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ESTUARY NEWS

NEWSLETTER OF THE PARTNERSHIP FOR THE DELAWARE ESTUARY: A NATIONAL ESTUARY PROGRAM

TOXICS: A Remnant of Our Industrial Legacy

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

The Delaware River's industrial legacy has its benefits and costs. The benefits include economic prosperity that has fueled art, architecture, world-renowned social and technical advances, and nationally-significant history. The physical remnants of this past have become part of our region's identity, from coal mines in Schuylkill County and shipyards in Philadelphia and Wilmington to historic downtowns and small towns throughout the region. Unfortunately, the costs include some toxic remnants of this legacy that are just as long lasting.

The tidal Christina River in downtown Wilmington, Delaware, was once home to numerous shipyards responsible for a legacy of PCBs and other toxic pollutants. Today the Christina Basin Clean Water Partnership and other groups are working to find solutions.

Toxic chemicals like polychlorinated biphenyls, or PCBs, and heavy metals like mercury pose threats to people as well as the environment, and these are among our top concerns for the health and future of the Delaware Estuary. Where do these contaminants come from, and how can we minimize their future impacts? That is the focus of this issue of *Estuary News*.

Some of the worst offenders, like PCBs, come from uses and even substances long abandoned, but will persist in our rivers for years to come. Today, scientists at The Academy of Natural Sciences in Philadelphia are learning about these contaminants in part by studying sediments from the Delaware River (see story on page 4).

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Others, like mercury, come mostly from coal-fired power plants far from the Delaware Estuary. Brought here by prevailing winds from western Pennsylvania and Ohio, these contaminants are largely beyond the control of local resource managers and policymakers. This is just one more reason to work on the national level to find cleaner ways to make energy.

The persistence of these substances and our limited control over their sources means that shedding our toxic legacy is taking longer than most of us would like. Fortunately, there is excellent work underway in the Estuary today to minimize the impacts of contaminants like these.

This year, the Delaware River Basin Commission is taking important steps toward reducing PCBs in the Delaware Estuary. In this issue of *Estuary News*, you can read more about these contaminants and the Commission's efforts to establish goals and a timetable for reducing them.

Also in this issue: important information about fish advisories, a critical tool for helping people reduce their exposure to contaminants like PCBs and mercury that can be found in fish. These advisories are released every year by each state in the Estuary to provide guidance on how to determine which fish can safely be eaten, and at what quantities.

In this issue we also have good news for fish in the Estuary (and those who appreciate them)! The Philadelphia Water Department has a new state-of-the-art fishway at the Fairmount Dam to help our finned friends make their way up the Schuylkill River. This new enhancement is one of many successful efforts to restore fish passage to the rivers and streams of the Delaware Estuary in recent years. Habitat improvements such as these provide an important boost to fish populations that are already impacted by contaminants.

The Delaware Estuary is not alone in dealing with the challenges of these contaminants. In August, the U.S. Environmental Protection Agency reported finding mercury in every one of hundreds of fish sampled from 291 freshwater streams across the country, with over a quarter exceeding the mercury level established by the agency for the protection of people who eat average amounts of fish. Earlier this year, the State of Washington's Puget Sound – a large area of which has been designated as a Superfund site because of PCB contamination – was featured in a PBS *Frontline* television program entitled "Our Poisoned Waters." Here on the East Coast, an unprecedented effort has just begun to clean up PCBs in the Hudson River in New York and New Jersey, another well-know PCB Superfund site.

Contaminants pose a daunting challenge, but one that we are better prepared to face thanks to the many organizations and agencies in the Delaware Estuary working hard to address them. We even have efforts underway to identify and reduce new emerging types of contaminants that can only be detected at minute levels, but which could be having significant effects on wildlife in the Delaware Estuary (see story on page 12).

We hope this issue of *Estuary News* will help you to put the challenge of contaminants in perspective, and inspire you to do your part to reduce contaminants in the Delaware Estuary. By minimizing the use of toxic materials in your home and properly disposing of pharmaceuticals and household hazardous waste, you can be part of the solution. For more information, please log on to www.DelawareEstuary.org and visit the "What You Can Do" Web page located beneath the "Lifestyle" tab, and read on! ■

MEETINGS CONTACT LIST

Meetings conducted by the PDE'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:

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Oyster Project Honored by Coastal America

The Delaware Bay Oyster Restoration Project, an ongoing effort to revitalize Eastern oysters in Delaware Bay, was honored with a 2008 Coastal America Partnership Award on October 4 during a bayside ceremony held at the University of Delaware's Coast Day festival in Lewes, Delaware.

Virginia Tippie, director of Coastal America, together with Deputy Assistant Secretary of the Army (Policy and Legislation), Terrence Salt, presented plaques and certificates to representatives from each of the Delaware Bay Oyster Restoration Task Force's 12 member-organizations. The Coastal America Partnership Award is the only environmental award of its kind given by the White House.

This award recognizes the collaborative, multi-agency effort that was needed to leverage and combine enough resources to successfully restore, preserve, and protect Delaware Bay's population of Eastern oysters. It furthermore recognizes the value of the task force's outreach efforts, an example of which could be seen at Coast Day in the form of an exhibition booth hosted by the Partnership for the Delaware Estuary, complete with freshly roasted Delaware Bay oysters available for free to thousands of festival goers.

Members of the Delaware Bay Oyster Restoration Task Force include the:

- U.S. Army Corps of Engineers, Philadelphia District
- New Jersey Department of Environmental Protection
- Delaware Department of Natural Resources and Environmental Control
- Rutgers University's Haskin Shellfish Research Laboratory
- Delaware River Basin Commission
- Partnership for the Delaware Estuary
- Delaware State University's College of Agriculture and Related Sciences
- Delaware River and Bay Authority
- Cumberland Empowerment Zone Corporation
- Delaware Bay Section of the Shell Fisheries Council
- Delaware Shellfish Advisory Council
- Commercial Township, New Jersey

This award adds to a growing list of accolades for the bi-state project; a list that also includes a gold medal from the Federal Executive Board this May and the 2008 Government Award from the Water Resources Association of the Delaware River Basin in April of last year.

Coastal America is a partnership of federal agencies, state and local governments, and private organizations whose mission it is to protect, preserve, and restore the nation's coasts. For more information please visit www.DelawareEstuary.org or www.CoastalAmerica.gov.

A tug boat and a lightering vessel assist the foundering *Athos 1*, a Greek oil tanker that struck a submerged anchor in the Delaware River off Paulsboro, New Jersey, on November 26, 2004.

PDE Scientist Joins Oil Spill Committee

The Partnership for the Delaware Estuary's Science Director, Dr. Danielle Kreeger, was recently appointed as a member of the Delaware River and Bay Oil Spill Advisory Committee, a group whose origin stems from the 2004 *Athos I* oil spill and the Delaware River Protection Act passed by Congress two years later. Kreeger holds one of two seats reserved for environmental scientists on this committee of 27, and she also sits on the group's Mitigation Subcommittee.

According to its charter, the purpose of the Delaware River and Bay Oil Spill Advisory Committee is to provide advice, recommendations, and prioritized steps for improving the prevention and response to future oil spills in the Delaware River and Delaware Bay. The group intends to release these recommendations in March of 2010.

Meetings of the Delaware River and Bay Oil Spill Advisory Committee take place at the U.S. Coast Guard Sector Delaware

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Back to the Future: Digging Deep into the Delaware's History

By David Velinsky, Ph.D., Environmental Biogeochemist, Patrick Center for Environmental Research, The Academy of Natural Sciences, and Roland Wall, M.S., Director, Center for Environmental Policy, The Academy of Natural Sciences

Like all natural systems, the Delaware River and Bay undergo continuous physical, biological and chemical changes. For at least two centuries, many of these changes have been the result of human actions, such as pollution and development. Because the Delaware River plays a critical role in the ecology and economy of the region, it is important to know how natural fluctuations in the environment, and human impacts, affect the aquatic resources within the watershed.

One key to understanding ecological change is found in the accumulated sediments that make up the Delaware's freshwater and estuarine tidal marshes. These sediments are carried as fine particles by tides and currents, trapping chemical and biological information, while being continuously deposited in wetlands fringing the estuary. For scientists, the information in deposited sediments provides a tape recorder of the estuary's condition at any given time.

Researchers from the Patrick Center for Environmental Research at The Academy of Natural Sciences and the College of Earth, Ocean, and Environment at the

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How a Core Sample is Taken

Step 1

A hollow tube known as a "corer" is positioned in the area where a core sample is needed. Drilling equipment may be necessary if attempting to penetrate dense earth or rock.

Step 2

The corer is pushed into the earth by hand and then carefully removed from the "core hole."

Step 3

The bottom of the corer is inspected to ensure the sample is intact. Losing even a quarter-inch of earth could mean the loss of a year's worth of data.

Step 4

The corer is carefully transported back to the laboratory where the core sample is removed and analyzed for PCBs, PBDEs, and many other chemical compounds.

Photos: Patrick Center for Environmental Research

Back to the Future continued from page 4

University of Delaware are using this unique window into the estuary's past environments to better understand and manage its future. In particular, they are asking three questions:

- Have past attempts to control and reduce human impacts to the Delaware been successful?
- How has the Delaware's ecosystem responded to past changes?
- How will the Delaware's wetlands respond to the sea level rise expected from climate change?

To answer these questions, scientists start with the gritty work of "examining the tape," or extracting three-to-five-foot, cylindrical samples of earth called "sediment cores," a task that involves using boats (and muddy boots) to bring heavy sampling equipment into marshes along the Delaware and its tributaries. Once there, the researchers take cores from PVC pipes driven vertically into the sediments that can be returned to the lab for analysis.

These sediment cores may contain up to 150 years or more of accumulated particles. The composition of the sediments at any spot on the core reflects the conditions at a specific point in time. Levels of nutrients and contaminants, and the community composition of microscopic algae (diatoms) found in the sediments, are excellent indicators of the environmental "health" of the estuary.

For a fun, and relatively clean classroom lesson on core sampling, do an internet search for "cupcake core sample."

Before the data can be analyzed, however, it is necessary to determine the rate at which the sediments have been accumulating, and from that, the approximate dates represented by each section of the core.

Fortunately, past human activities have provided precise reference points for determining the age of the sediments at any given point in the core. The testing of atomic weapons released cesium 137, a radioactive isotope, into the atmosphere that was transported around the globe. Since it is known precisely when these activities began, and when they ended, it is possible to date those sections of the core that contain cesium 137. Using this information, we can determine the average rate of sediment deposition and the approximate dates other cored sediments were deposited.

Although this research is still in progress, several important conclusions have already been reached.

It was learned that sediment in the Delaware accumulates at a steady rate of between 0.25 and 0.5 inches a year. With this standard, scientists can compare the same time periods from different locations in the Delaware, tracking sources and loadings of contaminants and estimating the relative environmental stresses across the entire study area.

Nitrogen and phosphorus concentrations were estimated during this time period, as well as concentrations of specific contaminants such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and polycyclic aromatic hydrocarbons (PAHs). For example, PCBs, a set of industrial contaminants common in the first half of the 20th Century, peaked in the 1970s and began to decrease following a national ban in 1976. The sediment cores reflect these changes over time, with peak PCB concentrations in many marshes found to have occurred in the mid to late 1970s. This demonstrates the national ban's effectiveness in protecting the environment; however, there are still site-specific sources polluting some marshes. Information from this study will be used to assist in setting standards for PCBs and in guiding the clean up and remediation of contaminated sites.

Other important ecosystem indicators taken from the cores, such as diatom assemblages, stable isotopes, and nutrient relationships are currently being analyzed to generate an assessment of the historic "environmental health" of the estuary and how it may change in years to come. The Delaware Estuary is one of the nation's great natural resources, and this study is an important step in learning how to conserve and enhance its many vital functions for future generations.

Funding for this research was provided by the Delaware River Basin Commission, Delaware Department of Natural Resources and Environmental Control, the Environmental Associates of The Academy of Natural Sciences, and the Patrick Center for Environmental Research Endowment Fund. ■

Credit: Pennsylvania Sea Grant

When it comes to eating local fish, it's possible to have too much of a good thing. Keep a copy of your state's fish consumption advisory inside your tackle box so you always know how many fish you can safely harvest.

FISH CONSUMPTION ADVICE... What Should a Person Believe?

By Ann Faulds, Associate Director, Pennsylvania Sea Grant, Delaware River Office

There are few people today who have not heard of omega-3 fatty acids and the benefits of eating fish. Recent research findings tout everything from lowering the risk of heart attack and promoting proper neural development during gestation and infancy to reducing rates of dementia and depression.

At the same time, all four states in the Delaware River Watershed issue fish consumption advisories. Throw in advice from non-profit and industry groups, the Food and Drug Administration (FDA), and the U.S. Environmental Protection Agency (EPA), and no wonder consumers and anglers can be perplexed. Some even cease eating seafood altogether, even as a growing body of research supports the benefits to health. It is especially confusing for pregnant and nursing mothers who are now encouraged to consume 12 ounces of fish each week. This advice seems to contradict recommendations to limit the consumption of high-mercury-content fish and sport-caught fish from contaminated areas.

What should you believe? Are Delaware Estuary fish safe to eat? The short answer to the question is...

...it depends. Many factors are involved in deciding on a healthful diet. What's good for one person might not be healthful for another, so the complex story about fish consumption advice can't be told in a short sound bite. To determine what is right for you and your family, let's look at one aspect at a time.

What is a fish consumption advisory?

Fish advisories inform the public that elevated concentrations of chemical contaminants have been found in sport-caught fish from specific waterbodies. They are

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You can reduce the PCB, dioxin, and chlordane contaminants your family eats if you...

- Fillet the fish and throw away the skin, head, guts, kidney, and liver.
- Trim the fillet to remove the fatty meat.
- Bake, broil, steam or grill fish and throw away cooking juices.
- Avoid frying, which seals in chemical pollutants contained in the fish's fat.
- Use only trimmed fillets when preparing soups, stews or chowder.

Additional ways to cut contaminants:

- Eat smaller fish as long as they are of legal length.
- Eat smaller portions and fewer meals of locally caught fish.
- Avoid eating fish eggs (roe).
- Do not eat the green mustard of crabs and lobsters.
- Consider all of the fish you eat when making meal decisions.

Note: Proper trimming and cooking reduces fat-soluble contaminants like PCBs, but does not reduce the level of mercury in fish.

Fish Consumption continued from page 6

designed to advise certain groups of people, such as children and women of childbearing age, about the maximum amounts of contaminated fish that they can safely eat. Often a team of agencies, like health, environmental protection, and fish and wildlife, are responsible for testing their state's fish and designing advisories based on their findings. The advisories can vary from state to state due to differences in analytical methods, risk-management approaches, or actual differences in contamination levels. Some are blanket advisories that apply to the entire state and some are site specific.

Fish advisories address the fact that all fish are not alike. The amount of contaminants you ingest from a meal of fish depends on the type of fish, where the fish comes from, how much and how often you eat fish, and how the fish is prepared. For example, a common carp might contain more contaminants than the same size channel catfish caught from the same location. Furthermore if you broiled and fried two fillets from the same fish, the broiled fillet would likely contain less fat-soluble PCBs than the fried fillet.

Fish advisories also address the fact that all people are not alike. Pregnant and nursing women, women who may become pregnant, and children under the age of five should be especially careful to limit their consumption of certain fish. People who eat fish frequently may also need to pay close attention to the kind of fish they eat.

Each of the four states in the Delaware Estuary has its own fish advisories, typically updated each year. Use the links at the end of this article to download the fish advisories for your state.

What are the fish contaminants in Delaware River Basin and where do they come from?

Like many urban watersheds, sediments in the Delaware Estuary contain a legacy of industrial contaminants. Fish and shellfish can take in these compounds from their habitats and the food they eat. Among the riskiest to health are some long-lived compounds that can accumulate in our bodies because we can't detoxify them very quickly.

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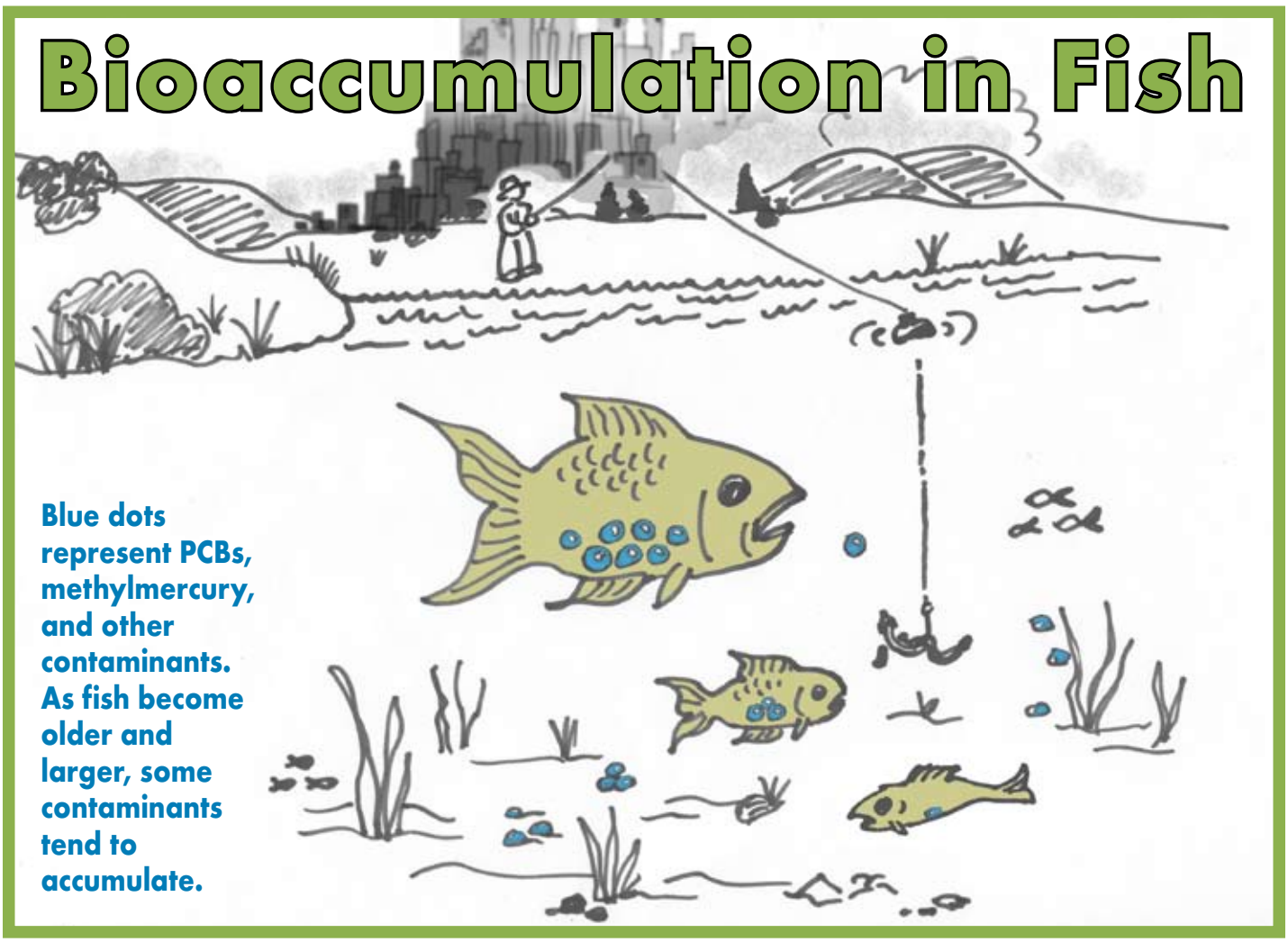

Fish Consumption continued from page 7

The main contaminants of health concern in the Delaware Watershed are organochlorine compounds and methylmercury, a compound of the heavy metal mercury. The main organochlorines of concern in Delaware Valley waterways include PCBs (polychlorinated biphenyls), dioxin, and chlordane. While the effects of organochlorines vary widely and are not well understood, the list of reported health impacts includes an elevated risk of nerve damage and neurodevelopment problems, cancer, liver damage, and thyroid problems.

The **PCB** group includes more than 200 compounds that were manufactured from 1929 until they were banned in the United States in 1979. Because they don't burn easily and are good insulators, PCBs were used as coolants and lubricants in transformers, capacitors, and other electrical equipment. They were also used as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other applications. PCB compounds vary in consistency from oily yellow liquids to waxy black solids with a range of toxicities.

Dioxins are byproducts of waste incineration, paper bleaching, pesticide production, and the production of PVC (polyvinyl chloride) plastics. **Chlordane** was a widely used insecticide until its use was banned in 1988. Even though organochlorine levels in the United States have declined since the 1980s, they persist in the environment for long periods and concentrate in many foods, including fish.

Mercury is a heavy metal released into the atmosphere from volcanic eruptions and human sources (coal-fired electric power plants, gold mining, institutional boilers, chlorine production, and waste incineration). While some amount of naturally occurring mercury is found in all seafood, the largest input of mercury to Delaware River aquatic systems is transported by prevailing winds from coal-fired power plants in western Pennsylvania and the Ohio River Valley. Once in the atmosphere, mercury cycles from rainwater into the watershed where it is converted by bacteria into a stronger neurotoxin called methylmercury. While oil-soluble organochlorines concentrate in body fat, mercury bonds to proteins throughout the body.

What are some of the risks and benefits of eating fish?

The benefits of eating fish are numerous. Fish are high in the omega-3 fatty acids that promote good cardiovascular health and reduce heart attacks. They are also a good source of protein, are low in saturated, or "bad" fat, and low in calories. Fish are good brain food, promoting proper brain function. Evidence suggests early exposure to omega-3 fatty acids enhances brain development.

Seafood rich in omega-3 fatty acids appears to be so nutritious that dieticians now recognize the **risk to health from not eating fish**. Leading fish consumption researchers now analyze the risks of consuming fish, along with the benefits, to gain a more balanced perspective on health effects. For example, in a 2005 risk-benefit study in *Environmental Health Perspectives*, the authors predicted that if a group of 100,000 people were to consume about six ounces of salmon per week over a 70-year lifetime, the group would have eight to 24 additional cancer deaths but ***7,125 fewer*** coronary heart disease deaths. In other words, the heart benefits of eating farm-raised and wild salmon far outweighed the estimated cancer risk by a factor of 300 to one. Fear of eating fish could result in thousands of excess coronary heart disease deaths annually and suboptimal neurodevelopment in children.

Ann Faulds of Pennsylvania Sea Grant's Delaware River Office demonstrates the best techniques to use while preparing grilled catfish during Pennsylvania Coast Day in 2006.

To include a healthy balance of fish in your diet, please follow the recommendations on page 9.

So what is my take on the issue? Everything in moderation. If you follow the local fish consumption advisories you should feel comfortable including select Delaware Estuary fish as part of your diet.

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Fish Consumption continued from 8

To include a healthy balance of fish in your life:

- Always follow local advisories for sport-caught fish.
- The FDA, EPA, American Heart Association, and other nutrition experts recommend eating at least two meals (12 ounces) of a variety of fishes (preferably fatty) per week.
- **Pregnant and nursing women** are encouraged to eat 12 ounces of low mercury fish a week. Popular low-mercury seafood available in the market includes ***salmon***, ***shrimp***, and ***farm-raised catfish*** and ***tilapia***. They should not eat shark, swordfish, king mackerel, or tilefish which contain high levels of mercury. Eat up to 12 ounces (two average meals) of light tuna per week. ***Albacore*** tuna, also called white tuna, has more mercury than light tuna. You may eat up to six ounces (one average meal) of albacore tuna per week. Follow these same recommendations when feeding fish and shellfish to children under five, but serve smaller portions.
- Frequent fish consumers should avoid fish high in mercury and contaminants.
- Patients who have coronary heart disease or need to lower their triglycerides may benefit from consulting their physicians about higher doses of omega-3 fatty acid in fish-oil capsules. (**Note**: patients taking more than three grams a day of omega-3 fatty acids from capsules should do so only under a physician's care. High intakes could cause excessive bleeding in some people.)

For more information about fish consumption, check out:

Delaware Department of Natural Resources and Environmental Control Fish Advisories:
www.FW.Delaware.gov/Fisheries/Pages/Advisories.aspx

FDA and EPA Joint Mercury Advisory:
www.epa.gov/fishadvisories/advice

New Jersey Department of Environmental Protection Fish Advisories:
www.state.nj.us/dep/dsr/fishadvisories/freshwater-advisories.htm

Pennsylvania Fish and Boat Commission Fish Advisories:
www.fish.state.pa.us/fishpub/Summary/SumConsumption.pdf

Pennsylvania Department of Environmental Protection Fish Advisories:
www.depweb.state.pa.us/watersupply/cwp/view.asp?a=1261&q=453946

Pennsylvania Sea Grant, "What Women Need to Know About Mercury in Fish and Shellfish"
http://seagrant.psu.edu/publications/consumption.htm ■

PDE Scientist continued from page 3

Bay office in downtown Philadelphia, and they are open to the public. The group is chaired by Captain Michael Linton, president of The Pilots' Association of the Bay and River Delaware.

Five years ago this November, the 750-foot Greek tanker *Athos I* struck an 18,000-pound submerged anchor in the Delaware River near Paulsboro, New Jersey, spilling nearly 265,000 gallons of crude oil. Over the following weeks and months, oil from the tanker's ruptured single hull flowed down the Delaware River and into tributaries, affecting over 280 miles of shoreline between the Tacony-Palmyra Bridge in Northeast Philadelphia and the Smyrna River in central Delaware.

Above water, the *Athos I* oil spill resulted in the deaths of nearly 12,000 birds. Below water it coated about 412 acres of river bottom with heavy crude oil. According to federal laws in 2004, the liability of Tsakos Group, owner of the *Athos I*, was limited to $45 million; a penalty which has since nearly tripled for single-hull tankers. Cleanup estimates, meanwhile, have run as high as $267 million. ■

Restoration of the Fairmount Fishway: A Key to Sustainable Fish Populations in the Delaware Estuary

By Lance H. Butler, Philadelphia Water Department, Office of Watersheds, and Joseph A. Perillo, Philadelphia Water Department, Bureau of Laboratory Services

Pennsylvania has a rich history of substantial spring runs of anadromous fishes, or fishes that migrate from salt water to spawn in fresh water. Nowhere is this more apparent than in the Philadelphia region, where centuries of annual American shad (*Alosa sapidissima*) migrations have helped to shape the natural, cultural, and economic heritage of the area.

The Schuylkill River, the largest tributary to the Delaware River, supported large numbers of American shad until the construction of dams in the early 1800s. Historical records indicate that American shad and river herring ascended the Schuylkill River as far upstream as Pottsville (100 miles), but have not done so since 1820, when Fairmount Dam was built. The dam served as a physical barrier to migratory fishes, completely blocking upstream movement and access to critical spawning grounds. In the years to follow, eight more dams were erected and unregulated industrial pollution resulted in the demise of anadromous fishes in the Schuylkill River.

Ask any inhabitant of Boathouse Row and they will tell you, the only way to paddle past Fairmount Dam is to portage around it. But what if you're a fish?

For more than 150 years, American shad appeared to have been extirpated from the Schuylkill River Watershed. However, in the 1970s, Pennsylvania Fish and Boat Commission (PFBC) biologists documented the presence of American shad in the tidal reach of the Schuylkill River below Fairmount Dam. Subsequent surveys by the PFBC revealed that river water quality and habitat in the Schuylkill River could again support a substantial population of American shad as well as other anadromous fishes, provided that fish passage was created at the Fairmount Dam.

In 1979, with funding from the City of Philadelphia, U.S. Fish and Wildlife Service (USFWS), and PFBC, a vertical-slot fish passage facility was constructed on the west side of Fairmount Dam. During the first few years of operation, Fairmount Dam Fishway was heavily used by resident fish populations; however, very few American shad or river herring were successfully ascending the fishway. Since none of the upstream dams were passable and few anadromous fishes were passing at Fairmount, the fishway was no longer actively maintained or monitored by 1984 and restoration efforts refocused on the Lehigh River. Between 1984 and 2001, the effects of time, natural forces, and a lack of regular maintenance severely limited the facility's ability to pass both resident and migratory species.

In 2001, the Philadelphia Water Department (PWD), in partnership with the U.S. Army Corp of Engineers (USACE), embarked on a cooperative program to restore and optimize the efficiency of Fairmount Dam Fishway. Major structural modifications, improved attraction flow through the fishway, and creation of a non-overflow section on the crest of the dam were only a few of the planned improvements to the fishway.

In addition to engineered improvements, PWD biologists developed a sophisticated digital video monitoring system to record fish passage for baseline conditions (i.e., before restoration) and post-construction conditions. The recorded video allows frame-by-frame analysis to identify and enumerate species ascending and descending the fishway. These quantitative data on diversity and abundance of fish are then compared to field-sampling data in

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Restoration continued from page 10

order to determine passage utilization.

Monitoring fish passage will allow the PWD's scientists to establish the size of the American shad run and compare those numbers to the upstream passage facilities and other fishways on the Delaware River. According to the USFWS, the Schuylkill River has adequate habitat to support 700,000 to 800,000 American shad, and 200,000 to 250,000 American shad per year may utilize Fairmount Fishway during upstream migration. The only way to verify utilization and efficiency is by video recording actual fish passage at the new viewing window.

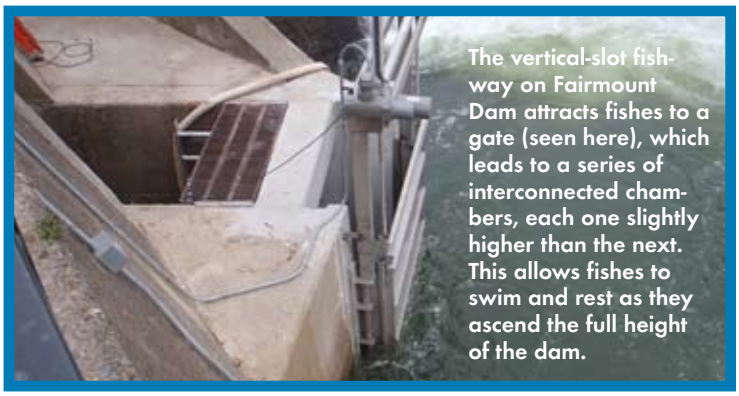
Prior to refurbishment of the fishway, PWD biologists saw a marked increase in the relative abundance of American shad, striped bass and other migratory species below Fairmount Dam. In total, 46 species of fishes have been identified in the tidal portion of the Schuylkill River, with 26 of these species utilizing the fishway in various densities. In 2007, scientists witnessed the highest volume of fish passage, with over 18,000 fish passing the viewing window between April 1 and July 1. While these numbers appear promising, it must be noted that the greatest number of American shad passing through the fishway in one year was 345, representing only 2% of the total number of fishes passed.

Today, the Fairmount Dam Fishway has been completely transformed. Although no quantitative data are readily available for distribution, preliminary information suggests that the new fishway is well on track to pass as many as 40,000 fish during the 2009 monitoring season. Moreover, scientists have already indicated that American shad passage through mid-May 2009 has surpassed pre-restoration numbers, and that final counts will be available in the winter of 2010.

As the farthest downstream passageway in the Schuylkill River Watershed, the Fairmount Dam Fishway is especially critical to the overall success of restoring migratory fish runs. Without access to critical spawning habitat above the dam, the long-term sustainability of anadromous fish populations, as well as the stability and persistence of resident species, is not feasible within the Schuylkill River. ■

Credit: Philadelphia Water Department

The newly renovated Fairmount Dam Fishway sits on the Schuylkill River, across from Boathouse Row in Philadelphia. It is now ready for any anadromous fish on their way from the Atlantic Ocean to the fresh-water spawning grounds located just upstream.



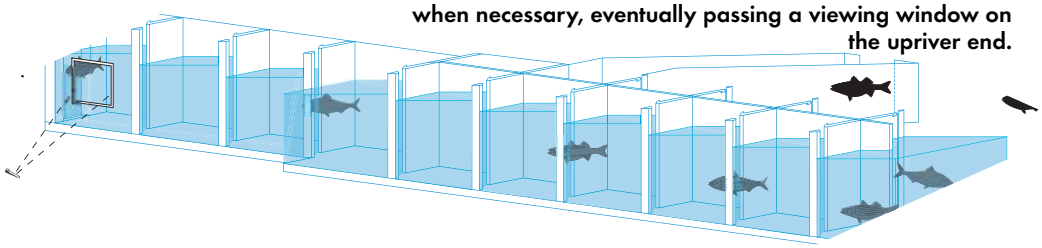
The vertical-slot fishway on Fairmount Dam attracts fishes to a gate (seen here), which leads to a series of interconnected chambers, each one slightly higher than the next. This allows fishes to swim and rest as they ascend the full height of the dam.

Credit: Philadelphia Water Department

This barrier located on top of Fairmount Dam is called a "non-overflow section." It provides fish with shelter from rushing water, so they can freely enter the fishway.

Credit: Philadelphia Water Department

Go to www.FairmountWaterWorks.org/Fishcam.php to see fish swimming through the Fairmount Dam Fishway live on the Web.



The Fairmount Dam Fishway allows fish to bypass Fairmount Dam by swimming between linked chambers built on an incline. This allows fish to rest in calm waters when necessary, eventually passing a viewing window on the upriver end.

Credit: Philadelphia Water Department

Dare to Keep Drugs Out of Your Drinking Water

By Shaun Bailey, Marketing and Communications Coordinator Partnership for the Delaware Estuary

Nearly every household has one or more medicine cabinets full of pharmaceuticals and personal care products. Experts warn that these should never be flushed down the drain. Instead, unused or expired products should be recycled or properly disposed of in the trash.

It's an otherwise slow shift at the hospital when, just after 2 p.m., patient John Doe is wheeled into the emergency department. After taking the man's vital signs, residents determine he has suffered a "myocardial infarction;" what doctors call a heart attack. With no time to spare they order intravenous nitroglycerine for improved blood pressure, norepinephrine for shock, and heavy, repeated doses of morphine for pain.

Across town at the wastewater treatment plant, sewage streams in from the hospital's 600 or so patients and staff. The typical treatment plant is well equipped to clean tens, if not hundreds of millions of gallons of wastewater per day, removing grease, grit, organic material, scum, solids, trash and, well, use your imagination. However, it isn't designed to remove pharmaceuticals like those given to John Doe.

To be fair, hospitals aren't entirely to blame. The truth is, anyone who takes prescription or over-the-counter medication sends trace amounts of these substances into their wastewater, which in our region, is returned to the Delaware River and Bay after a thorough cleaning by wastewater treatment plants. And it's not just sick people. Healthy people send pharmaceuticals into the water supply as well.

Only a small portion of medication is absorbed by the human body. The rest passes through, gets flushed, and is sent via sewers to treatment plants. And unused pharmaceuticals disposed of by flushing share the same fate.

At the Southeast Water Treatment Plant in Philadelphia, experts are using sophisticated methods to monitor levels of acetaminophen (Tylenol), nicotine, and other drugs people consume on a daily basis. Currently they are screening for 70 pharmaceuticals, and of these, 17 have been detected in minute amounts. Originally this number was reported as 56 having been detected, but this resulted from an unfortunate transcription error. It should be noted that Philadelphia is one of the few places in the country where officials are even looking for these compounds, which are only detectable due to relatively new technology.

"We tested for every compound for which a test was available. The amounts of chemicals that we found are extremely small," said Kelly Anderson, an environmental scientist at the Philadelphia Water Department. "Imagine drinking eight glasses of water a day for over 40,200 years. That's how much water you would have to drink to take in the amount of acetaminophen in a single dose."

The trouble is, overall prescription-drug use is increasing in the United States. According to the Kaiser Family Foundation, the number of prescriptions purchased in the United States increased from 2.2 billion to 3.8 billion between 1997 and 2007. That's an increase of 72% during a time span when the U.S. population only grew by 11%. It is unknown precisely how many of these medications go unused, but Earth 911 puts the number at somewhere between 20% and 60%.

People who save unused or expired medications run the risk of having them fall into the wrong hands. According to

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the U.S. Drug Enforcement Administration, nearly 7 million Americans are abusing prescription drugs. But humans are not the only ones who could be affected when medications make their way into waterways. Fish, frogs, and other aquatic species may be especially vulnerable due to their constant exposure to water. Patient John Doe would have to eat hundreds of thousands of fish dinners to get the same dose of medicine he received at the hospital, but researchers have found that even extremely diluted pharmaceuticals can harm wildlife throughout the food chain, right down to the smallest life forms.

"Our research in New York streams and rivers shows a strong relationship between high levels of caffeine, which is a proxy for other pharmaceuticals, and low abundance and diversity of the aquatic insect community," said Dr. Anthony Aufdenkampe, a scientist at the Stroud™ Water Research Center. "However," Aufdenkampe added, "the insect community might be responding to other co-related factors, such as contaminants associated with poor land use, sewage, etc. Research is currently lacking regarding the viability of aquatic species over multiple life cycles due to conditions which are now typical in our streams, where organisms are simultaneously exposed to dozens of pharmaceuticals and other compounds."

Fortunately, there is something citizens can do to prevent increasing levels of pharmaceuticals from entering their water supply. You may even practice such a routine right now when you dispose of household hazardous materials, such as used motor oil, gasoline, and paint thinner, just to name a few. Similar to these pollutants, pharmaceuticals should never be flushed down the drain. Instead you are advised to remove any labels to protect your privacy before returning them to your pharmacist, if permitted. It's also a good idea to request partial prescriptions in the first place. That way you are less likely to have leftover doses.

> New Jersey will become the first state in the country to host a coordinated, statewide take-back program on November 14, when the New Jersey Division of the federal Drug Enforcement Agency carries out Operation Medicine Cabinet. Visit www.OperationMedicineCabinetNJ.com to find one of more than 250 collection points near you.

If your pharmacy does not accept unused pharmaceuticals, the best solution is to store them in a cool, dry, and secure place far from the reach of children until you can drop them off at a neighborhood collection event. However, not all hazardous waste programs accept prescription medications. If yours does not, experts suggest that you:

- crush pills and add water
- put flour in liquids
- combine medication with an undesirable substance, such as coffee grounds, kitty litter, or sawdust
- seal in a nontransparent container and put in the garbage

Pharmaceutical collection events are few and far between, but awareness has spurred the creation of scattered pilot programs. One successful model is Medicine Cabinet Clean-out Day, which is organized by Nurses Healing Our Planet, an ad-hoc committee formed by the Delaware Nurses Association. This group has held a total of five collection events since 2008, and it now plans to host future events twice per year in partnership with local law enforcement and Christiana Care Health System of Newark, Delaware. At these collection events, "controlled" or addictive substances collected by volunteers must be immediately turned over to police officers. Each event has yielded gallons of these drugs, with a street value well over $1 million.

The Philadelphia Water Department recently wrapped up a pilot take-back program involving two long-term care facilities and one senior center. In the future its staff hopes to expand upon this research.

The concept of recycling medication is still in its infancy, but there are a few places that periodically accept expired and unused pharmaceuticals and personal care products (restrictions apply). These trailblazers include:

Delaware
Delaware Nurses Association

Southeastern Pennsylvania
Berks County Solid Waste Authority

Southern New Jersey
Burlington County Hazardous Waste Facility

Beyond
Earth911.com

"Clearly the issue of pharmaceuticals in our waterways is not something we are going to solve overnight," said Jennifer Adkins, executive director of the Partnership for the Delaware Estuary, a nonprofit seeking to bring people together to solve water quality issues in the Delaware River and Bay. "The first step to addressing this problem is to simply limit the waste in our own medicine cabinets." ■

This article was first published in the October issue of Grid Philly magazine and is reprinted here with permission.

Study Revealing Contaminants Caught in 'Webb' of Salt Marsh

By Rebecca L. Hays, Doctoral Candidate
University of Delaware

Salt marshes are found at the boundaries between uplands and estuaries, a zone of steep and fluctuating environmental gradients that influence the types and abundance of plants and animals that can thrive in the marsh. The uplands provide the marshes with freshwater and sediment, complete with nutrients and other contaminants from agricultural, municipal, domestic, and sometimes industrial sources. The estuary delivers salt water that floods and drains the marsh on a twice-daily cycle and may provide an additional nutrient source. Salt marshes are therefore dominated by salt- and flood-tolerant plants. The physical processes in salt marshes keep the plant biodiversity relatively low and grouped within certain areas called zones or "zonation" patterns. Meanwhile, the influx of freshwater, potential estuarine nutrients, and high rates of internal nutrient recycling maintain high levels of biological productivity.

From a distance, it might appear that salt marshes are just clumps of plants living on mud. However, a closer look would show that salt marshes support a thriving and important ecosystem. Salt marshes provide

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Credit: University of Delaware College Sea Grant Program

Dr. Anthony Aufdenkampe of the Stroud Water Research Center reels in a water sample from a bridge spanning the Murderkill River near South Bowers, Delaware, in April of 2008.

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essential habitat for juveniles and/or adults of countless species of invertebrates, fishes, birds, and game, some of which (blue crabs, weakfish, geese, and deer) are local delicacies. Other ecosystem services are less obvious; salt marshes trap sediments and dissolved contaminants, which can negatively impact the adjacent estuaries. In the absence of salt marshes, upland suspended sediments would go straight into the estuaries, which could decrease water clarity and reduce the abundance of floating and bottom-dwelling plants that support local fisheries. In the absence of this marsh filter, nutrient contaminants from upland waters can lead to eutrophication, or the growth of algae that depletes shallow waters of oxygen when it decays during summer.

As part of my research, I have helped to develop methods for assessing dissolved nutrient exchanges between Webb's Marsh near South Bowers, Delaware, and the adjacent Murderkill Estuary, along with a team of scientists, technicians, and students from the University of Delaware, the Stroud Water Research Center, and the U.S. Geological Survey. These methods used dissolved nutrient data (nitrate, phosphate, ammonium, silicate, and total dissolved nitrogen [TDN] and phosphorus [TDP]) collected hourly from the channel through which the marsh floods and drains for three tidal cycles (~38 hours), along with discharge measurements made 10 times per hour to calculate nutrient loads. My research involved the development of new methods for calculating nutrient loads under various marsh flooding scenarios that were observed during five different sampling periods over 11 months in 2007 and 2008.

The estimated nutrient loads for July and October 2007 indicate that Webb's Marsh is a source of all of the dissolved nutrients examined, but that the nitrate load is relatively small. The April 2008 data, which was sampled following a blowout tide, indicates that Webb's Marsh was a large source of nitrate, a small source of ammonium and TDN, and a nutrient sink, or collection point for phosphate, TDP, and silica. This source/sink change indicates that the seasonality of plant growth and bacterial activity regulate nutrient incorporation, storage, and remobilization.

The next step in this research is to examine data from the summer of 2008, including a period immediately following a severe storm, to determine the nutrient source/sink nature of the marsh during the summer. Ultimately, I hope to determine the magnitude of dissolved nutrient exchange between the marsh and estuary and identify the environmental processes contributing to seasonal exchange rates. This research will allow coastal managers to develop better nutrient budgets for estuarine systems dominated by salt marshes. The methods developed for Webb's Marsh may also be useful for estimating nutrient loads in similar ecosystems.

The next time you pass by a salt marsh, remember that you are not just looking at clumps of grass growing on mud. Salt marshes are biologically productive ecosystems that provide habitat for many commercially important species while acting as natural sediment and contaminant filters that keep the estuary healthy.

Credit: University of Delaware College Sea Grant Program

Geochemist, Stephanie Dix of the Stroud Water Research Center pours water from Delaware's Murderkill River through a sieve so it can be tested as part of her salt-marsh research in April of 2008. Looking on is Dr. William Ullman of the University of Delaware.

Funding for this research was provided by the Kent County Levy Court, Delaware Department of Natural Resources and Environmental Control, University of Delaware, and the National Aeronautics and Space Administration. ■

Editor's Note: *Rebecca L. Hays won the Best Poster 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.

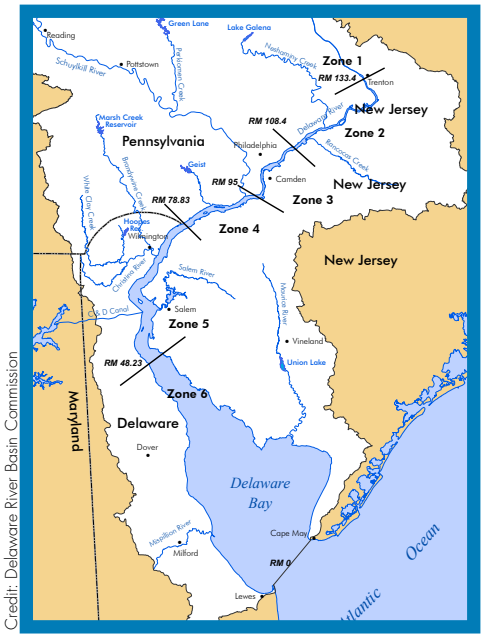
Interstate Plan on Harmful Pollutant Nears Completion

By Clarke Rupert, Communications Manager, Delaware River Basin Commission

The Delaware Estuary was an open sewer at the height of World War II. Along some reaches the fouled water was devoid of the oxygen needed to support fish and other aquatic life. Created in 1961, a major goal of the Delaware River Basin Commission (DRBC) in its early days was to bring the river back to life.

Blazing a new trail in water-pollution reduction, the DRBC in 1967 adopted the most comprehensive water quality standards of any interstate river basin in the nation. A year later, the DRBC adopted regulations for implementing and enforcing the standards.

Today, the Delaware's cleanup is hailed as a water quality success story and the river now supports year-round fish populations. However, when fish returned to the once-heavily polluted Delaware, tissue samples revealed another water quality challenge facing the river.



Above is a map of the DRBC's Water Quality Management Zones. The tidal portion of the Delaware River includes Zones 2-5, and the Delaware Bay is Zone 6. Zones 2-6 encompass the Delaware Estuary. (RM = river mile)

Polychlorinated biphenyls (PCBs) are a class of chemicals present in the waters of the Delaware Estuary at concentrations up to 1,000 times higher than water quality criteria allow and have been classified by the U.S. Environmental Protection Agency (EPA) as a probable human carcinogen. The United States banned the manufacture and general use of PCBs in the late 1970s, but the chemical stability of these compounds also allows them to persist in the environment. PCBs enter fish through absorption or by ingestion of prey and accumulate in their tissues at levels many times higher than in the surrounding water, prompting fish consumption advisories to be issued by the states of Delaware, New Jersey, and Pennsylvania for the Delaware Estuary.

The current DRBC water quality criteria for the protection of human health from PCBs in the tidal Delaware were established in 1996, before the EPA developed new methods to incorporate bioaccumulation information, and before site-specific, fish-consumption data were available for the river between Trenton and the Pennsylvania-Delaware state line. These criteria also vary by water quality zone, but do not include criteria for the Delaware Bay, for which the States of New Jersey and Delaware have established a criterion of 64 picograms per liter.

Rigorously applying the most current available data and methodology, including site-specific data on fish consumption, site-specific bioaccumulation factors, and the current EPA methodology for the development of human health criteria for toxic pollutants, the DRBC's Toxics Advisory Committee in July 2005 completed development of a new human health water quality criterion for PCBs for the entire Estuary of 16 picograms per liter.

Since then, the agency has worked diligently to develop a strategy for implementing the new PCB criteria in a way that is consistent with the National Pollution Discharge Elimination System (NPDES). This was a challenge because PCBs can persist in sediments for so long, making it extremely difficult to show significant improvements within the typical five-year NPDES permit cycle.

A small workgroup of DRBC and EPA staff began work on the details of such a plan in 2006, culminating in the "TMDL Implementation Plan for PCBs" in 2008. Under this plan, the DRBC and EPA will use the new PCB human health water quality criterion to develop Stage 2 Total Maximum Daily Loads (TMDLs) in December 2009. A TMDL sets the maximum amount of a pollutant that a water body can receive without violating applicable water quality standards and allocates that amount among sources in the watershed – both point (end-of-pipe) and non-point (runoff). Dischargers must then reduce loads to the allocated levels in order to achieve and maintain the standards.

Establishing new TMDLs for PCBs are an important step in a long-term plan to address one of the Delaware Estuary's biggest water quality challenges. Earlier this month, the DRBC hosted informational meetings on the revised human health water quality criterion for PCBs and its accompanying implementation plan. Earlier this month, the DRBC hosted informational meetings and accepted written comments on the revised human health water quality criterion for PCBs and its accompanying implementation plan. ■

ESTUARY EVENTS

Featured on ecoDelaware.com

Water Quest Scavenger Hunt

October 1 to November 13

Throughout Delaware

Spend some quality time exploring the First State's waterways this autumn as you and your teammates participate in the Water Quest Scavenger Hunt; top prize: $350. Groups of two to four people aged 18 years or older are invited to search the State of Delaware for a total of 20 answers to water-related clues. To learn more about this free contest organized by the Delaware Section of the American Water Resources Association, please visit www.deawra.org.

Featured on ecoDelaware.com

Nature Photo Scavenger Hunt

October 15 to November 12

Smyrna, DE

Bombay Hook National Wildlife Refuge invites you and your family to participate in a nature photo scavenger hunt. Those who succeed will receive a one-year pass to what the Delaware Birding Trail guide describes as "Unquestionably Delaware's single best-known birding site" (limited to the first 50 families). So what are you waiting for? Pick up your clues at the refuge's Visitor Center, or online at www.fws.gov/Northeast/BombayHook. Is your family up to the challenge?

Bird Walk

October 29, from 8:30 to 10:30 a.m.

Cape May, NJ

Visit the Nature Center of Cape May for its final bird walk of the season. No registration is required for this $10-per-person program. Just show up at the wildlife viewing platform inside Cape May Point State Park, borrow a set of binoculars, and set out with a naturalist as your guide. Participants are guaranteed to see at least 20 species or the walk is free. Please call (609) 884-2736 for more details.

Pennsylvania Hunt Cup

November 1

Unionville, PA

The tidal Delaware River Watershed lost 11 acres of forest per day between 1996 and 2001. You can help preserve some of this land as you simultaneous enjoy it during the 2009 Pennsylvania Hunt Cup. Since 1964, over half a million dollars has been raised for charity, including land preservation, as a result of this four-mile steeplechase race on horseback. Log on to PAHuntCup.org for more details.

Public Forum

November 4, from 7 to 9 p.m.

Milford, DE

Residents of greater Milford, Huston, and Slaughter Beach, Delaware, let your voices be heard. The Mispillion River Tributary Action Team is hosting a public forum at the Carlisle Fire Hall. The goal is to gather your input on how to best improve water quality in the two watersheds that drain to the Mispillion River and Cedar Creek. Don't let someone else decide for you. Tell this group of concerned citizens what changes you would like to see take place. For further details, please call Andrea Kreiner at (302) 423-2766.

OysterFest

November 6

Pittsgrove, NJ

Help to restore Delaware Bay's native population of Eastern oysters by slurping down this signature species at OysterFest, a fundraiser hosted by the Bayshore Discovery Project of Bivalve, – yes, *Bivalve* – New Jersey. This dinner and auction will take place at the Centerton Country Club, located just outside the centrally located City of Vineland. Please call (856) 785-2060 to get your tickets today.

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Featured on ecoDelaware.com

Marsh Maneuvers

November 7, from 1 to 3 p.m.

Wilmington, DE

Become a scientist for the afternoon by visiting the brand-new DuPont Environmental Education Center, where visitors can test the quality of Wilmington's water using nets, water-testing kits, and microscopes. The cost for this program is $15 per adult and $7 per child six years of age or older (member discount available). For further details please call (302) 656-1490.

Marsh Erosion Lecture

November 11

Millville, NJ

After you have celebrated Veterans Day, come to the Millville Public Library at 6:30 p.m. to learn about another protector of our shorelines, ribbed mussels. Dr. Danielle Kreeger of the Partnership for the Delaware Estuary will explain how native mussels are being drafted into the war against marsh erosion during this annual meeting of the Citizens United to Protect the Maurice River and its Tributaries. For more insight, please e-mail forrivers@aol.com. ■

Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE 19801

Partnership for the Delaware Estuary: a National Estuary Program

The Partnership for the Delaware Estuary, Inc., is a private, non-profit organization established in 1996. The Partnership leads collaborative and creative efforts to protect and enhance the Delaware Estuary and its tributaries for current and future generations. The Partnership is one of 28 National Estuary Programs. To find out how you can become one of our partners, call the Partnership at 1-800-445-4935 or visit our website at www.DelawareEstuary.org.

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