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Video Documentation of the Marine Community Utilizing Oyster Farm Habitat

Ambrose, Alexandria, Rutgers University, Haskin Shellfish Research Lab, 6959 Miller Avenue, Port Norris, NJ, 08349, alexandria.ambrose13@gmail.com; Daphne M. Munroe, Rutgers University; Jenny P. Shinn, Rutgers University; Lisa M. Calvo, Rutgers University

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Shellfish growers routinely observe fish and invertebrates interacting with their aquaculture gear. To quantitatively assess these interactions, point-of-view (GoPro®) cameras were used to document fish activity in and around oyster cages, floating bags, and a marsh habitat (a natural control) at an oyster farm in the Little Egg Harbor region of Barnegat Bay, New Jersey in 2018 and 2019. At least 29 species from 4 phyla were observed across all days and sites in over 100 hours of video. Nekton abundance was determined using MaxN, defined as maximum number of individuals of a given species present within each 1-minute segment of video. Species of both ecological and economic importance in the local ecosystem utilized the farm gear as habitat. MaxN values varied across sampled seasons and habitat type. Most frequently, juveniles of a given species were observed using oyster farm habitat, suggesting that the farm may support and enhance the natural nursery function of marshes. Additionally, observations indicated a stochastic relationship between wildlife and human activity on the farm. This collaborative work is part of an ongoing effort in Long Island Sound by the NOAA Milford Lab and is a first step towards a comprehensive regional characterization and evaluation fish habitat provisioning on oyster farms.

Analysis of Attainability Part 1: A Strategy to Determine Potential Designated Uses in the Delaware River Estuary

Amidon, Thomas, Manager, Water Resources Modeling, Delaware River Basin Commission, 25 Cosey Road, P.O. Box 7360, West Trenton, NJ, 08628, Thomas.Amidon@drbc.gov

Water Quality & Quantity II, Monday, 2:30pm

The DRBC approved a resolution in September 2017 recognizing the significant water quality improvements in the Delaware River Estuary and the vital importance of determining the appropriate designated aquatic life uses and water quality criteria necessary to support these uses in a 38-mile section of the tidal Delaware River stretching from Wilmington to Philadelphia. DRBC is leading this effort through a collaborative process informed by an Expert Panel comprised of nationally recognized water resource scientists and engineers, and in close consultation with its Water Quality Advisory Committee. The resolution directs that an "analysis of attainability" be performed to determine the highest aquatic life use that can be achieved, incorporating the results of specific scientific and technical studies that are either completed or currently underway. The approach to defining aquatic life uses based on dissolved oxygen (DO) condition will be presented.

The segment of the tidal Delaware River within its most urbanized corridor is currently designated for fish maintenance and passage, as opposed to the goal of protection and propagation [CWA 101(a)(2)]. Existing DO conditions, which improved since the water quality goals were established in 1967, support some degree of propagation among DO-sensitive resident and anadromous fish. Aquatic life use, specifically the degree of fish propagation, is directly related to DO conditions; a higher minimum DO condition can be expected to enhance the degree of fish propagation. DRBC is therefore proposing to define the fishery use as the degree of propagation associated with a given DO condition. This is consistent with USEPA guidance for Highest Attainable Use designation: "Adopt a broad use and the best pollutant/parameter levels attainable so the HAU is whatever use is attained at these levels." Metrics for minimum DO, which is most critical to supporting fish propagation, are used to assess DO condition.

3D Elevation Program Lidar Data Availability and Potential Use Cases For the Delaware Bay Estuary

Barlow, Roger, Physical Scientist, U.S. Geological Survey, 12201 Sunrise Valley Dr., Mail Stop 511, Reston, VA, 20192, rbarlow@usgs.gov

Monitoring & Assessment, Tuesday, 10:30am

Accurate and consistent elevation data publicly available on a regional basis can provide a basis for monitoring and analysis for conditions effecting stream flow, surface run-off and linking changes to land cover to water quality and water quantity in Delaware Bay Estuary. The 3D Elevation Program has recently delivered a five county area of Quality Level 2 topographic lidar, tide-coordinated to the State of New Jersey. This presentation will review the available data, where it can be retrieved from, and show science analysis and use cases using elevation data. The Chesapeake Bay Program has invested in a basin wide land cover change monitoring effort to help model and successfully predict seasonal and long term changes to the estuary such as harmful algal blooms, salinity variability, nutrients, and impacts on flora and fauna using 3D Elevation Program data combined with other spatial and monitoring data.

Nutrients, Salinity, and Oysters: The Impact of Extreme Precipitation Events on Eastern Oyster (*Crassostrea virginica*) Ecosystem Services in the Delaware Bay

Barr, Janine, Graduate Student, Rutgers University, 29 Montrose Avenue, Summit, NJ, 07901, jmb883@hsrl.rutgers.edu; Dr. Daphne Munroe, Rutgers University; Lisa Calvo, Rutgers University; Dr. Danielle Kreeger, Partnership for the Delaware Estuary; Kurt Cheng, Partnership for the Delaware Estuary; Dr. Julie M. Rose, NOAA Fisheries NEFSC Milford Lab; Dr. Skylar Bayer, Roger Williams University

Living Resources: Oysters, Monday, 4:00pm

Nutrient pollution in the Delaware Bay has been a longstanding and widespread issue that has engendered robust management strategies and innovative nature-based solutions such as mussel propagation and restoration efforts. The importance of nature-based solutions in reducing nutrient pollution and its impacts to the Delaware Estuary have been highlighted in the 2019 revisions to A Comprehensive Conservation and Management Plan for the Delaware Estuary. A second challenge facing the Delaware Estuary is climate change in that projected increases in the frequency and intensity of freshwater events (i.e., precipitation) will result in more short-term extreme low-salinity events across the system. To address these issues, research is being conducted concerning the role of farmed and wild eastern oyster (*Crassostrea virginica*) populations in complementing existing nutrient mitigation efforts in the Delaware Bay under two salinity conditions: contemporary and future salinity scenario. Specifically, the project aims to (1) estimate farm-level year-round filtration occurring at an intertidal oyster farm, (2) estimate bed-level year-round filtration occurring at a subtidal oyster bed, and (3) quantify each population's contributions to improved water quality under the two salinity conditions. Data are being collected using a flow-through filtration chamber to calculate in-situ filtration rates of oysters. These methods may be an improvement on traditional methods which assess oyster filtration using static water and/or laboratory diets which can overestimate filtration. Additionally, these data will address data gaps concerning site-specific effects of salinity stress on oyster filtration. These results could also be used to inform the development of nutrient trading programs in the Delaware Bay similar to those in the Chesapeake Bay and elsewhere in the world. This presentation will provide preliminary results from this ongoing oyster filtration research effort.

Microplastics in Delaware Estuary Blue Crabs

Boettcher, Hayden, University of Delaware, 700 Pillottown Rd, Lewes, DE, 19958, hayden@udel.edu;
Dr. Jonathan Cohen, University of Delaware; Ian Johnson, Ursinus College

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Microplastics (MP), characterized as plastic particles smaller than 5mm, are a pervasive marine pollutant in Delaware and around the world. In the Delaware Bay and associated river systems, microplastics are ubiquitous, presenting a potential threat to ecologically and economically important marine organisms. In Delaware, the blue crab Callinectes sapidus is a crucial predator, and comprises over 70% of the state's fishery landings in terms of value. In a crucial step towards investigating the threat posed by MP to the Delaware Bay blue crab population, adult crabs were sampled from the Murderkill River and Blackbird Creek. The stomach, gills, and digestive cecum were dissected, digested, and analyzed for the presence of MP. Microplastic particles were then confirmed and analyzed by micro-FTIR to determine plastic polymer types. In total, 15 of the 31 crabs sampled contained microplastics (~48%). Ingested MP types were dominated by filaments (28) followed by rubber (2) and fragments (1). The majority of microplastic particles were found in the stomach (21), followed by the digestive cecum and gills (5 and 3 respectively). This is the first confirmation of microplastic ingestion within the Delaware Estuary blue crab population. Further research will determine the scope of microplastic ingestion in blue crabs throughout the Delaware Bay, as well as investigate the impact of microplastic ingestion on blue crab health.

Concentration Theory for the Urban Estuary: Can Targeted Conservation Impact Water Quality in Densely Developed Sub-Watersheds?

Boon, Nathan, Senior Program Officer, William Penn Foundation, 100 N 18th Street, 11th floor, Philadelphia, PA, 19103, nboon@williampennfoundation.org

Urban Waters Panel, Tuesday, 2:15pm

The Delaware River Watershed Initiative, a $100 million, 10 year program of landscape conservation, environmental monitoring, outreach, and education is based largely on the resource concentration theory that focused conservation investment within individual watershed catchments can secure a sufficiently high proportion of natural landscape function as to lock in the conditions necessary to support clean and abundant surface waters.

Concentration theory preferences landscapes that are closest to the threshold for desired conditions, where a relatively small proportion of land area remains in need of natural restoration and/or permanent protection. Accordingly, the projects and focus areas of the Delaware River Watershed Initiative tend to incorporate predominantly rural landscapes. This rural pattern also reflects the expertise and capacity of a founding membership consisting primarily of non-profit land conservancies and watershed associations and an guiding focus on non-point sources of water pollution associated with forest loss, agricultural run-off, and stormwater.

Recent attention to issues of racial equity and environmental justice has invited additional scrutiny into patterns of investment that disfavor communities of color. This presentation invites the audience to apply the same principles of conservation theory within the urban environment through an analysis of restoration opportunities for the highly diverse and highly developed City of Philadelphia. Using a statistical model to project the relative impact of well-established stormwater restoration practices on the discharge of human fecal contamination from combined sewer overflows, the Philadelphia case study presents an urban analog to the rural focus areas of the Delaware River Watershed Initiative, suggesting how a science-based replication of concentration theory could be shown to deliver high conservation impact on water quality outcomes in parallel with community impacts aligned with values for environmental justice and racial equity.

Assessing the distribution of horseshoe crab eggs in relation to intertidal oyster aquaculture in Delaware Bay and red knot foraging distribution

Bouchard, Elizabeth, Graduate Assistant, Rutgers Haskin Shellfish Research Laboratory, 6959 Miller Ave, Port Norris, NJ, 08349, ehb52@hsrl.rutgers.edu David Bushek, Rutgers Haskin Shellfish Research Laboratory; Daphne Munroe, Rutgers Haskin Shellfish Research Laboratory; Brooke Maslo, Rutgers University

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

The resurgent eastern oyster (*Crassostrea virginica*) aquaculture industry in Delaware Bay may influence the ecological relationship between horseshoe crabs (*Limulus polyphemus*) and the threatened rufa red knot (*Calidris canutus rufus*). Delaware Bay hosts the world's largest spawning population of horseshoe crabs and red knots feed on the abundant eggs to fuel their annual circumpolar migration. Because intertidal oyster aquaculture in lower Delaware Bay overlaps portions of the spawning and foraging habitat, it may disrupt this trophic interaction to the detriment of these species. Prior research shows that oyster aquaculture does not impact the ability of horseshoe crabs to access spawning habitat on the beach, however, it is unknown how aquaculture may impact the distribution of horseshoe crab eggs available to the birds. The red knot distribution in Delaware Bay is driven primarily by horseshoe crab egg abundance, and while foraging behavior is not impacted by the presence of farms, red knot abundance is reduced by 2-7% while farms are actively being tended, so the relative abundance and distribution of horseshoe crab eggs in relation to oyster farms may significantly impact this shorebird species. Throughout the Spring 2021 and 2022 spawning and migration seasons, transect surveys using both sediment cores and quantitative photographs will be conducted overnight during the ebbing tide to determine the relative abundance of surficial eggs across the region containing oyster farms. The objective is to determine the effect of oyster farms on the distribution of horseshoe crab eggs and, consequently, on foraging red knots.

Oxygen and Nitrogen Sediment Flux Dynamics in the Delaware River Estuary

Brady, Damian, Associate Professor, University of Maine, 192 Clark Cove Rd., Walpole, ME, 04573, damian.brady@maine.edu; Kinman Leung, Philadelphia Water Department; Paula Kulis, CDM Smith; Eileen Althouse, CDM Smith; Jeffrey Cornwell, UMCES; Michael Owen, UMCES; David Walsh, Woods Hole Group

Water Quality & Quantity II, Monday, 2:30pm

In recent years the Delaware Estuary has experienced one of the most successful improvements in water quality in the U.S. This improvement manifests itself in increased dissolved oxygen concentrations and improved mussel and fish populations. To support fully mass balanced DO and nutrient water quality modeling, all sources and sinks of DO must be understood, including water column nitrogen dynamics and the sediment's role in both DO budgeting and nitrogen recycling. The Philadelphia Water Department conducted sediment flux surveys at over 100 sites in the Upper Estuary around Philadelphia in 2012-2013, and also in 2016-2017. The combined dataset constitutes the largest database of sediment fluxes ever constructed for the region. Our team has utilized generalized additive models to assess statistical trends, 3D water column modeling to infer transport and mechanistic kinetic interactions, and sediment flux models to analyze the mass balance of oxygen and nutrients in the Tidal Delaware and its sediments. Along-channel trends in sediment fluxes have been identified and incorporated into our conceptual understanding of overall nutrient and DO dynamics in the Upper Estuary. Insights on deposition gained from the sediment flux model are also incorporated into our conceptual understanding. This presentation discusses insights from statistical and mechanistic models, and how those insights are being incorporated into a larger water column mass balance and 3D water quality model.

Delaware River Basin Commission's Modernized Water Quality Assessment

Bransky, Jacob, Aquatic Biologist, Delaware River Basin Commission, 25 Cosey Road, West Trenton, NJ, 08628, jacob.bransky@drbc.gov; Ron MacGillivray, Delaware River Basin Commission; Elaine Panuccio, Delaware River Basin Commission; John Yagecic, Delaware River Basin Commission

Water Quality & Quantity I, Monday 1:00pm

Every two years, the DRBC compiles a Delaware River and Bay Water Quality Assessment Report which provides an assessment of the Delaware River and Bay's support of various uses during previous years. The basin states use the DRBC main stem assessment as part of their reports to the U.S. EPA. The assessment primarily involves comparing levels of key water quality indicators with DRBC stream quality objectives and identifying impaired waters (those that do not meet DRBC's water quality regulations). Water quality indicators include traditional water quality parameters such as dissolved oxygen and pH, along with other indicators like toxics, macroinvertebrate assessment, and fish/shellfish consumption advisories.

In 2020, DRBC made several changes to modernize its Water Quality Assessment Report. Data compilation, management, and analysis procedures were automated via the development of R scripts. Additional changes included methodological revisions to allow the report to better assess today's large continuously-collected datasets. Similar to past reports, assessment results were mixed. Support of uses varied depending on specific location and use. This paper will present a review of DRBC's Water Quality Assessment Report, the modifications for 2020, and brief overview of the 2020 assessment results.

Analysis of Attainability Part 2: Linking Aquatic Life Uses With Dissolved Oxygen Condition in the Delaware River Estuary

Bransky, Jake, Aquatic Biologist, Delaware River basin Commission, 25 Cosey Road, P.O. Box 7360, West Trenton, NJ, 08628, Jacob.Bransky@drbc.gov; Thomas Amidon, Delaware River Basin Commission

Water Quality & Quantity II, Monday, 2:30pm

The DRBC approved a resolution in September 2017 recognizing the significant water quality improvements in the Delaware River Estuary and the vital importance of determining the appropriate designated aquatic life uses and water quality criteria necessary to support these uses in a 38-mile section of the tidal Delaware River stretching from Wilmington to Philadelphia. DRBC is leading this effort through a collaborative process informed by an Expert Panel comprised of nationally recognized water resource scientists and engineers, and in close consultation with its Water Quality Advisory Committee. The resolution directs that an "analysis of attainability" be performed to determine the highest aquatic life use that can be achieved, incorporating the results of specific scientific and technical studies that are either completed or currently underway. The approach to assigning dissolved oxygen (DO) thresholds associated with degree of propagation for various species by season and zone throughout the estuary will be presented.

The segment of the tidal Delaware River within its most urbanized corridor is currently designated for fish maintenance and passage. The water quality goals established in 1967 have been exceeded, and consequently, fisheries have been enhanced due to improved DO conditions. While full attainment of propagation has not been demonstrated, some degree of propagation among DO-sensitive resident and anadromous fish has been observed. DRBC assembled information from literature sources, recent studies, and local fisheries professionals to characterize the occurrence and distribution of DO-sensitive species on a seasonal basis. DRBC leveraged results from aquatic life studies assembled by the Academy of Natural Sciences at Drexel and assigned DO thresholds that correspond to Unsuitable, Suitable, and Optimal conditions for propagation of various DO-sensitive species. These thresholds will be used in the context of our Analysis of Attainability to evaluate the degree of propagation that might be expected under further improved DO conditions.

Status of Delaware Bay Oyster Resources and Industries During COVID-19

Bushek, David, Director, Haskin Shellfish Research Laboratory, Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ, 08349, bushek@hsrl.rutgers.edu; Lisa Calvo, Rutgers University, Haskin Shellfish Research Laboratory; Jason Morson, Rutgers University, Haskin Shellfish Research Laboratory

Hot Topics, Wednesday, 3:30pm

COVID-19 hit the Delaware Bay region just as the New Jersey oyster fishery had set its annual quota, oyster seed were being ordered to stock farms, and the tourist season was prepping to usher in another busy season. In February, the future looked bright for oysterman and oyster farmers. New Jersey authorized a quota of 97,103 bushels to be harvested prior to any enhancement actions that would add up to 17,546 more bushels before seasons end. Oyster farmers on the Cape Shore flats and in the middle of the Bay had purchased gear for new seed and were tending those they had painstakingly overwintered for the upcoming summer market that has continued to increase. All these operations needed to sell product to generate money for the payroll of their hard-working staff. Then, on March 21, 2020 Governor Murphy invoked stay-at-home orders across NJ as did many other states across the country effectively closing restaurants and bars. As a result, the bottom fell out of the oyster market overnight and, in many cases, product harvested, packed and shipped was returned with nowhere left to sell it. Oysters produced for the raw bar have a specific size in which they are most valuable: too small and there is not enough meat inside the shell; too large and consumers lose interest. Moreover, NJ oyster resource managers weren't allowed out to conduct enhancement activities, ultimately limiting the total harvest quota. Those oysters returned or left in the Bay would start to grow out of market size and become less valuable and many would not survive. In this presentation we'll review some of the impacts of this catastrophe on oystermen, farmers, regulators, scientists and the resource itself.

Sea Level Rise Impacts on Delaware Estuary Wetlands and Marshes

Chen, Fanghui, Ph.D., P.E. Senior Water Resources Engineer, Delaware River Basin Commission, PO Box 7360, 25 Cosey Road, West Trenton, NJ, 08628, Fanghui.Chen@drbc.gov

Climate Change & the Delaware Estuary, Tuesday, 10:30am

Tidal marshes in the Delaware Estuary serve many important functions. They buffer coastal storms, slow shoreline erosion, offer shelter for sensitive species, absorb excess nutrients that would lower dissolved oxygen levels, and effectively remove carbon dioxide from the atmosphere and act as a carbon sink. They play an important role in reducing climate change. According to NOAA tide data collected at Lewes, Delaware, local sea level rose about 0.35 meters over the last 100 years. Sea level rise (SLR) not only will affect salinity intrusion and pose a threat to the major drinking water intakes near the Philadelphia area, it may also harm the estuary wetlands that are dominated by marshes surrounding the Delaware Estuary. During the past five decades, tidal wetlands have been lost at a rate of 1.03 sq-km per year in the Delaware Estuary, and land cover analysis shows 43.5 sq-km of tidal wetlands have already been lost to open water since 1975 (Edward W et al., 2018). DRBC staff have reviewed multiple SLR studies by other federal and state government agencies and proposed five SLR scenarios for our 2060 planning time horizon. The most likely range, from a 10 to 90 percent chance, of SLR for the Delaware Estuary will be 0.3 to 0.8 m with 0.5 m being the median for year 2060. In this presentation, the impacts on key environmental parameters associated with sea level rise were evaluated using a three-dimensional hydrodynamic model. Changes in water surface elevation, inundation frequency, and salinity concentrations in marsh areas surrounding the Delaware Estuary will be discussed. Changes in tidal wetland area, as estimated through model simulations under a range of future SLR scenarios, will also be presented.

Microplastics and Microfibers in the Murderkill and St. Jones Rivers

Cohen, Jonathan, Associate Professor of Marine Science & Policy, University of Delaware, 700 Pilottown Road, Lewes, DE, 19958, jhcohen@udel.edu; Hayden Boettcher, University of Delaware; Taylor Hoffman, University of Delaware; Anna Internicola, University of Delaware

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Data are emerging on microplastics and microfibers in the Delaware Estuary proper, but less has been reported for its tributaries. This information is needed to prioritize remediation efforts in the watershed, and to better understand and model microplastic/microfiber fate and transport. Here, we report on microplastics and microfibers collected though rain event-based net sampling of water in two Delaware Estuary tributaries. The St. Jones River has 68, 323 people in the watershed, which includes the city of Dover, DE. The nearby Murderkill River receives the outfall from a wastewater treatment plant serving 13, 000 people with an average flow of 12.5 million gallons per day. Both rivers are crossed by a major highway (DE Route 1). During river sampling, we found median microplastic/microfiber concentrations of 6 pieces/m3 (range: 0 – 35 pieces/m3) in the St. Jones River at Scotton Landing, and 3 pieces/m3 (range: 0.2 to 36 pieces/m3) across stations in the Murderkill River. Microplastic/microfiber concentration appeared independent of rainfall for both rivers. While a suite of microplastic types were found, microfibers were dominant in both rivers; a result consistent with sampling regionally in other estuarine tributaries. While microplastic/microfiber loading from the Kent County WWTP may contribute to concentrations observed in the Murderkill River, we did not find elevated microplastics in the WWTP's effluent canal near its junction with the river proper. The extent to which microplastics and microfibers are trapped on riverbanks and in saltmarsh systems is worth pursuing.

Vegetation response following dredged material placement and management efforts in a coastal marsh area in New Jersey

Collins, Samantha, Research Scientist, The Wetlands Institute, 1075 Stone Harbor Blvd, Stone Harbor, NJ, 08247, scollins@wetlandsinstitute.org; Lisa Ferguson, The Wetlands Institute; Brittany Morey, The Wetlands Institute; Lenore Tedesco, The Wetlands Institute

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Along the coast of New Jersey, coastal bird species are limited by suitable nesting areas and new strategies are being implemented to enhance or create nesting habitat through beneficial placement of dredged materials. Elevation is a key design consideration to meet project objectives related to habitat suitability for target species, but elevations above flood levels (MHHW) can promote growth of vegetation that may be undesirable for some species. Vegetation emerging during the nesting season in early successional and dredged material placement sites is a challenge for habitat management of nesting species that prefer open, sandy substrate with sparse vegetation. Sand from routine channel dredging operations was used to create nesting habitat on a tidal salt marsh in 2014 at a target elevation more than 1' above MHHW (3.6' NAVD88) based on predictions of local tide levels to contend with flooding from spring tides. After additional placement of sandy dredged material on the site in 2018, we implemented vegetation management (salt spray, direct salt placement, controlled burns) and monitoring efforts to better understand vegetation response to management practices and establishment following placement. We established 1m2 plots on the habitat in 2019 and 2020 to investigate vegetation communities at the end of the nesting season. Dominant plant species observed on the site in both years were *Ammophila brevigulata* (American beachgrass), *Amphicarpaea bracteata* (American hog-peanut), and *Digitaria sp.* (Crabgrass). We observed changes in the distribution and abundance of dominant plant species between years. A. brevigulata and A. bracteata had significantly higher Braun-Blanquet cover classes in 2020, while Digitaria cover classes were lower compared to 2019. Species richness was similar between years but we observed differences in plant species documented on the site between years. Results from this study suggest differences in species succession and responses to current management efforts following dredged material placement.

Delaware Botanic Gardens Living shoreline and Wetlands Enhancementy

Collins, Bob, Program Manager, Delaware Center for the inland Bays, 39375 Inlet Road, REHOBOTH BEACH, DE, 19971, jamesfarm@inlandbays.org; Douglas Janiec, Sovereign Consulting, Inc.; Brian Trader, PhD., Delaware Botanic Gardens at Pepper Creek

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

The objective of the Delaware Botanic Gardens Living Shoreline and Wetlands Enhancement project is to improve water quality and natural habitat in Pepper Creek through shoreline stabilization and wetlands enhancement at the Delaware Botanic Gardens. Nature-based, living shoreline tactics are used to stabilize and restore the eroding and degraded tidal marsh areas along 500 linear feet of shoreline. A demonstration project of the Delaware Center for the Inland Bays Inland Bays Living Shoreline Initiative, the project used a Delaware Water Infrastructure Advisory Council Community Water Quality Improvement Grant and several partners to improve habitat quality through use of native plantings in wetland and riparian buffer areas and control of invasive species. Innovative tactics include the use of native woody vegetation to build an features such as an anchored branch toe, a birds nest revetments and inverted root wads. The completed project will serve as a living shoreline demonstration site for the Inland Bays and be used to educate local residents, businesses, municipal officials and contractors about the advantages of living shorelines as an alternative to standard 'hardened' shoreline management practices such as rip-rap and bulkheads. A public viewing area and educational signage have been incorporated into the design.

Getting to Yes with Resilience Through Community Collaboration

Dean, Bradley, Communications and Partnerships Specialist, FEMA Risk Management Directorate, 400 C Street, Washington, DC, 20472, Bradley.Dean@fema.dhs.gov; Melissa Herlitz, Michael Baker International

Urban Waters Panel, Tuesday, 2:15pm

Reducing risk through resilience projects can protect communities and save lives, but communities don't often know how to get to "yes". Proactive and creative planning are necessary to identifying projects that build resilience and meet the needs of the whole community. Nature-based solutions are growing in popularity and are promoted as a method in FEMA's Building Resilient Infrastructure and Communities (BRIC) Program. But how can communities design projects that reduce risk and are informed by ideas from diverse stakeholders?

FEMA has created new tools to support community driven decision-making for nature-based solutions. "Building Community Resilience with Nature-Based Solutions" is a guide to help communities align their planning processes and programs to pursue projects effectively. It emphasizes the right questions to ask to align investments that reduce risk. Similarly, the "Guides to Expanding Mitigation" series highlights how risk reduction projects can meet broader resilience goals when community officials collaborate with the whole community, including sectors like agriculture and public health. These tools were informed by discussions with dozens of experts and were designed to provided communities with the inspiration they need to pursue resilience projects like nature-based solutions and expand who is at the table to bring holistic solutions.

This presentation will share ideas for getting to yes with resilience through community collaboration by highlighting opportunities to identify co-benefits, forge new partnerships, and seek creative funding sources.

Tidal and Non-tidal Wetland Health in the Red Lion Watershed, Delaware

Dorset, Erin, Environmental Scientist, Delaware Department of Natural Resources and Environmental Control, 285 Beiser Boulevard, Suite 102, Dover, DE, 19904, erin.dorset@delaware.gov; Alison Rogerson, Delaware Department of Natural Resources and Environmental Control; Kenny Smith, Delaware Department of Natural Resources and Environmental Control; Brittany Haywood, Delaware Department of Natural Resources and Environmental Control

Monitoring & Assessment, Tuesday, 10:30am

The Delaware Department of Natural Resources and Environmental Control's (DNREC) Wetland Monitoring and Assessment Program (WMAP) documented wetland acreage trends and determined the ambient condition of tidal and non-tidal wetlands in the Red Lion watershed in 2017. This was done with field assistance from the Partnership for the Delaware Estuary (PDE). The goals of this project were to: summarize acreage gains, losses, and changes across the Red Lion watershed based on the most current state wetland maps; assess the condition of tidal and non-tidal wetlands throughout the watershed; identify prevalent wetland stressors; assess the value that non-tidal wetlands provide to the local landscape; and make watershed-specific management recommendations to different audiences.

Mechanisms of salt intrusion in the upper Delaware estuary

Duzinski, Phil, Philadelphia Water Department, 1101 Market St, 4th floo4, Philadelphia, PA, 19107, phil.duzinski@phila.gov; Robert Chant, Rutgers University; Ramona McCullough, Scitek Consultants, Inc.; James Smullen, CDM Smith

Physical & Chemical Processes, Monday, 11:00am

The Philadelphia region is home to the largest freshwater port and the 2nd largest center for petroleum products in the United States. The City and nearby communities rely upon the freshwater section of the tidal Delaware River as a source for drinking water. The proximity of numerous sources of pollutant discharges near several of these drinking water intakes makes the study of transport mechanisms in this portion of the Delaware Estuary crucial for the Philadelphia Water Department. Additionally, the oligohaline range of the estuary, which contains the upstream extent of salt intrusion, is very sensitive to extremes in river discharge in the main tributaries and can advance to just below the City of Philadelphia during these low flow events.

An Environmental Fluid Dynamics Code (EFDC) numerical model of the Upper Delaware Estuary is used to analyze the potential mechanisms of dispersion in the tidal Delaware River. While the model domain is largely within the tidal-fresh upper estuary, the domain below Philadelphia becomes oligohaline during low-flow events and there is evidence that this intrusion is facilitated by a combination of a secondary circulation mechanism called differential advection (Lerczak & Geyer, 2004) and strain-induced periodic stratification (SIPS) (Simpson et al., 1990). These events appear to result in up-estuary transport at lower depths in this well- to partially-mixed estuary near the head of salt.

Advances in turbulent closure schemes used in numerical models in recent years have allowed for more accurate representation of the physics in estuarine processes involving buoyancy, such as salt transport. The use of these features in EFDC will be explored along with a discussion of the potential dispersion mechanisms.

Engaging youth during a lockdown

Eckl, Eric, Founder/Owner, Water Words That Work, LLC, PO Box 277, Frederick, MD, 21705, eric.eckl@waterwordsthatwork.com; Michael Harris, New Castle County

Outreach & Community, Wednesday, 1:30pm

When Covid-19 forced the cancellation of all public events, the New Castle County Department of Public Works needed to come up with an outreach alternative… fast! In just a few weeks, the County, it's partners, and vendors developed the Clean Stream Champion Coloring Contest, https://www.cleanstreamchampion.org/clean-stream-champion-art-contest-winners/. The contest offered families an opportunity to practice their skills and win prizes by entering original artwork on stormwater reduction topics. The last minute campaign was a success! The campaign handily met the county's MS4 requirements for the year, measuring more than 3 million media impressions in a county with ~500k residents. We secured 598 valid entries and featured the winners in a wall calendar.

In this presentation, we will offer an overview of the contest, as well as tips and lessons learned for others that seek to run outreach efforts 100% virtually.

Valuing Delaware Bayshore Treasures - Mispillion and Cedar Creek Delaware

Egan, Jennifer, Program Manager Conservation Finance, University of Maryland Environmental Finance Center, 310 Chickory Way, Newark, DE, 19711, jegan@umd.edu

Outreach & Community, Wednesday, 1:30pm

The University of Maryland Environmental Finance Center (UMD EFC) is engaged in providing an economic assessment of particular natural resources in the Mispillion and Cedar Creek watersheds, Delaware. This work, funded by the Pew Charitable Trusts, will support future work conducted by the Resilient and Sustainable Communities League (RASCL) partners. RASCL is a Delaware-based organization that provides information, technical assistance, and networking opportunities to state, local, and county governments, citizen groups, the private sector, and non-profit organizations to advance the goals of resilience and sustainability in the State of Delaware. The valuation of natural resources is a first step to understand what resources are of interest to key stakeholders and the value of those resources through an economic lens.

Over the last century, the watersheds around Milford and Slaughter Beach have experienced considerable losses in forests and wetlands and have significant agricultural lands in private ownership. Two National Wildlife Refuges border the area, and the area is an internationally recognized flyway for migrating birds. The communities of Milford and Slaughter Beach have a significant interest in protecting and enhancing the areas' natural resources, not only for long-term resource management for the citizens of the area but also for the Delaware Bayshore region's potential to draw visitors to the beauty of the Bayshore area through recreational opportunities.

This presentation will profile the framework used to value the area's natural resources and valuation findings. This project will provide the foundation for a recently received National Fish and Wildlife Foundation grant titled "RASCL Economic Valuation and Management Plan for the Mispillion and Cedar Creek Watershed" that will provide funds for a benefits and costs analysis of ecotourism opportunities, vulnerability analysis and a management plan for the Mispillion and Cedar creek watersheds.

Bycatch threats to Delaware Bay populations of diamondback terrapins

Ferguson, Lisa, The Wetlands Institute, 1075 Stone Harbor Boulevard, Stone Harbor, NJ, 08247, lferguson@wetlandsinstitute.org; Brian Williamson, The Wetlands Institute; Brittany Morey, The Wetlands Institute; Laura Chamberlin, Manomet

Living Resources, Monday, 11:00am

Drowning in crab traps is a top threat to diamondback terrapin (*Malaclemys terrapin*) populations, though the extent of loss is challenging to quantify due to a lack of bycatch reporting. Studies that derive estimates from derelict trap contents provide an incomplete picture of potential impacts due to decomposition of terrapin remains and loss of shell fragments from traps during retrieval. Following regular reports of dead terrapins at the tideline of beaches on the Delaware Bay, we began to quantify the number of terrapin carcasses washing ashore through a citizen science program, reTURN the Favor. Though the primary goal of the program is to rescue stranded horseshoe crabs (*Limulus polyphemus*), since 2017 program volunteers also record terrapin carcasses from late April–mid-July during surveys of 20-22 Delaware Bay beaches in New Jersey, covering approximately 27 km. Hundreds of carcasses were recorded each year during the survey period and observations were made across the majority of beaches surveyed, indicating a larger and more widespread issue than previously documented. A variety of simple methodologies have been implemented to improve the estimate of losses and determine rates of deposition and persistence. Results are providing insights to impacts of bycatch in crab traps on terrapin populations in the Delaware Bay, and helping us better understand spatial patterns of potential impacts. The engagement of a new network of volunteers, partners, and communities with terrapin conservation has also been a valuable outcome.

Depth Distribution and Composition of Microplastics in the Delaware Estuary Turbidity Maximum

Fontana, Julia, University of Delaware, 700 Pilottown Road, Lewes, DE, 19958, jfontana@udel.edu; Jonathan Cohen, University of Delaware; Hayden Boettcher, University of Delaware; Ian Johnson, University of Delaware; R. Alan Mason, University of Delaware; Tobias Kukulka, University of Delaware

Water Quality: Microplastics, Monday, 4:00pm

Marine microplastics in coastal and estuarine environments are highly pervasive yet poorly characterized. Estuarine Turbidity Maximum (ETM) regions are locations where physical processes associated with stratification accumulate suspended sediment. In the Delaware Estuary, the ETM accumulates microplastics at higher concentrations relative to the remainder of the bay. Thus, we sampled microplastic pieces at 6 stations along the Delaware Estuary ETM to determine the vertical distribution of microplastic concentrations, size, and polymer type throughout the water column. Microplastics were found at all 6 stations along the ETM, with average concentrations of 4.7 pieces/m3, 0.9 pieces/m3, and 2.0 pieces/m3 found at the surface (0m), middle (5m), and bottom (12m) depths, respectively. These samples were characterized by both size and type, and analyzed using micro-FTIR spectroscopy to determine plastic polymers. We found that microbeads were more common in deep samples, while fragments were found at both surface and depth, with fibers more common at intermediate depths. While FTIR analysis suggested a broad suite of polymer types, fragments in the ETM were predominantly polyethylene, fibers were commonly rayon, and beads mainly polystyrene. These analyses establish that microplastics are not simply a feature of the surface waters of the Delaware Estuary. By providing a more comprehensive assessment of the characteristics of microplastics found in the ETM, we further contextualize the microplastic problem in the Delaware Estuary.

Evidence of salt accumulation in beach intertidal zone due to evaporation

Geng, Xiaolong, Dr. & Research Assistant Professor, New Jersey Institute of Technology, 323 Dr Martin Luther King Jr Blvd, Newark, NJ 07102, Newark, NJ, 07102, gengxiaolong@gmail.com; Michel C. Boufadel, New Jersey Institute of Technology

Physical & Chemical Processes, Monday, 11:00am

In coastal environments, evaporation is an important driver of subsurface salinity gradients in marsh systems. However, it has not been addressed in the intertidal zone of sandy beaches. Here, we used field data collected from Slaughter beach in Delaware Bay along with numerical simulations to show that evaporation causes upper intertidal zone pore-water salinity to be double that of seawater. We found the increase in pore-water salinity mainly depends on air temperature and relative humidity, and tide and wave actions dilute a fraction of the high salinity plume, resulting in a complex process. This is in contrast to previous studies that consider seawater as the most saline source to a coastal aquifer system, thereby concluding that seawater infiltration always increases pore-water salinity by seawater-groundwater mixing dynamics. Our results demonstrate the combined effects of evaporation and tide and waves on subsurface salinity distribution on a beach face. We anticipate our quantitative investigation will shed light on the studies of salt-affected biological activities in the intertidal zone. It also impacts our understanding of the impact of global warming; in particular, the increase in temperature does not only shift the saltwater landward, but creates a different salinity distribution that would have implications on intertidal biological zonation.

Nitrogen Bioextraction by Juvenile Alewife Floaters, *Utterbackiana implicata*, During Pond Rearing in the Delaware River Basin

Gentry, Matthew, Shellfish Specialist, Partnership for the Delaware Estuary, 110 South Poplar St., Ste. 202, Wilmington, DE, 19801, mgentry@delawareestuary.org; Danielle A. Kreeger, Partnership for the Delaware Estuary; Kurt M. Cheng, Partnership for the Delaware Estuary; Matthew W. Gray, University of Maryland Center for Environmental Science Horn Point Laboratory

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Freshwater mussels are filter-feeding bivalves that occupy diverse freshwater environments. Nationwide, mussel assemblages are declining in range, abundance, and species richness. Partnership for the Delaware Estuary (PDE) created the Freshwater Mussel Recovery Program in 2007 to address declines in the Delaware River Basin. Part of restoration involves reintroduction of mussels to historical ranges. Reintroduction success (i.e. survival, persistence) depends on both habitat suitability and size of animals used. Juvenile mussel survival in nature is thought to be low but advances in hatchery spawning and pond rearing have increased survival. Pond rearing can raise hatchery-spawned mussels to sizes appropriate for rProelease, presenting an opportunity for transient ecosystem services in eutrophic ponds. Hatchery-spawned Alewife Floater mussels (*Utterbackiana implicata*), 1-3 years in age, were pond-reared in New Castle County, Delaware beginning in 2017. The filtration of particulate nitrogen (PN), and its partial assimilation into biomass, by over 8,000 of these mussels remaining in the rearing pond as of December 2020 was calculated to quantify one aspect of PN removal as an ecosystem service. Final nitrogen contents of U. implicata tissues and shells averaged 6.90% w/w and 0.65% w/w of dry biomass, respectively, and estimated yearly averaged clearance rates were 0.88 l/hr per gram dry tissue. This cohort of mussels had an average shell length of 44.19 mm, 262 g of nitrogen accrued in biomass, and filtered 735 g of PN per year. Given previous growth and mortality data, this cohort has a projected average shell length of 66.50 mm, 829 g of nitrogen accrued in biomass and filtration of 1769 g PN per year in December 2021. With mussel relocation for restoration projects, sequestered nitrogen is permanently removed from rearing ponds. These data suggest that tangible water quality benefits could be realized in rearing ponds depending on scale and duration of mussel residency.

An Intrinsic Index for Communities: Adaptation of Resilience to the Stress Level

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Outreach & Community, Wednesday, 1:30pm

The degree to which a community can survive and recover following a disaster is referred to as community resilience, and it depends on four sectors (based on our assessment). They are: transportation, energy, health and socio-economic. Works on resilience have been generally qualitative exhorting improvements in each of the sectors above. However, decision makers would benefit from a quantitative measure, i.e., an index for resilience. There are indices for each of the sectors, but they are only relative, based on comparison between entities, and they do not account for the stress level on resilience. In particular, we argue that a community could be resilient to a 10 year flooding storm but not to 50 year storm. Thus, there could not be an index for resilience independence of the stress level. In this paper, we developed a new approach to quantify community resilience that provides an absolute metric and reflects the impacted region. We labelled it Intrinsic Resilience Index (IRI), representing the combination of resilience levels of the four sectors. The computation of the IRI is GIS-based and it suffices for one to delineate any region (township, county, a number of adjoining counties, a State) to obtain its IRI. We applied the approach to New Jersey, and we found that the IRI ranged from 61% to 75%. A post-disaster IRI revealed that two counties would have low resilience due to the reduction of the road area and/or the reduction of the GDP (local economy shut down) to below minimum values.

Dam Removal Should Not Be Just About Dam Removal

Goll, Geoffrey, President, Princeton Hydro, LLC, 1108 Old York Road, P.O. Box 720, Ringoes, NJ, 08551, ggoll@princetonhydro.com

Restoration & Conservation I, Monday 1:00pm

Dam Removals have become synonymous with the restoration of fish passage, and more specifically, about the restoration of diadromous fish such as salmon, shad, and rive herring. But it is much more than simply the breaching of the dam and reconnecting the upstream and downstream segments of rivers. It is about balancing the values of stakeholders with sometimes conflicting objectives and overcoming the technical challenges of sediment management and protection of infrastructure. It is also an ecological uplift opportunity that goes well beyond fish passage. Many of the dams located in the watershed of the Delaware Estuary, as in many watersheds in the eastern United States are located in communities that developed around historic mill dam operations where, in the present, the dam is a central and historic element. It is important that stakeholders in the community understand all of the benefits of dam removal, and not simply for the restoration of aquatic organism passage, and it is further important to be able to illustrate how the removal of the dam will increase the positive and attractive attributes of a removed dam and restored river, with all of its functions and values. This presentation will illustrate the multi-dimensional restoration possibilities and community benefits that can be achieved when dam removal is viewed from perspectives such as water quality improvement, flood risk reduction and health and safety improvements, greenway connection, recreation and ecotourism, education, sustainable and resilient communities, and increased biodiversity. The presentation will also provide a broad review of the values of existing dams and their impoundments, the institutional and physical challenges of removal, and examples of successes of removed dams within communities in the Delaware River Estuary watershed and beyond.

Environmental Project Communications: Capturing the Audience with Meaningful Storytelling

Goss, Madeline, Communications Specialist, Delaware Center for the Inland Bays, 39375 Inlet Road, Rehoboth Beach, DE, 19971, mgoss@inlandbays.org

Outreach & Community, Wednesday, 1:30pm

In order to expand the impact of important environmental projects underway at the Delaware Center for the Inland Bays (CIB), it's vital for the public to understand why efforts such as reforestation or restoration are needed in the watershed so that residents and decision-makers can become invested, as well.

The Delaware Center for the Inland Bays (CIB) is a nonprofit organization and one of 28 National Estuary Programs. The CIB's mission is to preserve, protect, and restore Delaware's Inland Bays through education, outreach, science and research, restoration, and public policy. The CIB focuses its restoration efforts on partnerships and projects that lead to reforestation, shoreline stabilization, stormwater retrofits, and much more.

But why do some environmental projects get more press than others? The answer often lies in the story the projects have to tell, and how organizations share that story with the public and the media. The CIB must ensure that the word gets out about these projects in an accurate and timely manner, which means turning to mixed media options on social media (e.g., text, photos, and video) as well as pitching stories to traditional media sources.

Identifying problems and solutions from the outset of a project is critical to building momentum in public interest and ultimately lead to increased engagement. With everyone's attention divided these days, it's critical to communicate the "why" in the CIB's work from the start. We'll discuss how the CIB did this with a recent living shoreline project in Dewey Beach and how that effort paid off in constituent engagement, media coverage, and a recent visit to the site from a U.S. Senator and other local elected officials, and how and why we plan to use this multimedia storytelling approach in all of our projects.

USGS Lidar Data in the Lower Delaware River Basin, Pennsylvania

Gross, Eliza, National Map Liaison, U.S. Geological Survey, 215 Limekiln Road, New Cumberland, PA, 17070, egross@usgs.gov

Outreach & Community, Wednesday, 1:30pm

The U.S. Geological Survey (USGS) National Geospatial Program (NGP) provides a foundation of digital geospatial data representing the topography, natural landscape, and manmade environment of the United States. High-resolution lidar elevation data have been collected for much of the eastern U.S., including those areas within the Lower Delaware River Basin that surround the Delaware Estuary. From citizens to scientists, people can view and openly access NGP geospatial products and services, including lidar products, through a variety of portals, such as The National Map or Amazon Web Services. Current 3D Elevation Program lidar products and partners will be discussed, along with online tools, such as SeaSketch, that can used to help develop proposals and support collaborative data acquisition. Examples specific to the portion of the Delaware Estuary in Pennsylvania will be provided.

Mid Atlantic Coastal Wetland Assessment: Evolving for the Future

Haaf, LeeAnn, Wetland Coordinator, Partnership for the Delaware Estuary, 110 S. Poplar St, Suite 202, Wilmington, DE, 19801, lhaaf@delawareestuary.org; Beatrice O'Hara, Partnership for the Delaware Estuary; Emily Pirl, Barnegat Bay Partnership; Angela Padeletti, Partnership for the Delaware Estuary; Martha Maxwell-Doyle, Barnegat Bay Partnership; Metthea Yepsen, New Jersey Department of Environmental Protection; Danielle Kreeger, Partnership for the Delaware Estuary

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Since 2010, the Partnership for the Delaware Estuary, with the Barnegat Bay Partnership and the Academy of Natural Science of Drexel University have worked to implement the Mid Atlantic Coastal Wetland Assessment (MACWA) to track coastal wetland status and trends. The MACWA also supports coordinated and consistent efforts to assess coastal wetland condition across multiple states. Utilization of consistent methods among sites makes data comparable, offering explicit insights into spatial and temporal variability. MACWA data are useful for guiding restoration, understanding stressor-response relationships, and determining ecosystem services. The multi-level strategy of MACWA spans from remote sensing to site-specific intensive monitoring, following EPA national guidance. Over the past 10 years, the MACWA program has served not only as a basis for systematic scientific research, but as a platform through which numerous scientists, practitioners, land managers, and the public collaborated and engaged. As MACWA broadened through these collaborations, it has strengthened and evolved over time. For the 10-year anniversary of MACWA, a workgroup convened to reexamine the program's goals and discuss how to sustain the effort to continue to guide coastal wetland decision-making into the future. This meeting was held in the autumn of 2020, organized by the New Jersey Department of Environmental Protection, Partnership for the Delaware Estuary, and Barnegat Bay Partnership. Out of this effort, we identified three strategies to ensure MACWA's evolution: 1) strengthen the MACWA workgroup infrastructure, 2) add a fifth MACWA tier to accommodate a growing need for outreach and education, and 3) improve MACWA's online presence.

Runnel Creation and Monitoring at Reeds Beach Marsh, Cape May National Wildlife Refuge

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

Monitoring & Assessment, Tuesday, 10:30am

A two phase restoration project was conducted in 2017 and 2020 at Reeds Beach, part of Cape May National Wildlife Refuge. 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, 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). To improve tidal hydrology in a degrading and highly modified salt marsh, a series of new tidal ditches (runnels) were dug along the marsh platform using specialized equipment. Construction work in a low marsh provided challenges in itself! Pre- and post-construction monitoring efforts to evaluate the success of the restoration include water levels, vegetation change, marsh elevation, runnel elevation, and MidTRAM.

Carversville Farm - Stream, Floodplain, & Multi-Functional Riparian Buffer Restoration

Hartshorne, Michael, Aquatic Ecologist, Princeton Hydro, LLC, 203 Exton Commons, Exton, PA, 19341, mhartshorne@princetonhydro.com; Emily Bjorhus, Princeton Hydro, LLC; Cory Speroff, Princeton Hydro, LLC

Restoration & Conservation I, Monday 1:00pm

The Carversville Farm Foundation (CFF) aims to restore a reach of Paunacussing Creek which runs through Carversville Farm from one of impaired or absent riparian areas, entrenched and scoured banks and limited aquatic habitat, to a rich resource which is fully integrated into their sustainable farming operation. CFF is a non-profit, organic farm whose mission combines providing fresh, organic food to populations who lack a balanced diet while utilizing sustainable farming methods for the regeneration of the agro-ecosystem. In keeping with this mission, CFF contracted with Princeton Hydro (PH) to conduct a watershed and stream study of the Paunacussing Creek, which is a High-Quality, Cold-Water Fishery that bisects the property and is tentatively scheduled for a Total Maximum Daily Load (TMDL) in 2029. The results from this study showed impairments associated with a headwater reach that included lack of floodplain connectivity, bank scour, and impaired riparian corridor conditions. In response, PH secured a Pennsylvania Growing Greener grant that aimed to provide the engineering design and permitting necessary for floodplain restoration. In addition, a planting plan based on a multi-functional riparian buffer was developed. This presentation will discuss the integration of a 'productive' riparian buffer into an active organic farm and how this approach can enhance farming operations while simultaneously restoring aquatic resources. Through these initiatives, the proposed projects will serve to improve the Paunacussing and serve as a model for restoration of other local and regional agriculture operations.

PWD Water Supply Planning: PWD Salinity Model and Validation

Hesson, PhD, Molly, Sage Services LLC for the Philadelphia Water Department, 15 W Highland Avenue, Suite H, Philadelphia, PA, 19118, Molly.Hesson@sageservicesh2o.com; Phil Duzinski, PE, PWD; Ramona McCullough, PhD, SciTek; Jim Smullen, PhD, CDMSmith; KinMan Leung, PWD; Charles Pildis, SciTek; Paula Kulis, PhD, PE, CDMSmith

Water Quality & Quantity I, Monday 1:00pm

The Philadelphia Water Department (PWD) has constructed and validated a three-dimensional model of the upper Delaware Estuary in order to study the relationship between regulated freshwater flow, salinity intrusion and the drinking water supply to Philadelphia. This presentation will summarize the model set up, sensitivity analyses and validation results. The model validation periods are two salinity intrusion events in 2014 and 2016. The validation process uses multiple locations and timeframes to calculate velocity, water level and salinity metrics. The PWD salinity model simulated the hydrodynamics of the upper Delaware Estuary to a high degree of model skill and well represents salinity transport processes during periods of intrusion.

Microplastics in the Delaware Inland Bays

Hoffman, Taylor, University of Delaware, 700 Pilottown Rd, Lewes, DE, 19958, thoffman@udel.edu;
Jonathan Cohen, University of Delaware; Hayden Boettcher, University of Delaware

Water Quality: Microplastics, Monday, 4:00pm

Knowledge of microplastic presence in Delaware's waterways is currently limited. To further our understanding of microplastic pollution in Delaware, we conducted a study of microplastic abundance and composition in water samples from the Delaware Inland Bays, specifically, Indian River Bay and Rehoboth Bay. This study focused on two main goals: (1) collect and quantify microplastics from surface waters using net-based digestion and grab-based fluorescence approaches; (2) perform polymer composition analysis on microplastics. Microplastics were present in all towed water samples (n = 9) and in 14 of 18 water-grab samples collected from Indian River Bay and Rehoboth Bay. We found average microplastics concentrations of 2.4 pieces/m3 (median: 2.6 pieces/m3 ; range: 1.0 – 3.1 pieces/m3) in Indian River Bay, and 1.8 pieces/m3 (median: 1.7 pieces/m3; range: 1.5 – 2.2 pieces/m3) in Rehoboth Bay for towed water samples. Fibers were the dominant microplastic type, making up 71.7% of the total microplastic pieces collected. Fragments made up the remaining 28.3%. We determined polymer composition of samples by micro-FTIR. Polypropylene was the dominant polymer in Indian River Bay while polyethylene was the dominant polymer in Rehoboth Bay. For fluorescence analysis of water-grab samples, the average microplastic concentration was 2800 pieces/m3 (median: 2000 pieces/m3; range: 0-8000 pieces/m3) for Indian River Bay and 5000 pieces/m3 (median: 4000 pieces/m3; range: 0-16000 pieces/m3) for Rehoboth Bay. These results align with previous studies' findings and indicate that microplastics are plentiful in the Delaware Inland Bays, with discrepancies between net-based and water-grab fluorescence-based approaches.

Prediction of the salinity history of oysters in Delaware Bay

Howlader, Archi, Graduate Research Assistant, University of Maryland Center for Environmental Science, 2020 Horns Point Road, Cambridge, MD, 21613, ahowlader@umces.edu; Elizabeth North, University of Maryland Center for Environmental Science; Daphne Munroe, Rutgers University; Matthew Hare, Cornell University

Living Resources: Oysters, Monday, 4:00pm

The overall goal of the Selection along Estuarine Gradients in Oysters (SEGO) project is to investigate the phenotypic and genomic consequences of salinity-induced selection in oysters. Salinity is a major environmental stressor that affects the overall health of oysters. The aim of this analysis was to predict the salinity history of larvae, juveniles, and adult oysters collected at different sampling stations on the shoal of Delaware Bay using empirical relationships within +/- 2 psu. Three sources of historical salinity data were used to predict the salinity at five stations. Data from USGS station at Reedy Island Jetty and continuous near-bottom (0.5-1 m off bottom) measurements taken by U.S. Army Corps of Engineers at each sampling station were used to create predictive models after shifting the data according to the tidal basis. An independent dataset from Haskin Shellfish Research Laboratory was used to validate these models. The best-fitting models for predicting salinity at the sampling stations given the salinity at Reedy Island Jetty were logarithmic in form. The 95% prediction intervals had widths that ranged from 4.4 to 5.8 psu. When compared to the independent data set, the mean square error of the models for each oyster sampling station were: 1.7 psu for Hope Creek, 1.8 psu for Arnold, 2.0 psu for Cohansey, 1.7 psu Shell Rock, and 2.6 psu for New Bed. All but one of these models were within the desired accuracy range; the one outside this range (New Bed) was the furthest from Reedy Point Jetty (39 km down bay). Results demonstrate that observing systems data can be used for predicting salinity within +/- 2 psu at sampling stations within 30 km in this region of Delaware Bay. The application of these models to calculate metrics of salinity stress at each station will be discussed.

Delaware Botanic Gardens at Pepper Creek, A Demonstration Living Shoreline

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

Watershed Scale Coastal Resilience, Wednesday, 1:30pm

The Delaware Botanic Gardens is a native species gardens located along Pepper Creek, Sussex County, Delaware. The Garden consists of an open meadow area, sloped woodland and a tidal shoreline. A more than five hundred foot demonstration project was designed permitted and installed in 2020. New living shoreline tactics were developed especially for this project using mostly waste material from hiking trail clearings. This project features a bird nest revetment, inverted root wads, anchored branch toe, tradition tidal vegetation planting, a pollinator grove, and a viewing platform. This project involved the partnering and teamwork involving the Delaware Botanic Gardens, the Delaware Center for the Inland Bays, Sovereign Consulting, and lots of volunteers. The presentation will take the audience through the design and construction of the project.

Seagrass Plantation, A Model Hybrid Living Shoreline Project (for Communities) - Two Years Later

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

Watershed Scale Coastal Resilience, Wednesday, 1:30pm

Seagrass Plantation is a backbay community of the Indian River Bay, Delaware. Back in 2018, a more than 800 foot hybrid living shoreline was constructed, including two nearshore reefs, a stabilized connection to a tidal marsh, an oyster shell bag toe along a marsh which used more than 2,800 shell bags, supplemental plantings, and more. This project was entirely funded by the community without State or Federal financial support. This was one of the first projects to perform monitoring using the guidance: "Developing Monitoring Plans for Living Shoreline Projects in Delaware: A Goal-Based Framework." The project was a major success. Now with two years of monitoring data, the effectiveness of the nature-based tactics can assessed. The presentation described the original shoreline issues, the solutions, and the results of the project. The Delaware Center for the Inland Bays was a project partner.

Salt Marsh Response to Changing Climate: Investigating Ecosystem Function in High- and Low-Elevation Marshes.

Johnson, Erin, Research Technician, Villanova University, 800 Lancaster Ave, Geography and Environment, Villanova, PA, 19085, erin.johnson@villanova.edu; Dr. Nathaniel Weston, Villanova University

Physical & Chemical Processes, Monday, 11:00am

Salt marsh ecosystems are precariously positioned between the interface of land and water. Rising sea levels, decreasing sediment delivery, and a changing climate have increased uncertainly about the future of salt marshes. Marshes currently exist along a gradient of relative elevations in coastal systems, with differences in the structure and function of high-elevation versus low-elevation marsh areas. Rising sea levels may cause the permanent submergence of some marshes that are unable to maintain elevation relative to sea level but may also result in the conversion of high-elevation marsh to low-elevation marsh with changes to ecosystem function. How salt marshes will respond to the complex interactions between global change drivers is not thoroughly understood. This study was designed to develop a better understanding of the current geomorphic and biogeochemical attributes of high- and low-elevation marshes to better predict future alterations to ecosystem function. To explore these questions, a study was performed in marsh ecosystems at the Plum Island Ecosystems LTER, located in northeastern Massachusetts. A wide range of metrics, including surficial and subsurface parameters were measured over a three-year period at both high and low elevation marshes. These metrics included marsh accretion, aboveground biomass, soil sheer strength, soil bulk density, pore water nutrient concentrations, soil organic matter through loss on ignition (LOI), and the calculation of a decomposition indices using deployed teabags. The results of this study show clear differences between the characteristics of high and low elevation marshes, as well as considerable interannual variability, potentially driven by an interannual variations in climate. These findings will help to elucidate how the predicted shift towards a lower elevation marsh system will impact ecosystem function.

Observed Sea Level Rise in the St. Jones River

Keller, Neil, Student (undergraduate Environmental Science), Wesley College, 120 North State Street, Dover, DE, 19901, neil.keller@email.wesley.edu; William Kroen, Wesley College

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

The St. Jones River in central Kent County DE drains a mix of farmland, woods, urban area, and salt marsh before entering the Delaware Bay. Sea level rise poses threats to coastal life around the world due to an increase in flooding and storm surge intensity. The objective of this project was to find if sea level rise was occurring the St. Jones River. If there was sea level rise, was there an effect on salinity and turbidity? We examined historical data from the St. Jones Reserve portion of the Delaware National Estuarine Research Reserve. Data from the two tidally-influenced sites, the more upstream Lebanon Landing and the downstream Scotton Landing, were analyzed. The original data were collected by YSI Sonde at 15-minute intervals. The parameters specifically looked at in this study were georeferenced water level, turbidity, and salinity. We examined data sets every three years, starting in 1998 for Scotton Landing and 2004 for Lebanon Landing, to include 2019. A mean water level for the year was calculated using only the middle 50% of all the observed water levels to eliminate the effect of spring tides and storm surges. We found approximately a 0.20-meter increase in mean sea level at Scotton Landing from 2001 – 2019, and around a 0.14- meter increase at Lebanon Landing from 2004 – 2019. Despite this rise in sea level, there was no observed change in salinity. There was a slight decrease in turbidity during this period.

Measuring Costs and Effectiveness of Living Shorelines Projects in New Jersey

Kerr, Laura, Research Engineer, Stevens, Davidson Lab, Castle Point On Hudson, Hoboken, NJ, 07030, lkerr@stevens.edu; Jon K. Miller, Stevens; DanaRose Brown, Stevens; Nikki Zuck, Stevens

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

The costs and the effectiveness of five recently constructed New Jersey living shorelines projects (Gardner's Basin, Gandys Beach, Berkeley Island, Matts Landing and Strathmere) were evaluated. The projects were selected to capture the diversity of the living shorelines projects in New Jersey. They range in size from large to small, from simple to complex, and from relatively inexpensive to costly. The total cost for the five living shorelines projects in the study ranged from $88/lf to $2,018/lf. These costs were compared to nearby traditional gray shoreline treatments which ranged from $462/lf to 3,448/lf. Design, permitting, monitoring, maintenance and adaptive management costs were found to make up a greater proportion of the overall cost of the living shorelines projects, while construction costs including materials and labor drove of the cost of the traditional gray shoreline treatments. As a result, costs of the living shorelines projects were more evenly distributed through time, while the costs for the traditional shoreline stabilization approaches were more concentrated. The effectiveness of the living shorelines projects was evaluated by analyzing and comparing pre- and post-project shoreline changes and comparing them to a control site. Overall, three of the five living shorelines projects (Berkeley Island, Gandys Beach, and Matts Landing) were found to be clearly effective at stabilizing the shoreline in their respective project areas, and in some cases even promoted shoreline advancement (Gandys Beach and Matts Landing). Results from the other two sites were inconclusive. A second measure of effectiveness was evaluated for the three living shorelines projects designed to dissipate wave energy (Gardner's Basin, Gandys Beach, and Berkeley Island). All three projects were found to successfully dissipate wave energy under most conditions, although significant variability was observed.

Funding Water Infrastructure in the Delaware River Basin

Kohler, Ellen, Program Director for Water Resource, University of Maryland Environmental Finance Center, 7480 Preinkert Dr, College Park, MD, 20742, ejkohler@umd.edu; Karl Russek, The Water Center at the University of Pennsylvania

Urban Waters Panel, Tuesday, 2:15pm

Addressing the water quantity and quality challenges in the Delaware River basin requires collaboration and resources to maximize impacts. The Environmental Finance Center partnered with the Water Center at the University of Pennsylvania to look at how communities in the Lehigh River watershed have been funding their water infrastructure projects across all three water sectors - drinking water, wastewater and stormwater. The goal of the research was to better understand the funding and financing challenges facing these communities, what funding programs have been most effective, and what challenges still exist. We specifically looked at how past federal stimulus funding was used so as to identify any programmatic recommendations to ensure that future federal stimulus funding benefits a broad range of communities. The broader research project also included a focus in Lancaster County and in the Monongahela River watershed. During this session, we will share our research findings and recommendations.

Green Infrastructure and Hazard Mitigation: Integrating Water Quality and Water Quantity Planning

Konfirst, Matt, Regional Mitigation Coordinator, US EPA Region 3, 1650 Arch St., Philadelphia, PA, 19103, konfirst.matthew@epa.gov

Water Quality & Quantity I, Monday 1:00pm

Great potential for environmental protection and restoration can be achieved by using the full-suite of nature-based approaches in conjunction with policies available in an integrated state or local Hazard Mitigation Plan. To this end, federal and state agencies, includng EPA, FEMA, USACE, and state emergency management agencies in Maryland, Pennsylvania and Virginia have partnered to develop training materials to more consciouly incorporate major federal water quality programs into Hazard Mitigation Plans. Most of the water resource programs are required by the Clean Water Act or Safe Drinking Water Act and are implemented at State, Local, Tribal and Territorial levels. Several programs also have the potential for federal funding. In other words, integrating water quality planning with water quantity planning will better align financial resources to take advantage of the multiple benefits provided by environmental planning.

Nature-based solutions, including green infrastructure, provide a way to link these two planning processes. Nature-based solutions aim to increase society's resilience to impacts from natural hazards while protecting, managing, and restoring natural or modified ecosystems. Green infrastructure imitates the function of a natural system. For example, installation of a rain garden mimics natural hydrologic systems and helps reduce localized flooding through natural infiltration. These solutions also provide human well-being and biodiversity co-benefits.

Training materials have been developed for a daylong workshop, which will provide an in-depth look at synergies between water resource plans and Hazard Mitigation Plans. The results of several pilot workshops will be discussed, and training resources will be made available to attendees.

Integrated Coastal Modeling - a New DOE Project

Kraucunas, Ian, Principal Investigator, Pacific Northwest National Laboratory (PNNL), 902 Battelle Boulevard, P.O. Box 999, MSIN J4-02, Richland, WA, 99352, ian.kraucunas@pnnl.gov; David Moulton, Los Alamos National Laboratory; David Judi, Pacific Northwest National Laboratory; Elizabeth Hunke, Los Alamos National Laboratory; L. Ruby Leung, Pacific Northwest National Laboratory

Climate Change Impacts, Tuesday, 2:15pm

This presentation will describe a new project, funded by the U.S. Department of Energy, called Integrated Coastal Modeling (ICoM). ICoM is targeting some of the biggest uncertainties associated with the evolution of coastal regions, with an emphasis on developing and applying computational models and integrated modeling systems that can simulate the complex multiscale, multisector processes that typify coastal environments. Major scientific focus areas include the a seamless global-to-coastal Earth system modeling capability, a new model of coastal urban development and land use changes, and exploration of land-atmosphere, surface-subsurface, and human-Earth system interactions across a multi-decadal time horizon. Our initial geographic focus is the mid-Atlantic region of the United States, with particular emphasis on the Delaware and Susquehanna River Basins and their estuaries. Understanding changes in these regions will require considering processes that happen in upland areas, coastal cities, rivers, floodplains, estuaries, the open ocean, and the atmosphere that influence wind and precipitation patterns, water quantity and composition, ecogeomorphology, and coastal development, all of which span a range of spatial and temporal scales. The ICoM team is thus eager to build collaborations and connections with scientists, decision makers, and other stakeholders in the Delaware region. The long-term goal of ICoM is to deliver a robust predictive understanding of coastal evolution that accounts for the complex, multiscale interactions among physical, biological, and human systems and can be applied in additional coastal regions.

Climate Change Indicators in the Technical Report for the Delaware Estuary and River Basin

Kreeger, Danielle, Science Director, Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE, 19801, dkreeger@delawareestuary.org

Climate Change and the Delaware Estuary, Tuesday, 10:30am

Every five years, the Partnership for the Delaware Estuary coordinates production of a State of the Estuary Report on behalf of the Delaware Estuary Program. To provide the scientific foundation for this report, the program's Scientific and Technical Advisory Committee also coordinates a companion Technical Report for the Delaware Estuary and Basin (TREB). The goal of TREB is to analyze the status and trends for more than 50 environmental indicators representing diverse facets of the natural ecosystem such as water quality, living resources, habitats and land cover. When considered together, these indicators provide a comprehensive picture of the current and trending environmental condition of the watershed. The report also helps assess our progress in protecting, restoring and sustaining vital natural resources. The analysis of each indicator includes a discussion of actions and needs, providing a blueprint for future science and management. Climate change affects all of the indicators, and a devoted climate change chapter directly examines past, present and future projected data for mean temperature, extreme temperature, precipitation, streamflow, snow cover, ice jams, wind speed, and sea level rise. The report showcases how the pace of climate change appears to be quickening for some indicators, with likely severe consequences for some critical natural resources that have non-linear responses due to tipping points. For example, many tidal wetlands are predicted to have increasing difficulty accreting vertically to keep pace with sea level rise, and oysters and freshwater mussels are very sensitive to salinity rise. Example data from the 2017 TREB and plans for the 2022 TREB will be shown, and attendees will be invited to assist with developing next generation climate indicators such as related to extreme weather, flooding, and coastal resilience. For more info, see: https://www.delawareestuary.org/data-and-reports/state-of-the-estuary-report/

Importance of Seston Composition for Quantifying Nitrogen Filtration by Freshwater and Marine Bivalves

Kreeger, Danielle, Science Director, Partnership for the Delaware Estuary, 110 S. Poplar St., Suite 202, Wilmington, DE, 19801, dkreeger@delawareestuary.org; Kurt M. Cheng, Partnership for the Delaware Estuary; Joshua A. Moody, Partnership for the Delaware Estuary; Matthew J. Gentry, Partnership for the Delaware Estuary

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Natural and cultured populations of suspension-feeding bivalves affect water quality in various ways, especially in cases where their population size, water residence time, and seston loads are high. The ecosystem service ge

nerating the most attention by water quality managers is the removal, transformation and sequestration of seston-associated nitrogen. Bivalves must consume sufficient nitrogen to satisfy their demands for growth (biosynthesis) and reproduction (gametogenesis). The fate and form of filtered nitrogen (remineralization, sequestration) can vary widely depending the animal's nutritional status (e.g., seasonal protein sparing) and ecological interactions (e.g., microbial processing of biodeposits), and more research is needed to discern these effects in situ. In addition, an overlooked factor that affects bivalve ecosystem services is seston quantity and quality. A re-analysis of 30 years of bivalve clearance rate studies with diverse freshwater and marine species indicated that nitrogen concentrations in natural seston diets used in the experiments varied by two orders of magnitude. In contrast, bivalve clearance rates varied by less than one order of magnitude among species, after normalizing for body size and seasonal temperature. Nitrogen filtration rate therefore varied more with seston nitrogen concentration than bivalve species or salinity. To promote water quality throughout coastal watersheds, a multi-species approach could include oysters, ribbed mussels and the more abundant species of freshwater mussels that live in diverse niches along the salinity gradient. Greatest nitrogen removal rates would result from restoration and enhancement tactics that promote the greatest uplift in bivalve population biomass and in geospatial niches that have highest seston nitrogen concentrations.

Atlantic Sturgeon Habitat Utilization near the Delaware Bay Mouth: Targeted Approach using Acoustic Telemetry, Sidescan Sonar, Bottom Sampling, and Gut Content Analyses

Kuntz, Justin, University of Delaware, 1108 Talley Road, Wilmington, DE, 19809, jkuntz@udel.edu

Living Resources, Monday, 11:00am

Sturgeons (Acipenseridae) are considered the planet's most threatened group of animals by the International Union for the Conservation of Nature (IUCN) with approximately 2/3rds of sturgeon species considered critically endangered with the remainder deemed threatened primarily due to overfishing and habitat loss. Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) have been severely overfished since the late 19th century, and are currently listed under the Endangered Species Act (ESA). We are attempting to determine why Atlantic Sturgeon migrate to the same location in the Delaware River Estuary year after year in what is perhaps one of their largest marine concentrations. We utilized an innovative methodology that integrates high-resolution side-scan sonar with more conventional biotelemetry, and targeted collection efforts carried out in partnership with a leader in the Mid-Atlantic commercial fishing industry. Preliminary results suggest Atlantic Sturgeon are concentrated in two general locations in the lower Delaware Bay, varying in abundance at each location from late spring through the fall. Each location has been found to primarily consist of a sandy substrate, with pockets of coarse sands occurring in the shallower of the two regions. Based on our 2019 gut content analysis, polychaetes and crustaceans appear to be the majority of their sustenance, accounting for approximately 30% of the taxa identified each, as well as 59% and 30% of the total weight consumed respectively. Our findings suggest a link between congregation areas and food availability, and between food preferences and substrate types. These data provide information for why Atlantic Sturgeon would congregate in the lower Delaware Bay. The correlation between sandy substrates and seasonal sturgeon congregations constrains the location of critical habitat within the Bay. These results should be taken into consideration as enhanced protection for Atlantic Sturgeon within this saline environment are developed.

Freshwater Mussel Species Occurrence Surveys in the Delaware Estuary, Bucks County, PA

Lech, Gregory, Pennsylvania Fish and Boat Commission, 595 E. Rolling Ridge Drive, Bellefonte, PA, 16823, glech@pa.gov; Jordan Allison, Pennsylvania Fish and Boat Commission; Dakota Raab, Pennsylvania Fish and Boat Commission

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

The mission of the Pennsylvania Fish and Boat Commission (PFBC) is to protect, conserve and enhance the Commonwealth's aquatic resources and provide fishing and boating opportunities. As a partner of the Pennsylvania Natural Heritage Program, the PFBC is tasked with protecting threatened, endangered, and special concern species and investigating each species known range. Freshwater mussels are frequently characterized as the most imperiled taxonomic group in North America; but, while awareness of the vital role they play in aquatic ecosystems is growing, they are still largely overlooked and understudied. While the PFBC has targeted fish species in the Commonwealth for decades and has a plethora of internal data, the tracking of freshwater mussel species occurrence and range is, comparatively, in its infancy. In 2020, the PFBC conducted visual surveys within the Delaware Estuary to better determine the presence and range of freshwater mussel species. Surveys were conducted in 22 locations using surface-supplied-air at depths up to 15-feet between Bristol and Bensalem, in Bucks County, PA. Six species (# of individuals) were identified: *Elliptio complanata* (1965), *Utterbackiana implicata* (1764), *Leptodea ochracea* (26), *Lampsilis cariosa* (9), *Ligumia nasuta* (1), and *Lampsilis radiata* (1). Visual survey methods are inherently biased towards larger individuals; therefore, while many size classes (including small individuals) were recorded through measurement, recruitment cannot be verified. Subsequent surveys will be carried out in the upper tidal portion of the Delaware Estuary to further characterize species composition and range. The data presented should guide partners' quantitative surveys to determine density and recruitment of freshwater mussels in the Delaware Estuary.

Philadelphia Water Department High-resolution Water Quality Model in the Urban Tidal Freshwater Delaware River

Leung, Kinman, Environmental Engineer 3, Philadelphia Water Department, 1101 Market Street, 5th floor, Philadelphia, PA, 19107, kinman.leung@phila.gov; Eileen Althouse, CDM Smith; Paula Kulis, CDM Smith; Ramona McCullough, Sci-Tek Consultants; Damian Brady, Woods Hole Group; Katie Lavellee, Woods Hole Group; Sen Bai, Tetra Tech, Inc

Water Quality & Quantity I, Monday 1:00pm

Philadelphia Water Department's primary mission is to plan for, operate, and maintain both the infrastructure and the organization necessary to purvey high quality drinking water, to provide an adequate and reliable water supply for all household, commercial, and community needs, and to sustain and enhance the region's watersheds and quality of life by managing wastewater and stormwater effectively. In fulfilling its mission, the Department seeks to be customer-focused, delivering services in a fair, equitable, and cost-effective manner, with a commitment to public involvement. Having already served the City and region for nearly two centuries, the utility's commitment for the future includes an active role in the economic development of Greater Philadelphia and a legacy of environmental stewardship. In the previous Science and Environmental Summit, the Department had presented its numerical model of the tidal freshwater Delaware River developed for the Philadelphia Green City, Clean Waters program and how it utilizes the model for strategic planning. The model was applied to simulate in-stream concentrations of bacteria and dissolved oxygen in the Delaware River between Trenton and Delaware City. The US EPA 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, dissolved oxygen (DO), algae, and fecal coliform bacteria from tributaries and municipal and industrial discharges were all considered in model development. On June 1, 2015, the Department submitted water quality model results to PADEP as part of the regulatory requirement. The Department continues to update and refine the water quality model as part of a long-term planning strategy. The presentation will focus on progress that has been made since the last Summit, including applying the model to biogeochemical studies, and to assess the complex relationships in nutrient cycles.

Assessing climate change impacts on *Spartina alterniflora* biomass allocation using a dynamic vegetation model

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Monitoring & Assessment, Tuesday, 10:30am

Coastal salt marsh plays an important role in the regulation of coastline evolutions and they are experiencing environmental stresses from global warming. *Spartina alterniflora* (smooth cordgrass) is the dominant salt marsh-building plant along the US Atlantic coast. However, the impacts of climate change on biomass allocation of S. alterniflora are unclear. Most current coastal geomorphological models could capture the current distribution of vegetation but may fail to capture the vegetation response to future climate change. To better understand the biomass allocation of coastal vegetation under future climate change, we validated the functional assembled terrestrial simulator (FATES) model based on observed biomass data in seven salt marshes from Massachusetts to South Carolina. Then we use the model to predict dynamics of aboveground and belowground live biomass from 2020 to 2100. We find that warming would lead northern S. alterniflora to increase aboveground biomass and decrease belowground live biomass and lead southern S. alterniflora to decrease both aboveground and belowground live biomass. Warming would have stronger impacts on northern S. alterniflora than southern S. alterniflora. Our results suggest that global warming would decrease future belowground allocation even considering adaptation and acclimation.

Habitat Selection has Implications for Post-Settlement Growth of Oysters in Different Salinities

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Living Resources: Oysters, Monday, 4:00pm

As the interface between the saline ocean and freshwater rivers, estuaries provide valuable habitat for the Eastern oyster (*Crassostrea virginica*). While salinity at a given location fluctuates regularly with tides and precipitation, there are stark environmental differences upbay and downbay controlled by the salinity gradient. High salinity habitats downbay support higher oyster growth, while lower salinity upbay is a refuge from predation and disease. The brief larval phase is the only time oysters travel within the bay; therefore, habitat selection via larval settlement has growth and survival implications throughout the life of the oyster. Two experiments were performed in which oyster spat were collected from distinct Delaware Bay salinity regions, then transplanted to various salinity conditions in the laboratory where growth was regularly monitored. Transplanting into low salinity led to significant decreases in growth compared to transplanting to higher salinity, and growth of oyster spat differed based on the salinity conditions from which they were collected (i.e. their settlement conditions). An additional experiment was performed using hatchery reared larvae. Upon reaching competency, larvae were placed in one of four different salinity conditions to settle, and they were kept there for three weeks post-settlement, then measured. Spat were then transferred into new salinity conditions where they remained for three weeks and measured again. Settlement salinity treatments and transfer salinity treatments were fully crossed for a total of 16 treatments replicated 4 times. As before, lower salinity treatments were associated with lower growth, with settlement salinity having the greatest effect on reduced growth. Consequently, environmental conditions at settlement can impact subsequent oyster growth, despite changes in salinity. As increased freshwater events due to climate change are expected in the Delaware Bay, these differences in early oyster growth in response to habitat selection and salinity changes are important for oyster stock resilience.

Microplastics and Trapping of Buoyant Particles in Delaware Bay

Mason, Robert, PhD Student, University of Delaware, 1323 Wharton Dr, Newark, DE, 19711, ramason@udel.edu; Tobias Kukulka, University of Delaware; Jonathan H Cohen, University of Delaware

Water Quality: Microplastics, Monday, 4:00pm

Microplastic Marine Debris (MPMD) is an emerging major ocean pollutant; however, MPMD remains relatively understudied in coastal and estuarine regions. This study is part of an effort to investigate the scope of MPMD in Delaware Bay and its potential impacts on the ecosystem. A previous numerical simulation of MPMD in the Delaware Bay suggested that MPMD quickly organize into a patchy, inhomogeneous distribution over the span of a few hours. In this study we employ a regional hydrodynamic model of the Delaware Bay and its adjacent continental shelf to further understand what mechanisms drive this particle distribution and whether or not particles leave the bay. The model includes realistic wind, tide, and river discharge from the Delaware River and its tributaries. In order to simulate the motion of these buoyant, surface-trapped particles, we release an evenly distributed particle field across the bay and force them with the flow field from the model. This approach allows us to determine particle movement, residence times, and accumulation regions. In addition to studying realistic conditions, we also study idealized conditions to better understand each forcing's influence on particle movement and distribution. The forcings we consider are river discharge, wind, tidal phase, spring-neap variation, and bathymetry. Our findings show that most particles are trapped in the Delaware Bay until an event, such as a wind blowing toward the southwest, occurs to trigger particles being flushed from the bay. Our results suggest that traditional volume replenishment residence time estimates may not be applicable for buoyant tracers in estuaries since particle flushing may be driven by episodic events.

Using the Mid Atlantic Coastal Wetlands Assessment (MACWA) in Planning and Decision Making – Case Study Barnegat Bay Islands Work Group

Maxwell-Doyle, Martha, Project Director, Barnegat Bay Partnership, College Drive, Toms River, NJ, 08754, mmdoyle@ocean.edu; Emily Pirl, Barnegat Bay Partnership; Shannon Vasquez, Barnegat Bay Partnership; Virginia Rettig, USFWS E. B. Forsythe National Wildlife Refuge; Kimberly McKenna, Stockton University; Angela Anderson, Long Beach Township; Joseph A. Smith, USFWS E. B. Forsythe National Wildlife Refuge

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Coastal wetlands in New Jersey are threatened by the impacts of climate change (increased storm intensity and frequency, sea level rise) and anthropogenic disturbances (nutrient pollution, shoreline hardening). Marsh islands in particular provide many ecosystem services such as protected nesting habitat for colonial birds, and storm surge and wave protection for developed coastal communities. In 2018, a group of practioners lead by USFWS Edwin B. Forsythe National Wildlife Refuge (EBFNWR), Barnegat Bay Partnership (BBP), Stockton University (SU) and Long Beach Township established the Barnegat Bay Islands Working Group (BBIWG). The primary goal of BBIWG was to identify and prioritize islands in Barnegat Bay for potential restoration or enhancement projects. Initial steps were taken by SU to map all of the islands and begin to incorporate other existing data sets. During summer 2020, BBP re-directed its citizen efforts through Paddle for the Edge to assess and photograph island shoreline conditions. The Barnegat Bay Partnership and the EBFNWR field teams used the Mid Atlantic Tidal Wetlands Rapid Assessment Method (MidTRAM), to collect qualitative and quantitative data on island buffers/landscape condition, hydrology and habitat attributes. Each set of metrics and attributes are combined to give each island an overall score and P4E data will assist the working group in prioritizing islands for restoration projects.

Hydro-climatic Drought in the Delaware River Basin

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Climate Change Impacts, Tuesday, 2:15pm

The Delaware River Basin (DRB) supplies water to approximately 15 million people and is essential to agriculture and industry. In this study, a monthly water balance model is used to compute monthly water balance components (i.e., potential evapotranspiration, actual evapotranspiration, and runoff (R)) for the DRB for the 1901 through 2015 period. Water-year R is used to identify drought periods in the basin and 7 drought periods were identified. All but one of the drought periods occurred before about 1970; after this date, precipitation increased in the DRB and droughts were infrequent. The 7 droughts were largely driven by precipitation deficits, rather than by unusually warm temperatures. For 6 of the 7 droughts, the precipitation deficits were associated with atmospheric pressure patterns that resulted in northerly wind anomalies (i.e., conditions that deviate from the long-term mean) over the basin that indicate an anomalous flow of dry air from the North American continent into the DRB. An examination of drought events estimated from a tree-ring based reconstruction of the Palmer Drought Severity Index for the 490 through 2005 time period indicates that although there were some DRB droughts that were longer and more severe during previous centuries, the DRB droughts during 1901 through 2015 were comparable in duration and severity to most drought events during previous centuries.

Determining if an Elongation of the Growing Season has an Effect on Algal Blooms

Miller, Cassandra, Student (undergraduate Environmental Science), Wesley College, 120 North State Street, Dover, DE, 19901, cassandra.miller@email.wesley.edu; William Kroen, Wesley College

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

The National Estuarine Research Reserve System (NERRS) maintains a consolidated database of water quality, nutrient, and meteorological data from 29 units that can be used to help determine the quality of waterways. The goal of the Delaware NERR is to establish, protect, and manage natural estuarine habitats of Blackbird Creek and the St. Jones River for research, education, and coastal stewardship. The purpose of this project was to determine if water temperature stayed warmer longer during the year at the Blackbird Creek site, resulting in an elongation in the growing season. This elongated growing season means farming can happen for a more extended period, possibly increasing nitrogen and phosphorus levels from runoff. This will lead to an increase of chlorophyll in water, which will cause more algal blooms to form since warm water and high levels of nitrogen and phosphorus are vital factors in algal growth. Historical temperature data from the Blackbird Creek site were used to determine the growing season's length, then nutrient data and water quality data were analyzed to see if nitrogen, phosphate, and chlorophyll levels increased during the growing season. There was an elongation in the growing season from 1996 to 2019 of more than a month, mainly into October. Phosphate levels were highest during the summer and fall; chlorophyll levels showed a similar pattern. There is thus a weak correlation where phosphate could fuel growth. DIN levels were highest during the winter when chlorophyll levels were quite low, indicating no relationship between these two factors. There was no obvious trend in nutrient levels or chlorophyll concentration over the 20-year period.

Overwintering Alternatives for Eastern Oysters (*Crassostrea virginica*) Farmed in Delaware Bay

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Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Oysters farmed intertidally in Delaware Bay, NJ are susceptible to freezing, ice damage and increasingly unpredictable freeze-thaw cycles that can all lead to significant losses. Oyster grown subtidally are not susceptible to these risks while oysters grown in more northern regions are often overwintered in cold storage. Because subtidal access is limited in Delaware Bay, most intertidal farms leave oysters in place during winter exposing them to considerable risk. This study compared survival, condition and disease among oysters held intertidally, subtidally and under refrigeration during winter. Two year classes of the Rutgers NEH™ line representing sub-market and market-size oysters were deployed under each method in five replicate bags from December 2019 through mid-March 2020 then returned to the intertidal farm. Survival was measured monthly, while size, weight and condition were measured quarterly through October 2020. Oysters were assessed for dermo and MSX diseases at the start of the study and subsequently in June and October. Results indicated no significant differences in any parameters measured among overwintering methods. Winter weather during the study was mild and did not pose significant risk to intertidal stocks, but the fact that other methods performed equally well suggests that refridgeration provides a viable alternative in years when intertidal conditions are harmful.

An Introduction to the Wetland Assessment Tool for Condition and Health (WATCH)

Moody, Joshua, Restoration Programs Manager, Partnership for the Delaware Estuary, 110 S. Poplar St, Suite 202, Wilmington, DE, 19801, jmoody@delawareestuary.org; LeeAnn Haaf, Partnership for the Delaware Estuary

Monitoring & Assessment, Tuesday, 10:30am

Salt marsh acreage decline, and the contemporaneous loss of ecosystem services, is a principal concern to natural resource stakeholders in the Delaware Estuary, and intervening these losses is a regional priority. It is difficult, however, to assess the vulnerability of a salt marsh to the suite of stressors that it may experience. Many tools and data products currently exist to quantify site-specific metrics, but they tend to focus on a singular outcome (e.g., habitat quality, inundation, erosion) without considering the variety of feedbacks that contribute to a cohesive diagnosis. Although multi-metric monitoring protocols exist to score overall health, these relative, instantaneous measures were not intended to serve as diagnostic tools. Yet, a holistic assessment of current and future site-specific salt marsh function is a necessary step to inform enhancement efforts. Therefore, a consistent means for the integration of multiple salt marsh attributes to diagnose sources of functional deficiency is an important component of developing intervention strategies.

The Wetland Assessment Tool for Condition and Health (WATCH) is a flexible, systematic framework that integrates data regarding a suite of attributes, shown to be fundamental in salt marsh function, to gain a holistic understanding of site-specific salt marsh condition. For each attribute (lateral and vertical position, biology, hydrology, soil condition, and water quality), WATCH evaluates data against user-defined criteria and trajectories to identify evidence of current and/or future deficiencies. These attribute-specific deficiencies are subsequently integrated to identify unique combinations indicative of diminished functionality. When the data suggest diminished functionality for one or more attributes, but the evidence is not strong enough to indicate site-wide deficiency, WATCH identifies interrelated attributes for continued monitoring. This talk will introduce the WATCH tool and provide information regarding an introductory and training workshop scheduled for March 2021.

Utilizing stormwater ponds to expedite juvenile mussel growth in New Castle County, Delaware

Morgan, Leah, Science Fellow, Partnership for the Delaware Estuary, 110 S Poplar St, Suite 202, Wilmington, DE, 19801, lmorgan@delawareestuary.org; Kurt M. Cheng, Partnership for the Delaware Estuary; Danielle A. Kreeger, Partnership for the Delaware Estuary; Matthew J. Gentry, Partnership for the Delaware Estuary

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Freshwater mussels furnish ecosystem services such as water filtration and benthic pelagic coupling, which can positively affect water quality and surrounding ecology. However, freshwater mussels are one of the most imperiled aquatic animal groups on the continent with over 70% of the nearly 300 species considered imperiled or worse. As part of the Freshwater Mussel Recovery Program (FMRP), Partnership for the Delaware Estuary (PDE) collaborated with a federal mussel hatchery to propagate mussels from Delaware River broodstock, with the goal of introducing mussels into man-made waterways to promote water filtration and test

whether such systems could serve as rearing sites for later restoration. To diversify mussel grow-out options, researchers deployed the Alewife Floater, *Utterbackiana implicata*, in stormwater ponds across New Castle County, Delaware. Juvenile mussels 50 – 70 mm in shell length (SL) were deployed in baskets (n = 3) at each of six man-made sites in 2019 and monitored seasonally. Two private ponds served as reference sites where juveniles were previously grown and four sites were managed stormwater ponds. Through fall 2020, mussel size was largest at Tally Day pond (mean SL 86.0 ± 5.64 mm) and smallest at Airport Road pond (mean SL 69.8 ± 4.30 mm). Mussels at Tally Day pond exhibited the fastest growth (0.074 mm d^{-1}) while mussels at Winterthur, a reference site, grew slowest (0.031 mm d^{-1}). While Tally Day pond supported the greatest mussel growth, low mortality and impressive growth was observed at all sites. Stormwater ponds assessed seem suitable for juvenile freshwater mussel rearing based on PDE monitoring data thus far. Information learned from these efforts will apply to future outputs of the FMRP wherein mussels may be used to mitigate high levels of pollutants via filtration of

particulate matter, establishing new avenues for water quality management in man-made systems using nature-based approaches.

Examining Sources and Pathways of Phosphorus Transfer in a Ditch-Drained Field with Concentration-Discharge Relationships and Isotope Hydrograph Separation

Mosesso, Lauren, Graduate Student, University of Delaware, 531 S. College Avenue, 152 Townsend Hall, Newark, DE, 19716, lmosesso@udel.edu; Anthony Buda, USDA-ARS; Amy Collick, University of Maryland Eastern Shore; Casey Kennedy, USDA-ARS; Gordon Folmar, USDA-ARS; Amy Shober, University of Delaware

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Understanding the processes that mobilize and transport dissolved phosphorus (P) during storms is critical to managing P in flat landscapes with open ditch drainage and legacy soil P. In this study, we employed routine baseflow monitoring and intensive storm sampling at a ditch-drained site on Maryland's Lower Eastern Shore (July 2017 to September 2018) to assess whether concentration-discharge (C-Q) relationships and chemical and isotopic hydrograph separation

could provide insight into the processes that mobilize and transport dissolved P in ditch drainage. Using a segmented regression model, we determined that long-term C-Q relationship for dissolved P differed above and below a discharge threshold of 6.4 L s-1. Intensive storm sampling revealed that small storms (n=3) occurring at or below the discharge threshold generally exhibited complex hysteresis and dissolved P dilution patterns that were presumably driven by deeper groundwater inputs with low dissolved P concentrations (0.04 mg L-1). In contrast, large storms occurring well above the discharge threshold (n=4) induced rising water tables and preferential flow pathways that most likely tapped dissolved P-enriched shallow soil waters (0.89 mg L-1), producing consistent clockwise hysteresis and dissolved P flushing patterns. Notably, chemical and isotope hydrograph separation during two of the largest storms revealed significant event water fractions (59 to 68%) that strongly suggested a role for the rapid delivery of dissolved P via preferential flow pathways. Findings highlight the need to mitigate vertical P stratification as a means for reducing dissolved P flushing from ditch-drained landscapes with legacy P.

Status of Juvenile Freshwater Mussel Growth and Survivorship at Green Lane Reservoir

Newman, Malcolm, The Academy of Natural Sciences of Drexel University, 1900 Ben Franklin Parkway, Philadelphia, PA, 19103, men45@drexel.edu; Kathryn Longwill, The Academy of Natural Sciences of Drexel University; Roger L. Thomas, The Academy of Natural Sciences of Drexel University; Danielle Kreeger, Partnership for the Delaware Estuary; The Academy of Natural Sciences of Drexel University; Kurt Cheng, Partnership for the Delaware Estuary; Lance Butler, Philadelphia Water Department

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Freshwater mussels play an important role in maintaining healthy freshwater ecosystems and can be used as reliable indicators to evaluate water quality in streams and rivers throughout the United States. As filter feeders, mussels remove particulate matter from the water column, which can influence water quality where mussels are abundant. Mussels can also increase stream-bottom stability and provide habitat diversity for other macroinvertebrates and fishes. Researchers from the Academy of Natural Sciences of Drexel University, the Partnership for the Delaware Estuary, and the Philadelphia Water Department have been involved in freshwater mussel restoration efforts throughout the lower Delaware Estuary, including propagating mussels at The Mussel Hatchery in Philadelphia.

One of the greatest challenges to the success of many propagation programs is the need for adequate culturing or "grow out" sites, where juvenile mussels can be relocated and held until they reach a size whereby they can be transplanted into local streams. Within Pennsylvania, Green Lane Reservoir in Pennsburg, Van Sciver Reservoir in Tullytown, several ponds in Longwood Gardens and other local sites were determined to meet these criteria and the authors have gathered data suggesting appreciable mussel growth in these waters. We present recent data on the survivorship and growth of transplanted *Elliptio complanata*, *Utterbackiana implicata*, and *Saggitunio nasutus*, and microscopic juvenile *Saggitunio nasut*us deployed directly into floating baskets and compare with data collected from several other satellite culture facilities. From December 2019 to November 2020 at Green Lane, survivorship of S. nasutus was approximately 83.8% and the average growth was 18.4mm. U. implicata displayed a survivorship of 73.5% and an average growth of 8.2mm. During the 2020 growing season, we also initiated an experiment to compare the growth rates of freshwater mussels held in our historic floating/submerged baskets with those held in newly purchased commercial oyster culturing platforms.

Does Ammonium Supplied from Municipal Wastewater Suppress Primary Production in the Urban Delaware River?

Parker, Alex, Associate Professor, California State University Maritime Academy, 200 Maritime Academy Drive, Vallejo, CA, 94590, aparker@csum.edu; Joanna York, University of Delaware; Margaret Dolan, University of Delaware; David Walsh, Woods Hole Group

Hot Topics, Wednesday, 3:30pm

Despite elevated nutrient loading to the urban Delaware River, the estuary does not exhibit classical symptoms of cultural eutrophication. Phytoplankton biomass in the urban river is moderately high, especially in summer, but primary production rates are relatively low. Previous work in the urban river has shown lower carbon uptake associated with elevated NH4, suggesting that NH4, or an unidentified substance associated with NH4, depressed primary production. The goal of this project, funded by the Philadelphia Water Department, was to understand how potential changes to municipal wastewater treatment, including altering NH4 loads, would impact primary production in the urban river. We conducted surveys between New Castle, DE and Florence, NJ to characterize interacting controls on phytoplankton carbon and nitrogen uptake. Additionally, we carried out nutrient amendment and nitrogen kinetics experiments with water from stations upstream, within, and downstream of major wastewater inputs and compared phytoplankton growth on NH4 (as NH4Cl) to NH4 supplied from wastewater, and NO3. Results from both surveys and enclosures suggest that NH4 >6 µM suppressed phytoplankton NO3 uptake. Surveys showed that elevated C uptake was correlated with low NH4 concentrations. However, results from nutrient amendment experiments enriched with NH4Cl or effluent-NH4 >10 µM resulted in chlorophyll-a and C uptake rates comparable to unamended controls. Nitrogen kinetics experiments showed that NH4 added as NH4Cl, resulted in classical Michaelis-Menten saturating kinetics but when NH4 was supplied from effluent, concentrations of NH4 >40 µM resulted in lower NH4 uptake compared to controls. Together, our results suggest that an unidentified inhibitory substance associated with effluent is more likely than NH4 itself, to suppress primary production in the urban Delaware river. However effluent-NH4 loading is likely sufficiently diluted in situ as to be below our experimentally determined thresholds for an impact.

Volunteer-Driven Diamondback Terrapins Projects in the Delaware Inland Bays

Perez-Perez, Nivette, Project Manager, Delaware Center for the Inland Bays, 39375 Inlet Rd., Rehoboth Beach, DE, 19971, nperezperez@inlandbays.org; Zach Garmoe, Delaware Center for the Inland Bays

Living Resources, Monday, 11:00am

The Diamondback terrapin (*Malaclemys terrapin*) is the only species of turtle that lives its entire life in coastal salt marshes and estuaries along the Atlantic and Gulf coasts of the U.S. This ecologically important species serves as a predator within salt marsh ecosystems, preying on the salt marsh periwinkle, various crab species, and other invertebrates. In addition, female terrapins generate substantial attention during nesting season, which generally coincides with peak tourist use of local beaches and waterways. In an attempt to reach their breeding grounds, females are often struck by motor vehicles while trying to cross Coastal Highway, the main highway to and from Delaware's beaches. Diamondback terrapins face numerous additional threats such as habitat loss, nest predation, derelict crab pots, commercial harvest, and boat collisions. Yet despite their importance and charismatic nature, little is known about this iconic species' population status.

In response to these increasing threats and unknowns, the Delaware Center for the Inland Bays developed two volunteer-driven programs: an annual terrapin population survey and a terrapin nesting garden program. The population survey consists of volunteers conducting water-based kayak head counts in predetermined transects throughout major marsh areas, and stationary land-based point counts at other predetermined locations in the Inland Bays. The gardens are sandy patches built in strategically selected areas to provide suitable locations for female terrapins to safely lay their eggs. This session will highlight the challenges and successes in the first year of both programs and how the collaboration between staff, volunteers, and partners, led to an overall successful program launch even during the COVID-19 pandemic.

Research and Outreach Rapid Response to the 2020 Broadkill Beach Oil Spill

Petrone, Christopher, Marine Advisory Service Director, Delaware Sea Grant / Univ. of Delaware, 700 Pilottown Road, Lewes, DE, 19958, petrone@udel.edu

Hot Topics, Wednesday, 3:30pm

On October 19, 2020, the Delaware Department of Natural Resources and Environmental Control (DNREC) received its first report of oil observed on Broadkill Beach, a small Delaware Bayshore community located just north of Lewes and east of Milton. In the coming days and weeks, the oil spread via tidal action north to Bowers Beach, DE and south as far as Assateague Island, VA. It is estimated that 215 gallons of "heavy fuel oil" was spilled from an unknown source, with the total amount of oiled sand and debris removed from beaches totaling 85 tons over the next four weeks. Unified command suspended cleanup operations on November 13, 2020. This was the first substantial oil spill in the Delaware Estuary since the 2004 "Athos I" spill near Paulsboro, NJ. As with any oil spill, time is of the essence with respect to containing and collecting the oil. While cleanup is coordinated by the U.S. Coast Guard and, in this case, DNREC, many other organizations and citizens are eager to assist in any way. In the days following the Broadkill Beach spill, Delaware Sea Grant initiated a multi-faceted research and outreach rapid response. Outreach included social media posts, an unprecedented multimedia campaign utilizing their popular "15 Second Science" video series, and media and K-12 interviews. With a strong network of research faculty at the University of Delaware, Delaware State University, and other institutions, Delaware Sea Grant also launched a rapid response research Request for Proposals for projects costing up to $10,000. This presentation will describe these rapid response initiatives, their effectiveness, and lessons learned.

Importance of the Delaware Bayshore to Migratory Songbirds Measured by Refueling Rate and Breeding Origins

Pickett, Aya, Graduate Student, Delaware State University, 3113 Chipmunk Court, Bear, DE, 19701, ayapickett@gmail.com; Christopher Heckscher, Delaware State University

Living Resources, Monday, 11:00am

Coastal ecosystems along the Delaware Bay are quickly disappearing. Climate change, human development, and sea level rise have all taken part in degradation of this important habitat. A wide variety of organisms rely on these coastal areas, including songbirds. Songbird populations have been on the decline, as human pressures continue to threaten resources needed for survival.

In addition to these pressures, many songbirds undergo migration, an event that results in the highest rates of mortality in the avian life cycle. Unknown obstacles including predators, ecological barriers, and harsh weather conditions often prevent birds from completing migration. Songbirds use oceanic coastlines to navigate during migration, thus larger volumes of birds can be observed in these areas in spring and autumn. This phenomenon has been documented along the Delaware Bayshore, indicating that this portion of coastline could be critical habitat to actively migrating birds. They also heavily rely on areas in between destinations to rest and refuel. These areas, or "stopover sites", are vital to survival of migrants and are habitats of high conservation priority.

The present study aims to identify the potential of the Delaware Bayshore as a stopover site. I will be capturing songbirds in Milford Neck Preserve using mist nets. Mist net data will be used to understand abundance and diversity of birds using Milford Neck Preserve. Additionally, a blood sample will be collected from each migrant. Triglyceride concentrations will be extracted from blood samples, and used to determine refueling performance. I will also use refueling performance to analyze physiological and seasonal differences. I will additionally be collecting feathers from study species to determine natal origin.

Results from this study will be used to inform stakeholders and support management decisions regarding habitat conservation for migratory songbirds.

Chasing Ghosts in the Delaware Inland Bays: Utilizing Low-Cost Consumer Sonar to Detect Derelict Crab Pots and Classify Benthic Substrate

Repp, Jennifer, University of Delaware, 15974 Bowman Drive, Lewes, DE, 19958, jrepp@udel.edu; Kate Fleming, Delaware Sea Grant; Dr. Art Trembanis, University of Delaware

Monitoring & Assessment, Tuesday, 10:30am

With an estimated 2.3 derelict crab pots per acre in the creeks and coves of Delaware's Inland Bays, a two-year project by the University of Delaware and Delaware Sea Grant, funded by the NOAA Marine Debris Program, endeavors to remove one thousand of these pots and study their impact on the ecosystem. In December 2020 the team will deploy small boats and an Autonomous Surface Vessel equipped with side-scan sonar to map one thousand acres in Indian River Bay. Using machine learning and GIS analysis, the team will characterize the substrate to better understand the distribution of derelict crab pots - where do they cluster, and why? Then, in January 2021, a crew of volunteers will engage in a recovery round-up effort to remove five hundred pots from the mapped area and catalog their contents. This presentation will focus on the methods and results of the mapping and removal efforts, explore the new technology the team employs, and discuss the future goals and plans for the project.

Lessons Learned: Restoring the Northernmost Freshwater Tidal Marsh on the Delaware River

Rogers, Jennifer, Director of Stewardship, Mercer County Park Commission, 197 Blackwell Road, The Historic Hunt House, Pennington, NJ, 08534, jrogers@mercercounty.org; Mark Gallagher, Princeton Hydro

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Freshwater tidal marsh is one of the most valuable habitat types in New Jersey, yet has experienced the highest percentage of loss and degradation of wetland habitat in the state. The Mercer County-owned freshwater tidal marsh within John A. Roebling Park in Hamilton Township, is the heart of the larger 3,000-acre Abbott Marshlands, the northernmost tidal freshwater marsh of the Delaware River. The 466-acre Roebling Park provides habitat for rare organisms (wild rice, river otter, American eel), hosts prime breeding habitat for Bald Eagle, serves as an important stopover along the Atlantic Flyway, and is designated as a NJ Audubon Important Bird and Birding Area. Unfortunately, the area has experienced a significant amount of degradation, mostly related to the dominance of the invasive *Phragmites australis* (phragmites). The Mercer County Park Commission is currently working with Princeton Hydro to conduct a multi-year, multi-phased restoration of these important freshwater tidal wetlands in Roebling Park. In order to increase biodiversity, improve recreational opportunities, and enhance visitor experience at the park, the team put together a plan to reduce and control the phragmites. This stewardship project paired treatment of phragmites with the removal of dead phragmites biomass via an amphibious Marsh Master to expose the marsh substrate and its native seed bank. After just one year, the marsh has begun to recolonize and native marsh species have returned to the landscape with minimal phragmites regrowth. This presentation will highlight the methods that can be used to effectively control phragmites invasion and restore wetlands without having to install plant material. The team will share lessons learned leaving attendees with a renewed outlook on nature-based restoration principles.

Restoration of a Delaware Coastal Wetland Using Dredge Materials

Rogerson, Alison, Environmental Scientist, Delaware Department of Natural Resources and Environmental Control, 285 Beiser Blvd., Suite 102, Dover, DE, 19904, alison.rogerson@delaware.gov; Erin Dorset, Delaware Department of Natural Resources and Environmental Control; Kenny Smith, Delaware Department of Natural Resources and Environmental Control

Restoration & Conservation II, Monday, 2:30pm

In this talk we will provide a summary of the planning and both physical and biological baseline monitoring underway in Millsboro, Delaware as DNREC prepares to restore 15 acres of coastal wetlands. First, eight acres of Phragmites dominated high marsh will be restored to native high marsh through chemical and mechanical means. Second, seven acres of former low marsh will be recreated using dredge material sourced from the Indian River. This presentation will detail the myriad of considerations and challenges associated with demonstrating a beneficial use technique new to Delaware.

Impacts of Salinity Change on Greenhouse Gas Emissions in Marsh Ecosystems along the Salinity Gradient in the Delaware River Estuary

Shimon, Mayci, Villanova University, 611 E Thompson St, Philadelphia, PA, 19125, mshimon@villanova.edu; Erin Johnson, Villanova University; Nathaniel Weston, Villanova University

Climate Change in the Delaware Estuary, Tuesday, 10:30am

Tidal marsh systems provide important ecosystem services, including water quality mitigation and carbon sequestration. Positioned at the land-water interface, marshes are especially vulnerable to stressors associated with human activities and climate change, including sea level rise (SLR) and saltwater intrusion (SWI). Though the impacts of increasing salinity on carbon cycling and carbon emissions have been explored, the effects of SWI on nitrogen cycling and nitrous oxide (N2O) emissions remain less well understood. The goal of this research is to determine how changing salinity influences rates of dentification and N2O production, along with greenhouse gas (carbon dioxide, methane, and N2O) emissions from tidal marsh soils. Soil cores were collected from three sites along the salinity gradient in the Delaware River Estuary and subjected to simulated salinity amendment experiment to study how changing salinity (both increases and decreases) impacts greenhouse gas production and emissions from marsh soils over time. Carbon dioxide (CO2), methane (CH4), and N2O gas fluxes were collected from the soil cores and measured for depth-specific rates of denitrification and N2O production in the marsh soils over the 3 month experiment. This study will provide clarity on how salinity influences nitrogen cycling and greenhouse gas emissions in these ecosystems, with implications for feedbacks to the climate system, as well as the persistence of marshes in the face of global change.

Biodiversity, Education and Community Science in the Cooper River Watershed - Two Decades of Project-based Learning in an Urban Watershed

Smith, Ron, Environmental Science Educator, Haddonfield Memorial HS, 118 Leslie Ave, Merchantville, NJ, 08109, rsmith@haddonfield.k12.nj.us; Ryan Black, Haddonfield Memorial HS; Cleo Hamilton, Haddonfield Memorial HS; Valerie Goetter, Haddonfield Memorial HS; Ann Haas, Haddonfield Memorial HS; Kiki Shim, Haddonfield Memorial HS

Outreach & Community, Wednesday, 1:30pm

For twenty years the students of the environmental science program in the Haddonfield School District have investigated ecological principles in the field, improved habitat for biodiversity, monitored the health of aquatic and terrestrial systems and established on-going community science initiatives. The curriculum of our environmental program is built on a foundation of hands-on learning, service projects and inquiry-based community science study. Through partnerships with local and regional organizations, universities and county and state agencies, our students have learned science by practicing science. From estimating populations of Corbicula in the Cooper River, to enhancing habitats within the county park system and municipality, to quantifying ecological services of our natural resources, to monitoring the health of indicator species, our projects have contributed to regional conservation initiatives while affording students the opportunity to learn, collaborate and share what they have learned. We emphasize that this approach to science education has benefits far beyond test scores and learning standards.

Delaware Living Shoreline Committee: Site Evaluation Guidance

Smith, Kenny, Environmental Scientist, DNREC, 285 Beiser Blvd., Dover, DE, 19904, kenneth.e.smith@delaware.gov

Restoration & Conservation I, Monday 1:00pm

The Delaware Living shoreline committee was created to inform the public and information share with private contractors on the benefits and use of living shoreline techniques. The committee has hosted trainings and created documents, and the next step in this process was to create a document highlighting the metrics you should consider when designing a living shoreline. This Site Evaluation document consists of metrics that you can gather from online resources and on-site observations. The document runs through where and how to collect the information vital to evaluating your shoreline for the possible use of a living shoreline techniques and then a datasheet to organize all the information. The committee thinks of this document as just a single document in a series of documents that will allow individuals to complete all the steps from site evaluation to monitoring your project once it is complete.

Developing a Preliminary Conceptual Ecological Risk Assessment and Science Strategy for Microplastics in the Potomac River

Somers, Kelly, Physical Scientist, US EPA Region 3, 1650 Arch Street, 3WD31, Philadelphia, PA, 19103, somers.kelly@epa.gov; Matthew Robinson, DC Department of Energy and Environment; Bob Murphy, Tetra Tech; Jennifer Flippin, Tetra Tech; Ryan Woodland, University of Maryland Center for Environmental Sciences

Water Quality: Microplastics, Monday, 4:00pm

Microplastics (MP) are polymer particles less than 5 mm long and are an emerging contaminant of concern. The potential human health and environmental impacts of plastic pollution is being studied globally. Its impacts on aquatic resources and the food chain could have lasting impacts. The Chesapeake Bay's Science and Technical Advisory Committee (STAC) recognized this growing threat and hosted a workshop to start exploring the state of the science. Following the workshop, the Chesapeake Bay Program Plastic Pollution Action Team (PPAT) was formed and tasked with overseeing the development of ecological risk assessments (ERAs) looking at the effects of microplastics on CB resources.

The US EPA is working with Tetra Tech, the PPAT and STAC to develop a preliminary conceptual ERA, a uniform size classification and terminology document and a science strategy to address microplastics. The PPAT chose Juvenile Striped Bass as the ecological endpoint for this ERA because these age classes are likely the most exposed to MPs; the species is ubiquitous; the lower Potomac River is the second most important nursery for Striped Bass along the Atlantic Coast; the species is a major apex predator in the CB; and several of the bay jurisdictions have decades of data on the abundance of these age classes due to their respective juvenile Striped Bass surveys. The model will use data on qualitative food-web interactions between Striped Bass and prey collected in the Potomac and data on semi-quantitative food web interactions collected from across the CB to determine exposure and risk. Additionally, the PPAT is working towards approving a standard terminology document that will help ensure continuity in microplastic definition and measurement for future research in the watershed. The team is also completing a science strategy that addresses gaps in data and information identified during development of the ERA.

Nekton Monitoring to Assess Beneficial Reuse of Dredged Material in Salt Marsh Restoration

Szczepanski, PhD, Jack, Sr. Aquatic Ecologist, Princeton Hydro, 1108 Old York Rd, Suite 1, PO Box 720, Ringoes, NJ, 08551, jszczepanski@princetonhydro.com; Robert George, Princeton Hydro

Restoration & Conservation II, Monday, 2:30pm

Salt marsh restoration projects are implemented in many coastal areas, but the influence of salt marsh enhancement efforts on nekton communities is poorly understood. Nekton, classified as free-swimming fish, shrimp, and crabs, use various habitats within the marsh at different stages of their life history. Different restoration efforts may impact the nekton community in different ways. One method of marsh enhancement involves application of a thin layer of uncontaminated dredged material to areas of the marsh that exhibit stress relative to increased sea level rise and subsidence. This new thin layer of dredged material increases the elevation of the marsh plain but also fills in large and expanding ponds and pannes associated with subsidence. Changes to other marsh features, including carbon cycling, water depth, and tidal movement, could also influence habitat use by nekton. Surveys were conducted to examine nekton assemblages during the growing seasons from 2015-2017 at thin layer placement sites in Avalon and Fortescue, NJ. Species richness and density were compared between sites characterized by different habitat types at both enhanced and control locations. Richness was not greatly affected by enhancement while there was some variation in species density at Fortescue. Both richness and density varied between control and enhanced sites in Avalon.

Using Dredged Sediments to Uplift Marshes, Build Subtidal Shallows and Provide Marsh Edge Protection in the Seven Mile Island Innovation Lab, New Jersey

Tedesco, Lenore, Executive Director, The Wetlands Institute, 1075 Stone Harbor Blvd, Stone Harbor, NJ, 08247, ltedesco@wetlandsinstitute.org; Monica Chasten, USACOE - Philadelphia District; Lisa Ferguson, The Wetlands Institute; Samantha Collins, The Wetlands Institute; Christina Davis, NJ Division of Dish and Wildlife

Restoration & Conservation II, Monday, 2:30pm

The Seven Mile Island Innovation Lab is an initiative designed to advance and improve dredging and marsh restoration techniques in coastal New Jersey through innovative research, collaboration, knowledge sharing and practical application. Beneficial use placement projects were undertaken on two low-lying marsh islands that serve as important wading bird nesting sites in New Jersey. Dredged materials were placed on these islands in 2020 using a series of innovative and experimental placement approaches and tools to enhance marsh elevation and create a complex of marsh, marsh edge and intertidal features.

Gull and Sturgeon Islands contain areas of decades-old historic dredged material placement that currently provide diminishing quality habitat for nesting wading bird colonies. These marsh islands are otherwise comprised of low vigor Spartina marsh platform areas, lower lying, high vigor Spartina flats, and expansive areas of unvegetated intertidal flats.

The ecological goals for marsh elevation enhancements were to create areas suitable for wading bird nesting (>3.5' NAVD88) surrounded by progressively lower elevation marsh areas that grade to high marsh and Spartina alterniflora target elevations (2.1' – 3.2' NAVD88). In some areas, the island margins are comprised of intertidal to subtidal flats with dense to sparse macroalgal cover. Project goals also included expanding and shallowing adjacent island areas up to benchmark depths to establish macroalgal flats (-1' MLLW to MLLW) and building sandy marsh edge protection features that extend along marsh platform edges to provide island protection (2' NAVD88 grading down to MLLW).

Projects were constructed in Spring and Fall, 2020 resulting in marsh elevation enhancement, marsh edge protection features, and areas of intertidal shallows on both islands. The presentation will introduce project goals and initial outcomes. Planned monitoring will evaluate whether ecological goals were met.

Marine Microplastic Exposure of Atlantic Blue Crab (*Callinectes sapidus*) Larvae on the Delaware Bay Shelf

Thoman, Todd, University of Delaware, Robinson Hall, 272 The Green, Newark, DE, 19716, txthoman@udel.edu; Tobias Kukulka, University of Delaware; Jonathan Cohen, University of Delaware

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Coastal waters and estuaries such as the Delaware Bay act as important sources of anthropogenic contaminants, including microplastics, to the world's oceans as a result of direct exposure to human activity. Once in coastal waters, microplastics suspended in the ocean surface boundary layer are efficiently transported, concentrated, and dispersed through processes such as buoyancy-driven estuarine flow, wind-driven shelf flows, wind and wave-driven turbulent mixing, and tidal mixing and flushing. The combination of high prevalence of microplastics and efficient transport and mixing expose a myriad of organisms, both ecologically and economically important, to this pollutant, potentially causing significant harm in the process. This study seeks to identify key locations and flow features at which larvae of Callinectes sapidus, the commercially important Atlantic blue crab, spawned in the Delaware Bay experience the greatest risk of exposure to Delaware Bay-derived microplastics. This study utilizes the Remote Ocean Modelling System (ROMS) to model realistic flow fields in the Delaware Bay and the adjacent shelf region during the spawning season and larval development of C. sapidus through the incorporation of simulated winds, wind waves, tides, and river input. Resulting flow fields will be utilized to advect tracers representing C. sapidus larvae until delivery to and settlement within the Delaware Bay, as well as tracers representing microplastic pollutants. Key spatial regions of overlap between the two tracers in coastal waters will be closely examined using a high-resolution large eddy simulation (LES) paired to a Lagrangian stochastic model (LSM), allowing for better estimates of exposure through direct simulation of smaller-scale turbulent flows that advect and mix larvae and microplastics locally. This study serves as part of a larger effort to determine the risk microplastics pose to C. sapidus through larval exposure in the Delaware Bay region.

Breakwater Restoration to Build Back Native Marsh and Related Monitoring Efforts at Supawna Meadows NWR

Turner, Noel, Hydrologist, U.S. Fish and Wildlife Service, 24 Kimbles Beach Road, Cape May Court House, NJ, 08210, noel_turner@fws.gov; Heidi Hanlon, U.S. Fish and Wildlife Service

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Construction of a stone breakwater will be completed in two phases in an attempt to restore the negative impacts of centuries of farming on a tidal marsh unit of Supawna Meadows National Wildlife Refuge located along the Delaware River near Pennsville, New Jersey. Historically, the breakwater was constructed to keep water out for farming purposes. Phase 1 was completed in 2017 around the mouth of Mill Creek. The new breakwater construction will allow water flow, trap sediment, and reduce wave impacts from boat traffic and winds. Due to the proximity to the Salem River, one of the oldest barge ports in the country, there is the potential to expedite natural sediment accumulation by using dredge material from the shipping lane. Monitoring efforts to evaluate the success of the restoration include water levels, vegetation growth, marsh elevation, channel bathymetry, and suspended sediment concentrations.

A Planning Approach for Water Quality and Restoration Projects in Delaware's Inland Bays

Walch, Marianne, Science & Restoration Coordinator, Delaware Center for the Inland Bays, 39375 Inlet Road, Rehoboth Beach, DE, 19971, science@inlandbays.org; Michelle Schmidt, Delaware Center for the Inland Bays

Watershed Scale Coastal Resilience, Wednesday, 1:30pm

The Delaware Center for the Inland Bays (CIB), one of 28 National Estuary Programs (NEPs), oversees implementation of the Comprehensive Conservation and Management Plan (CCMP) for Delaware's Inland Bays. This is accomplished through outreach and education, development/implementation of restoration projects and planning, research and monitoring, and public policy. A key role of the NEPs is to convene and facilitate partnerships, bringing good science to management and policy decisions.

Over the past decade, the CIB has worked with state, local and community partners to develop and implement a number of water quality and restoration plans for the Inland Bays and their watershed. These include two municipal stormwater retrofit plans, a living shoreline project plan, a watershed reforestation plan, a shellfish enhancement plan, and a rapid assessment project plan. While some of these efforts have been more successful than others, the lessons learned have led us to a model approach that integrates best available science with the goals and constraints of stakeholders and funders. The result is a living, updatable plan that identifies and prioritizes specific restoration projects, with concept plans, estimated costs, projected environmental benefits, and other information that can easily be transformed into funding proposals. The CIB then works with partners, stakeholders, and decision makers to obtain funding and implement the plans. Examples of successful plans and processes will be presented, as well as data and modeling tools used, stakeholder participation, and lessons learned.

Burbage Road Water Quality Improvement Project

Walch, Marianne, Science & Restoration Coordinator, Delaware Center for the Inland Bays, 39375 Inlet Road, Rehoboth Beach, DE, 19971, science@inlandbays.org; Zachary Garmoe, Delaware Center for the Inland Bays

Watershed Scale Coastal Resilience, Wednesday, 1:30pm

In 2018 the Delaware Center for the Inland Bays (CIB) partnered with Sussex Conservation District (SCD) to develop a reforestation plan for the Inland Bays watershed. The objective of this plan was to identify and conceptualize priority green infrastructure reforestation projects that are the most cost-effective measures for improvements to water quality and wildlife habitat in the watershed. The plan used a GIS model to screen and rank publicly and privately owned agricultural parcels using multiple criteria. Using the model output, outreach to landowners was conducted to generate interest in reforestation activities. Both CIB and SCD then worked with interested landowners to develop conceptual designs for ten highly-ranked projects.

Among the projects selected was a 20-acre agricultural parcel owned by Sussex County on Burbage Road in Frankford, Delaware. This particular location has significant ecological value because of its proximity to a superfund site and the parcel's designation as part of the Groundwater Management Zone. In addition, a first order stream and tax ditch,

Blackwater Creek, runs adjacent to the parcel, draining nutrients and runoff to Little Assawoman Bay. CIB and SCD worked together to design and implement a 1.8-acre treatment wetland created from an existing drainage ditch. A wetland planting plan was developed by Environmental Concern, and the plants will be installed this spring with assistance from volunteers. In addition, seven acres on the parcel were planted with 3,000 native hardwood tree seedlings in early spring 2020. Partnerships have played a key role in the success of this project.

Living Shoreline and Stormwater Retrofit Projects on Read Avenue, Dewey Beach

Walch, Marianne, Science & Restoration Coordinator, Delaware Center for the Inland Bays, 39375 Inlet Road, Rehoboth Beach, DE, 19971, science@inlandbays.org Robert Collins, Delaware Center for the Inland Bays; Larry Trout, RK&K

Watershed Scale Coastal Resilience, Wednesday, 1:30pm

In 2017, the Center for the Inland Bays partnered with the Town of Dewey Beach to develop a stormwater master plan to address flooding and improve water quality in Rehoboth Bay. Implementation of the first two projects from that plan was completed in early 2020. A living shoreline and outfall upgrade project, located at the bayside end of Read Ave,. includes retrofit of an existing riprap revetment, restored tidal marsh, a low dune reinforced by Hesco™ flood barriers, an offshore oyster reef, a stabilized kayak launch, and three tidegates. The second project is a bioretention and infiltration facility retrofitted into a small grass island at the intersection of Read Ave. and Coastal Highway. That facility also includes permeable concrete and biochar soil amendment. Both projects were implemented through a partnership between the Center, the Town, and the Delaware Department of Transportation.

Satellite-based Monitoring of Delaware Bay Surface Area

Wang, Ruo-Qian, Assistant Professor, Rutgers University, RWH 328E, 500 Bartholomew Road, Piscataway, NJ, 08854, rq.wang@rutgers.edu;

Climate Change in the Delaware Estuary, Tuesday, 10:30am

Sea-level rise is considered to be the most important impact of global climate change (IPCC, 1991). A striking example is the increasing tidally driven flooding, which gives rise to shallow (several centimeters) and wide-spread floods, (Sweet et al., 2018). High tide flooding disrupts transportation and other infrastructure systems, degrades real estates, reduces income and jobs, exposes health hazards , and salinizes groundwater to deterioration coastal ecosystems (Moftakhari et al., 2017). The changing tides are significantly altering the hydrodynamics and topography of Delaware Bay. Here we present a project that uses satellite imaging to understand the history of the surface area of Delaware Bay. We are most interested in the following questions: What's the trend of tidal dynamics in Delaware Bay? Why are coastal tides at certain locations more sensitive to environmental and anthropogenic factors? What's the mechanism responsible for the changing tides? Are they driven by natural or human factors? How will the tides change to respond to the future shoreline and environmental changes? The recent advances in space-based coastal observation and tidal dynamics theory shed light on these questions. We will show our analysis results in the presentation.

How are Delaware Bay's Salt Marshes Faring in the Face of Sea Level Rise?

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Climate Change in the Delaware Estuary, Tuesday, 10:30am

In a Science Advisory Committee report to NJDEP we examined existing data on changes in the horizontal extent (area) of marshes in major estuarine systems in NJ, as well as changes in their vertical position (elevation) relative to sea level rise. Marsh loss rates in the Delaware Bay are 1.1-1.9% per decade, considerably less than elsewhere in the state. The difference is due to the large amount of marsh area gained through migration into low-lying maritime forests, which was not feasible in more developed parts of the state. An analysis of erosion rates in Delaware Bay found an average erosion rate of 3.2 m yr-1 for the entire Delaware Bayshore from 1940-1978, with average values of 2-5 m yr-1 along different segments. Marsh elevation rates, as measured with Surface Elevation Tables, range from 0.7 mm yr-1 to 6.9 mm yr-1 with median values of 4.3 mm yr-1 which is less than the rate of SLR, 5-6 mm yr-1. High sediment accretion was found in the tidal freshwater stations. We examined four types of remedies of marsh loss: migration pathways, Phragmites management, thin layer deposition of dredged sediment, and living shorelines, the latter two of which have pilot projects in Delaware Bay.

The fine line of success: An assessment of the target ecological elevations of three thin layer sediment placement projects in NJ

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Metthea Yepsen, NJDEP; William Smith, NJDEP; Nicholas A. Procopio, NJDEP

Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

As the relative sea levels of New Jersey continue to rise, the necessity for protecting our coastal marsh landscapes and the critical habitat they provide is becoming more apparent. Spurred on by the needs for enhancement of marsh habitat and for improved dredged material management, three thin layer sediment placement (TLP) projects in Fortescue, Middle Township, and Avalon, NJ were initiated in 2013 with the intention of increasing the resiliency of the NJ coastline against the effects of global climate change. TLP is a form of beneficial use of dredged material and can allow for the restoration of hydrophytic plant cover and avian habitat through increased sediment elevations and prevention of marsh "drowning." However, these recovery metrics are reliant upon meeting specific ecological elevations, and it can be difficult both to set and to achieve target elevations. To monitor elevations of the TLP projects and assess the subsequent effects of elevational changes on habitat type over time, we are utilizing a combination of site-specific water level monitoring, topographic surveys, and high-resolution drone surveys. With ArcGIS, we determined: (1) areas within the TLP projects that are within, above, and below the target elevations; (2) areas that are within key tidal datums; and (3) change in percent plant cover through drone imagery classification. Preliminary results show that although sediment compacted significantly after placement and sediment accretion has been slowed in treatment areas, elevations are trending towards the target ecological elevations and percent plant cover has increased after initial setbacks. Using these methods of assessment, we evaluate whether or not we selected the correct target elevations, whether or not we met our target elevations, and provide recommendations for target elevation setting for future TLP projects.

Determining Synchronized Feeding and Respiration Rates in Eastern Oysters (*Crassostrea virginica*) using an Ex situ Flow Through System in the Choptank River, MD

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Poster & Pre-recorded Discussion Session, Monday, 5:30pm & Wednesday, 9:00am

Oysters are considered ecosystem engineers due to their transformative effects over environmental quality. The biofiltration services that extend from their filter-feeding activity are highly regarded and often motivate oyster restoration activities.

As a result, quantifying the filtration rates of oysters and understanding the ecological factors that govern feeding activity is increasingly important to better predict the role of oysters in the environment. Early laboratory trials used stable experimental conditions (e.g. monoculture diets, stable temperature and salinity, etc.) that can elicit elevated and persistent feeding responses; however, estuaries are dynamic ecosystems with fluctuating environmental conditions that are bound to influence animal feeding over short timescales. Furthermore, few studies have monitored the long-term variation in feeding activity that typically required large amounts of tedious labor, often resulting in large data gaps. New approaches are needed to better track variations in oyster feeding for more precise estimates of biofiltration.

This project aims to estimate the long-term feeding and metabolic responses of the eastern oyster (*Crassostrea virginica*) on the Choptank River (Cambridge, MD) by leveraging recent technological advances in aquatic community observing and computer programming. The observing system consists of an imaging flow cytobot (IFCB) to determine changes in the algal community over time. Water quality and algal health data will be derived from a CTD and fast repetition rate fluorometer (FRRF), respectively. Simultaneously, feeding and respiration will be measured under ex situ, flow-through conditions and logged in real-time using separate sets of fluorometers and respirometers among replicate oysters in seperate channels. Oyster feeding and respiration responses to prevailing environmental conditions are estimated from signal differences among sensors during post processing by python scripts. This system will enable deeper understanding of how fluctuating algal communities and environmental variability influence oyster filtration rates for more precise quantification of biofiltration that can extend from large populations.

Stone Mulch as an Alternative to Herbicides for Protecting Tree Seedlings from Rodents in Forested Buffer Projects

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Restoration & Conservation I, Monday 1:00pm

For forested buffer restoration, protecting sheltered trees from rodent damage with 2A modified stone provides a cost-effective alternative to glyphosate herbicide applications. For roughly 15 years, herbicide applications have been a standard prescription for this protection. Concerns for workers, environment and cost led Stroud Water Research Center to test alternatives beginning in 2013, including vole guards, 2” clean stone, and 2A modified stone, which is a mix of particle sizes from very fine to roughly ¾” long dimension. Second generation trials tested 2A modified stone mulch vs. herbicide application. Two stone mulch amounts were tested: 20” diameter x 2” thick (roughly 40 lb) and 12” diameter x 2” thick (roughly 20 lb). Herbicide spots were 36” in diameter, applied 2x/year. Through three growing seasons, either 2A modified stone treatment was as effective as herbicide spots on survivorship, with a slight decline in growth rate for stone treatments. Stone mulch costs roughly 1/3 the cost of typical four-year herbicide applications, and requires 1 mobilization vs. 8 for herbicide use. Loss of stone due to flooding appears to be a minor concern. Access/logistics of getting stone to some sites can be challenging.

Impact of Changing Climate and Land Cover on Flood Magnitudes in the Delaware River Basin

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Climate Change Impacts, Tuesday, 2:15pm

Changing climate and land cover are expected to impact flood hydrology in the Delaware River Basin over the 21st Century. HEC-HMS models were developed for five case study watersheds selected to represent a range of scale, soil types, climate, and land cover. Model results indicate that climate change alone could affect peak flood discharges by -6% to +58%, a wide range that reflects regional variation in projected rainfall and snowmelt and local watershed conditions. Land cover changes could increase peak flood discharges up to 10% in four of the five watersheds. In those watersheds, the combination of climate and land cover change increase modeled peak flood discharges by up to 66% and runoff volumes by up to 44%. Precipitation projections are a key source of uncertainty, but there is a high likelihood of greater precipitation falling on a more urbanized landscape that produces larger floods. The influence of climate and land cover changes on flood hydrology for the modeled watersheds varies according to future time period, climate scenario, watershed land cover and soil conditions, and flood frequency. The impacts of climate change alone are typically greater than land cover change but there is substantial geographic variation, with urbanization the greater influence on some small, developing watersheds.

Seasonal Oyster Microbiome Dynamics at Low and Moderate Salinity Sites in the Delaware Bay

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Living Resources: Oysters, Monday, 4:00pm

The bacterial dynamics of the digestive gland were studied in wild oysters from the Delaware Bay at two sites spanning the salinity gradient of the natural oyster beds. The digestive gland is the organ with the highest abundance and diversity of both resident and transient microbiota within the oyster. Bacteria hosted in these tissues can be involved in digestion, and may also play a role in the nitrogen cycle of Delaware Bay given the carbon-rich and hypoxic conditions within the gut that can foster denitrification. Digestive gland samples were collected from low (~11 ppt) and moderate (~18 ppt) salinity sites monthly from July through October 2019 and were sequenced via Illumina MiSeq using the 16S rRNA V3-V4 hypervariable region to characterize the microbiome communities present. Samples were dominated by groups associated with digestive systems (Mycoplasma, Rickettsiales, Cyanobacteria, Lachnospiraceae, Chlamydialese, Bifidobacteriaceae, Spirochaetes, Campylobacteria), as well as bacteria with narrow chemical niches such as obligate anaerobes from Bacteroides, the nitriteoxidizing bacteria Nitrospira, and the annamox-performing Planctomycetes. Bacterial abundances were significantly higher at the low-salinity site. Alpha diversity of bacteria composition increased during the study period, and was higher as well as more variable at the moderate salinity site. Seasonality, likely driven by temperature, had the greatest influence on changes in bacterial composition. Additional experiments to quantify the presence and activity of denitrifying bacteria in these tissues are currently underway. Continuing to study the oyster microbiome will contribute to our understanding of the oyster's place in nutrient cycles as well as the dynamics underpinning the presence of bacteria that are potentially harmful to human consumers.

Fresh and saltwater interactions arising from sea level rise driven coastal marsh change

Zhang, Yu, Postdoc Research Associate, Los Alamos National Laboratory, 3000 Trinity Dr. Apt 46, Los Alamos, NM, 87544, yuzhang@lanl.gov; Daniil Svyatsky, Los Alamos National Lab; Joel Rowland, Los Alamos National Lab; David Moulton, Los Alamos National Lab; Zhendong Cao, Los Alamos National Lab; Chonggang Xu, Los Alamos National Lab; Wu Ma, Los Alamos National Lab

Physical & Chemical Processes, Monday, 11:00am

Sea level rise (SLR) is expected to break the balance of current coastal freshwater-saltwater interaction (FSI) and influences coastal ecosystem stability and sustainability. Numerous studies have investigated FSI under SLR assuming a static landscape topography. However, coastal marshes are not static. They evolve in response to SLR. In this study, we used a simplified marsh landscape based on a coastal marshland at the Delaware Bay. Using a physically-based coastal hydro-eco-geomorphologic model, ATS (Advanced Terrestrial Simulator), we investigated how coastal FSI would change with marsh evolution under different rates of SLR and upland groundwater conditions 100 years into the future. Our simulation showed that, without marsh elevation change, the rising sea level inevitably increases seawater inflow and causes larger saltwater intrusion landward, regardless of the level of upland groundwater table. However, we found that it is very likely that the marsh elevation increases with a higher accretion rate near the ocean boundary and a lower accretion rate for the inland marsh due to different sediment deposition rates, which forms a depression zone on the marsh landscape. The topographic change significantly alters saltwater flow characteristics, including a significant reduction of saltwater inflow at the ocean boundary and a longer residence time of ponded saltwater in the inland depression zone. Therefore, the marshland becomes more sensitive to the upland groundwater table, which determines the primary source of freshwater that can compete and dilute saltwater inflow on marshland surface and through subsurface. This study demonstrates the importance of considering marsh evolution in understanding the change of freshwater-saltwater interaction under sea level rise. The insights gained from this study can help improve our understanding of the vulnerability of coastal freshwater system and the importance of protecting upland groundwater resources.

Tracking vegetation response to beneficial use of dredged sediment for marsh platform restoration at three sites in Southern New Jersey

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Hot Topics, Wednesday, 3:30pm

Sediment dredged from navigational channels was hydraulically placed on the surface of salt marshes at three locations in New Jersey in 2015-2016 with the goal of enhancing marsh platform habitat. Vegetation was monitored in 1m^2 permanent plots following a before after control impact (BACI) design at each location. Annual monitoring measured the extent and richness of vegetation, species composition, percent canopy cover and stem height. As was expected, there was significant loss of vegetation extent and cover immediately following placement of sediment due to burial of vegetation. 2019 was the 4th season of monitoring at Avalon and Fortescue after material placement and 5th year of monitoring at Ring Island with results showing that vegetation has re-established in varying degrees at each site. Vegetative extent, (the percentage of monitoring plots with vegetation) has significantly increased at all sites since placement and percent cover of vegetation has also increased. At two of three study sites, the percent of study plots that are vegetated is at least equal to baseline conditions. Vegetation cover at Fortescue returned to baseline 3 years post placement and has continued to increase. Avalon has also seen a significant increase in vegetation cover from year 3 to year 4 of monitoring. Ongoing monitoring is necessary to evaluate success relative to the goal of providing uplift for native salt marsh vegetation, but with recovery underway, vegetation results were examined to determine the relative impact of several physical parameters (sediment application thickness, tidal inundation, distance to vegetation, distance to tidal water body, and elevation) on vegetation cover. While vegetation recovery at each site was influenced by different physical parameters sediment application thickness was not found to be a significant predictor of vegetation recovery 4 and 5 years post placement at any of the sites.

Author Index by Last Name