 1st Floor
Poster Session, Monday, 5:15pm, 5th Floor

This presentation will provide an overview and update of Department of Interior and National Fish and Wildlife Foundation funded habitat restoration along the Delaware Bay in New Jersey. The American Littoral Society and its partners have restored over three miles of horseshoe crab and shorebird beach spawning and foraging habitat along the Delaware Bay. This multi-year project is multi-faceted and includes the restoration of eight Delaware Bay beaches in NJ, the creation of intertidal, shelled oyster reef living shorelines, a robust monitoring strategy, marsh restoration through beneficial reuse of dredged material, future planning and marsh design, an educational and outreach program, a US veteran intern program, and a communications strategy that incorporates social media and a video series titled “The Hidden Coast”. This presentation will summarize each component of the restoration work, the methods employed for creating appropriate habitats, the logistics and techniques of installing an intertidal oyster reef, restoring beaches without offshore sand resources, preliminary monitoring results, and future projects. This ongoing project has produced tangible results which have benefitted not just the ecology of the Delaware Bay but also many Bayshore communities.

Additional: This project was awarded the 2015 New Jersey Governor's Environmental Excellence Award. Project partners include USFWS, Conserve Wildlife Foundation of NJ, Stockton University Coastal Research Center, and LJ Niles Associates.

The Delaware Estuary Living Shoreline Initiative (DELSI): Results and Lessons Learned Regarding Three Treatments in the Maurice River, NJ

Moody, Joshua, The Partnership for the Delaware Estuary, 110 S. Poplar St., Wilmington, DE 19801, jmoody@delawareestuary.org; Dr. Danielle Kreeger, The Partnership for the Delaware Estuary; David Bushek, Rutgers University, Haskin Shellfish Research Laboratory; Angela Padeletti, The Partnership for the Delaware Estuary

NJ Bayshore and Vicinity: Planning, Projects, Resiliency, Tuesday, 2:00pm, Crystal Room, 1st Floor

The Delaware Estuary Living Shoreline Initiative (DELSI) is a flagship program at the Partnership for the Delaware Estuary. Created in 2007 with the Rutgers University Haskin Shellfish Research Laboratory, the aim of DELSI is to investigate the potential uses of living shorelines, and other nature-based infrastructure, to protect and enhance valuable natural resources experiencing degradation, such as salt marshes and native shellfish populations. Since its inception, the DELSI program has installed 14 living shoreline treatments in five regions across two states. Three treatments installed in 2009-2010 along the Maurice River in Maurice River Township, NJ represent two different goals and two types of project management. Their maturation provides valuable data regarding living shoreline temporal development and definitions of success in a natural, dynamic system.

Sites D15 and E1 are ~80' intertidal coir log treatments in front of natural salt marshes. The goal of these treatments is to stem the erosion, but where E1 has been adaptive managed since its installation, D15 has been allowed to develop without managed interventions. Site E2 is a ~50' intertidal coir log treatment, but is positioned water-ward of the rip-rapped shoreline of a marina. Its goal is to provide ecological uplift through conversion to a natural, vegetated habitat, while enhancing protection of the landward infrastructure. The adaptively managed E1 and E2 sites have shown greater growth in terms of shoreline position and elevation, but the persistency of D15 highlights how marshes in need will respond to appropriate treatment even in the absence of augmentation. An important lesson learned from these treatments is that monitoring is instrumental in determining adaptive management needs as well as gauging success at the appropriate temporal scale. To date, all treatments have met their goals and continue to provide important data regarding development and endowment of ecosystem services.

Application of a Goal-Based Monitoring Framework for Assessing Performance of Living Shoreline Projects

Moody, Josh, The Partnership for the Delaware Estuary, 110 S. Poplar St., Wilmington, DE 19801, jmoody@delawareestuary.org; Danielle Kreeger, The Partnership for the Delaware Estuary; Angela Padeletti, The Partnership for the Delaware Esturay; David Bushek, Rutgers University, Haskin Shellfish Research Laboratory

Living Shorelines, Tuesday, 3:30pm, Grand Ballroom A, 1st Floor

Living shoreline tactics have been developed and tested in the Delaware Estuary to help stem rapid losses of coastal wetlands while addressing other management goals. Since 2008, the Partnership for the Delaware Estuary has worked with partners to install various types of living shorelines in 15 treatments along 1,160 linear feet of shoreline. Since most of these installations are new to this region, it is vital that their performance be consistently assessed to gauge performance and guide adaptive management. Therefore, a goal-based monitoring framework was developed that identifies core metrics and sampling methods based on project goals, and encourages the consideration of statistical approaches a priori, to drive spatial and temporal data collection. Here we describe how the framework performed on three different living shoreline treatments with unique goals. The Mispillion hybrid living shoreline placed 1300 oyster castles and 500 shellbags over 6,000 ft2 of intertidal shoreline to enhance populations of filter feeding bivalves with the primary goal of enhancing water quality. Thus, changes in shellfish densities and demographics were tracked and translated into water filtration capacity. Results indicated that the new animals were filtering approximately 5,000 lbs of TSS and 200 lbs of nitrogen per year by the end of 2016. In contrast, top goals at two of our bio-based living shoreline sites (Matt's Landing, 2010, and Money Island, 2014) were ecological uplift and erosion control, and these included placement of coir materials and shellbags along eroding marsh edges. Achievement of goals was assessed by comparing how well treated areas stemmed the horizontal retreat of the marsh edge, boosted vertical elevation, and enhancing vegetation and shellfish relative to untreated controls. The monitoring framework proved versatile for assessing different tactics and goals, yielding consistent, understandable outcomes to guide future wetland restoration.

Horseshoe Crab Activity and Interactions on Rack-and-Bag Oyster Farms

Munroe, Daphne, Rutgers University, 6959 Miller Ave, Port Norris, New Jersey 08349, dmunroe@hsrl.rutgers.edu; David Bushek, Rutgers University; Lisa Calvo, Rutgers University

Poster Session, Monday, 5:15pm, 5th Floor

Concern has recently been raised about the ability of horseshoe crabs (Limulus polyphemus) to safely navigate in and around intertidal oyster farm gear, and how farms may change shorebird foraging activity. During the 2016 crab spawning season, a series of experiments were conducted to assess the ability of crabs to move in, around and among the oyster farms to mate and spawn on the beach, and to survey the spatial distribution of dislodged eggs upon which Red Knots feed. These experiments included (1) testing rack heights for impairment of crab passage, (2) repeated crab census on paired farm/control sites to test if crabs avoid farms, and (3) spatial survey of dislodged egg distribution along the wrack zone. Results showed that all crabs, regardless of size, passed easily beneath racks 10 cm or more above the bottom. Thus, regulated rack height of 30.5 cm (12") should be sufficiently precautious to allow crab movement beneath racks. The crab census observed 853 crabs total, with no evidence of a difference in crab numbers among farmed and control transects ($p=0.3$, paired Wilcox signed-rank test). In total, 2 out of 853 (<0.5%) crabs were observed to be impinged on racks. Crab eggs washed up in the wrack zone were distributed unevenly throughout the survey region. Dislodged eggs were observed most frequently in the central portion of the survey area, and were not concentrated in the area of farms suggesting that in 2016, Red Knot foraging opportunities were not spatially coincident with farm locations.

Progress in Water Resource Mapping in the Delaware Estuary

Najjar, Kenneth, Delaware River Basin Commission, 25 State Police Drive, West Trenton, NJ 08628, ken.najjar@drbc.nj.gov; Karen Reavy, Delaware River Basin Commission; Chad Pindar, Delaware River Basin Commission

Poster Session, Monday, 5:15pm, 5th Floor

The Delaware River Basin (DRB) has long been a watershed of interest for study and evaluation, likely due to the large population (approx. 15M people) and the variety of other water uses it supports. The Delaware River Basin Commission (DRBC) as well as other public and non-public entities have been gathering new mapping data to describe landscape and watershed features for use in evaluating the health of the basin and for planning restoration and protective actions.

The poster being presented will illustrate the progress being made in mapping water resource elements of the Delaware Estuary, the lower portion of the DRB. The poster will provide the following information:

1. Description and mapping of land use in the Delaware Estuary watershed based on LiDAR data at sub-meter resolution prepared by the University of Vermont.

2. Mapping of headwater watersheds in the estuary prepared by USGS using automated and manual methodologies to delineate first order watersheds.

3. Web locations where data can be found and downloaded for use as well as identification of the groups preparing and supporting the data.

The poster will help potential users understand the availability of recent data that can be used to evaluate watershed conditions and develop management plans.

Brandywine-Christina Healthy Water Fund

Narvaez, Martha, University of Delaware, 261 Academy St., Water Resources Agency, Newark, DE 19716, mcorrozi@udel.edu; Gerald Kauffman, University of Delaware; Andrew Homsey, University of Delaware; Richie Jones, The Nature Conservancy, Delaware

Water Quality, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

A water fund is a mechanism for engaging direct beneficiaries of freshwater and other stakeholders in making investments within the watershed to improve water quality on a least-cost basis, enhance environmental and social values, and achieve quantifiable economic benefits. Water funds have been established for a variety of reasons taking on a variety of structures throughout the nation. There are numerous organizations assessing whether a water fund is a valuable tool in the local watershed. The William Penn Foundation has funded the University of Delaware, Water Resources Agency and The Nature Conservancy, Delaware to determine the feasibility of a water fund in the Brandywine-Christina watershed. This session will discuss the basics of a water fund and the successes, obstacles, and important strategies for determining the feasibility of and establishing a water fund in the Brandywine-Christina watershed.

Monitoring Coastal Storm Impacts Using the Surge, Wave, and Tide Hydrodynamics (SWaTH) Network Along the Delaware Bay

Nealen, Christopher, U.S. Geological Survey, 5522 Research Park Drive, Baltimore, MD 21228, cnealen@usgs.gov;

Poster Session, Monday, 5:15pm, 5th Floor

Storm surge and waves are the primary drivers of destruction along the coast, and catastrophic change in the nearshore environment. Documenting the height, extent, and timing of storm surge, and understanding how natural and man-made coastal landscape features may attenuate storm tides and waves will improve storm surge models, and may facilitate better nearshore land use and management decisions. Following Hurricane Sandy, the United States Geological Survey (USGS) began construction of an overland Surge, Wave, and Tide Hydrodynamics (SWaTH) Network along the Northeastern Atlantic Coast. This network, developed collaboratively with local, State, Tribal, and Federal agency partners, features the integration of long-term USGS real-time tide gages, temporary mobile, rapidly deployable, real-time gages (RDGs), and mobile storm-tide sensors (STSs). Most locations for the mobile RDGs and STSs have pre-surveyed reference points to NGVD 1988 datums and are equipped with receiving hardware that permits rapid installation of instrumentation in the hours and days prior to a storm. The data from this network will increase understanding about coastal storm sure inundation and wave energy dissipation in coastal areas along the Delaware Bay.

Walking the Talk: How a For-Profit Business Inspires Environmental Volunteerism and Stewardship

Offner, Kelly, United by Blue, 144 N. 2nd St., Philadelphia, PA 19106, kelly.offner@unitedbyblue.com

Motivate Voluneers and Make a Difference, Tuesday, 9:00am, Grand Ballroom C, 1st Floor

United by Blue is an outdoor lifestyle brand focused on waterway conservation. For every product sold, they remove one pound of trash from oceans and waterways through company organized, volunteer-based cleanups. Since 2010, United by Blue has worked with 6,000 volunteers across the United States to remove over 700,000 pounds of trash from rivers, lakes, creeks and oceans. How does a clothing brand that sells products like organic cotton t-shirts and bison-fiber jackets identify, engage, reward and inspire volunteers to pick-up soggy, heavy trash on a regular basis? This presentation will dig into United by Blue's volunteer recruitment and outreach strategies, challenges like rewarding volunteers and inspiring customers in an authentic way (that doesn't break the bank), and how they measure success. The presentation will also gloss over high-performing community, public and private partnerships; without them, United by Blue's conservation work is irrelevant. A brief group discussion will conclude the presentation, leaving you to envision a world filled with for-profit businesses dedicated to doing good.

Sediment Carbon Stock And Carbon Accumulation Rates In The Delaware Bay Tidal Salt Marshes

O'Hara, Beatrice, West Chester University of Pennsylvania, 750 S. Church St., West Chester, PA 19383, bo050179@wcupa.edu; Daria Nikitina, West Chester University of Pennsylvania; Matthew D. Serzega, West Chester University of Pennsylvania; Daniel Jennings, West Chester University of Pennsylvania; Deven Scelfo, West Chester University of Pennsylvania; Steven Esrey, West Chester University of Pennsylvania

Monitoring, Wednesday, 9:00am, Grand Ballroom A, 1st Floor

Salt marshes provide numerous benefits and services essential for mitigation and adaptation to climate change and resilience along the coast. Salt marshes are large carbon (C)-storing ecosystems; sequestering significant amounts of C from the atmosphere and oceans and storing it in the below ground sediments (Murray et al. 2011). When these systems are degraded they become a potential source of C emissions. Delaware Bay salt marshes are being lost at a rate of an acre/day (PDE 2012). Although the DE Bay is the 2nd largest estuary in North America, with ~ 830 km2 of tidal marsh area (Reed et al. 2008; Titus et al. 2008) that has been developing for ~2000 years, there are no studies that accurately estimate the amount of C stored in its salt marshes. Assessments of salt-marsh C pools, and salt-marsh C accumulation rate (CAR), typically focus on the top meter of sediment. Sediments accumulated at depths < 1 m usually represent < 100 years of salt marsh accumulation (Nikitina et al. 2014).

We reconstructed the history of salt marsh development along the NJ DE Bay at two similar sites using salt-marsh sedimentary archives. Estimated short and long-term CAR equal 2.3MgC/ha/yr., and 0.85 MgC/ha/yr. respectively. We documented variation in sediment and CAR through time due to changes in depositional environments and calculated C content through the entire sediment sequence. Estimates of C accumulation ranged from 355 MgC/ha (1 m depth) to 1,016 MgC/ha (3 m depth). The results show that the Delaware Bay salt marshes sequester significant amounts of C and suggest that C stock assessments focused on the top 1 m of sediment underestimate the total C stock by more than two-fold. Future studies should account for the entire salt-marsh sediment sequence for increased accuracy of C stock assessments.

Restoration of Vulnerable and Damaged Marsh Ecosystems to Improve Response to Sea Level Rise

Orescanin, Mara, Woods Hole Group, 81 Technology Park Drive, Falmouth, MA 2536, morescanin@whgrp.com; Weishar, L., Woods Hole Group; **Hamilton, R**. P., Woods Hole Group

Estuary Restoration, Monday, 1:30pm, Grand Ballroom A, 1st Floor

Rising sea level poses an imminent threat to low-lying marsh ecosystems owing to delicate balances between marsh elevation, water levels, salinity, and sediment supply and transport. Major contributing factors to marsh inundation include more-frequent and intense storms, such as Hurricane Sandy, with larger waves and storm surges into marshes behind barrier beaches. Further complications arise from human modifications to low-lying coastal areas, altering tidal exchanges and overall marsh health. Three marsh restoration projects within Delaware Bay show different mitigation approaches depending on physical limitations of the systems. The coastal hydrodynamic model, CMS-flow, was applied either with (Supawna Meadows) or without (Milford Neck and Reeds Beach) wave forcing, and with salinity transport calibrated and validated with data collected at each site. The telescoping CMS-flow grid allows variable resolution, ideal for marsh sites with small channels on the order of 2 m wide. The Milford Neck Conservation Area near Milford, DE, is a site where tidal exchange is limited by remnant structures and barrier beach and channel changes. Model results suggest improved tidal flushing can help restore nearly 400 acres of degraded marsh habitat and enhance climate change resilience. In contrast, rebuilding and reinforcing the existing breakwater at Supawna Meadows, near Salem, NJ, limits wave effects by storms similar to Hurricane Sandy. By creating systematic breakwater openings, tidal flushing is maintained, while the marsh behind the breakwater is enhanced by increased sediment deposition potential. A third restoration project at Reeds Beach on Cape May, NJ, incorporated small channels to improve marsh drainage in an area that was damaged by excessive mosquito ditching. All three sites demonstrate the benefits of understanding natural processes to select alternatives to improve marsh health and minimize system vulnerabilities to changing sea levels.

Habitat Restoration through the Application of Dredged Material

Paist-Goldman, Mary, Princeton Hydro, LLC, 1108 Old York Road, Suite 1, PO Box 720, Ringoes, New Jersey 08551, mpaist@princetonhydro.com;

Thin Layer Placement in Coastal Wetlands, Monday, 3:45pm, Crystal Room, 1st Floor

The NJDEP received a NFWF grant as part of the Hurricane Sandy Coastal Resiliency Competitive Grants Program. Grantees were charged with providing increased resilience to natural infrastructure that would increase the resiliency of coastal communities in the face of future storms like Hurricane Sandy.

Princeton Hydro and GreenVest along with project partners have worked collaboratively on a series of pilot projects to trial the beneficial reuse of dredged material to restore salt marshes in the state of New Jersey. Design elements of the project include restoration and enhancement of the interior high and low marsh, coastal dune and beach habitats. The underlying goal of these projects is to reduce of eliminate the current stress to the project marshes and to restore the ability of these marshes to be resilient against a these and other stressors including current and future sea level rise. Other goals include increasing the resilience of adjacent coastal communities and the enhancement of habitat for avian and nekton species

Dredged material has been placed over the degraded marsh at Fortescue within targeted areas to increase marsh elevations. Material was also placed to fill expanding pools by elevating the substrate to the same elevation as the adjacent marsh. The goal of the restoration activities was to arrest the subsidence-based marsh loss at the project site by filling of isolated pockets of open water and increasing marsh platform elevation. In addition, the beneficial reuse of dredged material facilitates routine and post-storm dredging and hence improves the navigability of the waters of the United States.

Overall the project hopes to inform how dredged material can restore degraded marsh and other coastal communities and provide potential benefits to shore communities in terms of increased resilience and reduction of wind, wake and wave energies.

Stream, Wetland, and Riparian Restoration of a Former Cranberry Bog Site in the Pinelands

Paist-Goldman, Mary, Princeton Hydro, LLC, 1108 Old York Road, Suite 1, PO Box 720, Ringoes, New Jersey 08551, mpaist@princetonhydro.com;

Estuary Restoration, Wednesday, 10:30am, Grand Ballroom A, 1st Floor

Stream, Wetland, and Riparian Restoration of a Former Cranberry Bog Site in the Pinelands

Evesham Township, Burlington County, New Jersey

Princeton Hydro and GreenVest worked collaboratively on this project situated in Watershed Management Area 14 (Mullica). The project is located directly online on the Alquatka Branch which is tributary to the Mullica River. The project design involved the creation, restoration and enhancement of 33.76 acres of freshwater wetlands and the restoration of a stream channel through the project site. Additional habitat consideration was given to Timber Rattlesnake and the Pine Barrens Tree Frog through project implementation. The site was historically used for cranberry production and included a network of earthen berms surrounding cranberry cultivating bogs. The water onsite was managed through ditches and water control structures set into the berms. The Alquatka Branch enters the site from the west and flows from southwest to northeast. This mitigation site was chosen due to its current agricultural setting and mixed forested area.

The deconstruction of the cranberry bogs involved the removal of the existing earthen berms and re-grading of existing burrow pot areas. The primary goal of the mitigation project was to enhance the palustrine ecological functions of the site including renaturalizing the site and restoring the hydrologic functions of the wetlands that have been extensively modified for agriculture. Riparian zone disturbance was necessary as the fundamental element of the project's objective was to restore, enhance and increase palustrine wetland habitat through the re-introduction of native wetland vegetation, and enhance and increase upland forest habitat in the wetland and riparian buffers. Additional regulatory hurdles involved potential flooding impacts downstream of the site and the change in hydraulic function upon removal of the cranberry bogs. The completed project incorporated a balance of both ecological and human health and safety benefits.

What's Living On Living Shorelines? Monitoring A Hybrid Living Shoreline Project In Delaware Bay

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Living Shorelines, Tuesday, 3:30pm, Grand Ballroom A, 1st Floor

Gandy's Beach is currently a Nature Conservancy Preserve along an area of undeveloped shoreline on the Delaware Bay, NJ. Its shore has been increasingly vulnerable to coastal erosion and was considerably impacted by storm surge from Hurricane Sandy. Over the past few years, a collaborative project has been underway to construct living shorelines using coir fiber logs, shell bags and Oyster Castles® to augment the beach. The main project goals are to reduce incoming wave energy, promote marsh accretion and increase the three-dimensional oyster habitat nearshore to create unique habitat for ecologically and economically important fish and crab species. The Haskin Shellfish Research Laboratory, Rutgers University has been conducting faunal monitoring to document habitat utilization by finfish and shellfish. To date, the project sites were sampled two consecutive years pre-installation and one year post-installation. The project seeks to characterize diversity and quantify abundances of the faunal community present before augmentation and as the shoreline installations mature. Fish and mobile invertebrates are sampled using block nets that are deployed on stationary poles across a tidal cycle and seine nets that are actively fished. Preliminary results indicate that the Gandy's Beach Preserve is habitat to ecologically and economically important species including: blue crabs, white perch, weakfish and black drum. Reef associated species, such as black sea bass, were present only after living shoreline installation indicating enhancement of biodiversity. Oyster recruitment and survival are sampled following a stratified random sampling count protocol. Results reveal that oysters recruit to and survive on Oyster Castles® and shell bags deployed intertidally over the course of a year despite winter icing. Monitoring is slated to continue over the course of the next couple years.

Designing Delaware: Creating Workforce Ready Graphic Designers through Environmental Partnerships

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Connecting Youth to the Environment, Wednesday, 9:00am, Grand Ballroom C, 1st Floor

Marketing to attract participants to environmental education program is crucial for their success, and successful marketing starts with good graphic designs. However, for many government and non-profit agencies being able to develop a full design and marketing contract with a professional ad agency can often be prohibitive. To help with that roadblock the Delaware National Estuarine Research Reserve partnered with the Delaware Tech, Terry Campus in spring 2016 to act as a client for a Project Elective course. This course was used as a pilot course to develop a Applied Practice Ad Design course. Reserve staff worked closely with the students as they produced designs for three large events that the Reserve hosts annually. The students created a full design plan and look for each event and supplied the reserve with the end products to be used in fall 2016. In the end not only did the Reserve receive a product they will use, but the students gained real world experience that made them better prepared to join the workforce. Join the Reserve Education Coordinator and Delaware Tech Visual Communications Department Chair to learn about the process and view some of the finished products.

Prioritizing Natural Coastal Protection Strategies Through Shoreline Assessments

Pollack, Christiana, Princeton Hydro, LLC, 1108 Old York Rd, Suite 1, PO Box 720, Ringoes, NJ 08551, CPollack@princetonhydro.com; Jessica Jahre, Princeton Hydro, LLC

Estuary Restoration, Monday, 1:30pm, Grand Ballroom A, 1st Floor

As coastal communities continue to recover from Sandy, many are looking toward an uncertain future of a changing shoreline, rising seas, and shifting storm patterns. Since Sandy, Princeton Hydro has been working with New Jersey Future in a targeted effort to communicate climate science and risk information to coastal communities in a productive manner that instigates change, but not panic. This presentation will focus on an effort to leverage existing science, data, and literature to help inform policy decisions at the local and state level to improve the future vitality of salt marshes in the region.

One component of this broader effort is to use shoreline assessments to evaluate existing and historic shoreline typology, conditions, and integrity of features, including dunes, bulkheads, and marshes. Shoreline assessments are a powerful tool to leverage spatial data, models, and other tools to evaluate the anticipated changes in water elevations and the potential impacts on existing shorelines, the built environment, and natural resources, including marshes. While assessments are powerful, established protocols and methods are still being evaluated and developed; this project will add to the existing assessment approaches within the field.

In addition to its value of communicating challenging science to the general public and decision-makers, the shoreline assessment approach allows communities to prioritize scarce and valuable resources. For example, due to a shortage of dredge material disposal sites, there is heightened interested in New Jersey in the beneficial re-use of this material to enhance marsh habitat. Shoreline assessments allow for an ecologically-based approach to evaluate the ecosystem, not constrained by political boundaries, in order to target and prioritize future restoration efforts. The shoreline assessment is also being used to inform policies such as boat traffic and wake zones that impact the marshes capacity to adapt to future conditions.

Contaminant Exposure and Productivity of Osprey (Pandion haliaetus) Nesting in Delaware Bay and River in 2015

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Monitoring, Tuesday, 10:00am, Crystal Room, 1st Floor

The last large-scale ecotoxicological study of ospreys nesting in Delaware Bay and River was conducted in 2002. Eggs from the northern region (C&D canal to north of Philadelphia) contained greater concentrations of organochlorine pesticides, PCBs, perfluorinated compounds, and brominated flame retardants than the central Bay and southern Inland Bays. While overall reproductive success did not differ among regions, egg loss from nests was related to levels of halogenated contaminants, suggesting pollutants were a significant stressor. In 2015, 27 osprey nests were visited at 7-10 day intervals and a sample egg was collected from each nest for persistent, bioaccumulative and toxic (PBT) contaminant analysis. A blood sample was collected from nestlings to assess exposure to pharmaceuticals and measure oxidative DNA damage as a general toxicity biomarker. Eggs lost, eggs hatched and young fledged did not differ among regions, and productivity was adequate to maintain a stable population (0.8-1.15 fledglings/active nest). Eggs from the northern region exhibited 10.1% shell thinning in 2002, but there were no differences in shell thickness across study sites in 2015, with values approaching the pre-DDT era thickness (0.505 mm). Only 2 of 21 pharmaceuticals were detected in nestling plasma. The pain reliever acetaminophen was present in 21 of 27 samples, with greater concentrations in the more densely populated northern region compared to the central region (geometric mean: 2.63 ng/mL vs. Kaplan-Meier mean: 1.81-1.97 ng/mL). The anti-inflammatory drug diclofenac was detected in 2 samples from the Inland Bays (<MDL-3.73 ng/mL). Our 2015 assessment of productivity, shell thickness, genetic damage and pharmaceuticals do not indicate substantial ecotoxicological risk for ospreys at the individual or population level. The status of fish-eating birds and condition of Delaware Bay and River will become clearer with results from the PBT contaminant analysis.

Paddle for the Edge: Using Citizen Science to Monitor Marsh Shorelines

Reilly, Erin, Barnegat Bay Partnership, 1 College Dr, PO Box 2001, Toms River,, NJ 08754, ereilly@ocean.edu; Martha Maxwell-Doyle, Barnegat Bay Partnership

Monitoring, Wednesday, 9:00am, Grand Ballroom A, 1st Floor

The Barnegat Bay estuary has lost 45% of the natural shoreline to bulkheading; remote sensing studies indicate high levels of erosion to remaining shorelines. With an interest in encouraging citizen science and investigating factors influencing shoreline erosion, the Barnegat Bay Partnership developed the Paddle for the Edge annual shoreline survey. Volunteers are trained and assigned a section of shoreline to survey via kayak, canoe or stand up paddle board using their smartphones. Surveyed metrics included erosion and accretion indicators, recreational and commercial use, vegetation types, land use, fauna indicators, and structural alterations. In 2 years approximately 30 miles of shoreline have been surveyed.

Blue Carbon Storage in Natural Estuarine Wetlands and Living Shorelines of Delaware and New Jersey

Reilly, Erin, Barnegat Bay Partnership, PO Box 2001,1 College Drive, Toms River, NJ 08754, ereilly@ocean.edu; LeeAnn Haaf, PDE; Sunny Jardine, University of Delaware; Danielle Kreeger, PDE; Rose Martin, EPA; Elisabeth Powell, Academy of Natural Sciences, Drexel University; Kirk Raper, Academy of Natural Sciences, Drexel University; Chris Sommerfield, Academy of Natural Sciences, Drexel University; David Velinsky, Academy of Natural Science Drexel University; Marianne Walch, Delaware Center for Inland Bays; Elizabeth Watson, Academy of Natural Sciences, Drexel University; Cathleen Wigand, EPA

Poster Session, Monday, 5:15pm, 5th Floor

Blue Carbon, or the carbon sequestered in oceanic and coastal systems, has become an area of intense interest for global carbon management in light of anthropogenically-linked global warming. The states of New Jersey and Delaware are uniquely suited to study carbon storage capacity, cycling, and planning for these natural processes because of the high density of coastal wetlands found in the region. To better understand natural carbon storage and potentially how restoration projects, specifically living shorelines, contribute to these carbon storage processes in Delaware and New Jersey estuary systems, three National Estuary Programs (NEPs) are working in collaboration with academic and governmental collaborators. The goals of this project are threefold: (1) to estimate the overall carbon stock found in Delaware and Barnegat Bays and rates of sequestration, (2) to contrast the carbon stocks between natural wetlands and living shorelines, and (3) to quantify offsets of carbon mitigation benefits that coastal wetlands provide due to emissions of methane and nitrous oxide, which have significantly greater global warming potentials than carbon dioxide. Data from dated sediment cores analyzed for soil organic carbon density, soil C density and biomass samples from living shorelines and control sites, and GHG emissions from static chambers were integrated and analyzed to accomplish these goals. Preliminary results will be discussed.

A Synthesized Gap-Free Continuous Sea Level Record for the Delaware River at Philadelphia

Reis, Victoria, Philadelphia Water, 1101 Market St., Floor 4, Philadelphia, PA 19107, victoria.reis@phila.gov; James T. Smullen, CDM Smith

Hot Topics, Wednesday, 1:45pm, Grand Ballroom, 1st Floor

Philadelphia Water Department is continually improving our planning processes for environmental compliance, flood mitigation and infrastructure development. A continuous long-term sea level record is useful in planning efforts for analyses such as hydrodynamic modeling, surge event frequencies, event return-interval estimates, etc. We have applied several techniques for filling gaps in the National Oceanic and Atmospheric Administration (NOAA) Philadelphia sea level records from 1901 to present. The Philadelphia sea level record spans 109.7 years, and there are 95 gap periods of varying lengths, constituting 5.9 years of total missing data. The approaches to fill the gaps employ time-domain statistical methods, and frequency-domain harmonic methods, using sea level data from other NOAA gages. These gages include Reedy Point Delaware, Lewes Delaware and Baltimore Maryland.

The fundamental approach relies upon the concept that the estuary length is relatively short in comparison to the wavelengths of the remote forcing mechanisms that drive subtidal sea levels. The method employs a low-pass time series filter to remove the astronomical tidal influences from all sea level records, and then focuses on the remaining low-frequency signals. The analytical approaches adjust the transferred data to respect local (in time) mean sea level and the historical sea level rise trend in Philadelphia. Once the gaps in the low-frequency Philadelphia record are synthesized, the tidal harmonics are reintroduced over the now continuous (filled) low-passed signal.

The problematic gaps in the Philadelphia record were during 1903-1904 and 1921-1923, when no data were available from gages in the Delaware estuary. However, it was found that a reasonable relationship exists between the low-frequency water levels at Philadelphia and Baltimore (average correlation coefficient of 0.63, yielding an RMSE of about 0.3 ft), likely a result of their similar distances from the ocean. The presentation will describe observed data conditions, techniques used, and examples.

Quantifying the water quality benefits of a new shellfish-based hybrid living shoreline

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

Poster Session, Monday, 5:15pm, 5th Floor

Living shorelines enhance ecological conditions while also achieving coastal management goals. For example, there is emerging interest in promoting water quality via filter-feeding shellfish that can be targeted in project designs. Bivalves such as oysters and ribbed mussels process large volumes of water, filtering seston, transforming associated pollutants, and reducing water turbidity. In 2014, a hybrid living shoreline was installed near the mouth of the Mispillion River, Delaware. This project was designed to promote water quality by enhancing habitats for oysters and ribbed mussels. Approximately 1300 oyster castles and ~500 shell bags were installed as a low relief breakwater to facilitate expansion of a small oyster reef. Approximately 25 coir logs and ~250 shell bags were installed to stabilize the marsh edge and provide attachment sites for ribbed mussels. By fall 2015, more than 5,000 oysters had settled and survived on the structures. Despite the hard winter of 2014-2015, survivorship was similar to the adjacent natural reef with continued growth and survival observed in 2015-2016. Shellfish size and density data were integrated with past PDE physiological rate study estimates to calculate the potential water quality benefits of the expanded oyster and mussel populations of this project. At the end of 2015, the recruited animals were estimated to filter 145lbs of TSS and 5lbs of particulate nitrogen per year. By November of 2016, however, these rates were expected to rapidly increase with bivalve growth rates to >5,000lbs of TSS and >200lbs of particulate N per year. The water quality benefits of this project should continue to increase as oyster and mussel populations continue to colonize and grow over the living shoreline treatments. These results confirm that living shorelines can enhance the carrying capacity for beneficial bivalve filter feeders, thereby improving water quality.

Mispillion Watershed: Wetland Status and Health

Rogerson, Alison, DNREC-Wetland Monitoring and Assessment, 100 West Water Street, Suite 10B, Dover, Delaware 19904, Alison.Rogerson@state.de.us; Andrew Howard, DNREC- Wetland Monitoring and Assessment; Brittany Haywood, DNREC- Wetland Monitoring and Assessment; Kenny Smith, DNREC- Wetland Monitoring and Assessment

Wetlands, Tuesday, 10:00am, Grand Ballroom A, 1st Floor

DNREC's Wetland Monitoring and Assessment program (WMAP) have been tasked to analyze and report on the health of the wetlands throughout the state with a total of 7 watersheds reported on so far. The Mispillion River watershed was the most recent watershed to be reported on. The Mispillion watershed contains the Cedar Creek watershed and the Mispillion River watershed and contains the towns of Milford and Slaughter Beach. The Mispillion watershed has historically lost about 19% of its wetland acreage since settlement mostly due to the conversion of headwater forested wetlands to agricultural fields. Approximately one quarter of the watershed is covered by wetlands with tidal estuarine wetlands making up half of the wetland population. In 2012 biologists completed wetland assessments in 34 tidal wetlands using the Mid-Atlantic Tidal Rapid Assessment Method (MidTRAM) Version 3.0. In addition, 33 freshwater riverine wetlands, 45 headwater forested flat wetlands, and one isolated depression wetland were visited and assessed using the Delaware Rapid Assessment Procedure (DERAP) Version 6.0. We found wetlands in the Mispillion to be comparable with the nearby Broadkill watershed and determined that one quarter were functioning in good condition. The high prevalence of invasive species (e.g. *Phragmites*) and shoreline obstructions to coastal wetland migration were the major negative stressors impacting tidal wetlands. The presence of adjacent agriculture or development and presence of invasive plants were the major stressors to non-tidal wetlands. The presence of various stressors in these wetlands are likely to experience reduced wetland values, like flood protection, water purification, and wildlife habitat. Wetland management in the Mispillion watershed should focus on preserving and buffering ecologically significant wetlands in addition to ensuring that coastal wetlands are able to migrate inland with rising sea levels and salt water.

The Promotion of Living Shorelines in Delaware through a Dedicated Work Group

Rogerson, Alison, Delaware Department of Natural Resources and Environmental Control, 100 W. Water St. Suite 10B, Dover, DE 19904, alison.rogerson@state.de.us; Danielle Kreeger, Partnership for the Delaware Estuary

Living Shorelines, Tuesday, 3:30pm, Grand Ballroom A, 1st Floor

Formed in 2013, the Delaware Living Shoreline Committee is a work group to facilitating the understanding, peer review and implementation of living shoreline tactics in Delaware. This committee is currently organized jointly by the Delaware Department of Natural Resources and Environmental Control and the Partnership for the Delaware Estuary and meets quarterly. Membership is approximately fifty members representing sixteen organizations ranging from state government, federal agencies, non-profit organizations, environmental consultants and engineers, and academics. Committee tasks are divided into four subcommittees: Policy, Implementation, Education and Outreach, and Standards of Practice. Each of the subcommittees meet separately on tasks that have been suggested by the larger group. Topics regarding Policy include working with the state tidal wetland permitting agency to update permitting criteria to offer expedited permits for qualifying living shorelines, and securing cost-share funding. The Outreach and Education group is addressing the need for universal signage to increase living shoreline awareness and visibility. Also, they organize annual living shoreline training workshops for professionals to gain classroom and field-based exposure to techniques, permitting and monitoring. Another outreach tool is a virtual tour of living shorelines in Delaware using esri StoryMap to review various techniques, explain project costs and share useful resources. The Standards of Practice subcommittee is producing a Delaware Living Shorelines Monitoring Framework with the help of New Jersey to guide users through creating an appropriate monitoring plan for documenting project success. The Implementation subcommittee has been seeking funding and potential demonstration sites. Meetings include guest speakers and discussions on new topics or publications. The committee serves as a sounding board for potential projects and members are connected with other local professionals.

Signals of sea-level rise in Delaware and Chesapeake Bay tides

Ross, Andrew, Pennsylvania State University, 503 Walker Building, University Park, PA 16802, andrewross@psu.edu; Raymond G Najjar, Pennsylvania State University

Physical and Chemical Processes, Tuesday, 2:00pm, Grand Ballroom A, 1st Floor

Numerical and analytical models predict that sea-level rise will significantly modify tides in many estuaries. This study combines a numerical model with a simple statistical model based on observations to test whether sea-level rise has already changed the amplitudes and phases of tides in the Delaware and Chesapeake Bays. The results show that sea-level rise explains the majority of the observed changes in the M2 component of the tide. The S2 tide shows evidence of both sea-level rise and a large-scale trend, while the K1 tide is noisy and shows small changes. In the Delaware Estuary, sea-level rise increases the amplification of the M2 component, leading to increased flooding risk in areas near Philadelphia. The numerical and analytical models are also used to explore how sea-level rise is causing these changes in tides and how much additional change might occur with future sea-level rise. Finally, other possible explanations for these changes are discussed.

Does Living Shoreline Design Affect Vegetation Diversity?

Runion, Kyle, Chesapeake Research Consortium, 645 Contees Wharf Road, Edgewater, Maryland 21037, runion.kyle@epa.gov;

Poster Session, Monday, 5:15pm, 5th Floor

Living shorelines have proved to be ecologically valuable structures. There are numerous living shoreline design types, each which aim to prevent erosion of the coast, but no studies have quantified their effect on vegetation on the shore above the structure. This study asks if the design type affects vegetation diversity on the shoreline. Shorelines above continuous, overlapping, and segmented sills were sampled for species richness and evenness using 1m2 plant counts. Two sites for each energy regime (high and low) were sampled for each of the three different design types for a total of 12 sites. Analysis found that continuous sills tended to have lower diversity and low energy sites tended to have higher diversity. *Spartina patens* was found to be less abundant at continuous sill sites. To maximize vegetation diversity, segmented and overlapping sills are recommended at low energy sites, and segmented sills for high energy.

Utilizing LiDAR to characterize forest structure and its effects on aquatic organisms at stream reach- and catchment-scales at DRWI restoration and protection sites

Ryan, Will, Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103, wjr43@drexel.edu; Scott Haag, Academy of Natural Sciences; Stephanie Kroll, Academy of Natural Sciences

Estuary Restoration, Wednesday, 10:30am, Grand Ballroom A, 1st Floor

LiDAR (Light Detection and Ranging) is a powerful technological tool with utility across many scientific and engineering fields. In ecological studies, it has been employed to provide three-dimensional visualization and interpretation of vegetation structure. For projects that require the establishment of baseline vegetation conditions and periodic monitoring, it is often difficult to objectively, efficiently, and accurately characterize forest vegetation cover and structure. This study aims to employ LiDAR to analyze the structure of forests within select Delaware River Watershed Initiative (DRWI) cluster catchments. In order to more effectively correlate forest integrity with aquatic IBIs (Indices of Biotic Integrity), we propose an analysis of vegetation adjacent to and upstream of a subset of DRWI stream reaches where simultaneous biotic and abiotic sampling is occurring. LiDAR analysis will be employed across several catchment scales, predominant catchment land cover types, and predominant vegetation types. We propose a paired design, in which the selected focus catchments have similar physical characteristics, yet exhibit within-class IBI-score disparities. An additional objective of the study is the validation of the LiDAR predictions with "ground-truthing" of the vegetation cover and structure adjacent to the selected stream reaches with standard field-based vegetation surveys. As an exploratory study, we hypothesize that a more accurate characterization of forest habitat can be made by utilizing a three-dimensional approach (i.e., LiDAR) versus a two-dimensional, binary approach (i.e., aerial- or satellite-based photographic image analysis), which characterizes land cover as either forest or non-forest (e.g., developed, agricultural, grassland). In addition, we hypothesize that select paired stream reaches with similar physical characteristics and disparate IBI scores (for algae, macroinvertebrates, aquatic salamanders, and fishes) will exhibit a significant difference in forest vegetation structure.

The Value of Delaware's Tidal Wetland Ecosystem Services: A Choice Experiment

Santoni, Amanda, Delaware Coastal Programs, 100 W Water Street, Suite 7B, Dover, Delaware 19904, Amanda.santoni@state.de.us (**Nicole Rodi** presenting)

Wetlands, Tuesday, 10:00am, Grand Ballroom A, 1st Floor

Tidal wetlands provide many valuable services, including water quality improvement, storm surge protection and wildlife habitat, which support a wide range of commercial and recreational activities. Despite the provision of these important ecosystem services, wetland acquisition and management programs must contend with many other important issues for attention from local stakeholders and decision makers. This study uses choice valuation methods to quantify the monetary value of tidal wetland ecosystem services in Delaware, and builds an informed argument for funding conservation and management programs. The study shows that 68 percent of households participated in at least one recreational activity within or in view of tidal wetlands in 2015. Overall, respondents were willing to pay more for larger increases in wetland acres, wildlife condition, water quality and coastal protection. The results of the valuation will be discussed in the context of current efforts to inform management decisions, planning, and policy for Delaware's tidal wetlands.

Ecosystem service valuation: the how and why for your coastal restoration project team

Schuster, Elizabeth, The Nature Conservancy, 2350 Route 47, Delmont, NJ 08314, eschuster@tnc.org;

Estuary Restoration, Monday, 1:30pm, Grand Ballroom A, 1st Floor

Coastal systems provide numerous services—often referred to as ecosystem services—to people, including buffering homes and roads from flooding, reducing wave energy from storms, providing nursery and feeding resources for fish, supporting nature-based tourism activities, and improving water quality. These ecosystem services provide tangible economic value to communities, by reducing damage costs to homeowners, increasing revenues for fishers, and generating more money spent by tourists interested in birding, boating and hiking. Many data gaps exist relating to the economic benefits provided by these ecosystem services. To help fill these data gaps, The Nature Conservancy and partners have written a guidebook titled: A guide for incorporating ecosystem service valuation into coastal restoration projects. The guidebook covers a range of topics related to ecosystem service valuation, including a framework for natural scientists and economists to work together to collect the appropriate data to conduct more ecosystem service valuation studies. In order to be successful, ecosystem service valuation must be more than just data collection – it should be a process that includes defining the project scope, stakeholder engagement, goal setting, selection of relevant metrics, and determining appropriate methods. By conducting more valuations studies, managers and practitioners can improve the management and design of projects for both people and nature, and increase community support and funding for restoration projects. This guidebook is the first of its type to provide a truly integrated framework for bringing together interdisciplinary teams to quantify the ecological processes and economic benefits related to coastal restoration.

Flow Management for the Delaware River and Estuary

Shallcross, Amy, Delaware River Basin Commission, PO Box 7360,25 State Police Drive, West Trenton, NJ 08628, Amy.Shallcross@drbc.nj.gov;

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

As the entity charged with the coordinated planning and use of the water resources within the Delaware Basin, DRBC is responsible for ensuring that an adequate amount of water is available in the river for multiple purposes including: drinking water, industrial use, salinity repulsion, waste assimilation, and aquatic life. The four basin states through the DRBC negotiated a Flow Objective at Trenton to ensure adequate freshwater inflows to the estuary and slow the upstream migration of salinity in dry periods. Extensive modeling and analyses were conducted to develop the flow objective and evaluate its efficacy in meeting the multiple objectives for use of Delaware River water. The DRBC coordinates with federal, state, local agencies, as well as, private reservoir operators for the releases of water during low flow conditions, and in particular, during drought conditions. Data from the USGS, NWS and reservoir operators are collected daily to evaluate conditions and determine appropriate amounts of water to be released. Complicating factors include withdrawals, discharges, hydropower generation, flow travel time, base flow estimation and forecast uncertainties. This presentation will focus on the complex challenges of flow management and will highlight the policies, operations and planning required to provide adequate flow to meet the multiple, and sometimes conflicting, needs for water throughout the basin.

InvertEBase: Providing Access to 200 Years of Land and Freshwater Mollusk Data from Eastern North America.

Shea, Elizabeth, Delaware Museum of Natural History, 4840 Kennett Pike, Wilmington, DE 19807, eshea@delmnh.org; Rudiger Bieler, Field Museum of Natural History; Taehwan Lee, University of Michigan, Museum of Zoology; Diarmaid O'Foighill, University of Michigan, Museum of Zoology; Jochen Gerber, Field Museum of Natural History; Janeen Jones, Field Museum of Natural History; Petra Sierwald, Field Museum of Natural History

Poster Session, Monday, 5:15pm, 5th Floor

Understanding the scope of biodiversity change projected to occur in North America in the coming decades requires a high-resolution picture of preexisting biodiversity levels. Natural history museums in the US have collecting legacies that go back hundreds of years, but for most invertebrate taxa, the information is difficult to access by a broad variety of end users.

To address this concern, the InvertEBase Thematic Collections Network (TCN), part of the iDigBio National Resource for Advancing Digitization of Biodiversity Collections, has been digitizing terrestrial and freshwater mollusks and arthropods of eastern North America for the past two years. The goal is to complete the data entry, georeferencing, and some imaging of millions of new and legacy records, and to provide public access to these data through portals such as Symbiota.org and iDigBio.org.

This poster summarizes the biodiversity data that has been digitized and made publically available by the collaborating institutions as we approach the end of grant year 2. In addition, we describe the development of a shared exhibit that will introduce the general public to the value of natural history collections, why digitization is important, and highlights from the collections of collaborating institutions.

This collaborative National Science Foundation award (NSF EF 14-02667, EF 14-02697, EF 14- 04964, and others), is made as part of the National Resource for Digitization of Biological Collections through the Advancing Digitization of Biological Collections program and all data resulting from this award will be available through the national resource (iDigBio.org).

Impact of Future Salinity Increases on Operational Costs of Power Plants in the Delaware Estuary

Shirazi, Yosef, University of Delaware, 144 King William St, Newark, DE 19711, yshirazi@udel.edu; Edward Carr, University of Delaware; Dr. George Parsons, University of Delaware; Dr. Porter Hoagland, Woods Hole Oceanographic Institution

Physical and Chemical Processes, Tuesday, 2:00pm, Grand Ballroom A, 1st Floor

Power plants along the Delaware Estuary withdraw enormous quantities of water for cooling purposes. Future salinity increases in the estuary, as projected in coming years and decades, impose elevated operational costs on these facilities through increased chemical treatment requirements. We develop a linked physical-economic model to describe cost increases at notable power plants along the estuary. First, we create month-appropriate salinity projections based on 40 years of historical data. Next, we overlay projected salinity increases from a deepened navigational channel and sea-level rise atop baseline salinity projections. From these composite projections, we calculate daily cost increases 50 years hence. Ironically, costs incurred by power plants relying on ecologically-preferred recirculating cooling systems are more sensitive to salinity increases than older, once-through cooling systems. Hope Creek Generating Station (HCGS), a large nuclear facility with a recirculating cooling system, incurs the largest share of cost increases in the estuary as a result of its downstream location and vast water requirements. Results indicate that a near-immediate 0.2 PPT increase in salinity at HCGS, as expected from a channel deepened to 45 ft., increases operational costs to HCGS by $0.8M in net present value (NPV), relative to a baseline with no salinity increase. A gradual 3 PPT salinity increase, as expected under a 2-foot rise in sea level, results in an additional cost of $8M in NPV for HCGS. Sensitivity analyses are performed on key model inputs, including discount rate, salinity rise, and water treatment costs. The reported values represent less than 1% of the electricity sales revenue from these facilities over similar periods.

Monitoring Wetland Flooding Dynamics in a Delaware Bay Tributary

Siok, Drexel, Delaware Coastal Programs, 100 W Water Street, Suite 7B, Dover, Delaware 19904, Drexel.Siok@state.de.us; Robert Scarborough, Delaware Coastal Programs, Delaware Coastal Management Program; Kari St.Laurent, Delaware Coastal Programs, Delaware National Estuarine Research Reserve

Poster Session, Monday, 5:15pm, 5th Floor

The Delaware Coastal Management Program (DCMP), in conjunction with the Delaware National Estuarine Research Reserve (DNERR), has established several long-term tidal wetland monitoring programs, including Surface Elevation Tables (SETs). However, additional research and monitoring of hydrological patterns are needed in order to better understand and predict wetland habitat changes, sediment accretion rates, and coastal property vulnerability in Delaware's tidal wetlands. These variable patterns include processes such as storm surge attenuation, tidal amplitude changes, and tidal lag times. In response to these unknowns, the DCMP and DNERR installed 12 HOBO water level recorders in the summer of 2016 within a targeted area of the St. Jones River watershed in order to capture the flooding dynamics of this Delaware Bay tributary. Seven HOBOs were placed within tidal branches to monitor water levels, four HOBOs were placed on the marsh surface near established SETs, and one HOBO was used to calculate the barometric pressure offset needed to accurately compensate for barometric pressure fluctuations resulting from weather variability. This on-going monitoring project will capture marsh water level and flooding dynamics, allowing scientists to assess if above-ground flooding duration in the St. Jones marsh effects sediment accretion at the SET sites.

The Impact of Past Management Practices on Tidal Marsh Resilience to Sea Level Rise in the Delaware Estuary

Smith, Joseph, Niles & Associates, po box 784, Cape May, NJ 08204, smithjam@gmail.com; Steven Hafner, Stockton University Center for Coastal Research; Larry J. Niles, Niles & Associates

Estuary Restoration, Monday, 1:30pm, Grand Ballroom A, 1st Floor

Defining appropriate management and conservation strategies to maximize tidal marsh resilience to sea level rise requires a clear understanding of the causes of marsh degradation. While sea level rise is a well-known threat to tidal marshes, current and past management practices on marshes can also greatly influence marsh condition, resilience and future persistence. In the New Jersey portion of the Delaware Estuary, we estimated the historic extent of tidal marsh impoundment for agriculture and determined current marsh condition and elevation in areas that were and were not historically impounded. We found that more than half of all tidal marsh in the study area had been historically impounded. A small fraction of this area remains impounded at present. While tidal flow has since returned to formerly diked areas, marsh recovery has been incomplete. Overall 21.6% of formerly impounded marsh has not revegetated, becoming open water after impoundment breaches. Marsh loss as a result of impoundment is also responsible in some cases for the loss of adjacent shoreline beaches. Conversely, only a small fraction of marsh that was never impounded has converted to open water since 1930. This difference is likely due to dramatic elevation deficits caused by impoundment. Marsh elevation of current and formerly impounded areas is significantly lower than the elevation of marsh areas that were never impounded. Supporting this finding, the frequency of high marsh vegetation in vegetated formerly impounded areas is half that of areas that were never impounded. Assigning the causes of current marsh condition and impacts of past management practices makes it possible parse the relative contribution of relative sea level rise and site-level management, resulting in more targeted conservation strategies.

MidTRAM 4.0 : Updates and Improvements

Smith, Kenny, DNREC: Wetland Monitoring and Assessment, 100 West Water Street, Suite 10B, Dover, Delaware 19904, Kenneth.e.smith@state.de.us;

Poster Session, Monday, 5:15pm, 5th Floor

The Delaware Department of Natural Resources Wetland Monitoring and Assessment Program (WMAP) and The Partnership for the Delaware Estuary(PDE) have recently updated the Mid-Atlantic Tidal Wetland Rapid Assessment Method (MidTRAM) to Version 4.0. The updates are a result of the extensive data that has been collected and analyzed by these two programs. The updates will provide a greater understanding of tidal wetland conditions, while still maintaining the goal of rapidly analyzing tidal wetlands. The protocol consists of 3 attributes, Buffer, Hydrology, and Habitat which represents the major wetland attributes. When all the scores are combined it provides a final score for every analyzed wetland point, which then can be used to create watershed wetland reports. Each attribute contains scoring metrics that are observed in the field or in the office using ArcGIS. Version 4.0 has been unveiled in the Appoquinimink watershed in New Castle County, Delaware in the summer of 2016.

A Feasibility and Baseline Assessment for Zooplankton Monitoring at the Delaware National Estuarine Research Reserve

St. Laurent, Kari, Delaware National Estuarine Research Reserve, 818 Kitts Hummock Road, Dover, Delaware 19901, Kari.stlaurent@state.de.us; Molly Williams, Delaware National Estuarine Research Reserve

Monitoring, Tuesday, 10:00am, Crystal Room, 1st Floor

Zooplankton are fundamentally critical organisms in the marine food web by serving as prey for economically important nekton, predators of primary producers, and drivers of biogeochemical cycles in aquatic systems. With this in mind, the Delaware National Estuarine Research Reserve (DNERR) sought to establish a fixed, long-term zooplankton monitoring effort in order to measure and assess zooplankton seasonal and annual variability at Scotton Landing on the St. Jones River, Delaware. In the summer of 2016, a zooplankton feasibility and baseline study was conducted to assess the optimal sampling protocol, bimonthly sampling time, and analytical approach to serve as representative temporal snapshots of the zooplankton community in a brackish tributary of Delaware Bay. Zooplankton samples were collected and compared during different stages in a tidal cycle (ebb, flood, high, and low), day versus night, and under different durations (1, 2, and 3 minutes). Here we present our initial findings of zooplankton species richness, dominant species, and overall biomass as well as our recommendations forward with an understanding of utilizing the best scientific approach while balancing available resources. This feasibility study initiates the data collection to assess if long-term changes to zooplankton biodiversity and total biomass will change due to natural climate variability and anthropogenic pressures (such as land-use, population, and climate changes) in the St. Jones River, Delaware.

Evaluation of Light Intensity under a Salt Marsh Boardwalk Utilizing Two Different Materials

St. Laurent, Kari, Delaware National Estuarine Research Reserve, 818 Kitts Hummock Road, Dover, Delaware 19901, kari.stlaurent@state.de.us; Michael G. Mensinger, Delaware National Estuarine Research Reserve

Monitoring, Wednesday, 9:00am, Grand Ballroom A, 1st Floor

In an effort to increase public access and appreciation of tidal wetlands in Delaware, the St. Jones Reserve component of the Delaware National Estuarine Research Reserve (DNERR) features a 2 mile walking trail. While boardwalks cause less impact than continuous foot traffic, traditional wooden panels can locally decrease light penetration to underlying vegetation. With this in mind, the DNERR installed three 6 by 9 foot sections using an alternative plastic material which has a greater open space, potentially allowing for greater light penetration than the traditional wooden planks. HOBO light sensors were placed under the three alternative material sections, as well as under a control of the traditional wooden planks, to monitor light intensity from September 2011 to April 2016. This study presents a comparative assessment of underlying light intensity between traditional wooden planks with the alternative grated material. Probability density functions of light intensity were tested by day, season, and year for distribution and mean differences using multiple, non-parametric statistical approaches. Additionally, the length of the solar growing season was calculated, which we operationally defined here as the non-winter daylight intensity length. Lastly, a cost evaluation of the materials was generated as well as on-site observations (sun angle, vegetation density and species). This study will provide wetland managers with insights on using different materials when constructing future boardwalks for public assess to a wetland.

Rebuilding Beaver Creek

Stahl, P.E., Timothy M., Pennsylvania Department of Environmental Resources, Bureau of Abandoned Mine Reclamation, 2 Public Square,5th Floor, Wilkes-Barre, PA 18701, tistahl@pa.gov

Estuary Restoration, Wednesday, 10:30am, Grand Ballroom A, 1st Floor

The subject portion of Beaver Creek from the village of Tresckow to Beaver Meadows, Pa (Banks Twp., Carbon Co. ~100 miles northwest of Philadelphia) existed prior to anthracite mining and was headwaters to the Lehigh and Delaware Rivers. One can only imagine living nearby or taking a hike amongst the diverse flora and wildflowers, seeing the native trout feeding on mayflies and nymphs, finding crawfish under the streambed rocks. It was once just as vibrant and healthy as any rural headwater stream found elsewhere in Appalachia. Beginning with deep mining over a hundred and fifty years ago, portions of the creek were dammed, diverted underground, and lost from the surface. Later strip mining lowered elevations, removed most of the stream bed, and stranded the water, thus eliminating the possibility of stream connectivity.

The OSM 13(3206)101.1 - Tresckow South project located south of the Village of Tresckow, (Banks Township, Carbon County) is an opportunity to not only reclaim the abandoned mine site but to also **"begin"** to rebuild the Beaver Creek. Eliminating Priority 1 & 2 Health and Safety AML Features is the primary goal. Besides these features, storm water must also be considered. The design conveys SWM flow downstream and off-site instead of infiltrating it on-site into the underground mine pool, thus the basis for a rebuilt creek. A positive effect of this project is any volume of storm water kept on the surface and out of the mine pool means that a similar volume of AMD is kept out of the Audenried and Quakake Tunnels. “Begin” is highlighted because rebuilding Beaver Creek will also require an extensive AML project involving both the PA3207–Junedale project and slight modifications to the OSM 13(2107)101.1–Beaver Meadows project, to establish complete connectivity to the stable downstream portion of the watershed.

Salt Marsh Resilience At Cape May And Supawna Meadows National Wildlife Refuges: Responding To Hurricane Sandy And Beyond

Szczepanski, John (Jack), U.S. Fish and Wildlife Service, Cape May National Wildlife Refuge, 24 Kimbles Beach Road, Cape May Court House, NJ 08210, john_szczepanski@fws.gov; Heidi Hanlon, U.S. Fish and Wildlife Service, Cape May National Wildlife Refuge; Michael Tolan, U.S. Fish and Wildlife Service, Cape May National Wildlife Refuge

Poster Session, Monday, 5:15pm, 5th Floor

Many of New Jersey's Delaware Bayshore marshes have a history of disturbance which includes mosquito control ditching, agricultural manipulations associated with salt hay production, impoundments for waterfowl, and conversion of manipulated marshes back to tidal systems. Though Hurricane Sandy had more immediate and severe effects on much of the Mid Atlantic Coast, it has also afforded the opportunity to restore the affected areas from those past disturbances and enhance the resilience to more long term changes in environmental conditions, like sea level rise (SLR). Our resiliency project incorporates efforts at two separate refuge sites; improvement of hydrology in the marsh interior scarred by mosquito ditching and salt hay production at Reeds Beach is the focus of the work at Cape May NWR while modifying a stone breakwater initially built for coastal protection of commercial interests at the turn of the century is the focus of work at Supawna Meadows NWR. MACWA and MidTRAM, in conjunction with intensive sediment and hydrodynamic modeling, were used to develop nature-based alternatives that will enable both sites to move in a positive direction toward their respective objectives. These aspects of the project aim to help each affected marsh to 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.

Using Green Infrastructure to Maximize Restoration Benefits

Thomas-Blate, Jessie, American Rivers, 1101 14th Street NW, Suite 1400, Washington, DC 20005, jthomas@americanrivers.org; Brian Hazelwood, American Rivers

Estuary Restoration, Wednesday, 10:30am, Grand Ballroom A, 1st Floor

Watersheds draining 13,539 square miles across four states provide life-giving freshwater to the Delaware Estuary. Rivers and streams coursing through that expanse have been impacted by development, dams and other barriers, water pollution, agricultural inputs, industry, and various other threats to their vitality. Until recently, many river conservation projects were completed in isolation. A single dam was removed, or cattle were fenced out of a stretch of stream, or perhaps a business installed a rain garden. In order to truly restore the health of these rivers that provide drinking water, fish habitat, recreational opportunities, and a myriad of other ecosystem functions, conservation practitioners should begin to consider implementing companion projects that employ a suite of compatible strategies.

American Rivers has developed and pilot-tested a conservation companion project approach in a new resource entitled, "Maximizing On-The-Ground Conservation Benefits: A Guide for Identifying Companion River Restoration and Green Stormwater Infrastructure Projects." This framework presents a process for identifying existing restoration project locations within a specific subwatershed that have objectives that could be enhanced by implementing complementary green stormwater infrastructure projects nearby. It further extends that process into identifying and prioritizing companion projects that can be proposed to municipalities and others interested in conservation implementation in that subwatershed. Case study tests of this approach are presented from the Tookany/Tacony-Frankford watershed in Pennsylvania and the Musconetcong River watershed in New Jersey.

This guide will be most beneficial to practitioners working in urban or suburban areas whose watersheds are impacted by extensive development or otherwise face critical stormwater challenges that can benefit from a green infrastructure approach. In an era of limited resources, investing in projects that will have measurable impacts is increasingly required. We present one approach for coupling conservation work to maximize benefits to a river ecosystem.

Exploring Effective Science Communication In The Digital Realm

Tossey, Lisa, University of Delaware/Delaware Sea Grant, 8 Jefferson St, Berlin, MD 21811, tossey@udel.edu;

Beyond Education to Engagement, Tuesday, 10:00am, Grand Ballroom C, 1st Floor

Science communication often suffers from numerous pitfalls including jargon, complexity, a general lack of (science) education of the audience, and short attention spans. Delaware Sea Grant, with its mission of "science serving the Delaware coast," has been taking on these challenges through innovative approaches using emerging digital technologies. These have included its 15 Second Science video series, which deliver complex marine science topics with visually stimulating footage and succinct audio in short, mobile-friendly episodes, and exploration of smartphone-based virtual reality educational offerings on deep-sea science with the Center for Dark Energy Biosphere (C-DEBI) Investigations. Let’s look at how to make the most out of digital platforms, such as social media and online video, for scientific outreach, and best practices for planning, producing, distributing, and evaluating related educational content.

Cape May Spit Growth, Migration Of The Delaware River, And Evolution Of The Delaware Estuary Over The Last 150,000 Years

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Poster Session, Monday, 5:15pm, 5th Floor

Delaware River incision during a sea-level fall ~140,000-150,000 yrs. (140-150 kyr) ago carved a river valley that in-filled with estuarine and beach sediment during the following sea-level rise ~ 125,000 yrs. ago. Spit growth forced the Delaware channel south of Cape May. Acoustic profiles of the inner continental shelf trace the paleovalley seaward, and image more recent channels of tidal/fluvial origin. We identify 4 erosional surfaces in subsea profiles and correlate to onshore drill records where possible. The youngest reflector is the transgressive ravinement surface, created by wave erosion as the shoreline migrated during sea-level rise. It appears as sand-filled shallow incisions capped by sandy shoals of 1-2 m amplitude in the bay mouth. Below this, organics from interbedded sand/clay yield calibrated radiocarbon ages of 4930 +/- 40 to 6110 +/- 30 BP at 9.8 m and 13.5 m depth, respectively. The second reflector displaying signs of erosion, interpreted as the land surface during the last glacial maximum ~22-18 kyr ago when sea level was ~125 m below present overlies weathered sands/clays with radiocarbon dates of >40,500 BP. We identify two additional erosional surfaces of ~ 70 and ~140-150 kyr. We interpret the ~140-150-kyr surface as a broad ancient river valley offshore, which connects to a similar feature crossing under present-day Cape May and to an ancient valley identified in previous seismic studies in Delaware Bay. Smaller meandering channels identified as ~70 kyr and of tidal origin flank and re-incise the older valley. Seismic data reveal stepwise channel migration toward the Delaware Bay mouth. Shoals and wave ripple complexes showing bayward transport overlie these channels. Thus, southward migration of the Cape May spit, with the “forcing” of the Delaware River channel southwestward, created the present-day bay bathymetry, including the main channel and the shallow waters in the eastern Bay.

National Victory for the Watershed: The Delaware River Basin Conservation Act

Urbish, Madeline, Coalition for the Delaware River Watershed, 172 West State Street, Trenton, NJ 08608, madeline.urbish@njaudubon.org

Hot Topics, Wednesday, 1:45pm, Grand Ballroom, 1st Floor

The Delaware River Basin Conservation Act was passed by Congress and signed into law by President Obama in December 2016. The law establishes the Delaware River Basin Restoration Program in the U.S. Fish and Wildlife Service, which will provide a watershed-wide framework for identifying, prioritizing, and implementing on-the-ground conservation projects to protect and restore the Delaware River Watershed. The law also authorizes a grant and technical assistance program, which will provide federal funding for this important work in the basin. The Coalition for the Delaware River Watershed and its partners worked over the past four years to advocate for the advancement of this legislation, and will now focus on ensuring the program is funded and that the U.S. Fish and Wildlife Service works collaboratively with the wide array of organizations working to protect and restore the watershed as it develops the framework for the Delaware River Basin Restoration Program.

Scrubbing Up the Schuylkill

Vassalotti, Virginia, Partnership for the Delaware Estuary, 110 South Poplar Street, Suite 202, Wilmington, DE 19806, vvassalotti@delawareestuary.org;

Trash Talking the Waterways, Monday, 10:45am, Grand Ballroom C, 1st Floor

The Schuylkill Scrub is a cleanup initiative that takes place from March 1 through May 31 every spring throughout the Schuylkill Watershed. For 6 years the Schuylkill Action Network (SAN) has been coordinating this initiative by encouraging and promoting volunteer cleanups. Recently, the SAN and its partners want to do more to prevent litter from ending up in our waters, instead of cleaning it up after the fact. The first step is to learn more about the litter issue in the Schuylkill watershed – where litter is originating from and ending up, and what type of litter is most prominent. By studying this issue, the SAN will be able to develop outreach programs and messaging targeted towards various audiences. This presentation will explore how the Scrub has evolved over the years, including the amount of trash removed from the watershed, and where the SAN would like to see the Scrub in the future.

Extensive Biogeochemical Sampling of the Sediment and Water Column in the Tidal Freshwater Delaware River, 2012-2014

Velinsky, David, The Academy of Natural Sciences of Drexel University, 1900 Benjamin Franklin Pkwy, Philadelphia, PA 19103, djv23@drexel.edu; Jeffrey Cornwell, Chesapeake Biogeochemical Associates; Mike Owens, Chesapeake Biogeochemical Associates; David Walsh, Woods Hole Group; Josef Kardos, Philadelphia Water

Water Quality, Tuesday, 9:00am, Grand Ballroom A, 1st Floor

An extensive sampling program was conducted from 2012-2014 in the tidal freshwater Delaware River between Trenton and Delaware City. In total, 106 samples were analyzed for surface sediment "surrogate" parameters (e.g., sediment chlorophyll-a, organic carbon, total nitrogen, total phosphorus, grain size, total organic matter), 127 samples were analyzed for sediment oxygen demand (SOD), and 48 samples were analyzed for benthic nutrient flux.

Unexpectedly, weak to no correlation was found between the surrogate parameters and SOD. When corrected to 20C, there was no significant difference in SOD between seasons. Although SOD measurements were of high quality and generally reproducible, rates were unexpectedly low compared to the dissolved oxygen inventory of the Estuary's waters.

The nutrient fluxes were generally typical of a system with modest rates of SOD. The modest SOD rates are indicative of processes associated with a terrestrial source dominated organic matter pool. These overall rates contrast greatly with algal driven systems such as the mesohaline Chesapeake Bay. The denitrification rates in summer and spring were quite high, driven by high concentrations of overlying water column nitrate as well as some coupled nitrification-denitrification.

SOD and denitrification showed little variance throughout the estuary; this is surprising because of the large urban component in the middle estuary. The mid-estuary "bulge" in soluble reactive phosphorus (SRP) effluxes was surprising because none of the other sediment data provide clues to the mechanism(s) that drive these SRP releases.

Water column nitrification rates were measured at 12 sites in both spring and summer seasons. The spatial pattern in rates matched that of a study from the 1980s. The highest nitrification rates were in DRBC Zone 4. Nitrification rates were much lower in spring compared to summer.

Program results were critical to development of a dissolved oxygen model of the tidal freshwater Delaware River.

Innovative Living Shoreline and Tidal Marsh Enhancement Project at an Inland Bays Marina

Walch, Marianne, Delaware Center for the Inland Bays, 39375 Inlet Road, Rehoboth Beach, DE 19971, science@inlandbays.org; Douglas Janiec, Sovereign Consulting Inc.; Brett Dietz, Sovereign Consulting Inc.

Living Shorelines, Tuesday, 3:30pm, Grand Ballroom A, 1st Floor

The Delaware Center for the Inland Bays (CIB) is engaged in an initiative to maximize the use of living shoreline stabilization techniques in the watershed. An important component of the Inland Bays Living Shoreline Initiative is the creation of publically accessible, local demonstration projects that can be used as tools for educating the public and marine contractors. The goal is increased adoption of these green shoreline management techniques, resulting in water quality and habitat improvements in the Inland Bays.

The third living shoreline demonstration in the Inland Bays is being completed at a privately owned marina on White Creek, a tributary of the Indian River Bay. Marina owners sought the CIB's assistance in designing green infrastructure to address loss of wetlands at their site. In addition to the marina channel and slips, the property has approximately one acre of existing *Spartina* marsh in two areas on either side of the docks. Wave energy, combined with sea level rise, has resulted in erosion of the marsh edges and overall loss of wetlands. Attempts were made in the 1990's to stabilize and protect eroding areas with stone revetments. In the long-term, this was ineffective, and wetlands loss continues.

The current project will stabilize nearly 500 feet of marsh edge, create 50 feet of new edge, and protect or restore over an acre of tidal marsh. A combination of several new, innovative living shoreline techniques and materials has been used, and the design incorporates beneficial reuse of dredge spoils from the marina channel. A truly unique component of this project is the use of a line of floating wetlands and permanent turbidity curtains, secured to pilings, which will serve to form new marsh edge, contain sediments and plantings, and provide attachment sites for ribbed mussels.

Jersey-Friendly Yards: Landscaping for a Healthy Environment

Walzer, Karen, Barnegat Bay Partnership, Ocean County College, PO Box 2001, Toms River, NJ 08754, kwalzer@ocean.edu; Becky Laboy, Ocean County Soil Conservation District

Beyond Education to Engagement, Tuesday, 10:00am, Grand Ballroom C, 1st Floor

Working to protect and restore the water quality and ecological integrity of New Jersey's estuaries, the state's three National Estuary Programs have targeted the reduction of non-point source pollution in stormwater runoff as a critical goal. Over the years numerous initiatives have been developed to educate property owners about "people" pollution and encourage behavior change at home – from educating about responsible fertilizer use to improving soil health and installing rain gardens. The challenge was to pull the multiple sources of information into one easy-to-use resource to help NJ property owners make sound landscaping decisions for a healthier environment. With that goal and grant funding from the NJ Department of Environmental Protection, the Barnegat Bay Partnership (BBP) developed "Jersey-Friendly Yards" (www.jerseyyards.org), a comprehensive online guide to low-maintenance, eco-friendly landscaping in New Jersey. The website provides NJ property owners with state-specific information about reducing use of fertilizers and pesticides, planting native species, conserving water, creating habitat for pollinators and other wildlife, and improving overall yard health. Website highlights include a searchable Plant Database (where users can create a custom plant list for their specific conditions) and the "Interactive Yard" (a tool for learning the basics about transforming a conventional yard into a Jersey-Friendly yard). Partnering with the BBP, the Ocean County Soil Conservation District (OCSCD) implemented six Jersey-Friendly Yards pilot projects funded by the grant. These six demonstration sites are now available to local communities as models of healthy low-maintenance landscaping. Presenters will showcase the website's resources and practical applications, including the results of the six Jersey-Friendly Yards implementation projects.

Do Nitrous Oxide Emissions Offset Potential Greenhouse Gas Mitigation Benefits of Wetland Restoration in Eutrophic Estuaries?

Watson, Elizabeth, Academy of Natural Sciences and Drexel University, 1900 Benjamin Franklin Pkway, Philadelphia, PA 19006, elizabeth.b.watson@drexel.edu; Rose Martin, Oak Ridge Institute for Science and Education Post-doctoral Fellow, Atlantic Ecology Division, ORD-NHEERL, U.S. Environmental Protection Agency; Kerstin Wasson, Elkhorn Slough National Estuarine Research Reserve; Kat Beheshti, University of California, Santa Cruz; Elisabeth Powell, Academy of Natural Sciences and Drexel University; David Velinsky, Academy of Natural Sciences and Drexel University; Cathleen Wigand, Atlantic Ecology Division, ORD-NHEERL, U.S. Environmental Protection Agency, Narragansett, RI

Wetlands, Tuesday, 10:00am, Grand Ballroom A, 1st Floor

Seagrass beds, mangrove forests, and coastal marshes cover less than a fraction of one percent of the earth's surface, yet they are efficient at organic carbon burial due to high rates of primary production and anoxic soils that sequester rather than mineralize soil carbon. Vegetated coastal habitats are also associated with large soil carbon stocks, which are vulnerable to loss due to land use change, coastal development, and sea level rise. Recent efforts have offered incentives for conservation or restoration of coastal ecosystems to offset carbon dioxide emissions, and therefore mitigate global climate change. While protection and restoration of coastal ecosystems offer many additional societal benefits in addition to climate change mitigation, siting of projects where carbon sequestration benefits are high may act to increase coastal restoration and conservation funding. Here, we ask whether high nitrate inputs cause wetlands to emit significant concentrations of nitrous oxide, a potent greenhouse gas, through incomplete denitrification, thus offsetting the greenhouse gas mitigation benefits of coastal wetlands. Here, we use data from dated sediment cores analyzed for soil organic carbon density in California, New Jersey, Delaware, and Pennsylvania, in concert with greenhouse gas emissions measurements performed using cavity ring-down spectroscopy, to estimate the net radiative forcing of coastal wetlands relative to their nitrate inputs.

Net Ecosystem Carbon Exchange and the Greenhouse Gas Balance of Tidal Marshes along the Salinity Gradient in the Delaware River Estuary

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Wetlands, Tuesday, 10:00am, Grand Ballroom A, 1st Floor

Tidal wetlands are productive ecosystems with the capacity to sequester large amounts of carbon (C), but we know relatively little about the impact of climate change on wetland C cycling in lower salinity (oligohaline and tidal freshwater) coastal marshes. In this study we assessed plant production, C cycling and sequestration, and microbial organic matter mineralization at tidal freshwater, oligohaline, and salt-marsh sites along the salinity gradient in the Delaware River Estuary over four years. We measured aboveground plant biomass, carbon dioxide (CO2) and methane (CH4) exchange between the marsh and atmosphere, microbial sulfate reduction and methanogenesis in marsh soils, and C sequestration with radiodating of soils. All three marsh types were highly productive but evidenced different patterns of C sequestration and greenhouse gas (GHG) source/sink status. The salt-marsh was a C sink, a minor sink for atmospheric CH4, and therefore an overall GHG sink. The tidal freshwater marsh was a modest source of CH4 to the atmosphere, and there were large interannual differences in plant production and therefore C and GHG source/sink status. The oligohaline marsh site experienced seasonal saltwater intrusion in the late summer and fall and the plant community at this site responded with sharp declines in biomass and production in late summer. Salinity intrusion was also linked to large effluxes of CH4 at the oligohaline site, making this site a significant GHG source to the atmosphere. The oligohaline site did not accumulate C over the 2 year study period, though radiodating indicated long term C accumulation, suggesting seasonal salt-water intrusion can significantly alter C cycling and GHG exchange dynamics in tidal marsh ecosystems. The marshes in the Delaware River have historically been strong C sinks, though climate change may be altering rates of C sequestration.

Monitoring the Response of Estuarine Wetlands to Anthropogenic Disturbances at the St. Jones Reserve After One Year

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Wetlands, Tuesday, 10:00am, Grand Ballroom A, 1st Floor

In April 2015, Delmarva Power & Light (DP&L) began an emergency pole replacement project that had the potential to impact portions of the DNERR Vegetation Monitoring site. Following pre-permit planning meetings, DP&L reached an agreement with DNREC's Wetlands and Subaqueous Lands section, the Division of Fish and Wildlife and the DNERR to have all power line replacement work completed with low impact equipment instead of heavy machinery to reduce the disturbance of marsh habitats. Equipment used during the project included a helicopter, an airboat and an Argo (amphibious off-road vehicle) to move construction workers across the marsh and matting to create a stable installation area around the power poles. Once the pole replacement was completed in May 2015, DNERR staff assessed the area and determined that the disturbance of construction was greater than expected and post-project monitoring was needed. The goal of the new monitoring project is to document the level of disturbance and how the marsh recovers or changes over time. This information is being captured by monitoring vegetation, soil bearing capacity, and photo documentation. Preliminary observations suggest recovery is occurring, at a slow pace, and continued monitoring is needed to understand the long-term response, impacts, and recovery of the tidal wetland system.

Completed Implementation of Prime Hook National Wildlife Refuge's Recovery and Resiliency Ecosystem Restoration

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Post Sandy Lessons, Monday, 10:45am, Grand Ballroom A, 1st Floor

Prime Hook National Wildlife Refuge in Delaware has restored tidal marsh in 4000 acres of wetlands previously managed as freshwater impoundments, which were impacted by saltwater intrusion through substantial dune breaches during storms, including Hurricane Sandy. The shoreline recovery along approximately 7000 linear feet along Unit II utilized over 1 million cubic yards of sand dredged from an offshore borrow site to close the breaches and create a dune and berm with a long sloping forebeach. A novel approach was used to incorporate naturally formed shoals in the creation of the backbarrier platform, which varies in width from 100-600 feet and was planted with Panicum and *Spartina* grasses to boost revegetation and provide added stability for the dune restoration. The strong nor'easter that hit in late January of 2016 had very little impact on the constructed project. A network of more than 20 miles of channels, ranging 25 to 50 feet wide and 3 to 4 feet deep, was dredged throughout the wetland units to restore tidal circulation. Channels. Approximately 600,000 cy of material dredged during this process was disposed on-site as a means of beneficial re-use, which will supplement marsh elevation in some areas of the wetlands. The extensive dredging operation required frequent adaptations of strategy and equipment in order to be successful. The Delaware Department of Transportation (DelDOT) has constructed a bridge along a portion of Prime Hook Rd. which will cross a large conveyance channel and thus complement the restoration project. Two water control structures and 1,800 feet of Fowler Beach Rd. will be removed to further facilitate tidal flow and hydrological connections between the restored units and existing salt marsh. Treatment of *Phragmites* is also part of the project. Success of the project will continue to be monitored to provide ongoing lessons for restoration practitioners.

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

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Poster Session, Monday, 5:15pm, 5th Floor

The beaches of the Delaware Bayshore provide import spawning habitat to the Atlantic horseshoe crab (*Limulus polyphemus*) every spring with peak spawning occurring around new and full moons during late April to mid-June. A portion of these beaches are also home to several New Jersey oyster farms. Conservation groups have expressed concern that farms may impede access to nesting beaches so this study compared abundances of horseshoe crabs on beaches at the Rutgers Cape Shore facility to better understand if racks used for aquaculture are affecting horseshoe crab access to the beach. This was done through an expansion of the ReTurn The Favor (RTF) volunteer effort orchestrated by The Wetlands Institute of Stone Harbor, NJ. RTF counts only live flipped or trapped (impinged) crabs. Here, all live horseshoe crabs were counted on the beach three hours after high tide during their nesting season along five adjacent beach segments. Two of the segments had active farms, three did not. Analysis of the data indicated that 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., those beaches with more sand and a gentler slope contained more crabs in agreement with previous studies on optimal spawning habitat.

Applications For Near Real-Time And Interactive Data Assessment In The Delaware River Basin

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Poster Session, Monday, 5:15pm, 5th Floor

Advances in data processing scripting languages (such as R) allow us to do more with the data we already collect. In recent years the Delaware River Basin Commission has been developing a series of applications to make the most of basin water quality and flow data. This poster session will highlight interactive examples, such as the Boat Run Explorer and AEMR Explorer, and near real time assessments including the DRBC flow and water quality dashboards. These applications provide real up-to-date understanding about the conditions of the Delaware River Basin and allow users to intuitively tailor visualizations to their individual needs. This poster will include an interactive electronic screen to allow conference attendees to use the applications, and will provide background on the data sets, scripts, and work flows behind the applications.

Beneficial Reuse of Dredge Material for Salt Marsh Restoration: Early Recovery of Vegetation and Epifaunal Macroinvertebrate

Yepsen, Metthea, New Jersey Nature Conservancy, 2350 Route 47, Delmont, New Jersey 08314, MYepsen@TNC.org; **Jessie Buckner**, New Jersey Nature Conservancy; Adrianna Zito-Livingston, New Jersey Nature Conservancy

Thin Layer Placement in Coastal Wetlands, Monday, 3:45pm, Crystal Room, 1st Floor

Coastal landscapes face new and dynamic challenges related to sea-level rise and intensified storm events. As coastal landscapes and their challenges change, coastal restoration techniques must adapt as well. The Nature Conservancy partnered with the New Jersey Department of Environmental Protection, New Jersey Department of Transportation, United States Army Corps of Engineers, and several other partners to explore beneficial reuse of dredged material to restore salt marshes in an ongoing project. Consistent monitoring before, throughout, and after the project quantifies the successes and lessons learned of this technique to inform adaptive management strategies for this and future projects.

The dredge material raises elevation in areas of concern. Loss of elevation affects plant community, the fauna that uses it, and contributes to an exponential cycle of erosion and elevation loss exacerbated by sea-level rise. By raising the elevation of the marsh platform, the overall health and resilience of the marsh ecosystem increases. Robustness of vegetation indicates marsh condition and functionality. Vegetation provides habitat, food, sediment stabilization, and fixes nutrients amongst numerous other benefits. Robustness can be measured qualitatively through photographs but also quantitatively through percent cover observations, stem height measurements, and biomass samples. Vegetation also suggests functionality of a marsh; weak vegetation indicates a problem which can then be explored further. Epifaunal macroinvertebrates can be also used as weathervanes to marsh health. Together, these metrics can give a strong understanding of marsh condition

Initial impacts of placed sediments on and recovery of these metrics pre-planting have been collected in a before-after-control-impact monitoring design. Early results show some initial recovery, but the results of longer term monitoring are still needed before the success of this experimental technique can be demonstrated. The impact of placement on vegetation and epifaunal macroinvertebrate will inform the next phases of this project and any future similar projects in this region.

A Goal-Based Framework for Coastal Restoration Project Monitoring Plan Development: Measuring Project Success, Informing Adaptive Management, and Guiding Future Project Development

Yepsen, Metthea, The Nature Conservancy, 2350 Route 47, Delmont, NJ 08314, myepsen@tnc.org; **Joshua Moody**, The Partnership for the Delaware Estuary; Elizabeth Schuster, The Nature Conservancy

Living Shorelines, Tuesday, 3:30pm, Grand Ballroom A, 1st Floor

Sea level rise, increases in storm severity and frequency, and the ecological degradation of many existing coastal habitats has led to restoration efforts becoming a top priority for many coastal management and research-based organizations. This rise in coastal restoration projects provides an opportunity for practitioners to learn valuable lessons regarding a variety of techniques, their performance, appropriate application, and adaptive management activities through the collection and sharing of data. In tandem with efforts from the Delaware Living Shoreline Committee, a New Jersey-based workgroup was assembled to write a user-friendly guide on the development of monitoring plans for coastal restoration projects, and recently published a document titled, "A Framework for Developing Monitoring Plans for Coastal Wetland Restoration and Living Shoreline Projects in New Jersey". Because it is important for all restoration projects to have some level of monitoring, the document covers a variety of coastal wetland restoration and living shoreline techniques and is intended for users with a range of backgrounds and budgets.

The framework laid out in the document walks the user through the process of developing a monitoring plan that is meaningful for a specific project. Users first select metrics that are relevant to their projects' goals and restoration technique, second they select methods of collecting data for each metric based on the user's specific considerations (e.g., budget, experience, etc.), and finally metrics and methods are inserted into the monitoring plan template provided.

By assessing coastal restoration projects with a common set of metrics and sharing lessons learned, we expect three major advantages: 1) improved technique selection and project design that better meets site-specific ecological and socioeconomic goals, 2) a better informed and interactive permitting process, and 3) increased funding and support for natural and nature-based solutions based upon the greater understanding of the ecological and socioeconomic benefits.

Spatial and Temporal Variability of the Composition of Urban Litter in the Riparian Zone of the Poquessing Creek

Yerk, Walter, Drexel University, 3141 Chestnut St, Curtis 251, Philadelphia, PA 19104, wgy23@drexel.edu; Nance Kerns, Friends of the Poquessing Watershed; Suzanne Zlotnick, Friends of the Poquessing Watershed

Trash Talking the Waterways, Monday, 10:45am, Grand Ballroom C, 1st Floor

The persistence of urban litter in waterways and riparian zones degrades them environmentally and aesthetically.

The Friends of the Poquessing Watershed have been recording outcomes of monthly clean-ups in a systematic order since 2014. The clean-ups have been concentrated in seven areas of the watershed. Collected litter was arranged into seven groups: (1) general trash and recyclables, (2) tires, (3) household items, (4) sport-related items and toys, (5) clothing, (6) automotive, and (7) miscellaneous large items. The classification was aimed to identify pathways and quantify volumes and variability of the litter produced by types of human activity.

Preliminary analysis revealed a strong correlation between the number of volunteer hours and bags of general trash and recyclables collected, and a moderate correlation between the number of general trash bags and all of the other groups of litter combined. Location was a strong predictor of both general and itemized litter. We identified persistent "hot spots" of certain groups of trash within the watershed. We will discuss the possibility of attributing the "hot spots" to the prevalence of commercial, recreational and residential activities within their proximity.

Quantifying litter load on the riparian zones will help to increase the effectiveness of clean-up efforts and target the litter prevention outreach programs.

An Assessment of Fish Species Richness in Cooper River, Camden County, NJ

Zucca, Natalie, Haddonfield Memorial HS, 401 Kings Highway East, Haddonfield, New Jersey 08033, nataliezucca@yahoo.com; Anna Haley, Haddonfield Memorial HS

Poster Session, Monday, 5:15pm, 5th Floor

Abstract - An Assessment of Fish Species Richness in Cooper River, Camden County, NJ

Cooper River, a largely urban river in western Camden County, NJ, has been the focus of restoration efforts over the last twenty years. About 16 years ago fish ladders were installed at the dams at the Wallworth and Evans Pond impoundments between the towns of Cherry Hill and Haddonfield. These fish ladders were installed to allow passage of migratory fish species, including Blueback Herring and Alewife that historically have used this tributary to the Delaware during spring spawn. Assessment of the use of these fish ladders by migratory species has been limited since their installation. In the spring of 2016, working in partnership with the scientists and staff from the Academy of Natural Sciences of Drexel University, Haddonfield Memorial High School Environmental Science students conducted an inventory of fish species richness at three sites along the Cooper River, above and below the dams at Wallworth and Evans Ponds. Many species were present in the river and ponds, including American Eels. However, no anadromous species were observed over two days of sampling. This inventory provides a useful baseline to compare future studies and to recommend additional site studies to further investigate the efficacy of restoration efforts and the potential presence of migratory fish in urban river systems in lower Delaware River tributaries.

Author Index:

Names listed alphabetically by last name, presenters in **bold**