

Green Tech Taking Root

Blue Carbon

Farms Yielding
Cleaner Water

Robots Aiding
Research



Newsletter of the Partnership for the Delaware Estuary: A National Estuary Program

ESTUARY NEWS

The Partnership for the Delaware Estuary

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

SUMMER 2017

VOL. 27 | NO. 4

Experts Using the Outdoors to Innovate

By Jennifer Adkins, Executive Director,
Partnership for the Delaware Estuary

Close your eyes and envision “infrastructure” — what do you see? Roads and bridges? Or maybe pipes and treatment plants? Here at the Partnership for the Delaware Estuary (PDE), we see oysters and mussels, plants and soil. This natural infrastructure is just as important, if not more important, to our health and well-being as built infrastructure.

At PDE, we’re finding innovative new ways to use natural and nature-based infrastructure to reduce pollution, and much more. Using science, we’re restoring plants and animals in ways that make water cleaner for families and businesses. Nature-based infrastructure is built by people to mimic nature using natural materials and systems to address pollution and other problems; sometimes faster and cheaper than traditional methods. It can be used as an alternative or a complement to more traditional infrastructure.

Developing these new tactics requires innovation, science, collaboration, and a balanced approach — all core values of the Partnership for the Delaware Estuary. This issue of *Estuary News* highlights innovative uses of natural infrastructure by PDE and partners, from the headwaters to Delaware Bay. ♡



Credit: Shaun Bailey of PDE

The U.S. Environmental Protection Agency (EPA) presented an Environmental Champion Award to the Partnership for the Delaware Estuary (PDE) on May 19 at the agency’s Mid-Atlantic Office in Philadelphia. The EPA awarded this honor largely because of PDE’s research on “green”, or natural and nature-based infrastructure.

MEETINGS CONTACT LIST

Meetings conducted by the Partnership for the Delaware Estuary’s implementation and advisory committees occur on a regular basis and are open to the public. For meeting dates and times, please contact the individuals listed below:

Estuary Implementation Committee
Jennifer Adkins, Executive Director (Chair) (800) 445-4935, ext. 102
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Monitoring Advisory & Coordination Committee
John Yagecic, P.E., Manager, Water Quality Assessment
Delaware River Basin Commission (609) 477-7271, ext. 271
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Toxics Advisory Committee
Dr. Thomas Fikslin, Director, Science & Water Quality Management
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The Estuary's Future: Your Input Needed

After 20 years, the *Comprehensive Conservation and Management Plan for the Delaware Estuary* (CCMP) is being revised. The Partnership for the Delaware Estuary (PDE) is taking the lead to assemble collective action and enhance the tidal Delaware River and Bay. So far in the revision process, more than 230 experts representing 70 organizations across the Estuary have participated in CCMP revision workshops. These experts contributed their knowledge on the three overarching themes outlined in the revision process. These themes include Clean Water, Strong Communities, and Healthy Habitats.

Results emerging from these workshops included crafting a refined list of strategies feasible for implementation. Each strategy was also assessed and tailored to minimize vulnerability to climate change.

The next phase of the CCMP revision will include stakeholder engagement sessions. Through a series of open house-style workshops, PDE will reach out to local partners and communities to explore new ideas that have yet to be captured in the revision process.

Incorporating the latest research and monitor-

ing techniques through scientific expertise, PDE looks forward to continuing to guide and participate in this process. A revised CCMP will establish measurable targets for the next 10 years to improve habitat, water quality, and community resilience in and around the Delaware Estuary. ♠



Dr. Danielle Kreeger of the Partnership for the Delaware Estuary greets experts at a Healthy Habitats Workshop on January 9 at the PSEG Energy & Environmental Resource Center in Salem, New Jersey.

Credit: Shaun Bailey of PDE

HOW YOU CAN HELP ► Attend a stakeholder engagement session. Options include:

September 12, from 11:30 a.m. to 1:30 p.m.
at the Tulpehaking Nature Center in Trenton, New Jersey

September 12, from 4:30 to 6:30 p.m.
at Silver Lake Nature Center in Bristol, Pennsylvania

September 13, from 4:30 to 6:30 p.m.
at the Hildacy Farm Preserve in Media, Pennsylvania

September 19, from 4:30 to 6:30 p.m.
at Ashland Nature Center in Hockessin, Delaware

September 26, from 11:30 a.m. to 1:30 p.m.
at the University of Delaware's Virden Retreat Center in Lewes, Delaware

September 28, from 11:30 a.m. to 1:30 p.m.
at the Camden County Environmental Center in Cherry Hill, New Jersey

September 28, from 4:30 to 6:30 p.m.
at Bartram's Garden in Philadelphia, Pennsylvania

October 5, from 4:30 to 6:30 p.m.
at the Bayshore Center at Bivalve in Port Norris, New Jersey

Go to: goo.gl/S4ZCm2

2010



2016



A living shoreline in Heislerville, New Jersey traps carbon dioxide in its plant roots and mud (i.e., sediment) that would otherwise escape and warm Earth's atmosphere.

Credits: Dr. Danielle Kreeger (left) and Josh Moody (right), both of PDE

- other National Estuary Program partners (The Center for the Inland Bays and the Barnegat Bay Partnership)
- the U.S. Environmental Protection Agency's Office of Research and Development
- faculty and students at Drexel University, the University of Washington, and University of Delaware

Together, we are compiling data on the carbon trapped in the sediments of New Jersey, Delaware, and Pennsylvania and mapping its density in coastal sediments. We are using field-based greenhouse gas analyzers to measure gas exchange in wetlands subject to different management practices and exposed to different levels of water quality. This state of the art equipment allows real-time analysis of methane and nitrous oxide, in addition to carbon dioxide. Wetlands emit these gases as a result of the anaerobic (oxygen-deprived) decomposition processes that are common in wetlands. These gases are more potent greenhouse gases than carbon dioxide (25-300 times), and the calculation of the greenhouse gas reduction benefits of wetlands or living shorelines requires their inclusion. In addition, measuring fluxes of these trace gases helps identify how improvements in coastal management can improve the greenhouse gas reduction benefits provided by wetlands.

Our research team has also been exploring the net economic benefits from managing shoreline erosion using living shorelines rather than traditional hard structures such as bulkheads. While living shorelines may be more

expensive to install than bulkheads, unlike bulkheads they can trap carbon and provide other valuable ecosystem services. Additionally, wetlands behind a bulkhead can become degraded when bulkheads are installed, leading to less carbon storage. When considering the value of carbon storage to society, we find that the economic benefits from some living shorelines can more than make up for their added installation cost. However, whether or not there are economic gains from living shorelines, based on carbon benefits alone, depends on the materials from which they are constructed. Additional work is needed to value the other ecosystem services living shorelines provide. This will help researchers generate a more complete assessment of the net economic gains from living shorelines as a green technology.

This research represents a new collaboration between academic and government scientists with National Estuary Programs that is focused on coastal blue carbon, an emerging global nexus of environmental science, conservation, and policy. Our goals are to:

- expand understanding of the carbon being trapped in the Mid-Atlantic region
- identify the impacts of water pollution and management tactics on the carbon trapped in wetlands
- raise awareness of the greenhouse gas reduction benefits of coastal habitats

HOW YOU CAN HELP ▶ *Talk to people you know who own seawalls and bulkheads. Ask them if they know the benefits of living shorelines.* Go to: goo.gl/5bS3vS

Success in the Saucony: Productive Farms Yielding Cleaner Drinking Water

By Virginia Vassalotti, Schuylkill Action Network Coordinator, Partnership for the Delaware Estuary



Credit: Tom Davidock

Wire fencing and concrete ramps minimize cows' impact on a tributary of the Saucony Creek outside Kutztown, Pennsylvania. Meanwhile, the surrounding plants and trees serve to soak up the nutrients left behind in the manure of livestock.

How we manage land has an impact on water, whether good or bad. Here's a story of how improving practices on farms led to cleaner, safer drinking water in the borough of Kutztown, Pennsylvania.

Kutztown gets its drinking water from groundwater before it is treated. All the land and water that drain to the Saucony Creek (what we call a "watershed") impacts Kutztown's groundwater. In the early 2000s, nitrates in Kutztown's groundwater were approaching an unhealthy level of nearly 8.5 milligrams per liter, or "mg/L" (the regulatory standard is 10 mg/L). As a result, the Borough of Kutztown had to invest in expensive treatment technologies to remove nitrates.

So you may ask "What's the big deal with nitrates?" At high levels, nitrates can impact the body's capability to bring oxygen to the bloodstream, causing minor symptoms such as headache, fatigue, and dizziness. Nitrates can also cause major symptoms such as seizures, coma, and death. This syndrome affects newborns the most, and because of the lack of oxygen in the bloodstream, one's body physically turns blue; hence the name of the condition, blue baby syndrome.

Simultaneously, in the Saucony Creek Watershed, the Schuylkill Action Network's (SAN) partners were hard at work, improving practices on farms. SAN is a collaboration of over 150 members. These members include environmental organizations, agencies, water suppliers, and other partners. Together they are all working to achieve the same goal of a cleaner Schuylkill River Watershed. With "action" being SAN's middle name, agricultural partners work with farmers to improve practices by:

- Managing manure in concrete waste-storage systems. That way manure can be used as a natural fertilizer when crops can take up the nutrients as opposed to spreading manure daily when sometimes crops cannot take up nutrients (i.e., during rain events or in the winter)
- Planting trees, or "riparian buffers", along streams, to act as a natural filter
- Keeping cows out of the stream with stream-bank fencing so there is less manure in streams and cows are not trampling the streambed
- Planting cover crops and not tilling to keep fertile soil on cropland, not in the stream

All of these practices help manage the amount of agricultural pollution coming off of a farm, including the amount of nitrates running off into streams or soaking into groundwater.

Over 30 of these projects now exist on 20 farms throughout the Saucony region. As a result, we began to see a decrease in nitrate levels. Now, nitrate levels are steadily at 6 to 6.5 mg/L. Kutztown is now able to save money on treatment costs while ensuring that their water is safer and cleaner for their customers.

This truly is a success story of how collaborative partnerships and dedicated funding can lead to clean water! ♦

HOW YOU CAN HELP ► Ask your local conservation district if farmers near you responsibly manage their runoff. Thank farmers who do and support those who desire to make improvements. Go to: SchuylkillWaters.org

Robots Changing the Nature of Research

By Stephanie Dohner, Doctoral Student, University of Delaware

Remember those great beach days? The sun, the surf, the birds flying about? But what about the bird that was stationary in mid-air? Was that shadow in the shallows just a fish? No need to worry; rather, welcome to the age of robotic studies.

Robots are revolutionizing environmental research and monitoring through improved beach mapping. Technological advances are making these systems versatile and economical thanks to tools capable of collecting high-resolution data in areas previously out of reach.

Ecologically and economically important areas, like the beach and nearshore, are dynamic locations influenced by waves, winds, as well as storms. The nearshore is considered shallow water where waves begin to shoal (change height) and is typically where swimmers and surfers rest to avoid breaking waves. Rough conditions there make frequent and accurate data collection difficult for scientists, city managers, and engineers. However, accurate mapping of changes in sand volume, shoreline location, and nearshore sand features are vital. These data inform beach management decisions, including methods to protect and repair the coast.

Historically, beach mapping was labor inten-

sive and took months or years to compile. This is where robots can save the day. Unmanned aerial systems (UAS), like the DJI Phantom 3 drone, employ cameras to map the beach while autonomous surface vehicles utilize sonar to map the nearshore. During low tide, when the beach is most exposed, aerial drones with GPS (global positioning systems) capture overlapping images of the beach below. The drone can be programmed with specific GPS points and will fly itself over the chosen area. Individual images are then stitched together into one large mosaic using a process known as photogrammetry. Computer software then calculates elevations from the two-dimensional pictures in a similar way as binocular vision enables depth perception.

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From left to right, then University of Delaware graduate students Jason Button, Danielle Ferraro, and Tim Pilegard pilot an autonomous kayak named Bubbles off Broadkill Beach, Delaware in the spring of 2016. The kayak is equipped with sophisticated devices that map the sea floor with incredible accuracy.



University of Delaware doctoral student Stephanie Dohner (left) and alumna Danielle Ferraro (right) guide a DJI Phantom 3 drone back to the school's Marine Operations Building in Lewes, Delaware last March. The drone is equipped with a sophisticated camera for mapping landscapes.

Credit: Stephanie Dohner

Credit: Dr. Art Trembanis of the University of Delaware

Restoring Nature's Water Cleansers from the Headwaters to the Bay

By Danielle Kreeger, Ph.D., Science Director, Partnership for the Delaware Estuary

Water quality in the Delaware River Basin has been greatly improved over the last 50 years. This improvement is thanks in large part to the Clean Water Act and the tireless environmental protection and restoration efforts of so many. But for most of our waterways, there is still a long way to go, and new threats loom, such as climate change and the pressures of continued population growth and development.

To sustain forward progress toward compre-



Credit: Kurt Cheng of PDE

Ribbed mussels filter water at a similar rate to oysters, when submerged. What is more, there are more ribbed mussels in the Delaware Estuary than any other shellfish. This means they collectively filter the most water.

species of *saltwater* clams and mussels and 13 species of *freshwater* mussels. From headwater streams to the mouth of Delaware Bay, most areas at one time had large beds of bivalves of one species or another. Unfortunately, most of our streams, rivers, lakes and coastal bays have seen dramatic declines or the total elimination of these animals.

If you care about clean water, declining shellfish populations should be alarming. Each adult



Credit: Kurt Cheng of PDE

An adult freshwater mussel can filter up to 20 gallons of water per day for up to a century. Scientists are also studying whether they can use them to "bioextract" specific pollutants.

hensive fishable and swimmable waters, we need to double down on our efforts to prevent pollutants from fouling our waters. Another opportunity is to restore nature's intrinsic ability to self-heal. Referred to as "natural and nature-based infrastructure", forests and wetlands filter air and water. Once you go below the water's surface, unseen beds of bivalve shellfish and aquatic plants work to:

- Sponge up many types of pollutants
- Reduce erosion (i.e., mud or "sediment" loss)
- Provide vital habitat for other animals such as fish

Dozens of species of bivalve mollusks are native to the Delaware Estuary Watershed. These shellfish include the charismatic and delicious eastern oyster. Lesser known are several



Credit: Shaun Bailey of PDE

An adult eastern oyster can filter up to 50 gallons of water per day until harvest. This fishery is highly sustainable, because upward of 10 baby oysters, or "spat", can grow on a single oyster shell.

mussel, clam or oyster filters several gallons of water per day, averaged across the year. Healthy beds of these shellfish can contain tens of thousands of animals per acre. Together they function like natural water filtration plants. Naturally then, their decline means that we need to work that much harder and spend much more money to minimize pollution or mechanically treat our water.

Over the past 12 years, PDE and partners have prioritized the protection and restoration of bivalve shellfish as a cost-effective means to achieve cleaner water. Our holistic shellfish restoration strategy includes:

- Restoring oyster beds in Delaware Bay with “shell planting”, or strategically placing clean shell on which baby oysters can attach and grow (pictured)
- Recycling oyster shell and reusing it to build living shorelines containing shellfish (see page 4 of our summer 2015 issue of *Estuary News*)
- Stemming the loss of ribbed mussels in eroding coastal wetlands (see page 9 of our winter 2016 issue of *Estuary News*)
- Reintroducing freshwater mussels to historic streams and rivers
- Researching water filtration benefits
- Finding ways to improve shellfish habitats

Although there are many barriers and unanswered questions with shellfish restoration, the overall prognosis is good. We now have the technology to breed most of these species in hatcheries, and we’ve developed tactics to restore habitats and prioritize areas for restoration. The main challenges are funding and building awareness for the value of bivalve shellfish. For example, oyster shell planting in Delaware Bay has been estimated to yield a \$25:1 return on investment based on dockside value. Yet, funds for large-scale shell planting have been unavailable since 2011. And no funding has been available for local mussel hatcheries since 2011.

We’re ecstatic to report that this shellfish restoration logjam has finally been broken, at least with respect to freshwater mussels. In April, PENNVEST announced that it would make a major investment in freshwater mussel restoration for the main purpose of promoting cleaner water. The 8-year, \$7.9 million project will include construction of a Philadelphia-based mussel hatchery. Scientists at this facility will produce baby mussels, or “seed”. These experts will then rear this seed for eventual release into the Susquehanna and Delaware river basins.

PENNVEST is also known as the Pennsylvania Infrastructure Investment Authority. This government department provides the sustainable financing communities need to maintain vital services. Examples include drinking water and sewer improvements, as well as reduced runoff pollution.

The new Mussels for Clean Water Initiative will also build on past mussel restoration efforts, such as by restocking mussels into suitable streams and ponds. An innovative aspect will be to test whether some pollutants can be “bioextracted” at strategic locations where water is polluted. The Partnership for the Delaware Estuary is now exploring ways to leverage this Pennsylvania-focused investment in Delaware and New Jersey.

Numerous hatcheries already exist for producing freshwater mussels. However, these hatcheries are mainly focused on restoring rare

species. The reason is freshwater mussels are the most imperiled animals in North America. To our knowledge, this will be the first mussel restoration program and hatchery in the world that is focused on rebuilding beds of both common and rare species for the main purpose of restoring nature’s water treatment capacity.

Shellfish restoration is no “magic bullet” that will solve all of our water pollution problems. But when applied in appropriate locations using science-based approaches, investments in shellfish beds provide a new opportunity to diversify and expand our clean water toolkit. ♦

HOW YOU CAN HELP ► Become a citizen scientist for PDE’s Freshwater Mussel Volunteer Survey Program. Go to: goo.gl/6kMCLq

“To our knowledge, this will be the first mussel restoration program and hatchery in the world that is focused on...restoring nature’s water treatment capacity.”

A National Program for the Entire River Basin

By Madeline Urbish, Director, Coalition for the Delaware River Watershed at New Jersey Audubon

From its cold headwaters in New York, renowned for wild trout fishing, to its beautiful coasts that attract beachgoers and birders alike, the Delaware River is truly an incredible resource. Home to important and unique species like the blue crab, trout, and oyster, it is easy to understand how the river and its surrounding land, or "watershed", is responsible for \$25 billion in economic activity and \$21 billion in natural benefits each year. Despite this significance, the Delaware River Basin lacked a federal program dedicated to protecting and restoring the entire watershed, from the Estuary to the Upper Basin, until very recently.

On its very last day of work in 2016, Congress passed the Delaware River Basin Conservation Act (DRBCA). This law was part of larger legislation known as the Water Infrastructure Improvements for the Nation Act. The DRBCA created, for the first time ever, a non-regulatory program aimed at identifying, prioritizing, and implementing conservation projects throughout the 13,500 square-mile watershed.

The importance of this success cannot be understated. The DRBCA was first introduced in 2010 by Congressman Mike Castle. The Coalition for the Delaware River Watershed began advocating for the act's passage when it was formed in 2012. Over the more than six years that the DRBCA moved through

The pristine waters of Russell Brook flow down Russell Brook Falls outside Roscoe, New York. From here it flows to Beaver Kill, the East Branch Delaware River, and downstream past Pennsylvania, New Jersey, and Delaware.



Credit: Carol Brightbill

Paddlers enjoy a South Jersey sunset from their stand-up paddleboards in Delaware Bay. The waters of multiple states converge on this estuary before emptying into the ocean.

Congress, less than 3% of introduced legislation was passed and signed into law.

In creating the Delaware River Basin Restoration Program, the DRBCA also authorized a program to support locally-driven restoration work through competitive grants and technical assistance. This incentive-based approach will strengthen exciting efforts across the watershed by leveraging private investment through a 50%, non-federal match requirement. These funds can go to support innovative projects at a local and regional level. Examples include:

- preventing pollution on cash-strapped family farms (see page 6)
- replanting riversides, so their trees and plants soak up polluted runoff
- protecting clean water using high-tech monitoring

The Delaware River Basin Restoration Program is headed up by the U.S. Fish and Wildlife Service (FWS). This agency began developing a framework for the program almost immediately after the DRBCA's authorization. Importantly, the FWS has been actively reaching out to the organizations and governmental entities already working in the watershed to collaboratively shape the program. In particular, the FWS has coordinated closely with the Coalition for the

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Credit: Andy Arthur, or Flickr user "andyarthur"

Advocates Rally for Delaware's Water

By Brenna Goggin, Director of Advocacy, Delaware Nature Society



Credit: Delaware Nature Society

People from across Delaware gather for the Clean Water Rally on June 6 outside Legislative Hall in Dover. The Delaware Nature Society organized this rally for its shared Clean Water: Delaware's Clear Choice campaign.

On June 6, hundreds of Delaware's strongest clean water advocates came together during the Clean Water: Delaware's Clear Choice 3rd Annual Clean Water Rally in Dover. The rally, which celebrated the release of the Delaware Clean Water and Flood Abatement Task Force (Task Force) report, urged legislators to implement many of the report's recommendations. Throughout the rally, one message was clear: we must include green technology when addressing water pollution.

The Task Force, made up of representatives from conservation groups, businesses, academia and government, studied Delaware's most pressing water pollution and supply issues by:

- Meeting with experts
- Reviewing data on water pollution and flooding
- Visiting sites that best illustrate Delaware's water management issues

At its conclusion, the Task Force issued a report which outlines Delaware's water management issues and makes recommendations on how to address them.

People across Delaware recognize that investing in clean water is a necessity. Delawareans also know they must be as efficient as possible with any funds collected for reducing water pollution and flooding. This is why it is incredibly important that we include green infrastructure as part of the plan.

There are two ways to approach water management: through "gray infrastructure" and "green infrastructure." Gray infrastructure is the

traditional pipes, drains and water treatment systems that address all things related to water. Green infrastructure approaches water management in a more natural way by incorporating sustainable solutions in clean water improvements. Examples of green infrastructure include rain gardens, living shorelines (see page 4), permeable pavements (think gravel instead of cement) and restored wetlands.

Gray infrastructure has its place. Nevertheless, it is important to recognize that green technology and green infrastructure provides more benefits for its cost and lasts longer — much longer. In fact, these technologies will continue to address water pollution and flooding issues for generations to come. For example, New York City purchased land around its reservoirs in the Catskill Mountains to ensure pollution from nearby roads and lawns does not enter the water supply. While this cost the city \$600 million, the capital costs to implement a similar gray infrastructure water management system would cost nearly \$6 billion. Additionally, Indianapolis used wetlands and trees to reduce rain and melting snow (i.e., stormwater) flowing into its sewer system. This stormwater reduction allowed the city to use smaller pipes, which, in turn, saved taxpayers nearly \$300 million.

Clean water is Delaware's future, and the future includes use of green technology. ♦

HOW YOU CAN HELP ► Learn more about the Clean Water: Delaware's Clear Choice campaign on its website.

Go to: CleanWaterDelaware.org

Insider Advice for Your Outdoor Classroom

By Todd Klawinski, Teacher, Caesar Rodney School District

Several years ago, when I first started teaching, I knew that, to teach science well, there had to be an outdoor-based laboratory experience for the students. So a couple of teachers, several students, and I proceeded by writing a small grant to be able to purchase some recycled plastic picnic tables and benches to put out by the pond on campus. We built it together and found that having a home base for studying the outdoors was a lot of fun. We also found that immersing ourselves in the real world was very useful to truly understanding what we learned in the classroom.

Throughout my teaching career, I've seen several versions of outdoor classrooms. These classrooms ranged from simple sitting spaces where one could read a book all the way to fully equipped platforms where students could actually explore waterways and run experiments in real time. Fast forward to today and this is still relevant as a best practice, especially as we really dig in to the Next Generation Science Standards (NGSS).

Getting buy-in by our administration was critical. They could see the opportunities not only for cross-curricular education throughout the departments, but also our ability to answer the need for kids getting back outdoors. We worked successfully to obtain grants from Home Depot and Lowe's to fund Phase 1, Establishment, and Phase 2, Infrastructure. Next, we applied for, and were recognized with, the:

- Delaware State Chamber of Commerce's Superstars in Education award in May 2016 for developing The Outdoor Classroom and Community Gardens at Postlethwait Middle School
- U.S. Department of Education's Green Ribbon Schools award in May 2017 after working toward greening our campus in preparation for developing an EcoCampus in the near future

Getting student buy-in is simple. All we need to do is ask "Who wants to go outside?" But wanting to go outdoors is only half of the equation. Students need to be mentally in a place where they will actually be productive in applying what they have already learned. With this in mind, we have designed and constructed The

Learning Deck. Throughout the year, including summer break, students can explore the habitats (restored forest, meadow, lowland/pond, and upland area). The teacher can see the entire facility perched upon the deck, or they can be down among the students. Those students who require a more controlled outdoor experience as they continue to develop in maturity



Credit: Tom Nutter, courtesy of the Delaware State Chamber of Commerce

Teacher, Todd Klawinski (lower right) leads a lesson in planting beans, lavender, and onions in April of 2016 at The Community Gardens, part of an outdoor classroom at Postlethwait Middle School in Wyoming, Delaware.

can be directed to stay on The Learning Deck during class time where they remain outdoors. Everyone goes outside!

Postlethwait Middle School has begun to transform and we are now actively working with NGSS outside of the classroom one lesson at a time. There is a new buzz around our community as this project enters Phase 3: Application/Curriculum. Most significantly, though, people are increasing the amount of time they are spending outdoors.

Outdoor education initiatives on public school campuses are going to be essential to the future of education in the 21st century by:

- Creating authentic career experiences in STEM fields
- Developing behavior management partnerships with intensive learning centers
- Committing to raising environmental awareness and stewardship

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Insider Advice for Your Outdoor Classroom *continued from page 12*

The national No Child Left Inside movement inspires a return to the land around us, even with some nifty weather-resistant technology in hand on occasion. This can reignite the minds of students and teachers and inspire the creative, out-of-the-box thinking that is so critical to our future. ♣

HOW YOU CAN HELP ► *Begin planning your outdoor classroom today.* Go to: DelawareEstuary.org, keyword "Schoolyard"

A National Program for the Entire River Basin *continued from page 10*

Delaware River Watershed, which led the collective effort that resulted in the DRBCA's passage late last year. As required by the DRBCA, the FWS has also coordinated with the Partnership for the Delaware Estuary, which oversees the National Estuary Program in the basin.

The Coalition for the Delaware River Watershed will continue working with its partners in the river basin and Washington, D.C. Together, we will ensure the program is funded so resources can flow to restoration and protection efforts throughout the region ♣

HOW YOU CAN HELP ► *Visit the Coalition for the Delaware River Watershed's website to learn more.*

Go to: DelRiverWatershed.org/drbcaweb



Credit: Shaun Bailey of PDE

Robots Changing the Nature of Research *continued from page 7*

Because these aerial surveys are only effective over the land, the survey equipment must take to the water! Autonomous surface vehicles (ASV) carry onboard sonar and GPS systems similar to those on recreational fishing boats, such as a Humminbird echosounder/sidescan combo. Single beam echo sounders send out one "beam" of sound. This sound measures the distance between the sea floor and the ASV. Meanwhile, multibeam measures a wider sector, or "swath", of sea floor. Together, these devices gather a more complete picture of the depth of the underwater landscape. This depth data is referred to as bathymetry. Inexpensive recreational autopilots such as the Pixhawk from 3DRobotics allow the user to plan and execute survey missions over specific areas with the ASV.

Following computer processing, UAS and ASV data is combined into a single file of elevations, latitudes, and longitudes. The beach elevations and bathymetry are combined to create one continuous elevation surface from land to sea known as a digital elevation model. This is the sunken treasure chest for beach managers! Shoreline locations and beach-face slopes are mapped with centimeter accuracy, sand volume changes can be calculated between two surfaces, and coastal features such as sand bars can be monitored for location and size changes.

It's an exciting time in the coastal community now that robots are able to quickly and accurately map the beach and nearshore. Using robots like aerial drones and ASVs to assess coastal evolution provides beach managers, safety officials, and researchers with accurate data on beach and shore-face changes. Knowing how the beaches are changing improves our understanding of this dynamic region that people will always love.

EDITOR'S NOTE: Stephanie Dohner won the Best Student Talk Award at the Delaware Estuary Science and Environmental Summit in January. In recognition of her accomplishment, the Partnership for the Delaware Estuary is pleased to share her research in *Estuary News*. ♣

HOW YOU CAN HELP ► *Introduce children to science, technology, engineering, and math. These subjects are the foundation for the innovations discussed here.*

Go to: goo.gl/faPKAL



Delaware Bay Oysters Featured in Philadelphia Airport Display

By Jeff Long, Watershed Outreach Specialist, Partnership for the Delaware Estuary

In April the Philadelphia International Airport debuted a display on the eastern oyster. This display was made possible thanks to support from the Partnership for the Delaware Estuary (PDE). Other contributors to its creation include the Haskin Shellfish Research Laboratory and the Bayshore Center at Bivalve.

The Partnership for the Delaware Estuary thanks Philadelphia International Airport for the chance to display its shellfish restoration work.

The exhibit is located past security in Terminal A East, which is mainly used for domestic travel.

Pictured here in the largest display case is how PDE uses recycled oyster shells in living shorelines (see page 4).

The eastern oyster exhibit is expected to remain on display for several more months. If you're traveling through Philadelphia International Airport, please stop by to see this wonderful exhibit! ♡

HOW YOU CAN HELP ▶ *Tell others to stop by the exhibit by sharing our Facebook post.*
Go to: goo.gl/XVu4eJ goo.gl/XVu4eJ

Credit: Philadelphia International Airport and Jeff Long of PDE (bottom center only)



Pennsylvania Coast Day

September 9, from 11 a.m. to 4 p.m. | Philadelphia, PA

See the Benjamin Franklin Bridge from a yacht (supplies limited). Splash past a submarine in a kayak, swan boat, row boat or skiff. Then explore the shore, where two dozen marine-themed exhibitors will greet you — with giveaways. These and other attractions will make Pennsylvania's coast come alive outside the Independence Seaport Museum. For details call (800) 445-4935, extension 112.

LINK ▶ DelawareEstuary.org, keyword "Pennsylvania"



Credit: Shaun Bailey of PDE

Island Birding

September 23, from 7:45 a.m. to 11 a.m. | Petty's Island, NJ

Discover forbidden Petty's Island, where access is seldom granted. Those who register are likely to see a variety of birds, all while walking in the footsteps of Benjamin Franklin, Blackbeard the pirate and others, or so legend has it. This excursion is free, but birders must be 12 or older.

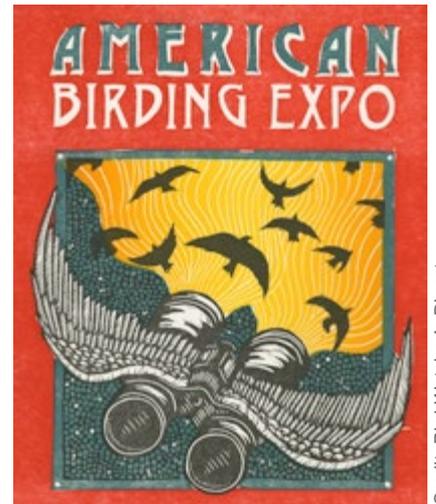
LINK ▶ PettyIsFallBirds.EventBrite.com, or call (908) 766-5787

American Birding Expo

September 29 to October 1 | Oaks, PA

Birders will flock to the Schuylkill Riverfront this fall. Together they will venture to Valley Forge National Historical Park for free daily bird walks. Then they will take refuge inside the Greater Philadelphia Expo Center. There exhibitors will greet them, as will noted presenters. Tickets are just \$10 per person, and those 16 and younger are free.

LINK ▶ AmericanBirdingExpo.com, or call (800) 879-2473



Credit: Bird Watcher's Digest



Credit: Gameface Media, courtesy of Delmo Sports

Escape to Lewes Open Water Classic

September 30, from 8 a.m. to 1:30 p.m. | Lewes, DE

Leap from a ferry boat into the beautiful Delaware Bay just a stone's throw from a lighthouse. It's all part of this endurance swim spanning either one mile or three; your choice. Those who compete will receive free finisher medals and event photos.

LINK ▶ DelmoSports.com/events/escape-lewes-open-water-swim-classic

Experience the Estuary Celebration

October 11, from 5:30 to 8:30 p.m. | Claymont, DE

Dine on fresh Delaware Bay oysters with fellow enthusiasts of the Delaware River and Bay. This fundraiser will take place at The Waterfall, conveniently located off I-95 and I-495. This water-themed venue will house a VIP reception, dinner, auctions, networking, and more. Go to: PDE2017.eventbrite.com

PLATINUM
DuPont: Clear Into the Future

GOLD
Exelon Generation PSEG

SILVER
Brown and Caldwell



Credit: Shaun Bailey of PDE



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The Partnership for the Delaware Estuary: *Connecting people, science, and nature for a healthy Delaware River and Bay*

The Partnership for the Delaware Estuary, Inc. (PDE), is a private, nonprofit organization established in 1996. The PDE, a National Estuary Program, leads science-based and collaborative efforts to improve the tidal Delaware River and Bay, which spans Delaware, New Jersey, and Pennsylvania. To find out how you can become one of our partners, call the PDE at (800) 445-4935 or visit our website at www.DelawareEstuary.org.

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Estuary News encourages reprinting of its articles in other publications. Estuary News is produced four times annually by the Partnership for the Delaware Estuary, Inc. (PDE), under an assistance agreement (CE-99398513-2) with the U.S. Environmental Protection Agency (EPA). The purpose of this newsletter is to provide an open, informative dialogue on issues related to the Partnership for the Delaware Estuary. The viewpoints expressed here do not necessarily represent the views of the PDE or EPA, nor does mention of names, commercial products or causes constitute endorsement or recommendation for use. For information about the PDE, call 1-800-445-4935.